Australian Cotton Cooperative Research Centre

Annual Report 2003/2004

Established and supported under the Australian Government Cooperative Research Centres Program

Contents

Mission Statement

Mission

To enhance the development and growth of the Australian cotton industry through the application of collaborative research, education and the adoption of sustainable farming systems.

Objectives

To enhance the prospects for expanding cotton production by researching viable and environmentally responsible cotton production systems for new regions in Western Australia, the Northern Territory and north Queensland. To develop solutions to specific regional environmental problems prior to promoting commercial activity.

To research and develop innovative technologies which provide an improved range of options for environmentally acceptable crop management and bioremediation.

To develop strategies for cotton production that encourages efficient use of resources while minimising inputs and the impact on the environment.

To have a coordinated national network of extension, support and education services which utilises modern techniques and delivery systems for the transfer and adoption of new technology by the cotton industry and to advance the knowledge and skills of those supporting the industry.

To develop innovative technologies for bleaching of pure cotton and cotton blends, continuous and semi-continuous procedures for the dyeing of cotton/wool fabric and a fibre modification technique for handling cotton sliver that incorporates a mercerisation process, that are environmentally and economically favourable.

From the Chairman & Chief Executive

The Year in Context
The cotton industry has endured a difficult year, with drought crippling production in some areas, curtailing it in others and creating general uncertainty overall. Gross cotton production fell from the normal 3 million bales to 1.5 million bales. Funds for cotton research have consequently been reduced and most projects have suffered funding cuts and unfortunately, in some cases, termination.

A Cotton CRC study focusing on the impact of the drought on Wee Waa, the traditional hub of cotton production in NSW, found that business gross turnover fell by 47 per cent to $110 million from 2001 levels of $207m.

Understandably, employment in Wee Waa was significantly impacted with permanent staff numbers falling to 69 per cent and casual employees to 52% of those in 2001. Similar trends would be evident in other major cotton growing regions where water availability was a limiting factor.

Under these circumstances, it is appropriate to review lessons from history, and to look forward to where the industry, and research in particular, should be heading in the future.

Economic Outcomes of Cotton CRC.
In this case, looking back tells us how far we have come, and in the Five-Year life of this CRC, independent empirical evidence suggests we certainly have come a long way.

The BDA Group analysis showed that the CRC has invested a total of $72m, in present value terms, on cotton research, development, extension and education over the past five years. This investment delivered an estimated $510m in benefits, in present value terms, to the Australian cotton industry, a return of $7.08 for each dollar invested. Thus, the CRC had delivered a solid economic return to the Australian cotton industry with considerable flow-on impacts throughout the economy.

Milestones
Four important milestones were reached this year: completion of Year Five of the CRC, culminating in a special Five-Year Review by an independent Review Panel (see separate summary), submission of a new Bid for a Cotton Catchment Communities CRC in July 2004, to take over the role of the CRC when the current term expires in June 2006, Hugh Barrett was nominated by ACGRA as the new chairman (effective 1st May) following Evan Cleland's retirement, Guy Roth was appointed CEO of the CRC (effective mid-September 2003) following the former CEO Dr Gary Fitt's appointment as strategy director with CSIRO Entomology in Brisbane.

Programs
Via Program One, the CRC has demonstrated the potential for cotton in Northern Australia by developing and successfully testing agronomic systems that minimize climatic and biotic constraints to both growing and harvesting cotton in several production areas in the North.

Utilising transgenic cotton, the program has successfully demonstrated the economic viability of cotton production with minimal use of chemical control measures. They have incorporated existing best management practices and modified them to fit the "Dry Season" approach to cotton production. At this stage, however, the Northern Territory government is opposed to cotton production in the Territory.

Within the Innovative Technologies portfolio comprising Program Two, the CRC team has clearly demonstrated the efficacy of Bt technology to control the major Helicoverpa pests with minimal use of chemicals. The result has been increased cotton yields, with less chemical usage and cost, and a significant reduction in endosulfan contamination of the environment. Management strategies were also developed and evaluated to minimize insect resistance to maintain the success of this technology.

Another promising research area within this program is the development of semiochemicals to attract (e.g MAGNET) or repel insects. The chemical "baits" can be loaded with specific toxins to kill damaging insects without disrupting beneficial insects.

Dr Hugh Barrett (new Board Chairman) and Mr Evan Cleland (retiring Board Chairman).

Program Three is oriented towards developing superior and more sustainable farming systems, particularly in relation to proper water management and maximizing irrigation water use efficiency. Major accomplishments have been the development and release of HydroLOGIC and WATERPak, two excellent water management guides. A soil properties database has also been released for several major cotton producing regions.

Education and Technology Transfer, the core of Program Four, has created a unique single "gateway" for knowledge exchange with in the cotton industry, delivering high quality information to the public through one gateway using a multi-media approach, fostered and faciliated by a skilled team of national extension officers. The CRC's Cotton Production Course, run by The University of New England, remains a trend-setter for other rural industries.

Fibres and Textiles, the major component of Program Five, has focussed on end users of the product. A detailed survey of major mills using Australian cotton revealed their likes and dislikes in relation to fibre quality traits, which have been passed on to Australian ginners, growers, consultants, breeders, researchers and seed companies.

Finally, Program Six has concentrated on environmental enhancement, emphasising water quality, native vegetation, beneficial insect dynamics, and biodiversity. There are many exciting PhD projects nearing completion in this program.

The Future

Despite past adoption of new technologies and strategies developed by the current Australian Cotton CRC, the industry still faces significant challenges to its economic viability.

This industry is confronted with increased global competition, high input costs, and calls for greater environmental and water efficiency focus, with prices (in relative terms) declining. To secure a long-term future for the industry it needs to be supported by a strong, co-ordinated public and private commercial research effort.

Past research programs have developed technologies and practices contributing to significant reductions in pesticide use and considerably improved water use efficiency, yet community and government concerns remains.

In regard to biodiversity and native vegetation management, while the area of cotton production is small, cotton farms occupy some of the most critical riparian and floodplain areas of the catchments in which it is grown. Cotton growers are therefore in a unique position to influence the conservation of some of Australia's most endangered ecosystems and species, as well as the quality of downstream waterways.

There is an opportunity for cotton research to partnership with Catchment Management Authorities, to lead research and develop educational programs that clearly establish and demonstrate the link between on-farm natural resource management and conservation, grower profits and catchment health.

On-farm research should continue particularly in areas such as nutrients, soil health, pests, disease, weeds, water use efficiency and transgenic crop management systems. These programs need to be complemented by embracing precision agriculture and decision support tools.

On-farm, catchment and regional issues research are irrelevant unless the cotton fibre produced is internationally competitive and profitable to all participants along the textile pipeline. Increased emphasis on objective measurement

John Harvey, PhD Student UQ, Guy Roth, Chief Executive Officer, Australian Cotton CRC, Sam Powell, PhD Student, USYD and Chris Vangas, PhD Student, USYD, during the 'Call on Cotton' tour for the Centre's PhD Students.

of fibre characteristics is needed together with a better understanding of agronomic, harvesting and ginning systems that minimise fibre damage and contamination and delivering higher returns to industry participants. Eco-labelling of Australian cotton through the Industry's Best Management Practice (BMP) initiative that secures access of Australian cotton to future markets, especially in Europe, remains an imperative to be explored.

Research is also irrelevant unless results are communicated quickly and efficiently.

Transforming technologies and other influences such as water reforms can rapidly alter the relationships between an industry and its communities. There is some evidence of this as, for example, herbicide tolerant cotton crops reduce demand for manual weed control, which in turn has reduced employment of casual workers. The social role of transforming technologies needs to be considered to allow for changes in the industry due to seasonal, global, structural and technological influences, to ensure the continuity of the skills base and services essential for cotton production.

The Cooperative Research Centre model of the Federal Government, which encourages joint ventures between research providers, universities, industry and private sector is the way the Australian cotton industry wishes to seize its future research opportunities. Hence, a new Cotton Catchment Communities CRC has been proposed.

There are exciting and challenging times ahead.

Finally, we would like to thank the Board, the Management Committee, Advisory Committee, Centre Visitor Prof Henry Nix and the administration team of Kym Orman, Lynda George and Nicky Schick for all their efforts during 2003/04. The Cotton CRC has had another great year thanks to the collaborative culture, knowledge and passion of everyone involved and our close links to industry.

Dr Hugh Barrett
Chairman

Guy Roth
Chief Executive Officer

Highlights

ECONOMIC RESEARCH OUTCOMES OF CRC

What we did

The BDA Group was commissioned by the Australian Cotton Cooperative Research Centre to undertake an independent economic evaluation of the Centre's outcomes over the first five years of operation.

How we did it

In consultation with CRC staff, BDA Group identified ten outcomes that were deemed to have had the greatest economic or environmental impact on the Australian cotton industry between 1999/00 and 2003/04.

The economic benefits to the Australian cotton industry were estimated for each outcome. Total benefits were compared against total CRC costs over the same period and measures of economic pay off derived.

Economic Payoff

Since its establishment the CRC invested a total of $72m, in present value terms, on cotton research, development, extension and education.

The investment made by the CRC delivered an estimated $510m in benefits, in present value terms, to the Australian cotton industry, a return of $7.08 for each dollar invested.

It was concluded that the CRC had delivered a solid economic return to the Australian cotton industry with considerable flow-on impacts throughout the economy.

5th YEAR RESEARCH REVIEW

More than 120 research scientists, support staff, graduates and PhD students gathered at Narrabri for the Annual Review of Cotton CRC research projects.

The two-day Review was also attended by members of its advisory committee, which provides industry feedback, assesses progress against objectives, and helps target future research directions.

The objective of the Annual Research Review is to subject the track record and achievements of the CRC's research programs and projects to a comprehensive and rigorous review by an independent panel of experts.

The 5th Year External Review Panel comprised:

- Dr. Daniel Krieg, (Chair and review team leader) Texas Tech University, Lubbock, Texas USA
- Prof Henry Nix, Visitor to Australian Cotton CRC Australian National University Canberra Australia
- Dr. John Williams, retired Chief, CSIRO Land and Water Canberra Australia
- Mr. Hamish Millar, Deputy Chair, Australian Cotton Growers Research Association and Cotton Grower Emerald Australia
- Dr. Michael Keller, Deputy Head, School of Agriculture and Wine, University of Adelaide Adelaide Australia

Six research programs and around 40 research projects in four States were analysed, over two days,

Output Area	Industry Outcome	Benefits
IPM	1. Reduced pesticide use	$250m
	2. Control of Whitefly	$10m
	3. Delayed Resistance	$53m
	4. Pesticides in water ways	$2m
	5. Pesticide spray drift	-
Weeds	6. Adoption of Round up Ready® cotton	$18m
Diseases	7. Fusarium Wilt	$184m
	8. Export cotton seed market	$4m
Water	9. Water use efficiency	$64m
	10. Deep drainage	$1m
	TOTAL [a]	**$586m**

via 40 individual presentations. The review team were also given extensive documentation and made a tour of ACRI. The executive Summary of their review is reprinted below.

EXECUTIVE SUMMARY:

This CRC has been extremely successful over the past five years as measured by a number of criteria. The reasons for the success include:

A. *Intelligent, dedicated Research Scientists addressing real-world problems in a scientific manner.*
B. *A Technology Transfer Team that truly interacts with the Research Scientists to develop state-of-science programs for the Cotton Industry using a variety of delivery mechanisms.*
C. *The CRC has been effectively and efficiently managed using a relatively small administrative structure and a management committee that truly fosters collaborative research and extension efforts for the good of the Cotton Industry and the community at-large. It has truly developed a spirit of cooperation and collaboration among Industry, Government and University personnel that has no equal in the scientific world. No single agency could ever achieve the degree of success enjoyed by the CRC.*
D. *Very importantly, the CRC benefits from serving an Industry that is well educated and eagerly seeking immediate, feasible solutions to their on-farm production problems as well as long-term solutions addressing sustainability of their environment for future generations. The industry demonstrated to us that they are not only totally supportive, but provide leadership and interact strongly with the research activities and the technology transfer approaches used to deliver solutions to the major problems associated with cotton production in Australia. Therefore the CRC benefits from Industry through financial, political, and emotional support*

This CRC has been extremely successful in solving some of the most-pressing problems of the cotton industry and demonstrating both economic and environmental benefits to the producers they serve and to the community at-large. The success of the CRC is reflected in the exceptionally high levels of adoption of its innovative research developments and in the 7:1 financial returns on investment from its outputs. These accomplishments are truly "Crown Jewels" of which all in this CRC can be very proud.

Dr Nilantha Hulugalle with Professor Daniel Kreig, Chair of the Review Committee (Texas Tech University, Luddock USA), and Tim Weaver, PhD Student, at the review dinner.

ANNUAL COTTON CRC AWARDS PRESENTED

Scientists, technologists and support staff from several States involved in a diverse range of research programs have shared in the annual Cotton CRC Research Review Awards.

The Communication Award was presented to Dr Stuart Gordon and Rene van der Sluijs, CSIRO Textile and Fibre Technology, Geelong.

The team's project involved a major survey of 31 international cotton spinners from 5 countries to provide a benchmark of Australian cotton fibre quality, to identify areas for improvement in breeding, production, harvesting, ginning and spinning that will add value to the Australian cotton industry. The award rewards the effort to achieve communication with those involved in the market end of the value chain.

Communication Award recipients Dr Stuart Gordon, Rene van der Sluijs and Award presenter Bridget Jackson (Chair CRDC).

The Innovation Award was presented to developers of the Palm Pilot OS® operating system in the field for electronic data collection and decision making using special crop management software.

The recipients included Dr Mike Bange, Darren Linsley Stuart Whiteside and Sandra Deutscher from CSIRO Plant Industry, and Dave Larsen, NSW Agriculture.

David Larsen and Sandra Deutscher receiving the award from Ralph Schulze, Executive Director CRDC (centre).

The Collaboration Award was presented to the developers of WATERpak, a comprehensive guide on water management of cotton, to be launched officially by Deputy Prime Minister John Anderson.

WATERpak has been a collaborative effort over almost 18 months involving the Award recipients Graham Harris (QDPI&F), David Williams (NSW Agriculture), Dirk Richards, Dr Steve Milroy and James Neilsen (CSIRO Plant Industry) and Helen Dugdale (CRDC).

Graham Harris, Helen Dugdale, award presenter Cotton CRC Chairman Dr Hugh Barrett, Dirk Richards and James Neilsen receiving the Collaboration Award.

Above are the recipients of the Corporate Citizen's Award Dr Lewis Wilson (CSIRO Plant Industry), Associate Professors Peter Gregg and Nick Reid (UNE), Dr Inakwu Odeh (USYD), Geoff McIntyre (QDPI&F), Dallas Gibb (NSW Agriculture), Bruce Pyke and Greg Kauter (CRDC), Dr Peter Carberry (CSIRO Sustainable Ecosystems), Brendan Doyle (UNE), Geoff Naylor (CSIRO Textile & Fibre Technology), and CRC support staff including Kym Orman, Lynda George, Nicky Schick and Tim Drew.

The Corporate Citizen's Award was shared by the industry-wide group responsible for preparing the bid for a new Cotton Catchment Communities CRC, which is currently under consideration by the Federal Government.

NEW CHAIRMAN APPOINTED TO COTTON CRC GOVERNING BOARD.

The chairman of the Australian Cotton Growers' Research Association, Glenn Fresser, announced the appointment of Dr Hugh Barrett from Narrabri, as chairman of the Australian Cotton Cooperative Research Centre, following the retirement of Evan Cleland. The appointment will continue until the end of the current Cotton CRC in June 2006.

Dr Barrett, an internationally experienced civil and irrigation engineer, has been involved in water resources engineering for more than 30 years in Australia, the USA, South East Asia, Africa, South America, Mongolia, Moldova , and Fiji. He is currently managing director of Hugh Barrettt and Associates, a consulting engineering practice headquartered at Narrabri, specialising in water resources and irrigation engineering. Dr Barrett was inaugural chairman of the Irrigation Association of Australia (IAA) for three years and served on the national board of the IAA for 10 years. He is currently Vice-Chairman of its North-Western NSW Regional Committee. He holds a Bachelor of Engineering degree from the University of NSW, and Master of Science and Doctor of Philosophy degrees in Irrigation Engineering from Colorado State University in the USA.

FORMER COTTON CRC CHAIR HONOURED

Evan Cleland, former chair of the Australian Cotton Cooperative Research Centre, has been farewelled by resaearchers, staff and fellow members of the CRC's Governing Board.

At a special function during the CRC's annual research review, CEO Guy Roth said Evan Cleland had been Chairman of the Governing Board since September 2000. "Evan has been a Rock of Gibralter on the CRC Board, with his leadership, vision, inspiration, guidance, oversight and attention to detail, particularly in relation to financial matters, and in the preparation of the bid for a new Cotton Catchment Communities CRC".

Hamish Millar, deputy chair of ACGRA, acknowledged the changing of the guard at the Cotton CRC, and thanked Evan for his services to the CRC, ACGRA and to the cotton industry. He praised his dedication, commitment and logic in many of the crises situations the industry had faced in the past, and wished him well in the future.

Responding to the accolades, Evan Cleland thanked the CRC community for what had been a "stimulating period" in his life, and for the progress of the many research programs under its wings.

He described his four years with the CRC, and particularly the preparation of the new bid, as a "wonderful participatory experience".

CRC RESEARCH COMMERCIALISED - MAGNET.

Airborne volatiles emitted by flowers and other vegetative plant parts that attract insects for feeding and egg-laying could be useful in pest management. Over the last 6 years or so, the Cotton CRC has developed blends of plant volatiles that can be used as attract-and-kill for Helicoverpa moths in cotton and other crops.

One of the major highlights of the project was finalising the license agreement with a commercial partner, Ag Biotech Pty Ltd. in August 2003. The International Patent has recently been published, and national phase patent application is underway for other countries. Our commercial partners have sourced materials and purchased equipment for large-scale production of Magnet®, and produced a Technical Brochure for distribution to the industry.

Another major highlight was the continuation of large-scale field trials for research and product evaluation purposes. Applications to the APVMA to do such trials were approved on 9 December 2003. The attract-and-kill product (Magnet®) was commercially released by Ag Biotech for product evaluation purposes between mid-December 2003 and March 2004. To our knowledge, this is the first time an attract-and-kill product based on plant volatiles has been available on a commercial scale for cotton anywhere in the world.

Associate Professor Peter Gregg and Dr Alice Del Socorro with the final product "MAGNET".

DARLING BASIN DEEP DRAINAGE AND GROUND WATER FORUM

In November 2003, the Cotton CRC hosted an important forum on deep drainage and groundwater in the Darling basin, which was funded by the National Program for Sustainable Irrigation.

The organising committee consisted of: Mark Silburn QNRM Toowoomba, Nicky Schick Cotton CRC Narrabri, Willem Vervoort Sydney University, Mac Kirby CSIRO Land and Water Canberra , Nilantha Hulugalle NSW Agriculture Narrabri, Anthony Ringrose-Voase CSIRO Land and Water Canberra, and Helen Fairweather NSW Agriculture Dubbo.

The workshop had a technical focus, relating to deep drainage and groundwater, but was aimed at a broader audience than irrigated cotton production. Around 60 people from state and federal agencies (MDBC, CSIRO L&W, DIPNR, NSW Agriculture, QLD. NRM&E QDPI, and Victoria DPI), universities (Sydney University, UTS, UNSW, USQ & UNE), representatives of funding bodies (CRDC and GRDC) and several catchment management organisations attended the two-day workshop. Expertise included soil scientists, hydrologists, hydrogeologists, geophysicists, agronomists, extension specialists, spatial and GIS experts. The outcome has been improved collaboration of the many players in a complex problem.

MOREE COTTON TRADE SHOW

In May 2004 was the Moree Cotton Trade Show, which is attended by everyone associated with the cotton industry.

The Cotton CRC extension team had several interactive displays at the trade show covering subjects such as water use efficiency, integrated pest management, weeds, disease management, soils and the environment.

The trade Show is one way the Cotton CRC promotes the uptake of its knowledge and is grateful to the Trade Show organisers for their support.

Cotton growers inspecting the Water Use Efficiency display at the Cotton Trade Show.

Sandra Deutscher explaining the interactive insect display to the next generation of cotton growers.

FIBRE PROPERTIES SURVEY YIELDS MIXED RESULTS FOR COTTON

A survey of international and domestic cotton spinning mills indicates that a significant and sustained focus on improving fibre quality is required for Australian cotton, despite its reputation as a high quality fibre.

Micronaire, nep and short fibre content stand out as the first priority. Fibre strength, an extremely important parameter to spinners, also needs to improve, as does the consistency of these and other properties delivered over a sales contract.

The survey was conducted by Australian Cotton Cooperative Research Centre's CSIRO's Textile and Fibre Technology Division , with the support of the Australian Cotton Shippers Association.

Thirty-one mills across the five countries were surveyed; eight from Japan, eight from South Korea, seven from Thailand, four from Indonesia and five from Australia. Together they consume in excess of 183,850 tonnes, or more than 810,000 bales, of Australian cotton annually.

Annual export figures show that 75% of the Australian crop is exported to Asia and mainly to four countries, namely Indonesia, Japan, Thailand and South Korea, which are among the worlds leading exporters of textiles, and with the exception of Japan, also the world's leading exporters of clothing.

The survey showed that Australian cotton is rated highly on fibre properties such as Contamination, including biological

contaminants such as stickiness and seed coat fragments, Classing grade, Staple Length, Colour, Spinning ability, Trash Content, and to a lesser extent Maturity and Extension.

Although the lack of contamination was rated as the most favourable fibre property of Australian cotton (though it could be argued that contamination is a product of the process rather than a fibre property), concerns were raised that incidences of some contaminants are increasing.

The spinners' concerns raised in this survey are supported by the ITMF contamination survey for 2003 which shows that, as is the case world wide, contamination of Australian cotton is on the increase, increasing from five percent in 1989 to 13 percent in 2003, but it is still considered as part of the least contaminated destinations in the world.

There are concerns regarding fibre properties such as high nep, short fibre content, and high Micronaire values. Neps in particular remain an adverse feature of Australian cotton. Neps affect the appearance of cotton yarns and fabric and are usually associated with lower yarn strength, poorer spinning performance and a more irregular yarn.

The appearance of dyed or printed fabrics is negatively influenced by the presence of neps, as neps, often comprise immature or "dead" fibres, which don't absorb dye and reflect light differently and appear as spots or "flecks" on finished fabrics.

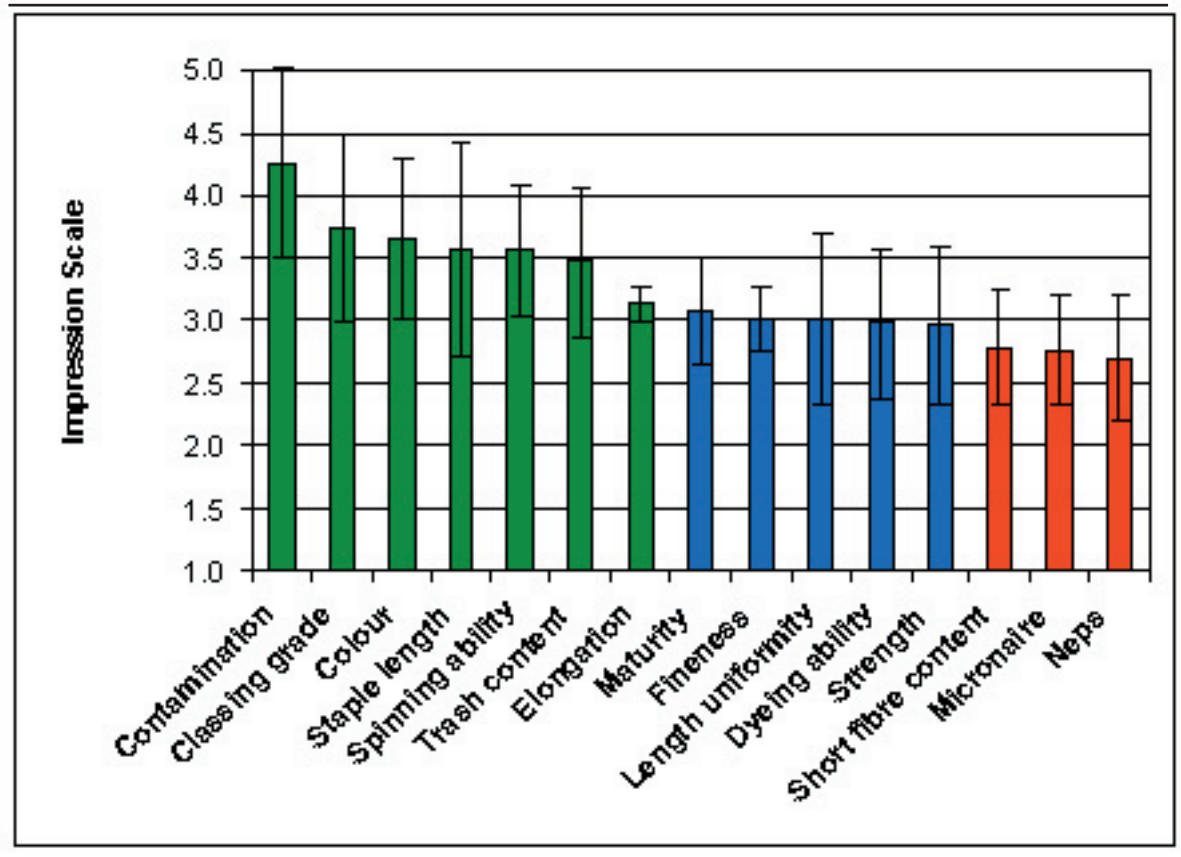
This causes fabrics to be downgraded or rejected, as there are no cost-effective means of covering or removing them once they are present in fabric.

The higher Micronaire of Australian cotton over the last two to three years was also an issue with mills, particularly those that spin fine count yarns (Ne 40 and finer).

In order to spin a quality yarn without processing problems, a minimum number of fibres is required in the yarn cross section and fibre fineness (as indicated by Micronaire) is directly related to the number of fibres in the cross-section for a given yarn linear density. Therefore as micronaire increases it becomes more difficult to spin fine yarns.

Excessive short fibre content is also perceived as a problem in Australian cotton. Short fibre content is taken to refer to those fibres shorter than 12.5 mm.

Excessive short fibre content leads to (especially in medium to fine counts) poorer spinning performance, an increase in yarn irregularity, a decrease in yarn tenacity, increases in yarn hairiness and fly generation (fibres liberated to the atmosphere in the mill), and more rapid deterioration of fabric appearance.



Rating: 1 = Bad, 5 = Good.
Spinners Impressions of Australian Cotton Fibre Quality.

With regards to nep and short fibre content, there was a general comment from many spinners that there had been an improvement in these properties in recent times, although at the same time there was a lack of consistency in these properties between contracts supplied to spinners.

It should also be noted that the "improvement" in the impression of nep and short fibre content in Australian cotton coincides with the production of high micronaire cotton that is less prone to nepping and fibre breakage, i.e., short fibre creation.

REVIEW OF INSECTICIDE RESISTANCE IN THE COTTON

The Cotton CRC has published an update on the pattern of insecticide resistance in the cotton industry.

The review was prompted by changes in chemical use triggered by the introduction of transgenic varieties, and the implementation of integrated pest management techniques involving greater reliance on friendlier insecticides.

Cotton CRC spokesman, Dr Lewis Wilson, said ongoing resistance monitoring was a coordinated effort between researchers, consultants, growers and extension personnel in both NSW and Queensland.

A joint author of the review, Dr Louise Rossiter, research entomologist with NSW Department of Primary Industries, said that of the two Helicoverpa species in cotton, *H.armigera* has developed the greatest resistance, while *H.punctigera* has the biological capacity to become resistant, although it has not done so.

Joint authors of the review were Dr Lewis Wilson, Dr Louise Rossiter, Bruce Pyke, Dr Robyn Gunning, Dr Grant Herron and David Kelly.

Above: Dr Lewis Wilson (CSIRO Plant Industry) and Dr Louise Rossiter (NSW Agriculture).

WHITEFLY ACTION PLAN SAVES COTTON GROWERS MILLIONS

An action plan developed with the assistance of the Australian Cotton Cooperative Research Centre has saved cotton growers in Central Queensland millions of dollars in chemical costs and fibre quality discounts.

Cotton CRC Program Leader, Dr Lewis Wilson, said Silver Leaf Whitefly (SLW) populations detected near Emerald in April 2001 had threatened to decimate the cotton industry.

"Timely research, information sharing, strategic planning, and industry-wide cooperation and communication, has averted a potential disaster in subsequent plantings," he said.

A chronological development of the industry's attack on SLW "Whitefly Management in Central Queensland" was prepared by CRC Industry Development Officer in CQ, David Kelly.

"Research by Dr Robin Gunning (NSW Agriculture) and Emma Cottage (UNE), found SLW to be resistant to most popular insecticides used in the cotton, which was a big problem, given that at that time none were registered in Australia for use against SLW," David Kelly said.

"In 2001, the Cotton Research & Development Corporation (CRDC), on behalf of the industry, successfully obtained emergency permits for a number of insecticides, but for that season, it was too late and SLW populations got out of control," he said.

In July 2002, a number of Central Queensland growers, consultants, extension and research people took part in a study tour of cotton growing areas in the USA that had successfully developed strategies to manage SLW.

The tour, funded by CRDC, Cotton Seed Distributors, and cotton grower associations on the Central Highlands, Dawson Valley and Biloela, provided information that would form the basis of a SLW management strategy in Central Queensland.

Following the return from the USA study tour, a management strategy for SLW in Central Queensland was rapidly formulated. Seed treatments were compared; monitoring methods refined; action thresholds developed; insecticide application methods reviewed; variety selection examined; host crops investigated; efficacious insecticides researched; and Area Wide Management groups became a lot more active.

Two Cotton CRC publications were produced: 'Silverleaf whitefly in Australian cotton' and 'Management of Silverleaf whitefly in Australian cotton'.

During the 2002-03 season the CRDC sponsored a visit to Australia by University of Arizona Entomologist, Dr Peter Ellsworth, who spent a week meeting with individuals

and groups in the CQ cotton industry, providing valuable reassurance that the adopted management strategy would work.

" The end result is that we now have an industry-supported SLW management plan in place at the start of each season, and by using a united approach have saved the industry from what was deemed to be a potential disaster less than three years ago" David Kelly said.

The SLW research team in action in the USA last year

RIPERIAN MANAGEMENT GUIDELINES

In conjunction with Land and Water Australia and the Cotton Research and Development Corporation the Cotton CRC has contributed to a new publication - "Managing riparian land in the cotton industry"

This publication contains grower case studies demonstrating the many things that landholders can do to enhance the riparian land on their properties. Different management options are provided, with the science underpinning these options described so that on-farm decisions can be made based on the best available information.

SPENDING SUMMER ON COTTON SCHOLARSHIPS

Four university students are completing important summer scholarship research projects with the Cotton CRC.

- Nathan Eulenstein (UQ Gatton) is studying nutrient and salt leaching under cotton-vetch and continuous cotton rotations in poorly structured vertisol soils (supervised by Dr Nilantha Hulugalle, NSW Department of Primary Industries);

- Andrew Traves (University of New England) is assisting in delivering HydroLOGIC to the cotton industry (supervised by Dirk Richards and Darren Linsley CSIRO);

- Angela McDowell (Sydney University) is studying the impact of extreme cold temperatures on the viability of cotton tissue (supervised by Dr Michael Bange and Dr Daniel Tan CSIRO/USYD).

- Kent Carnogursky (Charles Darwin University) is studying the effects of wet season cover crop species in rotation with dry season cotton on compaction of a Tippera soil at Katherine in the Northern Territory (supervised by Stephen Yeates and Andrew Dougall).

Dirk Richards (CSIRO Pland Industry) Andrew Traves (Summer Scholarship Student) and Darren Linsley (CSIRO Plant Industry)

Mike Bange (CSIRO), Dr Daniel Tan (CSIRO) and (Summer Scholarship Student) Angela McDowell

Cotton CRC summer scholarship UQ student Nathan Eulenstein.

Cotton CRC summer scholarship holder, Charles Darwin University, Kurt Carnogursky, working on cotton cover crops in the wet season at Katherine in the Northern Territory, to minimise soil erosion due to the high rainfall.

INTEGRATED PEST MANAGEMENT EXPANDS

An expanding number of cotton growers are embracing integrated pest management (IPM) to reduce pesticide use and ensure sustainability of the industry.

The Australian Cotton CRC's latest data shows that IPM has led to a 65 per cent reduction in pesticide use in conventional cotton fields and 80 per cent less in genetically modified fields since the first IPM guidelines were released in 1999.

Cotton CRC and Department of Primary Industries and Fisheries IPM Training Coordinator, Mark Hickman, said major developments in IPM had now been adopted by the majority of growers, which is a remarkable achievement for a self-regulated activity.

He said the most persuasive evidence supporting the adoption of IPM was grower group data demonstrating conclusively that fewer insect sprays can be associated with higher profit margins, while simultaneously delivering significant environmental benefits.

Cotton CRC IPM Coordinator, Mark Hickman (Left) presents St George cotton grower, Cleave Rogan, with his IPM Course Certificate.

PETROLEUM SPRAY COMPANY FUNDING WORK ON COTTON APHIDS

SACOA Pty Ltd, an Australian company that specializes in the development, and supply of Spray oils and Adjuvants, is funding a Cotton CRC PhD student to investigate the mechanism of tolerance of cotton aphids (Aphis gossypii) to petroleum spray oils (PSOs) on cotton.

Dr Robert Mensah, Principal Research Scientist with NSW Agriculture, said aphids have emerged as a major pest of cotton, causing significant yield losses, acting as a suspect vector of Bunchy Top disease, and developing a resistance to synthetic insecticides.

The project will lead to a better understanding of PSO use pattern against aphids, increased use of PSOs to control aphids, reduced reliance on synthetic insecticides, improved performance of the natural enemies of aphids, and improved sustainability and profitability in the cotton industry.

Previous research has shown that cotton aphids are susceptible to PSOs, but the mechanisms underlying their efficacy has not yet been demonstrated.

The new PhD project will develop an understanding of these mechanisms in transgenic and non-transgenic crops, providing a guide to product use and application technology.

The PhD student is Adriana Najar and research is taking place in Narrabri and Brisbane.

Joint supervisors of the research project are Associate Professor Gimme Walter (Department of Zoology and Entomology UQ) and Dr Robert Mensah (Principal Research Scientist with NSW Agriculture)

Kym Orman, Cotton CRC Business Manager, Dr Robert Mensah, NSW Agriculture, Justin Matthews (seated) and Andrew Johnston, SACOA Pty Ltd.

GETTING DIRTY: COTTON INDUSTRY TO BENEFIT FROM NEW SOIL SCIENCE

NSW Minister for Primary Industries, Ian Macdonald launched a new CD-ROM containing detailed data on the composition of soil from key cotton growing regions in NSW and south-western Queensland.

"This database is the result of a $3.7 million, 10-year project involving more than 11 scientists affiliated with the Australian Cotton Cooperative Research Centre and the University of Sydney," Mr Macdonald said.

"It draws on more than 90,000 records covering over 1,500 sites from the Namoi Lachlan, Gwydir and Macintyre valleys, and the Bourke and St. George Irrigation districts.

Cotton CRC Project Leader Dr Inakwu Odeh said the CD contained data on soil fertility and the levels of salinity, carbon and sodicity in soils. Growers, researchers, agronomists, and catchment authorities can develop better property plans and management strategies.

The "Soils Database and Assistant" CD-Rom is the result of research and funding from The University of Sydney, National Heritage Trust and the Cotton Research and Development Corporation.

Pictured at the launch of the Soils Database - NSW Minister of Agriculture Ian Macdonald, Dr Inakwu Odeh, University of Sydney.

COTTON RESEARCH IN THE NORTHERN TERRITORY

Preliminary results from research, conducted over the past five years by the Australian Cotton Cooperative Research Centre (Cotton CRC), were outlined to the Chief Minister, Clare Martin, and Minister for Primary Industry, Kon Vatskalis, in Darwin, March 2004.

The extensive research program, which also covers north Queensland and the Ord and Broome regions in Western Australia, involves expenditure of more than $3 million over a seven-year period in the NT alone.

Chairman of the Cotton CRC, Evan Cleland, who led the CRC delegation's discussions with the Chief Minister, noted the Government's decision to continue its support for the remainder of the research program.

Mr Cleland said the program includes inputs from several NT Government departments and CSIRO, and covers a suite of important issues such as soils, erosion, drainage, farming systems, and water and environmental issues.

"The CRC believes the Government will be better placed to consider future farming systems in the Territory based on environmental, ecological, and agronomic sustainability, as the result of current research programs.

"This research has been based on minimising chemical inputs; protecting and preserving flora, fauna, birds and beneficial insects; and utilising farming systems that draw minimally on water resources, and do not degrade or harm the environment for ancillary rural industries or recreational users," he said.

Some of the major outcomes of the Cotton CRC research

program recently reported by Dr Colin Martin (NT DBIRD) and Stephen Yeates (CSIRO) include:

- Irrigation practices that show that cotton is not a thirsty crop and uses no more water than other crops grown in the NT, i.e. maize, peanuts, bananas and mangoes.
- Irrigation management suitable for overhead drip systems, that prevents deep drainage and optimises water use efficiency.
- Weediness research showing that cotton will not become a weed whether or not it is genetically modified.
- Effective control of major cotton pests with minimal use of insecticides using Integrated Pest Management (IPM). That is, transgenic cotton, stimulation of beneficial insect populations using few, soft insecticide sprays, and suitable trap crops. No endosulfan is used on cotton in the NT.
- Insect resistance management systems that reduces the risk of pesticide resistance.
- Matching of nutrient applications to the crop's requirements, preventing loss of nutrients from the system.
- Appropriate soil management based on conservation farming practices viz

    - No-till cotton is grown which reduces soil and water loss, improves water infiltration rates, and reduces herbicide use
    - Cover crops are grown during the wet season to protect the soil from erosion and provide mulch for no-till sowing of the subsequent cotton crop
    - Crop rotation with peanuts, which prevents monoculture and enriches the soil in the NT.

Inspecting a crop of Best Bet cotton grown in Kununurra.

BIODIVERSITY LITERATURE REVIEW COMPLETED

The Australian cotton industry has taken an important step towards its goal of restoring, maintaining and enhancing biodiversity on cotton farms, with the publication of a review, funded by the Cotton Research and Development Corporation, of all available information on the subject.

Titled "A Review of Biodiversity Research in the Australian Cotton Industry," it ranges from reports on biological and ecological studies on farms, to legislation and policy documents.

The review was launched during the December 2003 annual conference of the Ecological Society of Australia, held at The University of New England.

Professor Hugh Possingham from The University of Queensland, who officially launched the review, congratulated the authors: Nick Reid, Gabrielle O'Shea and Letitia Silberbauer from UNE's School of Environmental Sciences and Natural Resources Management.

Professor Possingham, who chairs the Australian Government's Biological Diversity Advisory Committee, said: "The cotton industry needs biodiversity and biodiversity needs the cotton industry."

He said primary producers were in a "powerful position" for protecting native ecosystems on their land. The review would help "maintain and restore the biodiversity of cotton-based landscapes", he concluded.

Structure and Management

The Australian Cotton Cooperative Research Centre is an unincorporated joint venture between:

- CSIRO Plant Industry, Entomology, Textile and Fibre Technology, Sustainable Ecosystems.
- Department of Primary Industries & Fisheries Queensland, NSW Agriculture, Department of Agriculture Western Australia, and the Northern Territory Department of Business, Industry and Resource Development
- The University of New England and The University of Sydney
- Cotton Research & Development Corporation
- Cotton Seed Distributors, Queensland Cotton and Western Agricultural Industries

GOVERNING BOARD

The Board's functions and powers include establishing policy and setting strategic directions; monitoring performance indicators, programs and activities; approval of annual budgets and commercial arrangements; negotiating funding; and appointment and review of the performance of the Chief Executive Officer.
The Board is chaired by an independent chairman appointed by the Australian Cotton Growers' Research Association (ACGRA). The Board meets four times per year.

Non Research Providers

Chairman	Mr Evan Cleland up to 13/5/04 Dr Hugh Barrett from 13/5/04
Cotton Research and Development Corporation	Mr Dick Browne
Cotton Seed Distributors	Mr Peter Graham
Queensland Cotton/Western Agricultural Industries	Mr Paul Catlow
Independent Member	Mr Bob Galmes, Bonds Industries
Independent Member	Ms Di Bentley, Liverpool Plains Land Management Committee
CEO (100% Centre funded)	Mr Guy Roth

Research Providers

CSIRO	Dr TJ Higgins
NSW Agriculture	Ms Helen Scott-Orr
Department of Primary Industries Queensland	Mr David Hamilton
NT Department of Business Industry & Resource Development	Mr Bruce Sawyer
University New England/University of Sydney	Prof Les Copeland

Mr Evan Cleland

Mr Dick Browne

Mr Peter Graham

Mr Bruce Saywer

Prof. Les Copeland

Mr Guy Roth

Mr Bob Galmes

Ms Helen Scott-Orr

Ms Di Bentley

Mr David Hamilton

Mr Paul Catlow

Dr TJ Higgins

MANAGEMENT COMMITTEE

The Management Committee, chaired by the CEO, meets four times per year as well as holding teleconferences on a needs basis. Its primary responsibility is to implement Board policies. Its responsibilities include assessing and recommending research projects to the Board; overseeing progress in research projects and achievement of performance indicators; managing resources; and overseeing education and training, information services, publications, technology transfer and commercialisation. All Program Leaders are represented on the Management Committee.

Mr Guy Roth (Chair)	CEO	Cotton CRC
Mr Geoff Strickland Dr Michael Bange	Program One Leaders	Agriculture Western Australia CSIRO Plant Industry
Assoc. Prof. Peter Gregg Dr Stephen Allen	Program Two Leaders	University of New England Cotton Seed Distributors
Dr Lewis Wilson Dr Inakwu Odeh	Program Three Leaders	CSIRO Plant Industry University of Sydney
Mr Greg Kauter Mr Geoff McIntyre	Program Four Leaders	Cotton Research & Development Corporation Department of Primary Industry Queensland
Dr Geoff Naylor	Program Five Leader	CSIRO Textile & Fibre Technology
Mr Dallas Gibb Assoc. Prof. Nick Reid	Program Six Leaders	NSW Agriculture. University of New England
Mr Bruce Pyke		Cotton Research and Development Corporation
Dr Colin Martin		NT Dept of Business, Industry & Resource Development

Members of the Management Committee. Back Row Geoff McIntyre, Bruce Pyke, Dr Lewis Wilson, Guy Roth, Dallas Gibb, Greg Kauter, Dr Geoff Naylor, Kym Orman, Dr Stephen Allen and Assoc. Prof. Nick Reid. Front Row: Geoff Strickland, Dr Colin Martin, Dr Inakwu Odeh and Nicky Schick.

NORTHERN COMMITTEE

The Northern Committee comprising the Chief Executive Officer, Program One Leaders, and other research and industry partners is concerned with expansion into new regions. This committee advises the Management Committee on research priorities for Program One; ensures research expertise from other Programs flow into the new regions; and acts as a focus for interaction with northern communities and interest groups.

Mr Stephen Yeates, the Northern Liaison Officer based in Darwin, provides regular reports to, and takes direction from, the Management Committee through the Northern Committee.

Northern Committee

Mr Guy Roth	CEO Cotton CRC
Mr Geoff Strickland (Chair)	Program Leader Agriculture WA
Dr Michael Bange	Program Leader CSIRO Plant Industry
Dr Ian Titmarsh	Dept Primary Industries Qld
Dr Colin Martin	NT Dept of Business, Industry and Resource Development
Mr Adam Kay	Cotton Seed Distributors
Mr Stephen Yeates	Research Coordinator/Liaison Officer CSIRO Plant Industry

ADVISORY COMMITTEE

An Advisory Committee provides industry feedback on research and community issues; assesses progress against key objectives; and helps target future research directions. Members comprise growers, consultants, agricultural industry and community representatives.

Advisory Committee

Mr Bruce Finney	Australian Cotton Growers Research Association
Dr Don Sands	CSIRO Entomology
Mr Mathew Holding	Cotton Consultants Australia
Professor Graeme Hammer	Dept Primary Industries Qld, APSRU
Mr John Harrison	Amateur Fisherman's Association Northern Territory
Ms Sandy Robinson	Murray Darling Basin Commission
Ms Sheila Donaldson	Environment

WORKING PARTIES

The CRC has also established discipline-specific working parties to provide coordination, direction and feedback.

ADMINISTRATION

Executive Officer/Business Manager	Ms Kym Orman.
Research Liaison Officer	Ms Nicky Schick.
Administration Assistant	Mrs Lynda George.

The Administration team - Kym Orman, Lynda George and Nicky Schick.

Professor Henry Nix, Australian Cotton CRC Visitor, Australian National University, Canberra.

COOPERATIVE LINKAGES

Cooperation among our participant organisations, with our industry stakeholders and with the wider community is an essential attribute for our CRC. The Cotton CRC has continued to engender a collaborative culture and has grown its capacity to interact with a growing range of stakeholder groups. Likewise we maintain strong interactions with international research groups and with the cotton spinning industry in many countries.

Within programs we have a number of projects with multiple organisations involved, and with the establishment of a new Program on managing the whole-farm environment has resulted in expanded engagement with environmental organisations and particularly the Catchment Management Authority's in NSW and their equivalent bodies in Qld.

An important mechanism to ensure linkage into the cotton industry are our "Discipline Groups" which provide a regular forum for researchers, extension staff, growers, consultants and other industry groups to discuss research outcomes and identify future priorities. Discipline groups meet at least once each year and cover issues of insect, weed and disease management, farming systems, water and soils, decision support systems and extension. The FUSCOM group (Fusarium Coordinating Committee) is a great example of how all facets of the CRC and industry can cooperate to drive a research and communication program for this threatening disease.

Tremendous advances in the adoption of area-wide management of insect pests, coordinated management of Fusarium and significant improvements in water use efficiency through the Rural Water Use Efficiency Initiative in Qld are all examples of what can achieved through close cooperation of research, extension and industry.

In northern Australia we have maintained direct links with the communities of Katherine and Kununurra and more broadly with many interest groups through widespread distribution of the northern newsletter – Cotton Frontiers. An important step for the prospects of cotton in the NT is a new alliance with the Peanut Company of Australia (PCA) in Katherine where joint farming systems experiments involving cotton and peanuts in rotation are now underway at a commercial scale.

Another landmark outcome is establishment of a coordinated research effort on deep drainage and its consequences in irrigation soils of the northern Murray-Darling basin. This collaboration involves input from a number of CRC participants (University of Sydney, CSIRO, DNRM, NSW Agriculture, APSRU) in association with CRDC, MDBC, LWA. Several projects now underway will contribute greatly to efforts to manage the water balance of whole catchments in the MDB.

Links to other CRC's have been strengthened with existing joint projects with the CRC for Tropical Plant Protection, the CRC for Australian Weed Management; and new research with the Greenhouse Accounting CRC. We continue our association with the CRC for Freshwater Ecology to explore joint opportunities for research on biodiversity in rivers and on-farm waters associated with cotton as well as environmental flows. Links are developing with the new Irrigation Futures CRC.

Our Extension and Education program provides additional foundations for linkage across all partners in the CRC and into industry and the wider community. The Cotton CRC's Technology Resource Centre continues to provide effective co-ordination of information flow to industry in the form of printed materials, CD ROMS, computer based decision aids, an email "eNews" service and a comprehensive website (www.cotton.crc.org.au).

Finally our program on Cotton Textile Research has now developed close alliances with over 25 international cotton processors in Japan, South Korea, Thailand and Indonesia seeking to identify their needs as well as how best Australian fibre can meet these needs. This process has been greatly facilitated by Austrade and will feed back to producers and cotton breeders.

INTERNATIONAL LINKAGES

Many international linkages are maintained through personal associations of individual scientists. We facilitate this through a research exchange program which supports a number of international exchanges each year. During the 2003/04 financial year we supported visits by:

- Professor David Radcliffe, University of Georga, USA - to visit Australian to explore the model AVSWAT and discuss the possibilities for using this model as a catchment management tool in Australia.
- Ms Rose Roche, PhD Student, CSIRO Plant Industry to participate in the Beltwide Cotton Conference, San Antonio, Texas, USA, a forum recognised as the main conference for cotton research in the world.
- Mr Scott Johnston, CSIRO Plant Industry to participate in the Access/Visual Basic Developers Conference, Las Vegas, Nevada USA to exchange knowledge on different facets of software development.

Program One Overview

Growth in northern Australia

Program One Leaders - Geoff Strickland, Agriculture Western Australia and Dr Michael Bange, CSIRO Plant Industry.

Cotton industry expansion in the existing production areas of northern NSW and southern Queensland is constrained by resource availability, particularly water. However a scoping study conducted by Yeates (2001) showed that opportunities exist for expansion of cotton production into new geographic regions in northern Australia. Regions with active research investigation now include Western Australia (Broome and Kununurra) and the Northern Territory (Katherine) with prospects for additional research in north Queensland (Flinders River, the Burdekin and others). The potential area for new cotton could exceed 200,000 ha and would produce a further 1.5 million bales with an export value of $750 million. This level of development would generate significant new infrastructure and associated growth in northern Australia and diversify the production base of the Australian cotton industry.

The major Program 1 objectives are:

- ♦To enhance the prospects for expanding cotton production by researching viable and environmentally responsible cotton production systems for new regions in Western Australia, the Northern Territory and north Queensland.
- ♦To develop solutions to specific regional environmental problems prior to commercial activity.

Highlights, lowlights and achievements

CRDC's decision to terminate all its projects in northern Australia has had serious consequences with CSIRO withdrawing its agronomic team (Brian Duggan and Nerylie Gaff) from Kununurra and the WA Department of Agriculture reducing its in-kind support with the transfer of Amanda Annells to Carnarvon. Kununurra staff now comprises John Moulden (part-time) and a technical officer. Steve Yeates and Geoff Strickland provide limited guidance. The funding loss was partially offset with CRC funding at Kununurra for the agronomic "best-bet" demonstration block.

The NT government's unfortunate decision to "ban" commercial cotton production in the NT has also had ramifications with reduced CRC funds and the resignation of entomologists, Andrew Ward and Ali Duale. However, NT government funding support for cotton research has remained intact regardless of their commercial ban.

Despite these disappointments, some excellent research and new initiatives have occurred. A continuing highlight is the expansion of research at Katherine involving the Peanut Company of Australia (PCA), which grows peanuts in the Katherine region using centre pivot irrigation and sees cotton as a prospective rotation crop. Collaboration with PCA has enabled cotton to be grown off the research station and on a larger area.

Following the success of the best-bet Bollgard II® demonstration block utilising draft "NorPAK" guidelines in 2003, the exercise is being repeated at Kununurra in 2004. The challenge is to improve on the yield of 8.6 bales/ha with 83% water use efficiency achieved in 2003.

Field trials at Shamrock Station, south of Broome, in collaboration with Western Agricultural Industries

(WAI) focussed on evaluating Bollgard II® varieties for the first time. Yields from the top few varieties in the 2003 season were around 10 bales/ha. However, plans for the 2004 season were again hampered by land access issues associated with Native Title and, at the last minute, the trials were planted on private freehold land closer to Broome. The trials are strongly opposed by a local conservation group and the Kimberley Land Council but supported by other community groups.

Other significant highlights are as follows:

- A workshop involving Program 1 cotton researchers was held in Kununurra in October. The workshop was an important forum for information exchange and coordination of research activities. The majority of the workshop was devoted to refining NORpak, a preliminary Bollgard II® production package for northern Australia.
- CRC staff have contributed to meetings with environmental groups in Katherine and Broome to discuss their concerns about prospects for cotton growing.
- Rowena Eastick's report 'Potential weediness of transgenic cotton in northern Australia' was published by the NT government.
- University of Queensland student Andrew Davies submitted his PhD thesis on the ecology of *Trichogramma spp*. in the Ord River Irrigation Area.
- Katherine research received the benefits of its first CRC Summer Scholarship in the 2003/4 summer. Kent Carnogursky, who is studying for a degree in environmental science at the NT's Charles Darwin University, evaluated the effect of four cover crops on nutrient recycling and soil structure of Tippera clay loam at Katherine.
- Development of a specific component of the Cotton CRC's website to deal with northern related issues.
- Program 1 staff have developed excellent linkages with other researchers in the CRC and with industry. Examples include insect compensation studies with Tom Lei, field testing of Magnet® and mirid pheromone studies with UNE, new variety development with CSIRO and field testing handheld CottonLOGIC applications.
- Compiling by Dr Colin Martin (NTDBIRD) and Stephen Yeates (CSIRO Plant Industry) of "Overview of Cotton Research and Prospects in the Northern Territory to March 2004" as an information document for NT politicians and others.

Project Summaries

PROJECT: 1.1.01 *Viable and environmentally responsible cotton production systems for northern Australia: Scoping Studies and Research Liason/Coordinator.*

STAFF:
Stephen Yeates, CSIRO Plant Industry, Darwin, NT.

AIMS:
Assist in the investigation and development of viable and environmentally responsible production systems for new regions in Western Australia, the Northern Territory and north Queensland by:

- Facilitating actions following the publication of the scoping report and participate in new research projects.
- Provide scientific support to the Cotton CRC management and researchers. Coordinating and assisting in the supervision of collaborative research accross northern Australia.
- Maintaining effective communication with appropriate research bodies, CRC partners, relevant committees, and CRC management on matters relating to commercial development of cotton production in northern Australia.

INITIATIVES:
A successful northern workshop was held October 2003, where the draft 'best bet agronomic guidelines for cotton in Northern Australia' were reviewed and updated.

Assistance was provided in the design, review and interpretation of agronomic experiments at Kununurra, Katherine, Broome and Ayr, through face to face meetings emails and teleconferences. The outcome being focused research programs and plans.

In response to recommendations from the scoping study, collaborative research projects were initiated in 2003 were continued on: (1) the impact of cool night temperatures on cotton yield and quality, (2) the value of Roundup® tolerant cotton in integrated weed management (3) assessment of climatic risk to yield and quality. Work on catchment water balance modelling has stalled due to lack of funding.

Other initiatives include:

- Major contribution to the successful demonstration and documentation of NORpak agronomic practices at Ord River.
- Contributions to economic modelling, by consultants for Stage 2 development of the Ord River Irrigation Area. Cotton is now considered the major candidate crop for the development.
- Compiling with Colin Martin (DBIRD): "Overview of Cotton Research and Prospects in the Northern

Territory to March 2004" as an information document for NT politicians and others. This document was widely distributed.

- The development of modelling tools tailored for tropical Australia, and the application of these tools to desktop pre feasibility analysis for potential new growing areas near Laverton WA and at the Burdekin Irrigation Area Qld. The former was a paid consultancy (the CRC received $2,500).
- A draft 'best bet agronomic guidelines for cotton in Northern Australia' was compiled in early 2003 and successfully implemented in a field demonstration at Kununurra in 2003. A repeat demonstration crop is being grown in the 2004 dry season.
- Communication has been maintained with relevant research and other bodies in northern Australia. The project has faciliated the development of research protocols into cover crops, nutrition and pesticide movement, integrated weed management in the NT and WA.

In a field of 'Best Bet' cotton grown in the Northern Territory Rowena Eastwick (CSIRO Plant Industry) and John Moulden (Agriculture WA).

PROJECT: 1.3.02 *The role of IPM in sustainable cotton farming systems in the Northern Territory.*

STAFF:
Dr. Ali-Nur Duale,DBIRD, Katherine, NT

AIMS:
The primary aim of the project is to benchmark the ecology of the key pests and beneficial insects that are likely to impact on a future cotton industry in the Katherine area, before assessing preliminary integrated pest management systems. In 2003/04 the objectives were to:

- Monitor the seasonal abundance of lepidopteran pests *(Helicoverpa armigera*, *H. punctigera, Spodoptera litura* and *Pectinophora gossypiella* –Pink bollworm) weekly using pheromone traps at eight sites.
- Assess the role of companion crops (lablab)
- Determine the refuge requirements for Bollgard II
- Develop early and late season thresholds for the control of sucking insects.
- Make preliminary assessments of trap crops suitable for use in the Northern Territory.
- Rear and identify beneficial insect species (Parasitoids) and rank their status in the NT and link data to biodivesity studies.

OUTCOMES:

- Crops needed two sprays only compared to seven in the previous season.
- The abundance of the four insect species measured in pheromone traps at various sites in the district showed that the most numerous were *Spodoptera litura* and *Helicoverpa armigera* with peak numbers in May.
- Predator numbers (spiders) were high making it difficult to establish sucking pest thresholds.
- As in previous seasons *Trichogramma spp* numbers declined markedly in July.
- The pest:beneficial ratio was low during the season with consequent high fruit retention, mainly in the lower fruiting branches.
- Sucking pests up to 0.5/m early in the season had no impact on yield.
- Silverleaf whitefly (Bemisia tabaci B-type) was positively identified in cotton.

The success of Bollgard II ® in controlling Helicoverpa has changed the emphasis in IPM to sucking pests, consequently, many future activities are planned.

John Moulden (Agriculture WA) inspects cotton trials.

Summer Scholarship student Kent Carnogursky setting up his trial.

Measuring the pressure head at the siphons using a static siphon.

PROJECT: 1.3.05 *Environmental impact of chemicals used in cotton production in northern Australia*

STAFF:

Mr John Moulden, WA Department of Agriculture, Kununurra WA.
Mr C Norwood, WA Department of Agriculture, Kununurra WA.

AIMS:

To undertake a sampling program to identify the fate of pesticides and chemicals (defoliants, growth regulators etc.) applied to a commercial scale transgenic cotton crop.

INITIATIVES

A program was conducted in which a series of irrigation tail-water samples were taken during each irrigation event for this crop. The samples have been submitted to the Chemistry Centre of WA for analysis.

To calculate the total loss of applied chemicals to the environment it has been necessary to measure the flow of tail-water from the field. This has been achieved through the use of a V-notch weir, specifically designed for the field and installed in the discharge culvert.

OUTCOMES:

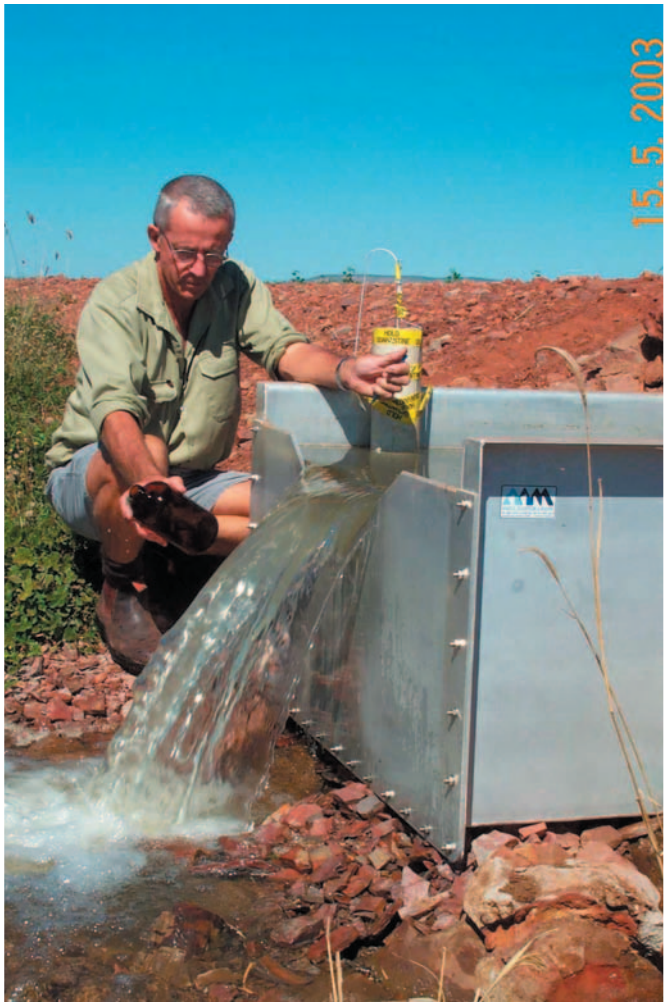
Aspects of the off-site impacts on the environment of a commercial-scaled cotton crop have been measured in a crop of Bollgard II® cotton grown on cracking black clay soil at Kununurra.

The quantity of water applied and lost as tailwater has been measured and an estimate made of crop water use efficiency.

Research has shown that the levels of applied chemicals appearing in tailwater is generally extremely low, in many instances below the limit of detection. In no case did the concentration of pesticidee approach the Australian Standard for Drinking Water (where such a standard exists).

It is relevant to contrast these results with data obtained by Ord Land and Water, working in conjunction with Rai Koolana, CSIRO Land and Water, Adelaide. The OLW project investigating the loss of endosulfan and atrazine from melon and sugar fields in the Ord River Irrigation Area has measured concentrations of endosulfan of 32 ug/L and atrazine of 350-700 ug/L in tailwater, following their application at label rates.

The cotton crop yielded 8.6 bales per hectare and used 7.5 Megalitres of water per hectare through the season. Water use efficiency averaged 83%. This water use figure compares favourably with the water requirements of many other crops currently being grown in the ORIA.



Measuring tailwater using a V-notch weir.

Program Two Overview

Innovative Technologies

Program Two Leaders Dr Steve Allen Cotton Seed Distributors and Associate Professor Peter Gregg, University of New England.

Commercial cotton production relies on a number of chemical inputs for high levels of production. While progress has been made in adoption of transgenic plants, Integrated Pest Management (IPM) and Best Management Practice (BMP), there remains an imperative to seek alternative management tools which minimise dependence on disruptive pesticides. This program reflects the need for innovative solutions to pest, weed and disease problems and the need for new tools to remediate or monitor environmental impacts. The program also includes fundamental work on the molecular genetics of cotton, which will aid in breeding for various characteristics including pest and disease resistance and fibre quality

Aims and objectives

To research and develop innovative technologies which provide an improved range of options for environmentally acceptable crop management and bioremediation.

- To rigorously evaluate the efficacy and environmental impacts of new transgenic plants.
- To develop and evaluate the use of attractants and repellents for Helicoverpa spp.
- To identify and evaluate effective biocontrol agents for soil-borne pathogens of cotton.
- To investigate the use of 'biofumigation' and 'systemic induced resistance' for improving the efficacy of disease control strategies.
- To develop more effective and user-friendly diagnostic kits for rapid detection of pests and diseases in plant tissues and in soil, and for pesticide residues and pest resistance.
- To investigate bioremediation techniques for pesticide contamination on cotton farms.

The utilisation of new technologies emerging from this program will be developed in Program 3, in the context of sustainable farming systems.

Research Highlights and Achievements

•Managing *Helicoverpa spp* on cotton with semiochemicals. – Both oviposition deterrent and feeding stimulant fractions have been isolated from G. nelsonii, Lumein, plant X and plant Y. Considerable advances have been made in the development of reliable bioassay protocols. The capacity of Solid Phase Extraction procedures to fractionate plant material has been increased six-fold.

•Pheromones for occasional pests of cotton. – The major highlight has been the successful identification of the green mirid sex pheromone attractant. Further testing of an 'attract and kill' formulation is planned.

•Gene silencing technologies to control *H. armigera*. – A new approach to the biological control of insects involves the addition of double stranded RNA into a target species to produce a highly specific 'gene silencing'. The piggyBac/EGFP construct has been completed and sequenced. Tentative optimal parameters

for biolistic delivery of DNA into insect embryos have been developed.

•Plant based attractants for Helicoverpa moths and sucking pests of cotton. A commercial product (Magnet®) has been developed. The APVMA provided a 'product evaluation' permit to enable large scale field trials. During the 2003/2004 season the product was used on 13,000 hectares of cotton in the Macintyre Valley, St George, Gwydir Valley, lower Namoi Valley and the Darling Downs of Queensland. There have been some indications that the effect of the product may extend for several kilometres away from a treated field.

•Enhancing the insect tolerance of Australian cottons through conventional and transgenic traits. The excellent efficacy of the VIP3A proteins expressed in GM cotton was demonstrated. Two seasons of field efficacy studies have shown a high and consistent control of *Helicoverpa armigera*.

Commercialisation

•The license agreement for the commercialisation of Magnet® was finalised in August 2003. The commercial partner is Ag Biotech Pty Ltd. The International patent has recently been published and national phase patent application is underway for Australia, the USA, Brazil, India and Europe. The commercial partners have sourced materials and purchased equipment for large scale production. A technical brochure for distribution to the industry has been produced.

•There was a significant contribution to the finalisation of the Resistance Management Plan for Bollgard II cotton which will now support the full commercial release of BGII varieties.

Project Summaries

PROJECT: 2.2.06 *Managing Helicoverpa spp. on cotton with semiochemicals*

STAFF:
Dr Chris Moore, QDPI, Moorooka, QLD.
Collaboration:
Dr Robert Mensah, NSW Agriculture, Narrabri NSW.
Dr Ertong Wang, NSW Agriculture, Narrabri NSW
Ms Angela Singleton NSW Agriculture, Narrabri NSW

AIMS:
The project aims to identify chemical components of the organ surfaces of plants, including cotton genotypes and trap and refuge crops, that influence acceptance or rejection by adult and larval heliothis, with a view to exploiting these bioactive compounds as stimulants and repellents/deterrents towards *Helicoverpa spp*. on cotton. The 2003-04 milestones were:
•Select most promising compounds for detailed chemical analysis
•Conduct small-plot field trials with candidate compounds
•Investigate the use of attractants and deterrents in trap-crop systems
•Investigate the use of attractants/stimulants in mixtures with biopesticides in field trials.
•Initiate patent and commercialisation of the most useful compounds
•Prepare results for publication

OUTCOMES:
Further elucidation of the structures of relevant compounds in G. nelsonii and Lumein has been achieved in part. Separation of a number of compounds from another plant (Plant Y), whose biological activity we hope to confirm in the near future, has been achieved, and their structures partially elucidated.

The Organic Chemist team at QDPI in Brisbane employed solid phase extraction (SPE) procedures to fractionate crude extracts of Lumein, Gossypium nelsonii, MHR 11 and Plant X. Six fractions of each plant were prepared by the Brisbane team and supplied to the Entomology team based in ACRI in Narrabri for bioassay studies against Helicoverpa spp. Dr Wang has improved the capacity of the SPE system so as to be able to process a 6-fold greater quantity of plant material than previously.

The bioassay results of Plant X fractions showed that Fractions 2 and 4 contain chemical compounds which can deter the feeding of H. armigera larvae. This is based on the weight test leaf consumed per larva, after the extract is dispersed on the leaf.

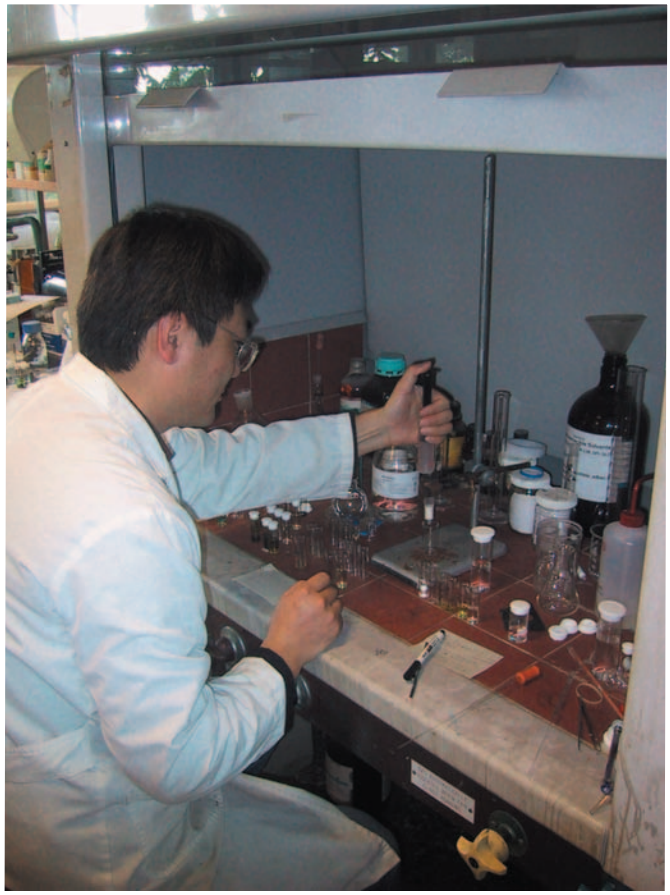
In the oviposition response tests conducted, the study showed that the oviposition deterrent index (ODI) recorded for Fractions 3 and 4 were significantly higher than the other

Plant X fractions tested indicating that these fractions contain deterrents to egg-lay.

We have previously reported that the native cotton species G. nelsonii was the most deterrent to oviposition of all the cotton genotypes tested. We have conducted appropriate choice experiments in the laboratory using H. armigera females. As an example of the results, in one set of such tests (no-choice tests), fractions 1, 2, 4 and 5 were confirmed to contain oviposition deterrents, but fraction 6 emerged as a stimulant.

In feeding tests for G. nelsonii, the results showed that the weight of leaves consumed per larva in fraction 6- treated leaves was significantly lower than the weight of leaves treated with water, implying the existence of feeding deterrent compounds. On the other hand, fraction 4 showed stimulant properties.

The study also showed that Lumein fractions 3 and 4 may contain feeding stimulants. Feeding stimulants have the potential to improve the efficacy of various control agents which have to be ingested. Oviposition stimulants and deterrents could be used in IPM to improve the performance of trap crops via a push-pull strategy.



Dr Ertong Wang in the laboratory.

PROJECT: 2.2.07 POSTGRADUATE *Pheromones for occasional pests of cotton*

STAFF:

Samuel Lowor, PhD Student, University of New England, Armidale, NSW

AIMS:

(i) Continue studies of roughbollworm lures in field trials and refine pheromone blends

(ii) Complete analysis of mirid pheromones and conduct field trapping studies.

OUTCOMES:

The major highlight has been the successful identification of the green mirid sex pheromone attractant. Pheromone traps have been attracting only males in the field trapping experiments. .

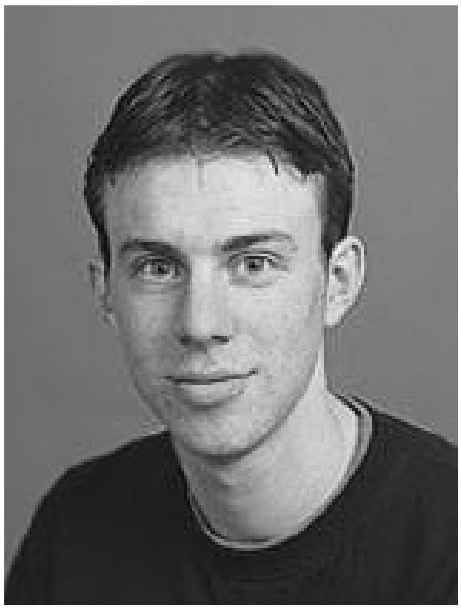
Extensive cotton growing areas in Australia are not only affected by *Helicoverpa armigera* and H. punctigera but by occasional pests like the cotton tipworm, Crocidosema plebejana, the rough bollworm, Earias huegeliana and the green mirid, Creontiades dilutus. Pheromone traps for these species would be potentially useful as monitoring tools in the field.

We have identified the major sex attractant pheromone components of these species from effluent air surrounding calling females and pheromone gland contents, using gas chromatography – mass spectrometry (GC-MS). Field trapping studies were conducted to determine optimum attractive blends for these species. Results indicated that the working sex pheromone blend for the rough bollworm has two, for the cotton tipworm, four components, and for the green mirid, two components.

In mirids, unlike *Helicoverpa spp.*, the adult males cause damage. This, and the fact that they are less mobile, makes them suitable targets for attract and kill. This project is looking at developing an attract and kill formulation that can be used to remove enough males to prevent mating and thereby reduce oviposition.

PROJECT: 2.2.08 *Postgraduate: Gene silencing technologies to control Helicoverpa armigera.*

STAFF:
Derek Collinge, PhD Student, CSIRO Entomology, Canberra, ACT.
Collaborator:
Dr Carolyn Behm, Australian National University, Canberra, ACT.



Derek Collinge, PhD Student.

AIMS:
- Develop piggyBac transposon based reporter constructs for GFP, GUS and DsRed.
- Determine the optimal parameters for the biolistic delivery of DNA into insect embryos.
- Assess the efficacy of piggyBac as a transformation vector in Helicoverpa armigera.
- Look at the long term stability and expression of transgenes in Helicoverpa armigera.

OUTCOMES:
New methods to protect cotton plants from insect pests must be sought to counter the growing incidence of resistance to our existing pesticides. With increasing public concern about environmental contamination by chemical pesticides, novel biological methods of pest control are of particular interest.

A recent breakthrough in the field of molecular biology, known as RNA interference (RNAi), shows tremendous promise in developing many new approaches to the biological control of insect pests. RNAi is a process by which addition of double-stranded RNA (dsRNA) into a target species results in highly specific gene silencing. By reducing the expression of any gene essential for the target pest's growth and development, RNAi could be used as an effective method of protecting crop plants from insect damage or of controlling the propagation of the pest insects themselves.

The aim of this PhD project is to assess RNAi-based approaches for the control of the major insect pest of Australia's crop agriculture, the cotton bollworm *Helicoverpa armigera*. In addition to assessing the efficacy of RNAi, this project will attempt to develop a genetic transformation system for this pest species.

Traditionally microinjection of insect eggs has been the method of choice for DNA delivery into insect. This study will look at the possibility of using biolistics as a novel, high-throughput method of DNA delivery in insects. Biolistics utilises a helium driven gene gun to shoot microscopic gold particles, coated in DNA, into insect eggs. Current work has focused on optimising the parameters of the gene gun to allow maximal DNA delivery and minimal egg mortality.

Thus far, it has been shown that the gold particles are able to penetrate insect eggs and preliminary results indicate possible transgene expression. The gene gun is also being used to introduce reporter genes such as GFP, GUS and DsRed into *H. armigera* eggs where a transposable element called piggyBac is being used to mediate the integration of these genes into the insect genome.

While the use of piggyBac in the stable integration of genes into insect genomes has been previously performed in other lepidopteran species, the stability of piggyBac integrated genes in H. armigera will have to be assessed. The development of a genetic transformation system for Helicoverpa will provide an extremely useful and versatile molecular biology tool for identification of genes essential to the species' development and reproduction. Ultimately, it is expected that the project will provide new solutions for the targeted control of Australia's most serious insect pest.

PROJECT: 2.2.09 *Plant-based attractants for Helicoverpa moths and sucking pests of cotton*

STAFF:
Dr. Alice Del Socorro, UNE, Armidale, NSW.
Assoc. Prof. Peter Gregg, UNE, Armidale, NSW
Dr. Chris Moore QDPI, Brisbane, QLD
David Van Ryswyck UNE, Armidale, NSW.
Dan Alter UNE, Armidale, NSW.
George Henderson UNE, Armidale, NSW.

AIMS
(a)Conduct olfactometer studies to test the attractiveness of modified blends to H. armigera moths of both sexes.
(b)Conduct small-scale field trials to evaluate the modified blends and other types of toxicants for H. armigera moths and other insects, including beneficials.
(c)Establish rearing methods and bioassay techniques for green mirids, initiate olfactometer experiments to test the effects of attractant blends to these insects.
(d)Initiate large-scale field trials to determine the impact of field-scale treatments on oviposition and on beneficial

insects and other pests.

(e) Publish refereed papers on Helicoverpa attractants, based on data from Project 2.2.3, after publication of the International Patent.

(f) Identify, and continue negotiations, with potential commercial partners.

We have two designs of olfactometers to test attractants for the green mirids. We attempted to rear green mirids in the laboratory from field-collected materials. We started with a large number of adults and late instar nymphs, but the succeeding generations yielded very few nymphs to maintain the culture. So, instead of doing olfactometer studies in the laboratory, we conducted small field experiments to test the attractiveness of this species to the attractant blend in Magnet® and other blends.

We were not able to publish refereed papers for the period but the research results have been presented in two scientific conferences in September and December (objective (e)). Though it was not originally nominated as an objective, we also conducted laboratory bioassays to determine if we can use other toxicants instead of methomyl with Magnet®. We developed a technique for ingestion tests with adult moths, and tested 13 other types of toxicants on lab-reared Helicoverpa moths. Results indicated that there might be possible alternatives to methomyl, but the speed of kill will be slower.

One of the major highlights of the project was finalising the license agreement with a commercial partner, Ag Biotech Pty Ltd. in August 2003. The International Patent has recently been published, and national phase patent application is underway for Australia, the USA, Brazil, India and Europe. Our commercial partners have sourced materials and purchased equipment for large-scale production of Magnet®, and produced a Technical Brochure for distribution to the industry.

Another major highlight was the continuation of large-scale field trials for research and product evaluation purposes. Applications to the APVMA to do such trials were approved on 9 December 2003. We conducted one large-scale field trial on 40 ha of cotton in the Darling Downs in December 2003-January 2004.

The attract-and-kill product (Magnet®) was commercially released by Ag Biotech for product evaluation purposes between mid-December 2003 and March 2004. Despite the late release and the widespread rain in January and March (which restricted the use of Magnet® because it is not rain-fast), about 13000 ha of cotton in the Macintyre Valley, St. George, Gwydir Valley, Lower Namoi Valley and the Darling Downs used the product. Data have been collated by consultants in each area, and will be analysed by the research team later this year.

To our knowledge, this is the first time an attract-and-kill product based on plant volatiles has been available on a commercial scale for cotton anywhere in the world. The product evaluation permit allowed material for the trials to be sold, and sales totalled approximately $150,000 for the season.

Small field experiments to test the attractiveness of the current attractant blend to green mirids and beneficials were conducted on faba beans, cotton and soybeans. The results indicated that Magnet® blend was moderately attractive to green mirids and to other sucking pests like Rutherglen bugs. We will be testing other attractant blends that can be used in an attract-and-kill approach for sucking pests. There appeared to be no significant attraction of the blend to most groups of beneficials, although a weak attraction to ladybirds and predatory bugs was observed.

PROJECT: 2.2.10 *Enhancing the insect tolerance of Australian cottons through conventional and transgenic traits*

STAFF:

Dr. Gary Fitt, CSIRO Entomology, Indooroopilly, QLD.
Dr. Moazzem Khan, QDPI, Emerald, QLD.
Dr. Lewis Wilson CSIRO Plant Industry, Narrabri, NSW.
Dr. Greg Constable CSIRO Plant Industry, Narrabri, NSW.

AIMS:

1. Commence field and laboratory studies of VIP3A proteins and other Cry proteins in several varietal backgrounds.
2. Complete field evaluation and sample collection from several Bollgard II varieties.
3. Identify study sites, collaborators and lines for assessment (including all commercial varieties, advanced breeding lines and some new germplasm)
4. Complete field comparisons of tolerance to mirids, aphids and Green vegetable bugs amongst all lines – work in conjunction with Dr. Tom Lei
5. Conduct large scale field evaluation of okra-nectariless cotton lines for mirid tolerance
6. Complete laboratory ELISA analysis of all BGII material
7. Complete write up of BGII, Ingard efficacy data

Following the development of this project proposal early in 2003, Dr. Fitt was appointed to a new position in CSIRO Entomology which involved transfer to Brisbane. In April CRDC advised that further funding for the project had been terminated and the CRC decided likewise to terminate its matching funding.

OUTCOMES:

We have demonstrated the excellent efficacy of the VIP3A proteins expressed in GM cotton. Two seasons of field efficacy studies have shown a high and consistent control of Helicoverpa armigera. The Vip3A technology from Syngenta will add an additional transgenic management

option for Helicoverpa to compliment the Cry proteins in BGII although there will be issues to consider about the best deployment strategy. At this stage Syngenta have delayed further development until a viable second gene is available to pyramid with VIP3A.

This project has contributed to the finalisation of the Resistance Management Plan for Bollgard II cotton which will now support the full commercial release of BGII varieties.

IPM systems and transgenic Bt cottons have provided considerable economic and environmental benefits to the cotton industry through dramatic reductions in pesticide inputs over the last 6 years. The work completed in this project, funded jointly by the Cotton CRC and CRDC, have supported those changes through improved understanding of the performance of transgenic cottons expressing the CryIAc and Cry 2Ab proteins and by early efficacy studies of new transgenes such as VIP3A.

In the first six months of this project we have built on the outcomes of previous projects to finalise Bt quantification using ELISA for the CryIAc/ Cry2Ab proteins in various varietal backgrounds and clarified the overall levels of protein in different plant structures. The work confirms the markedly higher concentration of Cry 2Ab achieved in all tissues compared with Cry IAc, but most notably in squares, the most vulnerable structures on the cotton plant.

Importantly the resistance management strategy for the commercial use of Bollgard II cotton has now been finalised. On the basis of enhanced efficacy, the strategy allows removal of the 30% cap previously applied to INGARD varieties, although all other aspects (refuges etc) remain the same as for INGARD. This guarantees that Australia maintains a highly conservative strategy likely to safeguard the clear environmental and production benefits of Bt cottons for a considerable period.

PROJECT: 2.2.12 POSTGRADUATE *Molecular diagnosis of Fusarium wilt of cotton in Australia*

STAFF:
Ms Lisa Gulino, PhD Student, CRC for Tropical Plant Protection, Indooroopilly, QLD
Dr Suzy Bentley, CRC for Tropical Plant Protection, Indooroopilly QLD
Dr Joe Kochman, DPI&F, Toowoomba, QLD.

Other Staff & Collaborators :
Dr Stephen Allen,
Ms Linda Swan,
Mr Wayne O'Neill,
Ms Sharon VanBrunschot.

AIMS:
- Finish sequencing of Australian Fov isolates (achieved September 2003)
- Optimisation of Real-time PCR diagnostic (achieved September 2003)
- Improved accuracy of Real-time PCR diagnostic (continuing)
- Application of Real-time PCR diagnostic to 'real' samples, including soil, seed and plant material (achieved September 2003)
- Finalise all lab work (minor work remaining)
- Submit thesis (Feb 2004)

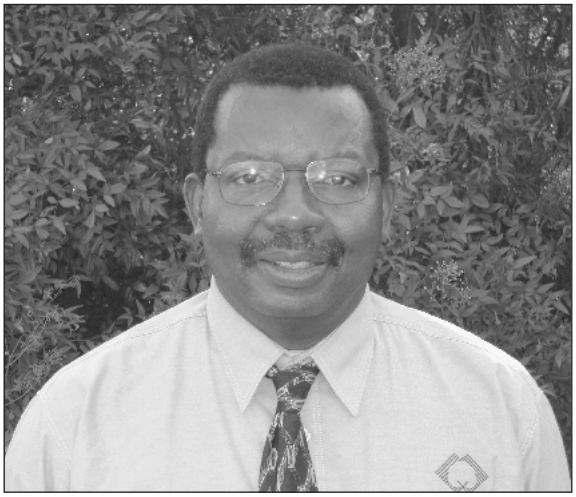
OUTCOMES:
Optimisation of the real-time PCR and the improved accuracy and sensitivity of the real-time PCR as compared to the traditional PCR test originally used was a real highlight. Another highlight was the ability of the Real-time PCR to detect Fov from 'real' samples, and at very low levels.

A rapid and highly sensitive real-time PCR based diagnostic has been developed for the identification of Australian strains of *Fusarium oxysporum f.sp. vasinfectum (Fov)*. The test has been validated and applied to the detection of Fov from 'real' samples. This diagnostic test will allow for:
- the direct detection of Fov from infected plant material, seed and soil
- more rapid turnaround times for detection (1-2days as opposed to 4 weeks using traditional methods)
- the ability to screen fields and seed for the presence of *Fov*, hence ensuring the pathogen is not spread
- rapid identification of new strains of *Fov* that may arise, either locally or from overseas
- the ability to be used as a research tool to further understand the epidemiology and etiology of (Fov).

Lisa Gulino, PhD Student.

Program Three Overview

Sustainable Farming Systems.



Program Three Leaders - Dr Lewis Wilson CSIRO Plant Industry and Dr Inakwu Odeh University of Sydney.

Key threats facing the industry include water use efficiency, management of pests, weeds and diseases, soil management, salinity risks and off farm movement of inputs. Consequently, the sustainability of cotton production depends on the development of strategies that ensure both profitability and efficient management of inputs and resources to minimize negative effects on the environment or indeed to enhance the cotton farm environment.

Program 3 continues to address these threats through a portfolio of research aimed at optimising the use of pesticides, fertilizers and water thereby reducing the opportunity for off-farm movement. Our research is also providing a fundamental understanding of crop growth and development and interactions with the soil that will be the basis for improving management. Issues such as integrated management of insects (IPM), weeds (IWM) and diseases (IDM), crop nutritional management, soil health and function and water use efficiency are emphasised. The integration and most effective use and management of transgenic cotton with herbicide tolerance or pest resistance genes is a major focus.

Much of the research is discipline focused, which is often essential for progress. However, emphasis is also placed on a farming systems approach. A farming systems scientist and several projects are addressing the challenges of understanding the interactions between elements of the systems, for instance the interactions between pest, water and nutritional management. This ensures outcomes are effectively integrated into the broader cotton agroecosystem to enhance both sustainability and profitability.

Highlights and Achievements

Mirids are emerging as a potentially important pest in Bollgard II cotton. This is due to reduced use of insecticides against Helicoverpa, which in the past also coincidentally controlled mirids. To improve management of these pests a workshop was held, bringing together research, extension and industry participants to review current research and identify research priorities. A further outcome was the development of a soon to be released Mirid Management Guide, bringing together the latest information and strategies for industry. Mirids are the subject of a major research effort looking at sampling, damage, thresholds, development of biopesticides and control. A new project is using rabbit protein as a marker on mirids to try and identify their key natural enemies. The rabbit protein is eaten with the mirid, and can be later detected in the gut of predators.

Integrated pest management (IPM) continues to be a major focus for research and development of revised Guidelines is well advanced. The new publication ' Guidelines for Integrated Pest Management in Australian Cotton, 2nd Edition' has been developed with input from a wide range of CRC entomologists, agronomists and extension officers. It is due for publication late in 2004. Further support has also been provided by

development of a web-based version of the Pest and Beneficial Guide. This tool is derived from the printed publication but has been updated with the latest information and more and better photographs and illustrations. It allows growers and consultants to rapidly identify all of the pests, predators and parasites, and also provides information of ecology, sampling and thresholds.

Weeds are a key threat to profitable production. Weed management options have been broadened by the release of the Roundup-Ready® cotton varieties, which are tolerant of the herbicide Round-up® early in their growth. The Cotton CRC has played a pivotal role in developing strategies to maximise the value of this technology for cotton growers and strategies to prevent the development of resistance to Round-up® in the weeds. A new project is specifically investigating the risks or resistance in model weeds. Other research is seeking to optimise herbicide use through use of thresholds, which take into account weed species, density and effect on cotton yield. This is showing promise as a tool to help improve herbicide management. Progress has also been made in management of weeds in dryland systems that include cotton. Fleabane is a major problem in these situations and a workshop was held to review knowledge and research to help growers to better manage this weed.

Drought continues to plague the cotton industry, putting water management as a high research priority. HydroLOGIC was recently released by the CRC as a tool to help improve on-farm water use efficiency. This decision support tool allows growers to enter data on soil moisture, crop growth and irrigation to forecast irrigation, ask 'what if' questions about delaying irrigation and calculate water use efficiency. Another significant initiative has been the development of the WATERpak Manual in collaboration with Program 4. This has brought together scientists from the Cotton CRC and other agencies to develop a manual that describes how plants use water, how to measure water use, methods for improving water use and for evaluating progress. Research continues to focus on elements of the water balance. A new lysimeter being installed at the ACRI will provide a resource for more detailed study of deep drainage rates under a range of farming systems. The use of effluent as a source of water has also been explored. Irrigation with treated sewage effluent caused large increases in soil nitrate-nitrogen, small increases in salinity, exchangeable magnesium, sodium and potassium, and small decreases in soil organic carbon. This suggests that continuous use of effluent may not be sustainable unless fields can periodically be managed with 'cleaner' water to help flush salts.

Possibly the biggest threat to cotton production is the various diseases, especially the devastating Fusarium Wilt as well as other economically significant diseases such as Black Root Rot and Verticillium Wilt. Screening for resistance to Fusarium by CRC scientists is showing useful levels of tolerance in selected cotton genotypes. Progress has also been made toward development of molecular techniques to allow fast accurate identification of the disease. Research indicates that delayed plantings of cotton suffer less from Fusarium, possibly because conditions are more favourable for plant growth and less favourable for the disease. Investigation of the role of weeds in the epidemiology of Fusarium also began but progress was delayed by the tragic death of the student, Richard Kent. Research with black root rot has shown that the strains affecting cotton are quite distinct from those collected from non-cotton areas, including native vegetation.

The Cotton CRC has an active soil health group and suite of coordinated projects. Regional studies of soil physical, chemical and hydraulic properties have continued, and provide the most comprehensive soils database available for any rural industry. This information was released for public use on CD as the 'Soil database and soil information system.' This allows users to interrogate the database for soils information and maps from a number of major cotton regions. Increasingly models are being used to combine a range of soil properties and understand and predict salinisation, deep drainage, acidification and carbon dynamics. The soil function project is progressing from where it has established interrelationships among influential soil properties affecting soil functions. Also a project on soil biology in relation to cotton cropping systems has deciphered differences in decline of soil microbial diversity in relation to cropping systems. There is potential for commercialization of a diagnostic measure of soil biological health. A new but related project in the soil health area involves collaboration with the University of Queensland through a PhD student who is investigating the interaction between the soil microbial diversity and the incidence of root diseases such as black root rot. Root carbon dynamics have also been investigated in detail. Net root weight by March (allowing for root losses and initiation) was of the order of 6-8 t/ha and carbon lost from roots (by root death) during a season ranged between 6 to 15 t/ha. This is the first measured data on root carbon dynamics in an irrigated Vertosol.

The advent of Bollgard II® with the potential for high early season fruit retention, resulting in imbalances between the demand for nutrients and the plants capacity to supply them is also looming as a potential problem. Cotton nutrition is therefore assuming a greater significance, especially in areas with a long history of cotton production or on more marginal soils. Recent research has begun to address these issues, with emphasis on sodicity, potassium and phosphorous. A new student has begun a project to understand the interactions between soil sodicity and cotton nutrition and growth. Vetch has been shown to be a viable natural way to increase soil fertility levels and reduce nitrogen inputs. However research also shows that vetch appears to improve soil structure and acidity, which further helps plant growth. Other research has shown that young cotton is very sensitive to salinity during its seedling stage, far more so than when mature. This has implications for evaluating the effects of salinity on cotton production.

Farming systems research continues to provide a broader understanding of the outcome of manipulating elements

of the production system. The long-term farming systems experiments are finishing this year with the final site a Warra returning to commercial production. Data from the sites is being collated for analysis and a report will be prepared. Research has shown that sowing vetch as a rotation crop increased exchangeable potassium and nitrogen. Compared with continuous cotton, it also resulted in less nitrate-nitrogen leaching before sowing cotton. Comparisons of 'old' and 'new' farming systems showed the advantages of the herbicide tolerant and pest resistant transgenic varieties. The experiments also highlighted the increased infiltration with retained stubble systems and risks of waterlogging. In other research, progress has also been made in overcoming problems with the retained stubble systems, particularly in taking advantage of increased infiltration but avoiding waterlogging. Such experiments continue to illustrate the need to put components together and test them.

Project Summaries

PROJECT: 3.1.08 *Ecology and development of management strategies for fusarium wilt in cotton.*

STAFF:
Ms Linda Smith, QDPI, Indooroopilly, QLD.
Dr Joe Kochman, QDPI, Toowoomba, QLD.
Dr Suzy Bentley, CRC for Tropical Plant Protection, Indooroopilly, QLD.
Other Staff & Collaborators
Ms Linda Swan, QDPI, Toowoomba Qld
Mr John Lehane, QDPI, Toowoomba Qld.
Mr W O'Neill, QDPI, Indooroopilly, Qld.
Mr G Salmond, QDPI, Dalby, Qld.
Miss Lisa Gulino, PhD student, CRC for Tropical Plant Protection, Indooroopilly, Qld.

Other Collaboration include: CSIRO, NSW Agriculture, Cotton Seed Distributors, UNE, and Deltapine.

BACKGROUND:
Fusarium wilt was first identified on the Darling Downs in Queensland more than eleven years ago in March 1993. Since then the disease has been recorded in most cotton production districts in Queensland and New South Wales except Emerald (Qld), Tandou and Hillston (NSW). To date, the disease has not been recorded in the Northern Territory or Western Australia.

AIMS:
1. Complete planting of field trials by December 2003 and complete disease assessment in germplasm.
2. Complete disease surveys to determine the extent of the fusarium wilt affected area by the end of May 2004.
3. Complete the monitoring of pathogen diversity, maintain the reference collection and wilt incidence database.
4. Field test PCR detection system and fine-tune.
5. Develop information packages and extend to the industry as results become available.

OUTCOMES:
There were some promising advances in resistance in germplasm and lines, with raw data indicating that one line out-yielded the Sicot 189 standard by about 25%. This line has recently been released as Sicot F-1 and was based on material initially identified for its disease resistance in a previous project and assessed in each generation of its development in the field trials at "Cowan".

During 2003/2004 a total 137 diagnostic samples were examined for the fungus *Fusarium oxysporum fsp. vasinfectum* (Fov) at DPI&F Indooroopilly. Of these, 57 returned a positive result for Fov; only one was race VCG 01112, the rest being race VCG 01111. There were new records of the disease from more farms and fields in districts where the disease has already been recorded, but not from districts where the disease has not yet been identified.

The current cycle of crop rotation trials is complete and final data collections are in progress. Information on the effect of some specific crop rotations on Fusarium wilt incidence will be made available as soon as these data are analysed.

A more precise and sensitive DNA diagnostics test is being applied to soil samples taken from the glasshouse and field trials as well as soil from Fusarium wilt and non-Fusarium wilt fields. The new format is able to differentiate the two Fov races from other races of Fov, from isolates of Fov, Lineage A (isolated from native species of cotton, supplied by Dr Bo Wang CSIRO) and other isolates of Fov.

The test is currently being applied to soil DNA extracts obtained by several different methods to finalise the method of soil extraction to be used with the new format. It is hoped that the test will become a useful research tool, particularly in investigating the soil population of Fov under different varieties and agronomic practices.

Linda Smith in the Laboratory in Indooroopilly, Queensland.

PROJECT: 3.1.09 *Pathogenicity and Diversity of Thielaviopsis basicola*

STAFF:
John Harvey, PhD Student, UQ, St Lucia QLD.
Dr Elizabeth Aitken, UQ, St Lucia, QLD
Dr David Nehl, NSW Agriculture, Narrabri NSW.

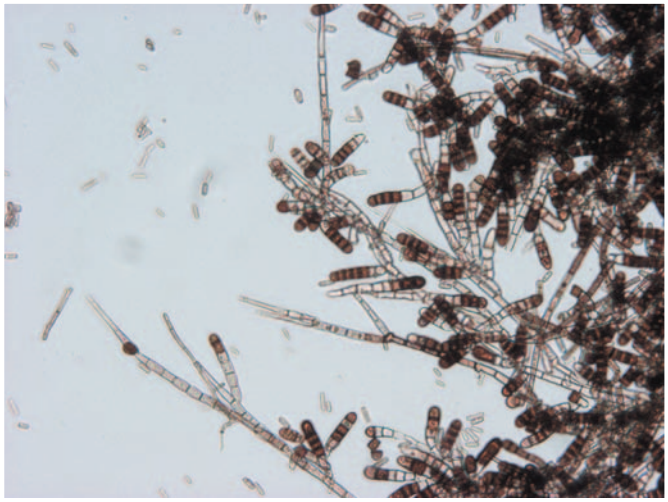
John Harvey, PhD Student.

AIMS:
- Perform pathogenicity trials, with particular emphasis on any strains isolated outside of cotton properties.
- Complete molecular diversity analysis using sequencing and AFLPs
- Finish culture collection

OUTCOMES:
The continued analysis of the data from the surveys of cotton growing catchments has given a clearer picture of how black root rot spreads. Pathogenicity work combined with genetic diversity analysis has shown some interesting data as to how host specific the various isolates are, particularly in regard to cotton.

To better target research into combating BRR, this project is providing information on the genetic diversity of *T.basicola* and aggressiveness/host specificity of Australian strains. Molecular marker technologies have been employed to estimate genetic diversity, with pot trials being used for disease assessment. A particular area of focus was the origins of the black root rot on cotton farms, which was investigated through collecting soil samples from around cotton properties and screening them for the presence of T. basicola.

Surveys of catchments surrounding cotton properties found the disease not to be present in undisturbed soils (such as forests) and only rarely present in highly disturbed sites (such as roadsides). The molecular markers techniques which were developed for this organism have shown that all cotton infecting strains of *T. basicola* are genetically similar, and most importantly, genetically different from those which infect other hosts, and the ones found in disturbed sites. Pathogenicity work has shown that this makes the isolates from disturbed soils unlikely to be able to cause the disease on cotton plants. Work is ongoing to expand the suite of molecular tools to further understand this disease, in conjunction with disease assessment work to provide the information required to manage the disease.



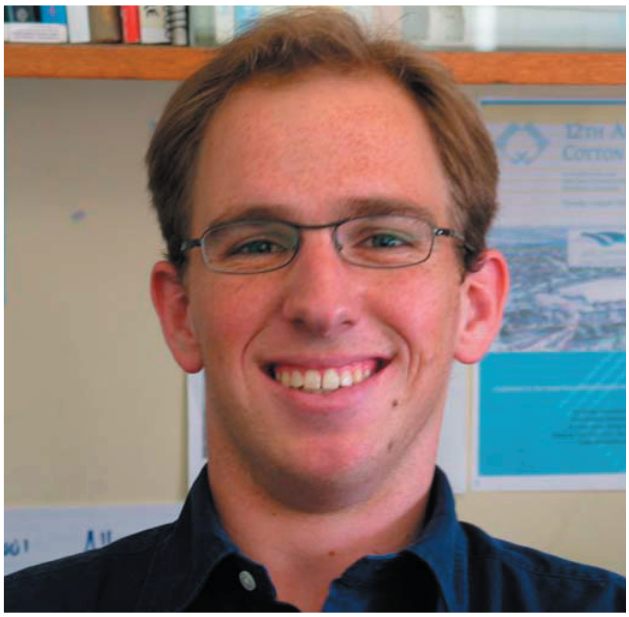
T. basicola spores.

PROJECT: 3.1.20 *Characterising soil structural stability and form of sodic soil used for cotton production*

STAFF:
Mr Simon Speirs, PhD Student, USYD, Sydney, NSW
Dr Stephen Cattle, USYD, Sydney, NSW
Dr Nilantha Hulugalle, NSW Agriculture, Narrabri, NSW
Dr Damien Field, USYD, Sydney, NSW
Dr Balwant Singh, USYD, Sydney, NSW

BACKGROUND:
The interaction of salts and sodium in cotton–growing soils (i.e. Vertosols) is not well understood in the Australian environment. Thus, the research undertaken in this project addresses the sustainability of soil physical condition given the use of irrigation water of reduced quality, and where high quality water is available, the structural affects that may occur where sodicity is an issue.

AIMS:
The major project objectives during the past year were:
- To sample soil from both the lower Namoi valley and the lower Gwydir valley.
- To ascertain major physico–chemical attributes and soil structural stability of soil samples from eight fields of the Darling, Hillston, Namoi and Gwydir cotton-growing valleys.



Simon Speirs PhD Student.

- To irrigate large soil cores collected from two fields in each of the four nominated regions and quantify the impact of increasing sodium on soil structural condition.

OUTCOMES:
Each of the above objectives was achieved. In June 2003, two irrigated cotton fields from each of the Namoi and Gwydir valleys were sampled.

The major physico–chemical properties of these soils have been determined (e.g. exchangeable cation concentrations, soil solution cation concentrations, organic carbon contents, mineralogy). The only soil property not fully analysed, the contribution of particular clay minerals, will be quantified during the later part of 2004.

An assessment of soil structural stability was conducted on soil from the irrigation furrow. This was completed using three different energy inputs: minimum (spontaneous dispersion), medium (end–over–end disruption) and large (ultrasonic agitation). In addition the influence of water quality on the stability of each sample was determined using end–over–end disruption at three levels of electrical conductivity each with four levels of SAR (0, 7.5, 15 and 30).

Throughout the year soil cores excavated in the field (168 in total) have been irrigated in the laboratory using six treatment solutions.

In studying the effect of water quality on soil physical condition, specifically structural stability and structural form, cotton fields in four major cotton growing regions are being compared. In each of the Bourke, Hillston, Moree and Wee Waa regions a number of large soil cores were obtained, along with bulk soil, from an irrigation furrow mid way along the tail drain of two separate fields.

Initially, analysis of soil structural form will be completed and a description of soil macropore and solid attributes obtained. It is then anticipated that irrigation treatments will be assessed to determine the affect of irrigation on soil physico–chemical attributes i.e. structural stability, exchangeable cations and soil solution cations. In conjunction with information obtained describing the effect of water quality on soil structural stability and physico–chemical attributes it is anticipated that a model of soil structural stability will be derived.

Using this model in combination with a description of changing soil structural form under differing irrigation regimes this information will equip growers, extension officers and researchers with a clearer understanding of the role of water quality in the management of Vertosols soil.

Simon Speirs collecting soil cores near Bourke.

Soil cores collected from Hillston prior to preparation for irrigation

PROJECT: 3.1.21 *Best weed management strategies for dryland cropping systems with cotton*

STAFF:
Dr Hanwen Wu, DPI &F, Toowoomba QLD
Dr Steven Walker, DPI &F, Toowoomba, QLD
Dr Ian Taylor, NSW Agriculture, Narrabri, NSW
Mrs Vikki Osten, DPI&F, Emerald, QLD

AIMS:
- To initiate studies on seed-bank dynamics of 5 summer weeds 2 long-term experiments are currently measuring emergence and seed persistence at different depths and soils for barnyard grass, liverseed grass, bladder ketmia, sowthistle and fleabane.
- To investigate herbicide options for improved fallow weed control 2 field experiments on control of fleabane in winter fallows, and 2 collaborative experiments on sowthistle in winter and summer fallows were successfully completed.
- To monitor the impact of weed management strategies on following components of crop rotations 2 long-term field experiments have been initiated on fleabane control in wheat / summer fallow and winter fallow / sorghum situations.
- To investigate options to improve reliability of weed control in sorghum 2 field experiments were successfully completed, one infested with barnyard grass and bladder ketmia in SQ, and other with sweet summer grass in CQ.
- To investigate the impact of manipulating sorghum agronomy on improving competitiveness against weeds 4 innovative field experiments were successfully completed in SQ and CQ.
- To plan and begin negotiations for a new jointly funded project on managing summer weeds in dryland cropping systems

OUTCOMES:
A project proposal was submitted to Weeds CRC and GRDC successfully obtaining 50% funding, and discussions have been held regarding involvement in the proposed new Cotton Catchment Communities CRC.

Major advances have been made during this year to address the priority weeds issues identified in the scoping study during 2001/02. Research has focused on developing better management of bladder ketmia, barnyard grass, liverseed grass, sowthistle and fleabane. The approach is to strategically manage these weeds, with a particular emphasis on developing better control practices for the weak-links of crop rotations and reducing the economic impact.

This year's research investigated herbicide options for effective fallow control, better in-crop weed control using combination of herbicides and crop competition for wheat and sorghum, and the seed-bank dynamics of these key weeds with regard to timing of weed control treatments.

Field experiments identified some very effective herbicide treatments for control of sowthistle in winter and summer fallows and for fleabane in winter fallows. These include a number of glyphosate mixes, as well as non-glyphosate based treatments, which are important for strategies to prevent development of glyphosate resistance.

As fleabane has become the most important weed issue for many dryland growers in the recent years, the team took the initiative to organise a specific workshop on this problem weed in February 2004. Weed control costs in fallows have doubled for many growers with fleabane, and zero-tillage systems were threatened due to problems with chemical control of this weed. At this workshop, results from current industry research were collated, gaps identified, and draft management strategies developed. These strategies are being tested in the recently established field experiments. The delegates regarded the workshop as highly successful and beneficial, as it provided them with best information currently available for control of this problem.

Field experiments in SQ and CQ validated that the best options for controlling annual grasses, such as barnyard, liverseed and sweet summer grass, were atrazine applied prior to the sowing rain and atrazine + metolachlor incorporated at planting. These provided 95-100% grass control, whereas other atrazine treatments were much less effective.

Sorghum row spacing had a large impact on both yield and weed suppression in the recent wet summer in SQ. In these growing conditions, weed-free yields were substantially greater in solid planting compared with single and double skip sowing. Weed growth was similar between the 2 rows at 1m spacing irrespective of the spacing of the adjacent rows. However, weed growth was at least double in the wider inter-row space than in the 1m inter-row space.

This indicates that weed management may need to be fine-tuned for the larger inter-row space to minimise the impact of uncontrolled weeds on yield and replenishment of the seed-bank. This will be investigated further next season. Information on the impact of sorghum varietal characteristics, such as tillering, maturity, seedling vigour, and stay-green, and sowing density on weed suppression was also obtained but not as yet analysed and interpreted.

Emergence patterns of barnyard grass differed greatly from that of liverseed grass. Barnyard grass emerged in a series of flushes throughout late spring and summer, in contrast to mainly one large flush of liverseed grass in late spring only. If this is a consistent trend, then management of these grasses could be treated differently depending on the sowing time of the summer crop. This will be investigated further next season.

PROJECT: 3.1.22 *Weed Resistance Risk Management Modelling in Glyphosate Tolerant Cotton*

STAFF:
Jeff Werth. PhD Student, University of Adelaide.
Dr Chris Preston. University of Adelaide, Adelaide SA.
Dr Grant Roberts CSIRO Plant Industry, Narrabri NSW.
Collaborators
Dr Ian Taylor, NSW Agriculture, Narrabri, NSW.
Dr Jeanine Baker, University of Adelaide, Adelaide, SA.

Jeff Werth, PhD Student.

BACKGROUND:
Glyphosate tolerant (Roundup Ready®) cotton is now widely used in the cotton industry and is likely to increase with new Roundup Ready® technology on the horizon. There are currently no examples of herbicide-resistant weeds in cotton systems in Australia, largely because of a diversity of herbicide inputs, cultivation and hand chipping of weeds. However the increased use of glyphosate associated with glyphosate tolerant cotton may increase risks of resistance evolution and species shifts.

AIMS:
The aim of this work is to develop a framework to assess the potential for glyphosate resistance to develop in Roundup Ready cotton systems. The major objectives for the past year were to complete the grower survey started last year, and collect data for the first year of the systems experiment. Other objectives were to undertake a competition study and dose response experiments.

OUTCOMES:
A survey of 40 growers, 10 in each of the Namoi, Gwydir, MacIntyre and Darling Downs regions was conducted. The aim of this survey was to investigate weed populations and management strategies and herbicide use patterns in Roundup Ready® and conventional crops. This survey has been completed and data analysed. A paper has been written that is in the editing stage before submission to a journal.

A systems experiment designed to investigate the population dynamics of *Echinochloa colona* (Barnyard grass) and *Urochloa panicoides* (Liver-seed grass) under a range of weed management practices is underway on an irrigated site at ACRI. An additional non-irrigated site was selected at Bellata, however due to lack of rainfall the area was not planted. The first season of data for the experiment at ACRI has been collected and is currently being analysed.

An experiment to measure the effect of different planting densities on the growth and reproduction of Echinochloa colona and Urochloa panicoides in terms of biomass and seed production (Intra-specific competition) is nearing completion. This experiment also examined the effect of the densities of the two weeds on the yield and biomass of cotton (Inter-specific competition). This experiment was conducted in 1m x 1m pots, and data from it is currently being analysed.

Experiments were undertaken to investigate the response of Echinochloa colona and Urochloa panicoides to various rates of glyphosate.

The information gained from this work will form the basis for management of the new Roundup Ready Flex®, a glyphosate tolerant cotton variety with improved gene expression proposed for release in 2007. Scenarios generated by the model will allow the OGTR to make assessments on how the addition or subtraction on weed management options may affect the potential for glyphosate resistance to occur in cotton weeds.

Experiments have been established examining the population dynamics of the two model weed species. The treatments consist of an IWM approach with and without the Roundup Ready® technology, a half IWM approach with the Roundup Ready® technology, and utilizing the Roundup Ready® technology only.

Results from these experiments will be used to develop a model that will predict the likelihood of glyphosate resistance evolution over a range of management strategies for a range of weed species. This will facilitate the development of sustainable weed management practices in Roundup Ready® cotton.

PROJECT: 3.1.26 *Maintaining a functional soil system for improved cotton production*

STAFF:
Dr. Damien Field, USYD, Sydney, NSW
Professor Alex McBratney, USYD, Sydney, NSW.
Collaborators
Dr. Peter McGee, Dr. David Nehl, Jan Skjemstad,

BACKGROUND:
Previous research of cotton growing soil has highlighted that some of the soil properties likely to restrict cotton growth may be broadly catagorised into organic carbon decline, soil structural limitations, pH limitations, salinity/sodicity, and a lack of information regarding how changes in soil microbial diversity may influence cotton production. This research project was initiated look at the interrelationships between the soil physical, chemical and biological properties that can be used to develop a set of indicators enabling the maintenance of soil function for cotton production.

AIMS:
- Characterising the soil properties, substrate functional microbial diversity and soil factors (Namoi samples) that influence soil function.
- Sampling northern NSW commence sampling identified soil profiles that characterise the Queensland cotton growing regions.
- Determine the interrelationships of the soil factors and use these to begin to build the postulated soil function model.

OUTCOMES:
The samples from the 20 NSW soil profiles used for cotton production have been analysed using near and mid infra-red (NIR-MIR) spectroscopy in collaboration with Jan Skjemstad (CSIRO, Adelaide). The spectra obtained have been used to estimate soil physical and chemical properties (e.g. clay content, CEC, ESP).

Combining the data from the assessment of the soil properties using the conventional techniques with the information from the NIR-MIR spectra will improve the NIR-MIR estimates of the soil properties and enable the uncertainty to be also assessed. The advantage of the NIR-MIR technique is that it enables the estimation of a range of soil properties in a timely and cost effective manner compared to conventional soil analysis.

Work is being undertaken with Jan Skjemstad, using the carbon data from NIR-MIR spectra, to model the carbon dynamics of soil used for cotton production.

Estimates of the soil hydraulic properties (i.e. the soil water retention and infiltration) of the soil cores have been completed using the evaporation method. This has involved employing the Generalised Likelihood Uncertainty Estimation (GLUE), providing an easy implementation of Stochastic inverse modelling, which gives a good estimate of the uncertainty of the measurements used to estimate the soil hydraulic properties (paper submitted to Geoderma).

Ancillary data has been extracted from the soil baseline database (CRC3.1.11) to be processed using Latin Hypercube sampling procedure enabling representative soil profiles of the Queensland cotton growing areas.

Work is continuing on measuring and identifying the interrelationships between the basic soil physical and chemical properties of cotton growing soil collected from NSW that will form part of the MDS and the sampling protocol of soil from cotton growing areas in Queensland has been identified.

PROJECT: 3.1.29 *Maintaining profitability and soil quality in cotton farming systems.*

STAFF:
Dr Nilantha Hulugalle, NSW Agriculture, Narrabri NSW.
Tim Weaver, PhD Student, NSW Agriculture, Narrabri NSW.

AIMS:
The aim of the project is to determine the long-term effects of rotation crops and stubble management on carbon sequestration, soil quality and nutrient leaching; and growth, yield and profitability of succeeding cotton. Key management issues considered in the project are tillage systems, rotation crops and stubble management systems, in particular, sowing cotton into standing wheat stubble, and their effects on soil carbon stocks, sodicity, salinity, deep drainage, profitability and root growth.

OUTCOMES:
Management problems with the cotton-vetch rotation included poor weed control and slow decomposition of vetch stem material such that at cotton picking a substantial amount of undecomposed vetch stubble was still present in the bed. Cotton yielded 4.0 ba/ha with cotton-vetch-cotton, 6.0 ba/ha with continuous cotton, 8.4 ba/ha with summer/winter fallow-cotton-wheat and 8.8 ba/ha with summer fallow-vetch-cotton-wheat.

Average cumulative gross margins were 2286 $/ha for cotton-vetch, 3341 $/ha for continuous cotton, 3406 $/ha for cotton-wheat (stubble incorporated) and 3637 $/ha for cotton-wheat (standing stubble)-vetch. Dr. Peter Grace and his team made measurements for nitrous oxide emissions in continuous cotton and cotton-vetch treatments in this trial. Mr. Nathan Eulenstein used these same treatments for his project on nutrient leaching (see report presented elsewhere in this annual report).

The continuous cotton treatments (both minimum and conventional-tilled) in the long-term tillage/rotation experiment in Field C1 at ACRI were sown with cotton in October. The cotton-wheat treatment was in its fallow phase and was not sown. Other researchers also made various

Dr Nilantha Hulugalle conducting soil analysis.

measurements in this experiment. Black root rot severity and spore numbers were higher with conventional-tilled than with minimum-tilled continuous cotton. Lowest spore number was detected in the minimum-tilled cotton-wheat plots.

Cotton lint yields were 6.3 ba/ha with conventional-tilled continuous cotton and 7.6 ba/ha) with minimum-tilled continuous cotton. Wheat yielded 2.8 t/ha in December 2003. Cumulative gross margins between June 2000 and December 2003 were 5262 $/ha with conventional-tilled continuous cotton, 5640 $/ha with minimum tilled continuous cotton and 5043 $/ha with minimum-tilled cotton-wheat (standing stubble).

The sites at "Buttabone" near Warren and "Woodgrain" near Boggabri were not sown in 2003 due to water shortages.

Key results are as follows:

- Analysis of results from Merah North indicated that except for sodicity indices, residual effects of the rotations were absent. Soil organic carbon has commenced declining from the high values observed in 2002 after the wheat-sorghum sequence.
- Soil carbon levels were higher with standing wheat stubble at Boggabri and Field C1 in ACRI but not in Dr. Nehl's experiment in Field 4 at ACRI. Wheat in the latter site was not fertilised.
- Sowing vetch as a rotation crop increased exchangeable K in the short-term and N in the medium to longer-term. It also resulted in a low concentration of nitrate-N throughout the profile before sowing cotton. Continuous cotton on the other hand showed a large bulge of nitrate-N at 90-120 cm, indicating that it had leached through the profile in the five weeks before sowing. By mid-season nitrate-N concentration had fallen with continuous cotton whilst it increased with cotton-vetch.
- Effluent water was moderately saline, and compared with river water, had higher concentrations of Na and Cl, nitrate-N and K, and lower concentrations of Ca and Mg. Irrigation with treated sewage effluent at Federation Farm caused large increases in nitrate-N, small increases in exchangeable Mg, Na and K, and small decreases in SOC. Salinity increased only in the 0.1-0.6 m depth. Gypsum application resulted in lower nitrate-N accumulation by 2003 but did not affect any other soil property or deep drainage between September 2001 and late January 2002.
- Nutrient samplers for extraction of soil water samples and access tubes for soil water content measurements were installed in Field D1 at ACRI. Soil cores were taken in May and December 2003 at Field C1, Merah North, Wee Waa and Boggabri (May only), and Federation Farm and Field D1 in September 2003 and May 2004 to evaluate deep drainage with the chloride mass balance model.
- Deep drainage during the 2002-2003 cotton season ranged from 4 mm in poorly-structured, sodic soils to 159 mm in well-structured, non-sodic soils. Mr. Weaver spent some time at Griffith University in November 2003 continuing with pesticide analyses in selected soil samples. No organo-chloro pesticides were detected at depth.
- Root measurements using the minirhizotron system were made during 2003-04 cotton season in Field D1 on continuous cotton and cotton-vetch treatments as these were the only treatments which had completed a rotation cycle.
- In both sites, root turnover patterns were similar with mean turnover rates peaking during the mid-December to early January period, with mean values of about 10 g/m^2/day being similar in both locations. Net root weight by March (allowing for root losses and initiation) was of the order of 6-8 t/ha and carbon lost from roots (by root death) ranged between 6 to 15 t/ha.

FUTURE MILESTONES:

- Sow winter rotation crops in May-June 2004 and complete harvests by December 2004. Sow cotton and summer rotation crops in October-November 2004 at ACRI sites, and Warra. Complete economic analyses for trials in Fields D1 and C1 at ACRI. Performance indicator for this objective is to have winter crops sown by June 2004 and harvested by December 2004, and cotton by November 2004 and picked by May 2005.
- Conduct pre and post season soil sampling to evaluate drainage with the chloride mass balance method and EM38 surveys in lower Namoi sites. Soil water samplers

Clearing vetch stubble from furrows.

installed in cotton treatments in Field D1 at ACRI, Wee Waa and Merah North for nutrient leaching monitoring. Performance indicators are to have EM-38 surveys completed by June 2005 and soils sampled and prepared for analyses by May 2005.

- Measure root growth in rotation experiment in field C1 and D1 at ACRI. Performance indicators are to have root images collated and prepared for image analysis by June 2005.
- Sampling for soil quality at ACRI (Fields C1, D1), Boggabri, Goondiwindi, and Merah North. Data for economic analyses collected & analyses commenced after cotton harvest. Sow winter rotation treatments. Commence soil analyses. Performance indicators are to have soils sampled between March-May 2004 analysed by December 2004, and those sampled after December 2004 prepared for analysis.

INITIATIVES & BREAKTHROUGHS

- Previously it was thought that cotton was highly tolerant to high levels of salinity. It appears, however, that during the seedling stage cotton is quite sensitive. Data collected from 9 fields on 5 farms over the past 3 years indicates the expected yield losses as soil chloride content at sowing increases.

- The curve suggests that yield losses of the order of 50% would occur when soil chloride levels in the 0-60 cm depth at sowing are of the order of 5.6 t/ha. The corresponding EC_e for this data set is 1.4 dS/m. This figure is very much lower then the 7.7 dS/m which is used in many models of salinity risk for cotton. Occurrence of similar values later in the season does not have any effect on cotton yields.

- These findings also suggest that cotton in many fields which are currently classified as low salinity risk may in fact be prone to salt-mediated yield losses. At the same time cotton growers may be underestimating the potential risk involved in growing cotton in these fields without allowing for an adequate leaching fraction (~20%). The detrimental consequences on their profitability and on soil and water quality can be substantial.

Seeding into vetch stubble.

PROJECT: 3.1.30 *Enhancing the impact of early season predation on Helicoverpa spp.*

STAFF:
Dr Sarah Mansfield, CSIRO Entomology, Narrabri NSW.
Dr Geoff Baker, CSIRO Entomology, Canberra ACT.
Dr Lewis Wilson, CSIRO Plant Industry, Narrabri NSW.

OUTCOMES:
Research to identity the key predators of Helicoverpa continued using the H. armigera specific monoclonal antibody in an ELISA assay. This technique has not worked reliably across a range of taxa. Results show it has a high detection rate but short retention time in *Geocoris lubra*, longer retention time and detection rate in *Nabis kinbergii*, low detection and low retention in *Dicranoliaus bellulus*, and virtually no detection in *coccinellids*. Using this technique Geocoris and Nabis stand out as major predators but the results are likely confounded by the problems with detection.

A new antibody was tested late in the project. This uses a rabbit protein marker. The marker labels prey that can then be exposed in the field. Subsequently, predators are collected and tested for the presence of the rabbit protein. In preliminary laboratory experiments, this technique performed very well. In particular for two beetle species, *D. bellulus* and *Hippodamia variegata*, the technique had both high retention and detection. The rabbit marker ELISA is more sensitive than the H. armigera monoclonal ELISA.

Initial field experiments confirmed the laboratory studies. Much greater levels of predation were detected with the rabbit protein ELISA than the H. armigera ELISA. For instance Dicranolaius bellulus showed 63% predation with the rabbit protein and only 18% with the H. armigera

protein. Coccinella transversalis showed 24% vs 5 %, and nightstalker spiders showed 33% vs 8% respectively.

This technique shows great promise as it can be used to label a range of prey species (eg mites, aphids, mirids). Such information on 'who eats who' and which predators appear to most influential will be invaluable in refining the use of beneficials in IPM systems.

PROJECT: 3.1.34 *Dynamic modelling of soil physical-chemical processes as indicators of soil health in the cotton-growing regions*

STAFF:
Dr Inakwu O.A. Odeh, USYD, Sydney NSW
Professor Alex. B. McBratney, USYD, Sydney, NSW
Collaborators
Dr John Triantafilis, USYD, Sydney, NSW.
Mr Nathan Odgers, USYD, Sydney, NSW.

BACKGROUND:
Prior to this project, reliable soil information was lacking or existed in scattered and uncoordinated patterns in the cotton-growing regions.

AIMS:
- To complete field work in the western Lower Namoi Valley and subsequent soil analysis.
- Continue to update the soil database and work on the GIS and mapping.
- Upgrade the Cotton CRC Soil Database and Soil Information System with the addition of data and digital soil property maps from upper Namoi, Bourke and St George irrigation districts.
- Complete sample analysis for soil chemical and physical properties for the western lower Namoi valley and incorporate this to the rest of the catchment for catchment modelling
- Carry out a dynamic modelling of landuse change in the lower Namoi Catchment as influenced by external (water supply) and internal (soil and physical landscape, present landuse patterns, etc.).
- To compile the whole cotton soil database and write the big report.

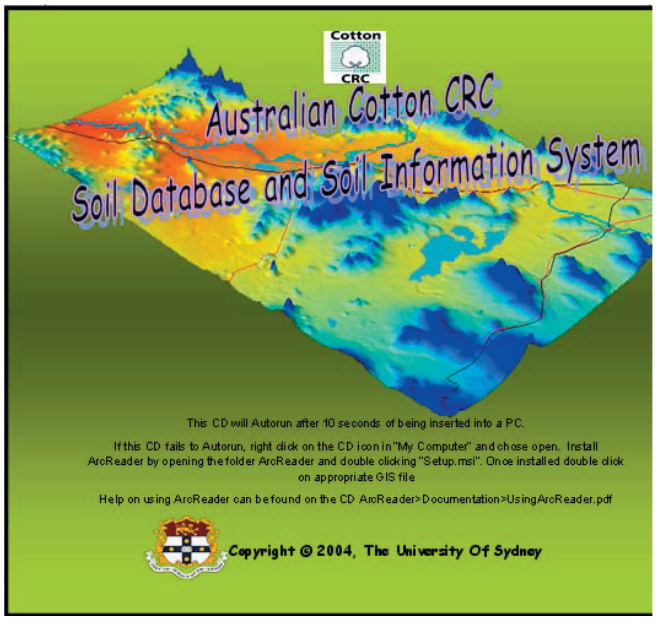
Glossary of Soil Properties Measured and Included in the Database are soil pH, Electrical conductivity, Bicarbonate extracted phosphorus (P), Exchangeable basic cations, Effective Cation Exchange Capacity (CEC), Organic carbon (OC), Total organic nitrogen and Particle-size fractions (clay and silt and sand).

OUTCOMES:
The outcome of this project is a huge amount of both quantitative and qualitative soil data incorporated in a Soil Database covering much of the cotton-producing regions of New South Wales and south-western Queensland.

The database initially covers the cotton-producing areas in three NSW northern and border river valleys: the Macintyre, Gwydir and the Lower Namoi, in addition to the Lachlan valley.

The data have been incorporated into a Microsoft Access database form. This form includes a 'Database Assistant' to make it easy to retrieve appropriate soil data for a specific region/area and purpose. The Database Assistant, which is written into CDROMs for easy distribution to the end-users, also facilitates the updating and maintenance of the database itself.

The Soil Database and Soil Information System were launched by the NSW Minister for Primary Industries, The Honourable Mr Ian MacDonald at the Moree Cotton Trade Show in May 2004.



The Australian Cotton CRC Soil Database and Soil Information System (CDROM)

PROJECT: 3.1.35 *Sustainable farming systems: Optimising cotton farming systems using new technologies.*

STAFF:
Dr Grant Roberts, CSIRO Plant Industry, Narrabri NSW
Clare Felton-Taylor, CSIRO Plant Industry, Narrabri NSW.

AIMS

The aims of this project are to initiate innovative farming systems experiments to develop viable and sustainable cotton cropping systems, particularly:

- New vs Old system – A large scale replicated experiment comparing a new vs old cotton system was established to quantify the advantages of our advancing technology. The new system consisted of a Bollgard II Roundup Ready variety planted into, sprayed out wheat stubble, IPM thresholds, optimum inputs (N, Pix, water etc) vs a conventional system that is based on prescription farming practices. Measurements included water use (in conjunction with Dirk Richards), insect numbers, crop inputs, growth parameters, cotton yield and quality.
- An experiment to examine the effect of Roundup Ready herbicide on early season insects was conducted (in collaboration with Lewis Wilson). This was the second season of this work and it again showed there are marginal effects of glyphosate on a range of insect species.
- The effects of late season pix on plant growth, yield and fibre quality were examined on Bollgard II and conventional crops. This procedure was examined across three times of planting, from early to late, to be able to generate differences in plant growth and boll maturing effects.
- A small ecological study was initiated to examine why roadside cotton volunteer establishment is low.
- Roundup Ready – the supervision of the postgraduate project being conducted by Jeff Werth on the potential for resistance to develop in Roundup Ready cotton systems proceed as planned.

Other aims are to 1) Coordinate collaborative research into cotton based farming systems, 2) Fibre quality measurement (Geoff Naylor, Geelong), 3) CRC dryland farming systems experiment (Warra, QDPI), 4) Roundup Ready management discussions and proposals, 5) Impact of temperature extremes on cotton performance (Michael Bange), 6) Application of crop simulation within the Australian cotton industry (Dirk Richards), 7) Physiology of high retention crops (Michael Bange), 8) The effect of herbicides on soil microbiology around transgenic crops (Gupta and Oliver Knox).

The final aim is promotion of CRC farming systems research at field days, conferences and industry press.

OUTCOMES:

- New vs Old System – This experiment was completed but the results were unexpected. The sprayed out wheat stubble appears to improve infiltration rates such that when additional rainfall occurs after an irrigation event then severe waterlogging can occur. In conjunction with Dirk Richards this was measured and compared to limited water regimes in both the old and new systems.
- Roundup Ready herbicide effect on insects – A second season was conducted on this research. No major effects were noted of the herbicide on either beneficial or damaging pests.
- Late season pix – Late season pix was examined on Bollgard II and conventional crops with no effects on yield evident across three times of sowing.
- Ecological study- A roadside experiment was established around ACRI and neighbouring cotton farms. Patches of areas were identified to establish why volunteers fail to establish readily on roadsides. The dry start limited this experiment but three sites were monitored. All three had very low numbers of plants establishing.
- Roundup Ready - Mr Jeff Werth the PhD student, has proceeded extremely well on the project examining the potential for glyphosate tolerant weeds to develop in Roundup Ready cotton systems.
- CRC Farming Systems Experiments - The CRC farming systems site at Warra continued preparing for the final year of cotton and the end of the trial.
- Extension - Farming systems research has been highlighted at a range of venues including field days CCA, CRDC and CSD conferences and grower discussion groups.
- Dryland farming systems experimentation on Roundup Ready technology was not achieved due to the late start and lack of experimental sites.

PROJECT: 3.1.36 *Nutritional constraints to efficient cotton production*

STAFF:
Dr Ian Rochester, CSIRO Plant Industry, Narrabri NSW.
Dr Lewis Wilson, CSIRO Plant Industry, Narrabri NSW
Greg Roberts, CSIRO Plant Industry, Narrabri NSW.

BACKGROUND:
This project evaluates the inclusion of legumes in cotton cropping systems and assesses nutritional problems experienced in cotton crops.

AIMS & OUTCOMES:

- Conduct regional trials to assess nutritional problems in cotton and examine K nutrition closely. Experiments and trials form Trangie to Emerald have been included in the surveys conducted over the past year. Potassium nutrition of the cropping systems experiment has continued and two new experiments examining K nutrition of Bollgard II cotton has been initiated.
- Review literature pertaining to potassium nutrition. This has been underway since the visit of Glen Harris (USA) but has been complicated with the interactions

of phosphorus and sodium.
- Determine calibrations for nutrient status using NIR technology. Leaf nutrient content has been reasonably well predicted using NIR technology, with some nutrients being assayed more accurately than others. Several types of NIR equipment are to be assessed in the next cotton season. This will enable more rapid and cheaper detection of nutritional problems
- Explore responses to potassium fertilizers. A new experiment examining response to K fertilizers (using Bollgard II cotton) has been initiated. Soil applied and foliar fertilizers are being compared, with no significant increases in lint yield.
- Continue legume cropping systems experiments at ACRI to assess benefits to soil health and N fertilizer use. The legume cropping systems experiments are continuing with substantially improved yields and gross margins measured following vetch cropping. In the past year, no N fertilizer was required in the vetch-based systems, including the back-to-back cotton system. Soil health improvements (increased organic matter) have been measured.
- Assess benefits of rhizosphere acidification in terms of nutrient uptake. Soil samples collected from the legume cropping systems experiments indicate small reductions in soil pH as a result of legume crop growth. Nutrient uptake is being assessed; nutrient analysis is currently being undertaken on DM samples collected in March 2004.
- Assess N fixation with free-living N fixing microorganisms (Bio-N). An initial experiment indicated that Bio-N was of little use in fixing appreciable quantities of N, especially in view of the amounts of N fixed by vetch and faba beans grown in rotation with cotton. Further investigations of these products are not warranted.
- Bollgard and other transgenic cotton varieties being assessed for nutrient uptake and management. Two experiments have been initiated to examine K nutrition of Bollgard II cotton. One compares Bollgard cultivars with their conventional parent, the other assesses Bollgard response to K fertilizers.

PROJECT: 3.1.37 *The Impact of Sodicity on Cotton Cropping Systems*

STAFF:
Kylie Dodd, PhD Student, UNE, Armidale NSW.
Dr Ian Rochester, CSIRO Plant Industry, Narrabri NSW
Dr Peter Lockwood, UNE, Armidale, NSW
Dr Chris Guppy, UNE, Armidale, NSW.

BACKGROUND
Almost 30% of the Australian landmass and 80% of the irrigated agricultural area in Australia are occupied by sodic soils. It has been estimated that the loss in agricultural production occurring as a result of soil sodicity in Australia may be worth up to $6.75 billion annually.
This PhD project aims to determine the mechanisms, by which soil sodicity impacts on the uptake of nutrients and growth of cotton crops, in order that soil sodium levels can be factored into crop nutritional management decisions. Preliminary research by Dr Ian Rochester has determined that there is a significant interaction between soil sodicity and cotton crop nutrition. The aim of this PhD project is to isolate the individual mechanisms of sodium impact on cotton nutrition and to determine their relative importance in affecting crop yield.

AIMS:
Major objectives for the past year were as follows;
- To complete a review of the scientific literature
- To identify sodic sites in the major cotton growing regions and undertake a program of plant tissue and soil sampling in the field
- To identify methods, by which to effectively address the issues associated with growing cotton in sodic soils under greenhouse conditions

OUTCOMES:
This project is still in its preliminary phase and thus the greatest achievement to date is the completion of a comprehensive review of the relevant scientific literature. This has illustrated the nature of the nutritional interactions that occur in sodic soils. It has also highlighted the importance of project, as little data exists on the relative impact of the various components of sodium stress on cotton plants under field conditions.

A program of plant tissue sampling has also been undertaken in order to determine the pattern of cotton growth and nutrient uptake in sodic fields. The enthusiasm from cooperating growers and industry groups involved in this sampling program has been very encouraging.

Upcoming work will include a variety of greenhouse experiments and laboratory studies. This will provide the basis for the development of appropriate field-based experiments on sodic sites in coming seasons.

Program Four Overview
Education And Technology Transfer.

Program Four Leaders Greg Kauter, Cotton Research & Development Corporation and Geoff McIntyre, Queensland Department of Primary Industries.

The Cotton CRC has a strong commitment to coordinating and integrating the research, extension and educational inputs of its participants to ensure maximum benefits for industry and the nation.

Our focus on a farming system approach and the integration of the university sector brings a unique opportunity to the Australian cotton industry for research and education synergy. The Centre is committed to ensuring research outcomes are quickly and effectively transferred to industry through a well-coordinated national extension team which utilises innovative extension techniques to achieve close liaison with the grower and consultant community.

OBJECTIVE
To utilise and enhance existing national networks of extension, support and educational services to optimise the adoption of new technology and practices by cotton growers.

The Cotton CRC has an extensive range of skilled extension personnel, including two specialist officers (Training and Evaluation) while the extension network represents the Cotton CRC in all major cotton production regions.

In collaboration with Cotton Australia, the CRC extension network in involved is the promotion of Best Management Practice program to industry and community.

The Cotton CRC has an ongoing commitment to the training of high quality PhD and post-doctoral students to provide the nucleus of a future agricultural research community in which both production and environmental sciences are well represented. The Cotton CRC is committed to supporting at least 35 PhD and Masters students over its lifetime.

The Cotton CRC operates a collaborative university level "Cotton Course" for industry and other appropriate short courses for industry. It will also provides opportunities for participants to improve their knowledge and skills through scientific exchanges, conferences and other courses.

KEY ACHIEVEMENTS.
Irrigated Water Use Efficiency
- Rural Water Use Efficiency Cotton and Grains Adoption Program

Queensland Department of Primary Industries' (QDPI) has, from July 1999 to December 2003, undertaken a water use efficiency (WUE) project titled "The Cotton and Grains Adoption Program" within Queensland's irrigated cotton and grains industries. The project was conducted in cooperation with the Department of

Natural Resources and Mines (DNR&M) through its Rural Water Use Efficiency Initiative (RWUEI).

The objective of this Adoption Program was to increase, by June 2003, irrigation efficiency in the cotton and grain industries by at least 10% and have 70% of growers adopting Best Management Practice guidelines for irrigation that were developed during the Program.

The Program had industry ownership through Cotton Australia and AgForce and was administered through the Australian Cotton Cooperative Research Centre. It was supervised by and took direction from a Consultative Committee with grower leadership which had representatives from all stakeholders including: irrigators, consultants, agribusiness, the Australian Cotton CRC, QDPI AFFS, DNR&M, Cotton Research and Development Corporation, the Australian Cotton Growers Research Association, AgForce and The National Centre for Engineering in Agriculture (NCEA).

Program personnel implemented an adoption program for growers from, St George, Goondiwindi, Dalby, Biloela and Emerald which are centers within the main irrigation regions for cotton and grains in Queensland. In addition, attention was paid to the irrigated peanut industry in the Burnett and Mackenzie river regions.

Highlights

- Program investment and productivity gains:
  - By the end of the 2001/2002 summer, bales of cotton produced per ML of irrigation water used had risen 12.8% over the previous season, saving 67,855 ML across the State.

This saving provides the capacity for the production of 113,996 extra bales of cotton with a value of $57 million (at $500/bale) adding approximately $855 million to Queensland's economy.

- Grower Involvement

The awareness and participation in the program reached 100% in some regions.

- Financial Incentives

There was an outstanding response to the Financial Incentives Scheme (FIS) which helped irrigators implement those changes to their management necessary to achieve Best Practice. $1.7 million of incentives have been contributed towards the purchase of water improvement technologies totalling more than $4.3 million. This represents a total contribution by growers of 1.5 times the incentives contribution. The cotton and grains component of the FIS was administered by Cotton Australia supported by irrigator advice and assistance from Adoption Program staff.

- Best Management Practice

The Cotton and Grains team has contributed to the drafting of the BMP Land and Water module.

The mid-term review (August 2001) indicated that 78% of cotton irrigators had become involved in BMP under the Cotton Australia BMP program. This involvement has been maintained and is expected to continue and most likely increase through to the introduction of the Land and Water Module.

- Improved environmental health

A significant benefit of the Cotton and Grains adoption Program is *improved environmental health* as a consequence of greatly reduced runoff of irrigation tailwater into rivers and streams and the associated reduction of nutrient and pesticide contamination of water. The Program has been successfully assisting irrigators to modify irrigation management to reduce tailwater.

Conclusion

The Program has resulted in greater awareness of water management issues. The Program Team has encouraged irrigators to focus on the precision of their application of water. Many are now using scheduling tools to determine when and how much water to apply, and so deliver to the root zone exactly what the crop requires.

EDUCATION AND TRAINING

Education and training services provided by the Cotton CRC are focused on increasing the industry's skills base through the provision of formal learning opportunities for the agricultural and research communities. The CRC cotton extension network also develops annual plans to develop and deliver informal training opportunities based on existing research resources (both people and printed).

Grower focused short courses have become a recognised platform to engage growers. Complex approaches to production and natural resource management can be promoted through these courses using participatory and action learning methodologies. The Cotton CRC 'IPM Short Course' is currently delivered throughout the industry. Participants are assessed against national learning competencies.

The Cotton CRC Graduate and Undergraduate Certificate Course delivered and awarded through the University of New England, will celebrate its tenth year of enrolments in 2004/05. The course unit entitled 'Cotton Farming Systems' has been redesigned to provide graduates with skills in systems interaction.

The scientific exchange program in 2004 saw a number of researcher travel overseas to expand their knowledge in integrated system approaches to production. A number of summer scholarship and post graduate student projects targeted cotton farming systems in 2004. Targeted training workshops in focus group evaluation and soil management have also been conducted for front line extension staff.

A key aspect contributing to the success of educational programs in farming systems is the development of decision support packages that allow growers to conduct

risk assessments for both tactical and strategic decisions. Training of extension staff in such packages is regularly conducted so that they are able is assist growers use such packages.

Summer Scholarships
The summer scholarship program for 2003/2004 were:
♦ Nutrient and salt leaching under cotton-vetch and continuous cotton rotations in a poorly structured Vertisol.
♦Impact of extreme cold temperatures on the viability of cotton tissue.
♦Delivering HydroLOGIC to the Australian Cotton Industry.
♦Geographic Information System (GIS) for Salinity Risk Assessment in the Macintyre River

Scientific Exchange Program
To enhance the exchange of ideas, the gathering of innovative technology or practices and overseas collaboration, the Cotton CRC sponsored four overseas trips/visits during the 2003/2004. They included:-
♦Rose Roche - PhD Student attendance at US Beltwide Cotton Conference as a presenter
♦Scott Johnston - FoxPro Developers Conference, California
♦Professor David Radcliffe - US Environmental Protection Agency, Atlanta
♦Professor Hanna Mustaparta - Neurosciences Unit, Norwegian University of Science and Technology

INFORMATION DELIVERY AND DECISION SUPPORT
Success of technology transfer is dependent on the rapid distribution of research outcomes to growers. This is achieved as researcher and extension staff work together to develop a range of written and computer based information packages and decision support systems that are readily available to growers through the Cotton Technology Resource Centre with many available on the CRC Website.

To further advance the delivery of field based decision support systems and data collection, researchers have utilised handheld Palm OS® pilot technology. The integrated use of models and data collection in this technology is believed to be a world first for agricultural sector. Consultants and growers can now record farm practices and use a range of computer decision support systems anywhere in the field.

A range of decision support packages have been developed in recent years years. These include SOILpak, NUTRIpak, ENTOpak and MACHINEpak. Three new information packages SPRAYpak, WEEDpak and Disease Management Guidelines were released in late 2002. New IPM guidelines and WATERpak will be released.

EXTENSION AND ADOPTION – Demonstrating technology to growers.
Introduction
Effective extension programs are being developed and delivered to communicate research findings to individual cotton growers and to industry using a variety of delivery mechanisms. A network of regional Industry Development Officers (IDOs) participates in a range of activities in collaboration with growers, consultants and agribusiness.

Aims and objectives
The provision of a coordinated national extension program to the Australian cotton industry using modern techniques and delivery systems and working in partnership with growers and consultants to optimise the adoption of new technology and practices by growers through demonstration and adaptation by:

- Expanding and enhancing the national cotton extension delivery program within the industry;
- Promoting on-farm demonstrations and field trials with strong grower and consultant participation;
- Establishing grower based Integrated Pest Management (IPM) and Area Wide Management (AWM) support groups;
- Examining social barriers to technology adoption.

Highlights and Achievements
The extension and adoption process established by the Cotton CRC continues to provide an excellent foundation for the development of a cohesive, well-focused and coordinated extension team.

Achievements:
- A review of the National Cotton Extension Coordinator (NCEC) position in 2003 has resulted in the establishment of:
- An industry Extension Coordinating Group within the team which provides overall leadership and coordination of the program
- A Cotton Extension and Evaluation Specialist position to provide extension and evaluation support for extension and research officers in the CRC with respect to methodology and ensure a focus on impacts of RD&E Investments.
- Phase 1 of National Program Sustainable Irrigation funded Knowledge Management research project was conducted by Ingrid Christiansen and Graham Harris. It identified knowledge and learning practices and developed an extension model for irrigation to be piloted in partnership with CRC Irrigation Futures. The Knowledge Management project developed the extension network's skills in interview techniques and first hand understanding of the issues.
- The leadership of a Silverleaf Whitefly extension program by David Kelly in collaboration with local and national industry resulted in the development of a management strategy for silverleaf whitefly. This entailed:

• Coordination of local cotton industry groups in identifying what needed to be done to manage the pest.
• The development and organisation of a CRDC funded study tour to the USA.
• Development and implementation of local management plan in collaboration with Central Highlands Cotton Growers Research & Technical Group, Dawson Valley Cotton Growers Association, and Area wide management groups.
• Promotion of the strategy to the wider industry via presentations, media releases etc.
• Funding approval for the establishment of environment extension program in collaboration with Program 6 with projects to be conducted in Queensland and NSW in a partnership with Cotton Australia, DAFF and the Qld Nation Action Plan for Salinity and Water.

The Cotton Extension Team

The cotton extension team, which includes extension officers in NSW Agriculture, QDPIF and CRDC, has a national focus on major industry issues and a prioritised list of regional problems. The Cotton CRC has funded two officers in the extension team and provides the leadership and coordination of a team which, in 2003/04, included:

- Nine Industry Development Extension Officers (IDOs), and four Water Use Efficiency extension officers located strategically throughout the industry;
- One Extension Technical Officer;
- Seven farming systems extension officers and five irrigation extension officers in NSW Agriculture and QDPI who contribute part of their time to cotton industry extension activities;
- Cotton Extension and Evaluation Specialist;
- The IPM Training Coordinator;
- Technology Resource Centre Coordinator.

- Extension team activities include:
- On farm trials and demonstration trials in collaboration with growers and consultants;
- Establishment and facilitation of grower groups participating in the adoption of IPM and Area Wide Management (AWM) and other issues including Best management practice and water management;
- Annual review and planning workshops;
- Industry wide benchmarking studies;
- Evaluation of extension activities.

The CRC Cotton Extension Committee comprising Geoff McIntyre, Department of Primary Industries Queensland (QDPI), Bruce Pyke, Greg Kauter, and Adam Kay, Cotton Research and Development Corporation (CRDC) Dallas Gibb, NSW Agriculture and Glen Fresser, Australian Cotton Growers Research Association (ACGRA) provides leadership of the extension team.

The new Extension Coordinating Group includes the program leaders, focus team leaders, Extension and Evaluation Specialist, Training Coordinator, TRC Coordinator and the CRC Liaison Officer. It has ensured a coordinated focus on national extension priorities and the development and implementation of the most effective delivery methods.

The Extension and Evaluation Specialist is responsible for the development of training opportunities for and the provision of extension and evaluation support for extension and research officers and has collated the national research, development and extension priorities in collaboration with the regional IDOs.

The team has maintained five focus groups that are responsible for identifying and prioritising national issues and planning and resourcing nationally focussed extension programs. They are:

- Farming Systems;
- Disease and weeds Management
- Environment;
- Insect Management;
- Water Use Efficiency.

The IDOs work closely with regional grower associations and maintain strong links with all research programs.

An annual cotton extension planning workshop provides the opportunity for the extension team, researchers and consultants to identify and prioritise national issues. Technical training has been undertaken in other workshops during the season.

Implementation of strategies for IPM and AWM of insects continues as a high priority for the extension team with a program focussed on the establishment of IPM and AWM grower groups and the application of the IPM pest management guidelines. The recent adoption of area wide management approaches has resulted in growers working together to manage complex problem and more importantly collectively considering off-farm impacts of individual practices. Area wide management groups provide an avenue for a coordinated approach to complex environmental issues such as vegetation and biodiversity management.

The IPM Training Coordinator has developed a grower focussed training program and delivered six short courses with local assistance provided by the IDOs supports it.

The Cotton CRC has completed the cotton and grains adoption project that is part of the Rural Water Use Efficiency Initiative RWUE) of the Department of Natural Resources and Mines in Queensland. Its objective was to improve water use efficiency in the cotton and grains industries in Queensland. This four-year program provided for an adoption project managed and delivered by the project coordinator and five extension officers in DPIQ extended until the end of 2003. The CRC has continued to ensure the maintenance of effective linkages with a similar NSW Agriculture initiative that is also associated with the CRC.

A RWUE Stage 2 project funded by the Queensland Department of Natural Resources and Mines in partnership with Cotton Australia has been established to build on the achievements of the first program. The Cotton and Grains adoption project commenced in January 2004.

NSW Agriculture has expanded irrigation extension in NSW with the establishment of two extension projects in the Namoi and Gwydir Valleys. Two extension officers will conduct irrigated water use efficiency projects focussed on the cotton industry.

The IDOs have provided significant contributions to the NUTRIpac, DISEASEpac and WEEDpac publications which are due for release to the industry and will be involved in the development of WATERpac in the next year.

The extension team has supported Cotton Australia and growers in the implementation of the industry Best Management Practice (BMP) program by providing technical resource support for growers developing and implementing management plans. Cotton Australia BMP facilitators and area managers manage the process and auditing procedures. BMP provides an effective vehicle for the delivery of new and advanced technical information and management strategies.

IDOs have continued to respond to a number of issues demonstrating the capacity of the extension team to address emerging industry needs in a timely manner.

The extension programs are primarily directed to industry clients – growers, consultants and agribusiness. However, IDOs also contribute significant support to community and environmental groups in the course of their normal activities and as members and participants in their regional communities. They provide information through regional publications and media outlets, as members of community groups and by participating in educational activities often in collaboration with Cotton Australia.

Linkages

Personnel in the Technology Resource Centre, CRDC, Cotton Australia (CA), Cotton Consultants Association, Cotton Seed Distributors and Deltapine Australia collaborate with and contribute to extension team activities.

The extension team has direct linkages with ACGRA nationally through the ACGRA Chairman and the Research Committee chairpersons who link directly with each of the focus teams. Regionally, all extension officers are active participants in the regional Cotton Grower Association and their RD&E sub-committees.

The IDOs collaborate with all research officers to ensure strong linkages between the CRC research and extension programs and with researchers in many other research organisations in NSW and Queensland.

Scientific Exchanges

PROJECT: 4.1.00 (SX18) *Scientific exchange Prof. David Radcliffe.*

STAFF:

Professor David Radcliffe, University of Georgia, U.S.A.
Dr R.W. Vervoort, The University of Sydney, Sydney, NSW
Mr. Dan Rattray, Queensland NRM&E, Toowoomba, QLD.

BACKGROUND:

Catchment scale modelling is an invaluable tool to determine the impact of policies and legislation on the catchment outcomes. However, Australia is relatively poor in catchment level modelling which takes into account the spatial variability of natural resources in the catchment. Current models generally do not take into account all variability. In the United States a GIS (geographical information systems) based model called AVSWAT has been developed. At each point in the landscape AVSWAT uses a similar approach to runoff modelling as PERFECT/HOWLeaky

Professor Radcliffe has considerable expertise with the programs BASINS and AVSWAT and uses this to model sediment, phosphorus and fecal coliform in catchments in Georgia. The visit was in cooperation with Mr. Dan Rattray from Queensland Natural Resources and Mines. Dan Rattray also has considerable experience with AVSWAT and uses the program to model pesticide runoff in a small catchment near Toowoomba under a GRDC grant.

AIMS:

Professor David E. Radcliffe from the Department of Crop and Soil Science at the University of Georgia visited Australia on a scientific exchange grant from the Australian Cotton CRC. The aims of the visit were to:

- Explore the model AVSWAT and discuss the possibilities for using this model as a catchment management tool in Australia.
- Explore uncertainty and how uncertainty could be dealt with using AVSWAT.

OUTCOMES:

As part of the program a small workshop on AVSWAT and uncertainty was organised in Toowoomba. During the workshop presentations were given on the capabilities of AVSWAT and how uncertainty in input data would affect the outcomes of the model. The workshop was attended by 20 researchers and included ample time for discussion. The issue of uncertainty was further explored in visits with John Doherty (Watermark Numerical Computing, PEST), DIPNR in Parramatta, NSW and during a presentation at the Faculty of Agriculture, Food and Natural Resources at The University of Sydney.

It was concluded that Australia is not totally unique in its management of water and non-point source pollution problems. Many other countries are working on similar problems and have developed considerable knowledge in modeling and management. This is of comfort to the cotton industry and points to new possible international links in the area of water resource management. The specific nature of the Australian environment and production systems would require adaptation, but this can be achieved since for example AVSWAT is freely available and the source code can be easily obtained.

AVSWAT is a model with considerable potential for use in the Australia. It fills a gap between the larger river basin models such as IQQM and EMSS, similar to CATSALT. It has the capacity to simulate the effect on water quality of changes in management within a (sub) catchment. AVSWAT can simulate a range of pollutants ranging from inorganic to organic to pesticides.

Above: Prof. Radcliffe, Mark Silburn and Dan Rattray inspecting one of the flumes used to collect data for Dan Rattray's AVSWAT modelling

PROJECT: 4.1.00 (sx16) *Scientific Exchange Ms Rose Roche*

STAFF:
Ms Rose Roche, PhD Student, CSIRO Plant Industry, Narrabri NSW.

AIMS:
The purpose of Exchange was to attend the Beltwide Cotton Conferences, San Antonio, Texas USA, 5-9 January 2004, coordinated by the National Cotton Council (US), a forum recognised as the main conference for cotton research in the world.

OUTCOMES:
A paper was presented titled 'Does a different plant type enhance performance of UNR cotton production systems?' at the physiology conference. Other researchers working on UNR production systems were also contacted including Dr Owen Gwathmey, Dr Craig Bednarz, Dr Derrick Oosterhuis, and Steve Wright. Discussions were also held with a number of American cotton growers, which was helpful in developing an understanding of what American growers perceive to be the benefits of UNR cotton production.

One important research gap identified was the development of a better indicator of cut-out (stopping of production of fruiting sites) for UNR production systems than five nodes above the last white flower (NAWF) which is used for conventional systems in Australia and the US. Dr Owen Gwathmey from The University of Tennessee and the leader of the Cotton Agronomy and Physiology Project in West Tennessee, suggested potential collaboration with his work looking at estimating maturity in UNR production systems across regions in the US and Australia.

PROJECT: 4.1.00 (SX17) *Scientific Exchange Mr Scott Johnston*

Mr Scott Johnston, CSIRO Plant Industry, Narrabri NSW

AIM:
This project for Scott Johnston to attend the Access/ Visual Basic Developers Conference, Las Vegas, Nevada USA, 8-12 June 2003. The goal of the conference is to serve as a forum for the exchange of knowledge on different facets of software development using the Microsoft Access/Visual Basic development environment.

OUTCOMES:
Attending the conference provided an excellent opportunity to gain exposure to a range of Microsoft .NET technologies. The information and discussions at the conference confirmed the confidence we have that the Microsoft .NET environment will be capable of enabling us to meet the current and future software development needs of the Cotton CRC Cotton Management Support Systems team. The knowledge gained by Scott has been invaluable to our efforts in planning and

initiating the redevelopment of Cotton LOGIC. We are now using Visual Basic and .NET technologies across all our decision support tools.

Summer Scholarships

SUMMER SCHOLARSHIP: 4.1.06 SS13 *Nutrient and salt leaching under cotton-vetch and continuous cotton rotations in a poorly structured Vertisol*

STAFF:
N. Eulenstein, Student, University of Queensland
Dr N.R. Hulugalle, NSW Agriculture, Narrabri, NSW

AIMS:
To quantify amounts of nutrients and salts (nitrates, chlorides, Na, Ca, Mg, K) lost in seasonal deep drainage out of the cotton root zone in a poorly structured, irrigated Vertisol sown with either continuous cotton or a cotton-vetch rotation during the cotton season of 2003-04.

OUTCOMES:
Measurements were made in two treatments in an on-going experiment: continuous cotton rotation where there was fertiliser applied at a rate of 150 kg N/ha prior to sowing in the form of anhydrous ammonia, and a cotton-vetch rotation where no fertiliser was applied.

Soil cores were taken to a depth of 120 cm before sowing the cotton to measure soil nitrates, chlorides, exchangeable cations, pH, EC, and texture at the start of the season. Throughout the season water was collected using the ceramic cup samplers, and analysed for nitrate-N, pH, salinity, calcium, magnesium, potassium, sodium and chloride. EM-38 surveys were done before sowing and during the season.

EM-38 surveys and soil sampling showed that the cotton-vetch rotation had a low concentration of nitrate-N throughout the profile before sowing cotton. The continuous cotton rotation on the other hand showed a large bulge of nitrate-N at 90-120 cm, indicating that it had leached through the profile in the five weeks before sowing.

The mid-season EM38 surveys in both treatments showed that while conductivity fell with continuous cotton, it increased with cotton-vetch. This may be due to nitrate-N leaching in the continuous cotton while breakdown of vetch probably resulted in nitrate-N increases in cotton-vetch. Growth and dry matter production of the two treatments were similar even though the cotton-vetch treatment did not have fertiliser applied prior to sowing. This suggests that the cotton sown after vetch had sufficient N available for its growth.

In summary, there was a more nitrogen lost through leaching when it was applied before sowing as a fertiliser compared with nitrogen from a leguminous source. Cotton was able to use leguminous nitrogen for normal growth and production.

SUMMER SCHOLARSHIP: 4.1.06 SS14 *Effects of cold temperatures on the viability of cotton tissue*

STAFF:
Dr Michael Bange, CSIRO Plant Industry, Narrabri, NSW.
Dr Daniel Tan, CSIRO Plant Industry, Narrabri, NSW.
Angela McDowell, Student USYD, Sydney, NSW.

AIMS:
- To test the hypothesis that exposure to 10 and 20 nights of 10°C does not affect cotton tissue viability
- Build on previous findings to improve the understanding of where the temperature threshold for cold shock in cotton lies
- To test a method used for determining the existence of cold shock (Tetrazolium viability test)
- Improve the understanding of the effects of cold temperatures on the physiology of cotton in terms of tissue structure and function, and plant growth and development.

OUTCOMES:
A project of seven weeks duration was undertaken over the summer of 2003/2004 by summer scholarship student, Angela McDowell (University of Sydney).

The outcomes of the experiment were:

- Cotton plants did not seem to be affected by 10 nights of cold shock at 10°C and were only slightly affected after 20 nights.
- Such results are consistent with more recent studies which suggest that cotton plants are able to withstand more extreme cold treatment than previously believed.
- Tetrazolium viability test proved to be a successful means of testing damage to leaf tissue following cold shock. It is useful in that it allows a quantitative value to be placed on damage.

Zetrazolium tests: On the left are results from a non-viable leaf following exposure to extreme cold temperature (2 nights at 2C). On the right is control; tetrazolium has been reduced to red formazin.

SUMMER SCHOLARSHIP: 4.1.07 SS15 *Delivering HydroLOGIC to the Australian Cotton Industry*

STAFF:
Mr Andrew Traves, UNE Student, Armidale, NSW
Mr Dirk Richards, CSIRO Plant Industry, Narrabri, NSW.
Mr Darren Linsley CSIRO Plant Industry, Narrabri NSW.

AIMS

- Support the HydroLOGIC Help Desk, and providing assistance to growers and crop consultants. This objective was achieved with all support requests being answered and solutions provided. The majority of requests were related to weather information and formats required to use HydroLOGIC to predict future irrigation requirements.
- Analysis, documentation and implementation of a contact management system (cotton industry database) for HydroLOGIC registration and support. This objective was not completed as it was deemed to be less relevant. The absence of this objective allowed of greater focus of the remaining objectives.
- Work alongside programmers developing decision tools for the cotton industry that are delivered via the Internet and handheld PDA's. A wide range of topics and development was achieved in this objective which included; the implementation of a software bug recording system for the tracking and reporting of software problems; design of an insect check recording database for Cotton CRC researchers, an assessment and recommendation on the CottonLOGIC web site; and the compilation of a heliothis diapause prediction tool.

PROJECT: 4.1.05 *IPM Training Coordinator*

STAFF:
Mark Hickman, QDPI&F, Toowoomba, QLD.

AIM:
To organise and conduct a series of IPM Short Courses (5 days per course) for the 2003-04 production season.

OUTCOMES:
During the 2003-04 season, seven new courses were established at: Emerald, St George, Dirranbandi, Goondiwindi, Narrabri, Trangie and Hillston. A total of 78 people attended the course – 52 growers, 19 agronomists (consisting of on farm, private and reseller agronomists), and 6 others. An average of 11 people per course was a desirable result providing for good interaction, which was reflected in the grower comments. These figures almost mirror the 2002-03 enrolments, except there was an extra workshop in this previous season.

A novel approach has been to record guest lectures onto CD for use at courses when guest lecturers are unavailable. It provided a break from hearing one presenter and ensured a common message was delivered. However, some of questioning and discussion that would normally occur was lost. A critical strength of the course for participants is the one-to-one discussion with researchers. In addition researchers also receive valuable feedback from growers.

Filming of the short course IPM has been completed and the project is in the final stages of editing.

The major focus for the 2003-04 course was to further increase interaction levels during the course and emphasise the adult learning principle of grower teaching grower into more field and classroom activities.

Course evaluations have indicated an expected management change after completing the course. The nature of the change was also investigated in the exit surveys after each component. Final data is still being assessed for 2003-04, however preliminary data based on an average of all four components indicated 76% of participants would change aspects of their management after the course, 7% said no and 18% were unsure. Aspects of plant monitoring and increased grower to consultant interaction in management decisions featured.

Grower verbal comments also reflect changes in attitudes. Quotes such as "if only I knew about these IPM approaches 8 years ago I would be better off now." (St George grower 2004). "The IPM course provides you with that window of knowledge." (Emerald grower 2004). In relation to the number of people that start the course compared to the number that attend the four components, the total for all years is 169 of a possible 178.

The following people have been involved in the delivery of the course for the past production season. People from NSW Agriculture include: Louise Rositter, Robert Mensah, Kirrily Rouke, Annie Johnson, Tracey Farrell. People from CSIRO: Martin Dillon, Sarah Mansfield, Mary Whitehouse, Tom Lei, Warwick Stiller and Scott Hardwick. People from the Department of Primary Industries and Fisheries: Dave Murray, Melina Miles, Brad Scholz, Paul Grundy, Rebecca Smith, David Kelly and Steve Ginns.

Greg Jensen, Brendan Donaldson monitoring plant growth with Course Coordinator Mark Hickman.

St George growers assessing for White Fly.

PROJECT: 4.1.08 *Graduate Certificate in Rural Science (Cotton Production) and Certificate in Agriculture (Cotton Production)*

STAFF:
Dr John Stanley, UNE, Armidale, NSW
A/Prof Robin Jessop, UNE, Armidale, NSW.

AIM:
To run the Certificate in Agriculture and Graduate Certificate in Rural Science (Cotton Production), and graduate 20 to 30 students from these courses each year.

OUTCOMES:
The cotton course has suffered a reduction in students completing units over the past two years. The decline has not shown up in the intake or graduate figures, presented in Table 1 and 2, because a healthy 27 students enrolled last year (Table 1) and the 20 graduates, this year, reflect the healthy intake two years ago (Table 2). Unfortunately, seventeen who enrolled last year did not complete the first unit (Cotton Production) so by second semester of 2003, numbers were down to 10 moving through the units from this intake.

Enquiries revealed a high number of redundancies throughout the cotton industry because of the drought. This either directly removed students (particularly trainee agronomists), or indirectly overloaded more secure or experienced agronomists causing them to pull out of the course.

There were 20 people graduated from the course in April 2004 bringing total graduates to 153 people (Table 2). About 30 Cotton CRC staff and other industry personnel deliver specialised lectures during the residential schools.

Transfer of the cotton course material into XML format is under way via a UNE program to improve the speed with which the course can be updated. This format will enable a wider range of electronic material (photos, video footage, animations, sound etc.) to be stored to support the course.

An online section remains part of each unit (10% of the assessment). The greatest benefit appears to be the opportunity for students to log on and interact with each other along with, quiz assessment tools, interactive debates for assessment, and references.

Twelve students at UNE completed the "Applied Cotton Production Unit" as part of their undergraduate studies in Rural Science, Agricultural Economics and Agribusiness. The Applied Cotton Production unit was again delivered as part of agricultural science degrees at other universities. Forty two students undertook this unit at 3 universities in Semester one 2004.

At The University of Queensland (Gatton campus) twenty two students undertook the unit which includes a two day residential at Gatton College. Eight students were given a four day residential at The University of Sydney, which this year included a day on integrated pest management.

Dr John Stanley, Course Coordinator, Cotton Production.

Table 1. Cotton Course Student Applications

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Graduate	19	13	14	16	24	17	17	19	16	12	2
Certificate	8	4	6	12	8	17	18	26	15	15	16
Total	27	17	20	28	32	34	35	45	31	27	18

Table 2. Cotton Course Graduates

Year	1996	1997	1998	1999	2000	2001	2002	2003	Total
GradCert	12	10	11	14	18	11	12	15	103
Certificate	1	4	3	6	13	9	9	5	50
Total	13	14	14	20	31	20	21	20	153

PROJECT: 4.2.05 *National Cotton Extension Coordinator*

STAFF:
Ingrid Christiansen, QDPI&F, Toowoomba, QLD

AIMS:
Identify future strategic directions for cotton extension & evaluation

OUTCOMES:

- Major study to identify strategic approaches for evaluation of cotton research – literature reviews and interviews of researchers.
- Contributed to developing new extension projects in WUE and environment.
- Liaison with industry and research sectors to identify priority issues.
- Review and enhance extension and evaluation knowledge and resources Skills audit of extension team, survey of evaluation skills in extension.
- Technical skills updated via Technical updates.
- Participatory Soils workshop conducted and evaluated.
- Writing skills training workshop prepared and delivered for extension, research and postgraduate students.
- Extension networks maintained through forums, conferences, projects and groups, news and information updates.
- Coordinate the national extension network.
- Completed Phase 1 of the Irrigation Knowledge Management Project. Gathered a detailed understanding of knowledge systems for irrigation in cotton and grains. Developed a model for irrigation knowledge that will be tested by Cotton CRC & CRC Irrigation Futures - with NPSI funds.
- Selected frameworks for cotton extension evaluation, and conducted training of extension staff in principles and practice of evaluation, including triple bottom line impacts.

Irrigation Knowledge Management Research

The Knowledge Management research project was conducted by Ingrid Christiansen and Graham Harris in collaboration with Professor Victor Callan, University of Queensland and the extension team. It was funded by the National Program for Sustainable Irrigation. This research project completed interviews with 90 growers of cotton and grains, consultants, extension workers, government researcher officers, and irrigation equipment suppliers to determine how information and knowledge about water management and water use efficiency is being used and managed in irrigated cotton and grains.

Highlights

- **Key issues affecting water management.**
  The project found that four issues in particular were currently impacting on water management:
  1. The availability, continued security and cost of water
  2. Returns per mega litre
  3. Water quality
  4. Water scheduling.

  Growers of cotton and grains accepted that water would be a more restricted resource for them in the future. Consultants believed that water management had now emerged as a major focus in their work with growers. Giving advice to growers about water use and efficiency will be an increasingly large part of consultants' work with growers.

- **Information, knowledge and knowledge sharing.**
  All groups believed that the industry was responsive to change, willing to continually learn, and that growers, consultants and extension officers were very willing to share information and knowledge. There was considerable information that was available to growers and consultants. A major concern, however, among growers and consultants, was the need for the information to have been tested and applied to determine its relevance and applicability to specific regions.

- **Major sources of information.**
  Growers were accessing a large number of people and resources in making decisions about water management. The major "people" sources were:
  - consultants
  - researchers
  - other growers
  - own experience.

  The major "resources" were:
  - trial data
  - field days

- *Cotton Tales*
- grower experiences
- case studies.

Growers preferred personal contact to gain information about water management. Growers accessed this range of people and resources over a number of seasons in thinking through major changes to water use and management. Consultants were the major source of information, and provided a close working relationship that could also bring into the growers' decision-making a variety of other information from research, trials and the consultant's experiences with other farmers in their region.

Consultants generally sourced information in very similar ways to growers, but were able to make more use of accessing information from other consultants, especially those in their own companies. In addition, they made more explicit attempts to directly resource research and the views of researchers.

- **What influences decisions?**
  The water reform process is playing a major role in shaping the context within which growers and consultants are making their current and future decisions about irrigated crops. Growers report that they are realistic and expect some form of cutbacks in water availability. However, they would like to see some reduction in the current levels of uncertainty about water security.

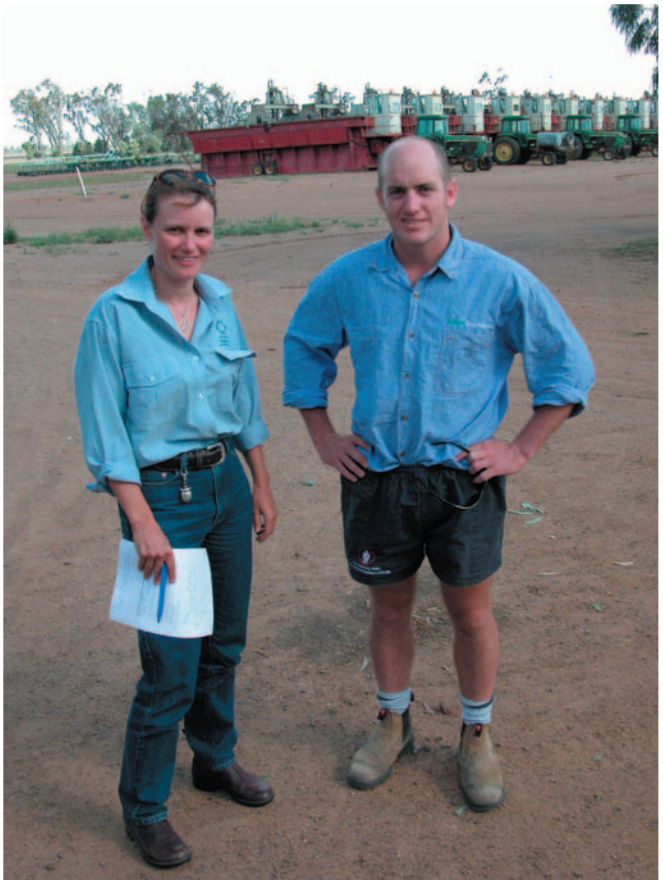
  Own experience was a prime factor in decision-making. The driving forces for positive actions to improve water efficiency are: evidence from in-house and outside trials, cut backs in water availability, the introduction of soil water monitoring devices, the continued need to gain maximum financial returns per mega litre of water, and access to knowledgeable and supportive consultants and agronomists. New ideas in water management have been looked at for some time but it was not until forces like those above had emerged, as well as the recent drought, that growers began to re-think their attitudes about water management practices. The barriers to changing growers' water management practices are the lack of practical evidence that the changes will actually work on their farms, and the financial and labour costs of introducing new technologies and farming practices.

- **Role of public and private service providers.**
  Growers and consultants had similar perceptions, but with some differences in their emphasis. Growers described the public providers' (research and extension) role as being about identifying growers' needs, and to get research completed and communicated back to growers to address their needs about irrigated crops and related issues. Consultants spoke more about the role being limited to having research commissioned and communicated back to the industry, with the implication that the consultant's role was more about identifying growers' needs than it was for the public provider. Consultants believed that they played a more hands-on role or day-to-day role in working with the grower to decide and to implement the crop and water management strategies for the season. At the same time, growers expected to see a cooperative relationship between consultants and extension. In general, growers and consultants felt that there was a lot of cooperation though the sharing of materials and knowledge between research and extension providers and consultants.

- **Research, development and extension needs.**
  Growers, consultants and suppliers identified a long list of issues that they felt required more in-depth research. Common to their lists were water scheduling, production and efficiency figures for different irrigation systems, salinity management, loss of water research and waterlogging.

Conclusion

The findings and recommendations from this research will be of significant benefit to the development and implementation



Ingrid Christiansen and Tim Richards - Ingrid interviewed Tim for the Irrigation Knowledge project.

PROJECT: 4.2.07 *Evaluating economic implications of new management approaches in cotton*

STAFF:
Ziaul Hoque, NSW Agriculture, Narrabri, NSW.
Bob Farquharson, NSW Agriculture, Narrabri, NSW.
Other Staff & Collaborators:
Mr. Martin Dillon, CSIRO Entomology, Narrabri, NSW,
Dr Ian Taylor, NSW Agriculture, Narrabri, NSW,
Dr Robert Mensah, NSW Agriculture, Narrabri, NSW,
Dr Nilantha Hulugalle, NSW Agriculture, Narrabri, NSW
Steve Harden, NSW Agriculture, Tamworth, NSW.

AIMS:
- Continue the study of economic benefits of IPM within the Boggabilla Area Wide Management (AWM) group for the last 5 seasons, from 1998-2003
- Compare the economic benefits of IPM within some 'grower groups' for 2001-02 season
- Prepare a revised economic analysis of weeds in dryland cotton
- Economic analysis of Petroleum Oil Spray (PSO) trials with Dr Robert Mensah
- Economic evaluation of IRM (Insecticide Resistance Management) strategies within Australian cotton industry

OUTCOMES:
An economic analysis has been done for the last 5 seasons Boggabilla data set from 1998 to 2003. The results were presented at the CRC Research Review in July 2003. Results show similar trends as before, with some exceptions. That is softer spray strategies achieved higher profits.

Results showed that for all three seasons, spray costs decreased and profits increased under Soft management compared to Hard strategies. They also showed that higher yields do not automatically translate into higher profits. However, results of different 'Soft' and 'Hard' groups of all seasons didn't always hold the true.

A study was undertaken to compare economic performance of IPM in four different IPM groups. Emerald, Boggabilla, Moree and Narromine these four groups were selected from New South Wales and Queensland. Their cotton data for 2001/02 season were analysed. The average performance of each group for BDI, spray cost ($/ha), yield (bale/ha) and gross margin ($/ha) were calculated on per hectare basis.

Group 4 maintained their profitability even spraying softer than any other groups. This group's average BDI was 43% lower than the all groups' average. Ingard® crop shows very good performance in all areas. Average Ingard® crop maintained its profitability even spraying softer. All group data shows that average Ingard® BDI is 50% lower than conventional average and profits is 11% higher.
Three years of the Boggabilla data-set (1998/99 to 2000/01), are currently being analysed with the cooperation of Steve Harden (NSW Agriculture Biometrician, Tamworth).

Although when all the data is considered as a whole there appears to be a negative correlation between BDI normalised for pest pressure and cotton field profitability, the bio-metrical results are not clear cut because each of the three seasons differs substantially in relation to Heliothis egg pressure and BDI.

A strong positive correlation between egg pressure and the number of sprays applied to each field in each season is also a confounding factor.

A joint project of Australian Cotton CRC, CRDC and Weeds CRC, the economic analysis was conducted in two phases. In the 1st phase, financial (on-farm) costs of weeds were assessed on an average farm basis for each crop type. A second phase was used to estimate the aggregate economic and social impact of weeds for the two production regions using an economic surplus model.

An economic analysis on 'Petroleum Oil Spray with Synthetic Insecticide Reduce Rate Trial 2003/04'. This trial was conducted by Dr Robert Mensah on ACRI (Australian Cotton Research Institute) site. Trial results showed that cotton could be grown more profitably spraying 1% PSO (Petroleum Oil Spray) along with conventional insecticide sprays. Half rate conventional insecticide spray and 2% PSO mixing also showed higher profits than conventional spray regimes.

An economic analysis of the rotation experiment conducted by Nilantha Hulugalle was completed. Cotton has been harvested from 4 treatments. Data has been entered into previous year spreadsheet. Finally, the data was transfered to Fiona Scott, Economist at Tamworth, for further analysis.

Upper Namoi East Field Day.

PROJECT: 4.2.08 *Trainee Cotton Industry Development Officer (Upper Namoi)*

STAFF:
Penny van Dongen, NSW Agriculture, Gunnedah, NSW

AIMS:
- Train as an Industry Development Officer, including promotion of Integrated Pest and Disease Management, resistance management and water use efficiency;
- Benchmarking with AWM groups;
- Conducting trials;
- Assisting in drainage, salinity, sodicity issues,
- Contributing to Cotton Tails.

OUTCOMES:
A number of trials were conducted involving mirid threshoulds, planting dates, row configuration, nitrogen leaching and irrigation monitoring. Support was provided for field days, for the Harparay Area Wide Management Group, which continue to meet on a regular basis, for a Boggabri group which met infrequently and a Breeza Plains group that met sporadically.

Access to Incitec database has enabled trends in sodicity to be looked at, although due to the nature of soil sampling it was difficult to draw conclusions. The field days were well attended and incorporated the crop competition. Water Use Efficiency is becomming a high priority in the valley. A water use efficiency encouragement award was integrated into the crop competition and benchmarking exercises are gaining interest.

The cotton production course was completed last semester and was extremely valuable as was a facilitation course undertaken in November. Irrigation training provided by QDPI in Dalby was excellent and has created a good base for future irrigation work.

Dryland row configuration trial.

PROJECT: 4.2.09 *Trainee Industry Development Officer*

STAFF:
Stephen Ginns, QDPI&F, St George, QLD
David Kelly, QDPI&F, Emerald, QLD

AIMS:
- Participate in trials and field days;
- Produce St George Cotton trial and yearbook for 2003-04;
- Coordinate the collection of heliothis for resistance management testing;
- Produce several issues of Cotton Tales;
- Establish a Hydrologic demonstration trial;
- Continue enrolment in Cotton CRC UNE Post Graduate Certificate in Cotton Production Course.

OUTCOMES:
Heliothis egg collections for the resistance monitoring project was very successful because it identified the heliothis species present and better enabled consultants and cotton growers to better manage insecticide application decisions.

The hydrologic trial at Cubbie station was another highlight, and with further testing of the technology next season cotton growers may be able to make more informed irrigation management decisions. The Bollgard 11 plant compensation trial was also very successful along with the early season development modelling of that crop.

The trainee industry development officer project has enabled QDPI cotton extension team to continue the presence of an industry development officer in St George, providing linkages between industry researchers and cotton growers as well as linkages into the regional community through the Maranoa Balonne catchment management group.

Dipping boots to prevent the spread of soil borne diseases during a farm tour.

PROJECT: 4.2.10 *Optimising field and farm scale water use efficiency for cotton farming systems.*

STAFF:
Dr Phil Goyne, QDPI & F, Warwick, QLD
Other Staff & Collaborators –
D. Richards, CSIRO Plant Industry, Narrabri, NSW.

AIMS:
- To quantify the relationship of Bollgard II and conventional cotton varieties between plant spatial arrangement , soil water extraction dynamics, agronomic and physiologic traits under (limited) irrigated conditions.
- Enhance the capability of OZCOT to perform for varying plant configurations.
- Quantify via OZCOT various management scenarios particularly genotype x row configuration (density, row spacing) x irrigation (volume, frequency).
- Extend the information to growers, through the CRC Extension Team, to assist in their farming system management decisions in a water limited environment.

OUTCOMES:
The project commenced with plantings of Bollgard II (Sicot 14 B) and a conventional variety (Sicot 80) in single skip configuration on October 16 at Macalister on the Darling Downs. Detailed crop growth and soil water extraction data have been monitored and are presently being processed and analysed. The trial was planted on a grey vertosol soil holding about 640 mm to 165 cms (95% FC).

Excellent rainfall throughout the season (457mm on the trial site, 44% of this prior to first flower) dictated the extent of the irrigation treatments applied: all plots received 0.8ML flush irrigation on January 10 (early flowering); half the plots received another irrigation of 1.1ML on February 13 (about 30 days prior to first open bolls). Plots receiving 2 irrigations out-yielded those with only one irrigation.

The grower cooperator estimates the value of the second irrigation to him was $1000 for the 1.1 ML applied. The effect on fibre quality is currently being determined. The project when completed will be capable of examining the economics of various of row configurations, variety, soil moisture , rainfall and irrigations applied.

PROJECT: 4.2.11 *Cotton Industry Development Officer Griffith.*

STAFF:
Mr Evan Brown, NSW Agriculture, Griffith, NSW

AIMS:
- Implement programs which promote the adoption of IPM, particularly for insect control and resistance management for both conventional and transgenic technology. This includes a number of on-farm demonstration trials, combined with IPM short courses.
- Assist in the delivery of IPM short course and establishment / ongoing development of Grower Support Groups.
- Establish AWM group/s in southern NSW Cotton growing regions and continued resistance monitoring
- Establish a monitoring project to compare insecticide use patterns in Conventional and Bollgard II® cotton crops.
- Participate in trials, demonstrations, case studies and promotion of decision support systems; produce trial booklets and contribute to Cotton Tales.
- Develop extension priorities with local growers and consultants and link/adapt national extension activities into local issues.

OUTCOMES:
The 2003/4 season saw 12,500 hectares planted along the Lachlan and Murrumbidgee rivers which is an increase on last years' 9200ha. Three plant compensation trials were undertaken during this season. An Ultra Narrow Row growth regulator trial was run in collaboration with Rose Roche (CSIRO Plant Industry) which looked at the effect of growth regulants on yield and maturity of UNR. The early results from the trial have shown that the growth regulants have improved maturity in UNR but decreased the yield.

An irrigation trial assessing deep drainage was carried out using Enviroscans® and G-bugs® technology. Results have shown that deep drainage occurs throughout the season. The trial has also shown potential for the G-bug® technology to be used in cotton irrigation scheduling. The project is in collaboration with Michael Grabham the Griffith Irrigation Officer.

Specific programs that promote the adoption of IPM, particularly for insect control and resistance management for both conventional and transgenic technology were conducted. These include a number of on-farm demonstration trials combined with the IPM short courses

The plant compensation trials directly assist in developing IPM strategies for this region. They have been of great interest to growers by allowing them to better understand plant compensation and increase their confidence in allowing a certain level of plant damage to occur before making control decisions. This season the IPM Short Course was run in collaboration with Mark Hickman. The course was held

over five days and there were 14 participants.

Promotion of the Hydrologic model has occurred with a workshop run on the 24th September by Dirk Richards (CSIRO Plant Industry).

In conjunction with other members of the environment team a survey was prepared to find out the understanding of riparian zones throughout the cotton industry.

In March 2004, in conjunction with the Hillston Cotton Growers Association, a research review meeting with 15 growers and a consultant was conducted.

Evan Brown has been appointed as the secretary of the CGA in the Lachlan Valley to help in the development of the CGA business plan and other projects.

A highlight of the year included a very successful field day with over 80 people attending. The inaugural crop competition was also held in March, which included 17 field entries over 8 farms.

The Annual Cotton Field Day in Hillston.

Growers inspecting a crop at a small field day in Murrumbidgee.

PROJECT: 4.1.13 *Cotton Industry Development Officer*

STAFF:
Julie O'Halloran, NSW Agriculture, Moree, NSW

AIMS:

- Develop extension priorities with local growers and consultants and link/adapt national extension activities into local issues.
- Contribute to the activities of the Weeds and Disease focus teams.
- Implement programs which promote the adoption of IPM, particularly for insect control and resistance management for both conventional and transgenic technology.
- Assist in the delivery of IPM short course and establishment / ongoing development of Grower Support Groups. (Incorporating IPM and BMP). Assist in implementation of BMP particularly for insect pest management and water management
- Co-ordinate the collection of egg samples from the local district for resistance testing
- To promote Decisions Support Systems such as SOILpak, SPRAYpak, COTTONlogic, HydroLOGIC and Ozcot.
- Produce a trial booklet detailing local trial results and distribute a local grower newsletter (Cotton Tales) on a frequent basis to promote research on current production issues.
- Co-ordinate the adoption of research into sound management practices in the Gwydir Valley cotton-growing region, including extension of water use efficiency and salinity issues and potential management options.

OUTCOMES:
Monitoring for Trichogramma continued and results were presented at grower group meetings. Parasitism levels of up to 80% have been detected with the potential to reduce the need to spray. Researchers were assisted in the release of a parasitic fly for GVB as another tool for IPM.

The 2003/04 season saw quite high numbers of whitefly and in particular silverleaf whitefly in crops around the valley. The need for continued monitoring of this pest through leaf collections as well as management options should control become necessary were promoted.

Co-ordination of egg collections for resistance testing was provided; DSS were promoted and demonstrated; a trial book was compiled; Cotton Tales was produced and distributed; and grower group meetings were held with researchers to discuss the impact of sodium levels on other nutrients and meetings on water use efficiency.

Several trials and demonstrations were organised, providing a platform to facilitate better communication between farmers, advisers and researchers from government and agribusiness. A major issue for the Gwydir Valley CGA was widespread herbicide hormone damage. Liaison between

Cotton Australia, NSW Agriculture District Agronomists, Gwydir Valley CGA and CCA attempted to address some of the causes of this widespread damage and ways to minimise further damage throughout the season.

Field walks to look at Fusarium research trials have demonstrated some management practices to improve plant establishment in Fusarium infected fields.

Results from Bollgard II damage trials conducted in the 2002-03 season were of great interest to growers. The apparent abilty of Bollgard II® to tolerate some damage early season and increase yield without significant delays in maturity has lead to some growers and consultants holding off on insecticide applications.

Several field trials were also carried out to address both national and local issues. These included a dryland Bollgard II® cotton row configuration trial which looked at quality from different parts of the plant within different row configurations. A plant stand trial was also conducted in double skip dryland to determine the minimum plant stand.

Regular interaction with 2VM/NOW FM in Moree, the local radio station, assisted with the extension of research and promotion of extension activities as well as providing information on topical issues.

PROJECT: 4.2.0 *Industry Development Extension Program – Darling Downs*

STAFF:
Ms Jenelle Hare, QDPI&F, Dalby, QLD

AIMS:
- To demonstrate the benefits of research to growers and industry through on-farm trials.
- To enhance communication to industry through grower-work groups and networks to discuss and disseminate these findings.
- To promote Decision Support Systems
- To assist in the development and implementation of IPM practices for the management of pests and diseases.
- Increase awareness of salinity monitoring and management in the cotton production system.

OUTCOMES:
Cotton extension survey programs were delivered on; Bollgard II management, Riparian Zones and NUTRIpak.

A fruiting factor trial was conducted on a dryland Bollgard crop at Macalister; five Bollgard sites were monitored as part of a coordinated Extension Team activity to field trial the Early Season Diagnostic Tool; and the CRDC Field to Fabric Bollgard trial were monitored at 'Mayfield' Dalby.

Cotton extension materials were developed and distributed to industry through the National Cotton Extension Team Focus Team network, and extension priorities were developed with local growers, consultants, growers associations, research and extension agronomists.

Heliothis egg collection from the Darling Downs region was coordinated with local CCA members, and despatched from DPI Dalby to ACRI for insecticide resistance monitoring. Aphids from local cotton crops were collected for resistance monitoring and evaluation.

A HydroLOGIC workshop was facilitated at Dalby and a local IPM course and regional Grower Groups (Area Wide Management), including demonstrations, supported. Ms Hare had a 30% time commitment with the Fusarium wilt project led by Dr Joe Kochman -'Ecology and development of management strategies for Fusarium wilt in cotton'; Linda Swan and John Lehane at Byee; and participated in the CRC Farming Systems rotation experiment at Mywybilla.

A local consultant newsletter 'Weather or Not' was produced to promote improved crop management, and a trial booklet detailing regional trial results produced.

PROJECT: 4.3.04 *Delivering science to Agribusiness - novel decision support tools*

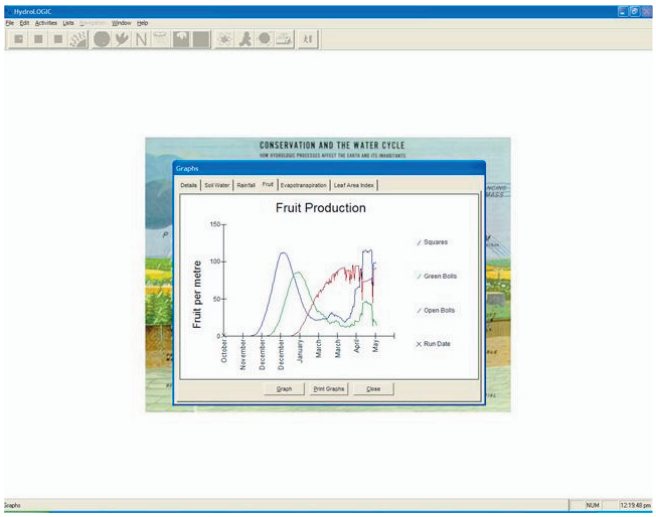
STAFF:
Dr Michael Bange, CSIRO Plant Industry, Narrabri NSW.
Laxmi Thakur, CSIRO Plant Industry, Narrabri NSW
Other Staff & Collaborators
M. Dillon, CSIRO Entomology, Narrabri NSW
Dr D. Murray, QDPI, Dalby, QLD
Dr R. Mensah, NSW Agriculture, Narrabri, NSW
Dr L. Wilson, CSIRO Plant Industry, Narrabri NSW
Mr S. Yeates, CSIRO Plant Industry,
Mr D. Richards, CSIRO Plant Industry, Narrabri, NSW.
Dr Grant Roberts, CSIRO Plant Industry, Narrabri, NSW
Dr Greg Constable, CSIRO Plant Industry, Narrabri, NSW.
Sandra Deutscher, CSIRO Plant Industry, Narrabri, NSW.

AIMS:
- Maintain and improve the functionality of the Cotton CRC's web site. Monitor acceptance of web-based information and review objectives and achievements in the light of changing technology and needs of the industry and the Cotton CRC.
- Assist redevelopment of the OZCOT crop simulation model using the common modelling protocol
- Complete HydroLOGIC for formal release.
- Identify software and approaches to facilitate efficient information dissemination.
- Facilitate and assist in the update of the Pest and Beneficial Guide and IPM Guidelines, using appropriate computing technology.
- Facilitate an industry advisory committee to provide direction and feedback on decision support systems.
- Identify, explore and develop new opportunities for computerised decision support to assist with cotton management.

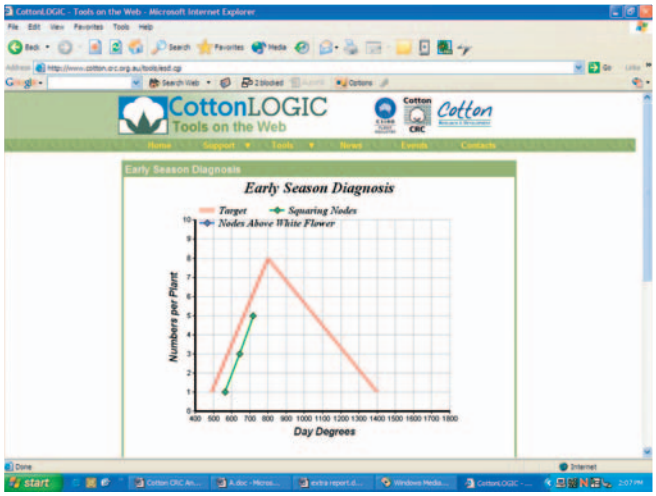
OUTCOMES:

This project forms part of the overall effort of the Cotton Management support systems team based in Narrabri. Some highlights of this project were:

- The Cotton CRC's website has been functioning well and usage is steadily increasing.
- Continued support of a CottonLOGIC helpdesk.
- Completion of a version of HydroLOGIC delivered to industry. In addition nine training workshop were conducted by Sandra Deutscher and Dirk Richards across the industry with 100 participants.
- Laxmi Thakur (Software Developer) was employed to replace Stewart Whiteside.
- An early season diagnosis (ESD) tool was developed for the Cotton CRC's website to assist with the agronomic management of cotton crops.
- Sandra Deutscher with the help of Lewis Wilson and Robert Mensah has re-structured the IPM guidelines using the authoring tool, 'HELP and MANUAL' which enables multiplatform delivery of information (eg. WWW, hardcopy, CD etc). It has now been organised into a series of objectives, similar to the IPM section in the BMP manual.
- The pest and beneficial guide has been updated with new information and is currently available over the Cotton CRC's website.
- Planning for the redevelopment of EntomoLOGIC software has begun.
- Working with IDO's and others Sandra Deutscher conducted field validations of the early season diagnosis tool used for Bollgard II management.
- Working with IDO's and others Dirk Richards conducted field validations of the HydroLOGIC for cotton irrigation management.
- The cotton crop simulation OZCOT is now fully implemented using CSIRO's common modelling protocol (CMP). A workshop held in Narrabri with other members of CSIRO planned future initiatives in the redevelopment of OZCOT which will allow the simulation model to be more accessible to other groups using the CMP.
- CottonLOGIC for Palm OS handheld was a finalist in the Australian Museum's Eureka awards in the category of Information technology.



Screen display from CottonLOGIC.



Screen display from CottonLOGIC.

PROJECT: 4.3.00 *Cotton Technology Transfer Centre*

STAFF:
Mr David Larsen, NSW Agriculture, Narrabri NSW

Other Staff & Collaborators
Dr Micheal Bange, CSIRO Plant Industry, Narrabri, NSW.

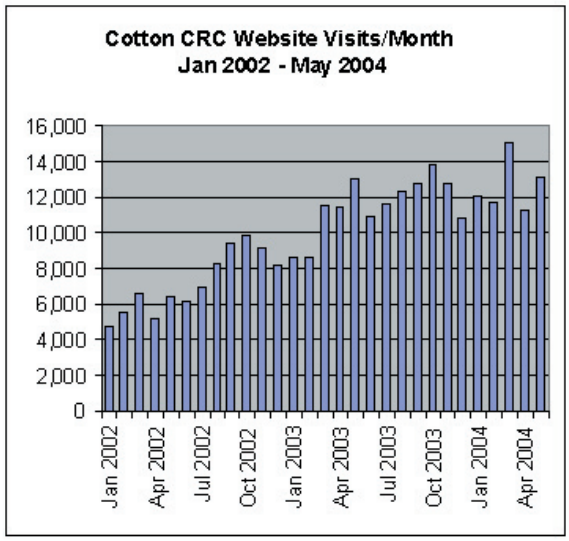
AIMS:

- Continue operation of the centre including responding to individual grower, consultant and other industry queries.
- Maintain responsibility for distribution of material including the new Paks – (Weedpak and IDM Guidelines)
- Visit regions to promote TRC (2700 records)
- Maintain Industry mailing /fax list
- Produce a Cotton Paks CD that encapsulates all the major paper based packages of the Cotton CRC.
- Produce material in response to special industry needs.

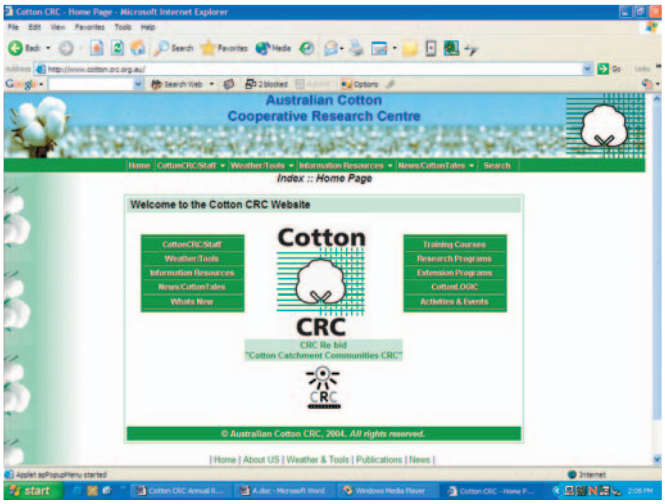
OUTCOMES:
The Australian Cotton CRC Technology Resource Centre (TRC) continues to serve the industry with extension material via paper , web and CD . The TRC assists researchers in producing and distributing research based material to industry in a timely manner.

The Cotton CRC web site administered by the TRC continues to provide information to industry with an average of over 400 users per day in the 12 month period to June 2004. Requests for information are also taken from the general public.

Material produced includes tables for Insecticide Resistance Management strategy and Resistance information sheet; produce an enhanced CottonPAKS CD by linking documents and improving indexing facilities and including a Cotton Symptoms Guide



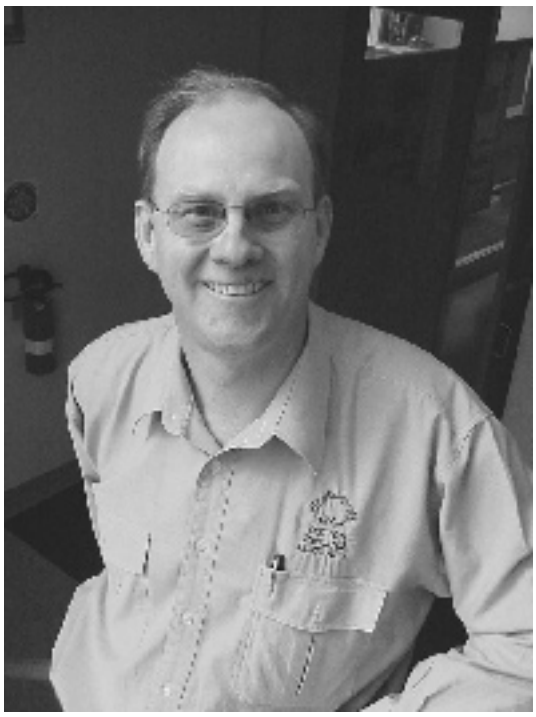
Australian Cotton CRC web site statistics showing increasing use patterns.



Main Menu page on the Australian Cotton CRC web site.

Program Five Overview
Cotton Textile Research

Program Five Leader Dr Geoff Naylor CSIRO Textile & Fibre Technology.



In the post harvest area, Program 5 is focussed on enhancing the commercial potential of Australian cotton in its key markets.

This year the program's activities have been concentrated in one project. This has been successfully tackling one of the programs major aims:

- To improve the quality of processed cotton by identifying the fibre characteristics best suited to the efficient processing of Australian cotton, and to provide appropriate feedback to the producer.

Highlights and Achievements

The project examining the quality of Australian cotton from the mill's perspective is now nearing completion. A summary of the results has been reported in trade journals including The Australian Cotton Grower. A full report is being prepared for release at the ACGRA conference in August 2004. Although Australian cotton is generally viewed as a quality fibre by spinning companies the results of the Mill Survey make it apparent that in order for Australian cotton to maintain it's status and continue to command a healthy price, a significant and sustained focus on improving Australian fibre quality is required. On the positive side, Australian cotton is generally rated highly, particularly on the basis of contamination, grade, colour, spinning ability, staple length, trash content and elongation. However high nep, short fibre content and the high micronaire values of the last few years were of particular concern to the spinning companies.

Indeed the negative consequences of high micronaire was reinforced when our planned commercial spinning trials had to be abandoned. Two separate lots of specially prepared (and ginned) cotton were rejected by Thai and Japanese mills as the micronaire was too high for spinning the required commercial yarn quality.

A smaller ginning and spinning trial was however successfully undertaken utilising the spinning mill at CSIRO in Geelong.

Another highlight was that Dr Stuart Gordon was invited to give a presentation to Bremen Cotton Conference in March on the outcomes of the project and an update on the Australian Cotton Industry.

Linkages
Linkages have been a key aspect of the success of the program this year.

- Important linkages continue with The Australian Cotton Shippers Association (ACSA). For example, Dr Stuart Gordon and Rene van der Sluijs participated in ACSA's trade exploration trips to Asia as the post harvest technical experts. Also ACSA arranged for Dr Stuart Gordon to make a presentation to the International Cotton Conference in Bremen.
- Linkages with textile processing mills in Japan, South Korea, Thailand and Indonesia, the local spinning mill Associations, Austrade offices, the local textile machinery representatives as well as individual mills have continued as a key aspect of the project work.
- Links with the cotton specialist at the major UK retailer, Marks and Spencer have been established. Indeed in March, Dr Geoff Naylor and Dr Stuart Gordon visited Marks and Spencer for useful discussions on opportunities for Australian cotton within the Marks and Spencer cotton portfolio.

Project Summaries

PROJECT: 5.2.03 *Quality Issues for Australian Cotton from a Mill Perspective*

STAFF:
Dr Stuart Gordon, CSIRO Textile and Fibre Technology, Belmont VIC
Mr Rene van der Sluijs, CSIRO Textile and Fibre Technology

AIMS:
• To Understand quality issues related to the use of Australian cotton from the spinners perspective.
• Identify fibre quality problems and other textile processing problems associated with Australian cotton.
• Prioritise and tackle these textile processing related R&D problems to improve the export potential of Australian cotton.
• Finalize and publish mill survey and processing (ginning and spinning) trials.
• Identify any significant processing issues for Australian cotton and devise suitable R&D activities.

OUTCOMES:
A survey was conducted by the CSIRO Textile and Fibre Technology Division (CTFT) with the support of the Australian Cotton Co-operative Research Centre (CRC) and the Australian Cotton Shippers Association (ACSA) to determine what customers of Australian cotton, i.e., the spinning mills, think about the quality and processing performance of Australian cotton. As well as being valuable from a marketing perspective the information will be valuable in shaping directions in research from breeding and growing through to ginning and classing.

Interviews were conducted by two CTFT officers visiting each mill to meet and interview the mill personnel. When the meeting had finished the completed responses were ranked by the officers using an impression scale from 1 to 5. Spinners impressions were generally based on their experiences with Australian cotton over several years and measured in relation to mainly HVI properties tested at the mill and to cotton they sourced from other countries.

The information gathered in the interviews was further enhanced by objective measurements on fibre samples gathered from bale lay-downs at each mill. Samples were collected four times over the past year using a formal sampling procedure developed by CTFT, which was demonstrated during the visit to each mill. These tests provided an independent and objective benchmark of the actual fibre quality being used in each mill, and allowed for direct comparison with samples of cotton from other countries, e.g. the USA and China, being used by the mill in the same lay-down.

The mill trial using custom-ginned cotton from the 02-03 season is nearing completion. Currently knitted fabric made from yarn in the trials is undergoing physical and dye tests. Results will be reported at the ACGRA Conference.

Unfortunately due to the high micronaire of the 2002-03 season, the mill trial in an overseas mill was abandoned. All custom ginned cotton by CTFT in 2003 (2 lots) was rejected by Thai and Japanese mills on the basis that the micronaire was too coarse (4.7+) for the required yarn count and trial set-up.

The 2004-05 mill survey report will recommend industry and R&D initiatives required to (further) improve the processing ability and market perception of Australian cotton.

Honey dew on cotton Lint.

Program Six Overview
Enhancing the Agricultural Environment

Program Six Leaders Associate Professor Nick Reid, The University of New England and Mr Dallas Gibb, NSW Agriculture.

Program 6 was conceived in May 2003, mid-way through the life of the CRC. The aim of the Program is to strengthen the CRC's profile in environmental research, and provide a sound platform for future growth in investment by building on the CRC's strengths in natural resource management. The key objective is to enhance the cotton farming environment by reducing environmental impacts and to maximise the contribution of cotton farms to catchment health.

Investment within the Program, is expected to exceed $3.5 M over the three year period 2003/4 to 2005/6 with more than $1.5 M raised through new external partnerships.

The Program has five themes:

- deep drainage and salinity;
- greenhouse gas profile and emissions;
- wetlands and pesticide remediation;
- native vegetation and biodiversity; and
- ecosystem services

Environmental education is a key output from research in all these themes, in conjunction with Program 4 of the CRC.

Benefits leading from research programs include:

- Quantification of deep drainage and its impact on salinity, sodicity and groundwater pollution, and strategies for reducing impacts.
- Benchmark greenhouse gas emissions from cotton farming systems, and the development of management strategies to reduce greenhouse emissions.
- Reduction by 30% of cotton pesticides in the riverine environment, publication of guidelines for on-farm development of environmentally beneficial wetlands, and initial industry adoption of wetland creation.
- Guidelines for managing native vegetation on cotton farms and their incorporation into the industry's BMP Land and Water Module.
- Quantification of the value of ecosystem services in cotton regions.
- Educational packages on ecosystem and other environmental services that promote linkages between cotton production activities and catchment health.
- Increase the skills base of advisory staff and environmental management services provided to growers across the industry.

The program works closely with program 3 (Farming Systems) and 4 (Extension and Education). Strong links have also been established with a number of catchment management bodies in NSW and Qld.

Highlights and Achievements

A key highlight of Program Six 6 was the launch of a 'Review of Biodiversity Research in the Australian Cotton Industry' by Professor Hugh Possingham at the Ecological Society of Australia's annual conference in December 2003. This review describes the role of biodiversity in cotton production systems, identifies the legislative and policy frameworks relevant to the cotton industry, as well as providing a review of current information about biodiversity in cotton growing regions in eastern Australia. It draws attention to the industry's environmental duty of care in several areas of potential impact, and suggests ways in which the industry can improve the protection and enhancement of biodiversity. Eleven key ecosystem services on which irrigated cotton production depends have been identified and linked to on farm and regional biodiversity.

The report provides a solid base for development of new projects in Program 6 in the area of biodiversity and ecosystem services, as well as developing a framework and rationale for increased investment in environmental research and establishing collaborative partnerships with organisation such as catchments management bodies.

In assessing ecosystem services new projects have been initiated for the Macquarie, Gwydir and Border River catchments. Key areas in which cotton production may both positively and negatively affect ecosystem service in the catchment will be targeted in these projects.

In the area of deep drainage and salinity, the CRC has invested heavily in assessing the risk of salinity in irrigated cotton regions. The work has involved extensive field and sub-catchment soil and EM surveys. The delivery of this work will occur through a new web based Geographic Information System (GIS) natural resources management service. This information will be useful for growers as well as catchment management bodies. It will allow the industry to prioritise those regions and sub-catchments that require future investment to reduce the risk of salinity.

The CRC held the Second Workshop of the Northern Murray-Darling Water Balance Group in Narrabri in November 2003. The workshop brought together a large number of high profile researchers from many research and academic institutions, including several outside the CRC, to establish future directions for research in water balance and deep drainage in the northern Murray-Darling Basin.

To increase the industry's skills base in natural resource and environmental management the CRC in working with the Australian Cotton Growers Research Association (ACGRA) has been successful in developing an industry partnership agreement with the Department of Agriculture, Fisheries and Forestry to focus on natural resource management. The program will see a number of new extension positions including a senior environmental specialist position established in 2004. These positions will work across all cotton regions as well as establish links with key catchment management bodies.

Progress towards Milestones

In the area of deep drainage and salinity, a number of projects have highlighted the potential for salinity to impact on the industry over the next 10 years. Two PhD students will complete their projects in 2004 in the area of salinity management. These projects 'Water Application and Hydrology' and 'Hydrological Impacts of Irrigation in the Bourke District' will provide important platforms for future research into salinity management beyond the farm gate. Our current understanding of the nature of deep drainage beneath cotton crops was updated at Workshop 2 of the Northern Murray-Darling Water Balance Group. Researchers across Programs 3 and 6 are working with staff in program 4 to develop extension and educational material on salinity and deep drainage.

In the area of native vegetation and biodiversity, excellent progress was made by several research students affiliated with the CRC. The research includes three PhD projects: (1) defoliant sprays impacts on native trees; (2) beneficial insects in native vegetation in cotton growing districts and (3) bats associated with cotton and remnant vegetation. A field investigation of remnant native vegetation condition on Moree cotton farms also commenced. Collaboration with the CRC for Fresh Water Ecology has been finalised to assess the capacity and interest of growers in managing for improved environmental outcomes in riparian zones and aquatic ecosystem health in the Border Rivers region.

In the area of ecosystem services, the review of biodiversity for the cotton industry was launched during the year and can be downloaded at the Cotton CRC website. Hard copies of the Executive Summary are available from CRDC or the CRC. Research on the value of ecosystem services underpinning irrigated cotton production in the Gwydir catchment continued through the year.

Loss of nitrous oxide has been highlighted as the industry's largest potential risk to greenhouse gas emissions. Research is continuing in this area with the aim to first establish a baseline for the industry's greenhouse gas emissions. This will follow with specific assessment and management of nitrous oxide. Collaborative arrangements have also been established with the CRC for Greenhouse Accounting for this research. The overall aim is to develop a simple greenhouse calculator that can be used by growers to estimate and thereby better manage emissions.

Project Summaries

PROJECT: 6.1.37 *Quantifying deep drainage using lysimetry*

STAFF:
Dr Anthony Ringrose-Voase, CSIRO Land & Water, Canberra
Dr Mac Kirby, CSIRO Land & Water, Canberra, ACT
Dr Nilantha Hulugalle, NSW Agriculture, Narrabri NSW
Mr Tony Nadeiko, CSIRO Land & Water, Narrabri, NSW.
Collaborator:
Dr Willem Vervoort, USYD, Sydney, NSW
Dr Rick Young, NSW Agriculture, Ornage, NSW

AIMS:
- Survey and characterise selected site for lysimeter
- Construct first lysimeter cell
- Purchase and install equipment for parallel measurement of drainage and measurement of other components of the water balance.
- Monitor drainage, water balance and water quality under conventional irrigated cotton production.
- Ensure measurements allow closure of the water balance
- Compare estimates of drainage made by alternative methods.
- Construct second lysimeter cell

OUTCOMES:
Mr Tony Nadeiko was appointed as the project technician to oversee lysimetre construction, installation and working.

Design of the lysimeter access well is nearly complete. It is a modification of that being used by NSW Agriculture for a similar GRDC funded lysimeter under Lucerne at Breeza near Gunnedah. Complex modifications are required to allow unhindered movement of irrigation water down the furrows, to minimize disruption of field operations and to ensure the well has a minimal effect on the hydrology above the lysimeter collection tray. In addition the OH&S aspects of the well have been taken into account.

The revised aim for 2004-05 is to install the first lysimeter during winter 2004 in time for the 2004-05 cotton season. The concrete access well will be installed in August (possibly September 04).

Analysis of soil chemistry, particle size distribution, mineralogy and hydraulic properties will be undertaken (mainly at CSIRO Land and Water, Canberra), where Lysimeter collection trays will be manufactured. Lysimeter collection trays and associated equipment will be installed through the access well walls at a depth of 2 m in September 2004. Measurement of drainage and other aspects of the water balance will start as soon as possible after installation and include as much of the cotton season as possible. Alternative methods of measuring drainage will be selected

PROJECT: 6.2.07 *The Effects of Cotton Defoliants on Native Trees from North-west NSW – Field-based Experiments*

STAFF:
Adam Downey PhD Student, UNE, Armidale, NSW
Associate Professor John Duggin, UNE, Armidale, NSW
Guy Roth , Cotton CRC, Narrabri, NSW.

AIMS:
The aim of this research project was to determine the effects of cotton defoliants on native tree species common to north-west NSW when exposed to direct application of cotton defoliants and assess those effects against the potential for off-target spray drift from the aerial application of defoliants.

OUTCOMES:
Achievements have been delayed due to illness of the principal researcher.The two major field experiments involved applying cotton defoliant chemicals to approximately 1304 young individuals of seven native tree species at different application rates and treatment combinations. Treatments were applied to planted young trees twice each year in April-May to simulate the cotton defoliation season during 2001, 2002 and 2003 to provide annual exposure for experiment 1 and periodic exposure during that period for experiment 2.

Experiment 3 involved the single application or single exposure of defoliants to seven remnant mature trees, while glasshouse experiments, 4 and 5, involved the application of a salt-based defoliant with and without oil to 72 (potted) young trees and the application of defoliants to 144 (potted) young trees experiencing different levels of moisture stress, respectively.

Tree health responses were assessed in relation to three major categories; (1) tree growth (height and new lateral shoot development), (2) defoliation and (3) tree damage (leaf spot and marginal necrosis and apical shoot or apex damage).

Results have thus far reflected general tends among all experiments that show treated trees exhibiting reduced height growth, variable lateral shoot development and increased defoliation, leaf necrosis and apex damage, when compared with untreated control trees.

Results have highlighted species, treatment and to an extent, application rate main effects, as well as complex first, second and third order interactions between variables. At this stage, no incidences of tree mortality have been attributed to defoliant effect.

PROJECT: *The role of native vegetation in harbouring beneficial insects and reducing insect pest damage in cotton*

STAFF:
Ingrid Rencken, PhD student, UNE, Armidale, NSW
Dr Letitia Silberbauer, Macquarie University, NSW.
Assoc. Prof Nick Reid UNE, Armidale, NSW.
Other Staff & Collaborators
Assoc. Prof Peter Gregg, UNE Armidale, NSW.

Ingrid Rencken PhD Student.

AIMS:
This project focuses on the use of native and other vegetation as a potential "nursery" and or refuge for beneficial insects. This is particularly relevant in ephemeral cropping systems like cotton. Through maintaining the non-cotton vegetation a steady and constant supply of beneficial insects is available to move into the cotton fields, thus reducing the amount of insecticides required by cotton growers.

OUTCOMES:
The surrounding non-cotton vegetation has been sampled to identify sites where beneficial insects occur. Movement and colonisation studies will also be carried out to determine the mobility and movement of beneficial insects into cotton. This project hopes to raise the awareness of the importance of the surrounding non-cotton vegetation as a potential source of beneficial insects. Initial results indicate there are beneficial insects in the surrounding non-cotton vegetation and highlight the importance of drought resistant vegetation. Two seasons of sampling are complete and a third season will commence in July 2004

Sampling River Reds with Suction Sampler

PROJECT: 3.2.18 *Measuring the Influence of Varying Water Quality on Drainage Through Irrigated Cotton Soils.*

STAFF:
Dr. Naidu Bodapati, NRM&M, Indooroopilly, QLD
Dr. Des McGarry, NRM&M, Indooroopilly, QLD

AIMS:
- Conduct Irrigation simulations on soil columns
- Complete simulation trials on all three lysimeter sites
- Install a further two drainage meter sites
- Sample collection from drainage meters
- Collate and analysis of data

OUTCOMES:
We have installed and instrumented mini-lysimeters at three sites in Queensland cotton fields (namely St George, Dalby and Goondiwindi) and are functioning well. In most situations deep-drainage was highest at the head-ditch, medium at the middle-lysimeter and the lowest at the tail end. The residence time of water on the soil seems to determine the amount of deep-drainage.

Average cumulative deep-drainage varied between sites: It was 132, 61 and 21 mm, at Dalby, Goondiwindi and at St. George, respectively in year 2002-03, while these values are 14, 56, and 117, respectively, in the year 2003-04.

We measured deep-drainage of soil columns collected from the field locations (St George, Dalby and Goondiwindi) by irrigating with four qualities of irrigation water. These include: (a) deionised water or good quality irrigation water (EC<0.3; SAR<5), (b) high saline (3 dS/m) and low sodic (SAR <5), (c) low saline (<0.3 dS/m) and high sodic (SAR >15), and (d) high saline (3 dS/m) and high sodic (SAR >15).

There was an interaction between soil type and water quality on deep-drainage under glasshouse conditions. Drainage was enhanced more by salinity than sodicity of the irrigation water in Dalby soil, while drainage was enhanced more by sodicity than salinity of the irrigation water in St George and Goondiwindi soils, compared to the drainage values from irrigating with fresh water.

PROJECT: 6.2.20

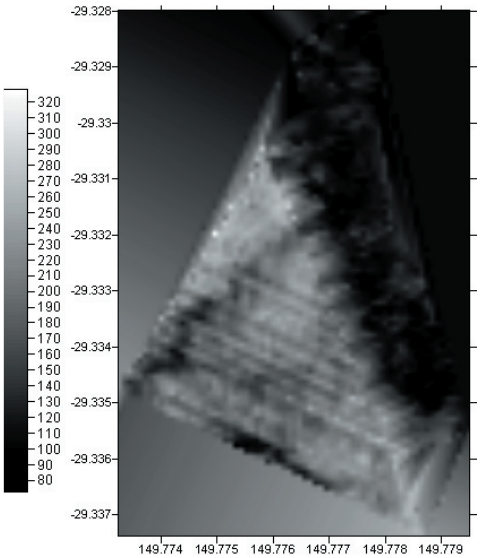
STAFF:
Dr Willem Vervoort, USYD, Sydney, NSW
Christopher Vanags, PhD Student, USYD, Sydney, NSW.
Other Staff & Collaborators
Dr John Triantafilis, USYD, Sydney, NSW.
Ms Diana Bennett, USYD, Sydney, NSW.

BACKGROUND
Palaeochannels, otherwise known as "prior streams", are ancient water-courses that have dried up or have been diverted over time. They contain sandier sediments than the surrounding soils and are covered by younger clay-rich sediments. This study hypothesises that palaeochannels may act as a shallow groundwater conduit, transporting water off-site or allowing it to drain below the root zone to recharge shallow aquifers.

AIMS
Our study aims at looking into how soil heterogeneity might influence deep drainage and ground water movement in the irrigated landscape. Our study looks at an irrigated cotton paddock which contains a small palaeochannel.

OUTCOMES
We have used electromagnetic induction to track the lateral extent of the palaeochannel, and are using ground-penetrating radar and direct-current resistivity to examine the depth of the channel in hopes that future investigators can determine their size and extent without costly and destructive drilling practices. Ground water wells are being installed within and around the channel in order to track the flow of irrigation water through the paddock and below the root zone.

The major highlight in this past year was getting the instruments in the ground in the appropriate places. The decision for instrument placement was based entirely on remote sensing, so it was reassuring to find the structure during drilling. We have also negotiated with the Department of Infrastructure, Planning and Natural Resources to provide us with a quad-bike mounted EM survey, and the placement of two fully instrumented piezometers on the study site. This information will be used to generate a computer model to predict deep drainage and offsite groundwater movement in hopes of better understanding the flow of shallow groundwater in these landscapes.



Map of the apparent electrical conductivity (EC_a) of a cotton paddock (area shown in red) in Moree, NSW using an EM 31. This data was used to locate the appropriate positions for equipment used to measure deep drainage through a palaeochannel thought to have been located on the paddock (shown as linear feature with lower conductivity).

Chris Vanags hoists a piezometer into the air, in the final stages of installation in a cotton paddock in Moree.

PROJECT: 6.2.22 *Sequestration of carbon below ground in cotton fields by arbuscular mycorrhizal fungi and cotton roots*

STAFF:
Ms Leonie Whiffen - PhD Student, USYD, Sydney NSW
Prof. Les Copeland, USYD, Sydney, NSW
Other Staff & Collaborators
Dr. Nilantha Hulugalle, NSW Agriculture, Narrabri, NSW
Dr. David Nehl, NSW Agriculture, Narrabri, NSW.

BACKGROUND
Fungi could play a crucial role in restoring the functionality of cotton growing soils and in reducing greenhouse gas emissions. Soil organic carbon (SOC), a key factor in soil condition, is in low or declining levels in cotton cropping regions of eastern Australia. Arbuscular mycorrhizal fungi (AMF) colonise plant roots and potentially could be managed to increase carbon storage and persistence.

Through a combination of field surveys at ACRI and lab base manipulative experiments, this PhD research will quantify the contribution that AMF make to SOC and investigate the role AMF play in soil aggregation and persistence of other forms of carbon.

AIMS
- •Maintain adequate production of monoclonal antibody for glomalin from hybridoma cell culture
- •Set up and maintain dual cultures of transformed roots and mycorrhizal fungi for in vitro production of glomalin
- •Complete and analyse field surveys at the end of this season and the beginning of the next
- •Develop experimental approach to studying glomalin in soil

OUTCOMES
An ampule of the hybridoma cells was obtained from the United States at the end of November 2003, but the viability of this sample was too low to establish a healthy bank of cells with which to work with. A second ampule was obtained on the 13th May 2004. The viability of this sample was also low (less than 10%) but attempts are currently being made to salvage this viable population. A warranty claim has been made to the supplier and a request for a sample of antibody from the scientist that began this work has been made so that analysis of samples collected so far can be completed. Approval was granted by the OGTR and the IBC to grow transformed roots and colonise them with AMF species at the end of November 2003. Since then two strains of Agrobacterium rhizogenes have been successfully resuscitated from frozen stocks and we now have an abundance of contaminant free transformed carrot roots in culture. Attempts have been made to initiate mycorrhizal colonisation of transformed roots using spores and, more recently, colonised roots fragments from pot cultures.

Counting Spores

Leonie Whiffen, PhD Student, taking samples in December 2003.

PROJECT: 3.2.01 *Environmental Benefits of On-Farm Wetlands*

STAFF:
Mick Rose, PhD Student, USYD, Sydney, NSW
Dr Angus Crossan USYD, Sydney, NSW
Prof Ivan Kennedy USYD, Sydney, NSW

Other Staff & Collaborators
Dr Robert Caldwell, USYD, Sydney, NSW.
Dr Willem Vervoort, USYD, Sydney, NSW
Dr Santo Ragusa, USYD, Sydney, NSW
Dr David Nehl, NSW Agriculture, Narrabri, NSW
Dr Stephen Johnson, NSW Agriculture, Narrabri, NSW.

AIMS
This project is aimed at assessing the benefits of constructed wetlands on cotton farms, in particular, the removal of pesticide residues from irrigation tailwater. Specific aims include:

- To continue isolation and characterisation of pesticide-

degrading microorganisms
- To reassess the environmental and economic performance of on-farm constructed wetlands based on two years of field trial data
- To plan the next phase of the project and develop strategies for practical application of wetland on a larger scale
- To improve pesticide remediation potential for on-farm wetlands and up-scale the design for whole farm improvement of water.
- To investigate the water balance in on-farm wetlands. A fourth year BscAgr student, Ian Miller, will be undertaking part of this research for his honours thesis under the supervision of Dr Vervoort and Prof Kennedy/Dr Crossan.

OUTCOMES

Two mixed cultures (that is, containing numerous microbial species) have been enriched, and their pesticide breakdown pathways examined. One culture appears to grow solely on prometryn as a carbon and nitrogen source, and also to mineralise prometryn when supplied with these nutrients. The other culture appears to grow solely on diuron, and will degrade (to metabolites) but not mineralise both diuron and prometryn when supplied with carbon and nitrogen.
A number (>10) of pure cultures have been isolated from each of these communities. Unfortunately, none of those examined so far have been able to initiate prometryn or diuron degradation. This work is continuing

Two years of data have now been collated for pesticide removal from water at the ponded wetland site on Mollee, and baseline results have been obtained for the flow-through system on Auscott. Water analyses showed that the efficiency of the ponded wetland markedly increased in the second year of operation, by between 20-40% removal, depending on the pesticide. The baseline results for the flow-through system show that sub-surface flow can reduce pesticide concentrations by up to 40%, but desorption of pesticide from prior irrigations can offset this benefit.

Good developments were made in finding interested collaborators to "up-scale" this project and test wetlands on a "working-farm" scale. Auscott and Cotton Australia have shown interest in our research and are likely to offer support and collaboration to enable future research.

Although the primary objective of this project was to investigate a pesticide-bioremediation system based on constructed wetlands, a number of other potential benefits have also been recognized. These include the use of on-farm wetlands to reduce sediment and nutrient loss in irrigation runoff, increase on-farm biodiversity, provide livestock feed and enhance pest management by fostering beneficial insect populations.

Another benefit provided by this project would be the on-going use of the trial sites as an educational tool for cotton growers, other agriculturalists, students and members of the wider community. A number of cotton growers have already visited at least one of the sites and expressed interest in developing similar systems on their own properties. Field trips with undergraduate and postgraduate students from the The University of Sydney have involved an in-depth tour of both sites and discussion of their chemical and biological importance.

It is possible that intellectual property will be pursued in relation to pesticide-degrading bacteria. At present, standard laboratory notebook practice is being followed. Further action will be taken if or when any novel pure cultures (single species) of pesticide-degrading bacteria are isolated and characterised.

PROJECT: 6.2.43 *Understanding the salinity threat in irrigated cotton areas of Australia – Phase IV Interpretation and Extension*

STAFF:

Dr John Triantafilis, USYD, Sydney, NSW
Dr Inakwu Odeh USYD, Sydney, NSW
Mr Sam Buchanan, PhD-Student, USYD, Sydney, NSW

AIMS

The project aims to consolidate research undertaken as part of Phase's II and III, synthesising data into results that can be extended and used as a framework for improved natural resource information in various irrigated cotton districts of south-eastern Australia. This includes Toobeah (Macintyre), Ashley (Gwydir), Wee Waa and Breeza Plains (Namoi), Warren and Trangie (Macquarie) and Bourke (Darling River valley).

In Bourke (Darling River) a hydrological study is being undertaken to determine why salinisation is a problem. This will be achieved using piezometer information and existing soil information (western side). The DLWC (Far-West Region) is keen to collaborate and provide funds to carry out this program. Mr Sam Buchanan (CRDC PhD student) will carry out the project in consultation with Mr Derek Yates (National Centre for Groundwater Management: UTS).

The specific aims include:
1) On the district-scale extend existing piezometer network and collect additional soil and water data in the Bourke Irrigation District to enable the development of a groundwater flow model to understand saline groundwater interaction from irrigation and the Darling River

2) Extend and interpret the results and data from Phase III and IV for improved natural resource management through: development of a Geographic Information System (GIS); development of a Web-page to allow extension officers and growers access and ability to query interpreted data layers stored on the GIS;

3) Publications in international and Australian soil and

water journals; and, publications in industry journals and periodicals.

OUTCOMES
The piezometer network was not installed owing to the withdrawal of DIPNR from funding the project and the inability to attract monies from the Natural Heritage Trust Envirofund program.

The completion of the EM and soil database and their publication on the world wide-web (Aim-a) has been delayed by the inability of the key researcher (Dr Triantafilis) to obtain complimentary funding to employ a research fellow to compile the information. Applications for funding were unsuccessful apart from the application entitled "Web-GIS development for natural resource management in the northern Murray-Darling Basin" to the National Competitive Component of the Natural Heritage Trust.

With the successful application made to the NCC-NHT it is envisaged a research associate or research fellow will be recruited to carry out the development of the web-GIS. It is also envisaged that funding applications will be re-submitted to allow for the installation of a piezometer network in the Bourke Irrigation District.

PROJECT: 6.2.35 *Whole farm salinity management strategies for cotton production in the Macquarie Valley.*

STAFF:
David Mitchell, NSW Agriculture, Trangie, NSW
Dr. N. Hulugalle, NSW Agriculture, Narrabri, NSW

BACKGROUND
All irrigation water contains salt, and when this water is added to the root zone to grow crops, the water is extracted by the plants and the salt is left behind. How irrigators manage the salt remaining in the rootzone will have a direct effect on the life of the irrigation enterprise. The only feasible way of managing this salt is by flushing the salt down the soil profile by application of more irrigation water than the plant needs. This extra water is called the leaching requirement and is related to the salt content of the irrigation water and the salt content of the rootzone soil.

AIMS
- Identify crop, fallow and water management strategies, which will reduce the rate of deep drainage and shallow water recharge
- Assess whole farm salt balance strategies that limit the impact of using poor quality for irrigation water

OUTCOMES
Five sites representing the main cotton growing soil types in the Lower Macquarie Valley were selected and soil sampled in late October.

Soil samples were taken at each site in October 2003 (pre cotton) and May 2004 (post cotton). At each sampling time three samples were taken within 5 m around the identified point to a depth of 2.1 m. These soil samples were analysed for ECe (uS/m) and chloride (mequiv).

This project measured the salt content of the soil profile in five representative irrigated soils in the lower Macquarie Valley before and after the 2003-2004 irrigation season. The amount of water and salt that was imported and exported from the field has been measured. From this measurement the amount of salt accumulated or leached from the rootzone will be established. This information will lead to a better understanding of the sustainability of irrigation in the lower Macquarie Valley.

Soil Sampling sites in the Lower Macquarie Valley.

PROJECT: 6.2.41 *Insectivorous bats, irrigated cotton, indigenous vegetation remnants and intensive production landscapes*

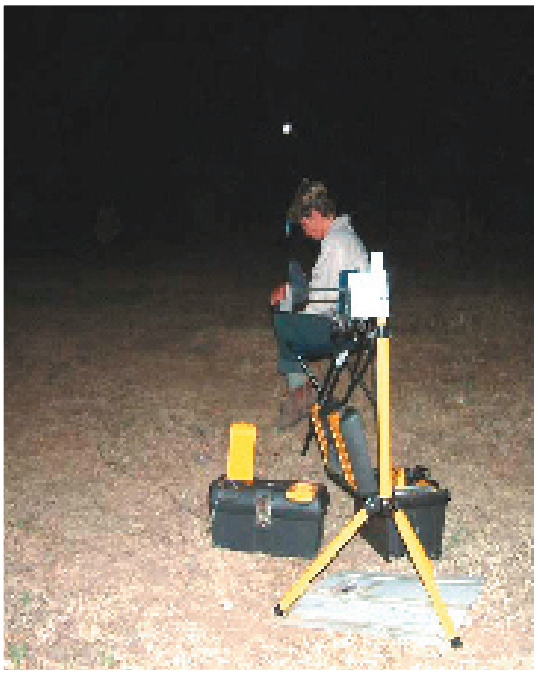
STAFF:
Leah MacKinnon, PhD Student, USYD, Narrabri NSW
Dr. Johannes Bauer, USYD, Orange, NSW.
Dr. David Goldney, USYD, Orange, NSW
Dr. Geoff Gurr, USYD, Orange, NSW.
Dr. Cilla Kinross, USYD, Orange, NSW
Alan Goode, Cotton Seed Distributors, "Little Mollee"; Narrabri, NSW
Phil & Pat Norrie, "Mollee"; Narrabri, NSW.
Mike, Alison & Andrew Carberry, "Cardale", Narrabri, NSW.

AIM:
The aim of this project is to investigate the microbat community across the 67 km² of three irrigated cotton production properties, to enable understanding of the linkages between, microbat foraging and roosting activities, and cotton fields and native vegetation remnants.

OUTCOMES:
This project is seasonally investigating and mapping microbat activities across eleven different vegetation and management categories within a cotton production landscape by:

- recording microbat ultrasound echolocation calls at 84 sites, to identify species and map activities;
- trapping microbats at selected sites, to verify ultrasound call identification, record release calls, and radio track selected bats to roost sites; and
- assessing native vegetation remnants, to provide a guide of tree hollow roost potential for microbats.

Results so far indicate that in this highly disturbed landscape, between 16 and 19 species of microbat have been identified, indicating a richness in species diversity. Of the ten chocolate wattled bats captured in one trap, three were lactating females, indicating there is at least one reproductive group of microbats in this cotton production landscape. Tentative result assessment of the 2003/04 cotton season bat ultrasound echolocation call activity landscape surveys indicates an increase in microbat activity over cotton fields during the growing season and distinct seasonal differences in patterns of vegetation use.



Leah MacKinnon taking notes whilst microbat ultrasound echolocation calls are being recorded by an Anabat recorder and storage unit outside the flash area.

A harp trap erected in an excellent location for trapping bats – a narrow track closed in by dense vegetation providing direct and easy flight paths for bats. The two banks of microfilament (fishing line) stretched by an aluminium frame, intercept bats in flight. Within this cypress pine remnant ultrasound echolocation calls of 7 microbat species were identified and 12 species were identified via trapping.

Publications

Awards

3.1.09 John Harvey - Selected as on of eight finalists for the CRC Australia "Showcasing PhDs" awards to be held in June 2004 Adelaide.

4.3.04 Dr Michael Bange received a 2004 Fulbright Professional Scholar Award (Coral Sea Award in Business and Industry) to help undertake studies in the USA.

4.3.04 CottonLOGIC for Palm OS handhelds was a finalist in the Australian Museum Eureka Science Awards for IT innovation.

Book Chapters

2.2.10 **Fitt, G.P**. (2003) Implementation and Impact of Transgenic Bt cottons in Australia. ICAC Recorder Vol 21(4): 14-19

2.2.10 **Wilson L.J., Mensah R.K., Fitt, G.P.** (2004). Implementing Integrated Pest Management in Australian Cotton, pp. 97-118. In: A.R. Horowitz, I. Ishaaya (Eds.), Insect Pest Management: Field and Protected Crops, Springer, Berlin, Heidelberg, New York.

2.2.10 **Fitt, G.P. and Cotter, S.** (2004) The **Helicoverpa** problem in Australia. Chapt in "Strategies for Helicoverpa Management: Prospects and Problems", H. Sharma Ed. CABI, In press.

2.2.10 **Fitt, G.P.** (2004). Implementation and impact of transgenic Bt cottons in Australia. Pp. 371-381 in *Cotton Production for the New Millennium. Proceedings of the third World Cotton Research Conference*, 9-13 March, 2003, Cape Town, South Africa, 1778 pages. Agricultural Research Council - Institute for Industrial Crops, Pretoria, South Africa.

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1.3.05 **Yeates SJ, Moulden JH, Strickland GR and N Gaff** (2004). Progress with sustainable cotton irrigation in tropical Australia: cracking clay soils. Poster presented at Irrigation Australia 2004 – Conference and Exhibition, Adelaide, April 2004

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2.2.09 **Del Socorro, A.P. and Gregg, P.C.** (2003). Development of commercial attract-and-kill systems using plant volatiles, for management of *Helicoverpa* spp. in cotton. *Ecological Society of Australia Conference, University of New England, Armidale, NSW, 8-10 December.*

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3.1.29 Oral presentation by **Dr. Hulugalle** at the 16th Triennial Conference of the International Soil Tillage Research Organisation, 13-18 July 2003, Brisbane, Qld.

3.1.29 Oral presentation by **Dr. Hulugalle** at Cotton Consultants Australia Inc. annual meeting in Narrabri, 18-19 May 2004.

3.1.29 Oral presentation by **Mr. Weaver** at Northern Murray Darling Basin Water Balance workshop, 19 – 20 November 2003, Narrabri, NSW

3.1.29 Poster paper by **Dr. Hulugalle** at Irrigation 2004, Irrigation Australia 2004 Conference, 11-14 May 2004, Adelaide, SA.

3.1.29 Internal Cotton CRC seminar by **Dr. Hulugalle** on 4 June 2004 entitled "Measuring root growth in Vertisols".

3.1.34 **Oral presentation** at the 5th International Conference of the Sub-commission on Pedometrics of the International Union of Soil Science (IUSS)- September 27-29, 2003, The University of Reading, UK. Reference: **Inakwu O.A. Odeh, Alex. B. McBratney and Budiman Minasny**. 2003. Modelling the risk of soil degradation: (multiple) indicator kriging approach to mapping the potential for soil sodification and structural decline. Proceedings of the 5th Conference of the Sub-commission on Pedometrics of the International Union of Soil Science (IUSS)- September 27-29, 2003, The University of Reading, UK.

3.1.34 **Oral presentation** at the International Conference on Innovative Techniques in Soil Resource Inventories Cha-am, Thailand, March 22-26, 2004 Reference: **Inakwu O.A. Odeh, Alex. B. McBratney and Budiman Minasny.** 2004. On pedometric approach to soil survey and modelling: advances in quantitative methods to take advantage of emerging technologies and rich sources of environmental data. Proceedings of the International Conference on Innovative Techniques in Soil Resource Inventories Cha-am, Thailand, March 22-26, 2004.

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4.2.05 **Christiansen Ingrid** (2003) Ever Improving: Building Skills and Culture to Evaluate Cotton Extension Outcomes 2003 APEN National Forum, 26 – 28 November 2003, Hobart.

4.2.05 **Christiansen Ingrid** Knowledge Management Research Project Poster displayed 2003 APEN National Forum, 26 – 28 November 2003, Hobart.

4.2.07 Oral presentation by **Ziaul Hoque** at CRC Research Conference 2003, July 23-24, Armidale, NSW.

4.2.07 Presentation by **Bob Farquharson** at CRC Research Conference 2003, July 23-24, Armidale, NSW on Benefit-Cost Analyses of cotton projects.

5.2.03 **Gordon, S** delivered invited paper at 27th International Cotton Conference in Bremen, March 2004, Bremen, Germany

5.2.03 **Gordon, S** delivered invited paper to Australian Cotton Shipper Conference, 'An Accent on Quality' September 2003, Royal Pines, QLD

6.2.07 **Downey, A** Australian Cotton CRC Annual Review 2001-2004: Narrabri 2001, Toowoomba 2002, Armidale 2003, Narrabri 2004

6.2.21 **Grace, P.R.** The role of models in the management of GHG emissions for sustainable agriculture, 2nd Joint Australia and New Zealand Forum on Non-CO_2 greenhouse emissions from agriculture, Australian Greenhouse Office, Melbourne, Australia, 20-22 October 2003.

6.2.41 **MacKinnon, L.** 2003. autumn – bats, cotton and vegetation . *Australian Cotton Cooperative Research Centre Annual Review*, Armidale.

6.2.41 **MacKinnon, L. Goldney. D., Bauer, J., & Gurr, G.,** 2003. bats, cotton and vegetation remnants, autumn . . spring? .. summer? …, *Bugs, birds and bats: conservation biological control, ESA Ecology 2003 Conference*, Armidale, NSW.

7.1 **G Roth** Integration of native Biodiversity research in the Australian Cotton Industry. Proc Ecological Society of Australia Conference, Armidale. 9/12/03.

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Grower Magazines & Articles

3.1.21 **Wu H** (July 2003) A scoping study on weed issues and their economic impact in dryland cropping systems with cotton. In 'Weedwatch', Weeds CRC Newsletter.

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3.1.21 **Walker S, Widderick M & Wu H** (Eds) Proceedings of fleabane workshop.

3.1.21 **Walker S** (April 2004) New weed the bane of dryland farmers. In 'Rural Weekly'.

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3.1.29 **Hulugalle, N., Weaver, T., Hicks, A., and Campbell, L.** (2003). Irrigating cotton with treated sewage. Aust. Cottongrower, 24(3), 41-42.

3.1.29 **Weaver, T., Hulugalle, N., and Ghaderi, H.** (2003). Salt and nutrient leaching under irrigated cotton. Aust. Cottongrower, 24(4), 24-26.

3.1.29 **McKenzie, D.C., Shaw, A.J., Rochester, I.J., Hulugalle, N.R., and Wright, P.R**. (2003). Soil and nutrient management for irrigated cotton. AGDEX 151/510, no. P5.3.6, 40 pp. (NSW Agriculture, Orange, NSW).

3.1.34 **Triantafilis J Short M and Odeh IOA.** 2004. Identifying deep drainage risk areas in the lower Gwydir valley. The Australian Cotton Grower, Toowoomba, Queensland, Jan-Feb. pp. 19-22.

3.1.36 **Rochester IJ** (2004). Vetch improves the productivity of irrigated cotton. *Australian cottongrower* (April-May) Vol 25(2) pp 58-61.

3.1.36 **Rochester IJ** (2004). Rotational vetch lifts cotton yields and profit. *Farming Ahead* No. 150 (July 2004) (in press).

4.1.13 **O'Halloran, J** Regional reports in each issue of the Cottongrower magazine

4.2.04 **Hickman, M**. *Cottongrowers gain pest management skills ,* Department Of Primary Industries Media Release, January 2004

4.2.11 **Evan Brown** - Cotton Tales: 2003-04 Season, Fourteen editions

4.3.04 **Bange, M., Carberry, P., and Marshall, J.** (2003). Dryland cotton: Balancing yield, quality and costs. The Australian Cottongrower 24(5).pp. 62-66.

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4.3.04 **Deutscher, S. A., Dillon, M., McKinnon, C., Mansfield, S., Staines, T., and Louise Lawrence**. (2003) Giving insects a good beating. The Australian Cottongrower. June/July issue.

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4.3.04 **Richards, D.Q., Bange, M.P., and Milroy, S.P.** (2003). A season without rain: Where's Noah when you need him! The Australian Cottongrower 24(3) pp.52-56.

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5.2.03 **Gordon, S.** 'Australian Cotton: How Good Is It Really? A report on the quality needs and perceptions of Australian cotton by domestic and overseas spinning mills', The Australian Cotton Grower Jan/Feb 2004

5.2.03 **Gordon, S** 'Spinner's Views on Australian Cotton', The Australian Cotton Grower Cotton Yearbook 2003

6.2.32 **Rose, M. T., Crossan, A. N., Kennedy, I. R.** (2003) Designing irrigation systems to improve water quality. The Australian Cottongrower, 24:5 pp. 8-12.

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6.1.33 **Taylor, IN** (2004) Cotton Weeds: Density is key. Farmers Weekly (South Africa) 16 Apr 2004

Industry CRC Information Sheets Research Reviews & Newsletters.

1.1.01 **Yeates S** - Cotton Frontiers No 5. – May 2004, Cotton CRC Northern Newsletter.

1.1.01 **Yeates SJ and Martin CC**. "Overview of Cotton Research and Prospects in the Northern Territory to March 2004" Published by NTDBIRD

4.2.05 **Christiansen IH, Larsen D, Dugdale H and Price J** (2003) Cotton Information Resources - Are they being used. A survey of the value and use of research and extension information resources provided by the Australian Cotton Cooperative Research Centre and the Cotton Research and Development Corporation. Occasional Publication 2003/02. Australian Cotton Cooperative Research Centre, Narrabri.

4.2.05 **Callan V, Christiansen I, Harris G and Cotton Extension Network** (2003) Knowledge Management in Cotton and Grain Irrigation. Australian Cotton Cooperative Research Centre.

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4.2.05 **Christiansen** (2004) Soil Management Extension Technical Training and Development – Evaluation and Recommendations. Unpublished.

4.3.06 **Ingrid Christiansen1, David Larsen, Helen Dugdale and Joanne Price.** COTTON INFORMATION RESOURCES– Are they being used? *A survey of the value and use of research and extension information resources provided by the Australian Cotton Cooperative Research Centre and the Cotton Research and Development Corporation. Australian Cotton Cooperative Research Centre Occasional Publication 2003 / 02*

4.3.04 **Richards, Q.D. and Bange, M.P.** (2003) 'Water-you cannot manage it if you don't measure it', January 2003, CRDC Spotlight.

4.3.04 **Richards, D., Bange, M.P., and Johnston, S.B.** (2003) HydroLOGIC Irrigation water management and risk analysis software User Manual V1.01, CSIRO Plant Industry and Australian Cotton CRC, September 2003.

4.3.04 **Richards, Q.D. and Bange, M.P. (2003)** 'Getting more crop per drop with HydroLOGIC', December 2004, CRDC Spotlight.

4.3.04 **Richards, Q.D. and Bange, M.P.** (2003) 'HydroLOGIC irrigation trial', Lower Namoi Cotton Trial Book December 2002-03.

4.3.04 **Richards, Q.D., and Bange, M.P., (2004)** HydroLOGIC furrow irrigation management software, WATERpak- a practical guide for water management in irrigated cotton, Australian Cotton CRC and the Cotton Research and Development Corporation.

4.3.04 **Richards, Q.D., and Milroy, S.P.,** (2004) Agronomic management and planting decisions, WATERpak- a practical guide for water management in irrigated cotton, Australian Cotton CRC and the Cotton Research and Development Corporation.

4.3.04 **Richards, Q.D., and Milroy, S.P.,** (2004) Irrigation management with limited water, WATERpak- a practical guide for water management in irrigated cotton, Australian Cotton CRC and the Cotton Research and Development Corporation.

4.3.04 **Richards, Q.D., and Tennakoon, S.B.,** (2004) A summary of water use efficiency in the industry, WATERpak- a practical guide for water management in irrigated cotton, Australian Cotton CRC and the Cotton Research and Development Corporation.

4.3.04 **Yeates S.J. and Bange M.P.** (2003). Preliminary simulation analysis of potential cotton lint yields and irrigation water requirements for different planting dates at Laverton WA. Australian Cotton CRC, Narrabri, NSW.

4.3.06 **Rossiter, L Wilson, L Larsen, D Pyke, B Gunning R Herron, G Kelly D.** ***(2003)*** Insecticide Resistance. Where are we now? *Australian Cotton CRC Information sheet*

6.1.37 **Ringrose-Voase AJ** (2004) Deep drainage. In "WaterPak", Cotton Research and Development Corporation, Narrabri, NSW. In press

6.2.41 **MacKinnon, L., Dillon, M., Rencken, I., Jarman, P., & Montgomery, J.** 2003. Bats – natural pest controllers, Improving biodiversity on cotton farms, *Managing riparian lands in the cotton industry*. Editors Lovett, S., Price, P. & Lovett, J., Cotton Research and Development Corporation

Key Events

Northern Program – 2 days - Annual Research Review, Kununurra, Western Australia.

Farming Systems Forum – 2 days - Improving Water Use, Moree.

Deep Drainage Forum - 2 day workshop focus on Darling Basin, Narrabri.

Commercial Sector Forum - Forum for Commercial Companies Associated with cotton, Narrabri, NSW.

Post Graduates Students - "Call on Cotton" Two day information session on cotton industry, Narrabri, NSW

Science Meets Federal Parliament Guy Roth & John Triantafilis.

NSW Government CRC Forum - Guy Roth, Nicky Schick, Helen Scott-Orr and Bridget Jackson, NSW Legislative Council, Sydney.

Media Interviews

1.1.01 Yeates S - ABC radio Darwin November 2003.

1.1.01 Yeates S - Commercial Radio Moree – April 2004

1.3.05 ABC North West WA **Date:** 27/05/2004 **Program:** WA Country Hour - John Moulden.

3.1.21 **Walker S** (January 2004) Managing weeds in more competitive sorghum crops. Channel WIN (Queensland).

3.1.21 **Osten V** (March 2004) Crop competition studies in sorghum and sunflower. Range Media for GRDC Website.

3.1.29 **Hulugalle N** - Local & Regional Newspapers "Injecting straight into wheat stubble" in "Agriculture Today" by Brett Fifield`

3.1.29 **Hulugalle N** - Local and regional newspapers "Repairing soil" in "Agriculture Today" by Tom Braz

3.1.29 **Hulugalle N** - Local and regional newspapers "Grey water a real option for cotton crop" in "Agriculture Today" by Annette Cross.

3.1.29 **Hulugalle N** - Local and regional newspapers "Grey water could be the answer – Treated sewerage water saviour for irrigators?" in the "Narrabri Courier".

3.1.29 **Hulugalle N** - Local and regional newspapers "Cotton industry focus in greenhouse gas project" in the "Cotton Magazine".

3.1.29 **Mr. Weaver** was interviewed by NBN Television regarding his research during the ACCRC's postgraduate week.

3.1.29 **Hulugalle N** - Media release by Annette Cross entitled "Grey water has uses".

3.1.34 **Dr Odeh -** Interviewed by the Border News on the CRC Soil Database and Soil Information System, after the their launch at the Moree Cotton Trade Show on the 26th of May 2004.

3.1.35 **Roberts G.N.** (2004). GM cotton could save our soil. Australian Biotechnology news, Feb. 14, Vol 2, No.3, p.13.

3.1.36 **Dr Rochester** - Media release: Vetch – the legume that increases cotton profits. 22 March 2004.

3.1.36 **Dr Rochester** - Interviews with ABC Radio (Tamworth and Rockhampton) 23 March 2004.

4.1.13 **Julie O'Halloran** - "Beneficial wasps kill grubs before they hatch" NSW Agriculture Today, The Land, February 26th, 2004.

4.2.05 **Ingrid Christiansen** 4WK Toowoomba 5/11/2003

4.2.05 **Ingrid Christiansen** "Irrigation Know-How" Media release 21/10/2003.

4.2.05 **Ingrid Christiansen** "Valuable Feedback from Irrigation Project" Media release 4/11/2003

4.2.11 **Evan Brown** - Media interviews: Radio Programs Interviews six times on the local 2RG

4.3.04 **Michael Bange** was Interviewed by radio 2WEB on temperature research being conducted by the Cotton Research Unit.

4.3.04 **Richards D** was interviewed by The Canberra Times in September 2003 regarding HydroLOGIC, with a subsequent article published in The Canberra Times titled *'Cotton boon: better crops with less water'*, 13th September 2003.

4.3.04 **Richards D** was interviewed by the North West Courier in September 2003 regarding HydroLOGIC, with a subsequent article published in the Cotton Magazine titled '*Software will save water'* September 2003, and in the Quirindi Advocate, '*Cotton irrigation software saves water'*, 17th September 2003.

4.3.04 **Richards D** participated in radio interviews regarding HydroLOGIC were conducted with 2UM Sydney radio, September 10, The Land newspaper, September 11, ABC Rural radio, September 16, ABC Rockhampton radio, September 17, Moree 2VM, February 4, The Land newspaper, February.

5.2.03 **Gordon, S** - Australian Cotton Outlook, August 2003

6.2.07 **Downey, A** - Interviewed by The Land" newspaper at "Ag-Quip" Field Days, Gunnedah, NSW, August 2001 and subsequent newspaper article.

6.2.07 **Downey, A** - Newspaper article from on-site Field-Day at "Milchengowrie", Boggabri, NSW, printed in "The Land" newspaper, The North-west Magazine and other newspapers in north-west NSW in July 2003.

6.2.34 **Triantafilis, J** - July 13, 2003. ABC Radio Australia Interview with Blanche Desailly. Defeating Salinity - Mobile Electromagnetic Sensing System.

6.2.41 **McKinnon, L,** 2003. Bats and cotton from the ESA Conference, *Rural Report*, ABC Radio New England Northwest, December

6.2.41 **McKinnon, L,** 2004. Bugs, birds and bats cleaning up in cotton crops, *Earthbeat*, Radio National. 31st January.

Roth G 21/7/03 ABC Radio National, Lippia Weed Distribution.

Roth G 27/10/03 Griffith Radio Station, Science Meets Federal Parliament.

Roth G 30/10/03 2WEB Bourke, Science Meets Federal Parliament.

Roth G 10/11/03 Qld Country Life Newspaper, Cotton in the Northern Territory.

Roth G 27/11/03 2WEB Bourke, Riperian Land Management on Cotton Farms.

Roth G 3/12/03 2WEB Bourke, Cotton Catchment Communities CRC proposal.

Roth G 23/12/03 2TM Tamworth, Biodiversity and its importance to the cotton industry.

Roth G 6/1/04 NOWFM/2VW Moree, Cotton CRC New Years News.

Roth G 9/1/04 NOWFM/2VM Moree, Cotton Catchment Communities CRC.

Roth G 27/1/04 NOWFM/2VM Moree, Drought Study.

Roth G 30/1/04 ABC Radio Darwin, Cotton research in the NT.

Roth G 13/2/04 NOWFM/2VW & 2WEB & NBNTV, Commercial partners and cotton Catchment Communities CRC.

Roth G 5/3/04 ABC Northern Territory, Cotton CRC research in NT.

Roth G 26/3/04 ABC Tamworth, Cotton Catchment Communities CRC proposal.

Roth G 30/5/04 NOWFM/2VM Take care with cotton defoliant application and native trees.

Roth G 5/4/04 ABC Tamworth, Cotton CRC Research.

Roth G 13/4/04 QLD Country Life, NT Cotton Research situation.

Roth G 26/4/04 ABC Tamworth, Postgraduate Research Students.

Roth G 30/4/04 Wee Waa News, Interview on the impact of the drought on Wee Waa.

Roth G 3/5/04 NBN TV, Drought study on Wee Waa.

6.1.33 **Taylor, IN** (2004) Integrated weed management saves money benefits the environment. The Land (NSW Agriculture Annette Cross)

6.1.33 **Taylor, IN** (2004) CSD WEB ON WEDNESDAY Introduction of Roundup Ready Flex to Australian cotton production systems 21 Jan 04

6.1.33 **Taylor, IN** (2004) New generation cotton provides spray flexibility The Land May 20th 2004

6.1.33 **Taylor, IN** (2004) Flexing muscles with Roundup Ready trials The Courier May 20th 2004

Media Releases

2.2.09 **Cribb, J.** (2003) A sniff of irresistible odour will soon lure female bollworm moths to their doom by the million in NSW and Queensland. Cooperative Research Centres Association Media Release – CRCA 28, July 2003.

4.2.04 *Cotton Growers Join Forces To Combat Insect Pests ,* Cotton CRC Media Release April 2004

4.2.04 *Integrated Pest Management Expands* , Cotton CRC Media Release March 2004

4.3.04 10th March 2003- Australian Cotton CRC- 'Irrigation logic explained'.

4.3.04 15th April 2003 – Co-operative Research Centres Association – 'Sustainable production pays off'.

4.3.04 15th September 2003- CSIRO Plant Industry and Australian Cotton CRC – 'Better water use in cotton crops'.

4.3.04 9th February 2004 – Australian Cotton CRC – 'Spending summer on cotton scholarships'

25 July 2003 Major breakthrough in reducing cotton pesticide use, **Dr Gary Fitt**

14 July 2003 Major cotton research conference, **Dr Gary Fitt**

21 July 2003 Top scientist to head Cotton CRC, **Evan Cleland**

27 July 2003 Accolades for Cotton CRC chief, **Dr Gary Fitt**

27 July 2003 CRC awards presented, **Dr Gary Fitt**

27 July 2003 Acting CEO appointed to Cotton CRC, **Dr Gary Fitt**

29 September 2003 World first spray guide for beneficial cotton pests, **Dr Lewis Wilson & Martin Dillon**

9 September 2003 Cotton growers join forces to combat insect pests, **Mark Hickman**

12 September 2003 Cotton CRC forms commercial link with AgBiotech, **A/P Peter Gregg & Dallas Gibb**

16 September 2003 Cotton CRC gains funds for new irrigation project, **Graham Harris**

27th October 2003 Putting regional science on parliament's agenda, **Guy Roth**

24 October 2003 Cotton pest enemies found hiding in the bush

28 October 2003 Whitefly action plan saves cotton growers millions, **Dave Kelly**

23 October 2003 $20,000 action on Lippia weed, **Guy Roth**

25 November 2003 New Dryland cotton guide now available, **David Larsen**

25 November 2003 Cotton knowledge and skills under pressure, **Dr John Stanley**

25 November 2003 UNE course breakout story, **Dr John Stanley**

7 November 2003 New integrated pest management guide for cotton, **David Larsen**

3 November 2003 Valuable feedback from irrigation project, **Ingrid Christiansen**

22 December 2003 Review helps cotton growers protect environment, **Guy Roth**

December 2003 Irrigation know-how, **Ingrid Christiansen**

2 December 2003 Cotton seeks community input into future research directions, **Guy Roth**

23 December 2003 Macquarie river management important for cotton, **Guy Roth**

27 January 2004 Petroleum spray for cotton aphids, **Guy Roth**

28 January 2004 Honours student contributes to cotton science

6 February 2004 Review of insecticide resistance in the cotton, **Dr Lewis Wilson**

February 2004 Scholarships solicit research interest in cotton, **Guy Roth**

9 February 2004 Spending summer on cotton scholarships, **Guy Roth**

27 February 2004 Cotton CRC issues whitefly management update, **Julie O'Halloran**

20 February 2004 Big improvement in cotton water storages, **Graham Harris**

6 February 2004 Crucial workshop to discuss Cotton CRC support, **Guy Roth**

5 March 2004 Cotton research to continue in NT, **Guy Roth**

15 March 2004 University students visit Narrabri, Wee Waa, Moree communities, **Dr John Stanley**

19 April 2004 New graduates from cotton course, **Dr John Stanley**

19 May 2004 New chairman appointed to Cotton CRC, **Glenn Fresser**

May 2004 Free water salinity tests at Moree Tradeshow, **Ingrid Christiansen**

21 June 2004 Annual Cotton CRC awards presented, **Guy Roth**

21 June 2004 Annual review of Cotton CRC research, **Guy Roth**

28 June 2004 Former Cotton CRC chair honoured, **Guy Roth**

7 June 2004 Cotton industry development officer wins scholarship, **Rebecca Smith**

Presentations, Public Relations, Communications & Submissions

Schick, N – Submission - Productivity Commission into Native Vegetation, Moree 20th August 2003.
Schick, N – Presentation QLD Science Teachers Association Conference – The University of Queensland.
Schick, N – presentation to CRC Precision Agriculture planning committee 28th July 2003.
Schick, N – presentation Namoi Valley Water Users Association AGM 14th August 2003.
Harris, G – presented to the CRC Irrigation Futures Summer Zone meeting in Goondiwindi 25th September 2003.
Schick, N, Roth, G & Gibb, D - presentation to DIPNR Knowledge Exchange in Tamworth 30th October 2003.
Schick, N Roth G, Deep Drainage Workshop 19th – 20th November 2003.
Schick, N & Roth, G Annual Conference of the Ecological Society, Armidale 2003 8th December 2003.

1.1.01 **Yeates S** - Letters to editors Katherine Times and NT News – August 2003.

3.1.34 **Dr Odeh** along with **Dr Triantafilis and Professor Copeland**, made a submission and participated at the public hearing for the "inquiry into coordination of the science to combat the nation's salinity problem" for the House of Representatives Standing Committee on Science and Innovation.

1.3.04 **Annells, A.J., Norwood, C.Y. and Strickland G.R.** (2003) The effect of aphids on winter grown cotton (a seminar presented at the Annual Australian Cotton CRC Northern Program Research Review held in Kununurra 8-9 September 2003.

4.1.06 A media release was compiled and gave a brief overview of the summer scholarships being undertaken for the summer of 2003/2004 and the students associated with each scholarship.

4.1.06 A presentation was given to staff of the Australian Cotton Research Institute, on 20th February 2004 following completion of the project.

4.3.04 **Michael Bange** gave three presentations at the CSD/CSIRO review in Narrabri – UNR, environmental and management effects on fibre quality and Tools for Bollgard Management.

4.3.04 **Dirk Richards** gave a presentation at the Lower Namoi (20th February 2003) and Upper Namoi (11th and 13th March 2003) field days outlining key research results and the application of the HydroLOGIC software.

4.3.04 **Dirk Richards** gave a presentation at the CRDC Farming Systems Forum outlining decision support tools for irrigated cotton water management including HydroLOGIC, 26th - 27th November 2003.

4.3.04 **Dirk Richards** presented a poster outlining research results and applications of HydroLOGIC displayed at the Moree Cotton Trade Show, 28th-29th May 2003.

4.3.04 **Dirk Richards** gave a presentation at 'Irrigation and the environment' workshop held by the Irrigation Association of Australia and Condamine Alliance organisations on applications of management tools including HydroLOGIC, 9th July 2003 at Dalby.

4.3.04 **Sandra Deutscher** gave a presentation on the comparison of the beat sheet technique with established methods for sampling pest and predator abundance in cotton. Annual grower/consultant update, Goondiwindi, June 2003.

4.3.04 **Sandra Deutscher** gave a presentation on comparison of the beat sheet technique with established methods for sampling pest and predator abundance in cotton. Annual grower/consultant update, Mungindi, July 2003.

4.3.04 **Sandra Deutscher** has dealt with over 100 CottonLOGIC support calls and has conducted numerous software demonstrations to visiting scientists etc.

6.2.34 **Triantafilis, J** - July 3, 2003. Macquarie 2100 Field Day. Present results from research carried out in the Warren and Trangie Irrigation districts. Trangie.

6.2.34 **Triantafilis, J** - October 14-15, 2003. Federation Australian Scientific & Technological Societies- Science meets Parliament. Parliament House Canberra.

6.2.34 **Triantafilis, J**. - October 19, 2003. The IXth Commonwealth Study Conference. The University of Western Sydney, Hawkesbury.

6.2.34 **Triantafilis, J** - October 19, 2003. Inquiry: Coordination of Science to Combat Nation's Salinity Problem. Commonwealth Parliamentary Offices, Sydney.

Roth G & J. O'Halloran presented to Moree Council, Cotton Research. 2/9/03

Roth G presented to NSW Government Legislative Council. Enquiry in Science, Parliament House, NSW, Public Good Benefits of Cotton Research. 21/10/03.

Roth G presented to Faculity of Sciences, The University of New England, Cotton Catchment Communities CRC. 29/10/03

Roth G presented to Science Review, Department of Infrastrueture and Natural Resources, Tamworth. The Australian Cotton CRC Environmental Research. 30/10/03.

Roth G presented to Cotton Farming Systems Forum, Moree, Riparian Land Management. 26/11/04.

Roth G presented to Faculty of Rural Management, The University of Sydney, Orange. Cotton Catchment Communities CRC proposal. 18/12/03.

Roth G presented to Macquarie Cotton Growers Association, Riparian Land Management 18/12/03.

Roth G, B Doyle, Peter Carberry, Nicky Schick presented to Moree and Narrabri Shire Councilors, Cotton Catchment Communities CRC 21/1/04.

Roth G presented to QDPI and The University of Queensland on Cotton Catchment Communities CRC proposal. 19/1/04

Roth G presented to Narrabri Shire Council. Cotton Catchment Communities CRC re-bid 17/2/04.

Roth G presentation to Gwydir Valley Irrigators Association. 17/2/04.

Guy Roth & Evan Cleland presented to NT Amateur Fisherman's Association, Darwin. Cotton CRC Research. 4/3/04.

Roth G presented to Upper Namoi Cotton Growers Field Day - Riparian Land Management. 9/3/04.

Roth G presentation to visitors from Government Official from China, Austrade visit. 22/3/04

Roth G presentation to Brazil cotton growers visiting ACRI. 25/3/04

Guy Roth, Dallas Gibb, Nicky Schick presentation to Narrabri Council on cotton Catchment Communities CRC re-bid. 20/4/04.

Guy Roth, Bruce Pyke presentation to AVPMA Board, Moree. Cotton Research outcomes and re-bid. 22/4/04.

Guy Roth presentation to Rotary Youth Class, New England North West - Water quality. 12/3/04

Refereed Journals

2.2.10 **Capalbo, D. M. F., A. Hilbeck, D. Andow, N. Birch, B. B. Bong, G. P. Fitt, E. M. G. Fontes, K.L. Heong, J. Johnston, E. O. Osir, A. Snow, J. Songa, and F.-H. Wan.** (2003). Brazil and the development of international scientific biosafety testing guidelines for transgenic plants**.** Journal of Invertebrate Pathology 83: 104-106.

3.1.34 **Odeh, I.O.A.** (2004). Review: Spatial Data Quality. Edited by Wenzhong Shi, Peter F. Fisher and Michael F. Goodchild. Taylor and Francis, London and New York, 2002. Hardback, 313 pp. ISBN 0-415-25835-9. Geoderma 116, 395-401.

3.1.21 **Walker SR, Taylor IN, Milne G, Osten VA, Hoque Z, Farquharson RJ** (2004) A survey of management and economic impact of weeds in dryland cotton cropping systems of sub-tropical Australia. *Australian Journal of Experimental Agriculture,* **44 (10)** in press.

3.1.26 **Field, D. J., Sullivan, L. A., Cattle, S. R. and Koppi, A. J.** (2004) Comparison of four methods for liberating various aggregate fractions in Vertosols to study their morphology. *Australian Journal of Soil Research*, **42**, 29-37.

3.1.29 **Hulugalle, N.R., Nehl, D.B., and Weaver, T.B.** (2004). Soil properties, and cotton growth, yield and fibre quality in three cotton-based cropping systems. Soil Till. Res., 75, 131-141.

3.1.29 **Hulugalle, N.R., Weaver, T.B., and Ghadiri, H.** (2004). A simple method to estimate the value of salt and nutrient leaching in irrigated Vertisols. Adv. GeoEcol., 36, In Press.

3.1.34 **Odeh, IOA, A.J. Todd and J Triantafilis.** (2003). Spatial prediction of soil particle-size fractions as compositional data. Soil Science 168, 501-515.

3.1.34 **Singh B., IOA Odeh and A.B McBratney**. (2003). Acid buffering capacity and potential acidification of cotton soils in northern New South Wales. Australian Journal of Soil Research 41, 875-888.

3.1.34 **Triantafilis, J, I. O. A. Odeh, B. Minasny and AB McBratney.** (2003). Elucidation of physiographic and hydrogeological features of the lower Namoi valley using fuzzy k-means classification of EM34 data. Environmental Modelling & Software 18, 667-680.

3.1.34 **Triantafilis, J, A. I. Huckel · I. O. A. Odeh.** (2003). Field-scale assessment of deep drainage risk. Irrigation Science 21, 183-192.

3.1.34 **Triantafilis J Odeh IOA Short M and Kokkoris E** (2004). Estimating and mapping deep drainage risk at the district level in the lower Gwydir and Macquarie valleys, Australia. *Australian Journal of Experimental Agriculture* 44, (in press).

3.1.34 **Triantafilis J Odeh IOA Warr B and Ahmed MF** (2004). Modeling and mapping the impact of saline water use in the lower Namoi valley. *Agricultural Water Management* 66, (in press).

4.2.07 **Walker S.R., Taylor I.N., Milne G., Osten V.A., Hoque Z., Farquharson RJ.,** (2004) A survey of management and economic impact of weeds in dryland cotton cropping systems of sub-tropical Australia, *Aust. J. of Exp. Agr*. Vol 44, issue 10 (in press).

4.3.06 **Bange M.P. ,Deutscher S.A., Larsen D.L., Linsley D., Whiteside S.** (2004) A handheld decision support system to facilitate improved insect pest management in Australian cotton systems. *Computers and Electronics in Agriculture*, 43: 131-147.

6.2.34 **Triantafilis J Huckel AI and Odeh IOA** (2003). Field-scale assessment of deep drainage risk. *Irrigation Science* 21, 183-192.

6.2.34 **Triantafilis J Odeh IOA Minasny B and McBratney AB** (2003). Elucidation of physiographic and hydrogeological units using fuzzy k-means classification of EM34 data in the lower Namoi valley. *Environmental Modelling and Software* 18, 667-680.

6.2.34 **Odeh IOA Todd AJ and Triantafilis J** (2003). Spatial prediction of particle size fractions as compositional data. *Soil Science* 168, 501-515.

3.1.36 **Rochester IJ and Peoples MB** (2004). N_2-fixation by vetch (*Vicia villosa* Roth) and other legumes and the productivity of irrigated cotton following these crops. *Plant and Soil* (in review).

3.1.36 **Dorahy C, Rochester IJ and Blair GJ** (2004) Response of field grown cotton (*Gossypium hirsutum* L.) to phosphorus fertilisation on alkaline soils in eastern Australia. *Aust. J. Soil Res*. **42** (in review)

4.3.04 **Bange, M.P. and Milroy, S.P.** (2004). Growth and dry matter partitioning of diverse cotton genotypes. Field Crops Research 87(1): 73-87.

4.3.04 **Bange, M.P., Deutscher, S.A., Larsen, D., Linsley,D., and Whiteside, S.** (2004). Handheld decision support system facilitates improved insect pest management in Australian cotton systems. Computers and Electronics in Agriculture. 43(2): 131-147.

4.3.04 **Milroy, S.P. and Bange, M.P.** (2003). Nitrogen and light responses of cotton photosynthesis and implications for crop growth. Crop Science 43: 904-913.

4.3.04 **Ritchie, J., Abawi, Y., Dutta, S., Harris, T. and Bange, M.** (2004). Risk management strategies using seasonal climate forecasting in irrigated cotton production: a tale of stochastic dominance. Australian Journal of Agricultural and Resource Economics. 48(1): 65-93.

6.1.33 **Taylor IN, Peters NCB, Adkins SW, & Walker SR** (2004) Germination response of *Phalaris paradoxa* L. (Awned Canary-grass) seed to different light qualities. *Weed Research* **44**, 1-11

6.1.33 **Taylor IN, Adkins SW, & Walker SR** (2004) Effect of Burial Depth and Cultivation on the Seed Bank Dynamics of *Phalaris paradoxa* L. in an Australian Sub-Tropical Environment. *Weed Research* (Volume unknown at time of writing)

6.1.33 **SR Walker, IN Taylor, G Milne, VA Osten, Z Hoque, RJ Farquharson** (2004) A survey of weeds in dryland cotton cropping systems of sub-tropical Australia. 1. Management practices and effectiveness. *Australian Journal of Experimental Agriculture* **44** (10)

Seminars, Workshops & Trade Shows

Science Week, Australian National Museum Display 16-19 August 2003.

2.2.09 **Del Socorro, A.** (2004). Moth Attractants. *WINCOTT Field Day, Warra, Qld, 5 February 2004.*

2.2.09 **Gregg,P. and Hawes,A.** (2003). Magnet - attractant technology for IPM of *Helicoverpa* spp. *Cotton Production Seminar, Cotton Consultants Australia Inc., Narrabri 27 August 2003.*

2.2.09 **Gregg, P.** (2004) *Thinking outside the square – alternative approaches to insect pest management*. Grower Forum, Moree Cotton Trade Show, 26 may 20034

2.2.10 March 2004, Dr. Fitt participated in the 3rd Workshop of "International Working Group on Genetically Modified Crops in IPM", held in Vietnam. The focus of the workshop was Bt cotton. Dr. Fitt coordinates the Resistance Management section of the International GMO Guidelines project.

3.1.08 **Dr J Kochman** presented a seminar entitled 'The effect of Fusarium wilt on the cotton industry in Australia' to staff and students of the faculty of Agriculture and Horticulture at the University of Queensland – Gatton Campus, on 16 October 2003.

3.1.09 **Harvey J** - CRDC Call on Cotton Tour- Narrabri April 2004

3.1.09 **Harvey J** - CRCTPP Research symposium-Brisbane October 2003

3.1.09 **Harvey J** - CRC Leadership and Development Course-Melbourne, September 2003

3.1.20 **Speirs SD** 2003 Characterising soil structural stability and form of sodic soil used for cotton production. Cotton CRC Annual Review, Armidale July 2003.

3.1.20 **Speirs SD** 2004 Managing soil structural stability in an uncertain environment. Call–on–Cotton, Narrabri 2004.

3.1.21 **Osten V** (August 2003) Crop competition studies in sorghum and sunflower. GRDC Grains Research Update Seminar, Capella.

3.1.21 **Wu H** (September 2003) Fleabane ecology and control. CRT Training Workshop, Dalby.

3.1.21 **Walker S, Widderick M & Wu H** (March 2004) Weeds CRC and Cotton CRC workshop on fleabane, Toowoomba.

3.1.21 **Osten V and Wu H** (March 2004) Crop competition studies in sorghum and sunflower. GRDC Grains Research Update Seminar, Goondiwindi.

3.1.21 **Wu H** (March 2004) Fleabane - the curse of zero-till farming, can we kill it yet? GRDC Grains Research Update Seminar, Goondiwindi.

3.1.21 **Walker S** (May 2004) Update on fleabane research. CRT Training Workshop, Dalby.

3.1.22 **Werth, J. A.** 2004. Modelling Weed Resistance in Cotton Systems. Glyphosate Resistance Meeting. 21st April. Powerhouse, Tamworth.

3.1.22. **Werth, J. A.** 2003. Weed Resistance Modelling in Glyphosate Tolerant Cotton. TIMS Herbicide Resistance sub-committee meeting. 26th August, ACRI

3.1.29 Presentation by **Dr Hulugalle** on minimum tillage systems for pupae busting at field day organised by Annie Johnson Cotton Industry Development Officer.

3.1.34 **Odeh**, **I. O.A.,** and J Taylor. 2003. Spatial analysis and GIS visualization of soil salinity in irrigated catchments of northern NSW. Paper presented at the 2nd Sydney University CSAM Annual Symposium on Salinity Assessment and Management, Zoology Lecture Theatre, The University of Sydney, November 14, 2003.

3.1.34 **Odeh, I.O.A.** Presentation and launching of the Australian Cotton CRC Soil Database and Information System at the 2004 Moree Cotton Trade Show, Moree Tafe Agricultural Centre, Moree, NSW. 26th May 2004.

3.1.35 **Knox, O.G.G., Gupta V.S.R. and Roberts, G.** (2004). Genetically modified cotton influence on soil microbiota. Proceedings of the 3rd Australasian Soilborne Disease Symposium, Barossa, SA.

3.1.35 **Roberts, G** - Oral presentations on Roundup Ready cotton volunteer management for joint Cotton CRC/NSW Ag/CSD field day in lower Namoi valley.

3.1.35 **Roberts, G.N.** (2003). Controlling seedling volunteer cotton. Presentation at the Cotton Consultants Annual General meeting, Goondiwindi. 15th May.

3.1.36 **Rochester I -** Farming systems forum (27/11/03) Legume cropping systems: soil water storage / crop WUE.

3.1.36 **Rochester I -** CCA meeting (18/5/04) Growing vetch in cotton systems.

3.1.36 **Rochester I -** ACRI seminar (21/5/04) Soil fertility and Cotton nutrition - current and future research.

3.1.36 **Rochester I -** Lecture to CRC cotton course students (25/5/04) Cotton nutrition.

4.2.04 **Hickman M.A.,** (2004) *An Overview of IPM in cotton,* WINCOTT Organisation, Narrabri 9th September 2003

4.2.04 **Hickman MA.,** (2004) *An Overview of IPM in cotton*, WINCOTT organisation, Emerald 13th January 2004.

G Roth & K Orman Finance Management. Crawford Fund Master Class in Research in Agriculture, Sydney. 9/2/04

4.2.05 **Christiansen, I -** Coordinated 2003 National Extension Network annual workshop, Barrington Tops, August 2003.

4.2.05 **Christiansen, I -** Helped to arrange an APEN SEQ forum event, February 2004.

4.2.05 **Christiansen, I -** Presentations to local governments for CRC Rebid – June 2004.

4.2.11 **Brown E -** Four Area Wide Management Meeting

4.2.11 **Brown E -** Water Planning Meeting & CGA local meeting June 23rd

4.2.11 **Brown E -** Hillston Irrigation Cropping Forum 17th September

4.2.11 **Brown E -** Research Review Forum March

4.2.11 **Brown E -** Defoliation Workshop

4.2.11 **Brown E -** Annual Field Day 16th March

4.2.11 **Brown E -** Irrigation Evaluation 2-3rd of June Hay and Hillston

4.2.11 **Brown E -** Research Seminar 8th June

4.2.14 **Hare J -** Plant Pathology Professional Development Workshop – Currimundi (Sept 2003),

4.2.14 **Hare J -** Soils and Irrigation Workshop – Dalby (Nov 2003).

4.2.14 **Hare J -** Attend CSD Field Day and Farm walks, 24 Mar 2004

4.2.14 **Hare J -** Attend DPI/Cotton CRC Field Day – Fusarium Trials at "Cowan" – 7 Apr 2004.

4.2.14 **Hare J -** Attend trichgramma field day at Neil Wegeners 22 Jan 2004

4.3.06 **Larsen, D** - CRC Review (to researchers)24/07/03

4.3.06 **Larsen, D** - Lower Namoi Field Day, 04/03/04

4.3.06 **Larsen, D** - Australian Cotton Trade Show Moree May 26-27/05/04

5.2.03 **Gordon, S** - Up date delivered to CRDC Board and staff at CTFT November 4th 2003

6.2.12 **Rencken, I.C.**2003The importance of native vegetation to beneficial insects and its role in Cotton AgroecosystemsCRC Review July 2003, UNE, Armidale

6.2.12 **Rencken, I. C**.2004The importance of native vegetation to beneficial insects in Cotton Agro-ecosystemsSchool of Rural Science and Agricultural Seminar, U.N.E26/05/2004

6.2.34 **Triantafilis, J -** July 23-24, 2003. Australian Cotton CRC Annual Review. Understanding the salinity threat in the irrigated cotton. UNE Armidale.

6.2.34 **Triantafilis, J -** November 14, 2003. CSAM Symposium Modelling of Rural and Urban Salinity. The University of Sydney.

6.2.34 **Triantafilis, J -** November 26-27, 2003. CRDC Farming Systems Forum. Improving on farm water use efficiency. Moree.

6.2.34 **Triantafilis, J -** November 28, 2003. Earth Resources Foundation: Geophysics for location and managing groundwater. The University of Sydney.

6.2.34 **Triantafilis, J -** June 8, 2004, 2004. UNE-Cotton and the Environment Course. Methods and Management of soil salinity. Narrabri.

6.2.41 **MacKinnon, L**. 2003. What's the link between bats, trees and cotton crops? Trees, bats and defoliants, *Cotton grower field day*, Boggabri.

6.2.41 **MacKinnon, L**. 2004. A contributor to IPM and crop health that we haven't known about – bats! *Cotton field days and Crop judging tours, Upper Namoi Cotton Growers Association*, Boggabri and Gunnedah.

6.2.41 **MacKinnon, L.** 2004. Microbats in a cotton production landscape – are there any? if there are, where are they, and what are they doing? *A Call on Cotton, Tour & Workshop for Post Graduates*, Cotton Research and Development Corporation, Narrabri.

6.1.33 **Taylor I.N.** (2003) Competitive impact of weeds on cotton. Determining the critical period of weed competition. 24 November 2003 ACRI

6.1.33 **Taylor, I.N.** (2003) Managing Roundup Ready cotton in the framework of Integrated Weed Management. 4 December 2003

6.1.33 **Taylor I.N. and Charles GW** (2004) Management of Polymeria take-all and integrated weed management in irrigated cotton systems Walgett field day March 2004

Visitors

Hon John Anderson MP, Member for Gwydir, Deputy Prime Minister of Australia. Aug 03

SOCCA Pty Ltd. Nov 03.

Area Consultative Committee Executive Officer. Nov 2003.

NSW TAFE & Rotodye Pty Ltd Nov 03

Hon Gerry Wood MP, Independent Member, Northern Territory Parliament. Jan 04

German Greenhouse Scientists – Ralf Kiese, Klaus Butterbach-Bahl, Deli Chen and R Eckard from the Institute for Meteorology and Climate Research, Garmisch-Partenkirchen, Germany. Jan 2004
NSW TAFE Executive, New England/ North West. Feb 04.

Commercial Sector Workshop on CRC Feb 04.

China Government Delegation March 04.

Brazilian Cotton Farmers Delegation March 2004

All Cotton Postgraduate Students. April 2004.

Chief Scientist of Australia, Dr Robin Batterham May 04.

NSW Bee Keepers Association May 04

Narrabri Shire Councilors May 04.

Anwyn Lovett and Richard Price Land & Water Australia 14th July 2003.
Allan McGufficke Western Catchment Management Board 21st July 2003.
Rebecca Letcher spent three days interviewing researchers and visiting irrigator groups July 2003.
Murray Chapman National Program for Sustainable Irrigation – Land & Water Australia 28th August 2003

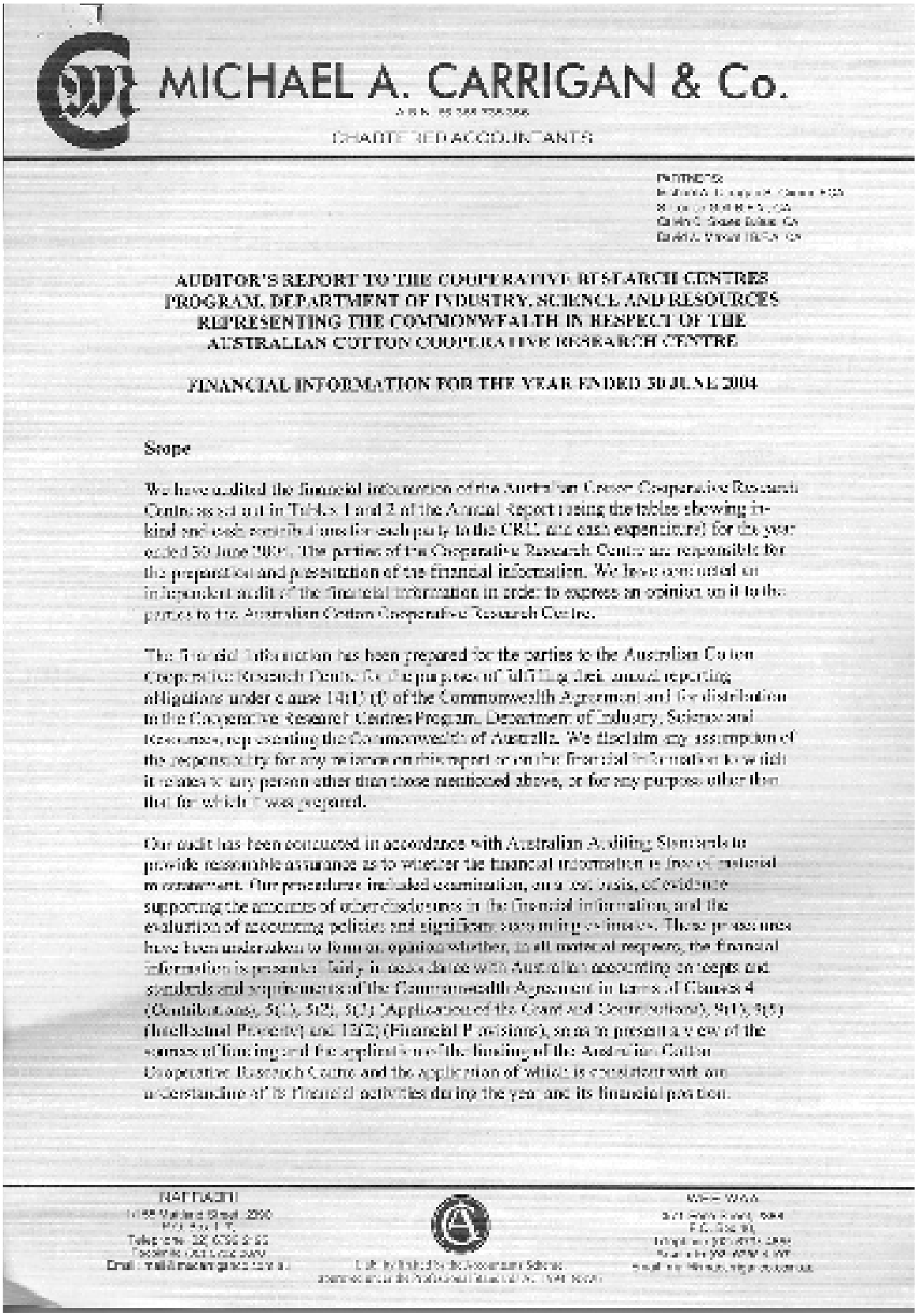
Jack McQue Queensland Natural Resources and Mines Deep Drainage study tour visited Dr N Hulugulle, G Constable and Gibb D. 15th September 2003

Simone Cobb ABC Television Tamworth completed a story of the Greenhouse experiments being conducted at the Australian Cotton Research Institute, Narrabri 13th October 2003.
Nick Schofield Land and Water Australia visited looking at potential partnership projects. 23rd October 2003.

Grains Research & Development Corporation Board visited Dallas Gibb and Nicky Schick. 28th October 2003.
Rebel Thompson Area Consulitive Committee 4th November 2003.
Andrew Rouse World Wide Fund 7th November 2003.
Dr Hanna Mustaparta visiting scientist 3rd February 2004.
Professor Ivan Kennedy, Dr Angus Crossan and Mick Rose completing experiments on wetlands on cotton farms, 13th February 2004.
Israeli Grower Visit 16th February 2004.

Di Bazley NBN Television completing researcher interviews. 17th February 2004.
Cotton Grower Services, Bayer, Syngenta attended a partnership planning meeting with Guy Roth, Dallas Gibb, Dr Lewis Wilson and Dr Robert Mensah 1st March 2004.
Federal Minister for Science Peter McGauran 15th March 2004.
Namoi and Gwydir Valley Beekeepers explained problems to researchers 3rd May 2004.
Calrossi Girls School Year 11 Agriculture Students visited research facilities 5th May 2004.
Lindsay Campbell Incitec visited the research facility 18th May 2004.
NSW Minister for Agriculture Ian McDonald visited 26th May 2004.
TAFE NSW representitives visited the research facility 11th June 2004.

Auditor's Report



MICHAEL A. CARRIGAN & Co.

CHARTERED ACCOUNTANTS

AUDITOR'S REPORT TO THE COOPERATIVE RESEARCH CENTRES PROGRAM, DEPARTMENT OF INDUSTRY, SCIENCE AND RESOURCES REPRESENTING THE COMMONWEALTH IN RESPECT OF THE AUSTRALIAN COTTON COOPERATIVE RESEARCH CENTRE

FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2004

Scope

We have audited the financial information of the Australian Cotton Cooperative Research Centre as set out in Tables 1 and 2 of the Annual Report being the tables showing in-kind and cash contributions for each party to the CRC and cash expenditure for the year ended 30 June 2004. The parties of the Cooperative Research Centre are responsible for the preparation and presentation of the financial information. We have carried out an independent audit of the financial information in order to express an opinion on it to the parties to the Australian Cotton Cooperative Research Centre.

The financial information has been prepared for the parties to the Australian Cotton Cooperative Research Centre for the purpose of fulfilling their annual reporting obligations under clause 14(1)(f) of the Commonwealth Agreement and for distribution to the Cooperative Research Centres Program, Department of Industry, Science and Resources, representing the Commonwealth of Australia. We disclaim any assumption of responsibility for any reliance on this report or on the financial information to which it relates to any person other than those mentioned above, or for any purpose other than that for which it was prepared.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial information is free of material misstatement. Our procedures included examination, on a test basis, of evidence supporting the amounts of other disclosures in the financial information, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion whether, in all material respects, the financial information is presented fairly in accordance with Australian accounting concepts and standards and requirements of the Commonwealth Agreement in terms of Clauses 4 (Contributions), 5(1), 5(2), 5(3) (Application of the Grant and Contributions), 5(4), 5(5) (Intellectual Property) and 12(2) (Financial Provisions), so as to present a view of the sources of funding and the expenditure of the funding of the Australian Cotton Cooperative Research Centre and the application of which is consistent with an understanding of its financial activities during the year and its financial position.

While we have not performed any audit procedures upon these estimates for the next period and do not express any opinion thereon, we understand that they have been formally approved by the Governing Board as required under the Joint Venture Agreement.

The audit opinion expressed in this report has been formed on the above basis.

Audit Opinion

1. The multipliers adopted by the Centre in value in-kind contributions other than salary costs have a sound and reasonable basis and each partner's component of the Researcher's Contributions for the year under report has been provided at least to the value for that year committed in the Budget as specified in the Agreement.

   The total value of all Contributions for the year under report equaled or exceeded the amount of grant paid during the year (not including advances) [Clause 5].

2. The Researcher has used the Grant and the Researcher's Contributions for the Activities of the Centre and in my professional opinion there appear to be no material reporting irregularities. [Clause 6(1)].

3. The Researcher's allocations of the budgetary resources between Heads of Expenditure has not been overweighted from the allocation in the budget by $100,000 or 20% (whichever is the greater amount) without prior approval by the Commonwealth. [Clause 2(2)] With the exception of:

   - salaries which were $1,979,000 over the original budgeted figure for the respective heads of expenditure.

   - other expenditures which were $117,000 over the original budgeted figure for the respective heads of expenditure.

4. Capital Items acquired from the Grant and Researcher's Contributions are vested as provided in the Joint Venture Agreement. [Clause 5(3)].

5. Intellectual Property in all Contract Material is vested as provided in the Joint Venture Agreement and no Intellectual Property has been assigned or licensed without the prior approval of the Commonwealth. [Clause 9(1), 9(3)] [or A statement signed by the Director/CEO or Board chair, to the effect that Intellectual Property in all Contract Material is vested as provided in the Joint Venture Agreement and no Intellectual Property has been assigned or licensed without the prior approval of the Commonwealth [Clause 9(1), 9(3)], has been seen by the Auditor.]

6. Proper accounting standards and controls have been exercised in respect of the Grant and Researcher's Contributions and income and expenditure in relation to the Activities of the Centre have been recorded separately from other transactions of the Researcher [Clause 12(3)].

5th October 2004

Firm: Carrigan & Co

Address: PO Box 117
NARRABRI NSW 2390

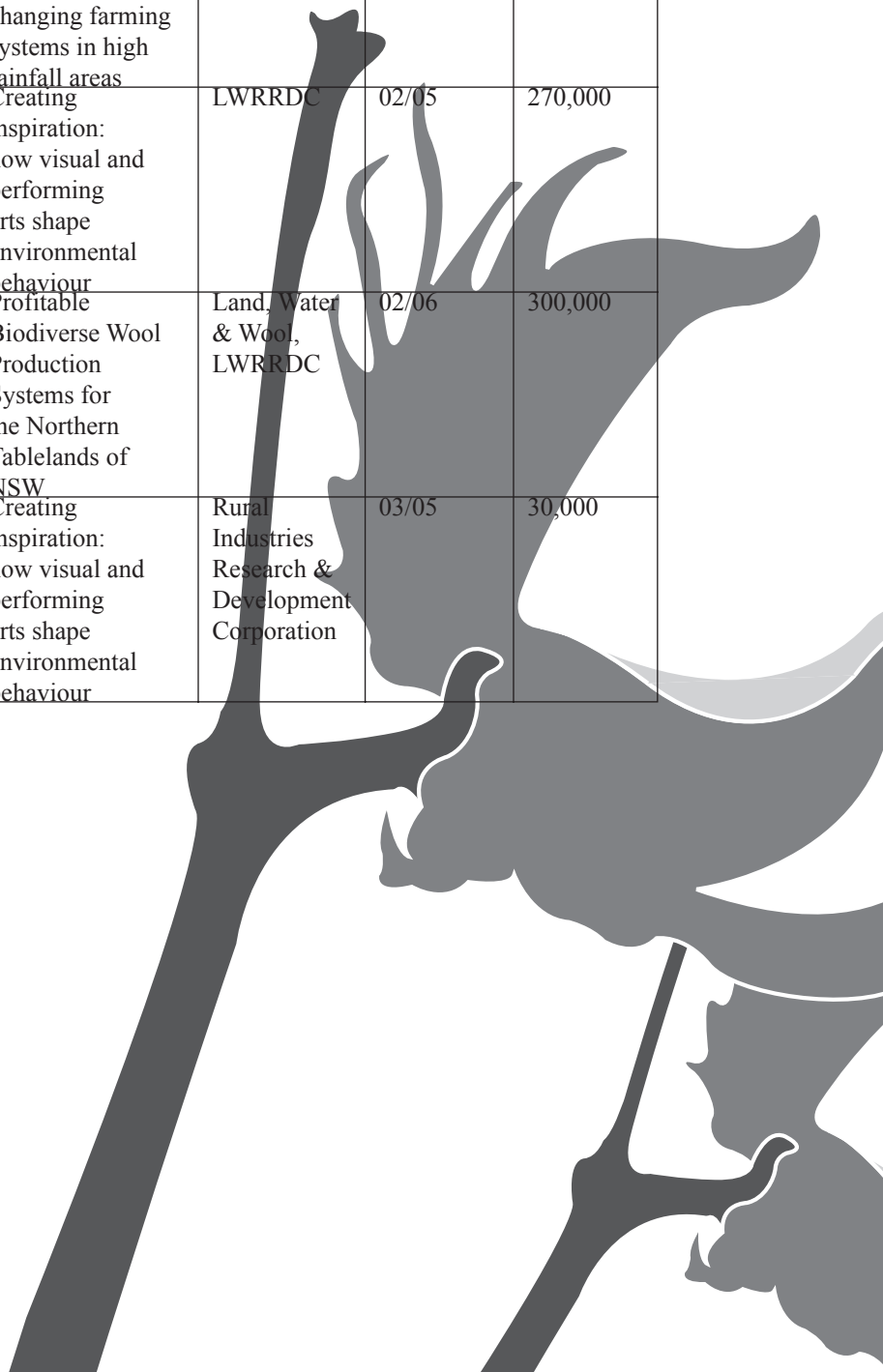
Signature:
Partner: Michael A Carrigan

Grants

Current Research Grants held by Key Cotton CRC researchers

RESEARCHER	ORGANISATION	TITLE	SCHEME	GRANT PERIOD	TOTAL $
Dr Geoff Naylor	CSIRO Textile & Fibre Technology	Instrumentation for Cotton Fineness and Maturity Measurement	CRDC	03/04	150,000
Dr Geoff Naylor	CSIRO Textile & Fibre Technology	Inter-laboratory Trials for Fibre Maturity Reference Samples	CRDC	03/04	30,250
Dr Michael Bange & Stephen Milroy	CSIRO Plant Industry	Training in crop physiology – Physiological determinants of Ultra Narrow Row Cotton	Research Grant	01/04	76,000
Dr Michael Bange & Darren Linsley	CSIRO Plant Industry	Supporting development and independent evaluation of cotton management packages	Research Grant	02/05	310,231
Dr Michael Bange & Tony Pfeiffer	CSIRO Plant Industry	ACRI Computing support	Research Grant	02/05	403,469
Dr Michael Bange & Dirk Richards	CSIRO Plant Industry	Delivering science to agribusiness: smart approaches to cotton irrigation management	Research Grant	04/07	672,982
Dr Michael Bange	CSIRO Plant Industry	Cotton crop management for improved fibre quality	Research Grant	04/07	382,319
Dr Michael Bange	CSIRO Plant Industry	Fulbright scholarship	Research Grant	04/04	16,874
Dr Michael Bange & Sandra Deutscher	CSIRO Plant Industry	Delivering science to Agribusiness-novel decision support tools CRDC component	Research Grant	03/06	300,000
Dr. Lewis Wilson	CSIRO Plant Industry	Incorporating aphids, insecticides and early season plant compensation in IPM	CRDC CSP147C	02/05	525,000
Dr. Lewis Wilson	CSIRO Plant Industry	Identification and management of 'Bunchy Top' syndrome	CRDC CSP143C	01/04	585,000

Dr. Lewis Wilson	CSIRO Plant Industry	Improving understanding of the ecology and management of cotton aphid.	CRDC CSP145C	01/04	264,000
Dr. Lewis Wilson	CSIRO Plant Industry	Aphids-control, ecology and CBT resistance.	CRDC CSP165	04/07	344,000
Geoff R Strickland	Department of Agriculture (WA)	Delivery of biological control agents for broad-leafed weeds in temperate pastures	Australian Wool Innovation	03/06	124,465
Geoff R Strickland	Department of Agriculture (WA)	Grains pest management for changing farming systems in high rainfall areas	GRDC	02/05	450,000
Assoc. Professor Nick Reid, I. Reeve, & D. Curtis	The University of New England	Creating inspiration: how visual and performing arts shape environmental behaviour	LWRRDC	02/05	270,000
Assoc. Professor Nick Reid	The University of New England	Profitable Biodiverse Wool Production Systems for the Northern Tablelands of NSW	Land, Water & Wool, LWRRDC	02/06	300,000
Assoc. Professor Nick Reid, I. Reeve, & D. Curtis	The University of New England	Creating inspiration: how visual and performing arts shape environmental behaviour	Rural Industries Research & Development Corporation	03/05	30,000



Performance Indicators

Performance Indicator	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004
Addressing industry need - Quality and relevance of the research program					
Number of publications					
- Refereed Journal	28	18	20	20	26
- Book Chapters	3	5	7	8	7
- Conference papers	31	25	14	68	38
Number of Research Reference Reports	10	7	11	30	19
Number of Conference Presentations	24	47	27	22	24
Number of Seminars and Workshops	100	84	34	76	65
Number of Trade Shows participated in	2	3	2	2	2
Number of Grower Magazine articles produced	40	31	24	34	29
Number of Media Releases	27	36	20	22	47
Number of Visitors to the CRC	15	19	26	14	35
Number of Public Relations exercises completed	1	8	11	29	50
Number of Media Interviews	18		34	31	55
Number of Awards and Prises.	6	2	2	11	3
Number of clients on Industry database	2,600	2,730	2,804	2,804	2,795
Number of hits per day taken on the CRC website.	400	540	540	540	500
Number of projects					
Program 1 – Growth in northern Australia	3	4	3	3	9
Program 2 – Innovative Technologies	9	8	7	7	8
Program 3 – Sustainable Farming Systems	19	21	27	29	15
Program 4 – Education and Training	18	15	20	19	29
Program 5 – Cotton Textile Research	2	3	3	3	2
Program 6 – Agriculture Environment					17
Contribution to Australia's sustainable economic and social development					
Industry Outcomes					***Benefits***
Reduced Pesticide Use					$250m
Control of Whitefly					$ 10m
Delayed Resistance					$ 53m
Pesticides in waterways					$ 2m
Adoption of Round up Ready® Cotton					$ 18m
Reduction Fusarium Wilt					$184m
Export cotton seed market					$ 4m
Water Use Efficiency					$ 64m
Deep Drainage					$ 1m
Total benefits to Australia's sustainable Economic and social development.					**$586m** A return of **$7.08** for each dollar invested.
Use and Commercialisation of research outputs					
Number of patents				1	1
Number of Business Plans completed				1	2
Number of Documents produced from research outputs in response to industry needs	18	18	15	11	14
Registered Users of EntoPAK	800	872	936	871	863

Registered Users of NutriPAK			533	675	669
Registered Users of SoilPAK	450	532	623	698	676
Registered Users of MachinePAK			408	408	408
Registered Users of SprayPAK				463	212
Registered Users of IDM Guidelines				516	523
Registered Users of WeedPAK				610	629
Registered Users of CottonPAK CD				383	470
Registered Users of CottonLOGIC	800	800	800	800	1091
Education and training					
Number of students graduated from the Cotton production Course	30	20	35	21	20
Number of CRC staff delivering specialised lectures during residential schools.	30	30	30	30	30
Number of scholarships and supporting grants awarded	10	10	10	10	20
Percentage of research students with a non-university supervisor or co-supervisor	34.6%	29%	42%	40.5%	60%
Percentage of students spending time on relevant projects in the industry sector	100%	100%	100%	100%	100%
Number of students involved in professional development courses	0	0	6	3	2
Number of Industry Development Officers	10	8	10	10	10
Number of Water Use Efficiency Extension Officers	5	6	11	7	7
Number of Farming System Extension Officers	7	7	7	7	7
Number of CottonLOGIC Specialised Support Officers	1	1	1	1	1
Number of IPM Training Coordinators	1	1	1	1	1
Number of Trainee Industry Development Officers.	1	1	2	2	2
Number of National Extension Coordinators	1	1	1	1	1
Number of Program Coordinators Best Management Practice	1	1	1	1	1
Number of IPM short courses and growers completing.			3 pilot IPM Short courses 34 Attended.	6 courses. 66 attended.	7 courses. 78 Attended.
Number of CottonLOGIC Workshops completed	20	17	11	11	10
Value of in-kind devoted to Technology Transfer and Communications.	$1.9604m	$2.378m	$2.485m	$2.792m	$3.002m
Value of Cash spent on Education and Technology Transfer.	$0.2146m	$0.523m	$0.499m	$0.402m	$1.700m
Collaborative arrangements					
Percentage of projects with participants from >2 partners	40%	69%	69%	69%	75%
Number of projects with non-CRC collaborators					
- Nationally	30	51	48	51	24
- Internationally	3	7	11	10	5

Number of International Scientific Exchanges completed	5	5	5	4	4
Resources and Budget					
Total income (cash & in-kind)	$15.212m	$16,162m	$16.989m	$17.925m	$16,498m
FTE research staff (excluding students)	47.84	53.50	50.14	52.41	48.36
FTE technical and support staff	48.41	43.50	50.35	50.61	29.05
Total Cash resources	$5.092m	$5.033m	$5.850m	$5.712m	$4.741m
Total cash contribution from sources other than AusIndustry	$3.092m	$2.833m	$3.650m	$3.612m	$2.641m
Total funding secured from Cotton Research & Development Corporation	$0.995m	$1.227m	$1.707m	$1.742m	$1.589m
Total additional external grants relevant to the CRC's goals received by CRC staff	$1.239m	$0.838m	$1.118m	$0.838m	$0.173m
Leverage (total funds v AusIndustry funding)	> 7.6	> 7.3	> 7.7	> 8.5	> 8.6
Management structure and arrangements					
Majority of Board members independent of research providers	7/12	7/12	7/12	7/12	7/12
Management Committee established	✓	✓	✓	✓	✓
Advisory Committee established	✓	✓	✓	✓	✓
Northern Committee established	✓	✓	✓	✓	✓
Financial reports delivered Quarterly to the Board.	✓	✓	✓	✓	✓
Annual Report submitted	3rd Qtr	3rd Qtr	3rd Qtr	2nd Qtr	2nd Qtr

Financial Statements

RESEARCH STAFF RESOURCES *ATTACHMENT B*

IN-KIND CONTRIBUTION BY ORGANISATION (PERSON YEARS) 2003/2004

				Main Activity	*Total % of Time*	*% Spent on Research Program SubProgram P 1*	*P 2*	*P 3*	*P 5*	*P 6*	*Total on Research*	*% Spent on Educ Prog*	*% Spent Ext Comm*	*% Spent Techn Trans*	*% Spent on CRC Admin*
						P 1	*P 2*	*P 3*	*P 5*	*P 6*					
Agriculture Western Australia															
Annells	Amanda	Dr	R		20%	20%	0%	0%	0%	0%	20%	0%	0%	0%	0%
Moulden	John	Mr	R		60%	60%	0%	0%	0%	0%	60%	0%	0%	0%	0%
Strickland	Geoff	Mr	R		70%	70%	0%	0%	0%	0%	70%	0%	0%	0%	0%
					1.50	*1.50*	*0.00*	*0.00*	*0.00*	*0.00*	*1.50*	*0.00*	*0.00*	*0.00*	*0.00*
Cotton Research & Development Corporation															
Dugdale	Helen	Ms	R		30%	0%	0%	5%	0%	0%	5%	0%	0%	25%	0%
Holloway	Rachel	Ms	R		11%	0%	0%	0%	0%	0%	0%	0%	0%	11%	0%
Kauter	Greg	Mr	R		9%	0%	0%	2%	0%	0%	2%	4%	0%	4%	0%
McLean	Jodi	Ms	R		10%	0%	0%	5%	0%	0%	5%	0%	0%	5%	0%
Pyke	Bruce	Mr	R		30%	0%	0%	5%	0%	5%	10%	5%	0%	15%	0%
Roth	Guy	Mr	R		6%	0%	0%	1%	0%	3%	4%	1%	0%	1%	0%
Schulze	Ralph	Mr	R		8%	0%	0%	0%	4%	0%	4%	0%	0%	4%	0%
Tout	Elizabeth	Ms	R		10%	0%	0%	0%	0%	0%	0%	0%	0%	5%	5%
					1.14	*0.00*	*0.00*	*0.18*	*0.04*	*0.08*	*0.30*	*0.10*	*0.00*	*0.70*	*0.05*
Cotton Seed Distributors															
Allen	Stephen	Dr	R		50%	0%	20%	20%	0%	0%	40%	5%	0%	5%	0%
Eveleigh	Robert	Mr	T		15%	0%	0%	0%	0%	0%	0%	0%	0%	15%	0%
Kay	Adam	Mr	T		15%	0%	0%	0%	0%	0%	0%	0%	0%	15%	0%
Marshall	John	Mr	T		15%	0%	0%	0%	0%	0%	0%	0%	0%	15%	0%
McDonald	Criag	Mr	T		25%	0%	0%	0%	0%	0%	0%	0%	0%	25%	0%
					1.20	*0.00*	*0.20*	*0.20*	*0.00*	*0.00*	*0.40*	*0.05*	*0.00*	*0.75*	*0.00*
CSIRO Entomology															
Akhurst	Ray	Dr	R		10%	0%	10%	0%	0%	0%	10%	0%	0%	0%	0%
Baker	Geoff	Dr	R		80%	0%	40%	40%	0%	0%	80%	0%	0%	0%	0%
Dillon	Martin	Mr	R		100%	0%	0%	90%	0%	0%	90%	10%	0%	0%	0%
Mahon	Rod	Dr	R		80%	0%	80%	0%	0%	0%	80%	0%	0%	0%	0%
Olsen	Karen	Ms	R		50%	0%	50%	0%	0%	0%	50%	0%	0%	0%	0%
					3.20	*0.00*	*1.80*	*1.30*	*0.00*	*0.00*	*3.10*	*0.10*	*0.00*	*0.00*	*0.00*
CSIRO Plant Industry															
Bange	Michael	Dr	R		40%	30%	0%	0%	0%	0%	30%	5%	0%	5%	0%
Brown	Tony	Dr	R		10%	0%	10%	0%	0%	0%	10%	0%	0%	0%	0%
Brubaker	Curt	Dr	R		30%	0%	30%	0%	0%	0%	30%	0%	0%	0%	0%
Constable	Greg	Dr	R		20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
Deutscher	Sandra	Ms	T		40%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Duggan	Brian	Dr	R		60%	20%	0%	40%	0%	0%	60%	0%	0%	0%	0%
Johnston	David	Mr	T		40%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Johnston	Scott	Mr	T		40%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Lei	Tom	Dr	R		10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Linsley	Darren	Mr	T		40%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Milroy	Steve	Dr	R		5%	0%	0%	5%	0%	0%	5%	0%	0%	0%	0%
Neilsen	James	Mr	R		40%	0%	0%	40%	0%	0%	40%	0%	0%	0%	0%

Pfeiffer	Tony	Mr	T	40%	0%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Reid	Peter	Mr	R	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
Richards	Dirk	Mr	R	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
Stiller	Warwick	Dr	R	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
Tennakoon	Sunil	Dr	R	5%	0%	0%	5%	0%	0%	5%	0%	0%	0%	0%
Wilson	Lewis	Dr	R	40%	0%	0%	35%	0%	0%	35%	5%	0%	0%	0%
				5.19	*0.50*	*0.40*	*2.14*	*0.00*	*0.00*	*3.04*	*0.10*	*0.00*	*2.05*	*0.00*

CSIRO Sustainable Ecosystems

Carberry	Peter	Dr	R	20%	0%	0%	10%	0%	0%	10%	0%	0%	10%	0%
Dalgleish	Neil	Dr	R	30%	0%	0%	20%	0%	0%	20%	0%	0%	10%	0%
Hochman	Zvi	Dr	R	20%	0%	0%	10%	0%	0%	10%	0%	0%	10%	0%
Probert	Merv	Dr	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Whish	Jeremy	Dr	R	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
				1.00	*0.00*	*0.00*	*0.70*	*0.00*	*0.00*	*0.70*	*0.00*	*0.00*	*0.30*	*0.00*

CSIRO Textile & Fibre Technology

Evans	David	Dr	R	5%	0%	0%	0%	5%	0%	5%	0%	0%	0%	0%
Gordon	Stuart	Dr	R	30%	0%	0%	0%	30%	0%	30%	0%	0%	0%	0%
Naylor	Geoff	Dr	R	35%	0%	0%	0%	35%	0%	35%	0%	0%	0%	0%
Prins	Martin	Mr	R	15%	0%	0%	0%	15%	0%	15%	0%	0%	0%	0%
				0.85	*0.00*	*0.00*	*0.00*	*0.85*	*0.00*	*0.85*	*0.00*	*0.00*	*0.00*	*0.00*

Dept of Business, Industry & Resource Development

Bellgard	Stan	Dr	R	10%	10%	0%	0%	0%	0%	10%	0%	0%	0%	0%
Bennett	Malcolm	Mr	R	20%	20%	0%	0%	0%	0%	20%	0%	0%	0%	0%
Dougall	Andrew	Mr	R	80%	80%	0%	0%	0%	0%	80%	0%	0%	0%	0%
Eastick	Rowena	Ms	R	20%	20%	0%	0%	0%	0%	20%	0%	0%	0%	0%
Ham	Christop	Mr	R	5%	5%	0%	0%	0%	0%	5%	0%	0%	0%	0%
Martin	Colin	Dr	R	75%	75%	0%	0%	0%	0%	75%	0%	0%	0%	0%
				2.10	*2.10*	*0.00*	*0.00*	*0.00*	*0.00*	*2.10*	*0.00*	*0.00*	*0.00*	*0.00*

Dept Primary Industries Qld

Cleary	Amanda		R	100%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Cupitt	D		R	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Franzmann	Bernie	Dr	R	90%	0%	0%	80%	0%	0%	80%	10%	0%	0%	0%
Ginns	Stephen	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Goyne	Phil	Dr	T	50%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Goyne	Phil	Dr	R	13%	0%	0%	0%	0%	0%	0%	0%	0%	13%	0%
Grundy	Paul	Dr	R	50%	0%	50%	0%	0%	0%	50%	0%	0%	0%	0%
Harris	Graham	Mr	T	50%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Hauxwell	Carrie	Dr	R	50%	0%	50%	0%	0%	0%	50%	0%	0%	0%	0%
Kelly	David	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Khan	Moazzem	Dr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Kochman	Joe	Dr	R	40%	0%	20%	20%	0%	0%	40%	0%	0%	0%	0%
McIntyre	Geoff	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
McLennan	Austin	Mr	R	50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
Meinke	Holger	Mr	R	40%	0%	0%	40%	0%	0%	40%	0%	0%	0%	0%
Miles	Melina	Dr	R	25%	0%	0%	25%	0%	0%	25%	0%	0%	0%	0%
Moore	Chris	Dr	R	50%	0%	50%	0%	0%	0%	50%	0%	0%	0%	0%
Moss	James	Mr	R	20%	10%	0%	10%	0%	0%	20%	0%	0%	0%	0%
Murray	David	Dr	R	30%	0%	0%	30%	0%	0%	30%	0%	0%	0%	0%
Osten	Vicki	Ms	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Reeson	A		R	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Salmond	Greg	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Scholz	Brad	Dr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Sequeira	Richard	Dr	R	10%	10%	0%	0%	0%	0%	10%	0%	0%	0%	0%

Silburn	Mark	Mr	T	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
Smith	Rebecca	Ms	R	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Smith	Linda	Ms	R	25%	0%	0%	25%	0%	0%	25%	0%	0%	0%	0%
Smith	Lawrenc	Mr	R	50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
Swan	Linda	Ms	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Titmarsh	Ian	Dr	R	10%	10%	0%	0%	0%	0%	10%	0%	0%	0%	0%
Walker	Steve	Mr	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Waters	David	Mr	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
				18.03	*1.30*	*1.70*	*6.80*	*0.00*	*0.00*	*9.80*	*0.10*	*0.00*	*8.13*	*0.00*

NSW Agriculture

Charles	Graham	Mr	R	65%	0%	0%	60%	0%	0%	60%	5%	0%	0%	0%
Cottage	Emma	Ms	R	30%	0%	0%	30%	0%	0%	30%	0%	0%	0%	0%
Farquharson	Bob	Mr	R	25%	0%	0%	25%	0%	0%	25%	0%	0%	0%	0%
Farrell	Tracey	Ms	R	60%	0%	0%	0%	0%	0%	0%	0%	0%	60%	0%
Gibb	Dallas	Mr	R	75%	0%	0%	0%	0%	0%	0%	15%	0%	60%	0%
Gibson	Trevor	Dr	R	10%	0%	0%	0%	0%	0%	0%	0%	0%	10%	0%
Gunning	Robin	Dr	R	50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
Heimoana	Viliami	Mr	R	100%	0%	0%	90%	0%	0%	90%	10%	0%	0%	0%
Herron	Grant	Dr	T	60%	0%	0%	0%	0%	0%	0%	0%	0%	60%	0%
Hulugalle	Nilantha	Dr	R	70%	0%	0%	65%	0%	0%	65%	5%	0%	0%	0%
Jenkins	Leigh	Ms	T	50%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Jhorar	Om	Dr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Johnson	Annie	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Johnson	Stephen	Dr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Mensah	Robert	Dr	R	50%	0%	45%	0%	0%	0%	45%	5%	0%	0%	0%
Nehl	David	Dr	R	65%	5%	20%	30%	0%	0%	55%	5%	0%	5%	0%
Rossiter	Louise	Dr	R	25%	0%	0%	25%	0%	0%	25%	0%	0%	0%	0%
Smith	Peter	Mr	T	20%	0%	0%	0%	0%	0%	0%	0%	0%	20%	0%
Swann	Barry	Mr	T	50%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Vancov	Tony	Dr	R	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
				11.25	*0.05*	*0.65*	*5.95*	*0.00*	*0.00*	*6.65*	*0.45*	*0.00*	*4.15*	*0.00*

The University of New England

Backhouse	David	Dr	R	20%	0%	0%	20%	0%	0%	20%	0%	0%	0%	0%
Daniel	Heiko	Dr	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Faulkner	Richard	A/Pr	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Gregg	Peter	A/Pr	R	50%	0%	30%	10%	0%	0%	40%	10%	0%	0%	0%
Jessop	Robin	A/Pr	R	20%	0%	0%	0%	0%	0%	0%	20%	0%	0%	0%
Reid	Nick	A/Pr	R	30%	0%	0%	0%	0%	30%	30%	0%	0%	0%	0%
Sindel	Brian	Dr	R	30%	0%	0%	30%	0%	0%	30%	0%	0%	0%	0%
				1.70	*0.00*	*0.30*	*0.80*	*0.00*	*0.30*	*1.40*	*0.30*	*0.00*	*0.00*	*0.00*

The University of Sydney

Campbell	Lindsay	Dr	R	15%	0%	0%	15%	0%	0%	15%	0%	0%	0%	0%
Copeland	Les	Prof	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Kennedy	Ivan	Prof	R	25%	0%	0%	20%	0%	0%	20%	5%	0%	0%	0%
Lyon	Bruce	Dr	R	5%	0%	0%	0%	0%	0%	0%	5%	0%	0%	0%
McBratney	Alex	Prof	R	30%	0%	0%	25%	0%	0%	25%	5%	0%	0%	0%
Singh	Balwant	Dr	R	10%	0%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Vervoort	Willem	Dr	R	25%	0%	0%	25%	0%	0%	25%	0%	0%	0%	0%
				1.20	*0.00*	*0.00*	*1.05*	*0.00*	*0.00*	*1.05*	*0.15*	*0.00*	*0.00*	*0.00*
Grand Total				*48.36*	*5.45*	*5.05*	*19.12*	*0.89*	*0.38*	*30.89*	*1.35*	*0.00*	*16.07*	*0.05*

ATTACHMENT B

COTTON CRC AND CASH FUNDED RESEARCH STAFF BY ORGANISATION (Person Years)

				Main Activity	*Total % of Time*	*% Spent on Research Program SubProgram P 1 P 1*	*P 2 P 2*	*P 3 P 3*	*P 5 P 5*	*P 6 P 6*	*Total on Resear*	*% Spent on Edu Prog*	*% Spent Ext Comm*	*% Spent Techn Tran*	*% Spent on Admin*
CRC for Greenhouse Accounting															
Grace	Peter	Dr	R		50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
					0.50	*0.00*	*0.00*	*0.50*	*0.00*	*0.00*	*0.50*	*0.00*	*0.00*	*0.00*	*0.00*
CSIRO Entomology															
Collinge	Derek	Mr	R		100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Hardwick	Scott	Dr	R		13%	0%	0%	13%	0%	0%	13%	0%	0%	0%	0%
Mansfield	Sarah	Dr	R		50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
					1.63	*0.00*	*0.00*	*1.63*	*0.00*	*0.00*	*1.63*	*0.00*	*0.00*	*0.00*	*0.00*
CSIRO Land & Water															
Ringrose Voase	Anthony	Dr	R		100%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%
					1.00	*0.00*	*0.00*	*0.00*	*0.00*	*1.00*	*1.00*	*0.00*	*0.00*	*0.00*	*0.00*
CSIRO Plant Industry															
Orman	Kym	Ms	A		100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Roberts	Grant	Mr	R		100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Rochester	Ian	Dr	R		100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Roth	Guy	Mr	R		80%	0%	0%	0%	0%	0%	0%	0%	0%	0%	80%
Schick	Nicky	Ms	T		100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Thakur	Laxmi	Ms	R		75%	0%	0%	0%	0%	0%	0%	0%	0%	75%	0%
Yeates	Stephen	Mr	R		100%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
					6.55	*1.00*	*0.00*	*2.00*	*0.00*	*0.00*	*3.00*	*0.00*	*0.00*	*0.75*	*2.80*
CSIRO Textile & Fibre Technology															
van der Sluijs	Rene	Mr	R		100%	0%	0%	0%	100%	0%	100%	0%	0%	0%	0%
					1.00	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*1.00*	*0.00*	*0.00*	*0.00*	*0.00*
Dept Natural Resources Qld															
Bodapati	Naidu	Dr	R		50%	0%	0%	50%	0%	0%	50%	0%	0%	0%	0%
					0.50	*0.00*	*0.00*	*0.50*	*0.00*	*0.00*	*0.50*	*0.00*	*0.00*	*0.00*	*0.00*
Dept of Business, Industry & Resource Development															
Duale	Ali-Nur	Dr	R		100%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%
					1.00	*1.00*	*0.00*	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*	*0.00*	*0.00*
Dept Primary Industries Qld															
Christiansen	Ingrid	Ms	T		100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Goyne	Phil	Dr	T		38%	0%	0%	0%	0%	0%	0%	0%	0%	38%	0%
Hare	Janelle	Ms	T		100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Hickman	Mark	Mr	T		100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Spragge	Andres	Mr	T		100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Wang	Ertong	Dr	R		100%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%
Wigginton	David	Mr	T		100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Wu	Hanwen	Dr	R		100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
					7.38	*0.00*	*1.00*	*1.00*	*0.00*	*0.00*	*2.00*	*0.00*	*0.00*	*5.38*	*0.00*

NSW Agriculture

Brown	Evan	Mr	T	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Hoque	Ziaul	Mr	R	25%	0%	0%	0%	0%	0%	0%	0%	0%	25%	0%
Larsen	David	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
O'Halloran	Julie	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Taylor	Ian	Dr	R	100%	0%	0%	80%	0%	0%	80%	0%	0%	0%	0%
van Dongen	Penny	Ms	R	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
				5.25	*0.00*	*0.00*	*1.80*	*0.00*	*0.00*	*1.80*	*0.00*	*0.00*	*3.25*	*0.00*

The University of New England

Del Socorro	Alice	Dr	R	90%	0%	90%	0%	0%	0%	90%	0%	0%	0%	0%
Downey	Adam	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Kent	Richard	Mr	R	70%	0%	0%	70%	0%	0%	70%	0%	0%	0%	0%
Lowor	Samel	Mr	R	100%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%
Rencken	Ingrid	Ms	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Stanley	John	Dr	T	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%
				5.60	*0.00*	*1.90*	*2.70*	*0.00*	*0.00*	*4.60*	*0.00*	*0.00*	*1.00*	*0.00*

The University of Queensland

Gulino	Lisa	Ms	R	100%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%
Harvey	John	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Najar	Adriana	Ms	R	100%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%
				3.00	*0.00*	*2.00*	*1.00*	*0.00*	*0.00*	*3.00*	*0.00*	*0.00*	*0.00*	*0.00*

The University of Sydney

Buchanan	Sam	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Crossan	Angus	Dr	R	100%	0%	0%	0%	0%	100%	100%	0%	0%	0%	0%
Field	Damien	Dr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Odeh	Inakwu	Dr	R	90%	0%	0%	90%	0%	0%	90%	0%	0%	0%	0%
Rose	Michael	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Speirs	Simon	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Triantafilis	John	Dr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Vanags	Chris	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Whiffen	Leonie	Ms	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
				8.90	*0.00*	*0.00*	*7.90*	*0.00*	*1.00*	*8.90*	*0.00*	*0.00*	*0.00*	*0.00*

University of Adelaide

Werth	Jeff	Mr	R	100%	0%	0%	100%	0%	0%	100%	0%	0%	0%	0%
				1.00	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*	*0.00*	*0.00*
Grand Total				*43.30*	*2.00*	*4.90*	*20.03*	*1.00*	*2.00*	*29.93*	*0.00*	*0.00*	*10.38*	*2.80*

ATTACHMENT B

SUPPORT STAFF

Contributed			CRC Funded (by employing organisation)	
Organisation	No. Staff (person years)		Organisation	No. Staff (person years)
Agriculture WA	10.80		CRC Greenhouse Accounting	0.08
Cotton Research & Development Corporation	0.00		Cotton Research & Development Corporation	0.30
Cotton Seed Distributors	0.30		Cotton Seed Distributors	0.00
CSIRO	11.30		CSIRO	9.10
Dept. Primary Industries, Qld	8.40		Dept. Primary Industries, Qld	1.00
NSW Agriculture	6.50		NSW Agriculture	3.80
NTDPIF	1.35		NTDPIF	0.05
Queensland Cotton	0.00		Queensland Cotton	0.00
University of New England	0.40		University of New England	0.50
University of Sydney	0.00		University of Sydney	0.00
WAI	0.00		WAI	0.00
TOTAL	29.05		TOTAL	14.83

ATTACHMENT B

SUMMARY OF CONTRIBUTIONS IN PERSON YEARS

	Total Equ Person Years	Person Years Spent on Research Program						% Spent on Edu Prog	% Spent on Ext Comm	% Spent on Tech Trans	% Spent on CRC Admin.
		Sub-program					Total on Research				
		1	2	3	5	6					
TOTAL CONT	48.37	5.45	5.05	19.12	0.89	0.38	30.89	1.35	0.00	16.07	0.05
TOTAL FUNDED BY CRC	43.30	2.00	4.90	20.03	1.00	2.00	29.93	0.00	0.00	10.57	2.80
GRAND TOTAL	91.67	7.45	9.95	39.15	1.89	2.38	60.92	1.35	0.00	26.64	2.80
Proportion of total professional staff resources in each activity	100%	8.12%	10.85%	42.70%	2.06%	2.59%	66.32%	1.47%	0.0%	29.06%	3.10

IN-KIND CONTRIBUTIONS FROM PARTICIPANTS (DOLLARS IN '000's)

TABLE 1

PARTICIPANT	Expenditure 2003/04 Actual	2003/04 Agr'mt	2002/03 Actual	2002/03 Agr'mt	2001/02 Actual	2001/02 Agr'mt	2000/01 Actual	2000/01 Agr'mt	1999/00 Actual	1999/00 Agr'mt	Cumulative Total to Date Actual	Cumulative Total to Date Agr'mt	04/05 Agr'mt	05/06 Agr'mt	GRAND TOTAL Total 7 yrs	GRAND TOTAL Agr 7 yrs	GRAND TOTAL Diff 7 yrs
CSIRO																	
Salaries	1,724	1,234	1,979	1,234	1,741	1,250	1,922	1,271	1,367	1,239	8,733	6,228	1,234	1,234	11,201	8,696	2,505
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	1,341	1,120	1,586	1,120	1,705	1,140	1,737	1,157	1,162	1,129	7,531	5,666	1,120	1,120	9,771	7,906	1,865
Total	**3,065**	**2,354**	**3,565**	**2,354**	**3,446**	**2,390**	**3,659**	**2,428**	**2,529**	**2,368**	**16,264**	**11,894**	**2,354**	**2,354**	**16,763**	**16,602**	**161**
NSW Agriculture																	
Salaries	1,305	1,029	1,254	1,029	1,109	1,029	1,108	1,029	1,086	1,029	5,862	5,145	1,029	1,029	7,920	7,203	717
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	967	1,029	967	1,029	966	1,029	967	1,029	967	1,029	4,834	5,145	1,029	1,029	6,892	7,203	-311
Total	**2,272**	**2,058**	**2,221**	**2,058**	**2,075**	**2,058**	**2,075**	**2,058**	**2,052**	**2,058**	**10,695**	**10,290**	**2,058**	**2,058**	**14,400**	**14,406**	**-6**
Qld Dept Primary Industries																	
Salaries	1,718	945	1,692	945	1,276	945	1,128	945	1,195	945	7,009	4,725	945	945	8,899	6,615	2,284
Capital		0		0		0	0	0	0		0	0			0	0	0
Other	2,115	1,186	1,952	1,186	1,447	1,186	1,381	1,186	1,344	1,186	8,239	5,930	1,186	1,186	10,611	8,302	2,309
Total	**3,833**	**2,131**	**3,644**	**2,131**	**2,723**	**2,131**	**2,509**	**2,131**	**2,539**	**2,131**	**15,248**	**10,655**	**2,131**	**2,131**	**15,325**	**14,917**	**408**
Agriculture WA																	
Salaries	167	281	253	281	261	281	287	281	270	281	1,238	1,405	281	281	1,800	1,967	-167
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	317	275	317	285	317	315	317	319	372	372	1,640	1,566	265	215	2,120	2,046	74
Total	**484**	**556**	**570**	**566**	**578**	**596**	**604**	**600**	**642**	**653**	**2,878**	**2,971**	**546**	**496**	**4,002**	**4,013**	**-11**
NT Dept of Business, Industry & Resource Development																	
Salaries	317	211	282	211	262	211	267	211	276	211	1,404	1,055	211	211	1,826	1,477	349
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	232	152	205	152	190	152	150	152	166	152	943	760	152	152	1,247	1,064	183
Total	**549**	**363**	**487**	**363**	**452**	**363**	**417**	**363**	**442**	**363**	**2,347**	**1,815**	**363**	**363**	**2,620**	**2,541**	**79**
The University of Sydney																	
Salaries	146	130	161	130	182	130	171	130	136	130	796	650	130	130	1,056	910	146
Capital		0		0		0		0	0		0	0			0	0	0
Other	254	224	279	224	315	224	295	224	235	224	1,378	1,120	224	224	1,826	1,568	258
Total	**400**	**354**	**440**	**354**	**497**	**354**	**466**	**354**	**371**	**354**	**2,174**	**1,770**	**354**	**354**	**2,495**	**2,478**	**17**
The University of New England																	
Salaries	450	292	580	292	605	292	467	292	502	292	2,604	1,460	292	292	3,188	2,044	1,144
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	190	221	238	221	260	221	230	221	236	221	1,154	1,105	221	221	1,596	1,547	49
Total	**640**	**513**	**818**	**513**	**865**	**513**	**697**	**513**	**738**	**513**	**3,758**	**2,565**	**513**	**513**	**3,816**	**3,591**	**225**
CRDC																	
Salaries	84	62	80	62	70	62	70	62	69	62	373	310	62	62	497	434	63
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	53	39	50	39	44	39	44	39	43	39	234	195	39	39	312	273	39
Total	**137**	**101**	**130**	**101**	**114**	**101**	**114**	**101**	**112**	**101**	**607**	**505**	**101**	**101**	**718**	**707**	**11**
Cotton Seed Distributors																	
Salaries	173	113	154	113	149	113	182	113	151	113	809	565	113	113	1,035	791	244
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	204	134	184	134	178	134	208	134	174	134	948	670	134	134	1,216	938	278
Total	**377**	**247**	**338**	**247**	**327**	**247**	**390**	**247**	**325**	**247**	**1,757**	**1,235**	**247**	**247**	**1,807**	**1,729**	**78**
Queensland Cotton																	
Salaries	0	31	0	31	12	31	35	31	7	31	54	155	31	31	116	217	-101
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	0	25	0	25	10	25	27	25	6	25	43	125	25	25	93	175	-82
Total	**0**	**56**	**0**	**56**	**22**	**56**	**62**	**56**	**13**	**56**	**97**	**280**	**56**	**56**	**349**	**392**	**-43**
Western Agricultural Industries																	
Salaries	0	68	0	68	12	68	70	68	52	68	134	340	68	68	270	476	-206
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	0	57	0	57	28	57	66	57	46	57	140	285	57	57	254	399	-145
Total	**0**	**125**	**0**	**125**	**40**	**125**	**136**	**125**	**98**	**125**	**274**	**625**	**125**	**125**	**848**	**875**	**-27**
Twynam Cotton																	
Salaries	0	120	0	120	0	120	0	120	157	120	157	600	120	120	397	840	-443
Capital	0	0	0	0	0	0	0	0	0		0	0			0	0	0
Other	0	65	0	65	0	65	0	65	101	65	101	325	65	65	231	455	-224
Total	**0**	**185**	**0**	**185**	**0**	**185**	**0**	**185**	**258**	**185**	**258**	**925**	**185**	**185**	**1,368**	**1,295**	**73**
TOTAL IN-KIND CONTRIBUTIONS																	
Salaries	6,084	4,516	6,435	4,516	5,679	4,532	5,707	4,553	5,267	4,521	29,172	22,638	4,516	4,516	38,204	31,670	6,534
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	5,673	4,527	5,778	4,537	5,460	4,587	5,422	4,608	4,853	4,633	27,186	22,892	4,517	4,467	36,170	31,876	4,294
GRAND TOTAL	**11,757**	**9,043**	**12,213**	**9,053**	**11,139**	**9,119**	**11,129**	**9,161**	**10,120**	**9,154**	**56,358**	**45,530**	**9,033**	**8,983**	**64,512**	**63,546**	**10,828**

ATTACHMENT C
TABLE 2

CASH CONTRIBUTIONS (DOLLARS IN '000s)

PARTICIPANT	2003/04		2002/03		2001/02		2000/01		1999/00		Cumulative Total to Date		04/05	05/06	Grand Total		
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual		Actual	Agr'mt			Total 7 yrs		Diff 7 yrs
CRDC Cash Contribution	350	350	350	350	350	350	350	350	350	350	1750	1750	350	350	2450	2450	0
Cotton Seed Distributors	300	300	300	300	300	300	300	300	300	300	1500	1500	300	300	2100	2100	0
Twynam Cotton	0	50	0	50	0	50	25	50	50	50	75	250	50	50	175	350	-175
The University of New England	0	0	0	0	0	0	0	0	100	100	100	100			100	100	0
TOTAL CASH FROM PARTICIPANTS	**650**	**700**	**650**	**700**	**650**	**700**	**675**	**700**	**800**	**800**	**3425**	**3600**	**700**	**700**	**4825**	**5000**	**-175**
NSW Government	0	0	0	0	0	0	0	0	95		95	0			95	0	95
Qld Government	65	0	646	0	618	0	591	0	841		2761	0			2761	0	2761
Other	184	0	254	0	127	0	45	0	14		624	0			624	0	624
Other (eg Interest)	45	0	128	0	48	0	48	0	44		313	0			313	0	313
External Grants	108	0	192	0	500	0	247	0	303	100	1350	100			1350	100	1250
CRDC Grants	1589	0	1742	0	1707	448	1227	652	995	970	7260	2070			7260	2070	5190
OTHER CASH	**1991**	**0**	**2962**	**0**	**3000**	**448**	**2158**	**652**	**2292**	**1070**	**12403**	**2170**	**0**	**0**	12403	2170	10233
CRC GRANT	**2100**	**2100**	**2100**	**0**	**2200**	**2200**	**2200**	**2200**	**2000**	**2000**	10600	8500	**1800**	**1000**	**24806**	**4340**	**20466**
TOTAL CRC CASH CONTRIBUTION (T2)	**4741**	**2800**	**5712**	**700**	**5850**	**3348**	**5033**	**3552**	**5092**	**3870**	**26428**	**14270**	**2500**	**1700**	**29631**	**9340**	**20291**
Cash carried forward	388		1336		1284		643		891		4542	0					
Less Unspent Balance	344		388		1336		1332		1562		4962	0					
TOTAL CASH EXPENDITURE (T3)	**4785**	**2800**	**6660**	**700**	**5798**	**3348**	**4344**	**3552**	**4421**	**3870**	**26008**	**14270**	**2500**	**1700**	**35808**	**24070**	**11738**
ALLOCATION OF CASH EXPENDITURE BETWEEN HEADS OF EXPENDITURE																	
SALARIES	3709	1730	4492	1915	3886	2585	3045	2615	2997	2394	18129	11239	1795	1232	21156	14266	6890
CAPITAL	60	0	48	0	232	0	58	0	167		565	0			565	0	565
OTHER	1016	899	2120	898	1680	1022	1241	1042	1258	1083	7315	4944	847	512	8674	6303	2371
TOTAL EXPENDITURE	**4785**	**2629**	**6660**	**2813**	**5798**	**3607**	**4344**	**3657**	**4421**	**3477**	**26008**	**16183**	**2642**	**1744**	**30394**	**20569**	**9825**

ATTACHMENT C

SUMMARY OF RESOURCES APPLIED TO ACTIVITIES OF CENTRE (DOLLARS IN $'000's)

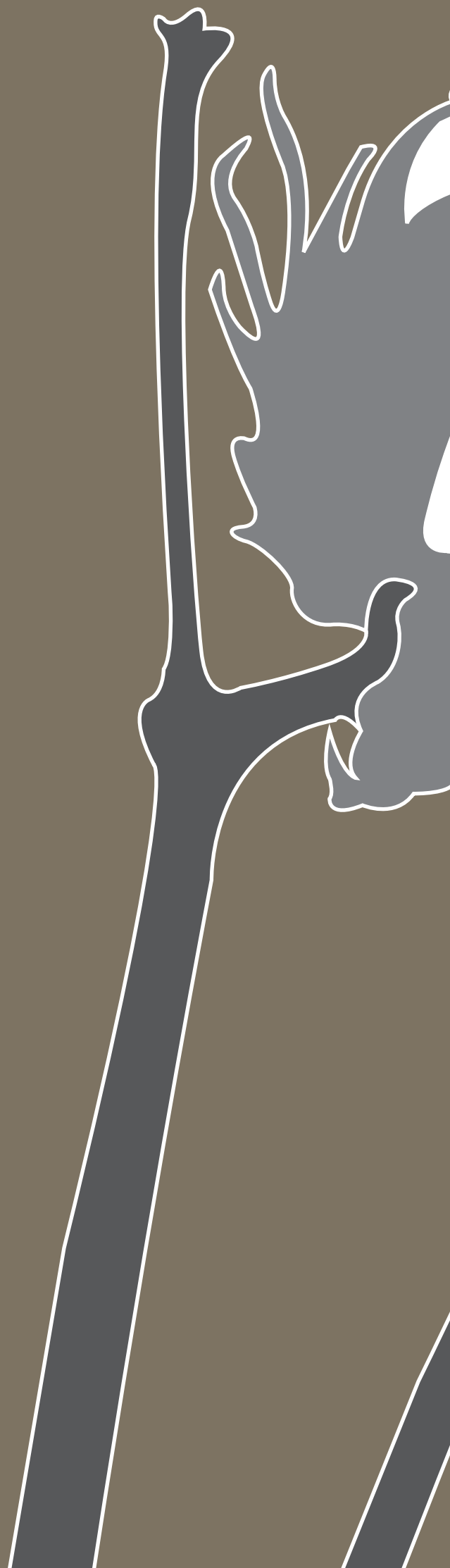
TABLE 3

	2003/04		2002/03		2001/02		2000/01		1999/00		TOTAL TO DATE		04/05	05/06	Total	Agr'mt 7	Diff 7
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Agr'mt	Agr'mt	7 years	years	years
GRAND TOTAL (IN-KIND) FROM TABLE 1 (T1)	11,757	0	12,213	9,053	11,139	9,119	11,129	0	10,120	9,154	56,358	27,326	9,161	9,119	74,638	45,606	29,032
GRAND TOTAL (CASH EXPENDITURE) FROM TABLE 2 (T3)	4,785	2,800	6,660	2,813	5,798	3,607	4,344	3,552	4,421	3,477	26,008	16,249	2,500	1,700	30,208	20,449	9,759
TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE (T1+T3)	16,542	2,800	18,873	11,866	16,937	12,726	15,473	3,552	14,541	12,631	82,366	43,575	11,661	10,819	104,846	66,055	38,791
ALLOCATION OF TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE BETWEEN HEADS OF EXPENDITURE (CASH AND IN KIND)																	
TOTAL SALARIES (CASH AND IN-KIND)	9,793	1,730	10,927	6,431	9,565	7,117	8,752	2,615	8,264	6,915	47,301	24,808	6,348	5,764	59,413	36,920	22,493
TOTAL CAPITAL (CASH AND IN-KIND)	60	0	48	0	232	0	58	0	167	0	565	0	0	0	565	0	565
TOTAL OTHER	6,689	899	7,898	5,435	7,140	5,609	6,663	1,042	6,111	5,716	34,501	18,701	5,455	5,099	45,055	29,255	15,800

ATTACHMENT C
TABLE 4

ALLOCATION OF RESOURCES BETWEEN CATEGORIES OF ACTIVITIES

PROGRAM	RESOURCE USAGE $ Cash ('000)		$ In-Kind ('000)		Contributed Staff	Cash Funded Staff
Research	2,635.4	55.1%	8,400.8	71.45%	30.89	29.93
Education	684.3	14.3%	349.7	2.97%	1.35	0.00
External Communications	71.5	1.5%	0.0	0.0%	0.00	0.00
Technology Transfer	1,016.3	21.2%	3,002.8	25.54%	16.07	10.57
Administration	377.5	7.9%	3.6	0.04%	0.05	2.80
TOTAL	**4,785.0**	**1.0**	**11,756.9**	**1.0**	**48.36**	**43.30**
	(T3)		(T1)			



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