Australian Cotton Cooperative Research Centre

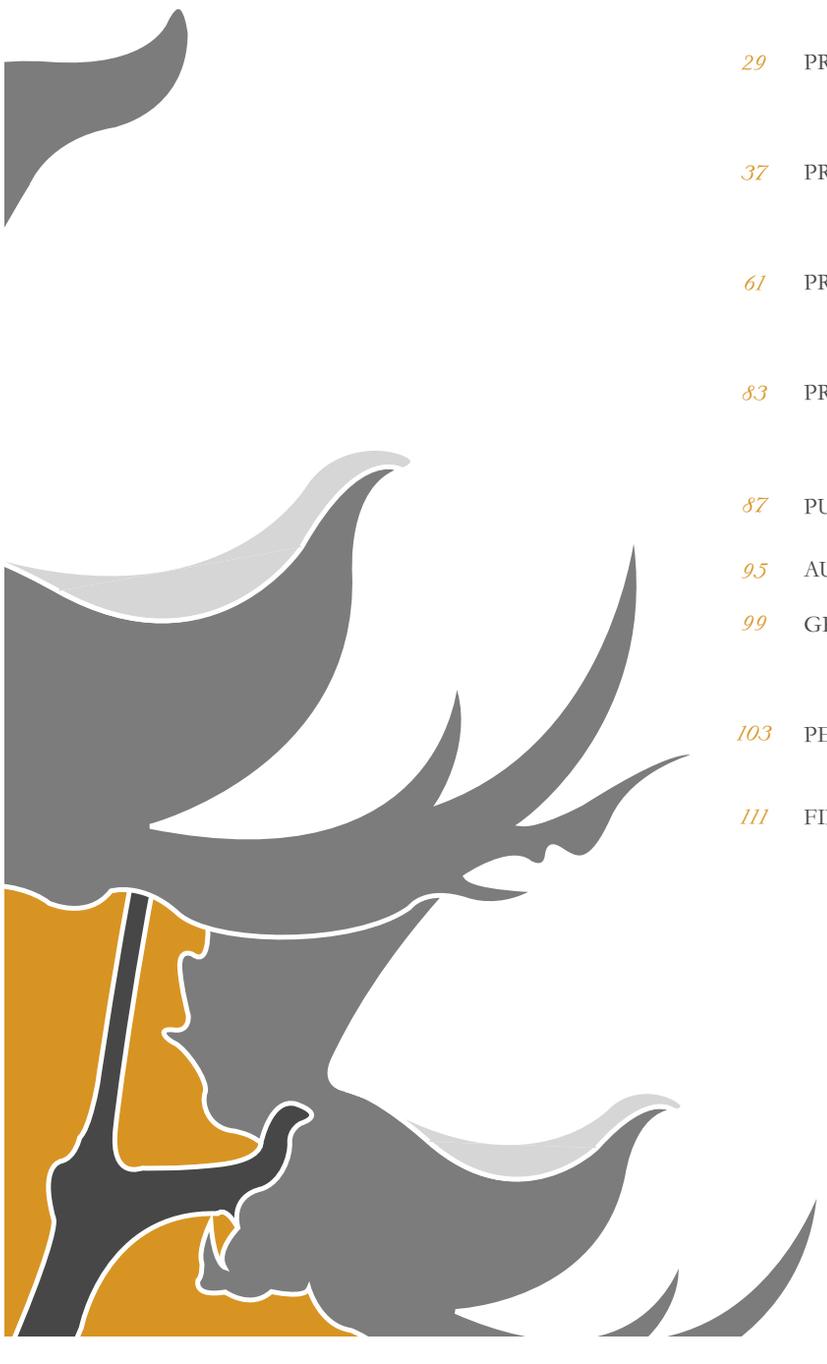
Annual Report 2001/2002

CRC AUSTRALIA

Established and supported under the Australian Government Cooerative Research Centres Program

Cotton CRC

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

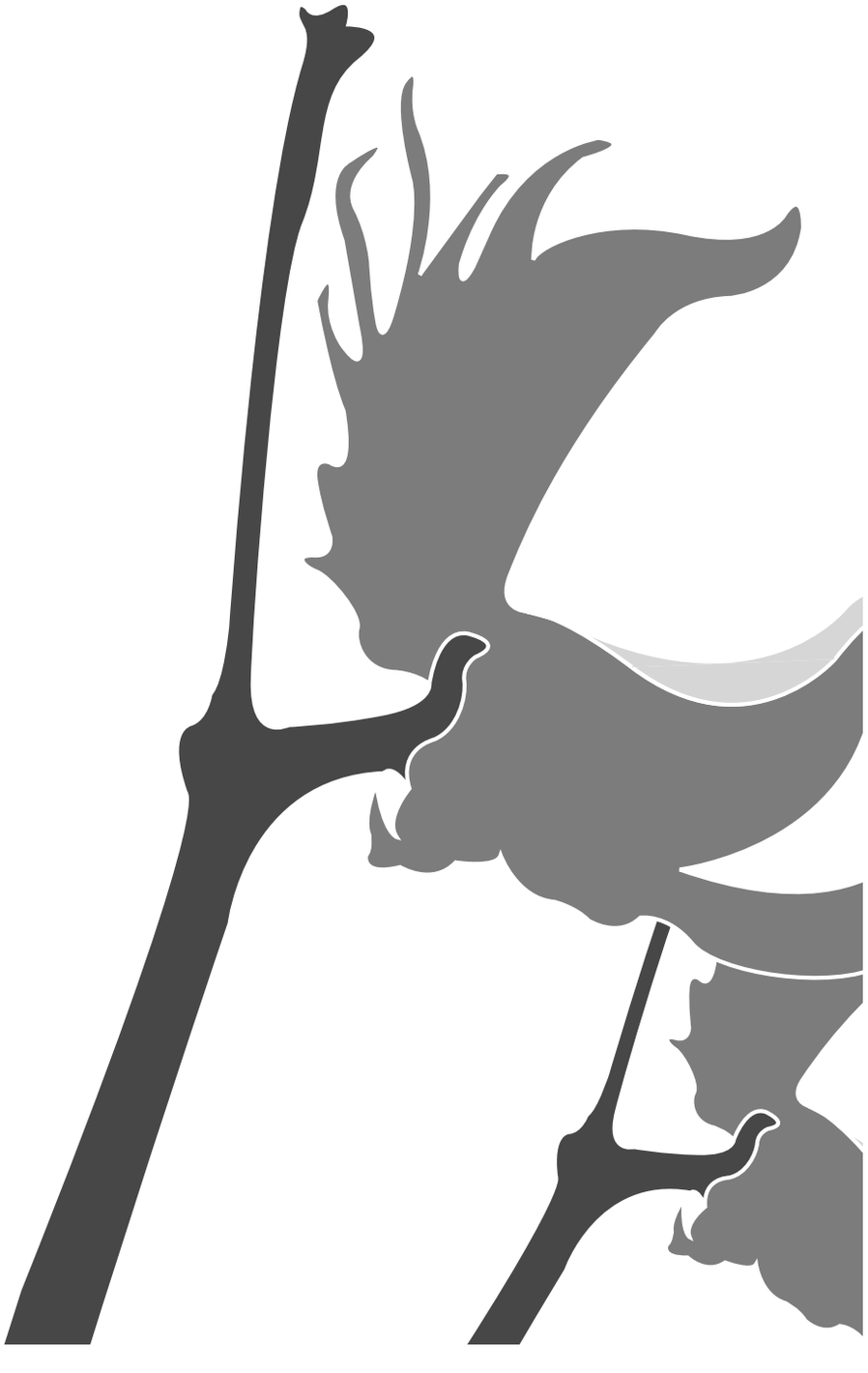
To enhance the prospects for expanding cotton production by researching viable and environmentally responsible cotton production systems for new regions in Western Australia, the Northern Territory and north Queensland. To develop solutions to specific regional environmental problems prior to promoting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



Chairman's Foreword

The annual report brings together in useful format the research activity and financial record of our CRC. CEO Dr Gary Fitt outlines the highlights of the year and writes proudly of effective collaborative research, institution to institution and between researchers, which is producing excellent results.

The research effort over many years, not only within the CRC, has delivered and continues to deliver to the industry the tools needed to respond to the many challenges of modern cotton production and environmental performance. That past and present effort has allowed cotton producers to effectively lift their game to reduce their environmental footprint.

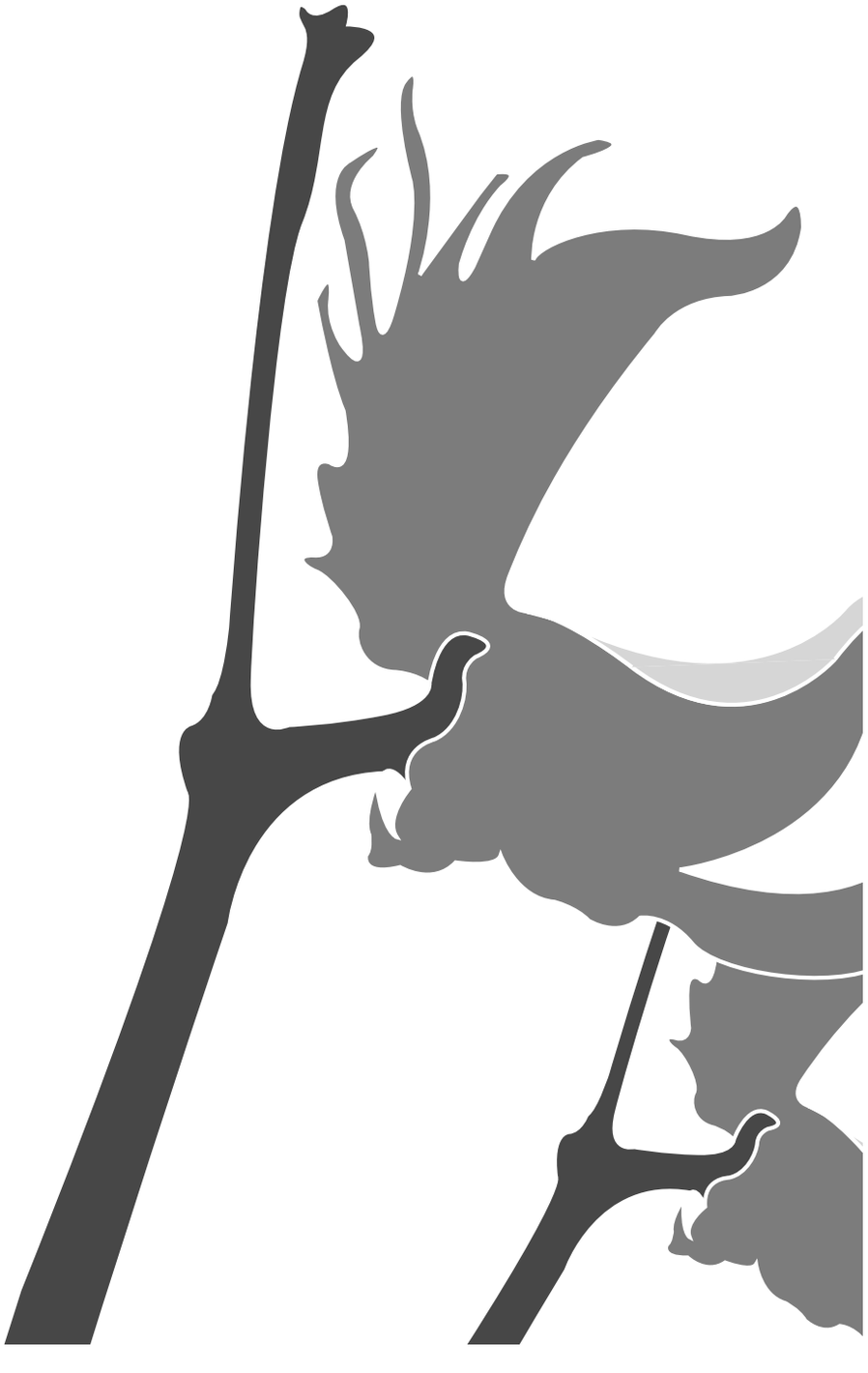
Uptake of research into practical application is clearly demonstrated by the strongly increasing coverage of Best Management Practice cotton farmers and the extent of Area Wide Management groups coordinating their pest management in a cooperative way over a region. These programs have a substantial environmental benefit and the Australian cotton industry is providing a world best standard.

The industry and the research community are approaching the point where an acceptable environmental benchmark is achieved. If that is the case, instead of playing catch up, the industry may be able to move forward onto the front foot and strive to lift the benchmark toward a balance between community environmental expectations and the demands of production.

The CRC's supplementary bid for an additional program was to be a major step to develop the tools needed for that environmental ambition. That the bid was unsuccessful should not divert us from continuing to strive in that direction. Efforts will be made to mount at least some of the components that were incorporated into the proposed program.

By the time this 2001-2002 report hits our stakeholders desks the CRC will be close to the middle of its term. The Board will be working to maintain a high level of research achievement through to the end of the CRC and to ensure that a sound, collaborative strategy is in place for the years beyond.

Evan Cleland
Board Chairman.



Executive Summary

Second Year Review

The year opened with highly positive outcomes from our Second Year Review. The reviewers commented on the highly collaborative and committed nature of the CRC and the clear focus of the staff on key industry issues - a compliment to all. The report concluded that the Cotton CRC has no major weaknesses and noted specifically that:

- Emphasis on sustainability, encompassing economic, social and ecological factors, has led to the adoption and application of a systems approach which could be seen as a model for agricultural CRCs in Australia.
- The centre's activities are considered to be outstanding in many respects, including the strategic approach, the addressing of major issues on a systems basis, its communication program and strong collaboration with all the major cotton research and research user organisations in Australia.

Nonetheless there is always room for improvement. The report suggested that we improve our business management practices, particularly in the identification and protection of valuable IP and seek to improve our internal communications. A coordinated communication strategy has been an issue for us and the appointment of a communication manager from July 2002 should help address this.
Meanwhile we work to nurture our obviously strong collaborative approach and build on that for the second half of the CRC.

Management Structure

There have been no significant changes in our structures over the last year. We maintain strong linkages into the cotton industry through our commercial participants (Cotton R&D Corporation, Cotton Seed Distributors, Queensland Cotton and Western Agricultural Industries), and through direct interactions with the Australian Cotton Growers Research Association and the Cotton Consultants Australia. During the year Dr. Geoff Naylor (CSIRO, Geelong) replaced Dr. Peter Cookson as leader of Program 5; Cotton Textile Research. We thank Peter for his tremendous effort in establishing the new textile program and look forward to Dr. Naylor building on his long history of innovative research leadership in cotton textiles.

Northern Challenges

Our research in northern Australia faces a number of challenges. This was highlighted at a Northern Review held in December 2001 where the CRC and CRDC Boards reviewed all the issues which impinge on our capacity to conduct research and on the potential for a cotton industry. The CRCs Scoping Report on "Cotton Research and Development Issues for Northern Australia" published in August 2001 provided a valuable and comprehensive summary of issues as background. Views were obtained from a number of environmental, industry and community groups; all helping to formulate our future investment plans.

Native Title continues to limit opportunities for research at Broome, although Western Agricultural Industries is hopeful that High Court rulings and negotiated agreements will soon provide a clearer path for research at least. In the Ord River Irrigation Area, uncertainties about Ord Stage 2 have not dampened progress with our large-scale pest management research conducted with a committed group of farmers. Likewise in the NT, our agronomic and pest management research continues to provide basic components for a sustainable production system. Hopefully that research will soon move to a larger scale in partnership with established farmers. In north Queensland we have deferred research while a clear 5-year R&D strategy is developed. The first phase of that is to complete a comprehensive scoping study of the resource, infrastructure and logistical issues to identify a small number of potential regions for future research.

Environmental Focus and New Collaborations

A major effort during the year culminated in May 2002 with a proposal to establish a new Program in the CRC with supplementary funding from the Federal government's Innovation Statement. The new Program "Enhancing and Managing Agricultural Ecosystems" will extend the sustainable production focus and build on our current suite of environmental projects to encompass the broad range of environmental challenges (water, vegetation, biodiversity) now confronting agriculture. Details are provided in the "Highlights" section of this report. The development of the proposal has greatly expanded collaborations with environmental and industry groups and promises and exciting leadership role for the cotton industry in a future where landholders will increasingly be -regarded as custodians of Australia's precious land resources.

Cotton Processing Research

Australia's textile industries provide an ever changing target for our textile research group. A further reduction in local spinning capacity followed the closure of Bradmills in Melbourne and the decision by Bonds to abandon local spinning. A high point was the decision by CSIRO to invest in new cotton processing equipment at Geelong to support textile research. Our projects will benefit greatly. The challenge will be to transfer outcomes to the processing industry, potentially overseas, in ways that advantage Australian cotton.

Research Results making a difference

In May the Cotton CRC was one of four CRCs to be showcased at the annual CRC Association Conference. The event was an opportunity to highlight the productive partnership of research groups, extension networks, consultants and growers which has resulted in the rapid adoption of Area-wide Management approaches in the cotton pest management. Founded on sound and innovative science about the agricultural ecosystem, with support from extension specialists and requiring commitment and confidence from growers the area-wide IPM approach is clearly a model for the future.

Many of the innovative technologies being researched in the CRC can be integrated into a farming systems approach on farm, but it requires additional extension and education to then coordinate those approaches across large areas of neighbouring properties.

Education and Technology Transfer are key elements underpinning the research success of the Cotton CRC and the long-term success of the industry. This year has seen the successful development and piloting of the IPM Short Course for growers. To be rolled out in the next year, the short course provided focussed training on Integrated Pest Management to add to the broader objectives of our award winning Cotton Production Course - a benchmark course for technical specialists working in the industry.

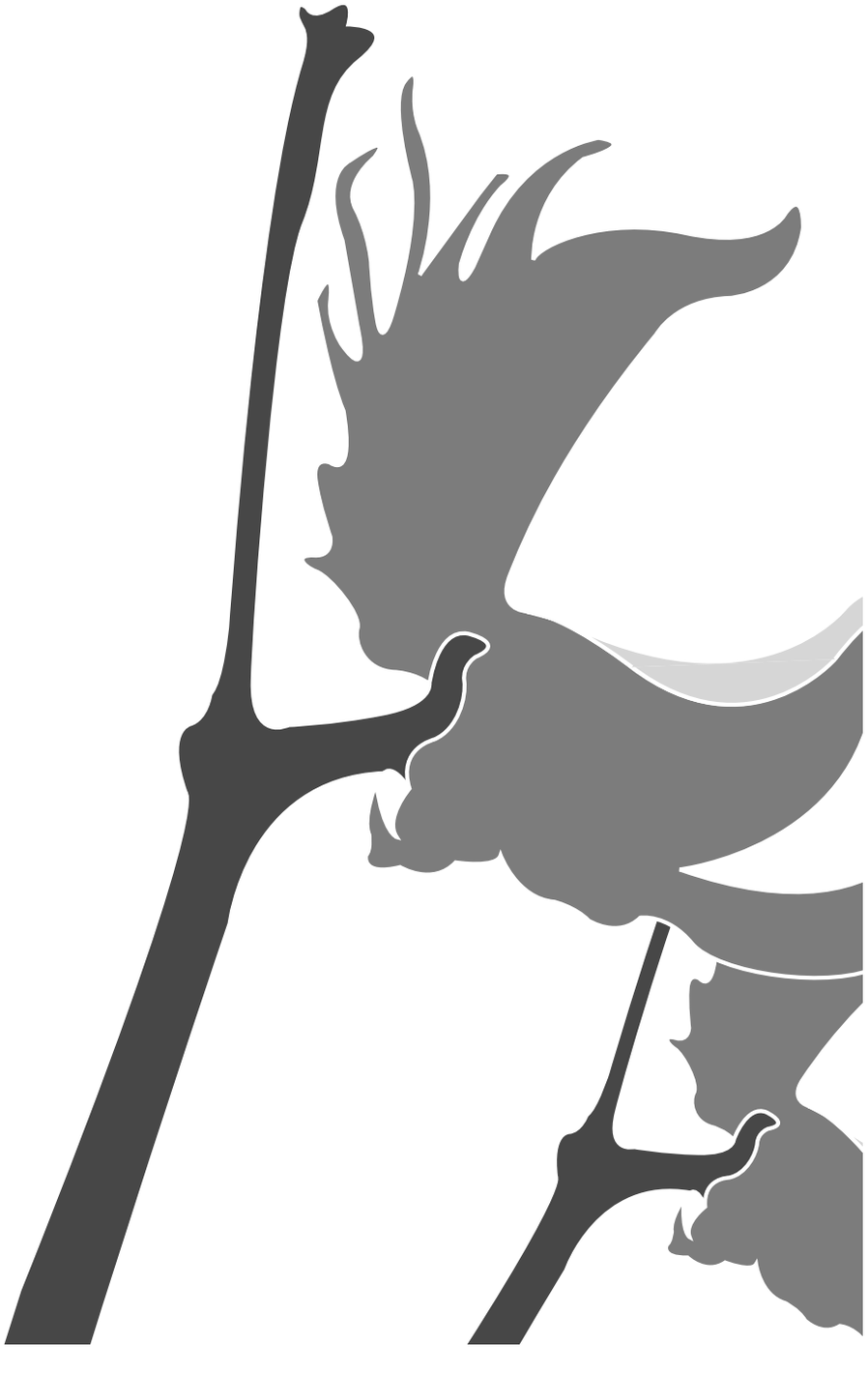
Annual Review and Awards

Our 2002 annual review of projects in June was held this year in Toowoomba. A different structure saw the CRC required to justify its research performance against five themes, each commencing with a challenge from an external expert speaker. The outcome was refreshing and rewarding for the participants, which this year included most of the 30 or so Postgrad students currently working in cotton. These students are our future researchers and a resource to be strongly supported.

Our annual awards this year went to:
Innovation – Martin Dillon (CSIRO), Ziaul Hoque and Bob Farqharson (NSW Agriculture) for the development of the BDI (Beneficial Disruption Index), a significant tool for analysing the performances of IPM and Areawide management systems.
Collaboration – the Weedpak team, Dr. Stephen Johnson (UNE), Graham Charles (NSW Agriculture), Dr. Ian Taylor (NSW Agriculture) and Grant Roberts (CSIRO) for completion of the WeedPAK manual – a tremendous new resource for the industry.
Corporate Citizenship – Stephen Yeates, our northern research coordinator, who is so often the public face of the CRC in northern issues.
Communication to industry – David Kelly (QDPI) – a model industry development officer based at Emerald in Central Qld where he produces a stream of high quality information for growers and acts as a strong conduit for researchers.

For the next year we will continue to focus on the strong strategic directions already in place as we anticipate strengthening our environmental focus and prepare for a bid for renewal in a couple of years time. Achieving outcomes will continue to rely on strong commitment from core partners, an excellent team of researchers and support staff and a supportive and receptive industry.

Dr. Gary P Fitt
Chief Executive Officer



Highlights

KUNUNURRA FARMERS COMMIT TO COTTON IPM.

Despite falling cotton prices and uncertainties concerning the future of the local gin, four farmers joined with the CRC research team to test-farm IPM tactics at Kununurra in the 2001 dry season.

As in previous seasons, farmers grew INGARD® cotton alone and with companion crops such as lucerne, lablab and pigeon pea. Companion crops are used to attract pests away from the cotton and also to act as a reservoir of beneficial insects. CRC staff are responsible for crop scouting and recommend IPM compatible sprays when required.

By repeating similar trials each year, any benefits accruing from IPM tactics can be measured against growing INGARD® alone, in terms of number of sprays required and yield.

A total of 385 ha of cotton was grown in the 2001 season, mainly for IPM evaluations on-farm. Two varieties were used, the okra leaf Siokra V16i and the normal leaf Sicot 289i.

One farmer, Darryl Smith, achieved outstanding results with his 60 ha cotton crop. Darryl's farm is the closest to town and is only separated from a tourist caravan park by the main irrigation channel. In response to concerns about aerial spray applications, Darryl has recently moved to a ground spray system that uses permanent traffic rows.

Importantly, Darryl uses the traffic rows as an IPM tool by maintaining them year round as lucerne strips. Thus the lucerne strips appear regularly throughout the crop rather than as blocks every 300m or so, as is the usually accepted practice. The lucerne covered traffic rows remain when other crops, such as melons, are grown in rotation.

Darryl achieved excellent yields from his IPM cotton with the Sicot 289i averaging 8.35 bales/ha

EVALUATING THE EFFICACY OF ENHANCED BT COTTONS

Through adoption of a number of new technologies, the cotton industry is steadily enhancing the sustainability of its production systems. One of the most significant areas of change has been in pest management, where the introduction of genetically modified INGARD cotton varieties, and a progressive adoption of other integrated pest management (IPM) tactics, has seen dramatic reductions in pesticide use.

With the advent of area-wide management groups, the industry is progressively implementing more ecological approaches to managing key pests such as *Helicoverpa*. Greater reliance on beneficial insects (predators and parasites), and careful use of cotton varieties with in-built protection against Helicoverpa, are key planks in this development.

INGARD cotton varieties produce a protein (Cry IAc) derived from the common soil bacterium, *Bacillus thuringiensis*, which is toxic to the larvae of *Helicoverpa* and similar species. The Bt protein has no effects on other organisms, so provides an effective and selective pest management tool and has produced pesticide reductions of 50% so far.

One difficulty however, is that production of the protein in the plant tissues changes through the growing season, such that plants are less effective in killing *Helicoverpa* in the second half of the season, and require some supplemental pesticide for control.

Of greater concern is the risk that *Helicoverpa* may evolve resistance to the single Bt protein. While a comprehensive resistance management strategy is in place, the main effort over the last few years has been to develop two gene Bt cottons, which produce a second protein (Cry2Ab). Since the two proteins challenge *Helicoverpa* in different ways, their combination greatly reduces the risk that Helicoverpa may evolve resistance.

The Cotton CRC project 2.1.1 has conducted field and laboratory studies to evaluate the efficacy of the two gene combination to determine how effective it is in killing *Helicoverpa* larvae, and research the factors which influence efficacy. We have also quantified the changes in plant chemistry and concentrations of the Bt proteins throughout plant development to better understand how the Bt plant responds to the environment.

Our research has involved four varieties expressing both the CryIAc and Cry2Ab genes from *Bacillus thuringiensis* (Sicala V3, Sicot 40, Sicot 289 and Siokra V16). One variety Sicala V2 was available with only Cry 2Ab, while a wide range of varieties expressing only Cry IAc were included.

Our results showed high and consistent efficacy of the two-gene combination, but also showed that Cry 2Ab alone was highly effective (Figure 1). These results are significant since the consistent high efficacy of the two gene plants should allow further reductions in pesticide use, whilst also providing greater protection against the risk of resistance.

Nonetheless, our results also indicate the need for ongoing vigilance in resistance management of two gene cottons, as we clearly do not have a season long two-gene strategy which would provide the maximal protection against resistance.

When introduced commercially, hopefully in the 2003/04 season, the two-gene cottons will be accompanied by a similarly rigorous and comprehensive management strategy to that currently used for INGARD varieties. In that way the long-term environmental benefits can be assured.

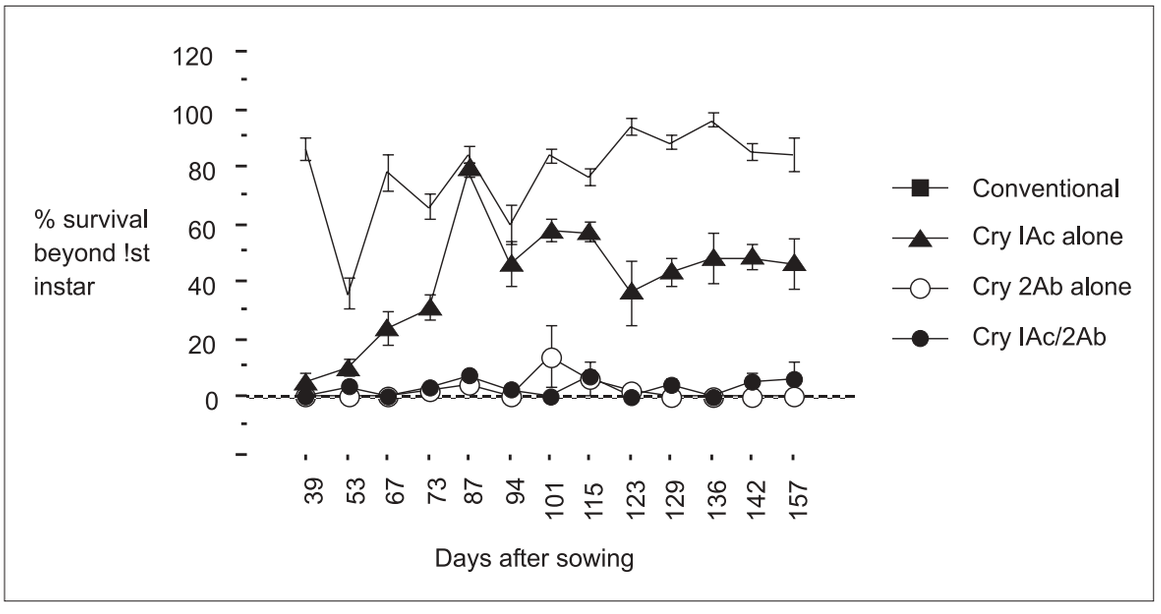


FIGURE 1. Bioassay survival of neonate *H. armigera* larvae on node 4 leaves from control varieties expressing Cry IAc and Cry 2Ab genes. Plants grown at PBI, Narrabri, 2001/2002.

ATTACKING THE FUSARIUM WILT PROBLEM

Fusarium wilt of cotton continues to develop as a significant threat to the viability of the cotton industry in Australia. The disease is widespread in Queensland and NSW with new outbreaks being recorded every season. Eleven CRC and CRDC funded projects are addressing the Fusarium wilt problem.

The unavailability of any significant varietal resistance has contributed to a realisation that the disease can only be controlled by the development and implementation of an Integrated Disease Management strategy. Consequently a range of potential disease control options are being investigated by plant pathologists with the Queensland Department of Primary Industries, New South Wales Agriculture, The University of New England, Cotton Seed Distributors Ltd and molecular biologists from CSIRO Canberra and Melbourne University.

The QDPI diagnostic service continues to receive samples from all cotton growing areas for confirming the presence of Fusarium wilt. Through collaboration with the CRC for Tropical Plant Protection, DNA diagnostic tools have been developed and are now being evaluated to enable more rapid diagnosis and quantification of the pathogen in samples of seed, plant stems, soil and water. The life cycle of the pathogen, the role of alternative weed hosts and the interaction between the pathogen and the host cotton plant are being reviewed. Australian native *Gossypiums* are being investigated as possible sources of resistance to the disease and as a possible origin of the pathogen.

A significant component of the cotton breeding effort is focused on identifying and incorporating better host plant resistance. Novel anti-fungal genes have been identified and introduced into cotton plants for evaluation under field and glasshouse conditions. Other field and glasshouse studies are investigating the impact of various rotation crop strategies on the population of the pathogen in the soil. The effects of biological, induced resistance, herbicide, fertiliser, cultivation and fumigation treatments are also being considered.

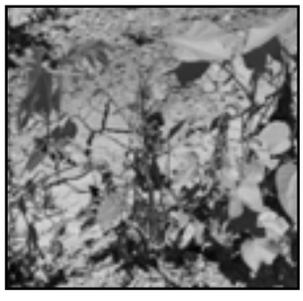
Laboratory assays have confirmed that the Fusarium pathogen is no longer viable in acid-delinted seed six months after harvest. The efficacy of methyl bromide fumigation for eliminating the pathogen from fuzzy seed destined for export has also been demonstrated.

Early diagnosis and recognition of the problem, access to more resistant cotton varieties, manipulation of the cotton plant's natural defense mechanisms, avoidance of farming practices that favour infection by the pathogen, and the adoption of crop rotation strategies that do not contribute to the build-up of the pathogen in the soil, should allow cotton growers to cope with the disease and minimise disease losses.

This significant research effort is being coordinated by an Australian Cotton CRC 'Fusarium wilt Research and Extension Coordination Committee' (FUSCOM) which includes representatives from grower and consultant groups as well as from funding bodies, the CRC cotton extension team and plant pathologists, cotton breeders and molecular biologists. The objective of FUSCOM is to foster collaboration and communication between the various research groups involved by organising annual workshops and field inspections.

FUSCOM invited and coordinated the visit of Professor Patrick Colyer from the University of Louisiana to review Fusarium wilt research in Australia. His report concluded that the efforts of the Australian cotton industry in the area of Fusarium research and management were "first-rate". FUSCOM has also developed a protocol for ranking commercial cotton varieties for their relative resistance or susceptibility to the Fusarium wilt pathogen.

Australian Cotton CRC plant pathologists have produced the 'Integrated Disease Management Guidelines' for distribution to the industry in the coming year. These guidelines include a programmed control strategy for each of the significant diseases of cotton in Australia (including Fusarium wilt) as well as a pocket symptoms guide and advice on identifying, assessing and monitoring diseases and improving farm hygiene.



A NEW GROWER FOCUSED COURSE ON COTTON IPM.

Integrated Pest Management (IPM) is a complex dynamic system requiring a change in attitudes to pest management. It allows growers and others to control diseases, insects, weeds and other pests in a cost-effective, environmentally sound and socially acceptable way. IPM in cotton is about using a number of tactics to manage pests in a way that ensures the sustainability of the industry.

To understand the key barriers limiting the adoption of IPM strategies, the Cotton CRC conducted a objective evaluation of grower and consultant attitudes to IPM. This evaluation highlighted the need for growers to develop greater knowledge, understanding and confidence in using key IPM principles. A lack of economic evidence that IPM improved farm profits was also seen as a chief deterrent to its adoption.

Following this review, the Cotton Research & Development Corporation (CRDC) provided funding for an IPM training coordinator, whose role was to develop, in consultation with industry and researchers, a grower focused short course in IPM. The Cotton CRC also recruited an economist to work specifically on IPM.

The IPM short course program includes:

- A comprehensive educational package, which clarifies the latest best practice for IPM as identified by industry experts (including growers).
- Economic links to IPM strategies across short, medium and longer-term timeframes.
- An extension program (including grower best practice groups) to assist growers to 'take responsibility' for management decisions.

The general structure of the course was based on the successful 'Research to Practice' program developed by the Viticulture CRC. It combines theory with on-farm practical lessons.

Growers benefit from the course by developing a clear understanding of IPM and how to implement changes to their own pest management practices. The course provides a forum for discussion, which helps provide solutions to real problems and challenges in pest management. Common perceptions about IPM, that it results in delayed maturity and lower yields, are replaced with a positive attitude of how IPM can improve long term profitability and yield while reducing the industry's reliance on pesticides. The contribution of CRC research scientists and extension officers (IDOs) as presenters of various modules has been critical to the success of the pilot courses to date and this level of input will be critical.

The course has been registered as a National Training Program and partnerships have been formed with Murrumbidgee and Dalby Agricultural Colleges as Registered Training Organisations to deliver the course. Growers attending the IPM short course are eligible for FarmBi$ subsidies.

Feedback from the course has been extremely positive. Some comments made by attending growers include:

" ..it has helped me gain a much fuller understanding of what is happening in our crop, and to better manage our crop from a more holistic point of view."

" I have got out of the course how IPM can work.."

"..I gained knowledge that would have taken me 10 years to gain.."

"..learnt a lot, rethinking farming. Well organised, exactly what we need to start us thinking."

"..small groups are great, good interaction, speakers who know their topics, presentations easy to follow, good material to take away.."

"..the course was the single most important thing I have done to improve my farming practices in the 30+ years I have been in business.."

Dr Sarah Mansfield in field with growers as part of an IPM short course.

NEW SPINNING MILL: A MAJOR RESEARCH FACILITY FOR AUSTRALIAN COTTON

The Cotton CRC's Textile Research program has been boosted by the commissioning of a new state-of-the-art spinning mill at the Geelong facility of CSIRO Textile & Fibre Technology.

This major investment in infrastructure by CSIRO of over $1 million covers the three main short staple spinning systems typically used in industry, namely ring, rotor and Vortex spinning. Table 1 lists the range of yarns that can be produced and the productivity of the three spinning systems that have been installed.

Table 1 – Yarn Count Range and Productivity of New Spinning Systems at CSIRO

SYSTEM	YARN COUNT RANGE	YARN DELIVERY SPEEDS
Ring	Ne* 15/1 – Ne 60/1	12 – 25 m/min
Rotor	Ne 5/1 – Ne 40/1	90 – 140 m/min
Vortex	Ne 15/1 – Ne 50/1	300 – 400 m/min

*Ne, the English Cotton Count, is the historical common measure of yarn thickness used by the cotton spinning trade. The first number is the number of 840 yard lengths formed from a single strand that would weigh one pound, and the second number is the number of strands plied together to form the yarn.

Once the yarn is produced, it can be knitted or woven through to finished dyed fabric using the existing facilities in Geelong, which means CSIRO can now handle all processing between ginned lint through yarn and fabric formation to final product

A major advantage of the new mill is the ability to efficiently spin lots as small as 30 kg of raw fibre, ideal for quality control testing and small samples often generated in research projects.

The new spinning facility will figure prominently in a new CRC project designed to ensure that Australian cotton is the preferred option for superior technical performance by international mills producing high quality cotton products.

With the support of the Australian Cotton Shippers Association and Austrade, links are being formed with mills in Japan, South Korea, Thailand and Indonesia to obtain first-hand technical information on, and samples of, the performance of Australian cotton during processing.

It is then planned to undertake comparative spinning trials with the various international spinners and the new mill in Geelong, in an effort to better understand how Australian cotton performs; and to iron out any potential processing difficulties. It is hoped that these trials will also establish best practice benchmarks for ginning and spinning preparation with links back to growing and harvesting practices.

Dr Stuart Gordon taking yarn samples from the new ring spinning frame at CSIRO.

ENHANCING THE AGRICULTURAL ENVIRONMENT – OUR BID FOR ADDITIONAL FUNDING

In January 2002 the Federal Government's Backing Australia's Ability announcement on national innovation policy provided additional funding to the CRC Program. As a result, existing CRCs were able to submit supplementary bids for funding in the 2002 funding round for CRCs. The Cotton CRC submitted a bid for a new three-year, $3 million program, on "Enhancing the Agricultural Environment".

The Australian cotton industry is a world leader in terms of efficiency and productivity. It is a major economic contributor to regional Australia and a generator of export income to the nation. However, there has been a public perception that the industry does not have equivalent credentials in regard to environmental responsibility.

The intent of our supplementary bid, and the new Program, is to equip cotton growers with the understanding, skills and knowledge necessary to achieve excellence in environmental management on farms – and subsequent recognition of the environmental sustainability of cotton by the Australian public.

Objectives of the Program will be to:

- increase understanding of cotton's place in the ecology of local regions
- facilitate on-farm changes in environmental management amongst growers
- provide materials and processes to drive further adoption of whole-farm environmental management via the Best Management Practice (BMP) and future Environmental Management System (EMS) approaches
- support the development of whole-farm management strategies which complement catchment plans and targets.

If funded, the new Program will commence in July 2003 and will cover the following Environmental issues:

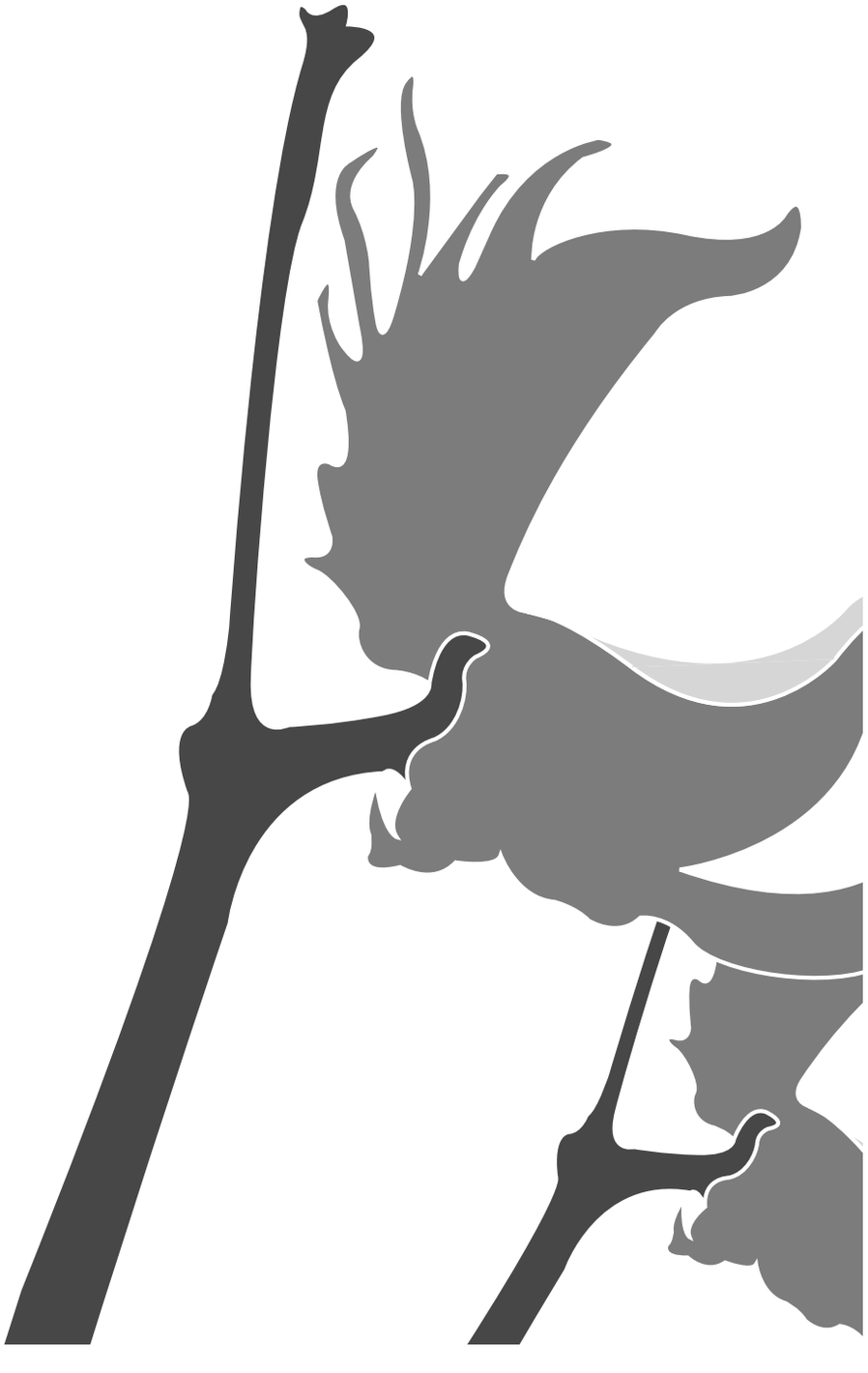
- Biodiversity on farms
- Water in the Environment
- Environmental Impacts of Genetically Modified Cottons
- Ecosystem Services and Incentives
- Implementation of enhanced management systems

The "Enhancing the Agricultural Environment" Program will comprise several unique and valuable features and benefits. It :

- Establishes a specific environmental component in the CRC to complement our ongoing research, education and extension efforts
- Generates national, regional and local Public Good Benefits in terms of improved water quality, better management of native vegetation and enhanced biodiversity
- Delivers benefits to a wide area of Australia, building on existing CRC research in Queensland, NSW, Victoria, WA and the Northern Territory
- Assists in catchment-wide environmental management, particularly in the Murray-Darling Basin
- Establishes, or builds on, collaborative links with five other CRCs: Freshwater Ecology, Australian Weed Management, Sustainable Rice, Tropical Savannahs and Catchment Hydrology
- Involves expanded commitments from several existing Cotton CRC Participants, but importantly brings 14 new Supporting Participants into the CRC
- Supports the training of an additional 6 PhD students and 1 Masters student
- Involves integration, collaboration and ongoing liaison with community groups and local Catchment Boards
- Integrates all components of the agricultural ecosystem including soil, water, irrigation, river flows and health, vegetation, flora, fauna, biodiversity, technology, management, and socio-economics, across a broad range of research, education and extension disciplines.

Overall, the new Program will greatly strengthen the Cotton CRCs portfolio of activities. The selection process will involve shortlisting of applications in September 2002, interviews in October 2002 and hopefully success in December, with new projects to commence in July next year.

Postscript: In late September, the CRC learnt that its Supplementary bid was unsuccessful. However, we propose to continue with a new program and with this area of work.



Structure and Management

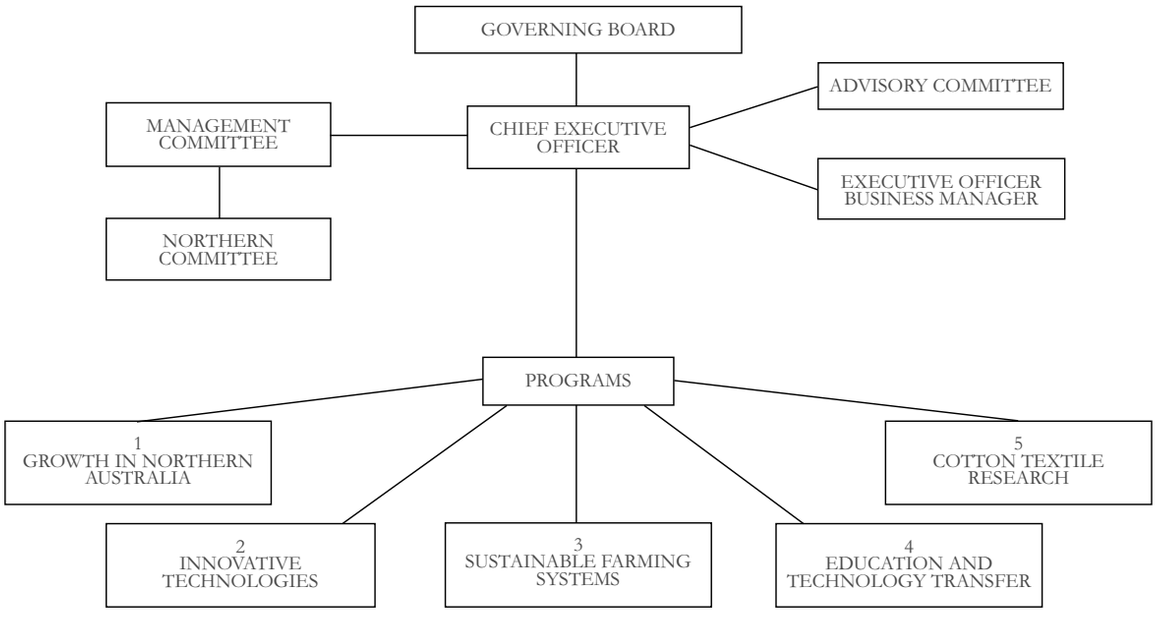
Participants

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 Queensland
- NSW Agriculture
- Agriculture Western Australia
- Northern Territory Department of Business Industry and Resource Development
- The University of New England
- The University of Sydney
- Cotton Research & Development Corporation
- Cotton Seed Distributors
- Queensland Cotton
- Western Agricultural Industries

Structure

The CRC works under a Governing Board and Committee structure. The Governing Board is responsible for policy and strategic direction. The Management Committee assists in Policy implementation. The Northern Committee advises on research relating to potential expansion of cotton into new regions, and an Advisory Committee assesses Programs against key objectives, monitors community concerns, and provides feedback on future research directions. These Committees are aided by discipline-specific Working Parties.



Governing Board

The Governing Board is chaired by an independent chairman appointed by the Australian Cotton Growers' Research Association (ACGRA). The Board is responsible for controlling the policy, practices and overall operation of the Cotton CRC. Its functions and powers include strategic directions, performance indicators, programs and activities, approval of annual budgets and commercial arrangements, negotiating funding for the CRC, and appointment and review of the performance of the Chief Executive Officer. The Board meets four times per year.

Mr Evan Cleland

Ms Bridget Jackson

Mr John Grellman

Mr Bruce Brown

Mr Bob Galmes

Professor Peter Flood

Dr Gary Fitt

Dr Jim Peacock

Ms Helen Scott-Orr

Mr David Hamilton

Mr Bruce Sawyer

Ms Di Bentley

NON RESEARCH PROVIDERS	
Chairman	Mr Evan Cleland
Cotton Research and Development Corporation	Ms Bridget Jackson
Cotton Seed Distributors	Mr John Grellman
Queensland Cotton/Western Agricultural Industries	Mr Bruce Brown
Independent Member	Mr Bob Galmes, Bonds Industries
Independent Member	Ms Di Bentley, Liverpool Plains Land Management Committee
CEO (100% Centre funded)	Dr Gary Fitt
RESEARCH PROVIDERS	
CSIRO	Dr Jim Peacock
NSW Agriculture	Ms Helen Scott-Orr
Department of Primary Industries Queensland	Mr David Hamilton
NT Department of Business Industry & Resource Development/ Agriculture Western Australia.	Mr Bruce Sawyer
University New England/University of Sydney	Prof Peter Flood

Management Committee

The Management Committee and Australian Cotton CRC Administrative Staff in October 2002. From Left to Right Ms Nicky Schick, Mrs Lynda George, Dr Gary Fitt, Ms Kym Orman, Mr Dallas Gibb, Dr Lewis Wilson, Mr Bruce Pyke, Dr Stephen Allen and Dr Inakwu Odeh (Standing in for Prof Alex McBratney).

Dr Geoff Naylor

Mr Geoff McIntyre

Dr Colin Martin.

Mr Geoff Strickland

Associate Professor Peter Gregg

Dr Michael Bange

The Management Committee is chaired by the CEO and assists the Governing Board in the operations of the CRC. It meets at least four times per year. Its primary responsibility is to assist the CRC meet its objectives through implementing policies as determined by the Governing Board. It assesses and recommends research projects to the Governing Board; oversees progress in research projects and achievement of performance indicators; and manages the allocation of resources, education and training, information services, publication of research outcomes, technology transfer and commercialisation. All Program Leaders are represented on the Management Committee and each Program, with the exception of Program Five, is managed by joint Program Leaders.

MANAGEMENT COMMITTEE		
Dr Gary Fitt (Chair)	CEO	Australian Cotton CRC
Mr Geoff Strickland	Program 1 Leader	Agriculture WA
Dr Michael Bange	Program 1 Leader	CSIRO Plant Industry
A/Prof Peter Gregg	Program 2 Leader	University of New England
Dr Stephen Allen	Program 2 Leader	Cotton Seed Distributors
Dr Lewis Wilson	Program 3 Leader	CSIRO Plant Industry
Prof Alex McBratney/Dr Inakwa Odeh for 2002.	Program 3 Leader	University of Sydney
Mr Dallas Gibb	Program 4 Leader	NSW Agriculture
Mr Geoff McIntyre	Program 4 Leader	DPIQ
Dr Geoff Naylor	Program 5 Leader	CSIRO Textile & Fibre Technology
Mr Bruce Pyke		Cotton R & D Corporation
Dr Colin Martin		NT Dept Business Industry and Resource Development.

Northern Committee

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

Joint Program Leader Geoff Strickland is in regular contact with management and relevant researchers. Mr Stephen Yeates is the Northern Liaison Officer based in Darwin. He provides regular reports to, and takes direction from, the Management Committee through the Northern Committee, and oversees a specific northern Australia communications strategy. The Committee meets annually, or as required. In the first year of the Cotton CRC it met five times.

NORTHERN COMMITTEE

Dr Gary Fitt	CEO Cotton CRC
Mr Geoff Strickland (Chair)	Program Leader Agriculture WADr
Michael Bange	Program Leader CSIRO Plant Industry
Dr Ian Titmarsh	Dept Primary Industries QldDr
Colin Martin	NT Dept Business Industry & Resource Development
Mr Adam Kay	Cotton Seed Distributors
Mr Stephen Yeates	Research Coordinator/Liaison Officer CSIRO Plant Industry

Advisory Committee

An Advisory Committee provides feedback on the quality of the science undertaken by the Cotton CRC; comments on its relevance; assesses progress against key objectives; identifies perceived research gaps and/or suggests future research directions; provides feedback on possible additional linkages the CRC could be utilising to further its objectives; and provides advice and information about existing and emerging industry and community concerns. Membership has been drawn from growers, consultants, other research organisations, other agricultural industries, and the broader community.

ADVISORY COMMITTEE

Mr Bruce Finney	Australian Cotton Growers' Research Association
Dr Don Sands	CSIRO Entomology
Dr Chris Moran	CSIRO Land & Water
Mr Jeff Coutts	University of Queensland, Rural Extension Centre.
Mr Mick Ryan	Cotton Consultants Australia
Dr Graeme Hammer	Dept Primary Industries Qld, APSRU
Mr John Harrison	Amateur Fisherman's Association Northern Territory
Mr Kevin Goss	Murray Darling Basin Commission
Ms Sheila Donaldson	Community

Working Parties

In addition, the CRC has established discipline-specific working parties to provide direction and feedback from industry segments, and the broader community.

Administration

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

Administration Team: Lynda George, Nicky Schick and Kym Orman.

Cooperative Linkages

Success in any CRC rests on its capacity to engender a culture of collaboration which draws on the full capabilities of each participant, and to use this internal strength to maximise linkages with other organisations. Wherever possible we encourage projects which involve collaboration of more than one participant and seek to develop a team approach in our research and technology transfer programs.

Our discipline groups cover all facets of cotton research (eg. IPM, weeds, diseases, farming systems, water and soils) and provide a regular forum for researchers, extension staff, growers, consultants and other industry groups to discuss research outcomes and identify future priorities. Our annual review meeting also provides an opportunity for both science and social interactions among all members of the CRC.

Our strongest interactions are with the cotton industry itself through the Australian Cotton Growers Research Association, which chairs the CRC board and provides participants in all the CRC's discipline groups. Our commercial participants further strengthen linkages into specific parts of the industry. This is particularly evident in the Northern Australia program, where interactions are facilitated through a Northern Committee with representatives from all researcher providers and commercial participants. We are progressively developing stronger links with communities in northern Australia as we expand our northern research.

Our Extension and Education program provides additional foundations for linkage across 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).

In the past year we have had regular links with a range of community, commercial and R&D funding organisations and have commenced a process of explicitly seeking to broaden the sources of support for cotton research and development by building new external collaborations. The following list highlights the diversity of the Cotton CRC's collaborative activities

- In northern Australia the Cotton CRC has participated in public field days at Kununurra and Katherine where community groups were able to learn more about our research programs in those regions. This is part of strengthening our interactions with northern communities.

- We continue to play a key role in the development of management strategies for transgenic cottons (insect and herbicide tolerant) through collaborations with the Weeds CRC, Australian Universities (UNE, Queensland, Melbourne), US universities (Arkansas, Mississippi State, North Carolina, Arizona), USDA-ARS researchers in the southern USA and with regulatory agencies in Australia (OGTR, NRA) and the USA (EPA).

- We have advanced new collaborative projects in areas of Water Balance in the Northern Murray-Darling basin and the Greenhouse Effects in Agriculture. The former involves new commitments from CRDC, LWA and close interactions with MDBC and GRDC.

- We have further developed our focus on research at the interface of agricultural production and the natural environment. The CRC board includes an independent member representing environmental interests, while the Murray-Darling Basin Commission and Amateur Fisherman's Association Northern Territory are represented on our Advisory Committee.

- During the past year we have developed a comprehensive proposal to establish a new environmental program. This will allow us to conduct the research needed to support the industry to meet new challenges in the areas of vegetation management, on-farm biodiversity, and enhanced water use efficiency. The proposal brings new linkages to NSW DLWC, NT Dept of Infrastructure Planning and Environment, Greening Australia, two consulting companies (4T Consultants and A & A Williams), Cotton Australia and Arthur Yates and Co.

- Our research into environmental issues such as salinity and potential impacts of irrigation on riverine environments provide cooperative links to irrigator associations in the McIntyre, Gwydir, Namoi, and Macquarie regions.

- We have liaised closely with Catchment Management Boards in NSW and similar structures in Qld during development of their Catchment Plans. The Cotton CRC has the capacity to provide the research needed to deliver on some elements of the plans and ongoing interactions will be strengthened.

- We have sought to strengthen links to other CRC's relevant to our research portfolio. These include joint projects with the CRC for Tropical Plant Pathology, the CRC for Weed Management Systems; and most recently the CRC for Freshwater Ecology with which we are exploring joint opportunities for research on biodiversity in rivers and on-farm waters associated with cotton as well as participating in joint research on environmental flows.

- With irrigation and water use efficiency having a high profile we have successfully managing the "Cotton and Grains" of the Qld Rural Water Use Efficiency Initiative. This brings funding of $3 million over four years and close collaboration with the Qld Dept of Natural Resources, and with RWUE teams in the dairy, sugar and horticulture sectors in Qld.

- The Cotton CRC extension network plays a key role in facilitating the cooperative approaches needed to implement Area-wide management approaches now being successfully implemented throughout the cotton industry. The national extension network also provides an interface for the CRC with the wider community.

- Our education program has maintained linkages to a range of educational institutions through the undergraduate unit in Cotton Production which is now available at UNE, University of Sydney, University of Queensland Gatton, University of Western Sydney and Orange Agricultural College. The course continues to attract great interest and has been the most popular undergradtae unit in Agriculture degrees at UNE and UQ Gatton.

- The CRC's extension team has very strong linkages with farming system extension programs in NSW Agriculture and DPIQ and has cooperated with Cotton Australia to spread the message of BMP (Best Management Practices), now being widely adopted across the industry.

- Our program on Cotton Textile Research has now developed close alliances with a number of international cotton processors seeking to identify their needs as well as how best Australian fibre can meet these needs. This process will feed back to producers and breeders.

International Linkages

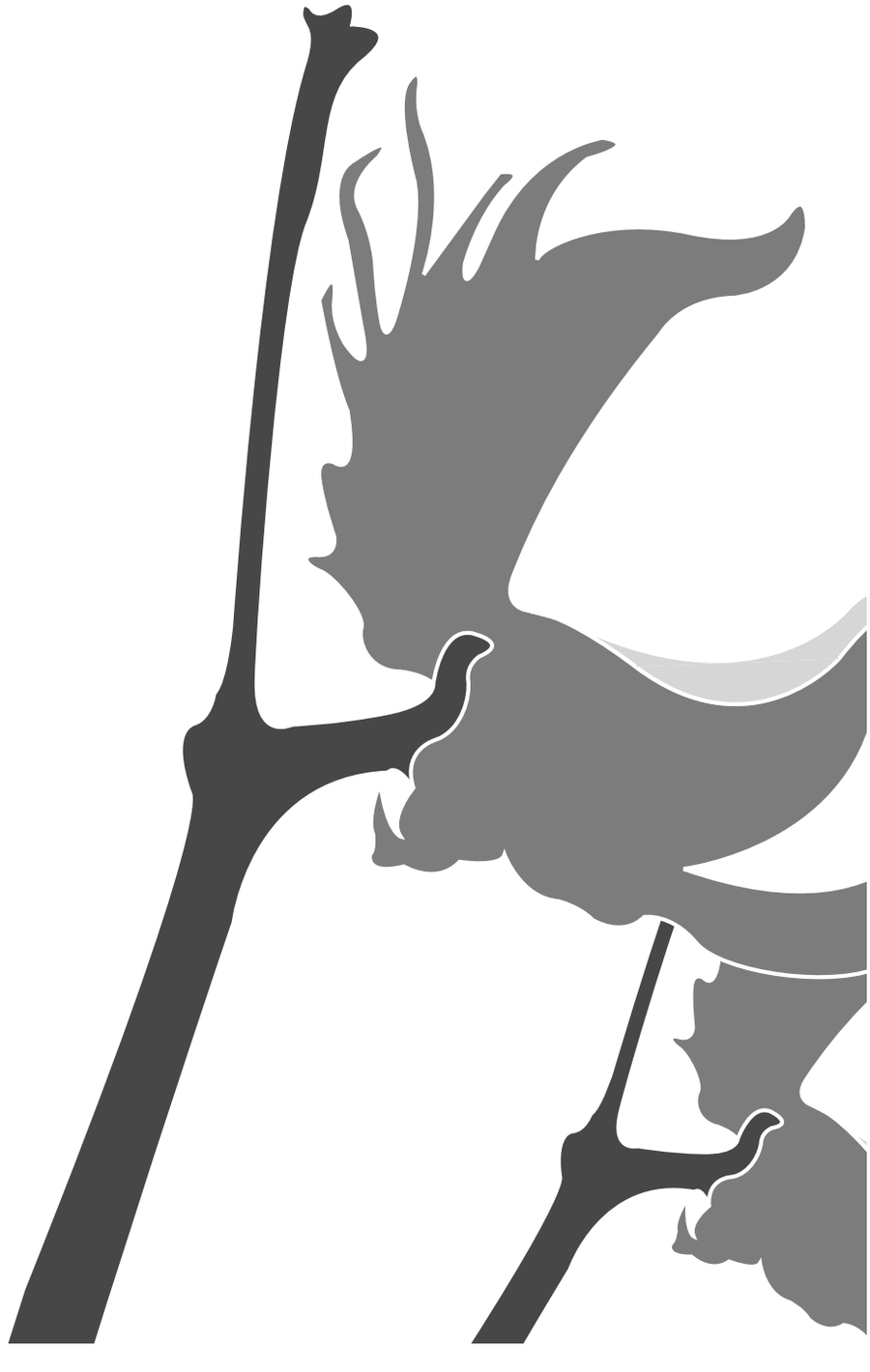
The CEO Dr. Gary Fitt is an executive member of an International Working Party established by the International Organisation of Biological Control (IOBC). The Working Party is focussed on the role of transgenic plants in integrated pest management and seeks to establish protocols to ensure GM plants provide benefits in many parts of the world. This provides the CRC with explicit links to research groups in Europe, USA, Asia and Africa.

Many other 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 2001/2002 This program supported visits by:

- **Professor S.E. Willams** Department of Renewable Resources, University of Wyoming to visit DBIRD Northern Territory.
- **Dr Nilantha Hulugalle (NSW Agriculture) -** 6th Symposium of the International Society on Root Research, Nagoya, Japan.
- **Dr Letitia Silberbauer (UNE) -** 1st International Symposium on Biological Control of Arthropods, Hawaii.
- **Dr Stephen Cattle (USYD) -** to visit Texas A&M University, USA for collaborative research.

During the year the CRC also hosted visits by:

- **Dr Yu Xiubo -** Chinese Ecosystem Research Network, Beijing, China July 2001.
- **Dr Guy Poppy -** McMaster Fellow, School of Biological Sciences, University of Southampton U.K., September 2001.
- **Fernando Gonzalez -** Agrometodos SA, October 2001.
- **Dr Tanja Schuler -** Plant and Invertebrate Ecology Division IACR-Rothamsted U.K., November 2001 Seminar "Effects of insect-resistant transgenic plants on arthropod natural enemies".
- **Prof. Anthony Shelton -** Cornell University, New York USA. January 2002. Seminar "Controversies in Agriculture: From Louis Pasteur to Bt Plants".
- **Dr John Westbrook -** USDA - ARS, SPARC, Areawide Pest Management Research Unit, Texas, USA. February 2002.
- **Dr Doug Landis -** Michigan State University, USA, February 2002. Seminar "Designing Landscapes for Enchanced Dispersal and Impact of Insect Natural Enemies".
- **Dr Patrick Colyer -** Red River Research Station Bossier City L.A. USA, February 2002, "A Review of Australian Fusarium Research"
- **Dr David Andow -** University of Minnesota, USA, June 2002. Seminar "Resistance evolution and parameter estimation".



Program One Overview

Growth In Northern Australia

Geoff Strickland and Dr Michael Bange – Program 1 Leaders.

INTRODUCTION

Opportunities exist for expansion of cotton production to new geographic regions where there are suitable soils and an assurance of water availability. Significant surface water resources are available from the Ord and Fitzroy rivers (WA); Katherine, Roper and Daly rivers (NT); and the Flinders, Gilbert and Einasleigh rivers (Qld). As well, major underground water reserves have been identified near Broome and Katherine.

Previous attempts at cotton production in the Ord River Irrigation Area during the 1970's ended in disaster due to uncontrollable insect populations. However, with greater understanding of pest ecology, a change to winter production systems, and the availability of new pest control strategies based on transgenic plants and other novel biological controls, it is appropriate to re-evaluate cotton production in northern areas. This does not mean simply transferring production practices for eastern Australia into northern regions due to the vastly different tropical environment and growing conditions.

The regions proposed for investigation in Western Australia (Broome and Kununurra); the Northern Territory (Katherine and Douglas/Daly areas) and north Queensland (various) provide significant opportunities to expand the industry. The potential area for new cotton could be as high as 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.

AIMS AND OBJECTIVES

The overall 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.

To pursue these objectives, eleven milestones have been established for the first four years of CRC operations.

HIGHLIGHTS AND ACHIEVEMENTS

Significant progress towards a number of milestones has been achieved. Importantly, the northern scoping study "Cotton Research & Development Issues in Northern Australia: a review and scoping study" by Stephen Yeates was published in August, 2001. The significant CRC document has been widely distributed and is an important resource for targeting future research projects.

Human resources in northern Australia were boosted during the year with the appointment of Andrew Dougall as cotton agronomist at Katherine. Andrew joins other recent appointees, Dr Brian Duggan (Kununurra - agronomy), Dr Andrew Ward (Katherine-pest management), Terry Woodger (Richmond-pest management) and Andrew Davies (Kununurra-Trichogramma PhD). The CRC has been fortunate to recruit high calibre staff to these important positions to complement existing staff in these areas and create an important "critical mass" in the northern regions.

SEVERAL PROJECTS THAT HAVE BEEN APPROVED TO COMMENCE:

1. Project: 1.2.01 AC 'Integrated pest management systems for sustainable transgenic cotton production in the west Kimberley' (Broome)

2. Project: 1.2.02 AC 'Cover crops and rotations for sustainable cotton cropping systems on light textured soils in NW Australia (Broome)'

3. Project: 1.3.01 AC 'Insect dynamics of the cotton ecosystem in the Northern Territory (Katherine)'

4. Project: 1.4.01 AC 'Pest management for transgenic cotton in far north Queensland'

5. Project: 1.4.02 AC 'Agronomy and farming systems for cotton production in northern Queensland' (Richmond)

Regrettably, the start of the two projects earmarked for Broome have been deferred due to the unavailability of land. Agronomic research planned for Richmond was also abandoned after a decision to terminate research at the previous site.

OTHER SIGNIFICANT HIGHLIGHTS ARE:

- A workshop involving all Cotton CRC researchers involved in activities relating to northern Australia was held in Darwin in December 2001. The workshop highlighted the two-way flow of benefits between northern and southern researchers. Some examples included testing CottonLOGIC on Palm Pilot, modelling temperature effects on crop growth and plant compensation to insect damage studies. Another important activity was to identify and discuss specific environmental issues for each of the regions not covered by present research activities. This was important to help the Cotton CRC identify what we were capable of contributing to, and knowing what activities need to be done by others.
- The workshop in Darwin was followed by a stakeholder review of cotton industry prospects in northern Australia. The review included Board members of the CRDC and the CRC as well as high level representatives from government agencies and agricultural organisations. The Northern Land Council and the Environment Centre (NT) also presented views to the review. Some positive outcomes from the meeting included strong support for cotton research by farmer organisations in the NT and WA, and progress towards the emerging cotton opportunity in Stage II of the Ord following the withdrawal of Wesfarmers from their proposed sugar monoculture project.
- Farmer participation in IPM trials at Kununurra involved 280 ha. of cotton plus various companion crops
- In conjunction with the NT government a "Strategic Plan for Cotton Research and Development in the Northern Territory" has been developed. This provided a blueprint for activities up toDecember 2005, in essence formalising the support for cotton research in the NT. A similar plan based on the NT model was developed for WA, whilst in Queensland a similar plan is being prepared for north Queensland.
- Results of our research on cotton crop development in northern Australia have been collated for analysis, with the aim to improve the cotton growth simulation model. The crop simulation model OZCOT will be used to explore and refine crop management options in these new regions.
- Dr Stan Bellgard hosted a visit by Professor Stephen Williams (University of Wyoming) on the subject of "Beneficial mycorrhiza associated with commercial cotton cultivars and native Hibiscus species in Katherine, Northern Territory". The work was supported by the Cotton CRC Scientific Exchange Program 2001.
- Meetings with environmental and community groups in Broome, Darwin and Richmond have been held to clarify their concerns about prospects for cotton growing. This feedback has helped sharpen our research efforts.
- Completion of a summer scholarship by the University of Queensland student Kerrie Gorman titled 'An analysis of soil systems, focusing on salinity and sodicity development, under irrigated cotton farming in the Richmond region'.
- Preparation of a draft report by Rowena Eastick (CSIRO/DBIRD) on "Potential weediness of transgenic cotton in northern Australia". This will contribute to the regulatory evaluation of future transgenic cotton varieties.
- Initiation of a north Queensland 5-year strategic plan by the office of state development, an outcome of the workshop held in Darwin. Initial stakeholder meetings have been held.

LINKAGES AND COLLABORATION

Linkages between the CRC research providers and the CRDC are very strong. In particular, the CRDC funds projects of direct relevance to the northern areas and there are linkages with several projects funded in the south. These include:

AWA2C	Defining an integrated pest management (IPM) system for INGARD® cotton in north-western Australia.
UQ28C	Ecology of Trichogramma egg parasites in the Ord River Irrigation Area and their role in cotton IPM.
CSP95C	Development of agronomic management options for dry season cotton production in north western Australia.
DPIF2C	Investigation of Cotton growing at different sites under different farming systems in the Northern Territory.

Other research activities that are integrated with projects funded by the Cotton CRC or CRDC include:

CSE90C	Ecological studies of Helicoverpa populations related to the successful implementation of IPM systems based on Bt transgenic cottons.
DAN139C	Pesticide resistance in cotton aphid and twospotted mite.
DAN118C	Resistance management in Australian cotton: conventional insecticides and transgenic cottons.
CSP96C	Breeding improved cotton varieties.
CSP124C	Predicting and enhancing cotton compensation following pest damage.
CSP125C	Continued development and field evaluation of micro-computer cotton management packages.

CSP140C The impact of temperature extremes on cotton performance.

PR-89X(2) Ecological assessment in northern Australia of transgenic cotton expressing the CryIA(c) and CryIIA delta-endotoxins from Bacillus thuringiensis

Dr Brian Duggan and a local grower in a crop of dwarf pearl millet, one of the crops being assessed as a wet season cover crop, and in a crop of cotton.

Project Summaries

PROJECT NUMBER: 1.1.01 AC

Project Title: Viable and environmentally responsible cotton production systems for northern Australia: Scoping Studies and Research Liaison/Coordination Officer.

STAFF

Mr Stephen Yeates, CSIRO Plant Industry, Darwin, NT.

Mr Stephen Yeates, Northern Coordinator for the CRC.

PROJECT AIMS

The project aims to 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:

1. Publishing a northern Scoping Study and with core partners of the Cotton CRC commencing the implementation process.

2. Maintaining effective communication with all appropriate government and industry bodies, on matters relating to commercial development of cotton production in northern Australia.

3. Ensuring a coordinated and high quality research effort by CRC collaborators accross northern Australia.

OUTCOMES

The Northern Scoping Study was published in August 2001 and distributed to stakeholders and interested parties. A key action has been to develop 5-year R and D plans for the Kimberley, NT and North Queensland that outline all the issues which must be addressed and identifies the most relevant bodies to address them. The 5 year plans incorporate a commitment to research beyond cotton production, e.g. land and water resources and environmental impact.

Communication has been established and maintained with relevant research and other bodies in northern Australia, with regular reporting to the CEO and northern Committee of the Cotton CRC.

There has been coordination of specific research activities across Northern Australia (e.g. studies into compensation from insect damage).

The project has been active in the review and planning of all CRC projects in northern Australia. Through a major northern review in December 2001 and the annual research meeting.

PROJECT NUMBER: 1.3.01 AC

Project Title: Insect dynamics of the cotton ecosystem in the Northern Territory

STAFF

Dr Andrew Ward, DBIRD, Katherine, NT
Ms Keera Shrimp, DBIRD, Katherine, NT
Ms Megan Connolly, DBIRD, Katherine, NT

COLLABORATORS

Dr Robin Gunning NSW Agriculture, Tamworth NSW.
Dr Ho Dang NSW Agriculture, Narrabri NSW.

AIMS

The primary objective of this project is to examine the insect dynamics of the cotton ecosystem in the Northern Territory.

Research was undertaken during the 2001 cotton growing season examining a number of areas including:

- monitoring of the key lepidopterous pests using pheromone traps;
- assessment of the baseline resistance level of *H. armigera* to Bt;
- assessment of resistance levels to *H. armigera* to conventional insecticides;
- monitoring the impact of beneficial insects in cotton grown under trickle irrigation as well as an overhead LEPA irrigation system.

OUTCOMES

Pheromone trap catches indicated that more than 98% of the *Helicoverpa* moths caught were *H. armigera*. This was supported with very high levels of *H. armigera* (>97%) in lepton tests conducted throughout the season. *Spodoptera litura* and Pectinophora gossypiella were also trapped. However, unlike *H. armigera*, which were present throughout the year, these two species were mainly caught in the wet season.

Baseline susceptibilities of *H. armigera* to BT were found to be similar to other areas whilst resistance to conventional chemistry was also observed. The only data available suggests that there is 100% resistance to fenvalerate (RF = 30), 43% resistance to fenvalerate/pbo, 42% resistance to bifenthrin, 83% resistance to thiodicarb (13% homozygote), 11% resistance to spinosad and 14% resistance to profenofos. There was no resistance recorded to chlorpyrifos.

A range of beneficial insects has been observed in the cotton growing in the Northern Territory. One of the most significant appears to be the egg parasitoid Trichogramma with early season parasitism being more than 70%. Other beneficial insects identified have been Microplitis, tachinid wasps, spiders and predatory bugs.

Preliminary investigations were undertaken to examine trap crops suitable for use in the Northern Territory. Of the crops examined it appears that Lab Lab and pigeon pea may have a good fit in IPM programs because they are attractive to a range of sucking insects as well as *Helicoverpa*. They also appear to be attractive to a range of beneficial insects.

A number of activities were undertaken to extend the research being undertaken in this project. These included participation in an information day for growers, legislators and researchers, as well as the preparation and publication of an article in the Cotton Grower magazine. Similar extension activities are ongoing.

Kenaf: A novel trap crop being examined in Katherine.

PROJECT NUMBER: 1.4.01 AC

Project Title: Pest Management for transgenic cotton in far north Queensland

STAFF

Dr Richard Sequeira, QDPI, Emerald QLD
Terry Woodger, QDPI Emerald QLD

AIMS

The objectives of the project were firstly to identify the population dynamics of *Helicoverpa* and other potentially key pest species such as mirids and other sucking bugs on native and feral host plants, without the presence of cultivated crops.

Secondly, to identify the native and introduced plant species utilised by pests within the Richmond district and to determine the dominant plant species preferred by *Helicoverpa*.

An understanding of the environmental impact of cotton on northern Australia's ecosystems is of vital importance to determine if development of a cotton industry into the future is viable. The assessment of the natural habitat in which *Helicoverpa* is found will be paramount for understanding the likely impact of cotton and for development of sustainable and 'green' pest management solutions.

OUTCOMES

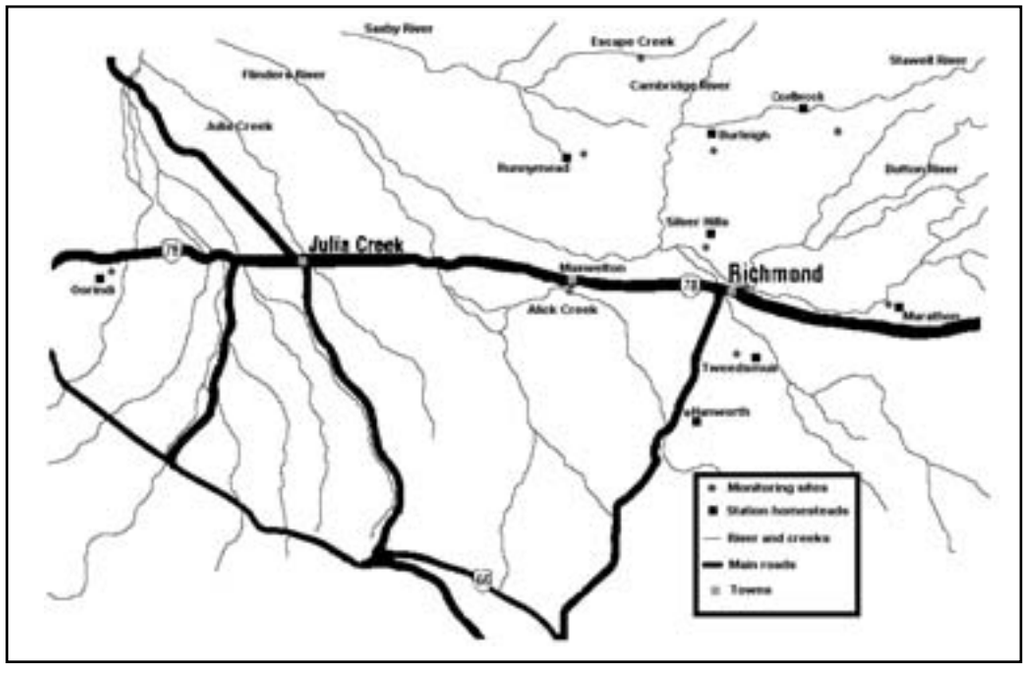
Due to the poor wet season in the Richmond district sampling of *Helicoverpa* on the study sites was not possible as there was little plant growth.

D-vac sampling was carried out to see what insect species were present under the drier than normal conditions in all three vegetation systems being investigated.

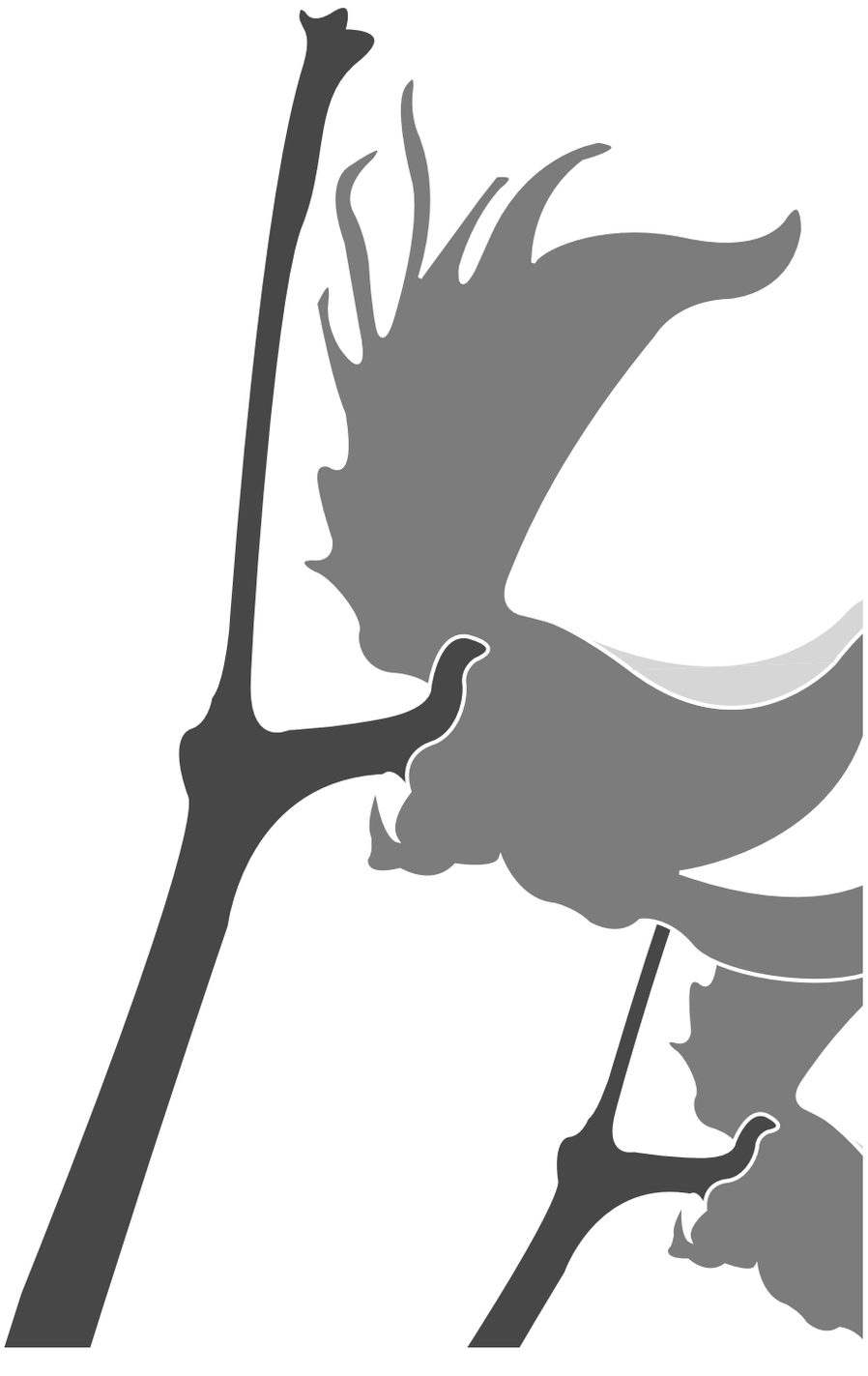
Terry Woodger with D-Vac sampler at Tweedsmuir Station, Richmond, western Qld.

The results of the D-Vac sampling showed that the flood plains of the Flinders River had a higher concentration of insect species than the Open Mitchell Grass Plains or the Open Dry-land Forest to the North of Richmond.

The sampling also showed high concentrations of Phoridae (flies) in the Flinders River flood plains. A closer look at last year's data from Richmond's cotton trials alludes to this species of fly having had a significant impact on *Helicoverpa*. Further investigations are required to establish if this species is of economic importance for the future development of the cotton industry in northern Australia.



Monitoring sites around the Richmond district.



Program Two

Innovative Technologies

Dr Stephen Allen and Associate Professor Peter Gregg - Program 2 Leaders.

INTRODUCTION

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

There have been seven Cotton CRC funded projects and 17 CRDC projects addressing the aims and objectives of the 'Innovative Technologies' program. Seven postgraduate students are associated with these projects (See below).

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.

HIGHLIGHTS AND ACHIEVEMENTS

**Evaluation and Management of Transgenic Cotton.*

The previous seasons experiments were repeated and results again demonstrated the high and consistent efficacy of Cry IAc/Cry 2Ab combinations and of Cry 2Ab alone. The presence or absence of the Roundup Ready gene had no impact on efficacy. There was no clear evidence that waterlogging had an influence on the Bt protein. Further work is needed on the impact of plant damage on efficacy and Bt protein concentration.

** Semiochemical Approaches to Control Helicoverpa spp.*
For the first time, attract-and-kill formulations containing plant volatiles and insecticides were tested in open field conditions, on corn and beans in the Bowen district. Large numbers of *Helicoverpa armigera* moths were killed, in relation to the relatively low population density, and the unexpectedly long persistence of the formulations was very encouraging. A full patent application has been submitted, including Patent Cooperation Treaty applications for overseas countries. Negotiations with potential commercial partners are proceeding.

** Managing Helicoverpa spp. on cotton with Semio–(signalling)–chemicals*
This project commenced only this year. Two Professional Officers have been appointed, one (Dr. Ho Dang) at ACRI and the other, Ertong Wang, at QDPI. Preliminary studies have identified oviposition preferences for *Helicoverpa* spp. on cotton and a number of other crops have been established. A plant which has oviposition deterrent and direct toxic effects has been identified, and analysis of its chemical compositon using HPLC techniques is in progress.

** Pheromones for occasional pests of cotton.*
This project began in January 2002. It is conducted by a PhD student, Samuel Lowor, and aims to identify the pheromones of a number of occasional pests of cotton, including common cutworms and rough bollworms, to provide methods for monitoring these pests. Cultures of these pests have been established in the laboratory, and preliminary analyses of the pheromone components of cutworms have been conducted using GC-MS techniques.

** Crop management protocols for the on–farm production and utilisation of viral insecticides in cotton*
Two experimental sites were established in pigeonpea-cotton intercrops. At each site, larval numbers were assessed and a commercial formulation of NPV applied by ground application to the pigeonpea component only at the recommended field rate ('Gemstar' at Lowana and 'Vivus' at the ACRI). Soil, foliage, and ground/canopy insects were recovered before and after application for laboratory analysis to quantify NPV production and movement.

** Molecular Diagnosis of Fusarium Wilt of Cotton.*
A protocol has been developed that allows efficient and sensitive PCR amplification of pathogen DNA from plant material, water and seed. Several soil DNA extraction methods are being compared and evaluated in conjunction with direct pathogen isolation in order to determine the most suitable protocol for detecting the pathogen in soil.

**Bioremediation Enzyme for Endosulfan Sulphate.*
A bacterium with endosulfan sulfate degrading activities has been identified. Researchers have characterised the enzymes involved in endosulfan sulfate degradation from this organism and have begun initial attempts at cloning the genes involved..

POST GRADUATE STUDENTS ASSOCIATED WITH CRC PROGRAM 2 PROJECTS.

STUDENT	TOPIC
Lisa Gulino	Molecular diagnosis of Fusarium wilt of cotton
Samuel Lowor	Pheromones for occasional pests of cotton
Erica Crone	Characterisation of a potential new insecticidal transgene
Michael Zuckerman	Protease resistant insecticidal proteins for controlling Helicoverpa species
Andrew Davies	Ecology of the Trichogramma egg parasites in the Ord River irrigation area and their role in cotton IPM
Mark Wade	Biology, ecology and utilisation of the Damsel bug as a predator in cotton
David Britton	Studies of slow-release formulations for semiochemicals in cotton pest management

ASSOCIATED CRDC FUNDED PROJECTS THAT CONTRIBUTE TO THE PROGRAM 2 OBJECTIVES

CSE 82C	Characterisation of a potential new insecticidal transgene
CSE 84C	Insect pest resistance and the role of induced responses to damage in Australian cottons
CSE 88 C	Protease resistant insecticidal proteins for controlling *Helicoverpa* species
CSP 102C	Isolation of novel cotton promoters to drive the robust expression of useful genes in transgenic cotton
CSP 113C	Australian native cottons as sources of resistance and new pathotypes of Fusarium wilt
CSP 114C	Discovery of genes involved in the expression of cotton resistance responses to Fusarium wilt by the application of microarray technology
CSP 115C	Targeted expression of genes for the manipulation of systemic acquired resistance responses of cotton for improved tolerance to fungal pathogens
DAN 151C	Conservation and utilisation of beneficial insects and other biological control agents for IPM in cotton II
DAN 153C	Managing black root rot of cotton
DAN 154C	Disease of Cotton (VII)
DAQ 105C	Improved application and formulation of viral biopesticides against *Helicoverpa*
DAQ 107C	Ecology and development of management strategies for Fusarium wilt of cotton
DAQ 111C	New biopesticides against emerging sucking pests
DAQ 116C	Assessment for the potential of resistance to Gemstar
MU 1C	Transgenic cotton for the control of Fusarium wilt
UQ 26C	Ecology of the Trichogramma egg parasites in the Ord River irrigation area and their role in cotton IPM
UQ 29C	Biology, ecology and utilisation of the Damsel bug as a predator in cotton

LINKAGES

**Evaluation and Management of Transgenic Cotton.*
Monsanto, CSIRO Plant Breeders (Dr Greg Constable, Mr Peter Reid) Cotton Seed Distributors Ltd., CRC for Weed Management Systems (Prof. Rick Roush), University of Melbourne (Dr David Heckel), Queensland Department of Primary Industries (Dr Richard Sequeira, Dr David Murray).
** Semiochemical Approaches to Control Helicoverpa spp.*
IPM Technologies Inc, USA, Bioglobal Ltd.

** Managing Helicoverpa spp. on cotton with Semio–(signalling)–chemicals*
CSIRO Narrabri (Dr. Greg Constable)

** Crop management protocols for the on–farm production and utilisation of viral insecticides in cotton*
CSIRO Narrabri (Martin Dillon)

** Molecular Diagnosis of Fusarium Wilt of Cotton In Australia*
Queensland Department of Primary Industries (Dr Joe Kochman), CRC for Tropical Plant Protection (Dr Suzy Bently), Cotton Seed Distributors Ltd. (Dr Stephen Allen), SARDI (Dr Kathy Ophel-Keller, Dr Alan Mackay), C-Qentec (Felice Driver)

**Bioremediation Enzyme for Endosulfan Sulphate*
Orica Ltd. and HRDC (Dr Irene Horne), University of Nebraska (Prof. Anthony Zera)

Project Summaries

PROJECT NUMBER: 2.1.01 AC

Project Title: Efficacy and field performance of new transgenic cottons

STAFF

Dr Gary Fitt, CSIRO Entomology, Narrabri, NSW
Dr Geoff Baker, CSIRO Entomology, Canberra, ACT
Ms C.L Mares, CSIRO Entomology, Narrabri, NSW
Dr R Mahon, CSIRO Entomology, Canberra, ACT
Ms K. Olsen, CSIRO Entomology, Canberra, ACT.

AIMS

Transgenic cotton varieties expressing the Cry Bt genes (CryIAc and Cry2Ab) from *Bacillus thuringiensis* offer considerable benefits for the sustainability of pest management systems for the cotton industry.

Our main focus in this project is to provide the detailed understanding of field performance of Bt cottons needed to manage them most effectively from a resistance point of view and gain the greatest benefit for pest management.

As a major part of the work we have sought to characterise the many factors which influence the field efficacy of Bt cotton varieties. INGARD varieties expressing only the CryIAc protein have been used commercially for some 6 seasons now. Most research now focusses on the two gene combinations with the addition of the Cry2Ab gene.

OUTCOMES

During the 2001/2002 we have continued field research at Narrabri and laboratory based work in controlled environments in Canberra. We conducted field evaluations of five varieties expressing the CryIAc and Cry2Ab genes from *Bacillus thuringiensis* (Sicala V3, Sicot 40, Sicot 289 and Siokra V16). One variety, Sicala V2, was available with only Cry2Ab allowing us to assess the influence of this gene alone, while a wide range of varieties expressing Cry IAc were included.

Results using laboratory bioassay of node 4 leaves confirmed results from last season, showing high and consistent efficacy of CryIAc/Cry2Ab combinations and of Cry2Ab alone. The combination of the Roundup Ready gene with either of the Cry genes had no influence on efficacy.

The two-gene combination showed bioassay survival of 10% or less throughout the growing season. We have shown previously that such efficacy would result in no survival under field conditions. As shown previously, the CryIAc plants showed decreasing efficacy up to about 95 days after sowing. Extremely high efficacy of the two-gene plants occurred in tissues from nodes 2 to 7 from the top of the plant.

The influence of factors such as waterlooging and plant damage on efficacy and Bt protein concentration were also continued. In the case of waterlogging we can find no clear evidence of an influence on Bt protein, while for plant damage the evidence is conflicting as yet and further work is needed.

While our results overall indicate that the consistent high efficacy of two-gene cottons will have even greater impact in reducing reliance on pesticides, they are very significant in showing that most of the performance of 2 gene plants relies on the Cry2Ab protein which appearsto be more consistently produced in plants over their growth cycle.

This indicates that ongoing vigilance will be required in resistance management, as we clearly do not have a season-long two-gene strategy that would be optimal for long-term delay of Bt resistance. Nonetheless, the two gene plants have considerably less resistance risk than that relying on one gene (CryIAc).

Greenhouse experiments at ACRI Narrabri.

PROJECT NUMBER: 2.2.01 AC

Project Title: Crop management protocols for the on-farm production and optimal use of viral insecticides in cotton

STAFF

Dr Andy Richards, CSIRO Entomology, Canberra, ACT.
Ms Janelle Scown, CSIRO Entomology, Canberra, ACT.

AIMS

This project is investigating the feasibility of applying a new technique in insect pest management. The technique is based on the "in-field" production of a naturally occurring insect virus ('NPV') in late season Helicoverpa trap crops and relies on the strategic application of commercial NPV formulations (e.g. 'Gemstar', 'Vivus') to seed the large-scale amplification of NPV in infected host larvae. The technique then utilises resident populations of insect predators to disseminate field-generated virus into adjacent cotton crops for improved Helicoverpa control.

OUTCOMES

This year is the second and final year of this project. Field and laboratory studies in the first year showed that while it was possible to amplify NPV in late season pigeon pea, detailed tests showed that predatory earwig species (originally considered to good candidates for disseminating virus) were quite unsuited to this role.

The majority of other 'beneficials' including, for example, ladybeetles, spiders, sucking bugs and lacewings, were considered as being unlikely to possess the necessary attributes of abundance, mobility, and larval feeding behaviour, to spread virus effectively - at least on an individual species basis. The possibility remained, however, that in combination cotton 'beneficials' may provide sufficient utility and it was determined that this should be evaluated. To this end, the key objective this year was to determine the extent of virus spread into a cotton crop. Experimental sites were established in pigeonpea-cotton intercrops at 'Lowana' (a commercial cotton farm in northern NSW) and on a dedicated experimental plot at the Australian Cotton Research Institute (ACRI).

At each site, larval numbers were assessed and a commercial formulation of NPV applied by ground application to the pigeon pea component only at the recommended field rate ('Gemstar' at Lowana and 'Vivus' at the ACRI). Soil, foliage, and ground/canopy insects were recovered before and after application for laboratory analysis to quantify NPV production and movement.

A regional scarcity of *Helicoverpa* in northern NSW late season meant that the Lowana experiment was discontinued. The application of 'Vivus' at the ACRI site, however, did coincide with a very late season influx of *Helicoverpa* in mid-April. The final samples were recovered from the field in mid May. At the time of writing, the majority of post-spray samples are in the process of being analysed and no conclusions can be drawn at this time other than confirmation that a virus amplification event had occurred within the pigeon pea. The full results and conclusions from this study will be presented in the final report.

PROJECT NUMBER: 2.2.03 AC

Project Title: Semiochemical approaches to control of *Helicoverpa* spp

STAFF

Dr Alice Del Socorro, UNE, Armidale, NSW
Associate Professor Peter Gregg, UNE, Armidale, NSW
Mr Richard Tennant, UNE, Armidale, NSW.
Mr Dan Alter, UNE, Armidale, NSW.
Dr Chris Moore, QDPI, Brisbane, QLD.

AIMS

To examine the role of attractant chemicals in the control of *Helicoverpa* –spp. The project is in its second year, and follows from a project of the previous CRC for Sustainable Cotton Production.

OUTCOMES

Our attractants have now reached the stage of commercial development. Our provisionary patent application expired in May 2002, and a full patent application is now in place. Negotiations with semiochemical companies have been initiated.

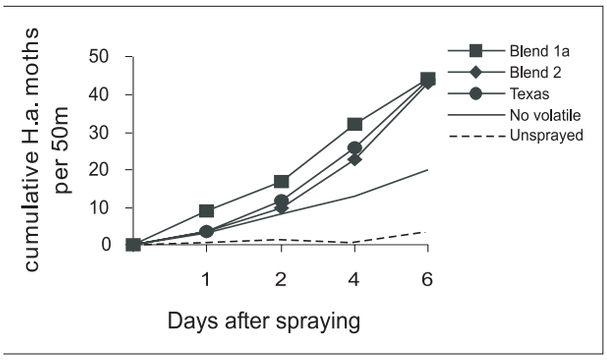
We conducted three open field trials in Bowen, Queensland, two in vegetative sweet corn and one in French beans. In all the trials, we included a previously published attractant blend (Texas blend) for comparison with our own blends, along with a formulation containing no attractant chemicals and an unsprayed section as control. The formulations were based on canola oil with the addition of feeding stimulant, thickener, emulsifying agent and antioxidants. All blends contained insecticide (0.5% methomyl).

During the first sweet corn trial, numbers of *H. armigera* killed ranged between 12 and 14 per 50m of treated row. In the second corn trial, the numbers of *H. armigera* ranged from 42 to 44. In beans, between 24 and 33 *H. armigera* were killed with the attractant treatments per 50 m of row. In all the trials, between 50 and 84% of the *H. armigera* killed were females.

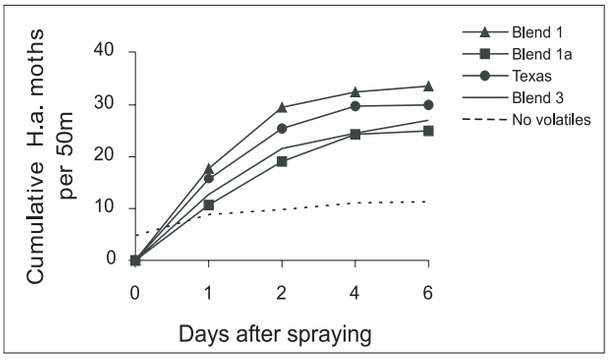
Other than *H. armigera*, other pests killed were Mythimna convecta (common armyworm), M. loreyimima (sugarcane armyworm), Spodoptera litura (cluster caterpillar) and Chrysodeixis spp. (false loopers). The effects of the attractant formulations persisted for up to 6 days.

We also continued field wind tunnel studies in the Darling Downs. We had 60-80% mortality when the weather was favourable (warm and moderately windy nights). Higher mortality was obtained with blends consisting of a combination of floral and leaf volatiles, confirming our olfactometer results that blend complexity is important. Methomyl (0.5%) was a better insecticide than carbaryl (1%). Feeding stimulants such as sugar and molasses were important to keep moths in the vicinity of the lures.

Sweet corn



French beans



Cumulative mean numbers of dead H. armigera moths per 50m sprayed with attract-and-kill formulations in open field trials, Bowen, Qld, April 2002.

Peter Gregg using a battery powered sprayer designed for application of Helicoverpa attractant formulations

Alice Del Socorro setting up a field wind tunnel for experiments on Helicoverpa attractants.

PROJECT NUMBER: 2.2.04 AC

Project Title: Bioremediation enzyme for endosulfan sulfate

STAFF

Dr John Oakeshott, CSIRO Entomology, Canberra ACT
Dr Robyn Russell, CSIRO Entomology, Canberra ACT

OTHER STAFF & COLLABORATORS:

Dr Irene Horne, CSIRO Entomology, Canberra, ACT
Prof Anthony Zera, University of Nebraska, USA

AIM

This project is part of a larger project with several stakeholders. The goal is to develop enzymatic bioremediation technologies for the clean-up of problematic pesticide residues in irrigation drainage waters and on horticultural commodities.

Priority pesticides in the overall project include the organophosphate (OP), pyrethroid, carbamate and endosulfan insecticides and the thiocarbamate herbicides.

This particular project is concerned with the isolation and characterisation of enzyme(s) that will degrade endosulfan sulfate, the toxic breakdown product of insecticide, endosulfan.

OUTCOMES

We have identified a bacterium with endosulfan sulfate degrading activities and have characterised the enzymes involved in endosulfan sulfate degradation from this organism. We are now in the process of cloning the genes involved.

A provisional patent describing the endosulfan and endosulfan sulfate degrading enzyme systems was filed on 7 June 2002, and an oral presentation was made by Dr Irene Horne at the Second Year Review (Stage 1) of the Australian Cotton CRC, Narrabri, July 2001.

Research technician, Ms Kahli Weir, busy at her lab bench at CSIRO Entomology in Canberra. Kahli, with Dr Tara Sutherland, has isolated a bacterial strain that can degrade endosulfan sulfate, the toxic metabolite of the insecticide, endosulfan.

Preparation of the dilute enzyme solution for field trials of an organophosphate degrading enzyme near Narrabri during the summer of 2000/2001. Here Orica employee, Michael Selleck, mixes 8 litres of enzyme concentrate with 172 litres of a buffer solution. The 180 litres of dilute enzyme solution was subsequently used to treat 80,000L of irrigation run-off.

PROJECT NUMBER: 2.2.05 AC

Project Title: Molecular diagnosis of Fusarium wilt of cotton in Australia

STAFF

Dr Suzy Bentley, CRC for Tropical Plant Protection, Indooroopilly, QLD.
Ms Lisa Gulino, PhD Student, Cotton CRC/CRC for Tropical Plant Protection, Indooroopilly, QLD.
Dr Natalie Moore, QDPI, Indooroopilly, QLD.
Dr Joe Kockman, QDPI, Toowoomba
Mr Wayne O'Neill, QDPI, Indoorpilly, QLD.
Miss Julie Pattemore, CRC Tropical Plant Protection, Indoorpilly, QLD.
Dr Stephen Allen, Cotton Seed Distributors, Narrabri, NSW.

OTHER STAFF & COLLABORATORS

Linda Swan, QDPI, Toowoomba, QLD.
Anthony Mitchell, QDPI, Toowoomba, QLD.
Kathy Ophel-Keller, South Australian Research and Development Institute, Adelaide, SA.
Alen McKay South Australian Research and Development Institute, Adelaide, SA.
Felice Driver, C-Qentec.

AIM

To develop a DNA-based diagnostic system for the detection and identification of the two Australian genotypes of Fov.

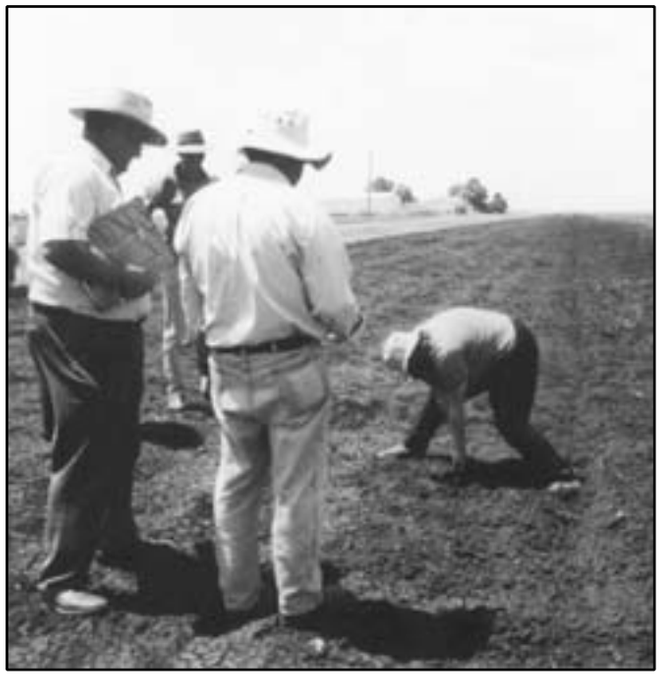
Since Fov was first recorded in Australia in 1993, it has been identified in several cotton growing regions of Queensland and New South Wales. Fusarium wilt is easily spread by the movement of contaminated soil attached to farm machinery, and irrigation water. The risk of establishment of Fov in new areas is also very high because the disease is seed transmissible and fungus has the ability to survive in plant debris and soil as chlamydospores for several decades.

Once a farm is infested with fusarium wilt there is no commercially viable way to eliminate the disease from the soil. The most effective way to control fusarium wilt is to select or breed cotton varieties with resistance to the disease. Other options for management rely on limiting the build-up of the disease through agronomic practices, like stubble management and crop rotation regimes.

OUTCOMES

The DNA diagnostic test being developed uses the polymerase chain reaction (PCR) to specifically detect DNA from each of the Australian genotypes of Fov in infected plant material, contaminated seed and infested soil. This test will be invaluable to the industry as early detection of fusarium wilt is critical for containment and control of the disease.

Cotton team taken at Cecil Plaine while addressing sampling issues for the diagnostic test, from L to R Julie Pattmore, Lisa Gulino, Suzy Bently (All CRCTPP) Richard Danial and Felice Driver (C-Qentec) Stephen Allen (CSD) and Joe Kochman (QDPI).



Joe Kochman, Stephen Alen and Lisa Gulino at Cecil Plains soil sampling for the Fov diagnostic test.

PROJECT NUMBER: 2.2.06 AC

Project Title: Managing *Helicoverpa* spp. On cotton with semio-(signalling)-chemicals

STAFF

Dr Chris Moore, QDPI, Brisbane, QLD
Dr Robert Mensah, NSW Agriculture, Narrabri, NSW.
Dr Ho. T. Dang, NSW Agriculture, Narrabri, NSW
Mr Ertong Wang, QDPI, brisbane, QLD.

AIM

Helicoverpa armigera remains the most important pest in Australian cotton and also the most resistant pest to different insecticide groups. Semio (signalling) chemicals that may impact on pest behaviour from refuge crops and cotton cultivars will be isolated and their effects as either oviposition repellent/ attractants or of feeding deterrent/stimulants will be tested. The promising candidate compound(s) will be extracted, purified and identified, then formulated for use as stand-alone products or together with others for IPM. The use of these chemicals might be as spray on cotton crop, in refuge or in combinations of effective methods.

OUTCOMES

During our preliminary screening, an unidentified plant species (referred to as Plant X) was found most effective in deterring oxi position by *Helicoverpa* spp. and causing very high mortality to larvae .

Initial study indicates that the toxin(s) are present in different plant parts with higher levels located in leaves. *H. punctigera* is most sensitive at second instar larval stage and 100 % mortality resulted in 48 hours.

The promising toxin(s) in plant X and other semio-chemicals in other refuge crops and cotton cultivars will be detected, isolated and tested in laboratory, glasshouse and field experiments in stages in the next phase of the project. Identification of the chemical structure of promising compounds will be undertaken.

PROJECT NUMBER: 2.2.07 AC

Project Title: Pheromones for occasional pests of cotton

STAFF

Mr. Samuel Lowor (Postgraduate Student)UNE, Armidale, NSW.
Dr. Peter Gregg UNE, Armidale, NSW
Dr. Alice Del Socorro UNE, Armidale, NSW.

OTHER STAFF & COLLABORATORS

Dr Chris Moore, QDPI, Brisbane, QLD.
Mr Dan Alter, UNE, Armidale, NSW
Mr. George Henderson, UNE, Armidale, NSW.

AIM

To investigate the development of Pheromone lures for sporadic or occasional cotton pest species such as cutworms and rough bollworms.

Pheromones for the key pests of cotton, *Helicoverpa armigera* and *H. punctigera*, have been available since the late 1970's. They have been widely used in research and for monitoring these pests. There is, however, very little information about pheromones of other cotton pests. This particularly applies to occasional pest species such as cutworms (*Agrotis* spp.).

It is currently difficult to forecast the abundance of these species. Considerable damage may occur before growers are aware of the problem. Other pests, such as the rough bollworms (*Earias* spp.), are likely to become more important with the expansion of the cotton industry to new areas, especially in northern Australia.

Pheromones have been identified for some species in this genus in south Asia and Africa, and successfully trialed in mating disruption studies. There is, however, no information on the

pheromones of the dominant Australian species, E. huegeliana. For these species the project will:

1. Identify the pheromone components produced by calling females, using GC-MS. This will be done by collecting effluvial air, passing it through absorbents such as Porapak or Super-Q, and extracting by solvents or thermal desorption. The contents of pheromone glands will be recovered by cutting the gland from calling females, followed by solvent extraction and GC-MS analysis.

2. Candidate pheromone blends will be formulated by mixing synthetic components in proportions indicated by the analyses, and impregnating them into rubber septa along with anti-oxidants. The resulting lures will be tested by flying male moths to them in a wind tunnel and compared to those obtained using live females, or whole pheromone gland extracts.

3. Blends which show potential in these studies will be tested in the field, at times and locations where the adult moths are likely to be present. We will use standard pheromone trap designs such as the canister trap, which is used for *Helicoverpa* spp. Light traps will be used for the noctuid moths, to verify the presence of the target species. Night vision glasses will be used to observe the behaviour of moths around the pheromone traps.

This project is conducted by an overseas PhD student whose stipend is paid by the University of New England. Funds for operating expenses are provided by the CRC.

OUTCOMES

Outcomes of the work will include pheromone lures for some important, but sporadic and occasional, pests of cotton. We anticipate being able to produce these lures at UNE in sufficient quantity and at reasonable cost for wider trials by growers and consultants at the end of the project.

Program Three Overview

Sustainable Farming Systems

Dr Lewis Wilson and Assoc/Professor Alex McBratney (Dr Inakwu Odeh standing in for Prof Alex McBratney) are the Program 3 Leaders.

INTRODUCTION

The sustainability of cotton production depends on the development of strategies that encourage efficient use of resources, minimise inputs and impact on the environment yet remain profitable. Key issues facing the industry include water use efficiency, management of pests, weeds and diseases, soil management, salinity risks and off farm movement of inputs.

Program 3 is addressing these key issues, through a coordinated portfolio of research covering production and natural resource management. Many of the projects reflect new approaches to problems or opportunities and represent effective collaboration with a range of funding bodies and agencies.

While a considerable portion of the program maintains a discipline focus, emphasis is placed on a farming systems approach, where project outcomes are integrated into the broader cotton agro-ecosystem to enhance both sustainability and profitability.

Program 3 consists of two sub-programs, reflecting our aim to address issues at the production system and environmental levels.

Subprogram 3.1 "Minimising Inputs", seeks improvements to the production system by optimising the use of pesticides, fertilizers and water and reducing the opportunity of off-farm movement. Issues such as integrated pest management (IPM) including insect, weed and disease management systems, crop nutritional management, soil health and water use are emphasised.

Subprogram 3.2 "Minimising Environmental Impact" targets the interaction between cotton production and the environment, and includes projects on: artificial wetlands for bioremediation of irrigation tailwater and biodiversity values; determining the nature and value of ecosystems services on which the cotton production depends; salinity risk assessment for cotton production regions; and research to better understand deep drainage and its consequences at local and catchment scale.

HIGHLIGHTS AND ACHIEVEMENTS

The achievements of Program 3 are founded on a broad body of research projects supported by CRDC and participant organisations that serve as in-kind contributions to the Cotton CRC.

These include key research into insecticide and herbicide resistance and management, both for pesticides and transgenics, development of components of IPM, such as pest thresholds, pest ecology, use of trap crops, a range of disease management projects, application and development of cotton simulation models and a number of water use efficiency related projects.

Cotton CRC funded projects seek to add value to these projects or fill science gaps, aiming to ensure a comprehensive research portfolio developed around the theme of Sustainable Farming Systems.

Sub–program 3.1 "Minimizing Inputs"

The management of pests remains a high priority. This is highlighted by the development of WEEDpak, a comprehensive information source for weed management which synthesises years of research into weed management, biology and ecology into a core document.

The concept of Integrated Weed Management is emphasised throughout to reinforce the message that it is important that all weeds are being effectively managed by at least one tactic to reduce the build up of a seedbank in the soil. Topics include weed identification and biology, management strategies, difficult weeds and incorporation of herbicide-tolerant transgenics.

WEEDpak reflects the CRC focus on collaborative outcomes with considerable input from Graham Charles and Dr Ian Taylor (NSW Agriculture), Dr Stephen Johnson (UNE) and Grant Roberts (CSIRO), plus contributions from several other research, extension and industry personnel. In recognition of their efforts the WEEDpak team received the 2002 Cotton CRC award for Collaboration. WEEDpak is planned for launch at the Australian Cotton Conference in August, 2002.

IPM has had a dramatic uptake over the past four years, and the Cotton CRC has made a significant contribution to this success through its National Cotton Extension Network which has maintained a focussed extension effort; through publication of the "Guidelines for Integrated Pest Management on Australian Cotton"; and by our economic analysis showing higher gross margins for IPM versus more traditional pesticide approaches.

The significance of these economic analyses, specifically the development of the 'Beneficial Disruption Index', was acknowledged when the researchers involved; Martin Dillon (CSIRO), Ziaul Hoque (NSW Ag.), Bob Farquharson (NSW Ag.) and Greg Kauter (CSD), received the 2002 Cotton CRC Award for Innovation.

The IPM Guidelines include a strong element on the provision and management of beneficial insects and spiders that contribute to pest control and form the cornerstone of our IPM systems. Several research projects are aiming to better understand where beneficial populations originate and the movement between cotton and 'natural' components of the landscape.

Fundamental also is understanding of the value of different predator groups in controlling pests, especially Helicoverpa spp. New research is seeking to quantify and compare the 'efficacy' of different predators and for the first time to consider formally the role of spiders, a previously overlooked group, in reducing pest abundance.

The development of cotton production in new regions of southern NSW (eg. Lachlan Valley) has increased demand for research into IPM there as well. As a result the Cotton CRC has established a research and extension team at Griffith in collaboration with the Grains R&D Corporation and the CRDC.

A research entomologist now works across both the cotton and grains industries and an IDO is in place to help implement sustainable IPM and farming systems. This team is contributing to improvements in the IPM system through research on trap crops, the role of weeds as pest hosts, and the development of Area Wide Management Groups in both the Hillston and Condobolin regions.

The 2001-02 cotton season also saw the first outbreaks of silver leaf whitefly (Bemisia tabaci B-biotype) on cotton. This occurred in the Emerald region of Queensland, as predicted by earlier risk analyses undertaken by Dr Paul De Barro (CSIRO).

This CRDC funded study and a series of Cotton CRC extension publications meant that grower awareness of the pest was already high. Collaboration across CRC organisations allowed a rapid assessment of the problem, and rapid implementation of key research and development strategies for the following season. David Kelly (QDPI), the CRC Industry Development Officer at Emerald, played a key role in co-ordinating the research response and providing growers with information and strategies to deal with the outbreak situation.

Cotton is currently threatened by a number of diseases, including the devastating Fusarium Wilt, but also a number of other economically significant diseases such as Black Root Rot and Verticillium Wilt. Management of these diseases remains a high priority, with emphasis on monitoring and preventing their spread, screening for varietal resistance, understanding disease ecology, including the role of weed species as alternative hosts, and the development of molecular techniques to diagnose the presence of disease.

Our efforts with Fusarium research and management is Highlighted earlier in this report. In particular the Cotton CRC pathology team has now produced Integrated Disease Management Guidelines to assist growers with the task of strategic management of disease threats. The IDM Guidelines are also proposed for launch in August 2002 at the Australian Cotton Conference.

Recognising the need for healthy, functioning soil, the Cotton CRC now 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.

Increasingly, models are being used to combine a range of soil properties and understand and predict salinisation, deep drainage, acidification and carbon dynamics. Another key objective is to bring together the large body of available soil information and to begin to use it to improve the soil / water balance models. These can be linked with weather information

and crop simulation models to allow more detailed questions to be asked about the impact of management practices on soils and plant growth.

One new project in the soil health area involves collaboration with 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 block root rot. The project will utilise study sites thought to be conducive or suppressive to black root rot and investigate the role of soil biology in these differences.

Farming systems research remains a recurrent theme with projects on

- the interactions between tillage and rotation crops with soil properties, root development, organic carbon and nutrient leaching and recovery
- factors contributing to crop earliness, seeking to better understand the relative contribution of variety, nutrient management, water use and pest management and the tradeoffs between them
- investigation of stubble retention systems to reduce erosion and their possible link with reduced pest levels
- development of legume based rotations to supply organic N, reducing the need for fertilizers, and the effects of these rotations on soil structure
- the effects of cotton defoliants on farm trees.

Unfortunately only one long-term Farming Systems experiment remains in operation (Warra QLd – dryland systems). The systems experiments outlined above now seem a more tractable way to address such questions.

Sub–program 3.2 "Minimizing Environmental Impacts"

Reductions in the use of pesticides is contributing to reduced pesticide loads on the environment but there is still a need to deal with some residues in tailwater to enable multiple use of water on farm.

An innovative project is now well established to investigate the potential for 'on-farm' bioremediation of irrigation tailwater using a linked system of artificial wetlands and microbial degradation chambers.. A pilot system has been established on a farm near Narrabri and is being evaluated as part of a Phd study. Artificial wetlands also offer possibilities for enhancing on-farm biodiversity.

There are strong links between the CRC's soils research and wider environmental consequences of water use. These include questions of salinity and deep drainage.

With significant support from the Natural Heritage Trust we have developed and applied techniques for mapping soils with potential salinity risks, both at a field and regional level, using electromagnetic sensing systems.

Quantifying salinity risks in the cotton industry remains a high priority although the major outcome of our work to date is to highlight that irrigation induced salinity is a very minor issue in the production regions of the northern Murray-Darling basin. Irrigated cotton production is more threatened by declining water quality of our rivers linked to dryland salinity.

To address the processes underlying Water Balance on cracking clay soils of the northern Murray-Darling basin, we have initiated broad collaboration among research and funding agencies to directly measure the components of water balance: drainage, evapotranspiration and runoff and identify priorities for associated research and develop strategies to avoid unwanted environmental change.

This project directly addresses issues of the functioning of water in the wider environment and our outcomes will directly support the catchment planning process which is well advanced in cotton regions.

Cotton is dependent on a range of 'ecosystem services' that are the natural processes, which result in the provision of clean water, productive soils, beneficial insects and pollination. A major collaborative project is seeking to determine the nature and value of ecosystem services supporting cotton production in the Gwydir valley. The project is coordinated by University of New England and linked with the national CSIRO and Myer Foundation project that is currently investigating ecosystem services in other agricultural systems.

With support from a range agencies including the Natural Heritage Trust, NSW Department of Land and Water Conservation, the Cotton Research and Development Corporation and the Gwydir Valley Irrigators Association, the project represents a tremendous opportunity for the Cotton CRC to interface with the community and to better understand the complex environmental and economic factors which underpin productive agriculture.

LINKAGES

Program 3 maintains numerous linkages with industry, other research organizations and community groups. Strong links remain between the key research providers and the industry core partners via a wide range of formal and informal fora. Other linkages contribute funding or coordination to other components of Program 3, including;

- National Heritage Trust contributing funding towards research on salinity risk, bioremediation through artificial wetlands and "ecosystem services".
- Links with the CRC for Tropical Plant Protection in Fusarium research
- Links with the DNRM Qld in irrigation/soils research
- Links with CSIRO Sustainable Ecosystems and NSW Department of Land and Water Conservation in the ecosystems services study
- Links with the GRDC for funding and coordination of area-wide management on the Darling Downs and IPM research in southern cotton regions
- Links with the regional Grower and Irrigator Associations in funding applications for salinity research

- Links with a wide range of CRDC funded projects including many in-kind contributions
- CSIRO Land and Water (Adelaide): joint research in role of organic matter in maintaining soil structure; (Canberra): collaboration in the soil baseline study
- Links with the Agricultural Production Systems Research Unit (CSIRO and QDPI)
- Weeds CRC for existing research and future joint opportunities on weed management in farming systems in Queensland

Project Summaries

PROJECT NUMBER: 3.1.00 AC

Project Title: Long term effects of cotton rotations on the sustainability of cotton soils II

STAFF

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Mr T.B. Weaver, NSW Agriculture, Narrabri, NSW.

AIMS

The aim of the project is to determine the long-term effects of rotation crops and their management on soil quality, nutrient cycling, and growth, yield and profitability of succeeding cotton in irrigated and dryland cracking clays (Vertisols).

The experimental sites are located on-farm at Warren, Merah North, Wee Waa in NSW; and Warra and Emerald in Queensland, and on-station at ACRI.

Project objectives for 2001-02 were to: take soil samples from all on-farm experimental sites for physical and chemical analysis; sow rotation crops and monitor their growth and nutrient uptake in NSW sites; collect economic data and evaluate farm profitability in NSW sites; monitor nutrient leaching and drainage during winter 2001 and summer 2001-02, and conduct EM38 surveys before sowing and after harvesting the rotation crops; and conduct any additional experiments if required.

OUTCOMES

Residual effects of rotation crops on soil structure were present even three years after all plots at Warren and Emerald had been sown to a single cropping system. This was such that the ex-wheat treatments had better subsoil structure than ex-legumes. Subsoil sodicity was higher at Merah North with cotton-dolichos and cotton-faba bean rotations than with either cotton-wheat or continuous cotton.

After sustained decreases since 1993, profile organic C values have stabilised at Warren and increased by very small amounts at Merah North and Emerald. For example, in the 0-60 cm depth at Merah North, the rate of increase was 15 g/m^2/year. K has decreased in all sites and premature senescence is very likely with the very low values in the dryland sites (Emerald, Warra). If this trend continues, deterioration in fibre quality and yields are possible.

Drainage and nutrient leaching was low during the winter of 2001, and was also low at Merah North during the summer of 2001-02. Results collected between June 2001-April 2002 suggest that low early season rainfall was a major contributing factor in reducing deep drainage and nutrient leaching.

These observations confirm the predictions made from the WaterMod 2 model that early season rainfall or high rainfall and irrigation were the major causes of deep drainage and nutrient leaching in irrigated Vertisols. Deep drainage was low in mid-season due to a high crop water use.

A chloride mass-balance model was used to calculate seasonal drainage for the 2000-01 season. Seasonal deep drainage at Merah North was 98 mm with continuous cotton, 76 mm with wheat-cotton and 19 mm with dolichos-cotton; 118 mm with wheat-cotton at Wee Waa; and 151 mm with wheat-cotton at ACRI where cotton was sown into standing wheat stubble.

These differences were caused by differences in stubble management, structure, texture and sodicity. The drainage values were used to calculate amount (kg/ha) and value ($/ha) of seasonal salt and nutrient leaching. The net difference ($/ha) between the costs (nutrients lost) and benefits (salts leached) was the estimated net value of nutrients and salts leached through in deep drainage.

These analyses showed that where water and soil salinity were low, nutrient and salt leaching resulted in a net cost. However, when soil and water salinity were high and because deep drainage was involved in salt leaching, a net benefit occurred, even though some nutrients like N and K were leached out of the cotton root zone.

In general a minimum deep drainage of 5-10% of all water received as rainfall and irrigation is needed to keep the soil in a non-saline condition. Yield variation in transects across the field was due mainly to nitrate-N leaching and waterlogging at Wee Waa and ACRI, and salinity at Merah North.

Most of the nitrate-N leached with deep drainage can be recovered by sowing a cereal crop such as wheat after cotton. The addition of moderate amounts of fertiliser to the wheat improved N recovery by increasing root growth. N recovery by the wheat crop is also related to the amount of rainfall received early in the cotton season (October and November).

In other words, high early season rainfall results in high amounts of N being leached out of the cotton root zone, and consequently the following wheat recovers high amounts of N. When early season rainfall is low, the reverse occurs.

Beachworth wheat rotation

Beachworth Cotton Rotation

PROJECT NUMBER: 3.1.02 AC

Project Title: Identification and remediation of nutritional stresses in cotton crops.

STAFF

Dr Ian Rochester, CSIRO Plant Industry, Narrabri, NSW
Mr Greg Roberts, CSIRO Plant Industry, Narrabri, NSW.

AIMS

To identify the critical nutrient concentrations in cotton leaves, develop techniques for rapid assessment of nutrients in cotton leaves, continue development of N-efficient cropping systems using legumes and assess soil quality improvement associated with legume cropping.

OUTCOMES

Unlike all previous experiments, no response to applied N fertilizer was evident in any of the cotton systems evaluated in 2001/2002. Also, no significant differences were identified due to previous crop i.e. the N fixed by vetch crops was not needed, nor was the N fertilizer applied needed. This is possibly due to the climatic conditions favouring mineralisation of nutrients and the lack of waterlogging associated with rainfall.

Vetch crops grown between cotton crops and after wheat were assessed for DM production and N fixation during the spring of 2001. About 160 kg N were fixed per ha. The most productive cultivars were Namoi woolly pod and Capello.

Cotton leaf samples were collected between flowering through to boll-filling from many sites during the 2001/02 season and analysed for nutrient content. Notably, severe potassium deficiency, and to a lesser entent phosphorus deficiency, symptoms were observed in many crops across most valleys.

The lower levels of P and K were commonly associated with higher levels of sodium, as was observed in the previous season. These leaf samples will be assessed using NIR techniques to determine if reasonable correlations with chemical analyses are possible later this year.

Glasshouse experiments have indicated that legume crops exude acids from their roots, thereby modifying their rhizospheres and the availability of nutrients near the root surface. Vetch also reduces the pH of its rhizosphere; this effect may be responsible for improving the availability of micronutrients in the soil and may be in part related to improved soil condition (tilth).

Further glasshouse experiments conducted during 2001 indicated that high soil sodium levels significantly reduced cotton (and legume) growth.

PROJECT NUMBER: 3.1.03 AC

Project Title: Integration of agronomy, crop physiology and modelling research capabilities.

STAFF

Dr Michael Bange, CSIRO Plant Industry, Narrabri, NSW.
Dr Stephen Milroy, CSIRO Plant Industry, Narrabri, NSW.
Mr Dirk Richards, CSIRO Plant Industry, Narrabri, NSW.
Ms Tanya Smith, CSIRO Plant Industry, Narrabri, NSW.
Dr Sunil Tennakoon, CSIRO Plant Industry, Narrabri, NSW.

AIM

To improve interaction of agronomic, crop physiology and modelling research activities.

This project provides additional technical resources which help to improve interaction between agronomic, crop physiology and modelling research activities. To ensure that the information collected in these studies is effectively used and understood by the industry it is important that resources are dedicated to facilitating the interaction across these disciplines.

This is primarily achieved by ensuring that crop model development is strongly linked to agronomic and crop physiology studies, as well as through activities that apply the model for crop management and research, and vice versa. Research and ultimate application of the technology gained in all the fields of study mentioned, is often greatly enhanced when consideration is given to the other components.

This project funds a technical assistant, and in this period the technical assistant has assisted and supported the following initiatives:

- Generating information for crop management by undertaking a risk analysis of agronomic management practices utilising the total modelling capacity of the OZCOT and APSIM models.
- Experimental work for derivation of parameters for the cotton model and provide assistance in the maintenance and development of code.
- Experiments to collect data against which to test the model's ability to simulate crop establishment with different sowing times and soil temperatures.
- Experiments to develop refined understanding of the impact of temperature extremes on cotton performance.
- Experiments investigating methods to quantify determinacy and to assess variation in determinacy among a diverse range of genotypes.
- The analysis of data on cotton crop growth responses to different nitrogen environments.
- The final large scale field experiment to investigate the crop physiological responses of cotton to waterlogging as well as assessing the performance genetically modified lines.

Soil sampling to measure plant available water holding capacity.

Cotton cultivars of diverse origin used to explore understanding of crop maturity and determinacy.

Soil characterisation on-farm - soil coring and rain exclusion tents in the field

PROJECT NUMBER: 3.1.05 AC

Project Title: Sustainable Weed Management Systems for Cotton.

STAFF

Dr Ian Taylor, NSW Agriculture, Narrabri, NSW.

AIM

The major aim of this project is to develop sustainable weed management programs with less reliance on pre-emergent residual herbicides. To achieve this aim the following objectives were set for the 2001/2002 cotton season.

Identify suitable low weed pressure fields and identify the major weeds, weed seed bank and other sources of infestation.

Establish and monitor best-bet treatments with reduced herbicide inputs on two candidate fields assessing weed pressure over time, seed banks and yield.

OUTCOMES

Following a series of weed surveys conducted during the 2000/2001 season, 13 candidate fields were identified as possibly having sufficiently low weed pressure to allow the exclusion of residual herbicides from the weed management program. To further clarify the weed pressure on these fields soil cores were extracted along the survey transects and the number of seeds contained within the soil seed bank determined.

A field in Biloela was identified as having the lowest weed pressure from the soil cores and the major species present in the field (sesbania pea, black pigweed, barnyard grass) could be controlled using post emergent herbicide applications.

A second field located at the Australian Cotton Research Institute (ACRI, Narrabri) with known high weed pressure was also selected to determine whether a reduced herbicide program was equally effective at controlling weeds on a high weed pressure field.

Eleven herbicide treatments ranging from a complete pre-emergent program through to over the top and directed

applications of Roundup Ready herbicide only were evaluated for weed control in each of the fields.

Each field was planted with a Roundup Ready/Ingard variety (Sicot 289RRi at Biloela and Sicala V3RRi at ACRI). Each treatment was assessed for weed control, replenishment of the soil seed bank, net change in soil seed bank increase or decrease and yield.

Excellent weed control and yields were obtained at the Biloela trial site. Due to the low weed pressure a Roundup Ready herbicide application at planting plus one over the top application and a single directed application was sufficient to control weeds throughout the season. There was little or no seed return to the seed bank in any of the low input treatments and yields ranged from 8 bales/ha to 10 bales/ha under the treatment regimes used.

The best yields were obtained from treatments that incorporated either nil or half rates of residual pre-emergent herbicides. Treatments incorporating a full residual pre-emergent herbicide program or where Staple⊇ was used at 120g/ha yielded significantly less. The reduction in herbicide application and hence overall cost of weed control represented significant savings to the grower in this instance.

Weed control at the ACRI site with much higher weed pressure was considerably poorer using the same herbicide treatments. In all treatments replenishment of the soil seed bank was high increasing future weed problems and yields were much lower (range 0.8 - 5.8 bales/ha) than those at the Biloela site. (range 6 - 9.8 bales/ha)

Seed return in those treatments using either full or half rates of residual herbicides was lower than those without these herbicides demonstrating the importance of using conventional herbicide programs in fields with high weed pressure.

spring; and refuge crops such as lucerne to provide habitat for beneficial species. Interactions between pest and beneficial invertebrates and bush remnants were investigated.

OUTCOMES

Southern NSW cotton plantings were well underway in the first week of October 2001 due to a warm start to the season. However, cool weather followed the initial warm period resulting in a protracted growing season even though warmer than average temperatures during late February–early May allowed for better growth and maturation of the crop than expected.

Together with the Griffith IDO (Evan Brown), we encouraged farmers and consultants in the Hillston region to form an Area Wide Management group (AWM). The group met on a weekly basis throughout the growing season. An AWM plan for *Helicoverpa* species has been developed and will be discussed at a series of industry meetings.

Of four releases of the egg parasite *Trichogramma* undertaken in maize crops during the 2001-02 season, only one resulted in reduced *Helicoverpa* larval densities. This failure is thought to be due to the timing of releases and inconsistent *H. armigera* egg densities in maize crops. Our current inability to accurately predict *Helicoverpa* egg laying behaviour, may limit the ability of mass *Trichogramma* releases to reduce the area wide build up of *H. armigera* in maize.

Regular monitoring of lucerne refuges through the 2001-2002 season show that they contained high densities of both pest and beneficial invertebrates. Although samples contained large numbers of *Helicoverpa* larvae, the rearing of collected individuals showed that they experience high rates of mortality due to parasites and diseases. End of season pupal samples revealed that few *Helicoverpa* complete their development under lucerne.

PROJECT NUMBER: 3.1.06 AC

Project Title: Cotton Production Systems for Southern NSW.

STAFF

Dr Scott Hardwick, CSIRO Entomology, Griffith, NSW.
Dr Geoff Baker, CSIRO Entomology, Canberra, ACT.

AIM

Research carried out during the 2001-02 season was directed at developing strategies that could reduce the seasonal build up in *Helicoverpa* numbers, and developing an understanding of the role of different vegetation types in the agricultural landscape.

Some of the strategies involved the use of egg parasites to reduce numbers of *Helicoverpa* in maize crops within the region, trap crops to intercept *H. armigera* adults emerging in early

PROJECT NUMBER: 3.1.06 AC

Project Title: Cotton Industry Development Officer – Griffith.

STAFF

Mr Evan Brown, NSW Agriculture, Griffith, NSW.

AIM

To monitor and evaluate the progress of cotton cropping activities in southern cotton growing regions.

OUTCOMES

The southern region had an extremely cold season. Cold shock days were the highest on record,. with 48 cold shock days by the end of January, or 69 by the end of the season. This contrasts with the extremely warm summer of 2000-01 with a large percentage of days well above 35°. Sowing commenced on the 16th of September, with an early warm spell. The warmth did

not last and crops planted after this warm spell took 16-25 days to emerge.

Plantings at Condobolin reached 2300ha, but a large area was lost to hail damage early in the season. Hillston dropped back this to 13000ha, with Hay and Carrathool reaching 2200ha combined.

The low prices on offer for cotton saw a number of growers try Pima cotton (*Gossypium barbadense*). It was a good season for Pima, with extremely dry conditions, subsequently very little Alternaria Leaf Spot and Bacterial Blight. On the disease front there were "NO" cases of Fusaruim or Verticllium Wilt, small pockets of Black Root Rot and some Rhizoctonia and Pythium, brought on more intensely by the cool start. It was impressive to see fields that have no cotton history take 21 days to emerge and still have no disease.

A full spectrum of trials were established in the southern region covering:

- Shoulder Wheat, looking at the benefits of plant protection from insects and early vigour.
- Nitrogen, potassium and phosphorus rates for UNR and conventional cotton.
- Early season tipping out and leaf damage trials looking at plant ability to compensate.

Together with CSIRO Entomologist, Scott Hardwick, an area-wide management group was established and an AWM plan developed.

ULTRA-NARROW ROW/PIMA

A total of 1300 Ha of UNR was planted in the southern region: 500 Ha at Hillston and 800 Ha at Carrathool. Majority of the crop established well but some fields struggled to achieve uniform plant stand under the cold start. These fields experienced stripping problems because of the excessive branching. Plants tended to have a greater number of vegetative branches as a result of the cool conditions, and along with high insect pressure required additional nodes to be grown, at the expense of some earliness. However, turnouts of up to 36% are being achieved and good yields to date.

Around 1400 Ha of Pima cotton was planted to take advantage of good prices. Crop had no significant outbreaks of disease during the year but given this variety's longer season length it has been slow to finish.

EXTENSION ACTIVITIES

As well is involvement in running a number of trails the IDO contributed to Cotton Tales, and organised farm walks and other events at Hillston, Condobolin and Hay. Other activities included spray workshops, a defoliation workshop, and a UNR field day at "Gundaline" station, on the Murrumbidgee.

Evan Brown IDO Cotton Griffth and Matthew Mitchell, Merrowie Head agronomist Hillston Field Day 2002 (Standing in a UNR field)

The 2002 Hillston field day was a success with over 50 attending. During winter a soil workshop was organised, along with sessions on pupae control, and preparation of the first southern trial booklet.

Soil workshop with Hillstan farmers on4th June 2002.

PROJECT NUMBER: 3.1.07 AC

Project Title: Coordination and promotion of innovative farming system research.

STAFF

Mr Grant Roberts, CSIRO Plant Industry, Narrabri, NSW.
Dr Greg Constable, CSIRO Plant Industry, Narrabri, NSW.
Claire Felton-Taylor, CSIRO Plant Industry, Narrabri, NSW.

AIMS

This project involves research on crop maturity, agronomic aspects of Roundup Ready⊇ cotton management, surveys of cotton volunteers, herbicide control of seedling cotton, understanding premature senescence at the Warra site and agronomic fibre quality research.

Grant Roberts collecting data in a field experiment.

OUTCOMES

Two crop maturity experiments were conducted examining the separate effects of insect management and agronomy on cotton crop maturity. The 2001-02 results suggest that agronomic management (N, water, pix and variety) have only limited ability to adjust crop maturity (6 days), whereas insect management has a greater impact on maturity (up to 28 days difference).

However, there can be yield penalties associated with advancing crop maturity (up to 1 bale/ha). Future analysis of agronomic management and economics will enhance our understanding of adjusting crop maturity and fibre quality.

The impact of simulated early season insect damage on Roundup Ready and Roundup Ready/Ingard cotton are evaluated under both irrigated and dryland conditions. Early season damage and glyphosate had no effect on Bt concentrations (ELIZA method), however there was large variability within the data.

Increasing the severity of simulated insect damage delayed crop maturity in dryland crops but further analysis is required on the associated effects on yield. The effect of glyphosate timing on Roundup Ready⊇ cotton in dryland systems was also evaluated.

Three surveys examining volunteer cotton were conducted:

- The diversity of Roundup Ready⊇ volunteers in previous Roundup Ready⊇ fields was quantified on the Darling Downs, McIntrye, Gwydir, Namoi and Macquarie valleys.
- A roadside survey evaluated the number of transgenic volunteers in the lower Namoi.
- A similar survey was conducted in northern Australia above 22° south parallel. This survey included the transport routes of fuzzy seed from Emerald to Atherton and dairy farms on the Atherton Tablelands. Overall these surveys provide valuable information relevant tp management strategies for Round up Ready cotton.

Two herbicides (Spray.Seed and Hammer) were identified as potential control methods for seedling Round Ready⊇ volunteers prior to planting cotton. The herbicide Spray.Seed was also seen as a possible option for controlling vetch in cotton /vetch rotations.

The evaluation of agronomic factors that contribute to fibre quality parameters (particularly neps) was continued with a large number of samples being evaluated from a range of treatments (crop maturity experiments, defoliation timing experiments, etc).

Picking can be significantly advanced by adjusting crop maturity through insect management. Left is early variety and early management; Right is long season variety and standard management.

Warra 2002 - View to North from sorghum stubble (Rep 2 treatment 2) to cotton (Rep 1 treatment 4)

The Farming System Warra Trial is a long-term dryland experiment operated in collaboration with the Bidstrup family and with most activities managed by Ms. Janelle hare (QDPI, Dalby) and Mr Greg Salmond (QDPI, Dalby). Each of the 15 plots is 2.5 ha in area, the total trial area being approximately 40 ha. The treatments for the trial are:

1. Cotton/(summer fallow)/Cotton
2. Cotton/(winter fallow)/Sorghum (winter fallow)/Cotton
3. Cotton/Winter cereal(D/C)/Cotton
4. Cotton/Legume (D/C)/Wheat/Cotton
5. Cotton/(summer fallow)/Wheat/(summer fallow)/Cotton

Winter season 2001, Sunbri wheat was sown in May into Treatment 5. Following a very dry growing season the wheat was harvested in 5 November. Yield of 1.6 t/ha was achieved. Treatment 3 was not

sown due to un-seasonally dry conditions experienced after the cotton harvest 2001.

In the summer of 2001/02, sorghum and cotton were sown into Treatments 2 and 4 respectively. The cotton variety Sicot 289i RR was sown in a single skip configuration into standing wheat stubble. The combination of low starting soil moisture and extreme hot climatic conditions experienced during the growing season contributed to severe plant stress and resultant sorghum yield of 1.76 t/ha, and cotton yield of 3.27 b/ha. Outcomes of the longterm rotations are soon to be analysed.

A potassium experiment was undertaken within the trial area to investigate issues of premature senescence that has been of major concern over the past few years. Soil samples taken after sowing indicated a positive response to potassium in the soil. However weekly foliar applications of K after flower provided inconclusive impacts on premature seresance. Further analysis is needed.

Cotton harvest Warra 2002 (Rep1 Treatment 4)

Fusarium field-day attendees Cowan Mwwybilla – 14/02/02

PROJECT NUMBER: 3.1.08 AC

Project Title: Ecology and development of management strategies for fusarium wilt in cotton.

STAFF

Dr Joe Kochman ,QDPI, Toowoomba, QLD.
Dr Suzy bentley, CRC Tropical Plant Protection, Indooroopilly, QLD.
Mr Greg Salmond, QDPI, Dalby, QLD.
Ms Lisa Gulino, PhD Student, CRC Tropical Plant Protection, Indooroopilly, QLD.

Dr Joe Kochman in the field.

AIMS

To investigate the ecology and development of management strategies for fusarium wilt in cotton.

OUTCOMES

New records of *Fov* were confirmed in the Brewarrina (NSW) district and in Pima cotton at Bourke. Pima cotton was also devastated by the disease in the trials at "Cowan" The disease was identified on more farms at Brookstead, Dalby, Goondiwindi, Toobeah, St George and Theodore in Queensland as well as Moree, Burke and Warren in New South Wales.

DNA sequence information that is unique to the Australian strains of Fov has been identified, and primers that identify Australian strains of *Fov* have been developed. This information is currently being used by PhD student, Miss Lisa Gulino, to develop a molecular diagnostic test for Fov to be used throughout the cotton industry.

The diagnostic tools developed to date are being used to identify *Fusarium* colonies isolated from soil sampled from rotation experiments. The data obtained will be used to validate the DNA diagnostic test and will be vital in establishing whether this test can differentiate between high medium and low levels of *Fov* in the soil.

About 25 hectares of field trials were planted at "Cowan" (Mr & Mrs G Clapham's property near Cecil Plains) in October 2001. More than 5000 plots were involved in the assessment of germplasm and current variety reaction to natural Fusarium infection.

Initial emergence in the germplasm evaluation trials was excellent but adverse climatic conditions ensured there was significant disease for differentiation of the germplasm being screened for resistance to *Fusarium*. Some promising germplasm has been identified.

The field trials also include about 4 hectares of crop rotation experiments and a number of small-plot bio-control experiments.

Some preliminary data from the rotation trial gives cause for concern, with *Fov* isolated from an apparently healthy mung bean crop. Trials involving 19 different rotation crops have also been planted in the glasshouse at Toowoomba.

Two hundred cotton plant specimens were received at the DPI, Indooroopilly and Toowoomba laboratories for analysis. Of these, 117 were confirmed as positive for *Fov*. All isolates of *Fov* analysed this season have belonged to the 'Downs' strain VCG 01111. This is the most common strain of *Fov* recorded in Australia.

Cotton seedlings showing a typical Black root rot infection patch.

PROJECT NUMBER: 3.1.09 AC

Project Title: Diversity and pathogenicity of *Thielaviopsis basicola*.

STAFF

Mr John Harvey, PhD Student, University of Queensland, St Lucia.
Dr Elizabeth Aitken, University of Queensland, St Lucia.
Dr David Nehl, NSW Agriculture, Narrabri

AIMS

The aim of this project is to increase understanding of the soil borne fungus Thielaviopsis basicola which causes Black Root Rot (BRR), specifically to investigate the genetic diversity of strains that infect cotton, to allow the development of better controls to this pathogen, and to assist in any possible breeding programs to reduce susceptibility.

OUTCOMES

At the onset of this project, the focus has been on developing techniques. In particular, methods to allow the isolation (from soil) and subsequent genetic analysis of *T. basicola* have been adapted and optimised to suit the projects requirements.

John Harvey, the PhD student conducting this work, has now participated in seedling disease surveys (conducted by Dr Nehl and associates) in the 2001-2002 season and has been in a position to collect field samples and also see the impact first hand of this serious disease affecting the Australian cotton crop.

Seedling disease survey soil cores have now been taken from infected farms, giving a collection of isolates ready for genetic analysis. More recent results from analysis of soil collected from regions surrounding cotton properties, strongly suggests that the pathogen is present off-farm, and this may have implications for control management.

This analysis is ongoing, hence firm recommendations cannot be made, however it is hoped that more data will be presented at the 11th Australian Cotton Conference (August 2002). In the meantime it appears that the "Come Clean, Go Clean" policy is even more important, and should be potentially expanded to include non-farm movements.

PROJECT NUMBER: 3.1.11 AC

Project Title: Dynamic modeling of soil physical-chemical processes as indicators of soil health in relation to land use in the cotton-growing regions.

STAFF

Dr I.O.A Odeh, University of Sydney, Sydney, NSW.
Professor Alex B. McBratney, University of Sydney, Sydney, NSW.

OTHER COLLABORATORS

Marian Dunbar (PG student), Dr John Triantifilis and Mr Alex Onus, University of Sydney, Sydney.

AIMS

To investigate dynamic modelling of soil physical-chemical processes as indicators of soil health in relation to land use in cotton growing regions.

OUTCOMES

We continued to improve the carbon dynamic models which were applied to soil data obtained for the the lower Macintyre, Gwydir and Namoi. Both the Rothamsted C Model and the CENTURY model performed well to a varying degree.

Sampling in the Bourke irrigation region and the required laboratory analysis of soil samples were completed. Additional sampling in the gap between the Macintyre and the Gwydir will be carried out in collaboration with Dr Triantafilis. Pedological models for gypsum and carbonate accumulation and their spatial distribution in the Bourke region were developed, in collaboration with a visiting student, Mr Ben Warr from the University of Reading.

Soil acidification process was modelled for the Macintyre, Gwydir and the Namoi valleys. The acidification model was also extended to the Bourke region, complemented by sodification models.

The acidification model indicates that current management practices for cotton may result in decreased pH within 30 years

in some fields. Some fields are at high risk of becoming strongly acidic (pH<5.5) in approximately 25 years.

GIS work and the development of the digital maps are continuing. GIS map query operations were used to manipulate map layers to answer soil quality questions in order to generate additional useful information. As an example we used them to decipher the spatial coincidence of Exchangeable Sodium Percentage (ESP)4 a measure of sodicity, electrochemical stability index (ESI) and the predicted probability of moderate to strong soil dispersibility based on *Aggregate Stability in WATer* (ASWAT) test values (See Figure).

Zones of high risk of moderate soil dispersion in the northwest and the southwest of Bourke in Figure a are evident in both maps. However, the spatial prediction of sodic soil (GIS query: ESP>5; not shown here) appears to either underestimate or overestimate the high risk zones depending on other factors not analysed here. Over 95 % of the area exhibits ESI values lower than the threshold value of 0.05 as suggested in SOILPak indicating that most soils are potentially dispersible. In reality only about 55 % of the area show some moderate dispersion or worse.

The use of ESI threshold of <0.05 appears to vastly overestimate the potential dispersibility at least for this study region. Based on the spatial analysis a threshold value of 0.025 is more appropriate. Further analysis of the Ca:Mg ratio shows the spatial coincident of areas with Ca:Mg ratio < 2, another threshold value below which soils are potential dispersive as reported in SOILPak, as only being partial in both cases of moderate and spontaneous (strong) dispersion with less than 10% of the area meeting this criterion. A few blobs of areas which have Ca:Mg ratio < 2 are outside the zones of moderate or spontaneous soil dispersion.

It appears that soil texture is an important factor affecting soil dispersion as the clay particles attached to coarse grains in coarse-textured soils would more readily disperse than in the case of clayey soils. When considered in terms of moderate clay dispersion, both the critical levels of ESI and Ca:Mg ratio need to be reviewed. Comparison with other project regions (e.g. lower Namoi) will be carried out to determine whether generalisation of the thresholds for ESI and Ca:Mg ratio is appropriate or not. All the GIS layers being created will be incorporated into a Web-enabled system for easy distribution and accessibility. Other models, including nitrate leaching, will be pursued in the coming year.

PROJECT NUMBER: 3.1.12 AC

Project Title: Cotton soil health: Influence on cotton root diseases.

STAFF

Florian Yan, PhD Student, University of Sydney, Sydney, NSW.
Professor Les Copeland, University of Sydney, Sydney, NSW.
Dr David Nehl, NSW Agriculture, Narrabri, NSW.

AIMS

- To assess the diversity of the soil microbial community in cotton soils using two methods: 1. community level physiological profile (CLPP) analysis, using Biolog plates; and 2. a DNA-based analysis called terminal restriction fragment length polymorphism (T-RFLP) analysis.
- To develop a protocol for the extraction of bacterial rDNA from cotton soils, which must be achieved before subsequent T-RFLP analysis can be preformed. The protocol must be optimised for clay soils, and must be developed with funding constraints in mind.
- To determine the relative role of biological factors in the suppression of black root rot in certain soils.

OUTCOMES

Black root rot of cotton has been observed to be more severe in some soils than in others. It is unknown whether the mechanism of suppression involved only physical/chemical factors, or biological factors as well.

This project has shown that biological factors play a key role in the suppression of black root rot. Further experiments have been initiated to determine whether or not this suppression is widespread in cotton-growing areas.

Soil microbial diversity is one biological factor that may affect the mechanism of suppression of black root rot. Two different methods are being used to measure microbial diversity in cotton soil communities. One method measures the capability of the soil microbes to use different carbon sources. The other method is DNA-based and provides a snapshot of microbes present in the soil. This DNA-based method is being refined to suit typical cotton-growing soils, and will also be useful for other researchers working with DNA in these soils.

PROJECT NUMBER: 3.1.16 AC

Project Title: Purchase of minirhizotron for the study of root dynamics in cotton-based farming systems.

STAFF

Dr N.R. Hulugalle, NSW Agriculture, Narrabri, NSW.

AIMS

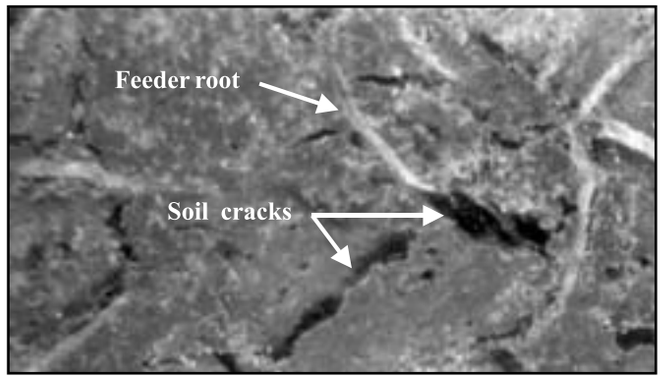
To study root dynamics in cotton-based farming systems by means of a minirhizotron system.

OUTCOMES

Preliminary results suggest that under irrigated conditions cotton loses a major proportion of its fine root mass, and survives on its tap root. With the end of the irrigation season in March, most of the fine root mass is replaced.

Minimum-tilled cotton has more roots in the furrows than intensively-tilled cotton. Root/shoot ratios during early crop growth (up to December, before irrigation commences) are in the order of 4, and not around 0.2-0.4 as previously thought. Root growth appears to take place primarily through existing soil cracks, and not through the bulk soil (Fig. 1).

The minirhizotron system was purchased and field use commenced in January 2002. A standard operating procedure (SOP) and protocols for using it under field conditions is being defined at present. Technical staff in the soil management program were also trained it its use. Mr. Peter Roberts, an honours student from the Department of Crop Science at Sydney University, commenced a project on root dynamics of irrigated cotton under different tillage systems during 2001-02.



Feeder roots growing through soil cracks at 50 cm depth on 13 march 2002

PROJECT NUMBER: 3.1.18 AC

Project Title: The role of weeds as alternative hosts of Fusarium wilt in cotton.

STAFF

Mr Richard Kent, PhD Student, UNE, Armidale, NSW.
Dr Brian Sindel, UNE, Armidale, NSW.
Dr David Backhouse, UNE, Armidale, NSW.
Dr Joe Kochman, QDPI, Toowoomba, QLD.

AIMS

The objective of this project is to ascertain the role of weeds as alternate hosts of Fusarium wilt in cotton. This will assist

in the formulation of weed management strategies to minimise the effect of alternate host species on Fov inoculum in cotton crops, in non-susceptible rotation crops and in fallows.

OUTCOMES

Since the appointment of PhD student, Richard Kent in January 2002 seeds of 70 different weed species have been collected representing 23 families. Collection of seed from other weed species is on-going. Seedling emergence is currently being determined from each of these seed lots, and glasshouse experiments are about to commence to determine the ability of different species to act as alternative hosts to Fov.

An extensive literature search on Fusarium wilt in cotton, with particular reference to the effect of weeds and other plant debris on Fov inoculum, has been completed. Much of the historic and current Fov research has been carried out in the USA where severe Fusarium wilt is usually associated with the root knot nematode. While this research may provide a guide for further research, it is not directly relevant to the Australian situation.

During Fusarium-related industry field visits, that were part of Dr Patrick Colyer's review, 36 root samples, representing 22 weed species from 14 families, were collected from Fov infested cotton fields. These samples are currently being analysed for Fov in the laboratory.

To date, four *Fusarium* species have been isolated including isolates of *Fusarium oxysporum*. It is yet to be determined if any of the *F. oxysporum* isolates are *Fov*. Staff at the University of New England are becoming familiar with techniques to isolate Fov from a range of different source materials.

PROJECT NUMBER: 3.1.19 AC

Project Title: Agronomic aspects of Bt efficacy in transgenic cotton.

STAFF

Dr Ian Rochester, CSIRO Plant Industry, Narrabri, NSW.
Ms. Jenny Roberts, CSIRO Plant Industry, Narrabri, NSW.

AIMS

This research aims to identify environmental constraints and management practices which impact on Bt efficacy in Ingard cotton.

OUTCOMES

Field experiments have been established to examine the impact of agronomic factors on Bt concentrations within the leaves of cotton plants. Bt levels were slightly higher at low plant density and with higher N fertilizer rates. The influence of shading was also assessed on two occasions, (shaded for 10 days each time) but no significant change in leaf Bt concentration was discerned. Leaves sampled later in the season from severely K-deficient plants also had lower levels of Bt than those plants having higher levels of K. A similar trend was seen with Zinc deficient plants early in the season.

Two glasshouse experiments indicated that the concentration of Bt in the leaves of waterlogged cotton was not significantly different from non-waterlogged cotton. Large variation has been found between individual plants within treatments in glasshouse studies, making it difficult to identify the effects of those treatments – the basis for this variation is now being investigated.

Glasshouse and field experiments have revealed that Bt concentrations in cotton leaves have largely not been influenced significantly by most of the agronomic treatments that have been imposed. High plant density and poor crop nutrition appear to influence Bt concentration, possibly more so than other agronomic factors. It is probable that where multiple deleterious conditions occur, these effects may be additive and potentially reduce Bt levels substantially.

PROJECT NUMBER: 3.1.20 AC

Project Title: 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 I.O.A. Odeh, USYD, Sydney, NSW.

AIMS

The interaction of salts and sodium in cotton-growing soils such as Vertosols is not well understood in the Australian environment. Thus the research undertaken in this project looks to address the sustainability of soil physical condition given the use of irrigation water of lesser quality, and where high quality water is available, the structural effects that may occur in sodic soil layers.

OUTCOMES

With increasing requirements for finite water resources and reduced allocations likely to be an ongoing issue, the use of poor quality water may become a major concern. Such action has the potential to increase the risk of salts cycling through the topsoil, a process likely to impact immediately on the structural behaviour of that soil, leading to possible soil dispersion and influencing soil hydraulic properties.

This may have the subsequent effect of altering the water use efficiency of crops. The process may be further complicated if sodic soil layers are considered. While such layers are potentially highly unstable, they may act in a similar or more stable manner if poor quality (salty) water is used. In such situations, the effect of sodium is reduced by the presence of other cations (salts) in the water.

Sampling at Hillston, Lachlan River valley, NSW.

The sampling scheme includes sodic soil from across various N.S.W. cotton-growing regions (the Lachlan, Lower Namoi, Lower Gwydir, and Maquairie River valleys). Sampling has already been conducted from the Bourke district, on the Darling River.

A complete assessment of a range of structural stability and form characteristics will be determined for all soil samples.

These soil structural characteristics determined will, after determination for each of the sampling sites, be used to assist growers in understanding the behaviour of cotton–growing soils with varying sodicity levels and subject to irrigation waters of decreasing quality. The results should also assist those growers who are considering the use of different water resources (i.e. bore water, river water) to manage the influence of salt across their property.

PROJECT NUMBER: 3.1.23 AC

Project Title: WEEDpak. A weed Identification and management guide for the Australian Cotton Industry.

STAFF

Dr Stephen Johnson, UNE, Narrabri, NSW.
Mr Graham Charles, NSW Agriculture, Narrabri, NSW.
Mr Grant Roberts, CSIRO Plant Industry, Narrabri, NSW.
Dr Ian Taylor, NSW Agriculture, Narrabri, NSW.
Ms Leah MacKinnon, UNE, Narrabri, NSW.

OUTCOMES

WEEDpak has been written and compiled by the weeds focus team of the Australian Cotton CRC (weed researchers at ACRI and extension personnel from the National Cotton Extension Network).

The production of WEEDpak, a weed identification and management guide, is an important step in helping achieve sustainable and cost effective weed control in the Australian

The Weedpak team with the finished product Left to right Mr Graham Charles, Mr Grant Roberts and Dr Stephen Johnson (Missing Dr Ian Taylor and Ms Leah MacKinnon).

PROJECT NUMBER: 3.1.25 AC

Project Title: Current and potential soil limitations to cotton production in the lower Lachlan River Valley region

STAFF

Mr Alex Onus, USYD, Sydney, NSW.
Dr Stephen Cattle, USYD, Sydney, NSW.
Dr IOA Odeh, USYD, Sydney, NSW.

AIMS

This research aims to establish whether the soils of the lower Lachlan River valley exhibit any properties that are currently or potentially limiting to cotton production.

The focus of this work is to characterise the main soil types of the lower Lachlan River valley in order to determine what soil properties of importance to cotton production are, or are likely to be, limiting to production. Until now, there has been no extensive investigation of soil condition in this emerging cotton-growing region.

From experiences of cotton producers in northern N.S.W., soil properties to be assessed will include texture, bulk density, water retention characteristics, structural stability, exchangeable sodium content, electrolyte concentration (salinity), pH, organic carbon content and phosphorus content. It is expected that the main outcome of this work will be a database of soil information for cotton-growing areas of the lower Lachlan Valley.

OUTCOMES

In recent years, the cotton industry has been expanding rapidly in the lower Lachlan River valley of southern New South Wales, particularly near the towns of Hillston and Condobolin,

where large expanses of alluvial floodplain composed of clayey sediment, the availability of irrigation water from the Lachlan River, and prevailing climatic conditions, have allowed the successful development of a cotton production industry.

The soils of the lower Lachlan valley appear to be similar to those of the northern N.S.W. cotton-growing region (i.e. Vertosols), but subtle differences in the mineral composition of these clayey soils exist. These subtle mineralogical differences have the potential to dramatically affect the physico-chemical properties of those soils, which in turn affect the hydraulic and structural behaviour of those soils.

It may transpire that these differences in soil properties are potentially more limiting to sustainable cotton production than climatic or pest factors.

The climatic and edaphic differences between southern and northern cotton-growing areas of N.S.W., means the regions are likely to differ in the range of soil limitations (both physical and chemical) to cotton production. There is a perception among some growers and consultants that subsoil sodicity, subsoil salinity and deep drainage are more prominent issues in the south than in the north; this may be related back to the more rigid southern Vertosols (less smectitic clay) being more permeable under some conditions.

At this early stage of the project a specific study area has been defined and various layers of digital information has been sourced and collated for this area. This information has been utilised to design a stratified random sampling scheme and soil sampling is scheduled to begin in early July.

1. District EM34/38 surveys in seven irrigated cotton growing districts of Toobeah (Macintyre), Ashley and Mallawaa (Gwydir), Wee Waa and Gunnedah (Namoi), Trangie and Warren (Macquarie) and Bourke (Darling River valley)
2. Soil and vadose zone sampling
3. Laboratory analysis of chemical and textural soil properties including EC_e, $EC_{1:5}$, EC_p, saturation percentage, exchangeable cations (Ca, Mg, Na and K), particle size analysis (clay, silt and sand fractions).

OUTCOMES

Phase III of the project has been strongly supported by NHT funds for work in different regions. Most of the time has been required to collect data in areas where salinity is a problem (Bourke, Warren and Trangie) the project has assess causes at field scale and determined best management options for growers.

In broad terms the project has demonstrated that salinity is not a major risk over large areas of cotton producing regions, but severe localised problems occur. Oftern these are associated with poor design and placement of water storage or tranmission structures.

To complement the work being carried out as part of the Cotton CRC, University of Sydney staff established the Centre for Salinity Assessment and Management within the Faculties of Agriculture, Food and Natural Resources, Science and Rural Management. The CSAM webpage will feature prominently the case studies and research work being carried out as part of this project.

PROJECT NUMBER: 3.2.00 AC

Project Title: Understanding the salinity threat in the irrigated cotton growing areas of Australia-Phase III-Implementation and Management

STAFF

Dr John Triantafilis, USYD, Sydney, NSW.
Prof Alex. B. McBratney, USYD, Sydney, NSW.
Dr Inakwu Odeh, USYD, Sydney, NSW.

OTHER STAFF & COLLABORATORS –

Mr Michael Short, USYD, Sydney, NSW.
Dr Ranjith Subasimghe, USYD, Sydney, NSW.
Dr Raj Singh Malik, USYD, Sydney, NSW.
Mr Sam Buchanan (PhD Candidate), USYD, Sydney, NSW.

AIMS

To gain a better understanding of the salinity threat in irrigated cotton growing regions, particularly in relation to the implementation and management of solutions. The most recent objectives were to complete:

STUDY AREA (VALLEY)	EM34/38 SURVEY MEASUREMENTS	APPROXIMATE SURVEY AREA (HA)	SOIL AND VADOSE ZONE SAMPLING	SAMPLING AND LABORATORY ANALYSIS
Toobeah (Macintyre)	1,208	65,000	43	Complete*
Ashley (Gwydir)	1,510	55,000	52	Complete*
Wee Waa (Namoi)	1,896 (no EM38)	200,000	52	Complete
Gunnedah (Namoi)	899	40,000	35 + 35	Complete
Trangie (Macquarie)	755	25,000	48 + 48	Complete
Warren (Macquarie)	564	20,000	35	Complete
Bourke (Darling)	1,099	50,000	50	Complete
Totals	7,931	455,000	315	

*Note: It is envisaged laboratory analysis will be completed by 30/09/2002.

PROJECT NUMBER: 3.2.01 AC

Project Title: Environmental Benefits of On-farm Wetlands: Development of an integrated system for remediation of waterborne pesticide residues in cotton farms

STAFF

Dr Francisco Sanchez-Bayo, USYD, Sydney, NSW.
Angus Crossan, USYD, Sydney, NSW.
Michael Rose (PhD Student), USYD, Sydney, NSW.
Dr Ivan R. Kennedy, USYD, Sydney, NSW.

AIMS

To develop an integrated system for remediation of waterborne pesticide residues on cotton farms.

OUTCOMES

A constructed wetland consisting of two ponds in series, one for sedimentation and the second including vegetation, was examined for its baseline potential to remediate pesticide residues. Pesticide levels in tailwater from irrigated cotton fields were seen to decline by up to 40% over a twelve-day period in the wetland. No significant differences were observed between each stage of the wetland system or between different pesticides. However, vegetative growth in the constructed wetland was less than anticipated because of misadventure and the time taken for establishment. In a related study, no reduction of pesticide was observed over 60 m of a naturally vegetated taildrain.

Related laboratory and greenhouse studies showed significant reductions of pesticide residues, particularly of insecticides, by wetland plant species grown hydroponically. These results provide a satisfactory baseline for further development of systems for on-farm remediation of pesticides in wetlands transported in tailwaters. However, to enhance the extent of remediation, filtration and adsorption beds may need to be incorporated and this requirement will be investigated in the next stage of this project.

PROJECT NUMBER: 3.2.02 AC

Project Title: Economic value of ecosystem services underpinning the Gwydir Valley cotton industry.

STAFF

Dr Letitia Silberbauer, UNE, Armidale, NSW.
Associate Professor Nick Reid, UNE, Armidale, NSW.

OTHER STAFF AND COLLABORATORS

David Thompson, Centre for Agricultural and Regional Economics (CARE)
Dr. Brian Wilson, NSW Department of Land and Water Conservation (DLWC)
Dr. Ian Oliver, NSW Department of Land and Water Conservation (DLWC)
Dirk Richards, CSIRO Plant Industry
The CSIRO/Myer National Ecosystem Services Project team, CSIRO Sustainable Ecosystems.

AIMS

The aims of this project are to publicise the nature and importance of ecosystem services among the Gwydir community, and to seek the community's assistance in identifying and prioritising the most important ecosystem services to them. We then wish to value management-induced changes in the provision and impact of the most important ecosystem services at both a farm and regional scale.

OUTCOMES

Our working definition of ecosystem services are the ecological conditions and processes that maintain soil, biota, aquatic systems and the atmosphere (i.e. our natural assets) and use those assets to produce goods that people want and need.

Ecosystem services fall into three broad categories (Fig. 1): (1) those that produce goods; (2) those that break down waste products; and (3) those that maintain natural assets. "Goods" can include food and fibre, as well as less tangible products like life fulfilment values. Ecosystem services derive from ecological processes. Examples of ecosystem services in rural catchments include the provision of clean water, adequate amount of water, habitat, aesthetically pleasing landscapes and recreational outlets, as well as pollination, natural pest control, local climate control, bioremediation of toxic compounds, and mitigation of extreme climatic events.

Ecosystem services are important because, although they are often free, they are not immune to human mismanagement. Unfortunately, we have sometimes failed to recognise and value ecosystems services sufficiently, and have inadvertently damaged them. Given the cost of rehabilitation, recognition of the damage done after the event is often too late. There is also growing consumer pressure for goods to be produced by sustainable production systems, and this will be increasingly important for market access in the future.

PROGRESS TO DATE

Highlights over the last 12 months have included:

- A community forum held in Moree May 2001;
- Production of the community forum report (October 2001);
- Production of a scoping study report (February 2002);
- Visits from Prof. Doug Landis (Michigan State University), Dr. Anthony Cole (Landcare NZ) and David Shelton (CSIRO Sustainable Ecosystems);
- Initial construction of farm-scale economic and biophysical simulation models of key ecosystem services using Vensim™.

PROJECT NUMBER: 3.2.07 AC

Project Title: The Effects of Cotton Defoliants on Native Tree Species from North-West NSW – Field-Based Experiments.

STAFF

Adam Downey PhD Student, UNE, Armidale, NSW.
Associate Professor John Duggan, UNE, Armidale, NSW.
Guy Roth, Cotton Research & Development Corporation, Narrabri, NSW.

AIMS

The overall aim of this project was to answer the question: does spray drift from commercially-used cotton defoliants impact on native trees common to the cotton-growing areas of north-west NSW?.

OUTCOMES

In order to answer this question, experiments were established with the planting of approximately 1300 juvenile trees from seven tree species common to the north-west on two cotton production properties at Boggabri, NSW. The experiments involved spraying the trees with four commonly used cotton defoliants at three rates (chosen from commercial rates) over three defoliation seasons, therefore "assuming" that the trees were exposed to heavy spray drift. We then measure any visible effects on the trees in relation to height growth, leaf or tree damage and actual leaf loss, or defoliation.

The results after 2 seasons show that two out of the four chemicals used have had negative effects (ie. slowed growth, defoliation etc.) on the three to four tree species, when compared to trees not subjected to defoliants, or "control" trees. Our preliminary analysis shows a species effect, (ie. effects are species dependent), a treatment effect, and an effect of application rate. However, it is clear at this stage that no trees have been killed as a direct result of exposure to the defoliants when sprayed directly onto them. Trees have been affected, but have then recovered with time.

Once, all the data has been analysed, we can provide definite recommendations about the extent to which defoliants cause trees damage and which trees are the most susceptible or tolerant.

PROJECT NUMBER: 3.2.08 AC

Project Title: Hydraulic modeling to develop sustainable irrigation management practices in cotton production.

STAFF

Dr Damien Field, USYD, Sydney, NSW
Dr V.W. Vervoort, USYD, Sydney, NSW.
Dr S.R. Cattle, USYD, Sydney, NSW.
Dr B Minasny, USYD, Sydney, NSW.

AIMS

To develop the concept of soil inference systems, which will be implemented as a toolkit for predicting soil hydraulic properties.

BACKGROUND

While much current research focuses on the development of new functions for predicting soil physical and chemical properties for different geographical areas or groups of soil types, there seems to be little effort to define the uncertainty of the prediction and use this information as a tool for decision making.

Pedotransfer functions are mainly used in terms of *data* translation. If we describe this translation function as *information*, and this information when properly and logically conjoined constitutes *knowledge*. Knowledge can generate various data. The soil inference system takes measurements we know with a certain precision and infers properties we don't know with given precision, by means of properly and logically conjoined pedotransfer functions. We call this the soil inference systems (SINFERS), where pedotransfer functions are the knowledge rules for inference engines.

This approach allows one to treat all kinds of uncertainty in a logically consistent way. This new concept will be implemented in a user-friendly software with proper graphical user interface (GUI). The program will ask questions such as "What soil properties do you have?" and will give output of soil hydraulic properties along with their uncertainties.

OUTCOMES

For the soil-water-plant model in swelling soils, we have identified and are working towards a complete model which comprises of:

- water movement in a shrink-swell soil (SWELL), which is numerical solution of Richards' equation based on material coordinate systems,
- preferential flow and soil shrinkage according to the theory proposed by Bronswijk,
- evapotranspiration, based on climatic data using the Penman-Monteith method, with an option for using the Bowen ratio
- cotton growth model, which will be based on the WOFOST routine.

Further work has concentrated on collecting field data to calibrate and validate the model. We are also searching for available field data from older research.

The complete model will have an interface which is a soil inference system requesting the basic information from the user. It will predict the soil hydraulic properties along with their uncertainties. The hydraulic properties will be used by the soil-water-plant model to predict water balance, and plant growth. This will be presented in an interactive graphical output.

PROJECT NUMBER: 3.2.09 AC

Project Title: 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.
Ms Judy Nobilo, CSIRO Entomology, Narrabri, NSW

COLLABORATORS

Mr Martin Dillon, CSIRO Entomology, Narrabri, NSW.
Dr Adam Slipinski, CSIRO Entomology, Narrabri, NSW.
Dr Stephen Trowell, CSIRO Entomology, Narrabri, NSW.
Dr Mary Whitehouse, CSIRO Entomology, Narrabri, NSW.
Dr Amelia Reddall, CSIRO Plant Industry, Narrabri, NSW.
Dr Robert Mensah, NSW Agriculture, Narrabri, NSW.
Dr Marie-Louise Johnson, University of Queensland, Brisbane, QLD.
Dr Paul Grundy, QDPI, Brisbane, QLD.
Dr Brad Scholz, QDPI, Brisbane, QLD
Dr James Hagler, USDA-ARS, Phoenix, AZ, USA.

AIMS

This project investigates how key insect predators contribute to the suppression of *Helicoverpa armigera* in cotton, and explores the interaction between predator abundance and diversity, agronomic practices and predation of *H. armigera* eggs and larvae. Three strategies are being used to determine the importance of different insect predators in cotton: manipulative experiments, direct monitoring of insect abundance in commercial cotton crops and development of a molecular technique (ELISA) to detect consumption of *H. armigera*.

OUTCOMES

The first group of predators to be examined were the coccinellids, particularly the three banded and variable ladybirds. Under controlled conditions three banded ladybirds consumed more *H. armigera* eggs than variable ladybirds. However variable ladybirds may be more effective predators of *H. armigera* eggs than three banded ladybirds under natural conditions. This has yet to be confirmed using ELISA analysis. Predatory bugs such as bigeyed and damsel bugs are the next group targeted for investigation.

Beneficial insects and spiders were monitored in one field at the Australian Cotton Research Institute (ACRI), nine fields on four farms in the Namoi and Gwydir valleys, and six fields

on six farms in the Macintyre valley. These fields represented a range of cropping systems and varieties (conventional, Ingard, unsprayed, dryland, irrigated, retained stubble). Beat sheet samples and visual checks were taken at each site at least once a month from November to February. All beneficial predators were counted and identified, usually to species. Insect predators were collected for subsequent ELISA analysis to test for consumption of *H. armigera*.

The most abundant beneficial predators in the sampled fields for the 2001/02 season were red and blue beetles, spiders, ants and damsel bugs. The relationship between insecticide use and beneficial predator abundance and diversity is to be investigated in collaboration with Martin Dillon and Dr Mary Whitehouse (CSIRO Entomology).

Many predators have been identified within cotton agroecosystems. The generalist predators play a significant role in managing the secondary pests of cotton. Likewise the native vegetation, weeds and winter crops play a role in generating and maintaining populations of generalist predators through providing important resources. Some of the resources are overwintering sites, alternate food sources, additional food sources, reproductive sites and shelter. The management of these resources within the native vegetation surrounding cotton becomes important in conserving these predators.

As this project has only recently begun there are no outcomes to report at this stage, but the results are directly relevant to other work on Ecosystem Services.

PROJECT NUMBER: 3.2.12 AC

Project Title: The role of native vegetation in harbouring benefical insects and reducing insect pest damage in cotton.

STAFF

Ingrid Rencken, PhD Student, UNE, Armidale, NSW.
Dr Letitia Silberbauer, UNE, Armidale, NSW.
Associate Professor Nick Reid, UNE, Armidale, NSW.
Associate Professor Peter Gregg, UNE, Armidale, NSW.

AIMS

To determine the role of native vegetation in harbouring beneficial insects and reducing insect pest damage in cotton

BACKGROUND

The study is investigating a range of habitats to assess their potential in supporting populations of generalist predators with the view to enhancing the predator efficiency of cotton agroecosystems. Focus areas include native vegetation and winter crops that support populations of predators. This has important implications for the management of native vegetation around cotton fields.

The mobility of predators from natural vegetation will be investigated. To determine whether vegetation needs to be managed adjacent to the field or further away.

Habitat management as a means of conservation biological control has been largely ignored within many IPM programmes. With the introduction of area wide management of pests it is clear that events outside the crop can have an impact on events within the crop. The aim of conservation biological control is to conserve naturally occurring predators within the agricultural landscape. This is achieved largely through reducing sprays and modifying the landscape to enhance predator efficiency.

PROJECT NUMBER: 3.2.13 AC

Project Title: In field Evaluation of Assassin Bugs as Biological Control Agents for Cotton Pest Management.

STAFF

Dr Paul Grundy, QDPI, Biolela, QLD.
Dr Ian Titmarsh, QDPI, Emerald, QLD.

AIMS

The Assassin Bug *Pristhesancus plagipennis* (Walker) is a natural enemy that has considerable potential for controlling *Helicoverpa* spp. and plant-sucking bugs in a variety of crops including cotton. Like many predatory insects, assassin bugs are often scarce in crops at critical times.

A solution to this problem can be found by mass-rearing and releasing nymphs into crops as required for the control of insect pests. Previous experiments in cotton have demonstrated that during low to moderate pest pressure years, a single release of these predators was enough to provide control over a 6-8 week period resulting in equivalent yields to conventionally managed cotton.

The main aim of this small project was to further investigate the feasibility of releasing assassin bugs for the control of *Helicoverpa* spp. and mirids in conventional and Ingard cotton.

OUTCOMES

Previous research had suggested that assassin bugs could be effective at a density of 1.4 predators per metre row in cotton. In these experiments we measured the biological control provided by assassin bugs when released at lower rates of 0.25, 0.5, 0.75 and 1.0 nymphs per metre row and compared these to un-sprayed and sprayed treatments.

Results suggested that release rates of 0.5 or more nymphs per metre (equivelant to 5,000 nymphs/ha) provided significant reductions in the number *Helicoverpa* spp. larvae and mirids on cotton. Crop yields also increased significantly with the release

of assassin bugs. The data provides evidence to support the use of these predators as a biological control and substantiates further research that is orientated towards using assassin bugs as a tool within an Integrated Pest Management program.

Fifth instar assassin bug feeding on *Helicoverpa* larvae.

PROJECT NUMBER: 3.2.18 AC

Project Title: Measuring the Influence of Varying Water Quality on Drainage through Irrigated Cotton Soils.

STAFF

Rachael Zischke, DNRM, Indooroopilly, QLD.
Ian Gordon, DNRM, Indooroopilly, QLD.

AIMS

The effect of irrigation with saline water in Australian cotton growing soils appears to have been inadequately quantified. The effect on drainage due to irrigation water quality has the potential to significantly increase losses below the root zone, thereby decreasing water use efficiency and increasing the risk of water table pollution and irrigation salinity. This project aims to quantify the effect of irrigation water quality on drainage through three different cotton-growing soils, hopefully providing the incentive for the further work that will be required to progress the quantification into practical applications.

The project comprises 3 major measurement techniques, namely column trials and irrigation simulations, tensiometry, and lysimetry. Collaboration with other researchers and QDPI WUE officers will ensure that further instrumentation and other soil moisture measurement techniques to capture the "water balance" will also be involved, such as disk permeameters, Enviroscans, flow meters, and furrow advance measurements.

OUTCOMES

Sites for instrumentation and column collection have already been chosen on the Darling Downs and at St George. Meeting with the farmers and other stakeholders have taken place, and some instrumentation has begun at the Darling Downs site, namely the installation of a set of tube tensiometers. There has been some initial teething problems with these instruments, however, preparations are now underway to install the next two sets thus completing the replication for site 1. Preparations are also underway for the installation of four mini lysimeters at the Darling Downs site in mid June 2002.

Installing Tube Tensiometers at Darling Downs Site.

Measurement of conductivity characteristics for each soil is necessary if a drainage flux is to be calculated from the soil water potential readings of the tensiometer. To this end, disk permeameter work has already taken place at the Darling Downs site with preliminary data currently being interpreted, and similar work is planned for St. George. A third site will be established near Goondiwindi.

Trenched Disk Permeameter work at Darling Downs site.

Column collection and set-up is planned for all three sites during the July – September 2002 period. Prototype columns are currently under construction in order to assess the practicality of set-up techniques and planned peripheral components such as vacuum systems and drainage measurement devices. A

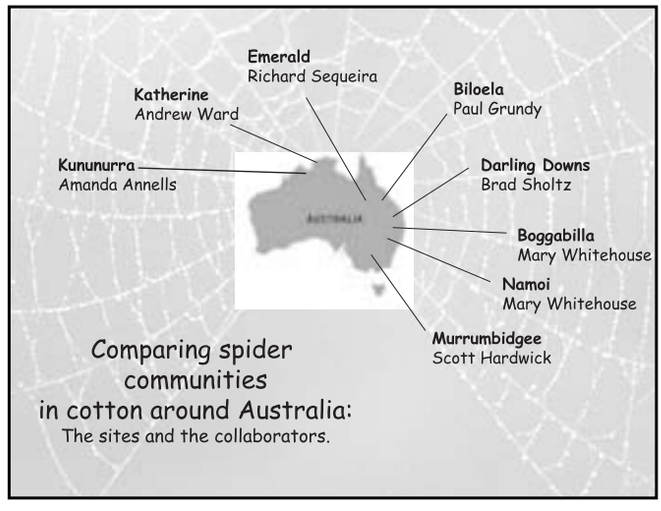
continuous rotational irrigation simulation regime is planned for 36 columns (12 from each soil type), including rainfall simulations and 'dry down' periods. A new 'compression-reduction' technique is being trailed in these columns in an attempt to reduce the problems associated with restricting a cracking-swelling soil in a column.

Assessment of new core cutting equipment (with thanks to Matt Redding, DPI Toowoomba)

OUTCOMES

With the help of many collaborators, we have sampled spiders in cotton crops at different sites around Australia. This has included crops at Biloela, Emerald, Darling Downs, Boggabilla, Namoi, Hillston, Katherine and Kununurra.

Once we analyse the results we will be able to establish whether the spider communities at these sites contain the same types of spiders, and whether the spider community changes during the course of a cotton season. With this information we will have a better understanding of the types of insect pests that are likely to be attacked by spiders, and a better understanding of how to make spiders more effective predators in cotton fields.



PROJECT NUMBER: 3.2.19 AC

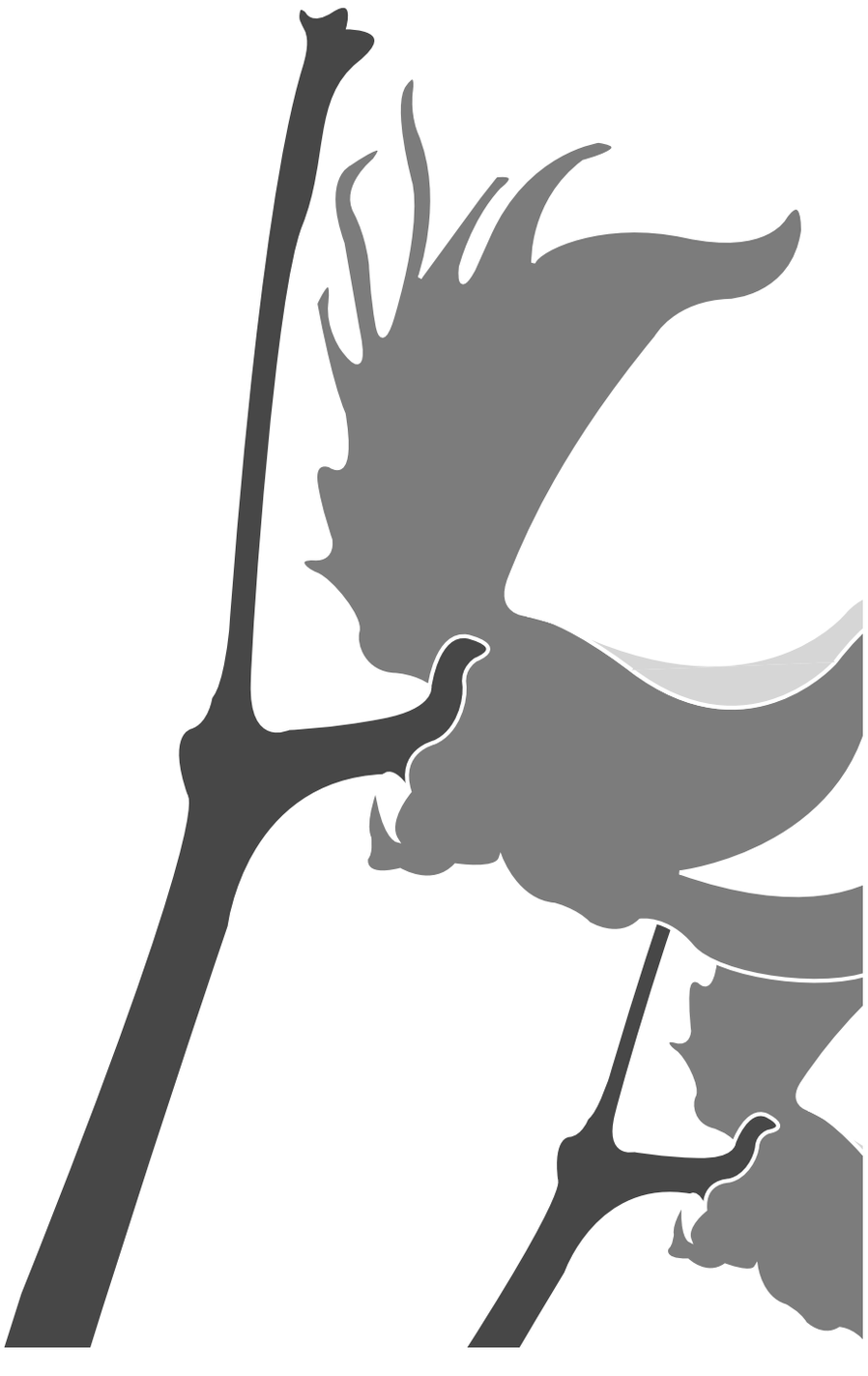
Project Title: The comparison of spider communities in cotton around Australia.

STAFF

Dr Mary Whitehouse, CSIRO Entomology, Narrabri, NSW.
Dr Geoff Baker, CSIRO Entomology, Canberra, ACT.

AIMS

The most abundant group of predators in cotton are spiders, but this large group of beneficials have been largely ignored. The first step in understanding how effective these predators are at controlling pests is establishing what species of spiders are active in cotton fields. Spiders tend to attack a group of insects rather than a particular species, but different spiders attack different groups of insects. In order to know which insect groups are attacked by spiders in cotton, we need to know what types of spiders are active in Australian cotton fields.



Program Four Overview

Education And Technology Transfer.

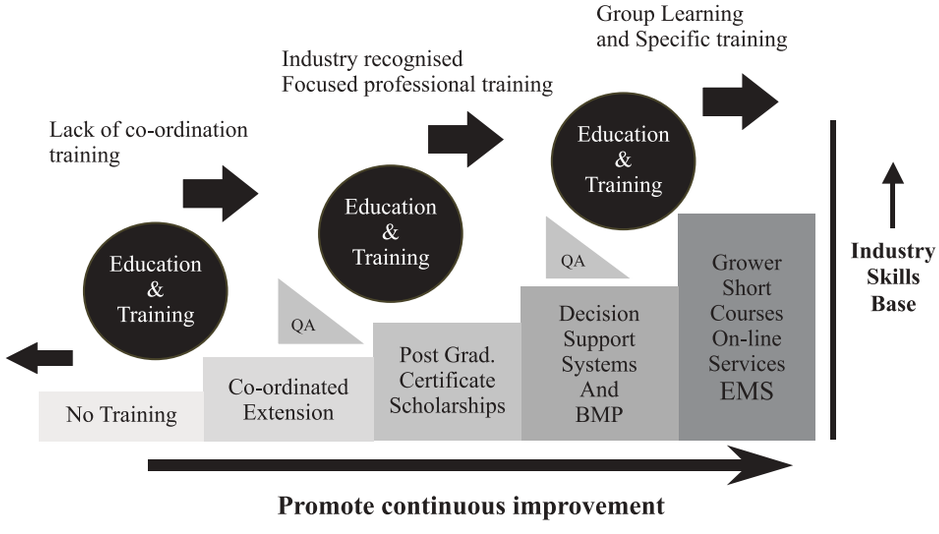
INTRODUCTION - EDUCATION AND TRAINING.

"Improving the skills base" of growers, consultants, research and extension staff working in the cotton industry is essential if the industry is to grow and survive into the future. New technology and practices for crop and natural resource management are being developed every year. To keep pace with this change, effective educational and training programs need to be in place. Educational programs developed within the CRC have initially targeted consultants, extension staff and key industry support personnel. Today specific training programs exist for growers and upgrading of the CRC Web site (www.cotton.crc.org.au) will improve the transfer of information not only to industry but also to the broader community.

The CRC's success in developing national training programs is well recognised. The CRC's certificate and post graduate certificate course in cotton production was recognised for its excellence by winning the Federal Governments 'National Business and Higher Education Training' award. New specialised grower focused short courses in IPM systems began with a series of pilot courses in 2001 and water management training programs will be operating by 2003. In collaboration with CRDC and Cotton Australia future training programs may be developed in Environmental Management Systems (EMS).

A key aspect contributing to the success of the CRC educational programs is the direct involvement of research staff in the delivery of courses and through the development of decision support packages which form a integral part of all training as well as supporting the industries BMP programs in crop and resource management.

EVOLUTION OF EDUCATION AND TRAINING IN THE CRC



A summer scholarship program provides the opportunity for undergraduate students studying relevant disciplines to work with researchers and extension staff of the Cotton CRC. This provides an entre to the CRC's extensive PhD scholarship program with some 20 postgraduate students currently supported. The final components of the education and training program is the promotion of scientific exchange and PhD scholarships.

AIMS AND OBJECTIVES

- Provision to industry of highly proficient consultants and agronomic management staff through continuation of certificate and post graduate certificate course in Cotton Production;
- Consultants fully accredited and participating in regular refresher courses;
- Cotton Production Certificate course being delivered to Australian and international Universities andstudents;
- Growers implementing farming systems using advanced management strategies learned from focussed short courses in IPM and BMP;
- Encouragement of high quality undergraduates to remain in agriculture through undergraduate and summer scholarships;
- Co-ordinated exchange program for industry researchers, extension officers and consultants operating within strong international networks.

HIGHLIGHTS AND ACHIEVEMENTS EDUCATION - COTTON PRODUCTION COURSE

The number of new enrolments and graduates for both the postgraduate and certificate course continues to grow. To help clear waiting lists, 35 people were admitted in 2002. A total of 20 students graduated from the course in April 2002 bringing total graduates to 112. There has been a steady increase in the proportion of people enrolling at the certificate level, which is encouraging and reflects the capacity of the course to meet the needs of those in the industry without any formal qualifications.

The course continues to be popular as an undergraduate elective "Applied Cotton Production" with over 54 students enrolled from 5 Universities. Positive feedback has been gained from the University of Queensland (Gatton) where the course was first introduced in 2001.

The course is endorsed by the Cotton Consultants Association of Australia as an essential training program for new consultants entering the industry. Over 50% of course graduates have been farm agronomists or consultants. The course also provides a key component of the training of new extension staff with in the Cotton CRC.

Change to the course structure in 2001 received positive feedback. The final unit "Cotton Production Systems" has a focus on putting to practise what has been learnt throughout the course. It involves farm case studies, grower implementation of BMP guidelines and area wide management strategies.

In line with objectives for the course to become more self-supportive, a business plan will be completed in 2002. This plan will assess the future of the course beyond the life of the CRC. Particular attention will be placed on assessing future demands for changes to the course content to reflect changes in crop production following the predicted increase in use of transgenic cotton. Existing modules in natural resource management and environmental management will also be reviewed to ensure that they meet industry demands. Opportunities for short courses in cotton production systems that could be offered the various services industries such as banks and chemical companies will also be assessed.

EDUCATION – SPECIALISED SHORT COURSES

A VETAB accredited "IPM" short course will be conducted with growers in the summer of 2002. It will provide an important step in increasing the skill base of growers and farm managers particularly at a time when the industry is expanding its adoption of IPM guidelines and area wide management strategies. The course will focus on the implementation of IPM strategies for insect control and will link with the industry 'Best Management Practice' (BMP) program.

The CRC water management extension and research team will target the development of an accredited training course in water management. The course outline will follow on from training programs developed by NSW Agriculture. To support the course new management guidelines will be developed in the form of written material, 'WaterPak' and computer decision support system 'HydroLOGIC'.

Through links to NSW Agriculture's WaterWise program, growers who complete the water management course will be able to receive State Government incentives to develop irrigation and drainage management plans.

POST GRADUATE SCHOLARSHIPS

Postgraduate Students at the Australian Cotton CRC Review June 2002. From Left to right Back row:- Florian Yan, Andrew Davies, Samual Lower, Richard Kent, Emma Cottage, Michael Zuckerman, Ingrid Renken, Middle row - David Britten, Sam Buchanan, John Harvey, Adam Downey, Amanda Cleary, Chrintina Hall Front row: Sven Delaney, Mick Rose, David Lea, Lisa Gulino and Sevage Bedrossian.

See Table on Right

SUMMER SCHOLARSHIPS

The summer scholarship program proved highly successful during the 2001/2002 cotton season with a diverse range of subjects covered:

- The role of spiders in controlling *Heliocoverpa* moths in cotton planted into wheat stubble;
- Evaluation of light traps for catching and suppressing *Helicoverpa* moths;
- Remediation of pesticides in water;
- Biological control of aphids;
- Ants as egg predators of *Helicoverpa spp.;*
- Environmental monitoring techniques for farm sustainability.

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 2001/2002. They included:-

- Professor S.E. Williams Department of Renewable Resources, University of Wyoming to the Northern Territory.
- Dr Nilantha Hulugalle (NSW Agriculture) - 6th Symposium of the International Society of Root Research, Nagoya, Japan.

COTTON CRC POST GRADUATE STUDENTS

Student	Degree	Commencement Date	Research Project Title/Thesis	University	Supervisors	Org	Funding	Current Status
Augusto Becerra Lopez-Lavalle	PhD	1 March 1997	Molecular genetic markers for accelerated selection of fusarium wilt resistant cotton cultivars - Project 3.2.4	USYD	Dr Bruce Lyon	USYD	Cotton CRC	In the process of writing up, due to submit mid 2001.
Broughton Boydell	PhD	1 March 1997	The applications of precision Agriculture techniques to cotton farming systems - Project 5.2.1	USYD	Prof Alex McBratney Dr Greg Constable	USYD CSIRO	Cotton CRC	Submitted April 2002.
Allison Cook	PhD	1 March 1998	Genetic marker systems for molecular breeding of cotton cultivars with enhanced resistance to fungal wilt disease - Project 3.2.7	USYD	Dr Bruce Lyon Dr Danny Llewellyn	USYD CSIRO	Cotton CRC	Due to submitt end of 2002.
Chris Dorahy	PhD	7 September 1997	Phosphorus nutrition of cotton - Project 5.3.1	UNE	Mr Ian Rochester A/Prof Graeme Blair	CSIRO UNE	Cotton CRC	Submitted June 2002.
Janelle Montgomery	PhD	21 August 1995	Water Application and Hydrology	UNE	A/Prof Don MacLeod Dr Richard Faulkner	UNE UNE	Cotton CRC	Extension due to submitt March 2003.
Olivia Kvedaras	PhD	1 July 1997	Mating behaviour in Helicoverpa armigera: influence of host plants - Project 2.2.13	UNE	A/Prof Peter Gregg	UNE	Cotton CRC	Submitted August 2002.
Dainis Rungis	PhD	1 March 1997	Development of molecular marker technologies in cotton - Project 3.2.5	USYD	Dr Elizabeth Dennis Dr Danny Llewellyn Dr Bruce Lyon	CSIRO CSIRO USYD	Cotton CRC	Submitted March 2002.
Warwick Stiller	PhD	1 January 1995	Improving water use efficiency of cotton	USYD	Dr Greg Constable Dr Lyndsay O'Brien Dr Bruce Sutton	CSIRO USYD USYD	Cotton CRC	Submitted mid 2000 - currently employed by CSIRO in plant breeding.
Mohammed Faruque Ahmed	Masters of Science in Agriculture	March 1997	Understanding the salinity threat in cotton growing areas of Australia Phase III - implementation and management - Project 3.2.0 AC	USYD	Prof. A McBratney Dr John Triantafilis Dr I Odeh	USYD USYD USYD	Cotton CRC	Submitted March 2001.
Andrew Huckel	Masters of Science in Agriculture	March 1997	Understanding the salinity threat in cotton growing areas of Australia Phase III - implementation and management - Project 3.2.0 AC	USYD	Prof. A McBratney Dr John Triantafilis Dr I Odeh	USYD USYD USYD	Cotton CRC	Submitted March 2001.
Esta Kokkoris	Masters of Science in Agriculture	March 1999	Understanding the salinity threat in cotton growing areas of Australia Phase III - implementation and management - Project 3.2.0 AC	USYD	Prof. A McBratney Dr John Triantafilis Dr I Odeh	USYD USYD USYD	Cotton CRC	Due to submit March 2003.
Angus Crossan	PhD	March 1997	Development of standard environmental tests for herbicides needed in cotton production - Project 1.1.5	USYD	Prof. Ivan Kennedy Dr Robert Caldwell	USYD USYD	CRDC	Submitted March 2001.
Marian Dunbar	PhD	March 1998	Quantitative Inventory of the irrigated cotton soil for sustainable land resource management - Project 1.2.1	USYD	Prof. A McBratney Dr I Odeh	USYD USYD	APA	Due to submit end 2002
Sevag Bedrossian	PhD	January 2000	Potassium Status and Mineralogy of Soil in relation to premature senescence	USYD	Dr Balwant Singh	USYD	CRDC	Due to submit in 2003
Andrew Davies	PhD	14 February 2000	Ecology of the Trichogramma egg parasites in the Ord River Irrigation Area and their role in cotton IPM	UQ	Prof Myron Zalucki	UQ	CRDC	Due to submit February 2003.
Dave Britton	PhD	1 August 1999	Studies of slow release formulations for semiochemicals in cotton pest management	UNE	A/Prof Peter Gregg	UNE	CRDC	Due to submit March 2003.
Craig Stewart	PhD	July 1998	Development of 'Nutrilogic' for precision agriculture - a decision support system for agrotechnology transfer in the cotton industry	USYD	Prof Alex McBratney	USYD	CRDC	Due to submit March 2003.
Constanza Angelucci	PhD	February 1998	Binding sites for the Cry1Ac delta-endotoxin of Bacillus thuringiensis in Helicoverpa	ANU	Dr Ray Akhurst	CSIRO Ento	CRDC	Due to submit early 2003.
Mark Wade	PhD	28 February 2000	Biology, ecology and utilisation of the Damsel Bug as a predator in cotton - towards real IPM	UQ	Prof Myron Zalucki	UQ	CRDC	Due to submit early 2003.
David Lea	PhD	1 March 1999	Risk factors for silverleaf whitefly outbreaks in cotton	USQ	Prof Myron Zalucki	UQ	CRDC	Due to submit June 2002.
Emma Louise Cottage	PhD	1 February 1998	Management of resistance in Bemisia tabaci to insect growth regulators and juvenile hormone mimics	UNE	A/Prof Peter Gregg	UNE	CRDC	Due to submit in 2002
Florian Yan	PhD	1 February 2001	Cotton Soil Health: influence on cotton root diseases	USYD	Dr Les Copland, Dr Tony Vancov, Dr David Nehl, Dr David Backhouse.	USYD NSW AG NSW AG UNE	Cotton CRC	Due to submit June 2004
Lisa Gulino	PhD	1 July 2000	Molecular diagnosis of Fusarium wilt of cotton in Australia	UQ	Dr Suzy Bentley	UQ/ CRCTPP	Cotton CRC/ CRCTPP	Due to submit June 2003
Adam Downey	PhD	1 July 2000	The effects of cotton defoliants on native trees from north western NSW field based experiments.	UNE	Dr John Duggin Mr Guy Roth	UNE	Cotton CRC	Due to submit September 2003
Samuel Lower	PhD	1 July 2001	Pheromones for occasional pests of Cotton.	UNE	Assoc/Prof Peter Gregg	UNE	Cotton CRC	Due to submit June 2004
John Harvey	PhD	1 February 2001	Diversity and pathogenicity of Thielaviopsis basicola	UQ	Dr Elizabeth Aitken	UQ	Cotton CRC	Due to submit January 2004.
Richard Kent	PhD	1 January 2002	The role of weeds as alternative hosts of Fusarium wilt in cotton.	UNE	Dr Brian Sindel	UNE	Cotton CRC	Due to submit December 2004.
Simon Speirs	PhD	1 September 2002	Characterizing soil structure stability and form of sodic soil used for cotton production.	USYD	Dr Stephen Cattle	USYD	Cotton CRC	Due to submit December 2004.
Damien Field	PhD	1 January 1998	The Bricks and Mortar of Vertosols "The xharacteristics of aggregation and assessing aggregate stability of vertosols used for cotton production.	USYD	A/P Toni koppo/Dr Stephen Cattle.	USYD	Cotton CRC	Submitted June 2000.
Ingrid Rencken	PhD	1 January 2002	Role of Native vegetation in harboring beneficial insects and reducing insect pest damage in cotton.	UNE	Ian Gordan	DNR	Cotton CRC	Due for submission April 2005.
Rose Roche	PhD	1 July 2001	Training in crop physiology - Functional responses of cotton to environment mediated via internal nitrogen dynamics.	CSIRO PI	Dr Michael bange.	CSIRO PI	CRDC	Due June 2004
Amanda Cleary	PhD	August 2001	The effect of cerial stubble on Helicoverpa activity in early season cotton.	QDPI	Dr David Murray	QDPI	CRDC	Due August 2004
Sven Delaney	PhD	February 2001	Development of gene promoters for cotton fibre development.	UA	Dr Sharon Orford	UA	CRDC	Due December 2003
Brendon Griffiths	PhD	July 2001	Simple field based test kit for pyrethroids.	NSW Ag	Ass/Prof Peter gregg.	UNE	CRDC	Due June 2002.
Adam Loch	PhD	February 2002	Estimating the impacts of Best Management Practices on public values for environmental tradeoffs in the Fitzroy Basin.	UCQ	Dr Colin Rolfe	UCQ	CRDC	Due December 2003
Damien Lightfoot	PhD	March 2002	Fibre improvement throughmodulation of transitions in cotton development.	UA	Assoc/Prof Jeremy Timmis	UA	CRDC	Due February 2005
Christina Hall	PhD	March 2002	Defence mechanisms of cotton against Fusarium oxysporum f.sp. Vasinfectum and control of fusarium wilt.	UM			CRDC	Due December 2004
Sam Buchanan	PhD	January 2002	Hydrological impacts of irrigation in the Burke district.	USYD	Dr John Triantifilis	USYD	CRDC	Due December 2004
John Humphries	PhD	February 2002	Analysis of TTG1 homologues in cotton for roles in fibre initiation.	UA	Assoc/Prof Jeremy Timmis	UA	CRDC	Due February 2005
Adriane Machado	PhD	March 2002	Gene discovery in cotton fibre initiation and development by comparing cotton lintless mutants to wild type on cotton ovule cDNA microarrays.	CSIRO PI	Dr Elizabeth Dennis.	CSIRO PI	CRDC	Due March 2005.

- Dr Letitia Silberbauer (UNE) - 1st International Symposium on Biological Control of Arthropods, Hawaii.
- Dr Stephen cattle (USYD) - To visit Texas A&M University, USA for collaborative research.

INFORMATION DELIVERY AND DECISION SUPPORT

Success of technology transfer is dependent on the rapid distribution of research outcomes to growers. To achieve this researcher and extension staff work together to develop a range of written and computer based decision support systems. To make these systems readily available to growers a number are available on the CRC Website.

In developing decision support systems links are made to the industries BMP program and training programs. They form a vital resource for extension staff in the development of nationalextension activities.

To further advance the delivery of field based decision support systems and data collection, researchers have utilised handheld Palm pilot technology. The use of 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.

Advances in the user-friendly crop simulation model, OZCOT has continued throughout 2001/02. The use of this model will provide an important extension tool in aspects of insect management, fertilizer use and water management. It will also allow growers to run a range of simulations to assist in risk management, particularly during periods of limited water, delayed planting or hail damage.

The CRC Website (www.cotton.crc.org.au) forms a vital link to growers and support industries as well as the broader community. The website has been updated in 2002 to provide a data based driven and interactive site. These improvements provide more effective access of information.

Resent surveys have shown that growers access the Internet at least twice a week. The CRC Website is already one of the most popular internet sites in the industry. Future promotion of the information on the site combined with update listings of new research outcomes will further promote the Website as a effective tool to access information and communicate to researchers and extension staff.

Technology Transfer

INTRODUCTION

The adoption of Cotton CRC research outcomes is vitally important to promote a sustainable cotton industry. The utilisation and application of the research is an integral part of the Cotton CRC strategic plan. The commercial benefit of the research flows to the growers, the region and to Australia through increased productivity and fibre quality; regional development; sustaining the resource base and the environment; reduction in the use of pesticides; and increased export earnings.

Effective extension programs continue to communicate research findings to individual cotton growers and to industry. A network of regional industry development officers (IDOs) participates in establishing on-farm demonstrations and field trials with grower and consultant participation. This is enhanced by the coordination and facilitation of grower groups and support networks to discuss and disseminate these findings. Regional newsletter and trial books effectively disseminate information and field days and farm walks are key activities for demonstrating and sharing experience related to new technologies.

AIMS AND OBJECTIVES

The provision of a coordinated national extension service to the Australian cotton industry using modern techniques and delivery systems and working in partnership with growers and consultants to demonstrate, adapt and adopt new technology by:

- Expanding and enhancing the national cotton extension service 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 originally established by the CRC Sustainable Cotton Production continues to provide an excellent foundation for the development of a cohesive, well-focused and coordinated extension team. The cotton extension team, which includes extension officers in NSW Agriculture, DPIQ and CRDC, has a national focus on major industry issues and a prioritised list of regional problems.

The CRC Cotton Extension Committee comprising Dallas Gibb, (NSWAg), Geoff McIntyre, (DPIQ), Bruce Pyke and Adam Kay, (CRDC) and Bruce Finney, (ACGRA) provides leadership of the extension team.

The National Cotton Extension Coordinator, Ingrid Christiansen, who commenced duties in March 2001, has ensured a coordinated focus on national extension priorities and the development and implementation of the most effective delivery methods. The development of training opportunities for extension officers and the establishment of industry wide linkages are key objectives for the coordinator.

There have been several changes in the extension team during the year highlighted by the establishment of an IDO position at Narrabri and the appointment of two trainee Industry Development Officers. The immediate extension team now includes:

- Twelve Industry Development Extension Officers including the two trainees and seven Water Use Efficiency extension officers located strategically throughout the industry;
- One Extension Technical Officer;

- Five farming systems extension officers and five irrigation extension officers in NSW Agriculture and DPIQ who contribute part of their time to cotton industry extension activities;
- Two spray application development extension officers;
- The IPM Training Coordinator in DPIQ.

The establishment of trainee Industry Development Officers positions ensures that we have the capacity to maintain continuity in the management of vacancies and special leave in the team. The first trainee was appointed to the Narrabri position in 2000/01, with a second established at Emerald during 2001/02.

FOCUS GROUPS

The Extension Team has maintained six focus groups that are responsible for identifying and prioritising national issues and planning and resourcing nationally focussed extension programs. The groups and time allocated to each by 100s are:

NATIONAL FOCUS	TIME SPENT
Insect Management	44%
Farming Systems	20%
Disease Management	19%
Weed management	9%
Environment	6%
Water Use Effeciency*	2%

*Does not include the DPIQ RWUE Project extension officers or the NSW Agriculture Irrigation Officers all of whom work full time on water extension programs.

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 provided in other workshops during the season.

Major activities have included:
- Increased establishment of IPM and area wide management grower groups;
- A series of insect management, agronomy and farming systems trials in collaboration with research officers and growers;
- Detailed development and implementation of disease management extension by the CRC Fuscom group;
- A large number of pesticide application workshops for growers;
- Continuing support of regional grower groups and demonstration trials in the RWUE project;
- Cotton Tales newsletters published at various intervals in all major cotton growing valleys;
- Publication of regional trial books;
- Publication of the Crop Rotation Chart;
- Completion of the second industry benchmarking study following the first three years ago;
- Focus group evaluation of IPM and AWM;
- Survey evaluation of grower use of information resources.

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. It is supported by the IPM Training Coordinator who has developed a grower focussed training program and delivered three pilot courses and by the project undertaking the economic assessment of IPM and insecticide resistance management (IRM) strategies. The assessment is based on data sets from IPM grower groups during the last two seasons and has demonstrated conclusively that fewer insect sprays can be associated with higher profit margins whilst deriving significant environmental benefits.

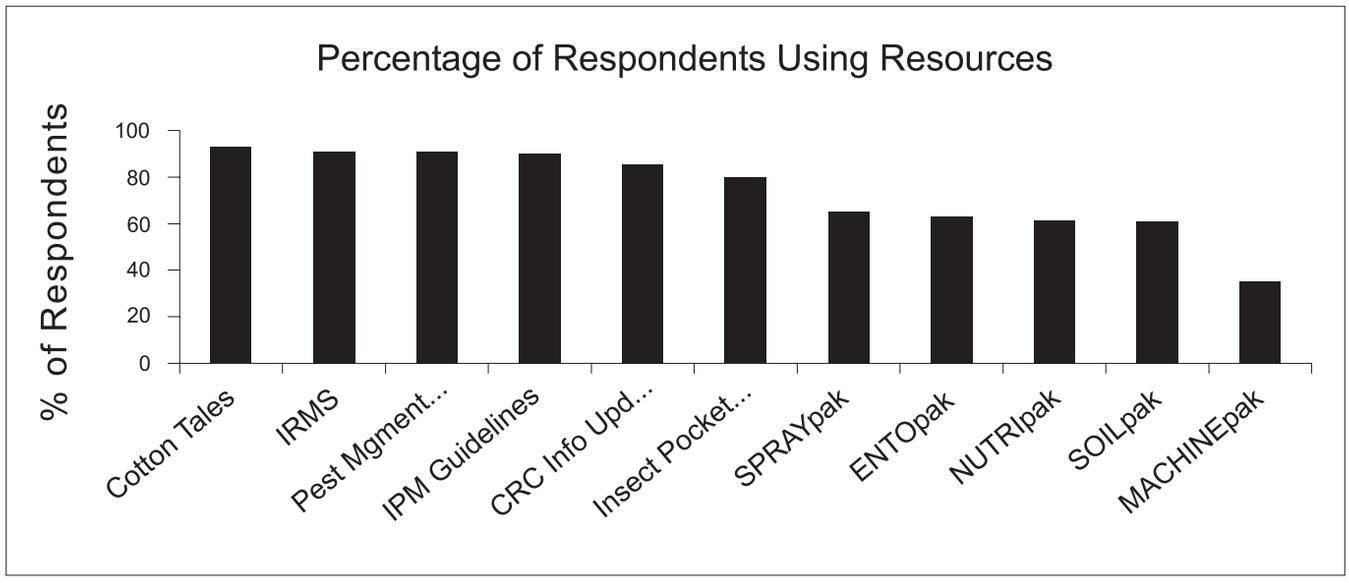
Results from our regular benchmarking survey indicate that growers preferred methods of improving knowledge of technology (in ranked order) are:
1. Mini field days and farm walks
2. Grower groups
3. Field days
4. Farm visits
5. District trial books
6. Training workshops
7. Newsletters and product information sheets
8. Rural press
9. Radio and TV.

and that the five most important topics are:
1. Soft options for insect management – AWM and IPM;
2. Water Use Efficiency;
3. Disease Management;
4. Crop nutrition;
5. Ground spray application and drift reduction.

Up to 68% of growers indicated a willingness to participate in nationally accredited training courses related to insect, disease, soil and farming system management.

The more recent CRC Cotton Information Resources Survey has indicated that currently 90% of grower have access to the internet and 38% use the CRC website.

The evaluation of IPM and AWM has demonstrated a wide level of acceptance throughout the cotton industry with a high level, broad understanding of IPM principles and practices evident across all industry sectors. This represents a significant change from 1997 where there appeared to be a lack of understanding and confidence in IPM systems amongst both growers and consultants.



In evaluating the use of key CRC extension publications by growers and consultants it has been shown that local newsletters such as 'Cotton Tales' are an effective methods of providing information to the industry. CRC publications in pest management are also well recognised across the industry. Packages suck as NutriPAK, DiseasePAK and EntoPAK are widely used by the IDO's. We have continued to deliver the "cotton and grains" project as part of the Rural Water Use Efficiency Initiative of the Department of Natural Resources and Mines in Queensland. The four-year program is delivered by the project coordinator and five extension officers through DPIQ. A mid term review of the project has demonstrated good progress toward achieving the objective of a 10% increase in WUE in QLD cotton and grain industries. Effective linkages have been maintained with a similar NSW Agriculture initiative to deliver similar outcomes in NSW.

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 outbreak of silverleaf whitefly in central Queensland this year, was one example of how the extension team can rapidly mobilis a response.

COMMUNITY LIAISON

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.

Liaison and communication with the broader community and environmental groups at a national level is a primary function of Cotton Australia and includes activities coordinated by the Cotton CRC.

Project Summaries

PROJECT NUMBER: 4.1.00 (SX 5)

Project Title:

SCIENTIFIC EXCHANGE:- Beneficial mycorrhizas associated with commercial cotton and native Hibiscus species growing in the monsoonal tropics of northern Australia

STAFF

Dr. S.E. Bellgard[1], Northern Territory Department of Business, Industry and Resource Development, Katherine, Northern Territory.

Visitor Professor: S.E. Willams[2] Department of Renewable Resources, University of Wyoming, PO Box 3108, Laramie, WY 82071, USA.

SUMMARY

Soil conservation may be viewed as the backbone of any sustainable agricultural program; it entails management practices that minimise soil erosion while they maintain soil fertility. Because of their beneficial role in attaining available soil nutrients for the host-plant-partner, mycorrhizal fungi are

an important, and much overlooked, contributor to this process. The importance of mycorrhizal fungi in sustainable agriculture is based on their role as a link between plant and soil.

Cotton is a mycotrophic plant in which growth and nutrient uptake is usually increased by mycorrhizal colonisation. The "Northern Development of the Cotton Industry" is based upon a sustainable cotton farming system. Very little information is available about the mycorrhizae associated with crop plants in the NT. A preliminary investigation in 1987 of maize plants and their mycorrhizae found infection levels up to 45% (J.P. Thompson, *pers. comm.*). No information is available on commercial cotton and its companion crops.

The visit of Prof. Williams allowed us to document for the first time the density and diversity of mycorrhizal fungi associated with cotton grown at Katherine. Additionally, samples were taken of native relatives of commercial cotton that occur naturally in the Katherine-Daly Basin. These included: *Hibiscus leptocladus* and *H. meraukensis*. The associations that were found to occur with cotton and native *Hibiscus* were very similar.

Hibiscus meraukensis and *H. leptocladus* are two members of the Malvaceae that occur in the native bush of Katherine. *Gossypium hirsutum* V16 Ingard® is being grown experimentally under overhead lateral irrigation at the Katherine Research Station. Both the native *Hibiscus* species and commercial cotton possessed mycorrhizal associations comprising; vesicles, arbuscules, internal and external hyphae, and in some cases extra-radical spores. The density and diversity of the mycorrhizal spores associated with the roots of the native and cultivated plant species also showed a high degree of similarity.

The genera of mycorrhizal spores identified were; *Acaulospora, Enthrophspora, Glomus, Sclerocystis* and *Scutellospora*. The native soils of the Katherine region have the mycorrhizal fungi necessary for the development of symbiotic associations with commercial cotton cultivars.

PROJECT NUMBER: 4.1.00 (SX 6)

Project Title: SCIENTIFIC EXCHANGE:- 6th Symposium of the International Society of Root Research, Nagoya, Japan

STAFF

Dr Nilantha Hulugalle, NSW Agriculture, Narrabri, NSW.

SUMMARY

Two papers were presented by Dr. Hulugalle at the 6th Symposium of the International Society of Root Research held at Nagoya, Japan, from 11-16 November 2001. These were:

1. Present a volunteered paper entitled *"Root growth and water depletion under wheat and grain legume crops sown in rotation with cotton in a Vertisol, by N. R. Hulugalle and P. C. Entwistle";*

2. Provide an oral presentation entitled *"Root systems of wheat sown in rotation with cotton can affect some soil physical properties"* at a workshop on wheat roots.

The conference was attended by 338 delegates from 33 countries.

While several non-invasive systems of monitoring root dynamics exist, only the computer-guided minirhizotron system can as yet be applied to field use. In addition, it can also be used to quantify population dynamics of soil microflora (inc. mycorrhiza), root diseases, macro- and meso-fauna, and soil carbon and possibly, nitrogen sequestration.

Disadvantages are its need for careful calibration and management/analysis of a very large number of computer-generated images. However, X-ray CT scans and electron micrography, in combination with appropriate models, can clarify the mechanisms of C deposition by root systems and their effects on soil structure.

Laboratory methods based on thin layers of paraffin wax and petroleum jelly can provide preliminary evaluation of crop species' and varieties' root tolerance to soil strength. This technique is possibly one that local plant breeders could use to evaluate variety tolerance to salinity, sodicity and toxic ions.

The soil immediately adjacent to the root system, such as the rhizosphere and rhizosheath and its associated fungi, mesofauna and mycorrhiza, are key elements in the functioning of a plant's root system and consequently, plant growth. The strong interest in soil biological health being expressed by industry sources is contrasted by the lack of expertise in this area in the Australian Cotton industry. During this conference I made contact with the research group led by Margaret McCully (CSIRO Division of Plant Industry in Canberra).

Post-conference tours (15-16 November) were made to the Kanaya Tea Research Institute of the National Institute of Vegetable and Tea Science and "Gyokuro no Sato", Village of Superior Tea, in Shizuoka prefecture, returning via the city of Kyoto. The tour studied upland and lowland land use, soils (alluvial soils in the lowlands and Andosols in the uplands) and cropping systems in this region. Major crops in this region include rice, tea, citrus, vegetables and bamboo.

PROJECT NUMBER: 4.1.00 (SX 7)

Project Title: SCIENTIFIC EXCHANGE - Visit of Dr S.R. Cattle to Texas A&M University.

STAFF

Dr Stephen Cattle, USYD, Sydney, NSW.

BACKGROUND AND AIMS

In 1995/96, Dr Richard Drees (Texas A&M University) and Dr Tony Koppi (USYD) participated in a CRC for Sustainable Cotton Production-funded exchange which characterised the micromorphologic and structural features of Vertosols under various cotton production systems. The exchange culminated in the preparation of a full set of soil thin sections from three profiles at each of the CRC farming System sites (Merah North, Warren, Dalby).

The aims of this scientific exchange, were for Dr Stephen Cattle to travel to Texas A&M University and work with Dr Richard Drees to:
1. throughly analyse the collection of thin sections for a range of soil structural attributes using the image analysis software Solicon;
2. describe the micromorphological features of the thin sections from the different sites and treatments using optical microscopy; and
3. to commence the preparation of manuscripts for submission to peer-reviewed journals on the results of these analyses.

OUTCOMES

Dr Cattle travelled to texas A&M University in late November 2001 and spent 4 weeks working with dr Drees to analyse approximately 160 photographic images of soil thin sections using the Solicon software. The analysis indicated quite pronounced structural differences between the different soil types, but only small differences between the soil samples representating different crop rotation treatments at the same location. A subset of the thin sections were also inspected using light microscopes to identify similarites and differences in soil attributes such as mineral composition, gravel content, aggregate shape and size, organic constituents and other micromorphological features. once again, differences between soild of the different regions were much greater than differences between soil samples subject to the various crop rotations at each of the three locations. microstructureal features, calcium carbonates and soil floral material were attributes that fluctuated quite markedly between regions.

two manuscripts resulted from the exchange; Edaphic and Management Impacts on Structural properties of vertisols in Eastern Australia. I. micromorphology and Physico-Chemical Properties, and II. Quantification of Structural Form. Both manuscripts are close to completion and will be submitted to the journal of the Soil Science Society of America.

PROJECT NUMBER: 4.1.00 (SX 8)

Project Title:
SCIENTIFIC EXCHANGE:- 1st International Symposium on Biological Control of Arthropods, Hawaii.

STAFF

Dr. Letitia Silberbauer, UNE, Armidale, NSW.

SUMMARY

Dr Silberbauer's attendance at the First International Symposium on Biological Control of Arthropods (ISBCA) in Hawaii, January 2002 allowed presentation of a paper and a poster.

She was able to meet with pre-eminent international researchers in the field of arthropod biocontrol expanding her network of contacts in this field. Exposure to the latest research and techniques in this area will allow considerable expansion of local research while some new collaborations were established.

PROJECT NUMBER: 4.1.2

Project Title: Post Graduate Certificate and Certificate in Rural Science (Cotton Production).

STAFF

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

Undergraduate Students Richard McKay, Jessica Shannon, Lee Streeter, Sarah Web and Connor Fitsgerald. All did the Cotton Module as part of their undergraduate degrees.

AIMS

The aim of the Post-Graduate Certificate and Certificate in Rural Science - Cotton Production, is to provide graduates with the necessary scientific and practical skills for sustainable cotton production. The course is directed at people already in the cotton industry and to those wishing to enter the industry in the future.

Graduates of the course learn how the cotton crop grows, how to manage the crop and the factors that affect the sustainability of cotton production in Australia. The Certificate course is offered to students who do not have a university degree. The Post-Graduate Certificate is offered to students that have completed a degree or equivalent study. Both certificates have the same curriculum and students are required to complete the following four subjects;

* Applied Cotton Production Cott 300/500 1st Semester
* Cotton Crop Protection Cott 301/501 2nd Semester
* Cotton and the Environment Cott 302/502 1st Semester
* Cotton Production Systems Cott 303/503 2nd Semester

OUTCOMES

The course continues to attract a full compliment of 35 externally enrolled students each year. This limit maintains the quality of the residential schools, which thrive on interactive activities on farm and at the Australian Cotton Research Institute. An online section of each unit provides 10% of the assessment and allows students to interact outside the residential schools.

Following Mr Guy Roth's appointment to the Cotton Research and Development Corporation (CRDC), Dr John Stanley was appointed as Course Coordinator. A course evaluation conducted by Guy Roth via a survey of the last three years' of graduates, is summarised below:

- 100% agreed the course notes were useful and well organised
- 93% indicated that they had used the course notes since completing the course
- 100% considered the residential schools useful, and 98% agreed that they should be compulsory
- 88% considered the course was well organised and run
- 100% felt that the course helped their work, and 93% thought that it fulfilled a valuable training role for the industry.

In 2001, the first unit of the certificate (Applied Cotton Production, COTT300) was delivered at the Universities of Sydney (Uni Syd) and Queensland (UQ) as well as the University of New England (UNE), as part of their respective degrees in Agriculture. This continued in 2002 with a two-day residential school, presented by the course coordinator, at each institution midway through the first semester.

The course at UNE and UQ (Gatton College) also includes weekly tutorial sessions. This year there were 52 internally enrolled, undergraduate students, fairly evenly distributed between the three institutions.

PROJECT NUMBER: 4.1.06 SS1

Project Title: Summer Scholarship: Farm Sustainability and Environmental Monitoring techniques.

The CEO of the Australian Cotton Cooperative research Centre Dr Gary Fitt with Summer Scholarship holders Robert McMahon, Natakie Elias, Chris Anderson and Leah MacKinnon, Martin Dillon one of the project supervisors is also present.

STAFF

Ms Rebecca Smith, UNE, Armidale, NSW.
Mr Guy Roth, CRDC, Narrabri, NSW.

INTRODUCTION

The impact of an agricultural system on the environment is a prominent issue, as shown by the development the Best Management Practice Manual to assist farmers manage environmental risks. It is vital to monitor the impact a system is having on the immediate environment. At this stage, the Australian Cotton Industry does not have a "standard" system that makes this monitoring and recording process simple, cheap and easy for farmers.

Initially, it is necessary to identify farm management aspects that have an affect on the environment. Issues include the use of chemicals and irrigation water, soil biota, salinity, erosion, birds and trees. Changes in these aspects can be short or long term, but in both cases it is first necessary to benchmark the quality of the farm environment in order to monitor the change. This was the aim of the Cotton CRC Summer Scholarship carried out around several farms in the Dirranbandi district in 2002.

Seven issues were identified as having potential for simple monitoring procedures. These were as follows:

1. PESTICIDE - monitoring of residues in tail water from Ingard and conventional cotton varieties and measurement of persistence in the sediment of storages

2. WATER QUALITY – salinity and nutrient status around the farm during an irrigation, and monitoring a series of storages along the river and throughout the season
3. WATER USE EFFICIENCY – timeliness and efficiency of irrigation events
4. SOIL QUALITY – macro fauna in cotton soils relative to other crops
5. BENEFICIAL INSECTS – status in cotton and other crops and pastures
6. BIODIVERSITY – area of a farm which has been developed relative to that under the native flora and undisturbed trees and grassland
7. GMOS – monitoring the positioning of genetically modified crops such as Roundup Ready® cotton and Ingard®

The project focused on water quality (salinity & nutrients), pesticide runoff, and beneficial insect numbers.

Results from the project will be presented as my thesis in October 2002.

PROJECT NUMBER: 4.1.06 SS2

Project Title: Summer Scholarship: Remediation of pesticide residues in cotton farm tailwater by constructed and natural wetlands

STAFF

Mr Mick Rose, USYD, Sydney, NSW.
Dr Angus Crossan, UDSYD, Sydney, NSW.
Prof. Ivan Kennedy, USYD, Sydney, NSW.

There is current concern over the high levels of pesticide residues that can be found in recirculated irrigation waters on cotton farms. This summer scholarship study has established the baseline potential for an integrated bioremediation system (IBS) to remove diuron, fluometuron and aldicarb residues from irrigated cotton tailwater. The IBS consisted of two wetland ponds in series, one open and the other vegetated, followed by a microbial bioreactor. The whole system was established on a property near Narrabri. We thank Mr. Phil norrie for his great support.

Pesticide levels in tailwater were seen to decline after successive irrigations following a single pesticide application. Pesticide levels were also observed to decline by up to 40% over a twelve-day period in the integrated bioremediation system, however no significant differences were observed between each stage of the system or between different pesticides. Growth of vegetation in the integrated bioremediation system was less than anticipated, warranting the need for a second year of study after further plant growth. In a related study, no spatial reduction of pesticide was observed over 60 m of a naturally vegetated taildrain. The results of this trial should provide a base to further develop a remediation system capable of accelerating pesticide removal from cotton farm tailwaters.

PROJECT NUMBER: 4.1.06 AC SS3

Project Title: Summer Scholarship - Biological control of *Helicoverpa*.

STAFF

Mr Chris Anderson, USYD, Sydney, NSW.
Dr David Nehl, NSW Agriculture, Narrabri, NSW.

AIM

The aim of this project was to investigate the potential for a fungus to deter feeding and/or reduce the proliferation of aphids in cotton.

OUTCOMES

A fungus that was originally isolated from cotton at Narrabri was kindly provided by Dr Peter McGee, University of Sydney. The potential for this fungus to deter feeding by *A. gossypii* was investigated by conducting choice and no-choice experiments. Aphids were either placed directly onto cotton-leaf disks (with or without prior inoculation with the fungus), or placed between the disks, and their movement was assessed. The source of the leaf disks was changed in different experiments to test for deterrent effects that were either localised or systemically induced in nearby and distant leaf tissue.

KEY OBSERVATIONS:

- Aphids preferred inoculated leaf disks over non-inoculated disks that came from a different plant
- Aphids showed no preference if the inoculated and non-inoculated disks came from the same plant, indicating that a systemic response made the non-inoculated disks equally attractive to the inoculated disks.

Plants in the glasshouse were inoculated with the fungus and nine aphid nymphs were placed on each plant. The subsequent increase in population was compared to non-inoculated plants over the following 20 days.

KEY OBSERVATIONS:

- The populations of aphids feeding on plants inoculated with the fungus initially increased at the same rate as those feeding on non-inoculated plants.
- After 12 days the rate of increase was slower on inoculated plants, suggesting the production of plant and/or fungal products that act (i) directly upon the reproductive physiology of aphids and/or (ii) on aphid growth rates and hence time to reproductive maturity.

These experiments have demonstrated the potential use of fungi as biological control agents that may reduce the proliferation of aphids in cotton. The observation that this fungus rendered plants more attractive to aphids (rather than deterring them) attests to the complex nature of plant/fungus/pest interactions. This attractiveness could be exploited in the deployment of IPM for the cotton aphid.

PROJECT NUMBER: 4.1.06 AC SS4

Project Title: SUMMER SCHOLARSHIP - Ants as egg predators of *Helicoverpa spp.*: Measurement of abundance and the effect of Agronomic practices.

STAFF

Ms Natalie Elias, USYD, Sydney, NSW.
Dr Sarah Mansfield, CSIRO Entomology, Narrabri, NSW.

AIMS

This project involved extensive observations of ant behaviour in cotton under different agronomic conditions including dryland, irrigated, and cotton planted into retained wheat stubble. Several sampling techniques for measuring ant abundance (beat sheet, visual inspection, Tanglefoot traps) were tested. Exclusion experiments were also used in order to test the effect of ground dwelling predators on *Helicoverpa* egg predation.

Ants are significant predators of lepidopteran eggs, including *Helicoverpa* spp. in cotton crops in the USA, Brazil and East Africa. *Pheidole, Iridomyrmex vicinus, Rhytidoponera metallica,* and *Paratrechina* are four common ant species found on cotton in Australia. However, quantitative data is lacking on the significance of ants as egg predators in Australian cotton crops.

In addition, sampling protocols to measure ant abundance have not yet been fully developed. As a result, the inclusion of ants in IPM systems has been restricted. A more thorough understanding of ant foraging would allow recommendations for crop scouting to be made. If ants are found to be significant predators of *Helicoverpa* eggs early in the cotton season, then conservation of ant populations may be considered when making management decisions.

OUTCOMES

Iridomyrmex vicinus was the dominant ant species observed in this study (96.7% of all observations) and was the only species seen removing eggs of *H. armigera.* Egg predation was rarely observed in this study (9 *H. armigera* eggs were taken by *I. vicinus* at 2 sites, on 3 separate dates); however egg pressure was relatively low at the sites sampled.

Foraging activity was greatest during the early part of the day while ground temperatures were relatively low. Ant activity was affected by all types of disturbance in the cotton crop (cultivation, irrigation, insecticide application). Soil disturbance through cultivation and irrigation destroys underground ant colonies that must be rebuilt afterwards. The time required for this reconstruction severely reduces the time spent foraging on cotton plants.

Ants did not return to active foraging until at least two days after a disturbance event and in some cases were still inactive more than a week later.

The beat sheet proved more effective for measuring ant abundance on plant foliage during the day and this technique collected both *I. vicinus* (81%) and *Pheidole* ants (19%), in contrast to visual checks which only recorded *I. vicinus.* Accurate measurement of ant abundance is difficult because ants are unevenly distributed within cotton fields and change their behaviour during the course of the day.

Exclusion of ground dwelling predators using cages or Tanglefoot significantly reduced predation on *H. armigera* eggs. Although we cannot say that ants were solely responsible for the predation observed in the exclusion experiments, ants are a major part of the ground-dwelling insect fauna in cotton fields. Other predatory insects such as earwigs and carabid beetles may also contribute to egg predation.

In conclusion, predatory ants can reduce *Helicoverpa* egg populations in some situations. However disturbance through irrigation, cultivation and insecticide application places serious limits on their foraging behaviour. At this stage, we cannot recommend any key threshold for ant abundance relative to pest pressure that could be used in IPM.

PROJECT NUMBER: 4.1.06 SS6

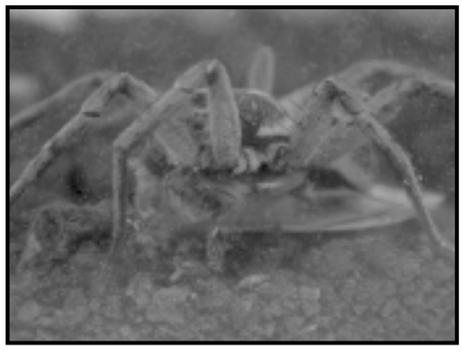
Project Title: Summer Scholarship: The role of hunting spiders (in particular wolf spiders) in controlling newly emerged *Heliothis* moths in cotton planted into wheat stubble.

STAFF

Mr Robert M. McMahon, UWS, Hawkesbury, NSW.
Dr. M. E. A. Whitehouse, CSIRO Entomology, Narrabri, NSW.

AIMS

1. To observe and record the response of hunting spiders to *Helicoverpa* spp pre-pupae and newly emerged moths, and to characterise the appearance of these prey items following attack.
2. To quantify the effectiveness of hunting spiders as predators of pre-pupae and emerging *Helicoverpa* spp moths.
3. To compare the abundance, diversity and size of ground-dwelling hunting spiders inhabiting cotton planted into wheat stubble with those inhabiting cotton planted into bare soil.



Wolf spider with *Helicoverpa armidgera* moth.

OUTCOMES

Three experiments were undertaken to address these aims.

Experiment 1 was based in the laboratory and tested the wolf spider's responses to moths, caterpillars and pupae.

Experiment 2 was set up under simulated field conditions, using four $1m^2$ cages, to test the ability of wolf spiders to control the emergence of moths.

Experiment 3 examined wolf spiders in a commercially grown cotton field. This experiment was divided into two parts: 1) to determine if there were more wolf spiders in a field of cotton sown into wheat stubble compared to a field of conventional cotton; and to determine whether a higher concentration of spiders in either area had a detrimental effect on their condition; 2) to determine the effectiveness of wolf spiders at controlling emerging Helicoverpa moths under field conditions, and whether the presence of more spiders resulted in greater control of the pest.

In Experiment 1,19 observations of wolf spider foraging behaviour in the laboratory revealed that wolf spiders are very voracious predators of Helicoverpa moths (Fig. 1), but prefer moths to larvae or pupae.

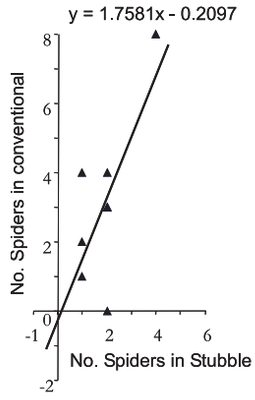


Fig. 1. Wolf spiders were 1.5 times more common in conventional than stubble cotton.

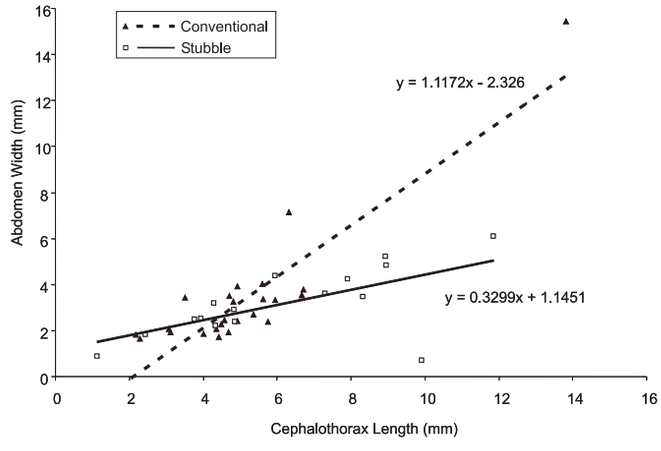


Fig. 2. Comparison of cephalothorax length and abdomen width of spiders found in the conventional and stubble plots.

In **Experiment 1**, 19 observations of wolf spider foraging behaviour in the laboratory revealed that wolf spiders are very voracious predators of *Helicoverpa* moths, but prefer moths to larvae or pupae.

Experiment 2 indicated that wolf spiders controlled *Helicoverpa* emergence in a simulated field condition. Moths emerging in field cages that contained wolf spiders had a lower chance of surviving than those emerging in cages that did not contain wolf spiders (Trial 1: Fisher's exact test, $n=13$, $P<0.001$; Trial 2: large numbers of pupae died so the trial had to be abandoned; Trial 3: Chi-square Test, $n=29$, $P<0.001$, $X^2=194$).

Experiment 3, the field experiment, revealed that wolf spiders were more abundant in the conventional cotton plot than in the stubble plot (Fig. 1), but that the conventional plot contained a thick, grassy understorey that may have influenced results.

Results suggest that smaller wolf spiders had better body condition (i.e. relatively larger abdomens) in the cotton grown into stubble, while larger spiders had better body condition in the conventional cotton with the thick grassy understorey (Fig. 2).

Our field-based experiment looking at the effect of wolf spider abundance on moth survivorship was inconclusive because many tethered moths used in the experiment went missing and could not be confirmed as killed by wolf spiders.

Leah MacKinnon removing insects from the novel light trap.

PROJECT NUMBER: 4.1.07 SS7

Project Title: Evaluating a novel light trap for catching and supressing *Helicoverpa* moths.

STAFF

Ms Leah MacKinnon, USYD, Orange, NSW.
Mr Martin Dillon, CSIRO Entomology, Narrabri, NSW.
Associate Professor Peter Gregg, UNE, Armidale, NSW.

AIMS

The increasing implementation of IPM and efforts to reduce chemical inputs within the Australian cotton industry have led to a range of new and alternative pest management options being evaluated. One such option under development by a commercial firm at Narrabri is the patented Vortex® Light Trap, which uses a vortex of water to capture insects attracted to light. We tested an array of prototype Vortex light traps during January 2002 as a Summer Scholarship project.

OUTCOMES

We investigated the effectiveness of Vortex light traps at capturing *Helicoverpa* moths, and whether egg densities were reduced in surrounding cotton. Nine Vortex light traps were positioned 100m apart in a 3 x 3 array in a field of INGARD® cotton at Auscott, Narrabri. The lights were run each night from 28 December onwards. A nearby field served as a nil-treatment comparison and there was a buffer field in-between. We monitored trap catches and undertook extensive insect checks in the two fields until 31 January 2002.

Helicoverpa moths were the predominant insect species captured by the light traps. Our results support the hypothesis that the continual removal of adult moths reduced *Helicoverpa* egg densities within the whole field, and especially within the 16 Ha treated area of intensive sampling. The area of influence of an individual trap remains to be fully quantified.

IAs an unreplicated trial for part of a single season our results must be interpretated with caution but there was sufficient promise to warrent more through evaluation in the future.

PROJECT NUMBER: 4.2.00 AC

Project Title: Extension Technical Officer, Dalby

STAFF

Ms Janelle Hare, QDPI, Dalby, QLD.
Mr Greg Salmond, QDPI, Dalby, QLD.

AIM

To provide extension activities, principally on the Darling Downs

OUTCOMES

Ms Janelle Hare, has been stationed at Dalby for three years, where she provides valuable support to a range of Cotton CRC and CRDC funded projects on the Darling Downs.

Ms Hare's key role is the on-site management of Cotton CRC Farming Systems Trial at *'Prospect'* Warra, where she worked closely with the trial co-operators The Bidstrup Family, their consultant, and Cotton CRC researchers. A series of trial reports and material for inclusion in the Darling Downs Cotton Trial booklet have helped publicise the outcomes from this site.

Ms Hare Soil Sampling at the Cotton CRC Dryland Farming Systems Trial "Prospect" Warra November 2001.

In other work Ms Hare established and managed three Early Season Damage Trials on the Darling Downs in conjunction with area wif\de management groups at Evanslea and Macalister. Both sites were utilised for grower/consultant farm walks and discussions about the value of early season IPM.

Ms Hare addressing growers at the Evanslea Early Season Damage Trial site March 2002.

Ms Hare continues to maintain weather data at DPI Dalby, from the eighteen grower-owned weather station network maintained by the Darling Downs Cotton Growers Association Inc. To facilitate access to the information Ms Hare has instigated a weekly newsletter – Weather or Not, which has been distributed to Darling Downs cotton consultants. Feedback has been extremely positive. During the year Ms Hare also strengthened her skills with completion of the Certificate in Rural Science – Cotton Production (UNE), graduating in March 2002.

PROJECT NUMBER: 4.2.03 AC

Project Title: Cotton Industry Development Office - Moree

STAFF

Ms Julie O'Halloran, NSW Agriculture, Moree, NSW.
Mr Dallas Gibb, NSW Agriculture, Narrabri, NSW.

AIM

To assist in education, extension and technology transfer in the Gwydir Region.

OUTCOMES

A key role is the coordination of area wide management groups which continued to meet for discussions on a range of issues, including Insecticide Resistance Management, heliothis population dynamics, INGARD and BOLLGARD II allocations, secondary pest management and planting cotton into wheat stubble.

Guest speakers attended on some occasions to report on selected topics. Meetings were generally well attended by growers and consultants. A local grower group will be participating again in a comparative analysis for the 2001/2002 season. This analysis focuses on benchmarking insecticide application, yield and gross margins.

Liaison with the local cotton grower association and cotton consultants resulted in setting extension priorities for the valley. As several new sites of Fusarium wilt were confirmed within the Gwydir Valley during the 2001/2002 season this was a major priority for the CGA.

An information and research update was held in May 2002. Interaction between the CGA, consultants and extension and research officers continues. The Gwydir Valley Cotton Field Day was well attended and focused on "Efficiency and Technology – Driving Profitability". Associated with this field day were local irrigated and dryland crop competitions. Regular interaction with the 2VM Moree radio assisted promotion of research and extension activities.

The Gwydir Valley Cotton Tales newsletter was distributed weekly during the season. This newsletter presents research results and information updates on issues relevant to the cotton industry as they arise, including field days and meetings. The newsletters are widely read and appreciated.

Several field trials were also carried out as part of cotton industry wide trials. These included fruiting factor trials to determine the effects of different techniques to monitor fruit retention and their relationship to crop yield and maturity. Fibre quality experiments were also carried out to relate conditions during flowering and fibre maturity to ultimate fibre quality.

PROJECT NUMBER: 4.2.05 AC

Project Title: National Cotton Extension Coordinator

STAFF

Ms Ingrid Christiansen, QDPI, Narrabri, NSW.
Mr Geoff McIntyre, QDPI, Dalby, QLD.
National Cotton Extension Coordinator, Ingrid Christiansen.

AIM

Aims of the project are to:

- Coordinate extension programs directed at regional areawide management IPM groups.
- develop a coordinated focus on national extension programs.
- develop and facilitate best delivery methods
- facilitate extension training activities
- ensure participation of research scientists in these programs.

OUTCOMES

The first full year of the National Cotton Extension Coordinator has been one of support and development, with a particular focus on new staff and in strengthening linkages with industry groups.

Most activities are covered in the Program 4 Overview. The 2001-02 season has been one of significant change for the extension team with several new faces on board. Two new trainee positions were funded to provide the flexibility needed to provide a continuity of extension service.

With much of our extension focus on IPM, we completed an industry wide survey of attitudes towards IPM in October 2001. this showed a significent shift to more positive acceptance and understanding of IPM principles since the last survey in 1997; A good indication that extension activities have been working.

PROJECT NUMBER: 4.2.07 AC

Project Title: Evaluating economic implications of new management approaches to cotton

STAFF

Ziaul Hoque, NSW Agriculture, Narrabri, NSW.
Mr Bob Farquharson, NSW Agriculture, Tamworth, NSW.

AIMS

To evaluate the economic implications of new management systems, such as Integrated Pest Management (IPM).

OUTCOMES

Economic analysis of the benefits of IPM has been conducted for three seasons since 1998/99. Using data from theBoggabilla Landcare Group, an area wide management group of 12 farms in north-west NSW. Spray regimes on 154 individual fields were compared based on their disruptive effects on beneficials and financial returns.

The third season (2000/01) data showed a similar trend to the previous two with, "softer" spray strategies confering better profits in both INGARD and conventional cotton. (See table below).

Similar comparative analysis is planned across a number of cotton regions, to determine the industry wide benefits of IPM, especially the economic benefits of spraying "softly".

A budgetary analysis has been done on the benefits of Petroleum Oil Spray being researched by Dr Robert Mensah. In preliminary trials the petroleum spray oil/IPM system showed cost reductions compared to conventional cotton or INDARD cotton systems.

Large-scale trials with oil sprays are being done in different regions and a full economic analysis is planned.

Our next focus will be on the economic analysis of Insecticide Resistance management in collaboration with Dr Lewis Wilson and Mr. Martin Dillon (both CSIRO, Narrabri).

A survey of dryland growers was used to evaluate the economic losses caused by weeds in dryland cotton systems. Field surveys by weed scientists were completed to validate the survey outcomes. Economic analysis of the cost of weeds will form the basis of future weed research.

Finally we are working with the CottonLOGIC team to incorporate gross margin reports in the crop management program.

	INGARD® SOFT COMPARED TO HARD			CONVENTIONAL SOFT COMPARED TO HARD		
	1998/99	1999/00	2000/01	1998/99	1999/00	2000/01
YIELD:	7% higher	same	1% lower	2% lower	2% lower	1% higher
AVE. SPRAY COSTS:	21% lower	42% lower	38% lower	17% lower	44% lower	16% lower
GROSS MARGIN:	25% higher	5% higher	8% higher	5% higher	5% higher	4% higher

PROJECT NUMBER: 4.2.09 AC

Project Title: Trainee Industry Development Officer - Emerald

STAFF

Ann Sullivan, QDPI, Emerald, NSW.
David Kelly, QDPI, Emerald, NSW.

AIMS

CRDC and the Australian Cotton CRC in partnership with DPIQ and NSW Agriculture have established the national cotton industry extension team with Industry Development Officers (IDOs) based in all major regions of the industry. The availability of trainee IDOs ensures continuity of extension programs as vacancies occur.

OUTCOMES:

Ms Ann Sullivan was appointed as trainee IDO at Wmerald. A training program was established to target all aspects of cotton production with particular attention given to the following disciplines:

- Integrated pest management and resistance management;
- Plant physiology and nutrition;
- Soil and irrigation management;
- Establishing effective growers groups and networks.

Ms Sullivan has enrolled in the Cotton CRC Cotton Production Course and will develop and conduct special projects, which provide for the development of their skills and assist the overall extension effort. Examples of special projects include: assisting the NCEC to conduct evaluation of regional or industry wide extension programs; assisting the development of extension support material (eg. Publications, coordination of material for "paks", manuals, videos, CDs etc, demonstration trials with researchers and other IDOs); support for specific initiatives (eg. Coordination of AWM group meetings and background information).

Anne Sullivan & Dave Kelly in the field Emerald, Queensland.

PROJECT NUMBER: 4.2.02 AC

Project Title: Improving on farm irrigation water use efficiency in the Queensland cotton and grain industries

STAFF

Dr Phil Goyne, QDPI, Warwick
Mr Geoff McIntyre, QDPI, Dalby
Mr Graham Harris, QDPI, Toowoomba, QLD.
Mr John Okello-Okanya, QDPI, Emerald, QLD.
Mr Andres Spragge, QDPI, Dalby, QLD.
Ms Sarah Hood, QDPI, St George, QLD.
Mr David Wigginton, QDPI, Biloela, QLD.
Ms Olivia Whiteoak, QDPI, Goondiwindi, QLD.

The Cotton CRC Water Team with staff from QDPI and NSW Agriculture.

AIM

The objective is to increase irrigation efficiency in the cotton and grain industries by at least 10%, and to have 70% of growers adopting Best Management Practice guidelines, by June 2003.

This project is being conducted within Queensland Government's Rural Water Use Efficiency Initiative (RWUEI), as the Cotton and Grains Adoption Program, by the Agency for Food and Fibre Sciences Farming Systems Institute of QDPI.

OUTCOMES

The project is firmly established in the five target regions (St George/Dirranbandi, Goondiwindi-Macintyre Valley, Darling Downs, Callide/Dawson, Emerald and Mackenzie/ Fitzroy). Awareness of the project has increased, grower management groups have been actively involved and irrigation benchmark data have been collected from the demonstration sites in both cotton and grain crops.

The Cotton/Grains team has monitored grower irrigation management, to establish initial benchmarks on irrigation and water use efficiency, and to determine where efficiencies can be improved. In addition, the team has actively promoted the RWUEI Financial Incentives Scheme that supports the purchase of equipment to improve irrigation efficiency. The team has also established an Irrigator Awards Scheme to reward co-operators and innovative irrigators.

The project was established in late 1999 with the appointment of a coordinator and five extension officers to conduct fieldwork. A desktop stocktake of irrigation water use in the Queensland cotton and grain industries was completed during the first summer to establish benchmarks of water use efficiency in all crops and to identify opportunities for improvement in collaboration with grower and consultants.

The Cotton/Grains team has monitored grower irrigation management, confirmed initial benchmarks on irrigation and water use efficiency and determined where efficiencies can be improved.

RWUE workshop at Ian Hayllor's property, near Dalby QLD.

RWUE officer Andres Spragge conducting a "measure to manage" workshop.

Cotton Australia and CRDC are developing an irrigation management module for the cotton industry BMP guidelines. The Cotton/Grains Adoption team is contributing to the development of this module that will be (with some modification) suitable for the irrigated grains industry.

Over 35 Water Use Efficiency trial sites were established in 2001/02 – in cotton, peanuts, sorghum, wheat, maize, navy beans and faba beans. Irrigation systems included furrow, subsurface drip irrigation (SDI), centre pivots, lateral moves, side roll and hand-shift sprinklers.

The SDI trials in heavy and light soils at Dalby, St George, Theodore and Emerald produced excellent results with increased yield, reduced water use and improved use of in-crop rainfall. however there were also encouraging results from furrow irrigation trials and benchmarking activities which showed that some farmers were achieving comparable yields and water use efficiency levels to the SDI systems. Given the results of top irrigators, the target of a 10% improvement in water use efficiency to 1.25 bales/ML is achievable for many growers.

PROJECT NUMBER: 4.2.04 AC

Project Title: IPM Training Coordinator

STAFF

Mr Bill Dalton, QDPI, Goondiwindi, QLD.
Mr Geoff McIntyre, QDPI, Dalby, QLD.
Mr Dallas Gibb, NSW Agriculture, Narrabri, NSW.

AIM

To develop and implement an Integrated Pest Management (IPM) short course program.

In recent years, financial, environmental and regulatory pressures have threatened the sustainability of the Australian cotton industry. This demands a deeper understanding and adoption of all available tactics to control insect pests.

IPM fits this description, by allowing growers to control diseases, insects, weeds and other pests in a cost-effective, environmentally sound and socially acceptable way.

However, IPM is a complex, dynamic system requiring a change in attitudes to pest management. Knowledge, understanding and confidence are needed for IPM to be successfully adopted.

OUTCOMES

As a result of subjective attitudinal research conducted in 1997, the Cotton Research & Development Corporation (CRDC) and Australian Cotton CRC provided funding for the position of IPM Training Coordinator, whose role is to develop, in consultation with industry and researchers, a grower focused short course in IPM.

The IPM short course program is now well advanced to deliver:

- **A comprehensive educational package**, which clarifies the latest **best practice** for IPM as identified by industry experts (including growers).
- **Economic links to IPM strategies,** with the assistance of Cotton CRC economists, within short, medium and longer-term time frames.
- **An extension program** (including grower best practice groups) assisting growers to 'take responsibility' for management decisions, emphasising economic sustainability rather than yield, and linking this with the training program.

Growers will benefit from a clear understanding of IPM, and the knowledge of what has been achieved by those participating in training will encourage further innovation and adoption. The course provides a forum for discussion, which should help to provide solutions to real problems and challenge current industry thinking.

Dr Dave Murray discussing early season pest management with growers.

IPM training coordinator, Bill Dalton, and a group of growers in hands-on IPM studies.

Perceptions about IPM such as delayed maturity and low yields can be replaced by positive considerations of maintaining profitability and yield while reducing reliance on chemical control measures.

The IPM short course structure and reference manual has been completed although further refinement and development will occur on an ongoing basis. Three pilot IPM short courses have been completed with a total of 28 growers, 4 consultants and 2 internal staff receiving training in the Macquarie, Lower Namoi and Darling Downs. full scale implementation is planned for 2002/03.

PROJECT NUMBER: 4.3.00 AC

Project Title: Cotton Technology Transfer Centre

STAFF

Mr David Larsen, NSW Agriculture, Narrabri
Mr Dallas Gibb, NSW Agriculture, Narrabri.

AIM

The role of the Australian Cotton CRC Technology Resource Centre (TRC) is to service the industry's extension material requirements, both paper-based and electronic. It assists researchers in the timely production and distribution of research-based material, as well as providing support for the CottonLOGIC program.

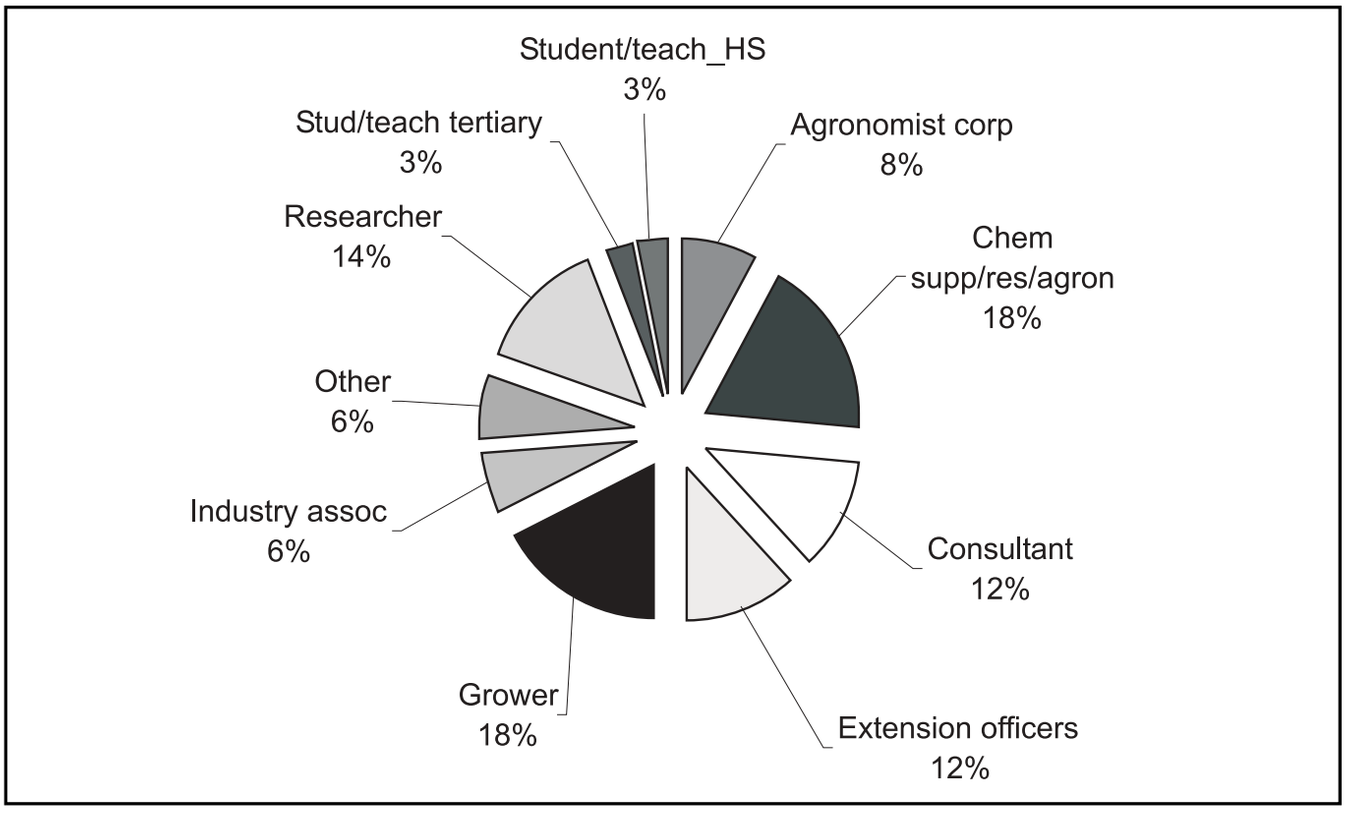
OUTCOMES

An example of how the TRC functions and provides important information to growers can be seen with the Integrated Pest Management Guidelines. These guidelines can be accessed by the industry in four ways:

1. As part of the ENTOpak folder distributed to over 936 users registered with the TRC
2. On the Australian Cotton CRC web site open to anyone with web access
3. On the web site snapshot provided with the CottonLOGIC CD distributed to 1164 within the industry and registered with the TRC
4. Within the Pest Management Guide for Cotton produced by NSW Agriculture and distributed to the industry as a whole using the TRC mailing list

EXTENSION PUBLICATION PRODUCED IN 2001/02

SERIAL NUMBER	PRODUCT NAME	AUTHORS	PRODUCT DESCRIPTION
TRC 12 07/01	Planning Ahead for Aphid Resistance Management	Grant Herron, Lewis Wilson & Dallas Gibb	CRC Information bulletin for industry wide mail out and web presentation
TRC 13 07008/07/01	Rotations and cotton disease CRC Information	Nehl	Information sheet outlining rotations and consequence for subsequent cotton crops
TRC 14w 08/01	IRMS hot areas Central Queensland	Gunning, Herron, Tucker, Pyke, Wilson	TIMS CRC CRDC AIRAC Document laid out for web and used for pocket cards
TRC 15w 08/01	IRMS Warm areas S. Qld, Macintyre, Gwydir, Lower Namoi	Gunning, Herron, Tucker, Pyke, Wilson	TIMS CRC CRDC AIRAC Document laid out for web and used for pocket cards
TRC 16w 08/01	Cool areas Macquarie, Lachlan	Gunning, Herron, Tucker, Pyke, Wilson	TIMS CRC CRDC AIRAC Document laid out for web and used for pocket cards
TRC 17w 08/01	IRMS Upper Namoi	Gunning, Herron, Tucker, Pyke, Wilson	TIMS CRC CRDC AIRAC Document laid out for web and used for pocket cards
TRC 18 10/01	Insect Resistance Management Plan for Ingard Cotton	Developed by TIMS committeee	Insect Resistance Management Plan for Ingard Cotton 2001 - 2002 layout of final document for printing by Monsanto
TRC 19 12/01	Aphids in Cotton: Cotton CRC Research Review	Lewis Wilson and Annie Spora	Research review on Aphid species and ecology in cotton
TRC 20 12/01	Strategies to manage Aphids in cotton	Lewis Wilson and Annie Spora	CRC Research Review December 2001 management section
TRC 21 03/02	Irrigation Scheduling of Cotton	Steve Milroy, Phil Goyne, David Larsen	CRC Information sheet
TRC 22 03/02	IWM (Integrated Weed Management) Guidelines	Graham Charles, Grant Roberts	CRC information sheet
TRC 23 06/02	Guidelines for Assessing Pupae risk For Dryland Cotton Growers	Hickman, Larsen, Dillon et al	CRC information sheet
TRC 24 06/02	Has Your Pupae Busting Been Effective May 2002	Rourke et al	CRC information sheet



A breakdown of users of the Technology Resource Centre services.

PROJECT NUMBER: 4.3.01 AC

Project Title: Developing innovative computer based technologies for effective delivery of information and cotton management decision support

STAFF

Mr Stewart Whiteside, CSIRO Plant Industry, Narrabri, NSW
Dr Michael Bange, CSIRO Plant Industry, Narrabri, NSW.

AIMS

To develope innovative computer-based technologies for effective delivery of information and cotton management decision support by:

- Extending the availability of computerised decision support systems, including mathematical models of cotton pests and crop production, industry databases, and extension material to all members of the cotton industry.
- Developing portable decision support tools for use in cotton crop management decisions.
- Maintaining and developing innovative web-based technologies delivered via the Australian Cotton CRC's web site.

David Johnston bench testing the hand-held palm version of CottonLOGIC.

OUTCOMES

This project strengthens the programming base of CSIRO's Decision Support development Team. A major outcome has been the Cotton CRC's new database-driven and interactive website, to assist with information dissemination.

Just as impressive is the development of the hand-held version of CottonLOGIC, which was validated by researchers in Kununurra and Katherine in northern Australia. A pilot group was then formed for more extensive field validation in the 2001/2002 summer. The software is due for release at the ACGRA Cotton Conference in August 2002.

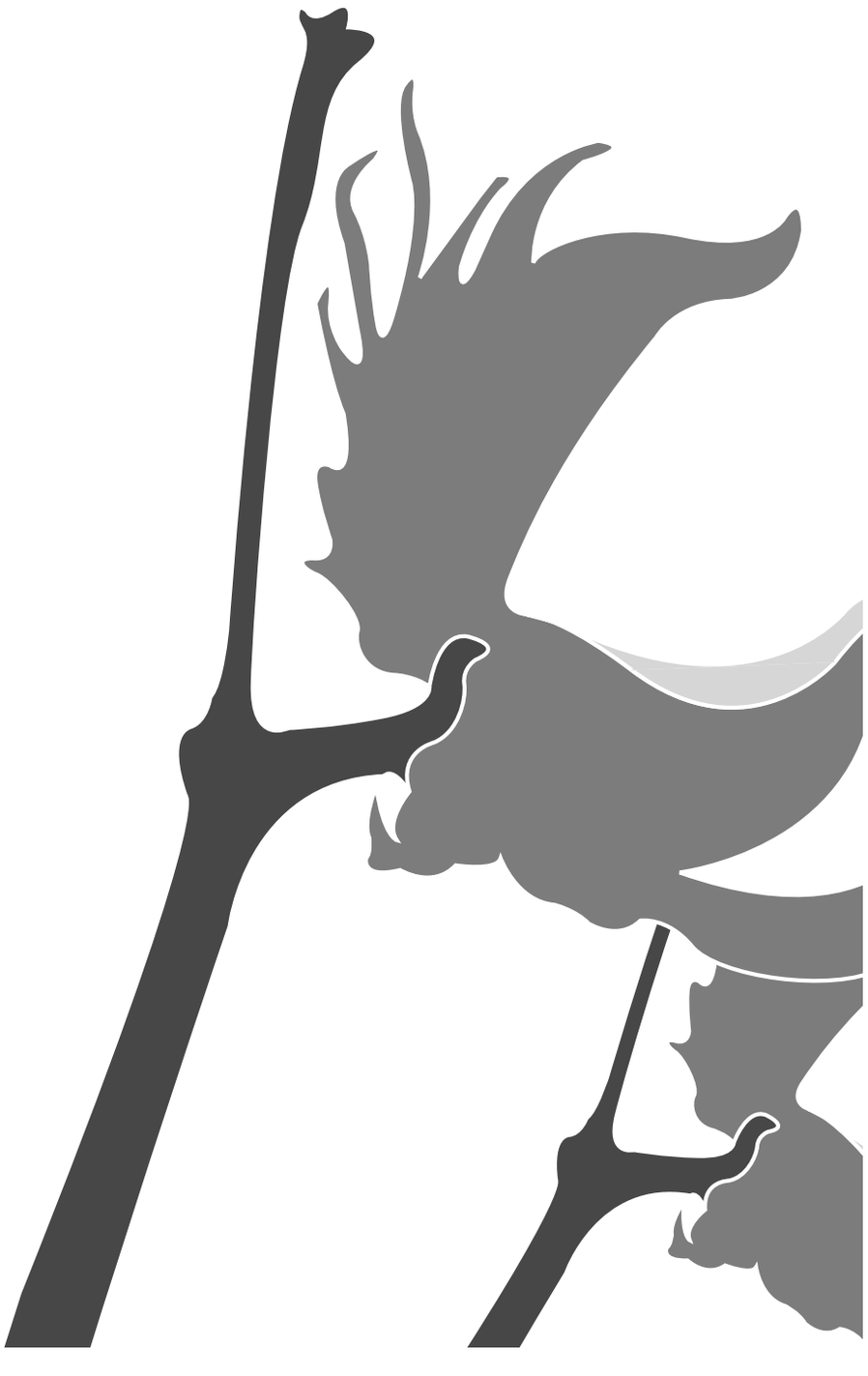
Extra programming resources have now been deployed to the development of water management tools, namely a water budgeting tool and a revamped HydroLOGIC.

Other achievements of the decision support development team were:

- A major version of CottonLOGIC released in January 2002.
- A prototype of water budgeting software made available to IDO's and water use efficiency officers for field validation.
- A revamped version of HydroLOGIC
- Software tools to assist processing large amounts of data generated by the OZCOT crop simulation model.
- Jointly developing software with the Agricyltural production
- Systems research Unit (APSRU) to assist with crop simulations and model validation data.

Dirk Richards, a member of the Cotton Management Support Systems team discussing OZCOT simulation results with growers.

The Cotton CRC now offers a fully database driven interactive website to assist with information dissemination.



Program 5 Overview

Cotton Textile Research

INTRODUCTION

The pressure for improved technical performance of textile fibres, including Australian cotton, is increasing. The global textile industry is increasingly required to both improve productivity and also identify products that can be differentiated to meet changing consumer requirements. Pressure for increased productivity drives up the speed of textile processing machinery, and also requires reduced wastage.

Program 5 is undertaking textile research to support the demand for Australian cotton in this highly competitive market. This research forms part of the activities of the Cotton Textile Research Unit at CSIRO Textile and Fibre Technology in Geelong.

AIMS

- To develop dyeing and bleaching technologies to support new products in cotton and cotton/wool blends.
- To reduce the environmental impact of cotton dyeing, bleaching and finishing.
- 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.
- To enhance the ability of Australian cotton to compete, on the basis of costs and product versatility, with synthetic fibres.

ACHIEVEMENTS AGAINST MILESTONES

1. The environmentally-friendly bleaching and dyeing technologies invented and developed by the CRC have been successful trialed and the technology transferred to a commercial dyehouse in Hong Kong. This is a major step forward in removing technical hurdles and thus enabling the Australian cotton-wool blend yarn spun by Rocklea in Australia to compete in major international markets.

2. A major development has been the commissioning of a state-of-the art cotton-spinning mill at CSIRO Geelong, which includes the three main short-staple spinning systems typically used in industry, namely ring, rotor and Vortex.

This complements other existing textile processing facilities, e.g. knitting and weaving and dyeing and finishing. This new facility is a major research tool that will allow the Cotton Textile Research Unit to undertake processing experiments under carefully controlled conditions using commercial scale equipment.

3. A new project has been initiated to examine the quality of Australian cotton from the mill's perspective. Initially this will obtain direct feedback and test samples from major customers ie technical managers of spinning mills in Japan, South Korea, Thailand and Indonesia.

It is hoped that this will lead to controlled processing trials, both in key overseas mills and also at the new CSIRO facility, to identify the strengths and any weaknesses of Australian cotton in this area.

LINKAGES

- Good communication and cooperation exists between all post-harvest researchers in Australia that are funded by the CRC and directly by the CRDC. This covers activities at the Cotton Textile Research Unit at CSIRO and the National Centre for Engineering in Agriculture in Toowoomba.
- Relationships with cotton processors and in particular Rocklea spinning and China Dye in Hong Kong have been keys to successful technology transfer of the new bleaching and dyeing technologies.
- Linkages have been formed with The Australian Cotton Shippers Association; local spinning mill associations in Japan, South Korea, Thailand and Indonesia; and Austrade offices. Local textile machinery representatives have also been contacted. This multi-pronged approach is valuable in quickly and efficiently developing a productive working relationship with key mills in these countries.
- In the area of fibre quality, an important issue for Australian cotton, Dr Stuart Gordon and Dr Geoff Naylor were invited to become members of the ITMF (International Textile Machinery Federation) International Committee on Cotton Testing Methods Working Group on fibre maturity and fineness. Both attended and made presentations to their meeting in Bremen, Germany in March 2002.

PROJECT NUMBER: 5.1.00 AC

Project Title: Innovative bleaching technologies for cotton and cotton blends

STAFF

Dr Jackie Cai, CSIRO Textile & Fibre Technology, Belmont, VIC.
Dr David Evans, CSIRO Textile & Fibre Technology, Belmont, VIC.

AIMS

To investigate the commercial feasibility of a new innovative bleaching technology for cotton and cotton blends.

OUTCOMES

An industrial trial was completed at China Dye Holding Ltd in Hong Kong (one of Rocklea's customers) in August 2001 for cold pad-batch bleaching of woven cotton/wool blends. This trial was jointly sponsored by Rocklea, Cotton CRC and CSIRO, with in-kind contribution from China Dye.

The industrial trial further demonstrated the commercial feasibility of the new bleaching technology. Following the trial, further laboratory study was conducted on some processing and testing issues raised by China Dye during the trial. Potential measures for the improvement were suggested.

Through communication and industrial trials, the new bleaching processes, based on TAED/H_2O_2, have been introduced to a number of textile manufacturers in Australia and overseas for commercial production.

Also, a novel technology for low temperature bleaching of cotton has been identified and is currently being evaluated. In trials to date, this new method is proving to be technically superior to the method using TAED/H_2O_2 system.

PROJECT NUMBER: 5.2.02 AC

Project Title: New Dyeing Process for Cotton.

STAFF

Dr D King, CSIRO Textile and Fibre Technology, Belmont, VIC
Dr Geoff Naylor, CSIRO Textile & Fibre Technology, Belmont, VIC.

AIMS

Large amounts of salt are used to improve the uptake of dyes by the cotton fibre. This creates a number of problems including increased corrosion of machinery, reduced efficiency of dyeing, and most importantly the problem of dealing with salt-containing effluent.

The aim of this project is to find an alternative to salt by pre-treating the cotton to give it a greater affinity for dyes. The particular approach in this project is to use the biopolymer chitosan, which has affinity for the cotton fibre surface, and through its chemical nature masks the normal repulsive forces that limit the uptake of dyes.

OUTCOMES

Preliminary studies have shown that chitosan is widely effective in promoting greater uptake of cotton dyes, but there is an unwanted side effect in the deterioration of the wash-fastness of the dyed cotton.

The results at this stage show that there is merit in completing this investigation of a potential new dyeing process due to its simplicity, the environmentally benign nature of chitosan, and the importance of the problem to the cotton processing industry.

Our research sheds new light on possible solutions to the problem of salt in cotton dyeing, and identifies the fundamental technical barriers to achieving such a breakthrough.

PROJECT NUMBER: 5.2.03 AC

Project Title: Quality Issues for Australian Cotton from the Mill perspective.

STAFF

Dr Stuart Gordon, CSIRO Textile & Fibre Technology, Belmont, VIC.
Dr Geoff Naylor, CSIRO Textile & Fibre Technology, Belmont, VIC.

BACKGROUND

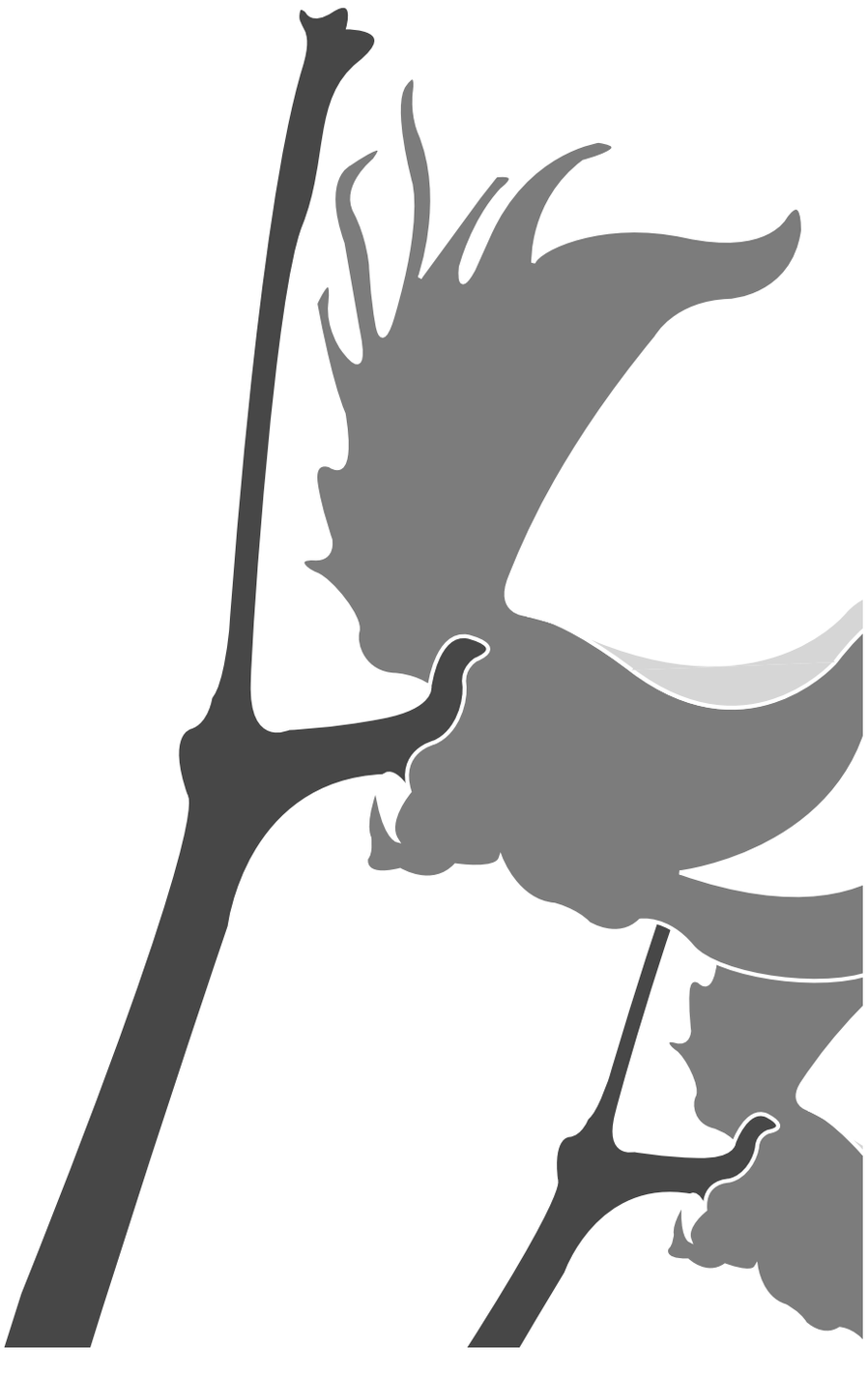
The objective of this project is to survey overseas spinning mills and test samples gathered from these mills, to accurately assess the needs and perceptions of our customers, so that the Cotton Industry can work towards its own quality benchmarks.

Information gained from a fibre quality survey will be backed by data from objective testing of fibre and yarn samples gathered from each mill. Visits are planned to mills in Indonesia, Japan, Thailand and South Korea. These countries represent the main export destinations for two-thirds of Australia's cotton.

Currently, quality is measured relative to competitive growths such as San Joaquin Valley cotton from California, long regarded as the premium Upland growth in the world export market. While comparisons with other growths are important it is equally important that the Australian industry becomes proactive in the specification of its product.

If Australia is to maintain and grow quality end markets it will need to extend the description of its product beyond the current USDA classing model and define it more in terms of its customer's needs. This means the Australian industry must create its own quality benchmarks and specify properties more relevant to its customers.

The project is currently in its initial stages. A good working relationship has been established with The Australian Cotton Shippers Association and a draft mill questionnaire has been formulated. Contacts with overseas mills are being established.



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THESES

Huckel A.I. (2001). Estimating clay content and deep drainage at the field scale in the Lower Gwydir River Valley (University of Sydney).

Ahmed M.F. (2001). Simulating and assessing salinisation in the Lower Namoi Valley. (University of Sydney)

Dorahy C.G. (2002). Determining the phosphorus requirement of cotton (*Gossipium L.*) grown on alkaline soils in Eastern Australia. (University of New England)

RESEARCH REPORTS

3.1.07 **Roberts G** (2001-02) Herbicide Control of Volunteer Seedling Cotton Preliminary Experiments. Report prepared for the Agro chemical companies, CropCare, Monsanto and Aventis.

1.1.01 **StephenYeates** (2001). Cotton Research and Development Issues in Northern Australia: a review and scoping study. August 2001, Australian Cotton Cooperative Research Centre. (http://www.cotton.crc.org.au/AboutUS/CrcNASs.htm)

CONFERENCE PRESENTATIONS

2.1.01 **Fitt G.P** (2001). Transgenic Cotton as a foundation for Integrated Pest Management – towards green cotton. Keynote paper at the World Chemistry Congress and 38th IUPAC Conference, July, Brisbane, Qld.

2.1.01 **Fitt G.P** (2001). An update on Bt cotton; performance and future. Annual Conference of the Aerial Agriculture Association of Australia (AAAA), August 16, Caloundra, Qld.

2.1.01 **Fitt G.P** (2001). Sustainability and the role of Bt cotton in IPM systems. Cotton Consultants Australia Annual Meeting, August 21, Goondiwindi, Qld.

2.1.01 **Fitt G.P** (2001). Development and Implementation of Bt cottons in Australia. 24th Congress of the International Society of Sugar Technologists, September 18-20, Brisbane, Qld.

2.1.01 **Fitt G.P** (2001). Transgenic Cotton as a foundation for Integrated Pest Management. Biotechnology and the Environment conference organised by the Australian Institute of Biologists, September 22-23, Canberra, ACT.

2.1.01 **Fitt G.P** (2001). Non-target effects of Bt cotton: A case study from Australia. 4th Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis* and its environmental impacts, November 11-14, Canberra, ACT.

2.1.01 **Fitt G.P.** (2002). GMOs and Sustainable Agriculture – Policy and Implementation. National Conference of the Local Government Association, Armidale, NSW. 14-17 February.

2.1.01 **Olsen K.** (2001). Poster on "Bt Cotton, the effect of two environmental factors, temperature and insect damage, on the efficacy of presquaring plants". 4th Pacific Rim Conference on the Biotechnology of *Bacillus thuringiensis* and its environmental impacts, November 11-14, Canberra, ACT.

2.1.01 **Fitt G.P** (2002). Development and Implementation of Resistance Management Strategies for Bt cottons in Australia. 3rd International Conference on Biopesticides, April 22-26, Kuala Lumpur, Malaysia.

2.1.01 **Fitt G.P** (2002). Area-wide management – a triumph of science and cooperation. CRC Association Annual Conference, May 2002, Sydney, NSW.

2.2.03 **Britton, D.R., Gregg, P.C. and Del Socorro, A.P.** (2001) Developing an attracticide for male cotton bollworm *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae): visual and chemical cues. International Society of Chemical Ecology, 18th Annual Meeting, Lake Tahoe, USA.

2.2.03 **Kvedaras, O., Gregg, P., Del Socorro, A., Alter, D. and Moore,C.** (2001) The influence of host plant volatiles on mating behaviour in the cotton bollworm, *Helicoverpa armigera* (Hubner). Australian Entomological Society, 32nd Scientific Conference and A.G.M., Sydney.

2.2.03 **Silberbauer, L. and Gregg, P.** (2001) Using pollen to trace short-term insect movement. Ecology Society of Australia Conference. Wollongong, NSW.

3.1.00 **Weaver, T.B., Hulugalle, N.R., Finlay, L.A., Jackson, K., and Ghadiri, H.** (2001). Salinity and drainage profiles under a cotton-wheat rotation in an irrigated Vertosol. Conference on Electromagnetic Techniques for Resource Management, 3-5 July 2001, Yanco, NSW, Australia.

3.1.00 **Hulugalle, N.R.** (2001). Root systems of wheat sown in rotation with cotton can affect some soil physical properties. Paper presented at a workshop on wheat roots on 13 November 2001 during the 6th Symposium of the International Society for Root Research, Nagoya, Japan, 11-15 November 2001.

3.1.00 **Hulugalle, N.R.** (2001). Root growth of wheat and legumes sown in rotation with cotton in a Vertisol (Poster presentation). 6th Symposium of International Society for Root Research, 11-15 November 2001, Nagoya, Japan.

3.1.03 **Richards D** (2002) presented his paper 'Raising the bar – techniques to evaluate increases in water use efficiency in cotton using crop simulation' paper presented at the Irrigation Australia conference, Sydney, May.

3.1.08 **Kochman J.** (2001). The challenges of getting the message out about plant diseases. 13th Plant Pathology Conference, September, Cairns Qld.

3.1.08 **Kochman, J** (2002) Fusarium wilt in cotton and some questions on soil health', Cotton Consultants Australia Cotton Production Seminar, May 9, Goondiwindi, Qld.

3.2.01 **Rose, M., Sánchez-Bayo, F. and Kennedy, I.R.** (2001) Phytoremediation of pesticide residues by wetland plants. Second National Wetland Conference, November, Broadbeach, Qld.

3.2.01 **Kennedy, I.R., Crossan, A. and Rose, M.** (2001) Soil Chemistry: Assessing the impact of pesticides on soil health & means of remediation. CRDC Soil Health Workshop, December, Myall Vale, ACRI.

3.2.02 **Reid N. and Silberbauer L.** 2001. Poster at the Ecology Society of Australia conference. Wollongong, NSW.

3.2.02 **Reid N., Silberbauer L., Thompson D. and Oliver I.** 2001. Oral presentation at the 2001 Rural Futures Conference. Armidale NSW.

3.2.19 **Whitehouse M** 2001. Argyrodes symposium co-ordinator: Introduction to the spider genus Argyrodes, Summary and future directions for research in Argyrodes. Oral presentation at XV International Congress of Arachnology (South Africa).

3.2.19 **Whitehouse M** 2001. The influence of scale and patchiness on spider diversity in a semi-arid environment. Oral presentation at XV International Congress of Arachnology (South Africa).

3.2.19 **Whitehouse M** 2001. Spiders and cotton: the awful truth. Cotton Consultants Australia Cotton Production Seminar, May, Goondiwindi, Qld.

4.2.04 **Dalton W.J., McIntyre G., Forbes M., Gibb D., Kauter G.,** (2001). Australian Cotton Cooperative Research Centre IPM training Workshops - 'learning together'. Cotton Consultants Australia Cotton Production Conference, Goondiwindi.

SEMINARS, WORKSHOPS & TRADE SHOWS

1.1.01 **Stephen Yeates** - October 2001, Katherine – Field day

1.1.01 **Stephen Yeates** - December 2001, Darwin – CRDC / CRC Northern Australian Review

1.1.01 **Stephen Yeates.** - March 2002, Kununurra – Presentation of results to Farmers and other Collaborators.

1.3.01 **Dr Andrew Ward** 2 October 2001 - Grower and Industry research update of cotton research being undertaken at Katherine

2.1.01 **Dr Rod Mahon** June 2001 - presentation to the Cotton Consultants AGM (Dalby).

2.2.03 **Assoc/Prof Peter Gregg.** (2002) Attractants for *Helicoverpa*. Presentation to the Jimbour area-wide management group, Dalby, 7 May 2002.

3.1.00 **Weaver, T.B. (2001).** Deep drainage and leaching in Vertosols, 38 pp. Seminar presented to School of Environmental Sciences, Griffith University, Nathan, Qld., on 20 November 2001.

3.1.00 **Dr Nilantha Hulugalle. (2002).** Presentation during Walgett cotton field day (8/3/02) on sodicity and laser-levelling

3.1.00 **Dr Nilantha Hulugalle. (2002).** Presentation to Sydney University final year crop science students on field instrumentation for cotton systems (13/3/02).

3.1.02 **Dr Ian Rochester** Presentation at Twynam Cotton meeting (Narrabri – 27/6/01)

3.1.02 **Dr Ian Rochester** Presentation at Potassium Workshop (Armidale – 3/7/01)

3.1.02 **Dr Ian Rochester** Presentation at Australian Cotton CRC Review (11/7/01)
3.1.02 **Dr Ian Rochester** Presentations to organic Cottongrowers (Narrabri – 31/7/01, Warren – 1/8/01)
3.1.02 Dr Ian Rochester Presentations to CQ Cottongrowers (Emerald – 8/8/01, Theodore – 9/8/01)
3.1.02 **Dr Ian Rochester** Presentation at Cotton/Greenhouse workshop (Narrabri – 16/8/01)
3.1.02 **Dr Ian Rochester** Presentation to Lower Namoi cotton consultants (Wee Waa - 7/11/01)
3.1.02 **Dr Ian Rochester** Presentation at Farming systems workshop (Narrabri – 6/12/01)
3.1.02 **Dr Ian Rochester** Presentation to Walgett cotton growers (Field Day - 14/12/01)
3.1.02 **Dr Ian Rochester** Presentation to Cotton Industry Development Officers (Narrabri – 12/1/02)
3.1.02 **Dr Ian Rochester** Presentations to Namoi cotton growers (Field Day - 6/3/02)
3.1.03 **Dr Stephen Milroy** - five presentations to grower groups and extension personnel covering topics of irrigation management, simulation modelling and crop physiology.
3.1.03 **Dr Michael Bange** - presentation to South African cotton growers on the agronomy and physiology research.
3.1.03 **Dr Michael Bange** - presentations to Breeza and Darling Downs cotton growers on the relative benefits of different row configurations in dryland cotton production.
3.1.03 **Dr Michael Bange** - presentation on Dryland Row Configurations – Balancing Yield, Quality and Costs at the Australian Dryland Cotton Grower Workshop, Sanctuary Cove, Qld.
3.1.05 **Dr Ian Taylor** - Presentation at Walgett , Lower Namoi Field Days, CCA meeting held at Dalby and Goondiwindi as well as a paper.
3.1.06 **Evan Brown** Hillston Ultra-Narrow Row Field Day 2002
3.1.06 **Evan Brown** Hillston Soils Workshop 4 June 2002
3.1.07 **Grant Roberts** Presented a seminar on "Crop maturity management strategies" at Cotton Seed Distributors research forum for cotton consultants. May 11th, Narrabri.
3.1.07 **Grant Roberts** Presentation on "Herbicide tolerant cotton" at the Australian Dryland Cotton Grower Workshop, 29th-31st August, Sanctuary Cove, QLD.
3.1.11 **Odeh, I.O.A.** 2001. The 'Bonn carbon sinks' and greenhouse gas (GHG) balance under the cotton-farming systems. The Department of Agricultural Chemistry & Soil Science Seminar Series, The University of Sydney, August 2001.
3.2.02 **L. Silberbauer** Oral presentation to the Annual Ecosystem Services workshop. Bunya Mountains, Qld. March 2002.
3.2.02 **B. Wilson.** Oral presentation to the Annual Ecosystem Services workshop. Bunya Mountains, Qld. March 2002.
4.2.07 **Ziaul Hoque** – 5 talks to grower groups at Boggabilla September and November 2001 and IPM groups in the Macquarie (March 26, 2002), Dalby (May 20, 2002) and Lower Namoi (May 24, 2002).
4.3.01 **Stewart Whiteside** CottonLOGIC training workshops, presentations at eleven workshops from Emerald in QLD to Hillston in NSW (August/September 2001).

MEDIA RELEASES

3.1.00 **Cross, A.** (2002). Impact of salinity under investigation. NSW Agriculture Today, 4 April 2002, p. 7; and NSW Agriculture Media Release, 12 April 2002 (http://www.agric.nsw.gov.au/reader/12961)
"Cotton Information Resources Survey 2002"
"UNE Council Visits Cotton Country"
"Background on Genetically Modified Cotton"
"Growers back whitefly control strategy"
"Lippia Under the Spotlight"
"Central Queensland group to study USA whitefly control strategies"
"WEEDpak – weed solutions for cotton"
"Award for cotton researcher"
"Integrated Disease Management Guidelines for cotton"
"Science gains ground on weed menace"
"Whitefly battle plan moves into gear"
"Rural Water Use Efficiency Initiative – Cotton & Grains Adoption Program"
"Cotton CRC makes progress"
"Murata Vortex Spinning: a New Spin on Textile Processing"
"Cotton Meeting to Discuss Hail Damage"
"Twin Row Cotton Shows Potential"
"Western flower thrip - a new pest threat for Emerald"
"Sustainability requires Viability"
"Cotton in the North in perspective"

MEDIA INTERVIEWS AND STORIES

1.1.01 **Stephen Yeates** ABC Country Hour NT June 2001CRC Research Progress
1.1.01 **Stephen Yeates** ABC Country Hour NT November 2001 Scoping Study

1.1.01 **Stephen Yeates** ABC Radio Broome November 2001 WA cotton
1.1.01 **Stephen Yeates** ABC NW WA live interview November 2001 Scoping study
1.1.01 **Stephen Yeates** ABC drive show Darwin April 2002 Cotton R & D in NT
1.1.01 **Stephen Yeates** ABC Country Hour NT April 2002 CRC Research Update
2.1.01 **Dr Gary Fitt** December 4 2001- David Cussons ABC Rural, Perth
6.1.02 **Dr Gary Fitt** ABC Tamworth Morning Radio Lippia problem and our research workshop. 24 June 2002
6.1.02 **Dr Gary Fitt** Ken Birch (2VM) for his cotton show. Story on CRC Summer Scholarships developing future researchers - focussed on the summer scholars, 17 January 2002.
6.1.02 **Dr Gary Fitt** - Richard Hudson ABC Rural, Cairns,4 December 2001
6.1.02 **Dr Gary Fitt** December 2001 ABC Radio Darwin - Northern Australia Scoping Study
2.2.04 **Dr Robin Russell** ABC Newcastle interview about Endosulfan bioremediation project. Story also covered in Weekend Australian, Murray Pioneer, Loxton News, River News Citrus Board News and Land wrote feature stories. ABC Berri, Port Lincoln, PortPirie, abc.net and ABC SA regional radio, ABC Earthbeat, Gnet news, Farming Ahead, Tasmanian Country, Garrard's Pest Review and Small Farms, and is also reproduced on CSIRO Entomology's website: http://www.ento.csiro.au/research/biotech/fieldtrial.html
3.1.02 **Dr Ian Rochester** Land newspaper article on Vetch cropping (13/9/01)
3.1.02 **Dr Ian Rochester** NW magazine newspaper article on Vetch cropping (31/10/01)
3.1.02 **Dr Ian Rochester** Audio interview for CSD clients on monitoring crop N (8/11/01)
3.1.02 **Dr Ian Rochester** Video interview for CSD clients on monitoring crop nutrition, winter crop options.
3.1.03 **Dirk Richards** 2VM Moree radio on 27th Mar 2002 on current season research activities in crop simulation.
3.1.03 **Dirk Richards** ABC Rural radio interview on the 19th of December 2001 following a climate analysis media release through CSD.
3.1.05 **Dr Ian Taylor** Radio interview with 2UE - Reducing reliance on residual herbicides. On Agricultue today - Managing Round UP Ready Cotton.
3.1.06 **Evan Brown** Local ABC Radio August 20th, 2RG: 2001, July 13th, Oct 19th, Dec 7; 2002, Feb 1st, Mar 22nd, May 17th.
3.1.07 **Grant Roberts** Newspaper articles (Queensland Country Life, Rural Weekly, Cotton Insight)
3.1.07 **Grant Roberts** Two interviews for CSD cotton outlook series presented to cotton consultants on pre Roundup Ready Cotton management issues and controlling volunteer cotton.
3.1.07 **Grant Roberts** Interview for CSD cotton web site on the use of late season growth regulators.
3.1.07 **Grant Roberts** Queensland Country life: Article on CRC farming systems site at Warra Queensland.
3.1.08 **Dr Joe Kochman** - interviewed about Fusarium wilt on 4 radio stations and the rural press on at least 5 occasions.
3.2.02 **Dr Letitia Silberbauer** Article for *The Land* newspaper 2001.
3.2.07 **Adam Downey** Interviewed by "The Land" at "AgQuip" in August 2001.
3.2.19 **Dr Mary Whitehouse** 2001. *The Cotton Industry Show* on 2VM Radio interview with Ken Birch. – coverage of the spider survey and the wolf spider work.
4.2.02 **Dr Phil Goyne** 4WK ,4HI, 2VM and regional ABC have broadcast interviews with WUE officers as has WIN TV.
4.2.03 **Julie O'Halloran** 2VM Radio Moree – Cotton industry show, regular contributions.
4.2.04 **Bill Dalton** Range Media – The Australian Cotton CD – Rom: Sept 2001 Edition. Three radio interviews & 1 T.V. interview
4.2.05 **Ingrid Christiansen** 2VM Radio Moree – Cotton Industry show – regular.
4.3.01 **Dr Michael Bange** interviewed by radio 2VM on the release of the Palm OS handheld version of CottonLOGIC.
4.3.01 **Dr Michael Bange** CottonLOGIC was promoted at the 2001 Moree cotton trade show.

CRC INFORMATION SHEETS AND RESEARCH REVIEWS

4.3.00 **Grant Herron, Lewis Wilson and Dallas Gibb,** Planning Ahead for Aphid Resistance Management. July 2001
4.3.00 **David Nehl,** Rotations and cotton disease. July 2001.
4.3.00 **Gunning, Herron, Tucker, Pyke and Wilson,** IRMS hot areas Central Queensland. August 2001.
4.3.00 **Steve Milroy, Graham Charles and David Larsen,** Sowing decisions with reduced water supply. August 2002.
4.3.00 **Lewis Wilson and Annie Spora,** Aphids in Cotton Cotton CRC Research Review. December 2001
4.3.00 **Lewis Wilson and Annie Spora,** Strategies to manage Aphids in cotton. December 2001
4.3.00 **Steve Milroy, Phil Goyne, David Larsen,** Irrigation Scheduling of Cotton. March 2002
4.3.00 **Graham Charles, Grant Roberts,** IWM (Integrated Weed Management) Guidelines for Australian Cotton Production. March 2002
4.3.00 **Kirrily Rourke,** Has Your Pupae Busting Been Effective?, May 2002

AWARDS

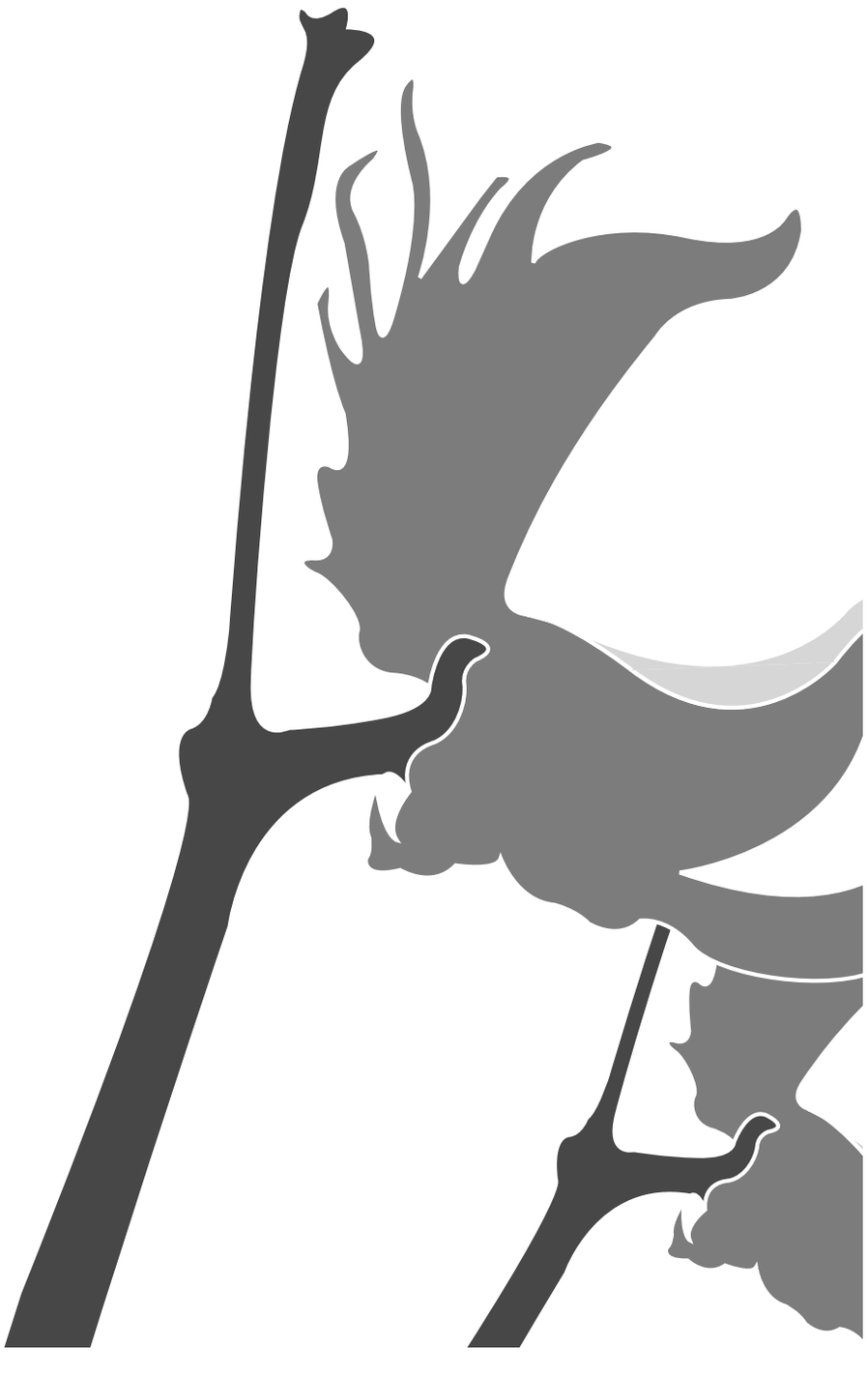
2.1.01 **Dr Gary Fitt** was awarded an Adjunct Professorship in the School of Ecosystem Management and Rural Science, UNE.
2.1.01 **Dr Gary Fitt** was elected a Fellow of the Academy of Technological Sciences and Engineering (ATSE) in November 2001.

VISITORS

Dr Yu Xiubo Chinese Ecosystem Research Network, Beijing, 27 July 2001. Tour.
Narrabri Public School Staff and Students Tour 8 August 2001.
Claude and Linda Sheppards, US Organic Cotton Growers, August 2001 Seminar "Experiences from the US in IPM & Organic Cotton Production, Vetch, Conservation and Use of Beneficials and New tools for IPM - spray oils".
Dr Guy Poppy, McMaster Fellow, School of Biological Sciences, University of Southampton U.K.,11th September 2001. Seminar " Assessing the risk of insect resistant GM crops - A scientific and PR challenge".
Dr Tanya Schuler, Plant and Invertebrate Ecology Division IACR-Rothamsted U.K., 23 November 2001, Seminar "effects of insect-resistant transgenic plants on arthropod natural enemies".
Dr Rebecca Letcher, Centre for Resource & Environmental Studies, ANU 16th November 2001, Seminar "Where should our water go?".
Prof. Anthony Shelton, Cornell University New York USA. Seminar "Controversies in Agriculture: From Louis Pasteur to Bt Plants". 24 January 2002.
Dr John Westbrook, USDA, ARS, SPARC, Areawide Pest Management Research Unit, Texas, USA. 12 February 2002. Seminar "Cotton Pest Management/IPM/AWM in Texas".
Dr Doug Landis Michigan State University, USA, Seminar "Designing Landscapes for Enchanced Dispersal and Impact of Insect Natural Enemies". 6 February 2002
Dr Patrick Coyler Red River Research Station Bossier City L.A. USA, 18 February 2002, "Fusarium-related industry visit".
The University of Sydney Soil Workshop, 23-27 February 2002.
Lower Namoi Cotton Growers Association Field Day "Dollar Decision$", 7 March 2002.
6 US Cotton Growers, Tour, 12 March 2002
Bureau of Sugar Experiment Stations Board Visit, 9 April 2002
3 Japanese Visitors 10 April 2002
University of New England Board visit and meeting, 22 April, 2002.
15 South African Cotton group, 31 May 2002, Tour.
Rice Industry Visit, 30 May 2002, Tour
The University of New England soil biology team: Kath King & Keith Hutchinson, 17 May, 2002, Seminar "Structure and Function in Soil Heterotrophic Systems".
Dr David Andow, University of Minnesota, Seminar "Resistant evolution and parameter estimation", 14 June 2002
NPIRD Regional Workshop 15th November 2001. Future of NPIRD.
DLWC Salinity Group Discussion on Potential collaboration 15th November, 2001.
CRC Irrigation Group Discussion on Proposal and support 21st March,2002.
Ian Rankine & Bill Wilkinson DNR Qld Discussion Emerald and Collaboration 29th April, 2002
Brian Keating CSIRO and **Bert Jenkins** Greening Australian and John Wolfenden UNE, Visit 24th April, 2002
Lippia Workshop Joint Cotton CRC, Weeds CRC, MDBC Workshop - June 25th, 2002

PUBLIC RELATIONS

Dr Gary Fitt, presentation to Coonabarabran Shire Council and High School 5 July 2001 - Genetically Modified Organisms.
Dr Gary Fitt, presentation to Gwydir Valley Cotton Growers Association July 12th 2001 - Genetically Modified Organisms.
Dr Gary Fitt addressed the AGM of the NSW Rural Counsellors on the 10th September and gave an overview of the Cotton CRC research program and the importance of sustainable cotton production to northern NSW rural economies.
Dr Gary Fitt gave a presentation to the January 16 Syngenta Conference Sydney, on the impact and importance of transgenic cottons for the industry and indicated some future directions for IPM and Area-wide management based on transgenic cottons.
Dr Gary Fitt – discussions with Catchment Boards; Macquarie – Dubbo Jan 23, Namoi – Gunnedah Jan 25, Border Rivers/ Balonne, Condamine Catchment Associations – Goondiwindi – Feb 27. Outlined current environmental and natural resource management research in the CRC and future plans.
Cotton CRC As part of National Science Week, the Cotton CRC had a display at the Science in the City event held at the Australian Museum, May 17-23. CRC staff from Sydney University and staff from Cotton Australia assisted to man the display.
Cotton CRC mounted a display as part of the NTDPIF pavilion at the Darwin show, July 27/28/29 2001.
Gary Fitt, David Hamilton, Geoff McIntyre and Bruce Brown (November 1 - Qld Government CRC Forum, Brisbane), participated in this one day forum for CRCs with nodes in Qld.
Gary Fitt attended the Academy of Technological Sciences and Engineering (ATSE) dinner, Hobart November 19, to be inducted as a Fellow of ATSE.
Gary Fitt August 2001, Dubbo City Council public forum on GM crops and the environment with a panel of experts and activists. Panel included Cotton CRC, CSIRO, NFF, Monsanto, Genethics Network, Organic Federation and OGTR. Forum was chaired by Neil Inall.
Stephen Yeates - February 2002 , Katherine – Presentation to Katherine Council.



Auditor's Report

MICHAEL A. CARRIGAN & Co.
A.B.N. 65 365 735 356
CHARTERED ACCOUNTANTS

PARTNERS:
Michael A. Carrigan B. Comm, FCA
S. Louise Gett B.F.A., CA
Calvin C. Skues B.Bus. CA
David A. Maxwell B.F.A. CA

AUDITORS REPORT TO THE CO-OPERATIVE RESEARCH CENTRES PROGRAM, DEPARTMENT OF EDUCATION, SCIENCE AND TRAINING REPRESENTING THE COMMONWELTH IN RESPECT OF AUSTRALIAN COTTON CO-OPERATIVE RESEARCH CENTRE

FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2002

Scope

We have audited the financial information of the Australian Cotton Co-operative 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 2002. The parties to the Australian Cotton Co-operative Research Centre are responsible for the preparation and presentation of financial information. We have conducted an independent audit of the financial information in order to express an opinion on it to the parties to the Australian Cotton Co-operative Research Centre.

The financial information has been prepared for the parties to the Australian Cotton Co-operative Research Centre for the purposes of fulfilling their annual reporting under clause 14 (1) (f) of the Commonwealth Agreement and for distribution to the Cooperative Research Centres Program, Department of Education, Science and Training, 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 weather the financial information id free of material misstatement. Our procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial information, and the evaluation of accounting estimates. These procedures have been undertaken to form an opinion whether, in all respects, the financial information is presented fairly in accordance with the 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), 9(1), 9(5) (Intellectual Property) and 12(2) (Financial Provisions), so as to present a view of the sources of funding an the application of funding of the Australian Cotton Co-operative Research

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Centre and the application of which is consistent with our understanding of its financial activities during the year and its financial position.

While we have not performed any audit procedures upon the estimates for the next period and do not express any opinion thereon, we ascertained 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 to 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 equalled or exceeded the amount of grant paid during the year (not including advances). (Clause 4)

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 5(1))

3. The Researcher's allocations of the budgetary resources between Heads of Expenditure has not been lower or higher than the allocation in the budget by $100 000 or 20% (whichever is the greater amount) without prior approval by the Commonwealth. (Clause 5(2)) With the exception of:

    - salaries which were $1,301,000 over the original budgeted figure for the respective heads of expenditure.
    - other expenditure which were $658,000 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(5)) (**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(5)), 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(2))

Date: 1st November 2002

Firm: Michael A. Carrigan & Co.

Address: 1/155 Maitland Street
Narrabri NSW 2390

Signature: _____
Partner: Michael A. Carrigan

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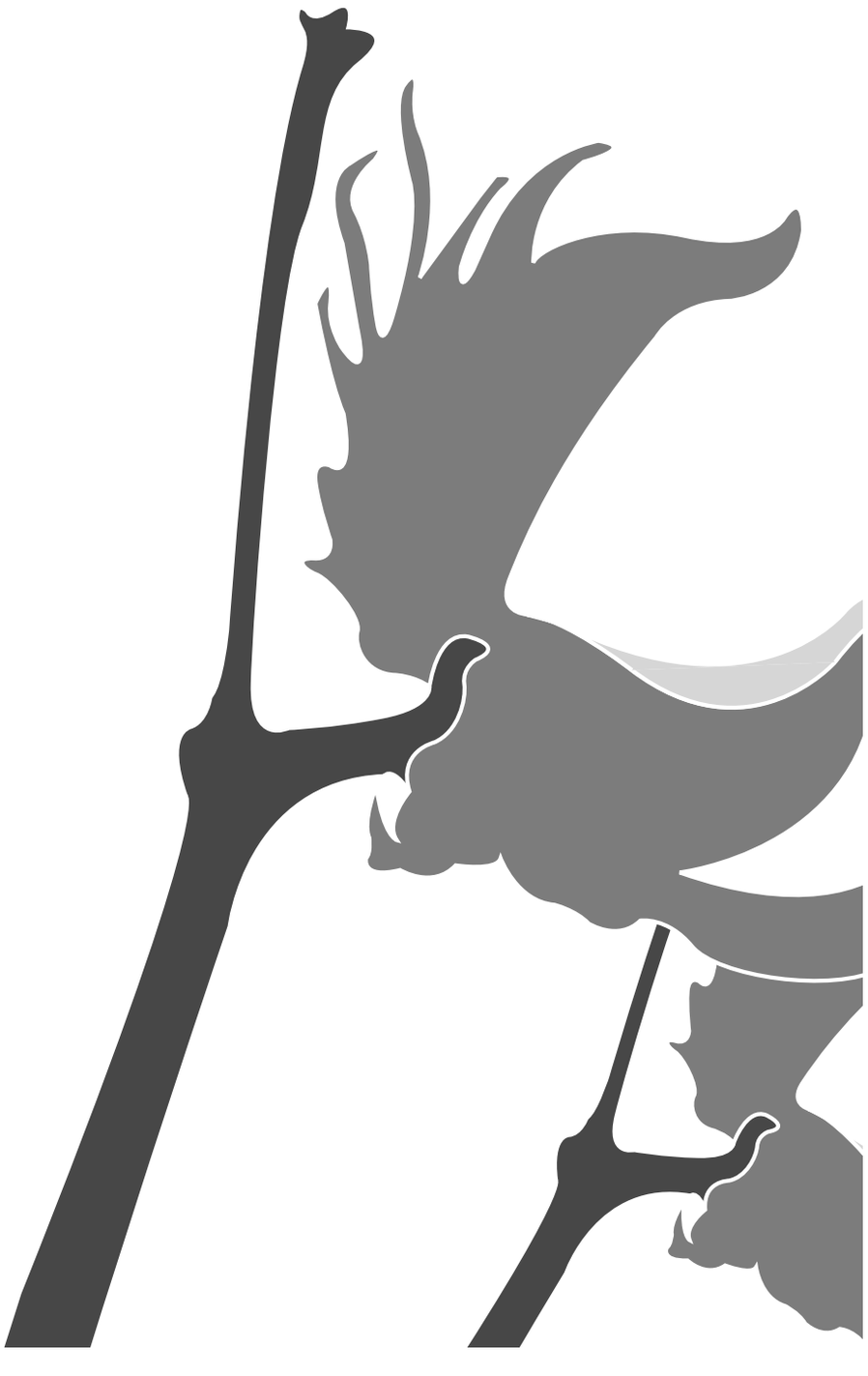
Grants

Current Research Grants held by Key Cotton CRC researchers

RESEARCHER	ORGANISATION	TITLE	SCHEME	GRANT PERIOD	TOTAL $'000S
Geoff Strickland	Dept. Agriculture WA	Defining IPM for NW Australia.	CRDC	1999-2002	267
Geoff Strickland	Dept. Agriculture WA	Biological control of Paterson's curse.	AWRAP & MLA	1998-2002	227
Assoc/Professor Peter Gregg	UNE	Management of resistance in Bemisia tabaci.	CRDC	1998/01	81
Assoc/Professor Peter Gregg	UNE	Attractant and kill technology for Helicoverpa armigera.	CRDC	1999/02	87
Assoc/Professor Peter Gregg	UNE	Impact of GM crops on pesticide use.	Academy of Technology, Science and Engineering.	2001	7
Assoc/Professor Peter Gregg	UNE	Report on Issues in Biotechnology in Australia.	Land & Water Conservation Australia	2002	20
Assoc/Professor Peter Gregg	UNE	Environmental assessment of GM canola.	Environment Australia	2001	45
Dr Michael Bange and Dr Stephen Milroy	CSIRO PI	The impact of temperature extremes on cotton performance.	CRDC	2001-2004	338
Dirk Richards and Dr Michael Bange	CSIRO PI	Application of crop simulation within the Australian Cotton Industry.	CRDC	2001-2004	355
Dr Michael Bange & Dr Stephen Milroy	CSIRO PI	Training in crop physiology – Functional responses of cotton to environment mediated via internal nitrogen dynamics.	CRDC	2001-2004	76
Dr Michael Bange and Sandra Deutscher	CSIRO PI	Continued development and field evaluation of micro-computer cotton management packages.	CRDC	2000-2003	396
Dr Michael Bange	CSIRO PI	Enhancing Access to climate and weather data.	CRDC	2000-2003	145

Dr Michael Bange and Darren Linsley	CSIRO PI	Supporting development and independent evaluation of cotton management packages.	CRDC	2002-2005	310
Dr Michael Bange Tony Pfeiffer	CSIRO PI	ACRI Computing Support	CRDC	2002-2005	403
Dr Lewis Wilson		Incorporating aphids, insecticides and early season plant compensation in IPM	CRDC	2002-2005	528
Dr Lewis Wilson		Improving understanding of the ecology and management of cotton aphid	CRDC	2001-2004	293
Dr Lewis Wilson		Identification and management of 'Bunchy Top' syndrome in cotton	CRDC	2000-2003	557
Dr Lewis Wilson/ Dr Geoff Baker		Enhancing the impact of early season predation on Helicoverpa spp.	CRDC	2001-2004	457
Dr David Murray/ Dr Melina Miles	Qld DPI	Heliothis management in south Queensland farming systems	GRDC	2001-2004	668
Dr David Murray/ Dr Melina Miles	Qld DPI	Heliothis management in south Queensland farming systems	CRDC	2001-2004	221
Dr David Murray/ Dr Moazzem Khan	Qld DPI	Pest status and management of shield bugs in cotton.	CRDC	2000-2003	348
Dr David Murray/ Dr Brad Scholz	Qld DPI	IPM in dryland cotton on the Darling Downs.	CRDC	1999-2002	379
Assoc/Professor Alex McBratney	The University of Sydney	Application of precision agriculture to cotton.	CRDC	2001-	35
Assoc/Professor Alex McBratney	The University of Sydney	Salinity risk assessment in irrigated farming systems across the lower Gwydir valley & Access relationships of irrigated farming to rising saline groundwater in southeast of Warren.	CRDC	2001-2002	200

Assoc/ Professor Alex McBratney	The University of Sydney	Variable-rate application of nitrogen: the determination of an empirical methodology for implementation.	Australian Research Council SPIRT	2001-2003	38
Assoc/Professor Alex McBratney	The University of Sydney	Development of an 'on-the-go' soil pH sensing system prototype for site-specific soil management.	Australian Research Council SPIRT	2001-2003	195
Assoc/Professor Alex McBratney	The University of Sydney	Development of precision agriculture in the grain industry.	GRDC	2002-2007	
Dr Geoff Naylor	CSIRO T & FT	Cotton fineness and maturity measurement using the Sirolan-Laserscan.	CRDC	2002-2003	
Dr Geoff Naylor	CSIRO T & FT	Measuring Cotton Fineness and Maturity using the Sirolan-Laserscam	CRDC	1999-2002	170
Dr Geoff Naylor	CSIRO T & FT	Participation in an international inter laboratory trial to develop standard reference cotton samples for fibre fineness and maturity.	CRDC	2001-2003	80
Dr Stuart Gordon	CSIRO T & FT	Measuring cotton fibre maturity using polarised light microscopy.	CRDC	2000-2003	295
Dr Stuart Gordon	CSIRO T & FT	A survey of cotton wax contents in Australian cotton	CRDC	2001-2002	38



Performance Indicators

NATURE OF INDICATOR	PERFORMANCE INDICATOR	YEAR 3 PERFORMANCE 2001/2002
OBJECTIVES OF THE CENTRE		
Outcome	Economic benefit to Centre	• CRC priorities closely aligned to sustainability needs of the cotton industry • Increasing interaction with wider community with environmental research addressing issues of national importance • Substantial funding secured from CRDC ($1.7 million in 2001/2002) • Enhanced sustainability of industry will maintain economic benefits to rural communities and Australian exports • Commercialization of one potential product in train with IP protection established. Centre IP fully assessed. • Research in northern Australia established in 4 regions. Developing links to government and community groups to facilitate future industry development contingent on research outcomes. • Significant move to establish public good environmental management research program
Input	Total Resources	• Total centre resources exceed $16 million (target $12.467 million for Year Three) • Total leverage to date > 3.7 vs. Commonwealth cash (target > 6.0) • Total cash resources year three - $5,798 million (target $3.348 million for Year Three) • Cash 34.23% of total resources to date (target 26.85% for life of the Centre)
Process	Program/ Project Management	• Board, Management Committee and Northern Committee established. • Annual plan and budget agreed. Three year Strategic plan in place. • Advisory committee established – comprising external scientific, industry and community representatives • Process for formal Annual Review of all projects established with third year review completed on the 17th & 18th June 2002. • Representative discipline groups established and provide feedback on progress and priorities.

Outputs	Centre Reports and Publications transferring research outcomes and technology to industry	• IPM Guidelines for Australian Cotton widely distributed and undergoing revision. • 15 documents were produced by the Technology Resource Centre in response to industry needs these were 'Managing riparian lands in the cotton industry', 'Sowing decisions with reduced water supply', 'Has your Pupae Busting Been Effective? May 2002', 'Irrigation Scheduling for cotton', 'Components of Integrated Weed Management (IWM) for Australian Cotton Production', '2002-2003 Insect Resistance management Strategy for Cotton', 'Planning Ahead for Aphid Resistance Management July 2001', 'Rotations and cotton disease CRC information', 'IRMS hot areas central Queensland', 'IRMS warm areas S Qld, Macintyre, Gwydir, Lower Namoi', 'Cool areas Macquarie Lachlan', 'IRMS Upper Namoi', 'Aphids in Cotton CRC research Review', 'Strategies to manage Aphids in cotton', 'IWM (integrated Weed Management) Guidelines for Australian Cotton Growers', 'Guidelines for Assessing Pupae risk for Dryland Cotton Growers'. • Distribution of 936' ENTOpacs, enhanced with new material, and 530 copies of NUTRIpac to growers • After the major upgrade of CottonLOGIC (Version 4.0) in December 2000, 1,164 registered users across the industry at the end of 2002 were recorded. • Northern Australia Scoping document was released in August 2001. • Cotton CRC Website upgraded and averaging 540 visits per day • Cotton CRC eNews alerts users to important new web content and CRC developments distributed to over 1204 addresses. • Over 2,804 clients on the Industry database, including 1,254 growers, 221 Cotton Consultants, 185 Agronomists, 336 Chemical Company representatives and agronomists and 97 external and education person
	Short courses	• The IPM Short Course structure and reference manual completed. Further refinement and development will occur on an ongoing basis. The course has been registered as a National Training Program and attracts FarmBis funding support. • Three pilot IPM short courses have been completed with a total of 28 growers, 4 consultants and 2 internal staff receiving training in the Macquarie, Lower Namoi and Darling Downs. Full courses will commence in 02/03. • A new version of CottonLOGIC was released in January 2002. • Successful CottonLOGIC workshops were held in 11 regions.

NATURE OF INDICATOR	PERFORMANCE INDICATOR	YEAR 3 PERFORMANCE 2001/2002
QUALITY AND RELEVANCE OF THE RESEARCH PROGRAM		
Outcome	Scientific Status and user satisfaction	• Industry involved in all discipline groups where identification of priorities and evaluation of research progress are addressed. • Advisory committee provides independent scientific assessment of progress. • Links to other research organizations help to maintain scientific status. • 2 awards – an Adjunct Professorship in the School of Ecosystem Management and Rural Science and a Fellowship in the Academy of Technological Sciences and Engineering (ATSE) were presented to Dr Gary Fitt.
Input	Research Program Resources	• $46 million Cash and in-kind resources on research program to date (target $84 million over the life of the Centre). • Distribution of resources across programs in line with Business Plan.
Process	Involvement with Research users and industry	• Eleven discipline groups and coordinators established to identify priorities and assess progress. Australian Cotton Growers Research Association and Cotton Consultants Association represented on each group. • CRC Advisory Committee established with representatives of industry (2), independent scientists (3), extension specialist (1) and community groups (3). Advisory Committee assists Management Committee in annual review process • Management Committee completes project selection process with input from discipline groups. • Northern Committee established to represent all commercial interests and research users in northern Australia to advise on research needs • CRC fully represented on Board of the Australian Cotton Industry Council. • CRC represented in Cotton Consultants Australia Inc. and liaises closely with Cotton R&D Corporation Board • Industry/Community Steering Committees established for projects in Water Use Efficiency (Qld) and Environmental Impacts of Irrigation (Gwydir), Ecosystem Services (Gwydir), Bioremediation (Namoi) and Salinity Risk Assessment projects (Various NSW Regions). • New working Groups established to research specific issues – Northern Murray Darling Basin Water Balance Group, Greenhouse Working Group. • Regular liaison with Grains Research & Development Corporation, Land & Water Australia, Murray Darling Basin Commission, various Irrigator Associations, CRC for Freshwater Ecology, National Program for Irrigation R & D, Australian Greenhouse Office, Carbon Accounting CRC, Sugar CRC, Rice CRC, Weeds CRC, Tropical Plant Protection CRC, Cotton Australia, Irrigation Association of Australia, Namoi Cotton Growers Association and Department of Natural Resources.
Outputs	External Publications	• 33 journal papers and book chapters and 30 conference and other publications in 2001/2002. • >88 presentations at Conferences, Workshops, grower meetings • 36 grower magazine articles and 34 press interviews.

NATURE OF INDICATOR	PERFORMANCE INDICATOR	YEAR 3 PERFORMANCE 2001/2002
STRATEGY FOR UTILIZATION AND APPLICATION OF RESEARCH OUTPUTS		
Outcome	Improve end user adoption	• Communication plan in place • Commitment to effective mixture of written, face to face and electronic information delivery • Maintenance of long-term farming systems sites researching sustainable farming practices • Establishment of additional demonstration sites for specific farming system issues. • Twenty demonstration sites established for Water Use Efficiency studies in Qld
Input	User Core Participant Resources	• $2.65 million in-kind devoted to Technology Transfer and communications in Year Three. • Technology Resource Centre as key physical resource for packaging and distribution of printed and electronic information. • $1.218 million CASH on Education, Technology Transfer in 2001/2002.
Process	Communication and implementation of Centre research outcomes and technology	10 Industry Development Officers and 11 Water Use Efficiency extension officers located strategically throughout the industry as well as 7 farming System extension Officers in NSW Ag and QDPI who contribute part of there time to cotton extension. 1 CottonLOGIC Specialized Support Officer and 1 Project Coordinator Best management Practices. 1 IPM training Coordinator, 2 Trainee Industry Development officers and 1 National Extension Coordinator. • Water Use Efficiency Officers established in 6 regions throughout Qld to support adoption of Best Management Practices for irrigation. • Research program outcomes packaged for industry use. • Industry BMP Guidelines reflect latest research outcomes. Centre staff involved in planning for additional BMP Modules on irrigation and disease management • Key researchers in all projects involved in industry field days and many participate in research at focal Farming Systems locations.

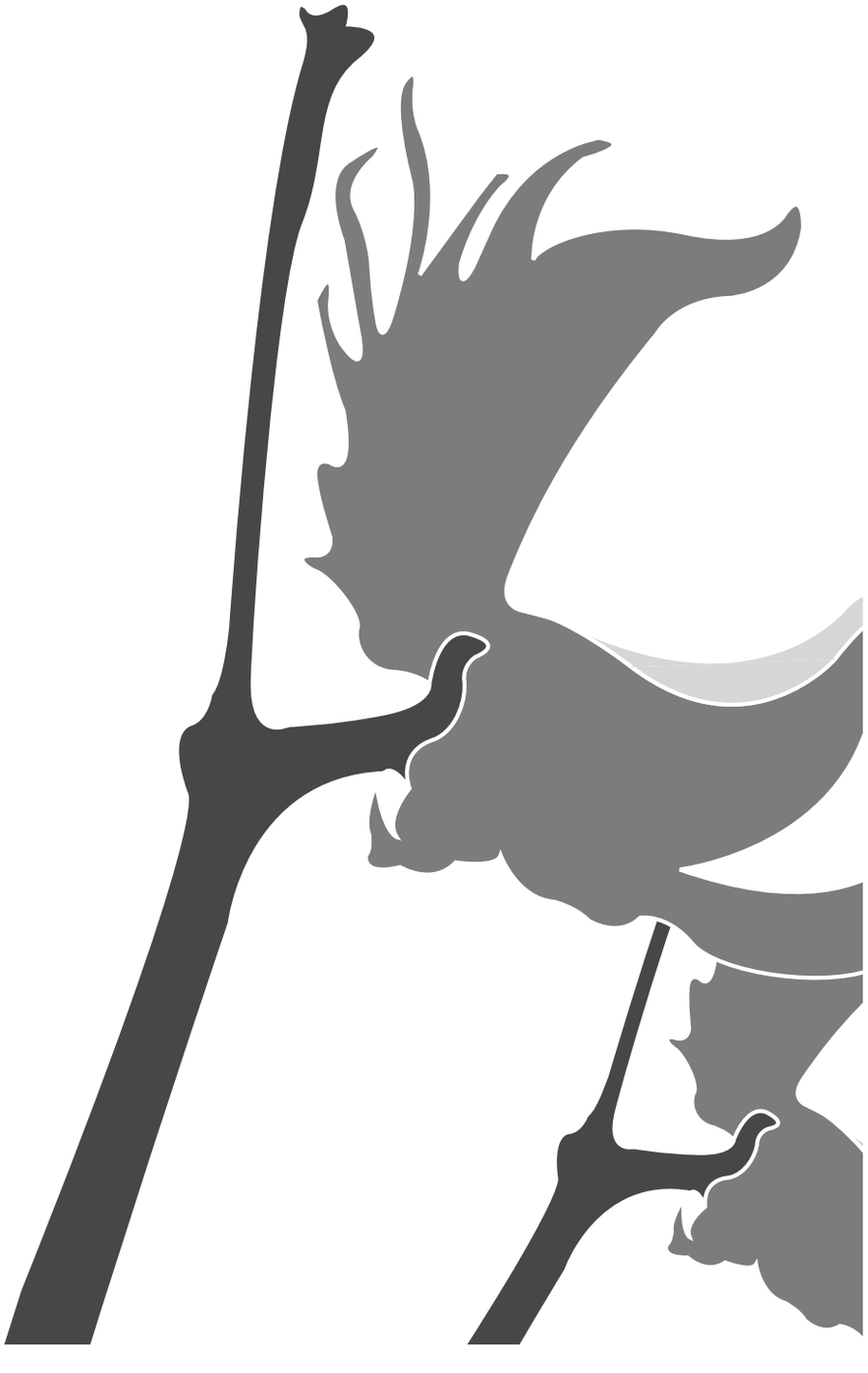
Outputs	Commercialization and IP management	• Business plan completed for two projects and IP protection in place for one project. • Discussions with potential commercial partners initiated. • Assessment made of other Centre IP.
	Technology transfer and adoption	• 18 Industry publications including IPM Guidelines, EntoPAK, NutriPAK, NutriLOGIC and numerous disease management guides. • Distribution of 178 information packs • Award winning Cotton CRC Website upgraded. • 17 CottonLOGIC workshops across all regions including northern Australia. • Participation in Australian Cotton Trade Show, Moree • Participation in 'Science in the City', Australian Museum, Sydney. • 13 Fields days in established regions • Research Update and Field Day in potential northern regions - Ord River Irrigation Area, WA and Katherine, NT. • Cotton Research Open Day for general public at Australian Cotton Research Institute, Narrabri
	PR/ Press Releases	• 19 press releases produced by the Australian Cotton CRC Communications group in response to news worth issues were "Cotton Information Resources Survey 2002", "UNE Council Visits Cotton Country", "Background on Genetically Modified Cotton", "Growers back whitefly control strategy", "Lippia Under the Spotlight", "Central Queensland group to study USA whitefly control strategies", "WEEDpak – weed solutions for cotton", "Award for cotton researcher", "Integrated Disease Management Guidelines for cotton", "Science gains ground on weed menace", "Whitefly battle plan moves into gear", "Rural Water Use Efficiency Initiative – Cotton & Grains Adoption Program", "Cotton CRC makes progress", "Murata Vortex Spinning: a New Spin on Textile Processing", "Cotton Meeting to Discuss Hail Damage", "Twin Row Cotton Shows Potential", "Western flower thrip a new pest threat for Emerald", "Sustainability requires Viability", "Cotton in the North in perspective" • Cotton CRC display produced and used at Richmond Community Forum (Qld); Emerald Science Day, Darwin Show (NT), Science in the City (Sydney) to raise awareness about CRC activities.

NATURE OF INDICATOR	PERFORMANCE INDICATOR	YEAR 3 PERFORMANCE 2001/2002
COLLABORATIVE ARRANGEMENTS		
Outcome	Cooperation in research within Australia and overseas and more efficient use of resources	• Informal linkages to 10 cotton research institutions in the USA, China and Japan. • Collaborative projects (4) involving researchers from USA, China and Japan • Joint projects established or planned with four other CRCs – Weeds, TPP, Carbon Accounting, and Sugar. • Research Discussions with Freshwater Ecology, Catchment Hydrology.
Input	Research Providers FTE In Kind	• Year 2 – Researchers 34.21 FTE In kind increased from 32.19 last financial year. (target 47.7 over the life of the Centre)
Process	Collaboration Between Researchers	• 69 % of projects involve two or more participants • Use of Shared facilities • Annual Research Review and discipline groups provide forums to develop collaborative links. • All students with at least one non-academic supervisor • Collaborative linkages established with external research associations • Summer scholarships involve undergraduate students from 4 Universities outside the CRC participants
	Collaboration between Researchers and Research Users	• Industry Advisory Committee meetings annually • Direct involvement of many growers with research projects on-farm • Northern Committee met and produced a draft 5 year plan for Northern Queensland. • Annual Research Review completed 17th & 18th June 2002 and involved participation by ACGRA and Cotton Consultants Association.
	International Collaboration	5 international exchanges in Year Three. 3 researchers visited the US, 1 to Brazil and 1 US researcher visited Australia. 3 centre researchers participated in international conferences.
Outputs	Collaborating authors on publications	• Collaborating authors on 38 % of centre publications

NATURE OF INDICATOR	PERFORMANCE INDICATOR	YEAR 3 PERFORMANCE 2001/2002
EDUCATION AND TRAINING		
Outcome	Cotton Production Courses	• 20 people graduated from the Cotton Production Course (Certificate and Diploma) in April 2002 – 112 have now graduated, 46% over the last two years • About 30 Cotton CRC staff and other industry personnel deliver specialized lectures during residential schools. • 16 undergraduates completed Applied Cotton Production unit at UNE. The undergraduate program is now delivered to 2 other universities, 20 students at University of Queensland, 15 students at University of Sydney.
Input	Education and training Program Resources	• $0.858 million cash and in-kind resources committed to education strategies in year three (target $3.3 million over the life of the Centre). • 30 in-kind scientists have input to course delivery.

Process	Industry training	• Year 3 – A total of 63 workshops/field days, research updates for industry and the wider community. • IPM short course developed in consultation with industry.
Outputs	Students, scholarships, lecturer	• 3 Postgraduates completed in year 3 • 45 graduated from Cotton Production Certificate Course • 4 undergraduate scholarships commenced. • 6 Summer Scholarships and 4 Honours Scholarships supported. • CRC lecturer position maintained, at least 30 scientists involved in presentation of course.

NATURE OF INDICATOR	PERFORMANCE INDICATOR	YEAR 3 PERFORMANCE 2001/2002
MANAGEMENT STRUCTURE AND ARRANGEMENTS		
Outcome	Continuity of long term research effort	• All research participant organizations maintain or increase commitment to Centre.
Input	Total cash and in-kind resources in general administration program	• $0.501 million cash and in-kind resources for Year Three (target $2.2 million over the life of the Centre). These figures include the CRC communication strategy, staff training and accommodate current staff salary levels.
Process	Governing Board	• Board established with Chair and two independent Directors. Independent Directors drawn from processing and environment areas. • Majority of Directors independent of research providers (7/12) • Timetable of quarterly board meetings established
	Project management skills	• Board approval for program of leadership training for Program leaders and future leaders in the Centre
Outputs	Financial Management and Reporting	• Budget reports and cash flow projections provided to Board and Management committee quarterly • Financial Data maintained on MYOB accounting.
	Monthly, quarterly and Annual Report on time	• Financial reports submitted on time to the Board • Annual report submitted in third quarter • Quarterly Cash Flow Statements submitted.



Financial Statements

RESEARCH STAFF RESOURCES — ATTACHMENT B

IN-KIND CONTRIBUTION BY ORGANISATION (PERSON YEARS) 2001/2002

			Main Activity	Total % of Time	% Spent on Research Program					% Spent on Education Program	% Spent External Communications	% Spent Technology Transfer	% Spent on CRC Administration
					SubProgram P 1	P 2	P 3	P 5	Total on Research				
Agriculture Western Australia													
Researcher													
Annells	Amanda	Dr	R	100%	100%	0%	0%	0%	100%	0%	0%	0%	0%
Moulden	John	Mr	R	60%	60%	0%	0%	0%	60%	0%	0%	0%	0%
Strickland	Geoff	Mr	R	70%	65%	0%	0%	0%	65%	5%	0%	0%	0%
				2.30	*2.25*	*0.00*	*0.00*	*0.00*	*2.25*	*0.05*	*0.00*	*0.00*	*0.00*
Cotton Research & Development Corporation													
Researcher													
Dugdale	Helen	Ms	T	8%	0%	0%	0%	0%	0%	0%	0%	8%	0%
Dugdale	Helen	Ms	T	10%	0%	0%	0%	0%	0%	0%	0%	10%	0%
Holloway	Rachel	Ms	T	10%	0%	0%	0%	0%	0%	0%	0%	10%	0%
Lester	Tim	Mr	T	10%	0%	0%	0%	0%	0%	0%	0%	10%	0%
Pyke	Bruce	Mr	T	25%	0%	0%	0%	0%	0%	0%	0%	25%	0%
Roth	Guy	Mr	T	8%	0%	0%	0%	0%	0%	0%	0%	8%	0%
Schulze	Ralph	Mr	T	5%	0%	0%	0%	0%	0%	0%	0%	5%	0%
Schulze	Ralph	Mr	T	8%	0%	0%	0%	0%	0%	0%	0%	8%	0%
				0.83	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.83*	*0.00*
Cotton Seed Distributors													
Researcher													
Allen	Stephen	Dr	R	50%	0%	20%	20%	0%	40%	5%	0%	5%	0%
Eveleigh	Robert	Mr	T	15%	0%	0%	0%	0%	0%	0%	0%	15%	0%
Kauter	Greg	Mr	T	13%	0%	0%	0%	0%	0%	0%	0%	13%	0%
Kauter	Greg	Mr	T	8%	0%	0%	0%	0%	0%	0%	0%	8%	0%
Kay	Adam	Mr	T	15%	0%	0%	0%	0%	0%	0%	0%	15%	0%
Marshall	John	Mr	T	15%	0%	0%	0%	0%	0%	0%	0%	15%	0%
				1.15	*0.00*	*0.20*	*0.20*	*0.00*	*0.40*	*0.05*	*0.00*	*0.70*	*0.00*
CSIRO Entomology													
Researcher													
Akhurst	Ray	Dr	R	10%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Baker	Geoff	Dr	R	80%	0%	40%	40%	0%	80%	0%	0%	0%	0%
Christian	Peter	Dr	R	13%	0%	13%	0%	0%	13%	0%	0%	0%	0%
De Barro	Paul	Dr	R	60%	0%	60%	0%	0%	60%	0%	0%	0%	0%
Dillon	Martin	Mr	R	100%	45%	0%	50%	5%	100%	0%	0%	0%	0%
Hardwick	Scott	Dr	R	50%	0%	50%	0%	0%	50%	0%	0%	0%	0%
Mahon	Rod	Dr	R	80%	0%	80%	0%	0%	80%	0%	0%	0%	0%
Oakeshott	John	Dr	R	30%	0%	30%	0%	0%	30%	0%	0%	0%	0%
Olsen	Karen	Ms	R	50%	0%	50%	0%	0%	50%	0%	0%	0%	0%
Richards	Andy	Dr	R	50%	0%	45%	0%	0%	45%	5%	0%	0%	0%
Whitehouse	Mary	Dr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
				6.23	*0.45*	*3.78*	*1.90*	*0.05*	*6.18*	*0.05*	*0.00*	*0.00*	*0.00*
CSIRO Plant Industry													
Researcher													
Bange	Michael	Dr	R	40%	30%	0%	0%	0%	30%	5%	0%	5%	0%
Brown	Tony	Dr	R	10%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Brubaker	Curt	Dr	R	30%	0%	30%	0%	0%	30%	0%	0%	0%	0%

			Main Activity	Total % of Time	% Spent on Research Program					% Spent on Education Program	% Spent External Communications	% Spent Technology Transfer	% Spent on CRC Administration
					SubProgram				Total on Research				
					P 1	P 2	P 3	P 5					
Deutscher	Sandra	Ms	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Duggan	Brian	Dr	R	100%	100%	0%	0%	0%	100%	0%	0%	0%	0%
Eastick	Rowena	Ms	R	10%	10%	0%	0%	0%	10%	0%	0%	0%	0%
Johnson	David	Mr	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Lei	Tom	Dr	R	40%	0%	0%	40%	0%	40%	0%	0%	0%	0%
Linsley	Darren	Mr	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Milroy	Steve	Dr	R	40%	0%	0%	40%	0%	40%	0%	0%	0%	0%
Pfieffer	Tony	Mr	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Reddall	Amellia	Dr	R	40%	0%	0%	40%	0%	40%	0%	0%	0%	0%
Richards	Dirk	Mr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Tennakoon	Sunil	Dr	R	40%	0%	0%	40%	0%	40%	0%	0%	0%	0%
Thongbai	Pongma	Dr	R	26%	0%	0%	26%	0%	26%	0%	0%	0%	0%
Wilson	Lewis	Dr	R	40%	0%	0%	35%	0%	35%	5%	0%	0%	0%
				5.96	*1.40*	*0.40*	*2.41*	*0.00*	*4.21*	*0.10*	*0.00*	*1.65*	*0.00*

CSIRO Sustainable Ecosystems

Researcher

Carberry	Peter	Dr	R	30%	10%	0%	10%	0%	20%	0%	0%	10%	0%
Dalgleish	Neil	Dr	R	30%	0%	0%	20%	0%	20%	0%	0%	10%	0%
Hochman	Zvi	Dr	R	30%	10%	0%	10%	0%	20%	0%	0%	10%	0%
Probert	Merv	Dr	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Whish	Jeremy	Dr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
				1.20	*0.20*	*0.00*	*0.70*	*0.00*	*0.90*	*0.00*	*0.00*	*0.30*	*0.00*

CSIRO Textile & Fibre Technology

Researcher

Evans	David	Dr	R	15%	0%	0%	0%	15%	15%	0%	0%	0%	0%
Gordon	Stuart	Dr	R	15%	0%	0%	0%	15%	15%	0%	0%	0%	0%
King	David	Dr	R	50%	0%	0%	0%	50%	50%	0%	0%	0%	0%
Naylor	Geoff	Dr	R	18%	0%	0%	0%	18%	18%	0%	0%	0%	0%
				0.98	*0.00*	*0.00*	*0.00*	*0.98*	*0.98*	*0.00*	*0.00*	*0.00*	*0.00*

Dept of Business, Industry & Resource Development

Researcher

Bellgard	Stan	Dr	R	20%	20%	0%	0%	0%	20%	0%	0%	0%	0%
Bennett	Malcolm	Mr	R	20%	20%	0%	0%	0%	20%	0%	0%	0%	0%
Dougall	Andrew		R	40%	40%	0%	0%	0%	40%	0%	0%	0%	0%
Ham	Christoph	Mr	R	10%	10%	0%	0%	0%	10%	0%	0%	0%	0%
Martin	Colin	Dr	R	75%	75%	0%	0%	0%	75%	0%	0%	0%	0%
Schultz	Graham	Mr	R	50%	50%	0%	0%	0%	50%	0%	0%	0%	0%
				2.15	*2.15*	*0.00*	*0.00*	*0.00*	*2.15*	*0.00*	*0.00*	*0.00*	*0.00*

Dept Primary Industries Qld

Researcher

Ferguson	Julie	Ms	R	13%	0%	0%	13%	0%	13%	0%	0%	0%	0%
Ferguson	Julie	Ms	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Franzmann	Bernie	Dr	R	40%	5%	0%	35%	0%	40%	0%	0%	0%	0%
Franzmann	Bernie	Dr	R	50%	5%	0%	45%	0%	50%	0%	0%	0%	0%
Gordon	Ian	Mr	R	20%	10%	0%	10%	0%	20%	0%	0%	0%	0%
Goyne	Phil	Dr	T	25%	0%	0%	0%	0%	0%	0%	0%	25%	0%
Grundy	Paul	Dr	R	25%	0%	25%	0%	0%	25%	0%	0%	0%	0%
Grundy	Paul	Dr	R	33%	0%	25%	8%	0%	33%	0%	0%	0%	0%
Harris	Graham	Mr	T	50%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Hauxwell	Carrie	Dr	R	50%	0%	50%	0%	0%	50%	0%	0%	0%	0%
Hughes	Peter	Mr	T	30%	0%	0%	0%	0%	0%	0%	0%	30%	0%

			Main Activity	Total % of Time	% Spent on Research Program					% Spent on Education Program	% Spent External Communications	% Spent Technology Transfer	% Spent on CRC Administration
					SubProgram				Total on Research				
					P 1	P 2	P 3	P 5					
Hughes	Peter	Mr	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Kelly	David	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Kerlin	Sarah	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Khan	Moazze	Dr	R	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%
Kochman	Joe	Dr	R	40%	0%	20%	20%	0%	40%	0%	0%	0%	0%
McIntyre	Geoff	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Miles	Melina	Dr	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Moore	Chris	Dr	R	5%	0%	5%	0%	0%	5%	0%	0%	0%	0%
Moore	Natalie	Dr	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Moore	Chris	Dr	R	25%	0%	25%	0%	0%	25%	0%	0%	0%	0%
Moss	James	Mr	R	20%	10%	0%	10%	0%	20%	0%	0%	0%	0%
Murray	David	Dr	R	30%	0%	0%	30%	0%	30%	0%	0%	0%	0%
Raymond	Mascha	Ms	T	25%	0%	0%	0%	0%	0%	0%	0%	25%	0%
Salmond	Greg	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Scholz	Brad	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Sequeira	Richard	Dr	R	100%	100%	0%	0%	0%	100%	0%	0%	0%	0%
Silburn	Mark	Mr	T	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Swan	Linda	Ms	R	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%
Titmarsh	Ian	Dr	R	5%	5%	0%	0%	0%	5%	0%	0%	0%	0%
Waters	David	Mr	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Yule	Don	Dr	R	5%	0%	0%	5%	0%	5%	0%	0%	0%	0%
				13.35	*1.35*	*1.50*	*4.80*	*0.00*	*7.65*	*0.00*	*0.00*	*5.70*	*0.00*

NSW Agriculture

Researcher

Blumenthal	Martin	Dr	R	5%	0%	0%	5%	0%	5%	0%	0%	0%	0%
Charles	Graham	Mr	R	65%	0%	0%	60%	0%	60%	5%	0%	0%	0%
Cottage	Emma	Ms	R	40%	0%	0%	40%	0%	40%	0%	0%	0%	0%
Farquharson	Bob	Mr	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Friend	John	Mr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Gibb	Dallas	Mr	R	75%	0%	0%	0%	0%	0%	15%	0%	60%	0%
Gibson	Trevor	Dr	R	5%	0%	0%	0%	0%	0%	0%	0%	5%	0%
Greenslade	Raelene	Ms	T	10%	0%	0%	0%	0%	0%	0%	0%	10%	0%
Greenslade	Raelene	Ms	T	25%	0%	0%	0%	0%	0%	0%	0%	25%	0%
Gunning	Robin	Dr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Gunning	Robin	Dr	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Heimoana	Viliami	Mr	R	100%	0%	0%	90%	0%	90%	10%	0%	0%	0%
Herron	Grant	Dr	T	30%	0%	0%	0%	0%	0%	0%	0%	30%	0%
Hickman	Mark	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Hulugalle	Nilantha	Dr	R	35%	0%	0%	30%	0%	30%	5%	0%	0%	0%
Hulugalle	Nilantha	Dr	R	33%	0%	0%	30%	0%	30%	3%	0%	0%	0%
Jenkins	Leigh	Ms	T	60%	0%	0%	0%	0%	0%	0%	0%	60%	0%
Jhorar	Om	Dr	R	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%
Mensah	Robert	Dr	R	25%	0%	23%	0%	0%	23%	3%	0%	0%	0%
Mensah	Robert	Dr	R	20%	0%	18%	0%	0%	18%	3%	0%	0%	0%
Nehl	David	Dr	R	65%	5%	20%	30%	0%	55%	5%	0%	5%	0%
Parker	Myles	Mr	T	20%	0%	0%	0%	0%	0%	0%	0%	20%	0%
Rourke	Kirrily	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Schulze	Klara	Ms	T	20%	0%	0%	0%	0%	0%	0%	0%	20%	0%
Smith	Peter	Mr	T	10%	0%	0%	0%	0%	0%	0%	0%	10%	0%
Swann	Barry	Mr	T	50%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Tonkin	Cameron	Mr	T	20%	0%	0%	5%	0%	5%	0%	0%	15%	0%
Vancov	Tony	Dr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Watson	Chris	Mr	T	33%	0%	0%	0%	0%	0%	0%	0%	33%	0%
				11.05	*0.05*	*0.60*	*4.50*	*0.00*	*5.15*	*0.48*	*0.00*	*5.43*	*0.00*

			Main Activity	Total % of Time	% Spent on Research Program					% Spent on Education Program	% Spent External Communications	% Spent Technology Transfer	% Spent on CRC Administration
					SubProgram				Total on Research				
					P 1	P 2	P 3	P 5					
Queensland Cotton													
Researcher													
Campbell	Ken	Mr	R	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Wilson	Barry	Mr	R	15%	15%	0%	0%	0%	15%	0%	0%	0%	0%
				0.15	*0.15*	*0.00*	*0.00*	*0.00*	*0.15*	*0.00*	*0.00*	*0.00*	*0.00*
The University of New England													
Researcher													
Backhouse	David	Dr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Blair	Graeme	A/Pr	R	20%	0%	0%	20%	0%	20%	0%	0%	0%	0%
Daniel	Heiko	Dr	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Faulkner	Richard	A/Pr	R	20%	0%	0%	15%	0%	15%	5%	0%	0%	0%
Gregg	Peter	A/Pr	R	50%	0%	30%	10%	0%	40%	10%	0%	0%	0%
Jessop	Robin	A/Pr	R	20%	0%	0%	0%	0%	0%	20%	0%	0%	0%
Johnson	Stephen	Dr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Reid	Nick	A/Pr	R	30%	0%	0%	30%	0%	30%	0%	0%	0%	0%
Rollings	Nick	Dr	R	5%	0%	5%	0%	0%	5%	0%	0%	0%	0%
Sindel	Brian	Dr	R	15%	0%	0%	15%	0%	15%	0%	0%	0%	0%
				2.90	*0.00*	*0.35*	*2.20*	*0.00*	*2.55*	*0.35*	*0.00*	*0.00*	*0.00*
The University of Sydney													
Researcher													
Caldwell	Robert	Dr	R	20%	0%	15%	0%	0%	15%	5%	0%	0%	0%
Campbell	Lindsay	Dr	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Cattle	Stephen	Dr	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Copeland	Les	Prof	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Kennedy	Ivan	Prof.	R	25%	0%	0%	20%	0%	20%	5%	0%	0%	0%
Lees	Edith	Dr	R	20%	0%	0%	10%	0%	10%	10%	0%	0%	0%
McBratney	Alex	Prof	R	30%	0%	0%	25%	0%	25%	5%	0%	0%	0%
Singh	Balwant	Dr	R	10%	0%	0%	10%	0%	10%	0%	0%	0%	0%
Vervoort	Willem	Dr	R	5%	5%	0%	0%	0%	5%	0%	0%	0%	0%
				1.40	*0.05*	*0.15*	*0.95*	*0.00*	*1.15*	*0.25*	*0.00*	*0.00*	*0.00*
Western Agricultural Industries													
Researcher													
Aldrich	Greg	Mr	R	20%	20%	0%	0%	0%	20%	0%	0%	0%	0%
Logan	John	Mr	R	30%	30%	0%	0%	0%	30%	0%	0%	0%	0%
				0.50	*0.50*	*0.00*	*0.00*	*0.00*	*0.50*	*0.00*	*0.00*	*0.00*	*0.00*
Grand Total				*50.14*	*8.55*	*6.98*	*17.66*	*1.03*	*34.21*	*1.33*	*0.00*	*14.60*	*0.00*

COTTON CRC AND CASH FUNDED RESEARCH STAFF BY ORGANISATION (Person Years)

			Main Activity	Total % of Time	% Spent on Research Program					% Spent on Education Program	% Spent External Communications	% Spent Technology Transfer	% Spent on CRC Administration
					SubProgram				Total on Research				
					P 1	P 2	P 3	P 5					
CSIRO Entomology													
Researcher													
Bird	Lisa	Ms	R	100%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Fitt	Gary	Dr	R	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Hardwick	Scott	Dr	R	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%
Mansfield	Sarah	Dr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Richards	Andrew	Dr	R	50%	0%	50%	0%	0%	50%	0%	0%	0%	0%
				4.00	*0.00*	*1.50*	*1.50*	*0.00*	*3.00*	*0.00*	*0.00*	*0.00*	*1.00*
CSIRO Plant Industry													
Researcher													
Orman	Kym	Ms	A	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Roberts	Grant	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Rochester	Ian	Dr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Schick	Nicky	Ms	R	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%
Whiteside	Stewart	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Yeates	Stephen	Mr	R	100%	100%	0%	0%	0%	100%	0%	0%	0%	0%
				6.00	*1.00*	*0.00*	*2.00*	*0.00*	*3.00*	*0.00*	*0.00*	*1.00*	*2.00*
CSIRO Textile & Fibre Technology													
Researcher													
King	David	Dr	R	50%	0%	0%	0%	50%	50%	0%	0%	0%	0%
Naylor	Geoff	Dr	R	10%	0%	0%	0%	10%	10%	0%	0%	0%	0%
				0.60	*0.00*	*0.00*	*0.00*	*0.60*	*0.60*	*0.00*	*0.00*	*0.00*	*0.00*
Dept of Business, Industry & Resource Development													
Researcher													
Ward	Andrew	Dr	R	100%	100%	0%	0%	0%	100%	0%	0%	0%	0%
				1.00	*1.00*	*0.00*	*0.00*	*0.00*	*1.00*	*0.00*	*0.00*	*0.00*	*0.00*
Dept Primary Industries Qld													
Researcher													
Christiansen	Ingrid	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Dalton	Bill	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Goyne	Phil	Dr	T	75%	0%	0%	0%	0%	0%	0%	0%	75%	0%
Hare	Janelle	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Harris	Graham	Mr	T	50%	0%	0%	0%	0%	0%	0%	0%	50%	0%
Hood	Sarah	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Moore	Chris	Dr	R	10%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Okello-Okan	John	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Spragge	Andres	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Whiteoak	Olivia	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Wigginton	David	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Zischke	Rachael	Ms	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
				10.35	*0.00*	*0.10*	*1.00*	*0.00*	*1.10*	*0.00*	*0.00*	*9.25*	*0.00*

			Main Activity	Total % of Time	% Spent on Research Program					% Spent on Education Program	% Spent External Communications	% Spent Technology Transfer	% Spent on CRC Administration
					SubProgram				Total on Research				
					P 1	P 2	P 3	P 5					
NSW Agriculture													
Researcher													
Dang	Ho	Mr	R	10%	0%	10%	0%	0%	10%	0%	0%	0%	0%
Hoque	Ziaul	Mr	R	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Larsen	David	Mr	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
O'Hallaron	Julie	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Spora	Annie	Ms	T	100%	0%	0%	0%	0%	0%	0%	0%	100%	0%
Taylor	Ian	M	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
				5.10	*0.00*	*0.10*	*1.00*	*0.00*	*1.10*	*0.00*	*0.00*	*4.00*	*0.00*
The University of New England													
Researcher													
Del Socorro	Alice	Dr	R	90%	0%	90%	0%	0%	90%	0%	0%	0%	0%
Downey	Adam	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Kent	Richard	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Rencken	Ingrid	Ms	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Roth	Guy	Mr	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
Silberbauer	Letitia	Dr	R	50%	0%	0%	50%	0%	50%	0%	0%	0%	0%
Stanley	John	Dr	T	40%	0%	0%	0%	0%	0%	0%	0%	40%	0%
				5.20	*0.00*	*0.90*	*3.50*	*0.00*	*4.40*	*0.00*	*0.00*	*0.80*	*0.00*
The University of Queensland													
Researcher													
Gulino	Lisa	Ms	R	100%	0%	100%	0%	0%	100%	0%	0%	0%	0%
Harvey	John	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
				2.00	*0.00*	*1.00*	*1.00*	*0.00*	*2.00*	*0.00*	*0.00*	*0.00*	*0.00*
The University of Sydney													
Researcher													
Crossan	Angus	Mr	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Dunbar	Marian	Ms	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Minasny	Budiman	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Odeh	Inakwu	Dr	R	90%	0%	0%	90%	0%	90%	0%	0%	0%	0%
Sanchez-Ba	Franciso	Dr	R	25%	0%	0%	25%	0%	25%	0%	0%	0%	0%
Speirs	Simon	Mr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Triantafilis	John	Dr	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
Yan	Florian	Ms	R	100%	0%	0%	100%	0%	100%	0%	0%	0%	0%
				6.40	*0.00*	*0.00*	*6.40*	*0.00*	*6.40*	*0.00*	*0.00*	*0.00*	*0.00*
Grand Total				*40.65*	*2.00*	*3.60*	*16.40*	*0.60*	*22.60*	*0.00*	*0.00*	*15.05*	*3.00*

ATTACHMENT B

SUPPORT STAFF

Contributed			CRC Funded (by employing organisation)	
Organisation	No. Staff (person years)		Organisation	No. Staff (person years)
Agriculture WA	3.15		Agriculture WA	0.00
Cotton Research & Development Corporation	0.00		Cotton Research & Development Corporation	0.00
Cotton Seed Distributors	0.30		Cotton Seed Distributors	0.00
CSIRO	9.95		CSIRO	9.25
Dept. Primary Industries, Qld	9.05		Dept. Primary Industries, Qld	1.10
NSW Agriculture	9.40		NSW Agriculture	2.90
NTDPIF	1.80		NTDPIF	0.00
Queensland Cotton	0.00		Queensland Cotton	0.00
University of New England	1.35		University of New England	0.10
University of Sydney	0.00		University of Sydney	2.00
WAI	0.00		WAI	0.00
TOTAL	35.00		TOTAL	15.35

ATTACHMENT B

SUMMARY OF CONTRIBUTIONS IN PERSON YEARS

	Total Equivalent Person Years	Person Years Spent on Research Program					% Spent on Education Program	% Spent on External Communication	% Spent on Technology Transfer	% Spent on CRC Admin.
		Subprogram				Total on Research				
		1	2	3	5					
TOTAL CONTRIBUTED	50.14	8.55	6.98	17.66	1.03	34.21	1.33	0.00	14.60	0.00
TOTAL FUNDED BY CRC	40.65	2.00	3.60	16.40	0.60	22.60	0.00	0.00	15.05	3.00
GRAND TOTAL	90.79	10.55	10.58	34.06	1.63	56.81	1.33	0.00	29.65	3.00
Proportion of total professional staff resources in each activity	100%	11.6%	11.7%	37.5%	1.8%	62.6%	1.5%	0.0%	32.7%	3.3%

ATTACHMENT C

IN-KIND CONTRIBUTIONS FROM PARTICIPANTS (DOLLARS IN '000's)

PARTICIPANT	EXPENDITURE 2001/02		EXPENDITURE 2000/01		EXPENDITURE 1999/00		CUMULATIVE TOTAL TO DATE		2002/03	2003/04	2004/05	2005/06	GRAND TOTAL Total 7 years	GRAND TOTAL Agr'mt 7 years
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Agr'mt	Agr'mt	Agr'mt	Agr'mt		
CSIRO														
Salaries	1,741	1,250	1,922	1,271	1,367	1,239	5,030	3,760	1,234	1,234	1,234	1,234	9,966	8,696
Capital	0	0	0	0	0		0	0					0	0
Other	1,705	1,140	1,737	1,157	1,162	1,129	4,604	3,426	1,120	1,120	1,120	1,120	9,084	7,906
Total	**3,446**	**2,390**	**3,659**	**2,428**	**2,529**	**2,368**	**9,634**	**7,186**	**2,354**	**2,354**	**2,354**	**2,354**	**16,763**	**16,602**
NSW Agriculture														
Salaries	1,109	1,029	1,108	1,029	1,086	1,029	3,303	3,087	1,029	1,029	1,029	1,029	7,419	7,203
Capital	0	0	0	0	0		0	0					0	0
Other	966	1,029	967	1,029	967	1,029	2,900	3,087	1,029	1,029	1,029	1,029	7,016	7,203
Total	**2,075**	**2,058**	**2,075**	**2,058**	**2,052**	**2,058**	**6,202**	**6,174**	**2,058**	**2,058**	**2,058**	**2,058**	**14,400**	**14,406**
Qld Dept Primary Industries														
Salaries	1,276	945	1,128	945	1,195	945	3,599	2,835	945	945	945	945	7,379	6,615
Capital		0	0	0	0		0	0					0	0
Other	1,447	1,186	1,381	1,186	1,344	1,186	4,172	3,558	1,186	1,186	1,186	1,186	8,916	8,302
Total	**2,723**	**2,131**	**2,509**	**2,131**	**2,539**	**2,131**	**7,771**	**6,393**	**2,131**	**2,131**	**2,131**	**2,131**	**15,325**	**14,917**
Agriculture WA														
Salaries	261	281	287	281	270	281	818	843	281	281	281	281	1,942	1,967
Capital	0	0	0	0	0		0	0					0	0
Other	317	315	317	319	372	372	1,006	1,006	285	275	265	215	2,046	2,046
Total	**578**	**596**	**604**	**600**	**642**	**653**	**1,824**	**1,849**	**566**	**556**	**546**	**496**	**4,002**	**4,013**
NT Dept of Business, Industry & Resource Development														
Salaries	262	211	267	211	276	211	805	633	211	211	211	211	1,649	1,477
Capital	0	0	0	0	0		0	0					0	0
Other	190	152	150	152	166	152	506	456	152	152	152	152	1,114	1,064
Total	**452**	**363**	**417**	**363**	**442**	**363**	**1,311**	**1,089**	**363**	**363**	**363**	**363**	**2,620**	**2,541**
The University of Sydney														
Salaries	182	130	171	130	136	130	489	390	130	130	130	130	1,009	910
Capital		0		0	0		0	0					0	0
Other	315	224	295	224	235	224	845	672	224	224	224	224	1,741	1,568
Total	**497**	**354**	**466**	**354**	**371**	**354**	**1,334**	**1,062**	**354**	**354**	**354**	**354**	**2,495**	**2,478**
The University of New England														
Salaries	605	292	467	292	502	292	1,574	876	292	292	292	292	2,742	2,044
Capital	0	0	0	0	0		0	0					0	0
Other	260	221	230	221	236	221	726	663	221	221	221	221	1,610	1,547
Total	**865**	**513**	**697**	**513**	**738**	**513**	**2,300**	**1,539**	**513**	**513**	**513**	**513**	**3,816**	**3,591**
CRDC														
Salaries	70	62	70	62	69	62	209	186	62	62	62	62	457	434
Capital	0	0	0	0	0		0	0					0	0
Other	44	39	44	39	43	39	131	117	39	39	39	39	287	273
Total	**114**	**101**	**114**	**101**	**112**	**101**	**340**	**303**	**101**	**101**	**101**	**101**	**718**	**707**
Cotton Seed Distributors														
Salaries	149	113	182	113	151	113	482	339	113	113	113	113	934	791
Capital	0	0	0	0	0		0	0					0	0
Other	178	134	208	134	174	134	560	402	134	134	134	134	1,096	938
Total	**327**	**247**	**390**	**247**	**325**	**247**	**1,042**	**741**	**247**	**247**	**247**	**247**	**1,807**	**1,729**
Queensland Cotton														
Salaries	12	31	35	31	7	31	54	93	31	31	31	31	178	217
Capital	0	0	0	0	0		0	0					0	0
Other	10	25	27	25	6	25	43	75	25	25	25	25	143	175
Total	**22**	**56**	**62**	**56**	**13**	**56**	**97**	**168**	**56**	**56**	**56**	**56**	**349**	**392**
Salaries	0	120	0	120	157	120	157	360	120	120	120	120	637	840
Capital	0	0	0	0	0		0	0					0	0
Other	0	65	0	65	101	65	101	195	65	65	65	65	361	455
Total	**0**	**185**	**0**	**185**	**258**	**185**	**258**	**555**	**185**	**185**	**185**	**185**	**1,368**	**1,295**
TOTAL IN-KIND CONTRIBUTIONS														
Salaries	5,679	4,532	5,707	4,553	5,267	4,521	16,653	13,606	4,516	4,516	4,516	4,516	34,717	31,670
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	5,460	4,587	5,422	4,608	4,853	4,633	15,735	13,828	4,537	4,527	4,517	4,467	33,783	31,876
GRAND TOTAL (IN-KIND) (T1)	**11,139**	**9,119**	**11,129**	**9,161**	**10,120**	**9,154**	**32,388**	**27,434**	**9,053**	**9,043**	**9,033**	**8,983**	**64,512**	**63,546**

CASH IN CONTRIBUTIONS (DOLLARS IN '000s')

PARTICIPANT	ACTUAL 2001/02		ACTUAL 2000/01		ACTUAL 1999/00		CUMULATIVE TOTAL TO DATE		PROJECTED 2002/03	2003/04	2004/05	2005/06
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Agr'mt	Agr'mt	Agr'mt	Agr'mt
CRDC Cash Contribution	350	350	350	350	350	350	1050	1050	350	350	350	350
Cotton Seed Distributors	300	300	300	300	300	300	900	900	300	300	300	300
Twynam Cotton	0	50	25	50	50	50	75	150	50	50	50	50
The University of New England	0	0	0	0	100	100	100	100				
		0		0		0	0	0				
		0					0	0				
TOTAL CASH FROM PARTICIPANTS	**650**	**700**	**675**	**700**	**800**	**800**	**2125**	**2200**	**700**	**700**	**700**	**700**
NSW Government	0	0	0	0	95		95	0				
Qld Government	618	0	591	0	841		2050	0				
Other	127	0	45	0	14		186	0				
Other (eg Interest)	48	0	48	0	44		140	0				
External Grants	500	0	247	0	303	100	1050	100				
CRDC Grants	1707	448	1227	652	995	970	3929	2070				
OTHER CASH	**3000**	**448**	**2158**	**652**	**2292**	**1070**	**7450**	**2170**	**0**	**0**	**0**	**0**
CRC GRANT	**2200**	**2200**	**2200**	**2200**	**2000**	**2000**	6400	6400	**2100**	**2100**	**1800**	**1000**
TOTAL CRC CASH CONTRIBUTION (T2)	**5850**	**3348**	**5033**	**3552**	**5092**	**3870**	**10125**	**7422**	**2800**	**2800**	**2500**	**1700**
Cash carried forward	1284		643		891							
Less Unspent Balance	1336		1332		1562							
TOTAL CASH EXPENDITURE (T3)	**5798**	**3348**	**4344**	**3552**	**4421**	**3870**	**14563**	**10770**	**2800**	**2800**	**2500**	**1700**

ALLOCATION OF CASH EXPENDITURE BETWEEN HEADS OF EXPENDITURE

SALARIES	3886	2585	3045	2615	2997	2394	9928	7594	1915	1730	1795	1232
CAPITAL	232	0	58	0	167		457	0				
OTHER	1680	1022	1241	1042	1258	1083	4179	3147	898	899	847	512
TOTAL EXPENDITURE	**5798**	**3607**	**4344**	**3657**	**4421**	**3477**	**14563**	**10741**	**2813**	**2629**	**2642**	**1744**

SUMMARY OF RESOURCES APPLIED TO ACTIVITIES OF CENTRE (DOLLARS IN '000s')

	ACTUAL 2000/01		ACTUAL 2000/01		ACTUAL 1999/00		CUMULATIVE TOTAL TO DATE		2002/03	2003/04	2004/05	2005/06	Total 7 years	GRAND TOTAL Agr'mt 7 years
	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Actual	Agr'mt	Agr'mt	Agr'mt	Agr'mt	Agr'mt		
GRAND TOTAL (IN-KIND) FROM TABLE 1 (T1)	11,139	9,119	11,129	9,161	10,120	9,154	32,388	27,434	9,053	9,043	9,033	8,983	68,500	63,546
GRAND TOTAL (CASH EXPENDITURE) FROM TABLE 2 (T3)	5,798	3,348	4,344	3,552	4,421	3,870	14,563	10,770	2,800	2,800	2,500	1,700	24,363	20,570
TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE (T1+T3)	16,937	12,467	15,473	12,713	14,541	13,024	46,951	38,204	11,853	11,843	11,533	10,683	92,863	84,116

ALLOCATION OF TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE BETWEEN HEADS OF EXPENDITURE (CASH AND IN KIND)

TOTAL SALARIES (CASH AND IN-KIND)	9,565	7,117	8,752	7,168	8,264	6,915	26,581	21,200	6,431	6,246	6,311	5,748	51,317	45,936
TOTAL CAPITAL (CASH AND IN-KIND)	232	0	58	0	167	0	457	0	0	0	0	0	457	0
TOTAL OTHER (CASH AND IN-KIND)	7,140	5,609	6,663	5,650	6,111	5,716	19,914	16,975	5,435	5,426	5,364	4,979	41,118	38,179

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	4,076.0	70.3%	8,295.0	74.5%	33.91	22.60
Education	499.0	8.6%	359.0	3.2%	1.33	0.00
External Communications	17.0	0.3%	0.0	0.0%	0.00	0.00
Technology Transfer	719.0	12.4%	2,485.0	22.3%	14.20	15.05
Administration	487.0	8.4%	0.0	0.0%	0.00	3.00
TOTAL	**5,798.0** (T3)	**1.0**	**11,139.0** (T1)	**1.0**	**49.44**	**40.65**