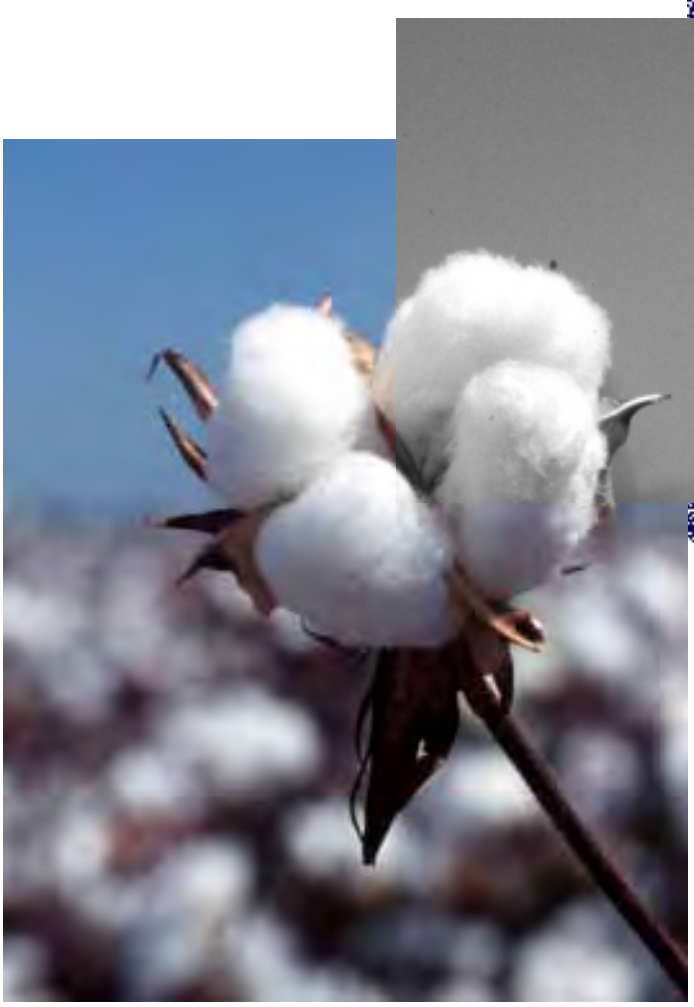
Cotton CRC

THE AUSTRALIAN COTTON COOPERATIVE RESEARCH CENTRE

ANNUAL REPORT 1999/00



ESTABLISHED AND SUPPORTED UNDER THE AUSTRALIAN GOVERNMENT'S COOPERATIVE RESEARCH CENTRES PROGRAM

CRC AUSTRALIA

AUSTRALIAN COTTON COOPERATIVE RESEARCH CENTRE ANNUAL REPORT 1999/2000

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

1. 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.

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

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

4. To have a coordinated national network for extension, support and educational services to the cotton industry.

5. To develop innovative technologies for bleaching, dyeing and other aspects of cotton processing for use by local and international spinning industries.

PARTICIPANTS

CSIRO
NSW Agriculture
The University of New England
The University of Sydney
Cotton Seed Distributors
Western Agricultural Industries
Department of Primary Industries Queensland
Agriculture Western Australia
Northern Territory Department of Primary Industry and Fisheries
Cotton Research & Development Organisation
Queensland Cotton
Twynam Cotton

Cotton CRC

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AUSTRALIAN COTTON COOPERATIVE RESEARCH CENTRE

ANNUAL REPORT 1999/2000

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EXECUTIVE SUMMARY

Gary Fitt

The past year has been one of transition for the Cotton CRC, moving from the successes of the CRC for Sustainable Cotton Production into our new guise as the Australian Cotton CRC. With six new participants, a commencement one year earlier than anticipated and many projects transferring from one CRC into the other the management and staff have faced numerous challenges. Despite this we have commenced a very productive research and extension program to meet the new directions of our strategic plan.

The Australian Cotton CRC clearly has a challenge to emulate the high standard of performance in the CRCSCP led so effectively by Dr. Greg Constable. In addition to myself as CEO and Chairman in Mr. John Blood, we have new commercial partners (Cotton Seed Distributors, Queensland Cotton, Western Agricultural Industries and Twynam Cotton) who bring additional resources, but more importantly represent a wealth of commercial expertise in identifying opportunities for development and experience in dealing with industry. All are committed to the Cotton CRC undertaking an objective research program to support expanded but environmentally sustainable production.

The Cotton CRC consolidates our previous focus on sustainability, education and extension and introduces two new areas of work. One is a major program exploring the feasibility for cotton production in northern Australia which will conduct objective research to develop production systems which are compatible with northern environments and meet community expectations. The second is a new research effort in cotton textile research and value-adding with a focus on reducing environmental impact of bleaching and dyeing processes and exploring value-adding opportunities for local consumption of Australian cotton.

An environmental focus is evident in several new projects where we are seeking to broaden the funding base for cotton research and address the ongoing sustainability questions associated with the industry. New initiatives in ecosystem services, salinity research and management, water use efficiency, on-farm wetlands for bioremediation and biological control options for pests and diseases support the industry's commitments to Best Management Practice and future development of environmental management systems.

A few comments about each program are pertinent.

Our northern Program has initiated a number of new research areas in four regions of northern Australia. The program highlights the many challenges ahead, including biodiversity and environmental assessments, native title and water allocation issues, and community attitudes to development. Our first newsletter for stakeholders sought to address some of these issues, establishing our philosophy about what is appropriate for northern Australia and setting out research plans to rigorously assess potential for environmental compatible cotton production systems.

The Innovative Technologies program research new techniques to manage cotton pests. Considerable progress has been made in developing attractants for *Helicoverpa*, which might be used in integrated pest management systems. Commercial interest in now being sought. Ongoing research with transgenic cottons seeks to fully integrate this biotechnology as a component of management systems.

Sustainable Farming Systems, our largest research program, integrates the many disciplines needed to identify optimal approaches to managing the soil and water resource, the crop, the pests and interactions with the environment to ensure a productive cotton industry can be sustainable. This program is the powerhouse generating many of our new postgraduate students.

Education and Technology Transfer are key elements underpinning the research success of the Cotton CRC and the long-term success of the industry. Our outstanding Cotton Production Course is a truly collaborative effort and is highly regarded as a benchmark achievement for those wanting to work in the cotton industry. Likewise the Cotton CRC coordinates a strong national extension team which addresses both local and national priorities.

Finally, our new Cotton Textile program has made rapid progress in establishing research needs along the "Field to Fabric" pipeline. Following two workshops involving stakeholders from the production, ginning and spinning industries as well as potential collaborators the Program is developing new research partnerships seeking to optimise downstream processing and producer returns.

The Cotton CRC itself is mostly about coordination – seeking to bring together the best available research, extension and educational resources to tackle significant issues in a collaborative way. We have approached our role in coordination through numerous discipline groups and planning workshops which are fully inclusive of all players. Several new research partnerships have grown from this.

We enjoyed a number of highlights through the year. In November, the Cotton CRC won the 1999 National Award for Excellence through Information Technology, in the Rural and Regional Category. These awards are run by the Australian Information Industry Association and sponsored by the Financial Review and Telstra. This was great recognition of the standard of the computer-based decision support package, CottonLOGIC, developed over several years by CSIRO Plant Industry and the quality and function of our Cotton CRC web site. Other highlights included the release of the cotton industry IPM Guidelines, which promise to be a major step forward in the industry adoption of integrated pest management approaches and the completion of postgraduate studies by several students.

Our first annual review and dinner in July saw the inaugural awards for Innovation, Collaboration and Corporate Citizenship. The award for innovation went to Dr Jackie Cai for her outstanding progress in developing innovative bleaching processes for cotton/wool blends. A large team coordinated by Dr Robert Mensah and Dr Lewis Wilson won the award for collaborative effort in producing the IPM Guidelines, while Dr John Triantifilis received the Corporate Citizenship award for his consistent support and promotion of the Cotton CRC.

A significant disappointment of the first year has been the decision by Twynam Cotton to withdraw from the Cotton CRC and from their interests in northern Australia. Twynam Cotton, previously in the form of Colly Cotton, have been strong supporters of the northern program and have invested significant in-kind and capital to explore the feasibility of cotton in the Northern Territory and the Ord River area. This support and commercial perspective will be sorely missed and needs to be replaced as soon as possible.

Overall the Cotton CRC is well placed to deliver major outcomes for Australia through a sustainable and productive cotton industry. We rely on strong commitment from core partners, an excellent team of researchers and support staff and close involvement with industry and the wider community. I look forward to playing a role in addressing the many challenges ahead.

Dr. Gary P Fitt
Chief Executive Officer

HIGHLIGHTS

UNDERSTANDING THE SALINITY THREAT IN IRRIGATED COTTON GROWING AREAS

In the cotton growing areas of northern NSW or southeast Queensland, the issue of soil and water salinity is not a major concern, although isolated instances of soil salinity have occurred, often as a result of leaking water storage's and supply channels.

Unfortunately, there is a lack of natural resource information to identify the potential threat of salinity, its spread in affected areas and how they can be managed. A project entitled "Understanding the salinity threat in the irrigated cotton growing areas of Australia – Phase III – implementation and management" aims to provide and use this information to suggest best management options to reduce the risks. Coordinated by Dr John Triantafilis and his team from The University of Sydney as part of the Australian Cotton Cooperative Research Centre, the project is funded by the Cotton Research and Development Corporation and various grants from the Natural Heritage Trust. The work involves collaboration with several industry groups including Coordinating Committee of Namoi Valley Water Users Association, Gwydir Valley Irrigators Association, Border Rivers Food and Fibre, Macquarie 2000, Bourke Irrigators Association and the Upper Namoi Valley Water Users Association.

EM34 used for reconnaissance surveys

A Mobile Electromagnetic Sensing System (MESS) is the key tool for the research. Able to detect subsurface changes in soil water and salinity levels, the MESS can be used at a field, farm or regional scale.

At the fieldscale case studies have been carried out to demonstrate where water use efficiency can be improved and how soil salinity could be managed in affected areas. In the lower Gwydir valley, northwest of Moree, the MESS was used to identify soil types susceptible to excessive deep drainage. These were associated with sandy prior stream channels, across which a supply channel had been constructed. In order to manage the problem the farmer has two options: 1) re-route the supply channel or 2) line the channel with an impermeable membrane. In the lower Namoi valley south of Wee Waa, the area along a water-storage where leakage was occurring was similarly identified with the MESS. Appropriate management involves the reconstruction of the storage wall along the area of leakage.

In order to place these studies into context with the surrounding cotton growing districts, larger EM surveys have been carried out. This was achieved using broadscale EM34 surveys. To date, information has been collected on approximate 500 m grids across 15 x 15 km areas at Bourke, Trangie, Moree, Gunnedah and a larger survey around Wee Waa (60 x 30 km). Similar surveys have been planned for an area west of Goondiwindi and southeast of Warren.

Mobile EM Sensing System (MESS) in cotton

Overall the studies in several cotton growing regions of the northern Murray-Darling Basin have shown that drainage and salinity problems are minor compared with those in the southern parts of the Basin. However, results in the Gwydir Valley emphasise the importance of identifying risks, and implementing pre-emptive management plans to meet the cotton industry's long term aims of environmental sustainability.

AREA-WIDE MANAGEMENT CATCHING ON

Area-wide management (AWM) has captured the interests of pest managers across eastern Australian field cropping regions as they struggle to keep costs down and produce crops in a sustainable manner. While heliothis (*Helicoverpa* spp.) is the main target of the AWM strategies implemented to date, the general principles and philosophies being promoted have application across the range of pest species and crops encountered. The community approach, based on regular communication among neighbours, serves as a conduit for the adoption of integrated pest management (IPM) practices.

AWM strategies are soundly based on our current understanding of the biology and ecology of the

pests and their interactions with crop and weed hosts. They identify potential bottlenecks in populations when the pest is at a point of low abundance or focussed in a particular crop or habitat. AWM targets these periods for coordinated action that aims to reduce overall population levels. If effective, these tactics will result in lower pest pressure on crops, and reductions in the use of broad spectrum conventional insecticides. No single strategy will be universally suitable for all regions but must be tailored to the climate, cropping system and environment.

The Cotton CRC has three specific research projects (in central Queensland – Dr Richard Sequira (DPIQ), southern Queensland – Dr David Murray (DPIQ) and north-west NSW – Martin Dillon (CSIRO Entomology)) that are developing, implementing and evaluating AWM strategies in central and southern Queensland and north west NSW. All three projects are funded by the Cotton Research and Development Corporation and coordinated for the Cotton CRC by Dr Murray. In addition to these research projects, a number of AWM grower groups have been formed to enhance communication and commence evaluating various tactics as a first step in the process of developing a local AWM approach. Communication and community participation are key components underlying the success of AWM.

The concept of "trap cropping" figures prominently in the AWM strategies developed to date. Trap crops are highly attractive to *Helicoverpa* and are designed to concentrate populations into small areas where they can be more easily controlled, often by destroying the crop. The AWM groups use trap crops for the beginning (chickpea) and end of season (pigeonpea and grain sorghum). The utility of trap crops is determined by local pest ecology and population dynamics, and many questions on how to maximize their benefits remain unanswered. Crop type, location, size and timing are just some of the factors under investigation, all of which hinge around understanding the behaviour of *Helicoverpa* moths at night, as they explore and exploit crops and associated habitats.

SOFT CHEMICAL OPTIONS RESULT IN HIGHER PROFITS MARGINS

A two-year comparison of "soft" and "hard" spray management techniques on adjoining cotton properties in northern NSW funded by the Cotton CRC has shown conclusively that fewer insect sprays can be associated with higher profit margins, as well as environmental benefits.

The study, which took place under widely different pest conditions in 1998-99 (heavy insect infestation) and 1999-2000 (light insect season), resulted in spray costs being lower, yields higher, and profits (gross margins) higher in the softer sprayed rather than harder sprayed fields in both seasons.

The Cotton CRC group, comprising Ziaul Hoque and Bob Farquharson (NSWA) Martin Dillon (CSIRO Entomology) and Greg Kauter (CSD) formed in September 1999 to evaluate the economics of cotton IPM. The commercial case studies are meaningful because of the large number of fields examined (1998/1999, 93 fields from 9 farms and 1999/2000, 154 fields from 12 farms).

The "soft" strategy aimed to reduce the number of sprays; preserve the activities of beneficial insects by using the least disruptive options available; and facilitate resistance management objectives. The main pest targeted in both options was *Helicoverpa* spp. The "hard" strategy focussed on pesticide efficacy and cost rather than on preserving beneficials, using the full range of control tactics available.

Fields were allocated into soft or hard groups based on the types and quantities of insecticide sprays applied. Insecticides were ranked on a scale of 1 to 7 according to their impact on beneficial insects as documented in the Cotton CRC IPM Guidelines. Chemicals with a very low impact on beneficial insects (eg Gemstar, Bt) were allocated a score of 1, while insecticides that had a high impact on beneficials (eg Pyrethroids) were given a score of 7 per application. Each field's overall spray rank was calculated by summing the number of sprays multiplied by their respective scores. The fields with the lowest score tallies (lower 50%) were then categorised as "soft" while those with the highest scores (upper 50%) were classed as "hard".

The results showed that average spray costs per hectare were lower (by 17% to 44%) for the soft option strategy than for the hard option in both INGARD™ and conventional crops in both years. This is good news for growers currently practicing cotton IPM.

Whilst in the first year there were slight yield differences between soft and hard fields, there were no significant yield differences in the second year in either INGARD™ or conventional crops.

Average gross margins were higher using the soft option strategy in both years for both INGARD™ and conventional varieties, averaging 5 percent higher for conventional crops in both years, 5 percent higher for INGARD™ crops in the second year, and a massive 25 percent higher in the first year when pest pressure was higher. These outcomes show the combined benefit of soft options and INGARD™ cotton as a component of IPM.

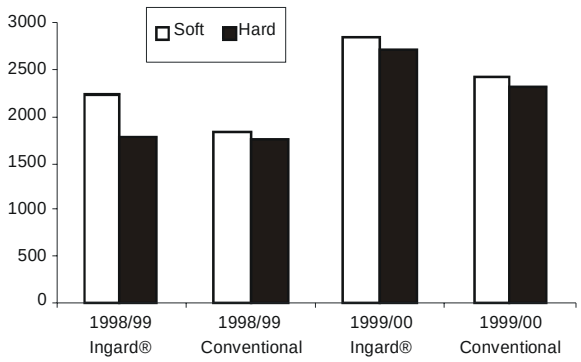
The economic study also examined the relationship between pest pressure and gross margin for hard and soft spray programs. A number of fields within the soft group had high insect pressures, but the soft approach adopted by these growers led to savings on insecticides which made a $350/ha average contribution to their gross margin.

The Cotton CRC study concluded that overall, hard spray strategies were associated with lower profits, indicating that the extra returns which may be obtained from applying sprays does not always cover the extra application costs nor take account of the negative impacts on natural control.

A further downside is the increased risk of resistance to insecticides, because higher spray numbers increase selection pressures exerted on the insect population, impacting on future susceptibility to insecticides.

The main message from the study was that there is potential for substantial financial, management, yield and environmental gains from adopting an IPM approach where sprays are applied only when necessary and by using selective, softer chemistry to enhance natural control from beneficial insects for as long as possible.

Soft Spray Options Make More Money (Gross Margin $/Ha)



Greg Kauter, CSD, Bob Farquharson, NSWA, Ziaul Hoque, NSWA and Martin Dillon, CSIRO Entomology

BUSINESS IS BOOMING WITH COTTON CRC COURSE

In April, 2000, 30 people graduated from the Cotton CRC's Cotton Production Course at The University of New England, which represents the highest number of graduates since the inception of the course. Another 30 people are due to graduate in early 2001, which means about one half of the 120 people who have now completed the course have done so in the last two years.

The Cotton CRC "Cotton Production Course" is designed to increase the cotton industry's skills base by training personnel in the scientific principals and latest technologies and practices of sustainable cotton production. It is the only specialised university training course on cotton production in Australia.

The course is offered in two streams, postgraduate and certificate, and is delivered as a part time external course over two years, via four units:

Applied Cotton Production
Cotton Crop Protection
Cotton and the Environment
Production Systems and Communications.

Although delivered through The University of New England, about 45 Cotton CRC researchers from CSIRO, NSW Agriculture, Dept Primary Industries Qld, The University of Sydney, The University of New England and the commercial sector deliver lectures and update the course notes on a regular basis.

This collaboration has resulted in a highly regarded and popular course being delivered to industry personnel. It would not be possible to deliver such a specialised technical course without this collaboration.

The course has greatly assisted in the transfer of new technologies to growers and increased the adoption of more sustainable management practices. The course is now part of the accreditation process of Cotton Consultants Australia Inc.

Interest in the course has been strong and due to high demand the course is fully booked for 2001.

Enrolments have been drawn from all the cotton growing regions in Australia (Figure 1) with a diversity of backgrounds represented (Figure 2). The Applied Cotton Production unit has been offered to interested undergraduates at UNE since 1996 where enrolments have risen each year and it is now the most popular elective undertaken by students. This year was the first time undergraduate students from another University completed a unit (University of Western Sydney) and plans are being been made with The University of Sydney and University of Queensland (Gatton) to have undergraduate units available from next year.

As the cotton industry is expanding into new regions in Western Australia and Northern Territory it is necessary to develop new teaching materials for students where distance will make it difficult and expensive to visit the eastern states. An Internet website has been developed with student protected passwords for course participants. This site has a bulletin board where students can communicate with staff and other students from remote locations. It also contains a number of self help quizzes and links to other cotton web sites. Multimedia CD ROM teaching material has also been produced. The course notes have been converted to CD ROM format and it is planned to produce some video based lectures to supplement this material.

The Cotton Production Course is an excellent example of collaborative outcomes from the Cotton CRC, serving a critical industry need and providing the future technical support base needed for the long term sustainability of the industry.

The occupations and location of these course graduates are shown in Figures 1 and 2.

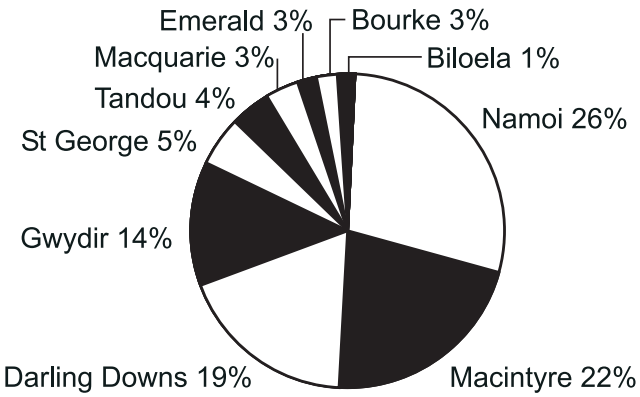


Figure 1. *The location of students who have completed the Cotton Production Course.*

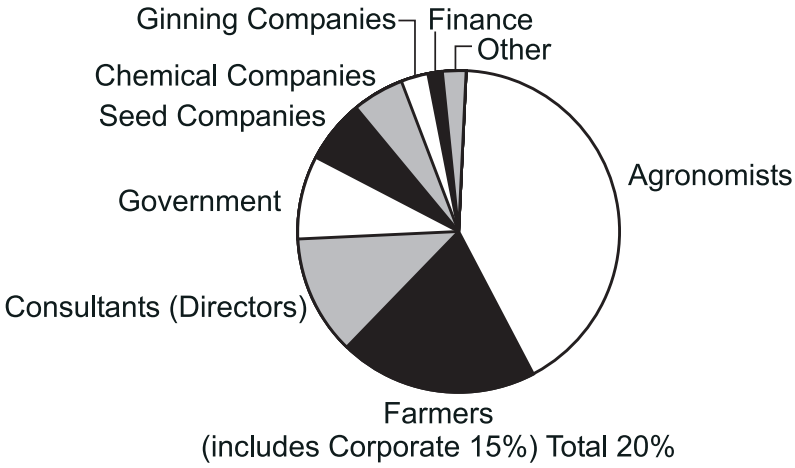


Figure 2. *The occupation of students who have completed the Cotton Production Course*

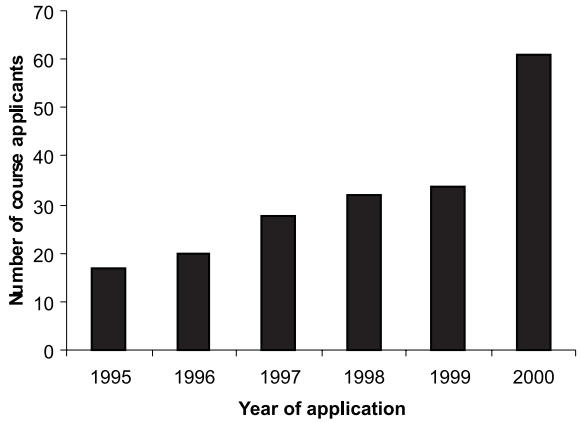


Figure 3. *Number of applicants for the cotton course 1995-2000.*

STRUCTURE AND MANAGEMENT

PARTICIPANTS

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

CSIRO – Plant Industry, Entomology, Textile and Fibre Technology, Tropical Agriculture
Department of Primary Industries Queensland
NSW Agriculture
Agriculture Western Australia
Northern Territory Department of Primary Industry and Fisheries
The University of New England
The University of Sydney
Cotton Research & Development Corporation
Cotton Seed Distributors
Queensland Cotton
Western Agricultural Industries
Twynam Cotton

Twynam Cotton have given 12 months notice and will be withdrawing from the Cotton CRC as at 31 December 2000. The Cotton CRC is actively seeking a replacement from the industry sector.

GOVERNING BOARD

The Governing Board is chaired by an independent chairman appointed by the Australian Cotton Growers' Research Association (ACGRA). The chairing of the Governing Board by the ACGRA representative reflects the standing of the ACGRA as the organisation declared by the Minister for Primary Industries to be the representative of the industry. This ensures our research remains sound and relevant.


John Blood


Bridget Jackson

The Governing Board is responsible for controlling the policy practices and overall operation of the Cotton CRC. Its functions and powers will include matters related to determining the strategic directions of the Centre, performance indicators, programs and activities of the Cotton CRC, approval of annual budgets, approval of commercial arrangements, negotiating funding for the Cotton CRC and appointment and review of the performance of the Chief Executive Officer. The Governing Board will also be the responsible authority for annual and other reports as required by the core partners and the Cotton CRC Committee. It meets four times per year and consists of a majority of non research providers. Several participants share Board seats based on their equity in the Centre.


Bobbie Brazil


Gary Fitt


Jim Peacock


Graeme Robertson


Nick Gill


David Hamilton


Keith Entwistle


Bob Galmes


Helen Scott-Orr


John Grellman

NON RESEARCH PROVIDERS

Chairman	Mr John Blood
Cotton Research and Development Corporation	Ms Bridget Jackson
Cotton Seed Distributors	Mr John Grellman
Queensland Cotton/Western Agricultural Industries/Twynam Cotton	Mr Nick Gill
Independent Member	Mr Bob Galmes, Bonds Industries
Independent Member	Mrs Roberta Brazil
CEO	Dr Gary Fitt

RESEARCH PROVIDERS

CSIRO	Dr Jim Peacock
NSW Agriculture	Ms Helen Scott-Orr
Department of Primary Industries Queensland	Mr Don McNee (until November 1999) Mr David Hamilton (since November 1999)
Agriculture Western Australia/Northern Territory	
Department of Primary Industry and Fisheries	Dr Graeme Robertson
The University New England/The University of Sydney	Prof Keith Entwistle

MANAGEMENT COMMITTEE

The Management Committee is chaired by the CEO and assists the Governing Board in the operations of the Centre. It meets four times per year and its primary responsibility is to assist meeting the objectives of the Centre through implementing policies as determined by the Governing Board. This comprises: assessing and recommending research projects to the Governing Board; overseeing progress in research projects and achievement of performance indicators; managing 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 Five is managed by joint Program Leaders. Joint Program Leadership brings a broader range of knowledge and expertise to the management of the Program and decreases the workload for the individual.

Management Committee

Dr Gary Fitt (Chair)	CEO	Cotton CRC
Ms Maxine O'Brien	Executive Officer	Cotton CRC
Mr Geoff Strickland	Program One Leader	Agriculture Western Australia
Dr Michael Bange	Program One Leader	CSIRO Plant Industry
A/Prof Peter Gregg	Program Two Leader	The University of New England
Dr Stephen Allen	Program Two Leader	Cotton Seed Distributors
Dr Lewis Wilson	Program Three Leader	CSIRO Plant Industry
Prof Alex McBratney (Since April 2000)	Program Three Leader	The University of Sydney
Dr Philip Wright (Until March 2000)	Program Three Leader	NSW Agriculture
Mr Dallas Gibb	Program Four Leader	NSW Agriculture
Mr Geoff McIntyre	Program Four Leader	Dept Primary Industries Queensland
Dr Peter Cookson	Program Five Leader	CSIRO Textile and Fibre Technology
Mr Ralph Schulzé		Cotton R & D Corporation
Dr Colin Martin		NT Dept Primary Industry & Fisheries

NORTHERN COMMITTEE

A Northern Committee comprising the Chief Executive Officer and Program Leaders of Program One, together with other research and industry partners concerned with expansion into new regions has been established. This committee advises the Management Committee on research priorities for Program One, ensure research expertise from Programs Two, Three and Five, flow into the new regions, and will act as a focus for interactions with northern communities and interest groups.

In respect to managing the research activities in northern Australia, Mr Geoff Strickland one of the Program Leaders visits northern Australia frequently and he is in regular contact with management and relevant researchers by email, telephone and face to face. The Cotton CRC has also appointed, Mr Stephen Yeates a scientist with extensive knowledge of agriculture and the community in northern Australia as the Northern Liaison Officer who is based in Darwin. His main role is to liaise closely with all research projects and community organisations across the various regions and he provides regular reports to and takes direction from the Management Committee through the Northern Committee. In addition, a communications strategy has been prepared specifically for northern Australia.

The Northern Committee is committed to meet once per year but in the first year of the Cotton CRC it met five times to establish the research priorities and management of the Program. All members have considerable expertise relevant to growing cotton in northern Australia.

Northern Committee

Dr Gary Fitt	CEO	Cotton CRC
Mr Geoff Strickland (Chair)	Program Leader	Agriculture Western Australia
Dr Michael Bange	Program Leader	CSIRO Plant Industry
Dr Ian Titmarsh		Dept Primary Industries Qld
Dr Colin Martin		NT Dept Primary Industry & Fisheries
Mr Barry Wilson		Queensland Cotton
Mr Ivan McLeod		Western Agricultural Industries
Mr Adam Kay		Cotton Seed Distributors
Mr Nick Gill		Twynam Cotton
Mr Stephen Yeates (Since 1 October 1999)	Research Coordinator/Liaison Officer	CSIRO Plant Industry

ADVISORY COMMITTEE

An Advisory Committee has been established to provide feedback on the quality of the science being undertaken by the Cotton CRC; comment on its relevance to the cotton industry; assess our progress measured against the Cotton CRC's key objectives; identify any perceived research gaps and/or suggest future research directions; provide feedback on possible additional linkages we could be utilising to further our objectives; and provide advice and information about existing and emerging industry and community concerns.

Members of this committee have been drawn from growers, consultants within the cotton industry, from other research organisations, other agricultural industries and the broader community.

The Advisory Committee participated in the first Annual Research Review and provided feedback directly to the Management Committee and to the Governing Board through the Chief Executive Officer.

Advisory Committee

Mr Bruce Finney	Australian Cotton Growers Research Association
Mr James O'Conner	Cotton Consultants Australia
Dr Mike Raupach	CSIRO Land & Water
Dr Don Sands	CSIRO Entomology
Dr Graeme Hammer	Dept Primary Industries Qld, APSRU
Mr Derek Foster	Dept Primary Industries Qld, Rural Extension Centre
Mr John Harrison	Amateur Fisherman's Association Northern Territory
Mr Kevin Goss (unable to attend)	Murray Darling Basin Commission
Ms Sheila Donaldson	Community (unable to attend)

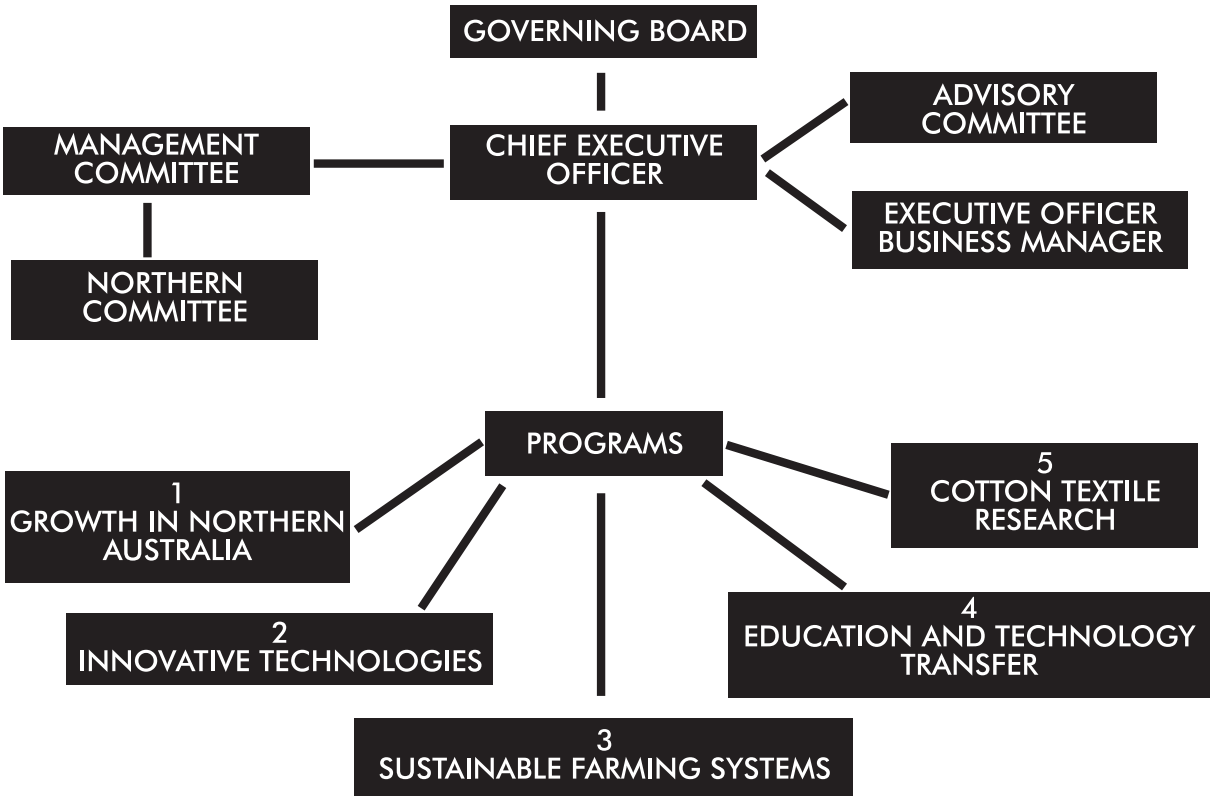
WORKING PARTIES

We have established discipline specific working parties to provide direction and feedback from components of industry and the broader community.

ADMINISTRATION

Executive Officer/Business Manager	Miss Maxine O'Brien, CSIRO Plant Industry
Research Liaison Officer	Miss Nicky Schick, CSIRO Plant Industry
Administration Assistant	Miss Jane Maynard, CSIRO Plant Industry

ORGANISATIONAL STRUCTURE



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 through science discipline groups and project teams.

We have developed a series of discipline groups to cover all facets of cotton research (IPM, weeds, diseases, and farming systems and soils). Meetings of the groups are coordinated by Program Leaders and a Research Liaison Officer, and involve research providers, growers, consultants and other industry groups. Meetings are held regularly through the year to provide valuable planning forums and strengthen the team approach. Discipline coordinators then meet with Management Committee to finalise priorities for future work. Our annual review meeting then provides an opportunity for both science and social interactions among all members of the Cotton CRC.

Our strongest interactions are with the cotton industry itself through the Australian Cotton Growers Research Association, which chairs the Cotton CRC board and provides participants in all the Cotton CRC's discipline groups. Integration of our new industry partners (Cotton Seed Distributors, Queensland Cotton, Twynam Cotton and Western Agricultural Industries) over the first year has ensured particularly strong links between research providers and the commercial side 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.

Two components of our extension and education program provide additional foundations for linkage across the Cotton CRC and into industry and the wider community. The Technology Resource Centre coordinates the flow of information to industry in the form of printed material and the website, while the Cotton CRC's Cotton Production Course involves participation by some 45 of the Cotton CRC's scientists in an outstanding collaboration.

In the past year we have had regular links with a range of 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 had input into the planning process for the Ord-Bonaparte project, a major new multi-agency initiative, which proposes a comprehensive landscape scale assessment of the environmental and social impacts of the Ord Irrigation development on ecosystems in the catchment, the river system and the native environment. Cotton CRC research at the field and farm scale will be linked to the Ord-Bonaparte project.

- Developing management strategies for transgenic cottons (insect and herbicide tolerant) is critical for the long term sustainability of GM cotton and is the subject of an international research effort. Our research in this area involves links to many experts in resistance management in Universities throughout Australia (Adelaide, Melbourne) and internationally (Arkansas, Mississippi State, North Carolina, Arizona) with USDA-ARS researchers in the southern USA and with regulatory agencies in Australia (GMAC, IOGTR) and the USA (EPA). This work also brings links to Monsanto Australia.

- A range of other projects in biotechnology of cotton involve links to the University of Adelaide and University of Alberta.

- Our research into environmental issues such as salinity and potential impacts of irrigation on riverine environments benefits from strong links to a range of grower and irrigator associations which facilitate funding applications to the National Heritage Trust and Salt Action.

- With an increasing focus on research at the interface of agricultural production and the natural environment, we plan to further develop opportunities to support environmental research. The Cotton CRC board includes an independent environmental director, while the Murray-Darling Basin Commission and Amateur Fisherman's Association Northern Territory are represented on our Advisory Committee.

- Fusarium wilt now poses a significant threat to cotton production. To address this we have developed relationships with the CRC for Tropical Plant Pathology which may lead to joint research projects on Fusarium management. Similar links are in place with CSIRO Plant Industry, Adelaide to improve our capacity to deal with "bunchy top", a recently emerged syndrome affecting cotton crops.

- With irrigation and water use efficiency having a high profile we have successfully developed a close collaboration with the Qld Dept of Natural Resources, who are providing $3.0 million over four years to support a major extension and development program being conducted by QDPI

in cotton/grains industries in Queensland. As part of the larger Rural Water Use Efficiency Initiative, the Cotton CRC co-ordinates the cotton/grains component.

- Area-wide management is the collaborative approach to insect pest management now being researched and implemented throughout the cotton industry. The Cotton CRC and CRDC have links with GRDC to ensure effective coordination of area-wide management on the Darling Downs and IPM research in southern cotton regions.

- Discussions with the CRC for Weed Management Systems lead to a proposals for a new collaborative project in Queensland which has become part of the renewal bid for that CRC.

- Through the Cotton Production Course, our education program has established links with other Universities and colleges including University of Queenland, University of Western Sydney and Yanco Agricultural College.

- The Cotton 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 new program in cotton textile research has developed close alliances with a number of Australia's leading cotton processors, who are now supporting partners of the Cotton CRC. These include Rocklea, Bonds and Sheridan, and chemical companies such as Ciba and Clariant.

- Two "Fibre Plus" Workshops held in February and May 2000 brought researchers together with growers, ginners and processors to identify critical issues in the post-farm gate and value-adding arenas. As a result a close association has formed with the National Centre for Engineering in Agriculture (NCEA) at the University of Southern Queensland, Toowoomba. A research framework, based on the "field-to-fabric" pipeline, has been developed which identifies critical stages in processing, our joint research capability and current research effort. Research in early-stage cotton processing, to be funded by CRDC, will be coordinated through the Cotton CRC with outcomes enhanced through future joint initiatives between the Cotton CRC and NCEA with supporting industry partners.

INTERNATIONAL LINKAGES

Our research in developing attractants for Helicoverpa moths involves collaboration with the Shanghai Institute of Entomology

To ensure linkage with developments internationally the Cotton CRC maintains a research exchange program which supports a number of international exchanges each year. During 1999/2000 we supported visits by:

- Dr. Michael Bange and Mr Grant Roberts (CSIRO Plant Industry) to several research centres in the southern USA

- Extension team members, James Quinn and Mark Hickman (NSW Agriculture) together with Dave Kelly and Greg Salmond (QDPI) to experience extension techniques throughout the US cotton belt

- Mr. Alex Thomas (CSIRO Plant Industry) to an international conference on decision support systems

- Dr. Mitsutoshi Kitao (Forestry and Forest Products Research Institute, Sapporo, Japan) to the Australian Cotton Research Institute for a collaborative project on cotton responses to damage.

GROWTH IN NORTHERN AUSTRALIA

PROGRAM ONE OVERVIEW

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, Katherine, Fitzroy and Daly rivers as well as major underground water reserves 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 now feasible to re-evaluate cotton production in these areas. However, production practices for eastern Australia cannot be simply transferred into northern systems due to the vastly different tropical environment and growing conditions.

The proposed regions in Western Australia (Broome and Kununurra); the Northern Territory (Katherine and Douglas/Daly areas) and North Queensland (Upper Burdekin, Flinders River, Urannah, and the Gilbert and Einasleigh Rivers) provide significant opportunities to expand the industry. The potential area for new cotton, 200,000 ha, would produce a further 1.5 million bales with an export value of $750 million. This level of development will 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 promoting commercial activity.

To pursue these objectives, seven milestones have been established for the first two years of Cotton CRC operations.

Geoff Strickland and Mike Bange

MILESTONES

Year 1 and 2:

1. A Northern Committee convened to define specific research and development needs.

2. A report produced which documents the status of current and past cropping research activities relevant to cotton production in northern Australia.

3. Appropriate research staff and industry liaison officers appointed.

4. IPM studies in the Ord region of NW Australia continued in collaboration with farmers.

5. Baseline studies of key pests, weeds and diseases commenced with experiments and surveys.

6. Agronomic, entomological and IPM experiments commenced in all northern regions.

7. Major environmental issues defined for each region by 2001 and benchmarks for a sustainable production system established.

HIGHLIGHTS AND ACHIEVEMENTS AGAINST MILESTONES

Whilst significant progress towards all milestones has been achieved, highest priority has been afforded to the initiation of a **scoping study.** To this end, Stephen Yeates has been appointed to the position of Northern Liaison Officer based with CSIRO in Darwin. The major initial challenge of this position is to compile and publish a scoping study, which will review past northern research and development activities and establish parameters for future research. The Northern Committee will review the scoping study (due July 2000) and make a targeted call for research projects based on the directions established by the report.

Five initial projects have been approved to commence the collection of baseline data on agronomy, pest and weed ecology.

1. Project Number: 1.1.0 AC 'Northern Australia cotton disease survey report'

2. Project Number: 1.1.1 AC 'Viable and environmentally responsible cotton production systems for northern Australia: Scoping Studies and Research Liaison / Coordination Officer (Darwin)'

3. Project Number: 1.2.1 AC 'Integrated pest management systems for sustainable transgenic cotton production in the west Kimberley (Broome)' [to comence in 2000/01]

4. Project Number: 1.3.1 AC 'Insect dynamics of the cotton ecosystem in the Northern Territory (Katherine)' [to comence in 2000/01]

5. Project Number: 1.4.1 AC 'A baseline study of insects on cotton in far north Queensland (Richmond)'

Other significant highlights are as follows:

- A workshop where all Cotton CRC researchers involved in activities relating to northern Australia was held in Darwin on 17 November 1999 to discuss and define activities to achieve milestones.

- A CottonLOGIC workshop was held in Darwin in early April 2000 to teach researchers the principles and operation of the software for use in their research.

- Cotton CRC Researchers reviewed and contributed to both the Northern Territory cotton pre-feasibility study and the Ord Stage II environmental impact statement.

- Results of research recording cotton crop development in northern Australia have been collated for analysis with the specific aim to improve the cotton growth simulation model.

- The Cotton CRC is now represented on the NT Cotton Strategy Group.

- The Cotton CRC, through Department of Primary Industries Queensland, will seek approval for experimental use of Ingard™ cotton for the 2000 - 2001 season.

- A meeting was organised by NTDPIF on behalf of the Cotton CRC to provide an opportunity for a range of environmental groups to clarify their concerns about prospects for cotton in the NT.

- The Cotton CRC has raised the awareness of the need for careful disease quarantine to protect the north against serious pathogens such as Fusarium.

LINKAGES AND COLLABORATION

Linkages between the Cotton CRC research providers and the commercial partners are particularly strong. In addition the CRDC funds projects of direct and indirect relevance to the northern areas. Other research activities that are integrated with the Cotton CRC include:

- Defining an integrated pest management (IPM) system for INGARD™ cotton in north-western Australia

- Ecology of *Trichogramma* egg parasites in the Ord River Irrigation Area and their role in cotton IPM.

- Investigations of the potential weediness of Ingard™ cotton in northern Australia.

- Work undertaken to develop agronomic management options for dry season cotton production. Specific work is being undertaken to investigate optimum irrigation and fertiliser (N & P) management.

- The Ord-Bonaparte Project. The Cotton CRC had input into the planning process for this major new initiative, which proposes a comprehensive landscape scale assessment of the environmental and social impacts of the Ord Irrigation development on ecosystems in the catchment, the river system and the native environment. Cotton CRC research at the field and farm scale will be linked to the Ord-Bonaparte project.

NORTHERN AUSTRALIA COTTON DISEASE SURVEY REPORT

Project Number: 1.1.0 AC

Staff:
Dr Joe Kochman,
Dept Primary Industries Qld, Toowoomba, Qld
Dr David Nehl
NSW Agriculture, Narrabri, NSW

Overview: A survey of disease issues at Katherine, Kununurra and Broome was conducted in late July / early August 1999.

Key findings were:

- Seedling diseases are unlikely to be a serious issue unless wet weather is experienced after sowing. Seedling pathogens favoured by cool conditions (eg *Rhizoctonia*) should be less prominent than those favoured by warm conditions (eg *Macrophomina*).
- Although Alternaria leaf spot is widely distributed in the north, its severity will be determined by the frequency of overnight dews with cool conditions and nutritional stress in cotton (especially potassium and phosphorus). Even with the exceptionally cool conditions this year the disease was not severe if crop nutrition was good.
- A suspected finding of *Verticillium* at Kununurra were not confirmed. Other soilborne diseases, including Fusarium wilt and black root rot pose a significant threat to cotton production if introduced. Their exclusion through strict quarantine practices is a very real and achievable prospect for each of the regions.
- Large numbers of 'tourists' from the eastern cotton industry who visit northern locations with little thought given to transfer of pathogens or weed species pose a significant risk. BMP guidelines to minimise the risk have now been implemented at Katherine and Kununurra.

Cotton CRC Northern Research Coordinator, Steve Yeates

VIABLE AND ENVIRONMENTALLY RESPONSIBLE COTTON PRODUCTION SYSTEMS FOR NORTHERN AUSTRALIA: SCOPING STUDIES AND RESEARCH LIAISON / COORDINATION OFFICER

Project Number: 1.1.1 AC

Background: This project establishes a Research Coordination Officer in the north to assist in the investigation and development of viable and environmentally responsible production systems for new regions in tropical Western Australia, Northern Territory and north Queensland. Mr Stephen Yeates was appointed to the role as a Research Scientist with CSIRO Division of Plant Industry and based in Darwin.

Aims and Milestones:

- Establish contacts with all relevant core partners and any other bodies relevant to Cotton CRC in northern Australia plus assist with the development of a communication plan for northern Australia.
- To liaise closely with all projects and provide regular reports to and take direction from the Management Committee through the Northern Committee.
- Begin the Scoping Study.
- Under the direction of the Chief Executive Officer and Program 1 Leaders define projects be supervised by the appointee.

Staff:
Mr Stephen Yeates,
CSIRO Plant Industry, Darwin, NT

Progress:
Contact has been made with all core partners and links established with the majority of research and industry bodies relevant to northern Australia (Ag WA, CSIRO, NTDPIF, DPIQ, Queensland Cotton, Twynam Cotton, Monsanto, CSD, farmers, consultants, interest groups such as NT Amateur Fishermen's Association). Liaison has commenced with all northern projects and some relevant southern projects. These activities have been outlined in progress and update reports and in the first northern newsletter which will be an important vehicle for communication to all stakeholder groups across the north.

Planning meetings were conducted with all groups involved in research in the coming season at Kununurra, Katherine and Richmond (no field work at Broome in 2000). These resulted in comprehensive plans and co-ordinated activities across the locations.

Work toward the scoping document was advanced with a first draft completed by June 2000. Reviewing past cotton and other relevant research in northern Australia, including environmental impact research and physical resource data, has involved interviews with key personnel and reviewing of reports.

A BASELINE STUDY OF INSECTS ON COTTON IN FAR NORTH QUEENSLAND (RICHMOND)

Project Number: 1.4.1 AC

Aims and Milestones:

- Conduct field surveys in far north Queensland to evaluate the relative pest status of insect species on cotton crops.
- Evaluate the effectiveness of *Bt*-toxin genes in cotton for controlling *Helicoverpa* during the season.
- Evaluate the impact on transgenic cotton on habitual fauna of the cotton ecosystem.
- Evaluate the annual dynamics of crop succession and the potential for trap crops in *Helicoverpa* control.

Staff:
Dr Richard Sequeira,
Dept Primary Industries Qld, Emerald, Qld

Progress:

The Richmond trial area consisted of a commercial scale evaluation and a smaller research site. The research site involved three treatments, INGARD™ cotton, conventional cotton and pigeon pea as a potential trap crop / refuge crop. All treatments on the research site were unsprayed but managed agronomically in the same manner as the commercial site.

Planned observations included: (a) Leaf bioassays to determine changes in efficacy of INGARD™, (b) suction sampling to quantify the diversity of insect communities in each treatment, (c) pheromone trapping, (d) sampling all life stages of *Helicoverpa*, and (e) plant mapping. Unfortunately due to a number of problems during planting a number of activities had to be abandoned.

Suction sampling, pheromone trapping, pupae digging, egg and larval collections and plant mapping of the INGARD™ and conventional cotton have not been fully analysed as yet but in general there were no differences in the insect fauna colonising INGARD™ and conventional cotton crops. Pheromone traps showed both species of *Helicoverpa* (armigera and punctigera) were present throughout the growth of the crop; no pink or spotted bollworm moths were caught. Moths were most abundant in the pheromone trap located nearest the commercial cotton trial whilst other traps placed some distance from the cotton showed little activity for much of the monitoring period. Larval activity on the unsprayed cotton treatments was dominated by loopers (sometimes exceeding 30 larvae/m) for most of the monitoring period. By comparison, larval activity on the commercial site was almost entirely Helicoverpa. We also identified 10-12 different weed species in cleared bushland surrounding the trial are which are hosts for *Helicoverpa*. High levels of larval parasitism (60-80%), especially by *Microplitis* species, were recorded. Plant mapping data shows totally unsprayed INGARD™ plants retain a substantial fruit load in comparison to conventional cotton. Diapausing *Helicoverpa* pupae have been recovered around the trial site indicating that diapause is possible in this region.

Large scale cotton trials at Richmond, North Queensland.

Amanda Annelles (WA Agriculture) and Gary Fitt inspect test management experiments at Kununurra, WA.

INNOVATIVE TECHNOLOGIES

PROGRAM TWO OVERVIEW

INTRODUCTION

Commercial cotton production relies on a number of chemical inputs for high levels of production some of which (insecticides, herbicides). 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 waterlogging tolerance, pest and disease resistance, and fibre quality.

AIMS AND OBJECTIVES

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

- To rigorously evaluate the efficacy and environmental impacts of new transgenic plants.
- To develop and evaluate the use of attractants and repellents for area wide management systems 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 implementation of new technologies emerging from this program will occur in Program 3, in the context of sustainable farming systems.

Peter Gregg and Stephen Allan

HIGHLIGHTS AND ACHIEVEMENTS AGAINST MILESTONES

Evaluation and Management of Transgenic Cotton.

Experiments investigating the effect of temperature on the efficacy of pre-squaring Bt cotton were conducted in plant growth rooms using Siokra V15. INGARD™ plants grown at lower temperatures had lower efficacy. Plants grown at low temperatures also exhibited greater inter-plant variation in efficacy than those at higher temperatures. Both results are consistent with studies of efficacy of commercial INGARD™ crops. Studies of refuge crops on commercial farms confirmed the value of pigeon peas in producing susceptible *Helicoverpa* moths for resistance management, and simulation studies combined with information from previous Cotton CRC projects on local movement, suggested that current recommendations for location of refuges are adequate. Unfortunately Monsanto, owner of the INGARD™ (Cry IAc) and P2 (CryIIAa) genes, decided not to allow commercialisation of the P2 gene in Australia, and also required that all research with the P2 gene be terminated. This prevented continuation of work on two gene Bt cotton, although new two gene combinations are now commencing assessment.

Mating Behaviour in *Helicoverpa armigera*: influence of host plants

Overseas studies have suggested that the production of sex pheromone by female *Helicoverpa* spp. is increased by the presence of volatile chemicals from host plants. If this is translated into increased mating success in some host crops, then the presence of certain refuge crops might influence both the overall success and the spatial distribution of mating. This might affect the development of resistance to Bt. This PhD project has indicated that such effects are unlikely to be important. Although pheromone production may be increased in the presence of host plants, field studies showed that the crop around moths did not affect their mating success. Wind tunnel work showed that host plants also do not have significant effects on male response to pheromone.

Environmental Impact Assessment of Genetically Engineered Insect Viruses

The second of two field trials using a specially marked *Helicoverpa* Nuclear Polyhedrosis Virus (NPV) has been completed. Initial results indicated that while tox+ viruses were less likely to be propagated in field release plots when compared to wild-type strains, these viruses may also have potential to disperse and persist in the wider environment. A rapid diagnostic screen for wild-type NPV isolates has been developed. An application is being prepared to conduct the first field release of a recombinant 'rapid-action' *Helicoverpa* NPV in Australia. Following advice from the Genetic Manipulation Advisory Committee, it has been designed around a virus gene deletion construct. The trial is being planned for early 2001. Its successful completion will mark a significant advance toward the implementation of safe and effective alternative insecticides for *Helicoverpa* control in Australian cotton.

Genetic Engineering for Waterlogging Tolerance in Transgenic Cotton

Transgenic cotton plants over-expressing the enzymes ADH and PDC (which may be important in waterlogging tolerance) are being assayed in field conditions. A system for testing tolerance to hypoxic stress in the model plant *Arabidopsis*, which was optimized as part of this project, was used to evaluate several lines of *Arabidopsis* with altered levels of fermentative enzymes. Increasing PDC significantly improved the plants' ability to tolerate the stress. For this reason, DNA constructs with an *Arabidopsis* PDC gene have been made and are being introduced into cotton.

Molecular Genetic Markers for Accelerated Selection of *Fusarium* Wilt Resistant Cultivars

An analysis of the F_2 progeny of a cross between the varieties Siokra 1-4 and MCU-5 indicates the existence of a single dominant gene for resistance to *Fusarium* wilt in the MCU-5 germplasm. Six polymorphic DNA fragments have shown association with the *Fusarium* wilt resistance gene, making them potential marker candidates. These markers could increase the efficiency of selection for enhanced resistance to a disease which is becoming increasingly important in Australian cotton.

Molecular Marker Systems for Breeding Cotton Cultivars with Enhanced Resistance to *Verticillium* Wilt Disease.

A number of potential markers have been identified by Amplified Fragment Length Polymorphism (AFLP) techniques, and marker linkage with the gene conferring tolerance to *Verticillium* wilt is currently being investigated. DNA marker 63-171, which is linked with *Verticillium* wilt tolerance in the variety Acala Royale has been characterised. The AFLP marker has been cloned, sequenced and the source of the polymorphism ascertained through sequencing of the flanking DNA. Forty-seven defence response cotton genes that are up-regulated during *Verticillium* wilt infection have been partially sequence-characterised. Full sequence characterisation has been done for six genes.

Isolation of Genes Controlling Fibre Development in Cotton

A suite of genes encoding transcription factors that are expressed in the early stages of cotton fibre development is now available. Nine cDNAs encoding transcription factors of the myb class, have been isolated from a cDNA library. Six of these clones represent genes that have not been previously identified from cotton. Relative quantitative expression data has been obtained for five of these genes. Two of the genes are relatively more active at the early stages of fibre development. To provide additional insight into the role these two genes may have in fibre biology, their expression pattern is being defined at the cellular level by RNA in situ analysis. If these genes are expressed only in those epidermal cells destined to become fibres, the genes will then be over and under expressed in transgenic cotton.

Development of Molecular Marker Technologies in Cotton.

An Amplified Fragment Length Polymorphism marker technique was used to search for markers linked to the brown lint and Okra leaf characters and to assess the amount of variation between two parent varieties. The rate of polymorphic loci between the two parental varieties was found to be approximately 0.5%. No markers linked to either gene have been found, although over 5000 potential loci have been examined. An inter-specific cross (*G. hirsutum x G. barbadense*) was used to map the gene for bacterial blight resistance. The level of polymorphism detected was around 10%, a level that should allow the detection of markers linked to any gene of interest. RFLP markers linked to various bacterial blight resistance genes have recently been reported and have now been used to determine the identity of the blight resistance gene found in Australian cotton cultivars. Preliminary results suggest that the resistance gene is different from the previously assumed gene complex reported in the pedigrees of the Australian cottons.

Attractants for adult *Helicoverpa* spp.

Over 170 volatile compounds were identified from a total of 40 plants that have been screened for attractiveness to *H. armigera* moths in the olfactometer. Eight of the 32 single chemicals and 13 of the 20 chemical blends tested in the olfactometer were found to be significantly attractive to female moths. Synthetic blends have been developed which are as attractive in the olfactometer as the most attractive plants. 15 field trials have been conducted in the Darling Downs, the Ord River and China. *Helicoverpa* spp., and several other pest moth species, have been trapped in significant numbers. Though the catches in traps baited with plant volatiles were lower than those in pheromone traps, they were dominated by female moths. This suggests that attract-and-kill for females using these techniques might be possible. This work has attracted interest from several potential commercial partners, and negotiations are in progress.

LINKAGES

Evaluation and Management of Transgenic Cotton.: Monsanto, Cotton Seed Distributors 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)

Mating Behaviour in *Helicoverpa armigera:* Queensland Department of Primary Industries (Dr. Chris Moore)

Genetically Engineered Insect Viruses: Queensland Department of Primary Industries (Dr. Richard Sequira, CRDC Project DAQ 91C), NSW Agriculture (Dr. Robert Mensah, CRDC Project DAN 119C), CSIRO Entomology (Dr. Simon Duffield)

Genetic Engineering for Waterlogging Tolerance in Transgenic Cotton: University of Alberta, Edmonton, Canada (Kathleen Ismond, visiting PhD student), CSIRO Plant Industry, Canberra (Dr. P. Hunt)

Isolation of Genes Controlling Fibre Development in Cotton: Department of Genetics, Adelaide University (Dr. Sharon Orford and A/Prof Jeremy Timms)

Development of Molecular Marker Technologies in Cotton:
Kathleen Ismond – Visiting PhD student – University of Alberta

Attractants for adult *Helicoverpa* spp: Queensland Department of Primary Industries **(**Dr Chris Moore), University of Queensland (Dr. Bronwen Cribb, Dr. Craig Hull), Shanghai Institute of Entomology (Prof Jia-wei Du, Dr Shao-fu Xu, Dr. Xiao Chun), IPM Technologies, USA (Philipp Kirsch), Biocontrol Australia (Stephen Sexton).

Markers for *Fusarium* Wilt resistance: Queensland Department of Primary Industries (Dr. Joe Kochman, Dr. Natalie Moore), CSIRO Plant Industry, Narrabri (Dr. Greg Constable, Mr. Peter Reid), Cotton Seed Distributors (Dr. Stephen Allen).

Markers for *Verticillium* Wilt resistance: CSIRO Plant Industry, Narrabri (Dr. Greg Constable, Mr. Peter Reid, CRDC Projects US33C, US43C), Cotton Seed Distributors (Dr. Stephen Allen, CRDC Projects US32C).

EVALUATION AND MANAGEMENT OF TRANSGENIC COTTON

SUB PROGRAM 2.1: EVALUATION OF TRANSGENIC ORGANISMS
Project Number: 2.1.1 AC

Aims and Milestones:

- Continue field evaluation of new lines of Bt transformed varieties in small plots, including 2 gene stacks of CryIAc and Cry IIA genes, quantifying efficacy of field grown plants against *Helicoverpa* species.
- Quantify the impact of Bt plants expressing Cry IAc, CryIIA and both genes on larval growth and adult fitness of *Helicoverpa* spp. which survive on maturing plants losing efficacy.
- Continue large scale field trials of two gene Bt cotton to examine environmental impact of Bt cotton on beneficial and non-target invertebrates and obtain data required for regulatory approval of the technology (funded by Monsanto).
- Continue studies of the effectiveness of a range of refuge options in collaboration with CRDC Project (CSE64C).
- Complete studies of variability of INGARD™ cotton efficacy in commercial fields identifying spatial scale of variation, individual or line variability and correlations with some environmental variables.
- Complete simulation studies using the HEAPS population model to identify refuge size requirements for deployment of two gene Bt cottons and provide advice to TIMS committee.
- Collaborate with TIMS Committee to update the INGARD™ Resistance Management Strategy as required from experimental data on field performance of refuge crops and INGARD™ varieties.
- Investigate the effects of combinations of different stress factors or sequential periods of environmental stress, on the efficacy of Bt cotton.

Staff:
Dr Gary Fitt,
CSIRO Entomology, Narrabri, NSW
Ms Cheryl Mares
CSIRO Entomology, Narrabri, NSW
Dr Joanne Daly,
CSIRO Entomology, Canberra, ACT
Ms Karen Olsen,
CSIRO Entomology, Canberra, ACT
Dr Lewis Wilson,
CSIRO Plant Industry, Narrabri, NSW
Dr Ray Akhurst,
CSIRO Entomology, Canberra, ACT
Mr Colin Tann,
CSIRO Entomology, Narrabri, NSW
Mr Martin Dillon,
CSIRO Entomology, Narrabri, NSW

Progress:
Having fully validated our bioassay procedures in previous seasons, a comprehensive set of experiments were planned for 99/2000 to allow comparisons of efficacy of lines expressing CryIAc or CryIIA or their combination in a number of genetic backgrounds of cotton. In the past we have shown significant varietal interactions with efficacy. Trial plots were established at Narrabri (NSW) and Biloela (Qld). Unfortunately Monsanto, owners of the INGARD and P2 genes, supplemented its decision not to allow commercialisation of the P2 gene in Australia, by also requiring that all research with the P2 gene be terminated. Bioassays and other studies continued with INGARD lines, while most effort is now focussed on laboratory studies to use a quantitative ELISA to measure concentrations of CryIAc protein in plant samples collected over previous seasons.

Our research with refuge crops occurred on commercial farms where unsprayed refuges of pigeon pea, sorghum or cotton were grown as well as several locations where sprayed conventional cotton was used. Results confirmed the reliability of pigeon pea as a refuge to produce high densities of *Helicoverpa* adults. By contrast al the unsprayed cotton performed very poorly with virtually no pupae produced, even though it has been more reliable in previous years. Future work will continue to quantify these refuge types but with more focus on refuges for dryland cotton situations.

Efficacy of INGARD™ crops remains a priority. Two years of data were collected on the efficacy of commercial INGARD™ crops with approximately 100 fields involved each season. An analysis of agronomic data collected from each site indicates associations of variable efficacy with planting date and seedling stresses due to low temperatures prior to squaring. Two experiments have been completed to directly assess the effect of planting date on efficacy. They show reduced efficacy in the earliest sown plants in 1998/99. Unfortunately the 1999/2000 experiments were severely disrupted by pesticide drift from nearby trials.

Staff involved with this project (Fitt and Wilson) have maintained a significant involvement through the TIMS committee in the development and implementation of the pre-emptive Resistance Management strategy for INGARD™ cotton. This included discussion about increasing the 30% cap on planting of INGARD™. For reasons of resistance management the cap has not been altered for the 2000/2001 season.

Research in CSIRO's Canberra laboratories investigated the effect of temperature on the efficacy of presquaring Bt cotton in controlled environment growth rooms using Siokra V15. Plants grown at lower temperatures had lower efficacy. Plants grown at low temperatures also exhibited greater inter-plant variation in efficacy than those at higher temperatures. Both results are consistent with studies of efficacy of commercial INGARD™ crops reported above and add to our understanding of the factors influencing efficacy of INGARD™ plants.

ENVIRONMENTAL IMPACT ASSESSMENT OF GENETICALLY ENGINEERED INSECT VIRUSES

Project Number: 2.3.1

Aims:
To contribute to the implementation of genetically enhanced viral insecticides and improved efficacy of naturally occurring viruses for use by the cotton industry through:

- the application of environmental impact assessments
- strategic research into the ecology of *Helicoverpa* virus interactions

Milestones:

- Conduct a series of field trials at the ACRI to test the efficacy and potential environmental impact of a genetically enhanced (tox+) *Helicoverpa* NPV insecticide in cotton
- Prepare and submit applications to GMAC and the National Registration Authority (NRA) for the deliberate release of a genetically enhanced *Helicoverpa* NPV insecticide

Staff:
Dr Andy Richards,
CSIRO Entomology, Canberra, ACT
Ms Su Young,
CSIRO Entomology, Canberra, ACT
Dr Peter Christian,
CSIRO Entomology, Canberra, ACT
Dr John Oakeshott,
CSIRO Entomology, Canberra, ACT

Progress:
In early 1999, the second of two field trials using a specially marked *Helicoverpa* NPV insecticide was completed. This trial was designed to simulate the behaviour of genetically enhanced viral insecticides that employ neurotoxin genes (tox+ viruses) in order to evaluate their relative fitness compared to naturally occurring (wild-type) strains. These agents are of particular interest because they are now near to commercialisation elsewhere in the world. Results from initial laboratory analyses indicated that while tox+ viruses were less likely to be propagated in field release plots when compared to wild-type strains, these viruses may also have greater potential to disperse and persist in the wider environment. These findings were presented at a meeting with the Genetic Manipulation Advisory Committee (GMAC), who oversee the use of GMO's in Australia, in May 1999. Following this meeting, GMAC advised that any field release applications involving tox+ NPV insecticides should be delayed until these findings, and other concerns, could be properly evaluated.

Work on the development of a rapid diagnostic screen for differentiating wild-type *Helicoverpa* NPV isolates was completed. This screen, based on standard molecular techniques, was designed to provide a rapid means of accurately determining the identity of closely related virus isolates for use in environmental monitoring. Its primary purpose is to

monitor the impact of recombinant viruses on naturally occurring virus populations in both natural and agricultural settings. It also has capability though to identify environmentally "fit" viruses, for example, strains with greater UV stability. Finally, we are currently preparing an application to conduct the first field release of a recombinant 'rapid-action' *Helicoverpa* NPV insecticide in Australia. Following GMAC's advice, this insecticide has been designed around a virus gene deletion construct. The trial is being planned for early 2001. Its successful completion will mark a significant advance toward the implementation of safe and effective alternative insecticides for pest *Helicoverpa* control in Australian cotton.

Introducing genetically modified virus to a controlled field experiment.

GENETIC ENGINEERING FOR WATERLOGGING TOLERANCE IN TRANSGENIC COTTON

Project Number: 3.2.2

Aims and Milestones:
The aim of this project is to produce cotton with increased levels of alcohol fermentation through the insertion of extra copies of the *Adh* and *Pdc* genes using *Agrobacterium* transformation, and to evaluate the effects on waterlogging tolerance. Similar experiments are being carried out on the model plant *Arabidopsis thaliana*. The results of these studies may suggest better ways of improving waterlogging tolerance in cotton.

Staff:
Dr Marc Ellis,
CSIRO Plant Industry, Canberra, ACT
Dr Danny Llewellyn,
CSIRO Plant Industry, Canberra, ACT
Dr Liz Dennis,
CSIRO Plant Industry, Canberra, ACT
Ms Kathleen Ismond,
PhD student, The University of Alberta, Canada

Progress:
Transgenic cotton plants over-expressing ADH and PDC were assayed in field conditions at ACRI in collaboration with P. Thongbai, M. Bange and S. Milroy. The trials suffered from doubts about the level of waterlogging stress imposed on the plants and no difference in yeilds was observed. Further tests are under way.

A system for testing tolerance to hypoxic stress in Arabidopsis, which was optimized as part of this project, was used to evaluate several lines of Arabidopsis with altered levels of fermentative enzymes. The manipulation of most enzymes (ADH, lactate dehydrogenase, Alanine aminotransferase) had no effect on tolerance. In contrast, increasing PDC significantly improved the plants' ability to tolerate the stress. For this reason, we have made DNA constructs with an Arabidopsis PDC gene and are in the process of introducing them into cotton.

Our observations made on Arabidopsis are the first instance of transgenic plants with improved tolerance to low oxygen, and have important implications on future strategies for the improvement of cotton waterlogging tolerance.

MOLECULAR GENETIC MARKERS FOR ACCELERATED SELECTION OF FUSARIUM WILT RESISTANT COTTON CULTIVARS

Project Number: 3.2.4

Aims and Milestones:
- Establish a suitable disease assay for determining relative resistance levels of cotton plants against Fusarium wilt.
- Conduct genetic analysis on a segregating F_2 progeny derived from cultivars that exhibit extreme resistance or susceptibility to Fusarium wilt
- Conduct DNA marker analysis using AFLP on selected segregating F_2 progeny with extreme disease resistance or susceptibility phenotypes.

Staff:
Mr Augusto Becerra Lopez-Lavalle, PhD student, The University of Sydney, Sydney, NSW
Dr Bruce Lyon,
The University of Sydney, Sydney, NSW

Progress:
A number of scoring techniques have been evaluated as indicators of relative Fusarium wilt resistance of selected cotton cultivars. Leaf symptoms, plant height, vascular discolouration, and vascular discolouration length index (VDLI) were assessed in order to grade disease severity in two commercial Australian cotton cultivars (CS 189^+ and Siokra 1-4) and one non-commercial cultivar (MCU-5). The results indicated that MCU-5 has the highest disease resistance level, whereas Siokra 1-4 the lowest resistance level, observations consistent with field experience.

MCU-5 and Siokra 1-4 together with their segregating F_2 progeny were assessed for resistance to a local isolate of *Fusarium oxysporum* f.sp *vasinfectum* (*Fov*) during two glasshouse trials. Genetic analysis in the F_2 progeny indicates the existence of a single dominant gene for resistance to Fusarium wilt in the MCU-5 germplasm.

Molecular marker techniques, (Amplified Fragment Length Polymorphic DNA - AFLP), is being used to analyse the parental cultivars MCU-5 and Siokra 1-4,

using 64 AFLP primer combinations. Polymorphism identified should be sufficient to find linked DNA markers.

Individual DNA samples obtained from F_2 plants that segregate for extreme disease resistance or susceptibility have been analysed using 96 AFLP primer combinations. AFLP analysis has shown that approximately 20% of the polymorphic DNA fragments detected in the parental cultivars segregate in the F_2 progeny. Six polymorphic DNA fragments have shown association with the Fusarium wilt resistance gene, making them potential disease marker candidates.

The identification of molecular markers for enhanced resistance to Fusarium wilt in cotton would permit more efficient selection of disease resistant plants during the breeding of elite cotton varieties. In particular, plants could be selected for disease resistance in the absence of the pathogen and independent of seasonal/environmental conditions.

DEVELOPMENT OF MOLECULAR MARKER TECHNOLOGIES IN COTTON.

Project Number: 3.2.5

Aims and Milestones:
The aim of this project is to develop the use of molecular markers in cotton, and to assess the feasibility of their use in marker-assisted breeding of cotton. To achieve this, markers linked to phenotypically easy to score, single gene traits were sought (brown lint, okra leaf and bacterial blight resistance). Various molecular marker techniques were examined, in order to assess their usefulness in cotton.

Staff:
Mr Dainis Rungis, PhD student,
The University of Sydney, Canberra, ACT
Dr Danny Llewellyn,
CSIRO Plant Industry, Canberra, ACT
Dr Liz Dennis,
CSIRO Plant Industry, Canberra, ACT
Dr Bruce Lyon,
The University of Sydney, Sydney, NSW

Progress:
Mapping of a population from an intra-specific cross between two *G. hirsutum* varieties was used to search for linked markers to a brown lint and okra leaf genes, and to assess the amount of variation between the two parental varieties. The rate of polymorphic AFLP loci between the two parental varieties was found to be approximately 0.5%. This low level of polymorphism was confirmed by the use of microsatellite (SSR) markers, which are usually variable in many orgasnisms.

Of a set of 214 loci, only 10 were polymorphic between the two *G. hirsutum* parents. No markers linked to either gene have been found, although over 5000 potential loci have been examined. An inter-specific cross (*G. hirsutum x G. barbadense*), on the other hand, was used to map the gene for bacterial blight resistance. The level of polymorphism detected by the AFLP technique was around 10%, a level that should allow the detection of markers linked to any gene of interest. The search for a linked AFLP marker is in progress, and already 3500 loci have been scanned. Preliminary results suggest that the resistance gene is different from the previously assumed gene complex reported in the pedigrees of the Australian cottons.

The rate of polymorphism between the parents in the initial mapping population (*G. hirsutum x G. hirsutum*) was found to be very low. Locating linked markers to any particular gene is difficult with such a low polymorphism rate, and suggests that techniques other than SSR and AFLPs (perhaps single nucleotide polymorphisms or SNPs), will be needed to effectively use molecular markers in breeding with *G. hirsutum*. As expected, the rate of polymorphism between the different species, *G. hirsutum* and *G. barbadense,* is much higher, and consequently markers linked to a particular gene are easier to locate.

MOLECULAR MARKER SYSTEMS FOR BREEDING COTTON CULTIVARS WITH ENHANCED RESISTANCE TO VERTICILLIUM WILT DISEASE

Project Number: 3.2.7

Aims and Milestones:
- To identify and characterise DNA marker loci linked with Verticillium wilt tolerance in *Gossypium hirsutum* cultivars.
- To develop discriminating PCR primers to differentiate allelic DNA marker possession in plant breeding material.
- To develop an early germination genotypic screening assay that employs PCR amplification and fluorescence detection to identify DNA markers in small samples of cotton tissue.
- To identify and characterise RNA markers linked with Verticillium wilt tolerance through gene expression analysis of cotton defence genes.

Staff:
Ms Alison Cook, PhD student,
The University of Sydney, Sydney, NSW
Dr Bruce Lyon,
The University of Sydney, Sydney, NSW
Dr Karin Lyon,
The University of Sydney, Sydney, NSW

Progress:
Previously we had used the AFLP (Amplified Fragment Length Polymorphism) technique combined with the BSA (Bulked Segregant Analysis) to identify a single DNA marker (63-171) linked with Verticillium wilt tolerance in *G. hirsutum*. To identify further DNA markers, 192 *Eco*RI/*Mse*I AFLP primer combinations were used to screen two *G. hirsutum* cultivars Acala Royale (wilt-tolerant) and CS50 (wilt-susceptible) and their F_2 progeny. A number of putative markers have been identified and marker linkage with the gene conferring tolerance to

Verticillium wilt is being confirmed.

A protocol to isolate and characterise DNA marker loci identified through AFLP analysis has been developed. This protocol has been employed to characterise DNA marker 63-171, which is linked with Verticillium wilt tolerance in Acala Royale. The marker 63-171 will enable the development of PCR primers that can confirm possession of the disease tolerance-linked DNA marker in cotton tissue.

A genotypic screening system for the rapid assay of cotton seedling tissue for DNA markers has also been trialed.

V. dahliae infected and uninfected root tissue from wilt-susceptible, -tolerant and -resistant cotton cultivar tissues has been collected. Roots were harvested at intervals from 0 to 96 hours post-infection so that it will be possible to observe changes in host plant gene expression during Verticillium wilt infection.

ISOLATION OF GENES CONTROLLING FIBRE DEVELOPMENT IN COTTON

Project Number: 3.3.1

Aims and Milestones:

- The primary objective is to isolate and characterise genes that are expressed early in the initiation and development of cotton fibre cells. We are targeting genes that encode transcription factors, specifically the cotton equivalents of the Glabra 1 and Glabra 2 genes identified from the model plant, Arabidopsis. Additionally, we aim to isolate novel transcription factor genes that may have a fundamental role in fibre differentiation.

- Assess the role the isolated genes have in fibre development by over and under expressing the gene products in transgenic cotton.

Staff:
Dr Danny Llewellyn,
CSIRO Plant Industry, Canberra, ACT
Dr Lexie Press,
CSIRO Plant Industry, Canberra, ACT
Dr Liz Dennis,
CSIRO Plant Industry, Canberra, ACT

Progress:
A number of genes involved in fibre development have been isolated. Six of these represent genes that have not been previously identified from cotton. We have commenced an extensive assessment of the temporal and spatial expression patterns of the genes in order to determine which of them isolated may have a role in fibre differentiation. Two of the genes are relatively more abundant at the early stages of fibre development. To provide additional insight into the role these two genes may have in fibre biology, their expression pattern is being defined at the cellular level by RNA insitu analysis. If these genes are expressed only in those epidermal cells destined to become fibres, the genes will then be over and under expressed in transgenic cotton .

Two additional genes, Glabra 2 and Glabra 2 have been isolated. In the model plant Arabidopsis, the Glabra 2 gene has a pivotal role in the development of specialised epidermal cell hairs and in cotton this gene is a likely candidate for a major regulatory gene impacting on fibre development. Similar studies are under way with Glabra 1.

We now have a suite of cotton genes encoding transcription factors that are expressed at the early stages of cotton fibre development. We can address the question of the function these genes have in cotton fibre development by engineering cotton plants with increased and decreased levels of the gene product. An increased understanding of the role these genes have in fibre biology will greatly assist in the development of transgenic cotton with altered fibre traits.

MATING BEHAVIOUR IN HELICOVERPA ARMIGERA: INFLUENCE OF HOST PLANTS

SUB PROGRAM 2.2: BIOLOGICAL TECHNOLOGIES
Project Number: 2.2.13

Aims and Milestones:

- To determine whether mating success in *Helicoverpa armigera* is influenced by the surrounding host plants.

- If host plants are found to influence mating success, to determine the underlying mechanisms involved.

Staff:
Ms Olivia Kvedaras, PhD student,
The University of New England, Armidale, NSW
A/Prof Peter Gregg,
The University of New England, Armidale, NSW
Dr Chris Moore,
Dept Primary Industries Qld, Brisbane, Qld
Dr Alice Del Socorro,
The University of New England, Armidale, NSW
Mr Dan Alter,
The University of New England, Armidale, NSW

Progress:
Overseas studies have suggested that the production of sex pheromone by female *Helicoverpa* spp. is increased by the presence of volatile chemicals from host plants. If this is translated into increased mating success in some host crops, then the presence of certain refuge crops might influence both the overall success and the spatial distribution of mating. This might affect the development of resistance to Bt. This PhD project has indicated that such effects are unlikely to be important. Although pheromone production may be increased in the presence of host plants, field studies showed that the crop around moths did not affect their mating success. Wind tunnel work showed that host plants also do not have significant effects on male response to pheromone.

ATTRACTANTS FOR ADULT HELICOVERPA SPP.

Project Number: 2.2.14

Aims:

- To examine the attractiveness of extracts from Australian plants to male and female *Helicoverpa armigera* and *H. punctigera.*
- To compare the attractiveness of these extracts with substances developed in overseas research.
- To identify the active chemicals in the most promising of these extracts,
- To develop and field test lures based on these extracts.

Milestones:

- Conclude chemical analyses and field trials.
- Prepare results for publications.
- Initiate patenting and commercialisation for most useful lures.

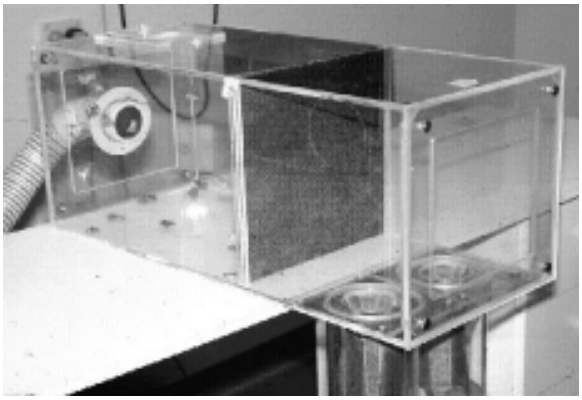
Staff:
Dr Alice Del Socorro,
The University of New England, Armidale, NSW
A/Prof Peter Gregg,
The University of New England, Armidale, NSW
Dr Chris Moore,
Dept Primary Industries Qld, Brisbane, Qld
Mr Dan Alter,
The University of New England, Armidale, NSW
Mr George Henderson,
The University of New England, Armidale, NSW
Prof Jia-wei Du,
Shanghai Institute of Entomology, China
Dr Shao-fu Xu,
Shanghai Institute of Entomology, China
Meng-Zhin Wang,
Shanghai Institute of Entomology, China

Progress:

Over 170 volatile compounds have now been identified from a total of 40 plants that have been screened for attractiveness to *H. armigera* moths in the olfactometer. Eight of the 32 single chemicals and 13 of the 20 chemical blends tested in the olfactometer were found to be significantly attractive to female moths. Synthetic blends, which are as attractive in the olfactometer as the most attractive plants, have been developed.

For field testing, synthetic blends were formulated in Sirene®, which slows the release of volatiles and contains antioxidants and uv-protectants to prevent their degradation. Various blends that were found to be attractive in the olfactometer were tested in a total of 15 field trials on the Darling Downs (Queensland), Kununurra (Western Australia) and Henan Province (China). Though many blends have captured *H. armigera* moths of both sexes, the numbers caught have been low relative to those caught by pheromone traps in the same experiments. Some blends have also caught large numbers of other pest moth species, especially soybean loopers, *Thysanoplusia orichalcea.* We have not yet field-tested the most recently developed, highly attractive blends.

Results have been sufficiently promising to initiate commercialisation discussions with potential partners and to develop a patent application.



Two-choice olfactometer used to identify attractive volatile compounds.

Field observation tower used to observe moth behaviour.

SUSTAINABLE FARMING SYSTEMS

PROGRAM THREE OVERVIEW

INTRODUCTION

Program 3 seeks to develop strategies for cotton production that encourage efficient use of resources while minimising inputs and impact on the environment.

Key issues facing the industry and addressed in Program 3 include water use efficiency, management of pests and diseases, soil management, salinity risks and off farm movement of inputs. Throughout the program emphasis is placed on a farming systems approach, to ensure that research is integrated into the broader cotton agroecosystem. This was reinforced in 1999 by the appointment of a Farming Systems Scientist to coordinate research in this area and to assume responsibility for management of the Cotton CRC's long term Farming Systems Experiments.

The first year of the Cotton CRC has been one of transition from the structure of the previous CRC for Sustainable Cotton Production. A number of projects in Programs 1 and 5 of the previous CRC were incorporated into the new Program 3. Consequently, this report deals largely with projects approved under the old CRC, now in transition to the projects in the new Cotton CRC Program 3.

HIGHLIGHTS AND ACHIEVEMENTS

All of the projects in Program 3 have achieved their stated objectives. Key outcome areas include soils, water, diseases and farming systems. While this report focuses on those projects directly funded, either in part or full, by the Cotton CRC there are many other projects under the Cotton CRC umbrella. Projects cover areas of insecticide resistance, much of the research into IPM systems, disease management, application and development of cotton simulation and water use efficiency. Collectively theses projects represent the Cotton CRC's comprehensive research portfolio around Sustainable Farming Systems.

Of high priority over the past seasons has been the increased research and extension effort to address the spread and management of Fusarium wilt. This devastating fungal disease has been increasingly recorded from fields outside of the previous focal areas of the Darling Downs and MacIntrye Valleys, and now occurs in the Macquarie Valley, the Upper Namoi Valley in NSW and the Baralaba and Dirranbandi regions in QLD. Cotton CRC research has documented the spread of Fusarium and several field experiments are now focused on farming systems responses for management. Recognising the threat of Fusarium Wilt the Cotton CRC has established a Fusarium Research Co-ordinating Committee, which has produced two update publications for growers and held two workshops.

Lewis Wilson and Alex McBratney

Soils have benefited from a major increase in research effort during the life of the former Cotton CRC and this will continue. An extensive inventory of soils has been completed for the lower Macintyre, Gwydir and Namoi Valleys and this is being extended to the Upper Namoi, St George and Bourke regions. The inventory provides a comprehensive record of a range of physical and chemical characteristics of these soils. Highlights of real or potential soil problems are being provided in soil quality indicator maps linked with a geographic information system. Other soils research has addressed issues of the role of microbes in degradation of residues and the development of relationships, based on easy to measure soil characteristics, that will allow prediction of the hydraulic properties of cotton soils. A major thrust for the new Cotton CRC is the issue of soil health. A soils research review in June 2000 will review current soil research and directions. Likewise deep drainage remains a contentious issue.

There are strong links between the Cotton CRC's soils research and issues of water use. These include water use efficiency and water balance, salinity and deep drainage. Two workshops have been convened to identify priorities for further research on drainage, evapotranspiration and runoff; all elements of the water balance on cracking clay soils.There has been a major effort to develop and apply appropriate techniques for mapping soils with potential salinity risks, both at a field and regional level using electromagnetic sensing systems. Widescale sampling of soils has been used to develop and validate the Sodium SaLF model to predict the salinity risk for specific soils being irrigated with poor quality water. Research into the salinity risks in the cotton industry remains a high priority in the current Cotton CRC, with a number of projects submitted to other agencies such as Salt Action and the National Heritage Trust.

Farming systems will receive increased emphasis in Program 3 with greater co-ordination across Cotton CRC partners. In addition to the ongoing farming

systems sites we have initiated experiments to investigate factors contributing to crop earliness and stubble retention systems to reduce erosion and their possible link with reduced pest levels.

The development of IPM systems for cotton remains a high priority, particularly as supporting technology for the cotton industry BMP program. Research areas include selective pest control, resistance management, area wide management and trap cropping. August 1999 saw the launch of the IPM Guidelines for Australian cotton, which form the core of ENTOpak. This represents a culmination of collaborative efforts. The Cotton CRC has also commenced investigations of the cause of the Bunchy Top Syndrome found extensively in cotton in 1998-99. This research is likely to expand in future.

With significant new areas of research into 'on-farm' bioremediation of irrigation water contaminated with pesticides, quantifying the value of ecosystem services provided to the cotton industry and development of production systems for southern NSW, Program 3 will be a dynamic and well integrated program to produce sustainable farming systems outcomes.

LINKAGES

Program 3 maintains linkages with industry, other research organisations 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;

- Salt Action and the National Heritage Trust contributing funding towards salinity research
- Links with the CRC for Tropical Plant Pathology in Fusarium research
- Links with the DNR Queensland in irrigation/soils research
- 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 Growers Associations and Irrigators 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 role of organic matter in maintaining soil structure and Canberra, collaboration in the soil baseline study
- Links with the Agricultural Production Systems Research Unit (CSIRO and QDPI)
- Weed Management CRC for existing research and future joint opportunities in Queensland
- Links with CSIRO Plant Industry, Adelaide and QDPI, Brisbane in research into Bunchy Top Syndrome

HERBICIDES AND COLLEMBOLA IN COTTON GROWING SOILS

SUB PROGRAM 3.1: OPTIMISING INPUTS
Project Number: 1.2.3

Aims and Milestones:
- To make a preliminary assessment of the effect of herbicides used, and likely to be used, in cotton production on the Collembolan, *P. minuta,* which is a predominant species of soil fauna in some cotton-growing soils.
- To determine whether herbicides used or likely to be used, in cotton production are metabolised by *P. minuta*

Staff:
Dr Edith Lees,
The University of Sydney, Sydney, NSW
Mr Eun-Kee Park, PhD student,
The University of Sydney, Sydney, NSW

Progress:
The overall research plan as described in the initial proposal included the following sections.

Year 1: Assessment of toxicity of herbicides to *P. minuta* using methods developed for studies on endosulfan toxicity.
Year 2: Comparison of the response of *P. minuta* from cotton-growing soils and areas not treated with agricultural chemicals used in cotton production to determine whether *P. minuta* develop tolerance to chemicals used.
Year 3: The metabolism of herbicides by *P. minuta.*

The determination of the toxicities of a group of herbicides was carried out in 1997-98 and was reported in the 1997-98 Annual report to the CRCSCP, and also (as a poster) to the Australian Cotton Growers Conference in 1998. In addition the toxicities of á-?and â-endosulfan, endosulfan sulfate, aldrin and dieldrin have been determined. The herbicides are much less toxic to the insects than the endosulfans, or aldrin and dieldrin. In the assay used, aldrin and dieldrin were less toxic than the endosulfans, but this may result from the assay method used. The low solubility of aldrin and dieldrin in the salt solution used in these experiments may have contributed to their apparent low toxicity. However this may also be relevant in the field, because the availability of aldrin and dieldrin may be reduced by stronger binding to soil particles. On the other hand, the low toxicities of the generally more soluble herbicides probably indicates a real low toxicity to *P. minuta.*

The variability from year to year of the levels of various soil fauna in cultivated and non-cultivated land is not fully understood. Reasons for high levels of particular organisms in some soils under some conditions may include the differential effects of particular chemicals on predators and the impact of seasonal variations on the levels of chemicals which are retained in the soil. To date we have been unable to obtain sampled of *P. minuta* to complete the second part of this project However in studies of the

interaction of *P. minuta* with the endosulfans we have we shown that the insects collected from the field were probably not resistant to endosulfan at the time they were collected. Their susceptibility to endosulfan did not change during several years in culture without exposure to endosulfan. The short life cycle of the insects, the limited periods of the year when field soil insects are exposed to high levels of the insecticides and herbicides, and the capacity of the insects to metabolise insecticides may mitigate against the development of resistance.

The experimental work in this project has been carried out by Eun-Kee Park in parallel with his PhD studies on *P. minuta* and endosulfan. In recent studies he has shown that *P. minuta* can metabolise endosulfan to endosulfan sulfate, which can be extracted from the insects and assayed by ECD gas chromatography. In addition the insects can convert aldrin to dieldrin, which can be extracted and assayed. The endosulfan sulfate produced by the insects can be further metabolised to a form which can not be extracted and detected by ECD gas chromatography. The fate of the endosulfan sulfate is not known. It may be converted to a non-extractable conjugate. Alternatively it may be converted to an extractable de-chlorinated (and thus non-toxic) form which would not be detected by ECD gas chromatography.

HPLC assay methods are now available in the Department for the determination of several herbicides and the metabolism of these herbicides will be examined in the next few months as the next stage of this project.

Eun-Kee Park's PhD thesis entitled 'Endosulfan and *Proisotoma minuta* (Tullberg) from cotton-growing soils in Australia' has now been submitted for examination. Material on herbicide interaction with *P. minuta*, supported by the CRCSCP has been included in the thesis, and acknowledgment made to the Cotton CRC for support.

THE APPLICATION OF PRECISION AGRICULTURE TECHNIQUES TO COTTON FARMING SYSTEMS.

Project Number: 5.2.1

Aims and Milestones:
- Collect proximal yield data on core and satellite project sites. The core sites are Peter Glennie's property "Norwood" 10 km north of Moree and the AXA (National Mutual) property "Teleraga Station" 52 km west of Moree.
- Collect proximal yield data and remotely sensed yield estimates on a series of fields for comparative analysis. Attempt to refine the "Farsite" Landsat transformation for yield estimates. This was predominantly done for the Upper and Lower Namoi and Gwydir river areas.
- Perform analysis of yield data and continue to investigate within-field variability leading into write up of research results.
- Perform comparative analysis of "Farsite" estimates and proximal yield-monitor measurements. Develop methods to generate potential management zones within field using multiple years of existing Landsat images to generate yield estimates for the past 11 years.
- Write thesis.

Staff:
Mr Broughton Boydell, PhD student,
The University of Sydney, Sydney, NSW
Prof Alex McBratney
The University of Sydney, Sydney, NSW

Progress:
A number of reliable yield monitors are now commercially available. As a result the acquisition of proximal (yield monitor/mapping) data was a relatively simple task.

Development and analysis of an improved "Farsite" Landsat data transformation was greatly assisted by this large quantity of yield data. Together with large Landsat image covering the Gwydir, and Upper and Lower Namoi valleys donated by IAMA we were able to compare all yield data with the Landsat yield estimates. Using this data 100,000 Ha of irrigated cotton has been transformed to create yield estimate maps and compared with ~5,000 Ha of yield monitor data. We now have scope to characterise "within-field" variabilities of cotton yield across a large area and so identify opportunities that exist for improved within field management.

DETERMINING THE PHOSPHORUS (P) REQUIREMENTS OF COTTON GROWN ON ALKALINE SOILS IN AUSTRALIA

Project Number: 5.3.1

Aims and Milestones:
- To identify the critical soil and plant P limits for cotton
- Investigate the benefits of P fertilisation on early crop vigour, crop maturity and lint yield
- Improve confidence in interpreting soil and plant tissue tests.

Staff:
Mr Chris Dorahy, PhD student,
The University of New England, Armidale, NSW
A/Prof Graeme Blair,
The University of New England, Armidale, NSW
Dr Ian Rochester,
CSIRO Plant Industry, Narrabri, NSW
Mr Greg Roberts,
CSIRO Plant Industry, Narrabri, NSW

Progress:
Over the past three cotton-growing seasons 18 field experiments were established in the Macquarie, Namoi, Gwydir and MacIntyre Valleys to determine cotton response to phosphorus (P) fertilisation. Soil, plant and lint yield measurements were taken from each site to determine if soil P was limiting to crop growth.

Out of the 18 sites studied, only three demonstrated a significant ($P<0.05$) lint yield response to P fertiliser application. This suggests that despite low extractable soil P levels, in the non-responsive sites, cotton was able to gain its P requirements from the soil.

Investigation of the soil P status on these sites revealed that there are potentially larger pools of P in the soil to which the plants have access. These pools are not being measured by the existing soil tests. On the sites which did respond to P it is likely that these sites were inherently low in soil P.

Across all sites, a strong positive correlation ($r^2>$ 0.90***) was found between early season P uptake and uptake of exchangeable calcium. This provided evidence to suggest that cotton plants use an uptake mechanism involving rhizosphere acidification to increase P availability on alkaline soils. This mechanism is currently being investigated in the final phase of experimentation.

An experiment was conducted at ACRI, Narrabri to investigate P fertiliser recovery by cotton. This revealed that up to 50 % of applied P is precipitated as inorganic P compounds within 24 hours of application. However, if banded, sufficient P remained available for subsequent P uptake. It was estimated that the cotton plants were able to recover 35% of the P applied. In addition, the observed increase in P uptake in the P treated plots was attributed to an increase in uptake of native soil P from within the fertilised band, rather than as direct uptake of applied P.

This project will provide the cotton industry with a more reliable means of determining when crop response to P fertiliser is likely and give greater confidence in soil test interpretation.

Post-graduate student, Chris Dorahy, winner of the Queen's Trust Award For Young Australians (1999).

COTTON RESIDUE DECOMPOSITION

Project Number: 5.1.4

Aims and Milestones:

- To compare the population dynamics of cotton pathogens in the residue left on the surface buried in the soil.
- To determine the populations of microorganisms associated with residue decomposition.

Staff:
Dr Subbu Putcha,
NSW Agriculture,Canberra, ACT
Dr Stephen Allen,
NSW Agriculture, Narrabri, NSW
Mr Anthony Mitchell,
NSW Agriculture, Narrabri, NSW

Progress:

In order to characterise microbial decomposition of residues we have devoted considerable time to developing DNA probes as fast and reliable ways to inventory the pathogens associated with crop residue and the bacterial participants in the residue degradation complex. In fungi, the ITS regions and in bacteria, the 16S and 23S regions were targeted for the purpose.

One application of these primers, based on a few nucleotide differences in the ITS region, is to detect *Fov* from soils with known Fusarium wilt problems and plant tissue with visible disease symptoms. However, in some cases *Fov* was not detected in soil samples containing plant debri where it was expected to be present. Quantifying sensitivity/detection limits and optimising DNA extraction methods and amplification conditions requires further work.. It also appears that detection of *Fov* in plant tissue is harder.

Studies on the effect of the *Bacillus* strain, which has shown promise in biocontrol of Fusarium wilt, on cotton residue degradation and reduction in *Fov* inoculum. This *Bacillus* sp. is known to colonise plant residue saprophytically and participate in the breakdown of the residue.

LONG-TERM EFFECTS OF COTTON ROTATIONS ON THE SUSTAINABILITY OF COTTON SOILS II

Project Number: 3.1.0 AC

Aims:
Determine the long-term effects of rotation crops and their management on soil quality changes, nutrient uptake and cycling, growth and yield of succeeding cotton, and profitability on Vertisols used for irrigated and dryland cotton production in New South Wales and Queensland.

Milestones:
- Sow winter and summer rotation crops after cotton harvest
- Take soil samples from all experimental sites at Warren, Merah North, WeeWaa, Warra and Emerald for analysis. Perform *in-situ* measurements of soil properties where required. Complete laboratory analyses and perform data analyses on the results
- Monitor growth and nutrient uptake by winter rotation crops in NSW sites
- Collect economic data and evaluate farm profitability in NSW sites
- Conduct any additional experiments if required.

Staff:
Dr Nilantha Hulugalle,
NSW Agriculture, Narrabri, NSW
Mr Tim Weaver,
NSW Agriculture, Narrabri, NSW
Ms Fiona Scott,
NSW Agriculture, Narrabri, NSW
Mr Lloyd Finlay,
NSW Agriculture, Narrabri, NSW

Progress:
Research has continued at study sites at Warren, Merah North and Wee Waa in NSW, and Emerald and Warra in Qld.

Wheat rotation crops sown at the Warren and Wee Waa sites were harvested, and yield and nutrient uptake evaluated. Economic data was collected for evaluation of profitability.

Structural damage was significant due to sowing and land preparation under very wet conditions after the floods of 1998. However, there was structural regeneration of the soil profile during the cotton growing season of 1998-99 due to the frequent wetting/drying cycles. All plots which had a history of wheat had better structure, whereas those with a history of legumes had poorer structure but are increasing in soil organic C. Plots with poor cotton growth due to insect damage, waterlogging and black root rot had substantial reserves of soil N left at the end of the season. Consequently the following wheat yields reflected the end of season N reserves at Warren. At Wee Waa where additional N was applied, this did not occur. Additional experimental work included:

- A long-term experiment (15 years) on tillage and cotton-wheat rotation systems was continued at ACRI. Stubble management on the wheat rotation plots was modified so that cotton could be sown into the wheat stubble in 2000. No cotton was sown in this field in 1999. Heliothis pupae emergence was monitored in all minimum-tilled plots during 1999. Although pupae numbers averaged 2.5/m after cotton harvest in May, subsequent moth emergence was negligible.
- Samples were taken from a herbicide experiment conducted by Grant Roberts (CSIRO Plant Industry), to quantify the displacement of divalent cations (Ca and Mg) from the exchange complex due to adsorption of the herbicides onto the clay particles. Greatest displacement occurred with Roundup and Gesagard.
- The drop-cone method penetrometer was modified to evaluate plastic limit in heavy clay soils. This was tested on soil samples taken during 1997-99 from the rotation experiments.
- A laboratory experiment was conducted on stubble decomposition of cotton, soybean, faba, green and mature wheat, and their effects on soil organic carbon and other soil properties. When relatively small amounts of stubble are added to the soil much of the carbon in the stubble is converted into inorganic C (ie. lime). Only when extremely large amounts of stubble are available are there any significant changes in soil organic C. This process is facilitated by stubble of low C/N ratios.
- Leaching of nitrates, cations and chlorides under a minimum tilled wheat-cotton rotation was monitored from July to November 1999 by using ceramic soil water samplers, and measuring soil water content with a neutron probe and salinity with an EM38 meter. Significant nitrate and chloride leaching occurred towards the head ditch end and centre of the field, whereas it was negligible near the tail drain end. These differences appear to be caused by the very high clay content and absence of drainage pores (mainly root pores) at the tail drain end of the field. Drainage did not occur through soil cracks, as the soil remained wet for much of the growing season due to the frequent rainfall.

SOURCES OF BENEFICIAL INSECTS COLONISING COTTON FIELDS.

Project Number: 2.2.16

Aims:
To investigate the origins of beneficial insects which colonise cotton fields, using quantitative sampling methods and insect-borne pollen as a marker of origin.

Milestones:
1998/1999
- Appoint Research Fellow
- Select and establish field site(s)
- Conduct first season's sampling for beneficial insects
- Examine pollen carried by these insects

1999/2000
- Conduct second and early third season's sampling for beneficial insects
- Examine pollen carried by these insects
- Analyse data and prepare publications

Staff:
Dr Letitia Silberbauer,
The University of New England, Armidale, NSW
A/Prof Peter Gregg ,
The University of New England, Armidale, NSW
Dr Alice Del Socorro,
The University of New England, Armidale, NSW
Mr George Henderson,
The University of New England, Armidale, NSW

Progress:
Dr L. Silberbauer commenced in the project in October 1998. After preliminary assessment in field studies commenced at a site in the upper Namoi Valley, near Boggabri. It encompasses several cotton fields on three neighbouring properties; "Milchengowrie", "Kilmarnock" and "Brigadoon". These sites were chosen because the cotton was managed, as far as possible, with soft-option chemicals, thus maximising our chances of finding populations of beneficial insects in and around the cotton.
Samples were collected every three weeks during summer from the cotton crop, from other crop and non-crop vegetation nearby to assess the population of beneficials. Sampling continued during the winter of 1999 to identify winter refugia for beneficials. After sorting and identification of key beneficial species we used scanning electron microscopy (SEM) to examine pollen present on the external surface of individual insects. Most individuals carried identifiable pollen. The data suggests beneficial insects move between vegetation types. Cotton pollen was found on many individuals caught outside cotton crops, suggesting that cotton is visited regularly. Likewise, most specimens sampled from within cotton crops carried non-cotton pollen, suggesting that the beneficials utilise the surrounding vegetation.
These results show the important role of vegetation diversity in maintaining on-farm populations of beneficial species. Once complete the study will assist in the design of IPM systems.

COORDINATION AND PROMOTION OF INNOVATIVE FARMING SYSTEMS RESEARCH

Project Number: 5.1.5

Aims and Milestones:
- Initiate innovative farming systems experiments which combine a range of disciplines including soil science, crop agronomy, insect, weed, disease and water management. The objective being to develop viable and sustainable cotton cropping systems. Experiments identified in the previous CRC will be the starting point and these include the concept of managing earliness in cotton, stubble retained systems and dryland weed management.
- Coordination of collaborative research and extension into cotton based farming systems including the core Cotton CRC systems trials.
- Promotion of Cotton CRC farming systems research at field days, conferences and industry press.

STAFF:
Mr Grant Roberts,
CSIRO Plant Industry, Narrabri, NSW
Ms Clare Felton-Talyor,
CSIRO Plant Industry, Narrabri, NSW
Mr Greg Salmond,
Dept Primary Industries Qld, Dalby, Qld
Ms Jenelle Hare,
Dept Primary Industries Qld, Dalby, Qld

Progress:
Coordination of the Cotton CRC's farming systems was reviewed through a planning meeting of all participants. Research in this project involved studies of the earliness systems, stubble/mulch management and dryland farming systems.

Seven sites were established to compare conventional management against an agronomic package that adjusted water, nitrogen, growth regulators and insect management to shorten the period between planting and picking. A short season variety was included as an alternative treatment. Preliminary results show that some sites obtained earliness without reducing yield but other sites suffered a yield penalty. The short season variety nearly always matched the early treatment for yield and earliness showing that appropriate varieties are one important component of earliness although in long season areas earliness will be associated with yield penalties.

A commercial scale experiment on Auscott is quantifying the effects of stubble retention / mulch on water runoff, soil bed profiles, beneficial insects and cotton disease. Cotton bed shape was maintained with stubble retention, while cotton insect pest populations were both positive and negative. This research will continue.

Research in dryland farming systems focussed on weed management and the effect of a range of glyphosate timing applications on fruit retention and

yield was conducted. There were no significant yield differences, even when the glyphosate timing was double the recommended timing interval. 1st position fruit retention was significantly reduced as glyphosate timing was delayed on Roundup® Ready cotton.

Herbicide control options were evaluated in both vetch and faba bean crops to improve the adoption and management of these crops as rotations. There was a significant reduction in nitrogen fixation with the application of some herbicides. The effects of these herbicides on the following cotton crop have also been evaluated.

More effective management of the Cotton CRC cropping systems sites at Beechworth and Warra has been achieved with the appointment of two new technical officers. Premature senescence, Sunscald and Alternaria were major problems at the Warra site and Verticillium wilt incidence was high at Beechworth. As a result crop cut-out occurred early this season. Average yield this season was 2.79 bales/ha for the Warra site and 5.86 bales/ha for Beechworth. Winter crop yields at Warra were; Wheat 1.99 tonne/ha, protein 12.5%; Chickpea 1.03 tonne/ha. These farming systems have now operated for a number of rotations and analysis over the next year will start to identify long-term trends.

DISEASE SURVEYS

Project Number: 2.5.3

Aims and Milestones:
To monitor the distribution and importance of diseases in irrigated and dryland cotton by regular disease surveys.

Staff:
Dr Stephen Allen,
NSW Agriculture, Narrabri, NSW
Mr Kurt McTaggart,
NSW Agriculture, Narrabri, NSW

Progress:
Various pathogens continue to impact on cotton production. To quantify the geographic incidence of disease we have completed annual surveys for some time.

Disease surveys across the industry were completed as planned in November, 1999 and the Hillston area was included for the first time. Black root rot was very common and occurred in most areas including Hillston. Fusarium wilt has been confirmed on two more farms in NSW; one near Boggabilla, the second in the Macquarie Valley. Fusarium wilt has also been detected in new fields on farms where the disease had been previously detected.

In collaboration with seed companies we conducted experiments at ACRI and on the Darling Downs to compare the efficacy of 15 fungicidal seed treatments.

One technique to suppress Fusarium wilt is to flood fields during summer. This option was tried on Field 5 and 6 at "Tarcoola North" (Gwydir Valley) where three large Fusarium affected areas had been identified. The field were flooded in January 1998 followed by planting in October 1999 of a 'more resistant' cultivar. To date we have seen no plants with symptoms of Fusarium wilt.

ECOLOGY AND DEVELOPMENT OF MANAGEMENT STRATEGIES FOR FUSARIUM WILT IN COTTON.

Project Number: 2.5.4

Aims:
- Monitor the distribution of Fusarium wilt and pathogen diversity in cotton growing areas (liaise with Dr Allen for NSW crops).
- Characterise and type any *Fusarium oxysporum* isolated from wilted cotton in new areas (this will include samples from all cotton growing areas in Australia).
- Screen, both in glasshouse and field trials, a range of cotton germplasm for reaction to *Fov.*
- Assist plant breeders with development of disease tolerant cultivars.
- Investigate stubble management and other agronomic practices on pathogen survival and subsequent disease development.
- Extend information on disease management to Industry and contribute to development of protocols to retard the spread of the disease to new areas.

Milestones:
- Complete planting of field trials by December.
- Complete assessment of field trials by June.
- Complete cotton disease surveys by July.
- Complete assessment of germplasm and assist with crossing of selected germplasm by July.
- Publish research results in scientific journals, industry journals and extend results to farmers, extension officers and consultants at workshops and industry meetings.

Staff:
Dr Joe Kochman,
Dept Primary Industries Qld, Toowoomba, Qld
Dr Natalie Moore,
Dept Primary Industries Qld, Brisbane, Qld
Mr Greg Salmond,
Dept Primary Industries Qld, Dalby, Qld
Mr Neil Obst,
Dept Primary Industries Qld, Toowoomba, Qld
Mr Wayne O'Neill,
Dept Primary Industries Qld, Brisbane, Qld
Dr Suzie Bentley,
CRC for Tropical Plant Protection, Brisbane, Qld

Progress:
Some 180 cotton specimens from Qld, NSW and WA were received. Of these, 57.3% were positive for *Fov*. Of the positive specimens, 97 belonged to VCG 01111 (Darling Downs strain) and five belonged to VCG 01112 (Boggabilla strain). New recordings

were made in the districts of Baralaba and Dirranbandi in Qld and in Bourke, Boggarbi, Carroll (Upper Namoi) and Warren in NSW. No positive recordings of *Fov* were made from Emerald in Qld, Walgett, Wee Waa, Narrabri, Tandou or Hillston in NSW or from WA. *Verticillium* was recovered from 25 specimens. Other fungal pathogens identified included *Phomopsis, Rhizoctonia*, *Alternaria*, *Lasiodiplodia theobromae* and *Colletotrichum gossypii*. Various other *Fusarium* species and *Tricothecium roseum* were also recovered on more than one occasion. Several cultures were lodged with the Plant Pathogen Herbarium at Indooroopilly for future reference. Details of all diagnostic specimens received have been entered into a searchable database. This database presently contains more than 670 entries in total.

One hundred and twenty three varieties and breeding lines from both CSIRO and Deltapine breeding programs were assessed in the glasshouse for reaction to *Fov*. This information together with data from over 800 lines being assessed on the field provided crucial direction for breeders. Another glass house experiment is exploring the suggestions that transgenic cotton varieties may be more susceptible to Fusarium wilt than their recurrent parents.

A series of field experiments was planted in October to address the impact of crop rotation and stubble handling on Fusarium incidence. Unfortunately these hailed out on 16 November 1999. Remnant seed was used to replant most of the trials on 29 Nov. Although the trial will not be picked because of the extremely late planting, disease incidence data and disease resistance selections have been made.

IMPROVING THE N NUTRITION OF COTTON USING ROTATION CROPS

Project Number: 5.3.2

Aims and Milestones:

- Quantify the nutritional benefits of rotation crops to cotton by comparing summer and winter legume crops and forages for their ability to reduce the amount of fertilizer N needed to optimise cotton yields.
- Continue to monitor N cycling and collect soil and tissue nitrate data from the three Cotton CRC farming systems experiments.
- Use experimental and on-farm data to develop and validate relationships which assess crop N status and allow earlier predictions of N fertilizer requirements. Develop appropriate on-farm techniques to improve grower confidence in conducting and interpreting soil and plant tissue tests. Provide technical input in the nutriLOGIC / NUTRIpak program to ensure growers become more conversant with the nutritional requirements of cotton.

Staff:
Dr Ian Rochester,
CSIRO Plant Industry, Narrabri, NSW
Mr Greg Roberts,
CSIRO Plant Industry, Narrabri, NSW
Dr Mark Peoples,
CSIRO Plant Industry, Canberra, ACT
Mr Bob Gault,
CSIRO Plant Industry, Canberra, ACT

Progress:

Understanding the response to N fertilizer by cotton following a range of rotation crops provides important information for productive farming systems. N recovery following either wheat, soybeans or cowpeas (green-manured) was determined. For this season cotton following soybeans or cowpeas required about 170 kg N/ha, whereas following wheat, required 190 kg N/ha. This difference is much smaller than in previous years and relates to very poor fertilizer recovery (about 20%) in this season. Crop nutrient uptake was similarly poor in experiments sampled throughout the cotton-growing regions. This effect is possibly due to improved crop nutrition and / or soil quality (reduced soil strength). Continuous cotton grown with green-manured vetch each winter out-yielded continuous cotton grown with out vetch intercropping by 95%. As in all previous experiments conducted within this project, the treatments that included legumes in their cropping sequence out-yielded by 4% those systems that did not include legume crops, continuing a pattern seen now for several seasons.

Providing reliable test procedures for use by crop managers is an important aspect of optimal crop nutrition. Soil and petiole nitrate testing have continued to indicate the relative N fertility of the various cropping systems examined and allowed decisions to be made on N nutrition. In addition to experiments at ACRI, measurements of soil, petiole and leaf N and crop DM samples have been collected and analysed from the Cotton CRC's Farming Systems sites. The SPAD meter which measures greenness of the leaf can reliably indicate crop N nutrition although differences in predicted N fertilisers required between years of experimentation remain a concern about its reliability.

The Farming Systems sites were also monitored for disease, weeds and insects.Cotton diseases were not a problem in the 1999/200 season, although substantial losses through boll rots occurred in highly fertilized treatments. VAM was not deficient in these experiments. Weeds are being more problematic, especially nutgrass, and self-sown cowpeas following that rotation crop. Insect management has improved from previous years, although insect pressure reduced lint yields in these experiments. Soil structural measurements indicate that vetch produce a substantial improvement to soil condition as do most legume crops.

COTTON AGRONOMY, PHYSIOLOGY, MODEL DEVELOPMENT AND VALIDATION

Project Number: 5.4.3

Aims and Milestones:

To provide much needed technical support for agronomic and crop physiology research activities. The person will contribute to the following specific project objectives:

- To assist with research to quantify differences between cotton varieties
- Collect and process data to demonstrate the value of linking crop and soil monitoring with the predictive capability of simulation models.
- Collect data with the aim of developing better understanding of environmental effects on fibre quality
- Collect data to validate simulation models including those related to water extraction, late and early cultivar development and fibre quality.
- Assist with research into the relationships between foliar nitrogen and photosynthesis
- Assist with research into the physiological responses of conventional and transgenic cotton lines to waterlogging.

Staff:

Dr Michael Bange,
CSIRO Plant Industry, Narrabri, NSW
Dr Steven Milroy,
CSIRO Plant Industry, Narrabri, NSW
Dr Pongmanee Thongbai ,
CSIRO Plant Industry, Narrabri, NSW
Mr Graeme Rapp,
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

Progress:

This project provides technical support for a number of agronomic and physiologiacl experiments. These include studies of:

- short and long season cultivars to collect data for validation of simulation models
- the physiological responses of cotton to waterlogging through measurements of leaf photosynthesis
- fruit counts
- nitrogen analysis
- leaf chlorophyll
- retrospective mapping of fruit position
- soil water content
- biomass sampling
- light interception
- maturity picks and yield
- the performance of eight transgenic lines with enhanced alcohol fermentation to waterlogging in the field
- the physiological effects of an exogenous inhibitor (AVG) on waterlogged cotton and efficacy for field use
- impacts early season insect damage on soil water extraction and yield in crops grown in skip-row configurations (done collaboratively with growers)
- the effects crop growth of frequent irrigations postulated as a means of improving in field water use efficiency (collaboratively with growers).

Nitrogen nutrition on commercial farms involving frequent measurements of leaf photosynthesis and nitrogen content information will be used to derive responses of photosynthesis to leaf nitrogen concentration. All these experiments provide additional validation data for the cotton crop model OZCOT or physiological insights which will enhance future model development. In addition we continued working with growers to implement the APSIM farming systems model to provide strategic decisions on their farms. This involved detailed soil characterisation completed at 19 locations, with a further 25 fields sampled for soil moisture and nitrogen to depth at the start of the season for use in benchmarking exercises with grower groups.

Plate 1 : Waterlogging experiment in the 1999/2000 season. Plants were exposed to these conditions for more than 72 hrs at each irrigation event.

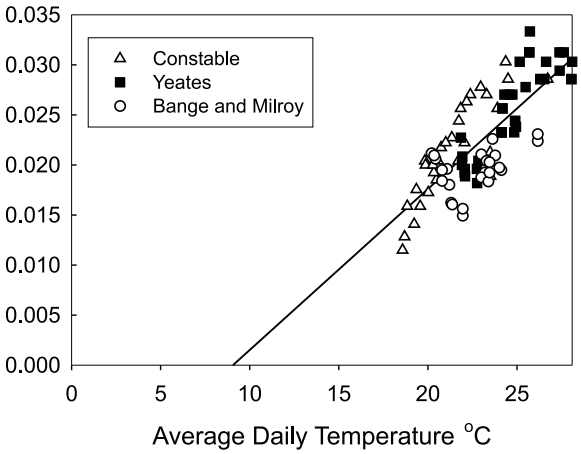


Figure 1: Compilation of field data used to analyse the effects of temperature on crop development. Responses like this are used in crop management (eg. day degree calculations) and for refining crop simulation models.

PHYSIOLOGICAL AND AGRONOMIC FACTORS AFFECTING THE EFFICACY OF BT IN TRANSGENIC COTTON

Project Number: 3.1.1 AC

Aims and Milestones:

- To assess in detail the impact of agronomic factors on the efficacy and expression of both one (Cry 1Ac) and two gene (Cry IAc & CryIIA or CryX) INGARD™ cotton varieties
- To develop a management package that optimises the efficacy of Bt in cotton varieties
- To assist the overall coordination of agronomic and physiological research into the efficacy of Bt cotton

Staff:
Dr Phil Wright,
NSW Agriculture, Narrabri, NSW
Ms Jenny Roberts,
NSW Agriculture, Narrabri, NSW

Progress:

Field experiments on the impact of plant density, plant growth regulators, waterlogging and herbicides on Bt expression where made on a range of cultivars. Measurements on plant growth were made along with repeated bioassays and samples were taken for quantitative Elisa. While transitory impacts on Bt expression were evident with some herbicide and waterlogging treatments, the most striking impact was that of plant density. Two cultivars (Sicot 289i and Siokra101i) were sown at 2, 4, 8, 12 and 24 plants/m. Early in the season Bt expression was poorer in plants at low densities, however this changed as the season progressed so that by the 7th of January plants at the standard industry density of 12 plants/m were those with the poorest expression (fig. 1). When the data was examined across the season it suggests an optimum plant density for Bt expression of about 8 plants/m. These results need to be confirmed over several seasons. However they do show that there is potential to influence and manage Bt expression with agronomic practices.

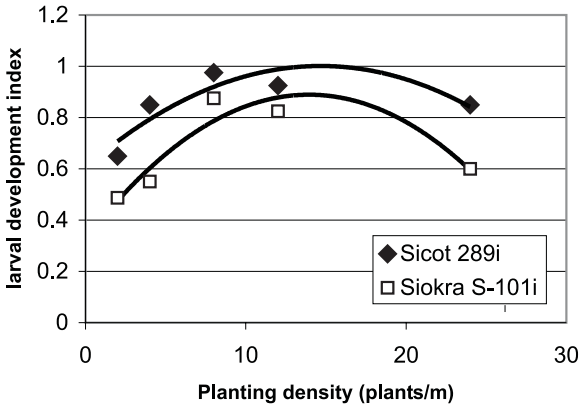


Figure 1. During January the poorest efficacy (high larval index) occurred at planting densities of about 10-12 plants/m

COTTON BUNCHY TOP DISORDER - INVESTIGATION INTO POSSIBLE ROLE OF A VIRUS OR PHYTOPLASMA.

Project Number: 3.1.2 AC

Aims:

- Establish whether the disorder is caused by a transmissible pathogen.
- Establish whether or not viruses or phytoplasmas are the causal agents of the disorder.
- Use of results to assist with identifying management of the disorder: e.g. possible identification of vectors or alternative weed hosts.

Milestones:

- Transmission experiments completed
- Non-specific tests for viruses or phytoplasmas completed
- PCR and/or immunosorbent electron microscopy tests targeted at particular virus groups or phytoplasmas completed

Staff:
Dr John Thomas,
Dept Primary Industries Qld, Brisbane, Qld

Progress:

1) Transmission tests:

Mechanical: No transmission of any infectious agent was obtained when sap extracts from "bunchy top" affected cotton were innoculated onto healthy cotton, and ten other common virus test plant species.

Aphids: Symptoms of cotton "Bunchy Top" were not reproduced when colonies of healthy *Aphis gossypii* and *Myzus persicae* were established on Delta Emerald cotton seedlings. In one experiment, aphids were allowed to colonise the plants for five weeks, killed, and the plants monitored for a further five months. In the second experiment, *A. gossypii* were allowed to continually colonise plants for five months. Attempts to transmit Bunchy Top using *A. gossypii* from affected plants failed due to a high level of aphid parasitism.

Grafting: No transmission of Bunchy Top symptoms were observed when scions from field-affected plants were side cleft grafted to healthy cotton seedlings. In the first experiment, 14 scions were grafted, but scion survival was poor. In a second experiment, 20/27 Bunchy Top scions have survived for at least 8-9 weeks, but no transmission of symptoms has occurred after12-14 weeks. The scions have survived, but not put out new growth.

2) Non-specific assays

Thin section electron microscopy of Bunchy Top cotton tissue did not reveal the presence of any viruses or phytoplasmas. No virus particles were observed in partially purified "miniprep" extracts from Bunchy Top cotton.

3) Specific assays
No positive reactions were obtained when PCR was conducted onBunchy Top cotton, using degenerate primers designed to following pathogen groups; phytoplasmas, closteroviruses, luteoviruses. Similarly, no virus particles were detected by electron microscopy in purified extracts obtained using methods designed for members of the luteovirus, nanovirus, closterovirus groups, or in sap extracts examined by immunosorbent electron micoscopy for geminiviruses.

In summary, no evidence was found for a virus or phytoplasma being the causal agent of cotton Bunchy Top. However, all evidence presented here is negative evidence, and the possibility cannot be excluded that such a pathogen is present, but has so far gone undetected.

BUNCHY TOP SURVEYS

Project Number: 3.1.3 AC

Aims and Milestones:
- To monitor crops for presence of Bunchy Top
- To follow-up reports of crops with Bunchy Top
- To characterise the growth of Bunchy Top cotton
- To undertake preliminary grafting and aphid transmission studies

Staff:
Dr Lewis Wilson,
CSIRO Plant Industry, Narrabri, NSW
Dr Bernie Franzmann,
Dept Primary Industries Qld, Toowoomba, Qld
Mr David Lea, PhD Student,
Dept Primary Industries Qld, Toowoomba, Qld
Ms Simone Heimoana,
CSIRO Plant Industry, Narrabri, NSW
Ms Amanda MacDonald,
CSIRO Plant Industry, Narrabri NSW

Collaborators:
Dr Neil Forrester,
Deltapine, Narrabri, NSW
Dr Philip Wright,
NSW Agriculture, Narrabri, NSW
Dr Stephen Milroy,
CSIRO Plant Industry, Narrabri, NSW
Dr Ali Rezaian,
CSIRO Plant Industry, Adelaide, SA
Dr Greg Constable,
CSIRO Plant Industry, Narrabri, NSW

Progress:
1 Routine surveys of cotton crops growing in fields that had Bunchy Top syndrome affected crops the previous season, showed no signs of Bunchy Top. Poor early growth was explained by herbicide damage or diseases such as black root rot.

2 In February reports of crops affected with Bunchy Top were received from the Namoi and MacIntyre Valley. These were confirmed and the characteristics of Bunchy Top plants were described by measuring plant attributes on ten pairs of plants from each of four fields, ie a Bunchy Top plant next to a healthy plant. This included internode lengths, fruit mapping, dry matter partitioning and will include nutritional analysis. Symptoms are; smaller leaves, shortening of internodes particularly near the top of the plant, smaller fruit and angular light green blotches confined by secondary veins on the margins of some leaves.

3 Overall,Bunchy Top has been reported again this year but at a much lower frequency. Affected fields have been confirmed in the Namoi, Gwydir, Macquarie and McIntyre regions. This season the syndrome has been strongly associated with the presence of high aphid densities, with the worst instances found where there were 'hot-spots' of aphids early in the season.

4 Aphids transmission studies at ACRI indicate positive transmission of Bunchy Top from affected plants to healthy plants, although sample sizes were small (6 plants)

5 Dr Forrester managed a Bunchy Top nursery plantation. Ratoon cotton, affected with Bunchy Top last season showed strong symptoms this season. Aphids from the ratoon cotton were used as a source of infection for adjacent new planting. New plantings showed Bunchy Top symptoms and clear indication of varietal differences in susceptibility.

6 Preliminary experiments in the glasshouse at ACRI using graft transmission tests transmission have just produced results indicating transmission of symptoms described above. The number of plants in these experiments was small and they need to be repeated with a more comprehensive experimental design to confirm transmission.

It now appears likely that Bunchy Top has spread from affected to healthy plants in the current year in the field, with similar observations in the glasshouse. Bunchy Top seems to be a recurring problem with the potential to affect industry significantly in the future. We (Wilson and Rezaian) have proposed the following research to address this problem;

Stage 1.
Confirm that Bunchy Top is transmissible by a comprehensive range of experiments including graft transmission and aphid transmission and field replanting. This would mainly be done at ACRI. If successful we would then proceed to;

Stage 2.
Identify the causal agent and develop a detection protocol, this would mostly be done at Adelaide.

Stage 3.
Characterise the disease epidemiology and mode of field infestations (alternative hosts), this would be done jointly between ACRI and Adelaide.

DEVELOPMENT OF STANDARD ENVIRONMENTAL TESTS FOR HERBICIDES NEEDED IN COTTON PRODUCTION

SUB PROGRAM 3.2: MINIMISING ENVIRONMENTAL IMPACTS
Project Number: 1.1.5

Aims and Milestones:
- To examine the fate and transport of herbicides in cotton growing soils
- To characterise the risk of herbicides used in cotton production and provide information that can help growers select herbicides that will have minimum impact on the environment.

Staff:
Dr Sundaram Baskaran,
The University of Sydney, Sydney, NSW
Dr Francisco Sánchez-Bayo,
The University of Sydney, Sydney, NSW
Prof Ivan Kennedy,
The University of Sydney, Sydney, NSW

Progress:
Risk assessment experiments were conducted for four herbicides in association with three soil types. A range of important physico-chemical properties of the three herbicides (solubility in water and octanol, vapour pressure and bio concentration factor) and three cotton growing soils (pH, organic carbon and clay) were measured. Kinetics studies, equilibrium sorption values and partitioning to organic carbon were then determined for each herbicide. Persistence of the four herbicides in three soil types was measured under laboratory conditions to provide degradation half-life of herbicides under control conditions. A similar study under field conditions is now under way.

These tests provide new data for the development of parameters and risk factors in particular cotton growing environments. A relative risk rating of each herbicide under specific growing conditions can be determined using the newly developed EcoRR scoring method, which provides a tool to enable cotton growers to choose the chemicals of lesser risk to the environment.

ADVANCEMENTS IN QUANTITATIVE IRRIGATION WATER QUALITY – SOIL PROPERTY DECISION SUPPORT GUIDELINES FOR SUSTAINABLE IRRIGATION

Project Number: 1:5:4

Aims:
Further validation of the Sodium SaLF model (produced for the Cotton CRC project "Quantitative irrigation water quality - soil property decision support guidelines for sustainable irrigation") in other cotton areas with poor quality irrigation water.

To provide a software package incorporating salinity prediction with GIS (Geographical Information Systems) as decision support system with regard to sustainable cotton production.

Milestones:
YEAR 1 (1997/98)
- Delineation of key sites for the soil sampling program.
- Development of the GIS salinity package.

YEAR 2 (1998/99)
- Completion of soil sampling.
- Validation and refinement of the model SaLF.
- Completion of GIS package prototype.
- Presentation at field days or meetings with a salinity and deep drainage focus.

YEAR 3 (June 99 – Dec 99)
- Sodium SaLF model final accuracy assessment and refinement.
- Collaboration with regional staff and others on enhancements to the GIS package.
- Preparation of final report.

Staff:
Mr Ian Gordon,
Dept of Natural Resources, Brisbane, Qld
Ms Rachael Zischke DNR,
Dept of Natural Resources, Brisbane, Qld

Progress:
Between 1995 and 1998 annual soil sampling was completed on 13 sites spread from north- western NSW to south-east Queensland, and covering a wide range of cotton growing soils and climate conditions. A total of 624 soil cores were sampled across the sites.

Leaching fraction predictions were calculated using the SSaLF (salt balance- soil property), USSL (mass balance), and SODICS (transient mass balance) models for all fields for all years.

The wide range of cotton growing soils, and climates sampled in this project, as well as sensitivity testing of the three models have assisted in assessing the 'robustness' of the SaLF model.

In parallel, a GIS package has been developed to assist with the broad scale application and presentation of SSaLF. A limiting factor in this process has been the lack of a universal structure to soils databases. The development of the Sali-Fields database for Queensland soils provides a partial solution to this problem although further development is required.

Overall the work highlights the potential problems associated with deep drainage on cotton soils and the need to better quantify this process.

UNDERSTANDING THE SALINITY THREAT IN THE IRRIGATED COTTON GROWING AREAS OF AUSTRALIA – PHASE III – IMPLEMENTATION AND MANAGEMENT

Project Number: 3.2.0 AC

Aims and Milestones:
Apply Mobile Electromagnetic Sensing System (MESS) to determine usefulness in:

- identify factors and management in areas experiencing soil salinity;
- identify potential application of gypsum/lime to ameliorate sodic fields; and
- identify areas of water-use inefficiencies near dams and channels.

Conduct EM34 surveys to describe distribution of EC_a that can be related to:

- areas where shallow or deeper saline water tables are suspected; and
- where excessive deep drainage or ground-water recharge may be occurring.

Coordinate and ensure there is collaboration between the various projects where soil and water research is occurring in the irrigated cotton growing areas.

Staff:
Dr John Triantafilis,
The University of Sydney, Sydney, NSW
Mr Matthew McRae,
The University of Sydney, Narrabri, NSW
Mr Andrew Huckel,
The University of Sydney, Narrabri, NSW
Mr Faruque Ahmed,
The University of Sydney, Sydney, NSW
Ms Esta Kokkoris,
The University of Sydney, Sydney, NSW

Progress:
1) Field scale:

a) A MESS survey was undertaken on Cumberdeen field 4 (lower Namoi valley) to identify causal factors and possible management in area experiencing soil salinity. Preliminary results suggest that the cause of the outbreak is due to a leaking storage dam and the use of slightly saline/sodic water.
b) Similarly, a MESS survey was undertaken on field 10 at Warianna (lower Namoi valley) to identify areas that require gypsum and/or lime to ameliorate sodic soil condition. Preliminary interpretation of the data has confirmed the strongly sodic nature of the field, which is caused by the application of sodic groundwater.

2) Multiple-farm scale

a) An EM34 survey has been completed in the lower Macquarie valley and has identified areas where saline groundwater is apparent and areas where shallow or deeper saline water tables are suspected
b) Funds have successfully been sought to carry out similar surveys in the lower Macintyre and Bourke irrigation area.

3) Collaborative links have been established with Other researchers including: Janelle Montgomery (CRC-University of New England) Dr Inakwu Odeh (CRC-University of Sydney) Dr Stephen Raine (CRDC-University of Southern Queensland).

THE ENVIRONMENTAL IMPACT OF IRRIGATION IN THE GWYDIR VALLEY ON THE MURRAY DARLING BASIN

Cotton CRC Project Number: 1.5.9

Aims:

- To measure water quality upstream, within and downstream of the Gwydir irrigation area.
- To measure the quality of water on-farm.
- To combine water quality data with river flow data to determine inputs of salts and nutrients along the Gwydir Valley watercourses to establish the Gwydir Valley's input to the Murray Darling Basin.
- Demonstrate inexpensive Electromagnetic (EM) methods to assess irrigation inefficiencies at a multi-farm level.
- Demonstrate inexpensive EM methods to identify shallow ground water levels at a multi-farm level.
- To assess the provision, by on-farm storages in the Lower Gwydir Valley, of resources that support wetland bird species, feeding, breeding, growth and migratory habits.
- To collate and interpret information for irrigators on options for management of on-farm storages in relation to wetland bird species.

Milestones:
Year 1:

- Set up water sampling sites on watercourses and on-farm that will be linked to soil salinity and birdlife studies,
- Collection of water samples and analysis for salts and nutrients,
- Conduct survey of bird numbers, species and identify key breeding sites.

Year 2:

- Continue monitoring of water quality throughout the Gwydir valley. Based on results from Year 1, identify areas of poor water quality and select sites for soil salinity surveys. Conduct soils salinity surveys.

Year 3:

- Further monitoring of water quality. Collate results from water quality, soil salinity and birdlife studies. Examine the contribution of irrigation to any environmental problems that are identified. Recommend strategies to reduce any adverse effects of irrigation.

Staff:
Mrs Janelle Montgomery,
The University of New England, Moree, NSW
A/Prof Richard Faulkner,
The University of New England, Armidale, NSW
Dr John Triantafilis,
The University of Sydney, Sydney, NSW
Prof Peter Jarman,
The University of New England, Armidale, NSW

Progress:
Water sampling commenced in October 1998 and will continue to April 2001. Over 700 samples were collected in the first year and tested for pH, EC, dissolved oxygen, turbidity, dissolved solids, suspended solids, chloride, sodicity, a range of cations, total nitrogen and total phosphorus. Preliminary investigation suggests the water quality is of a medium salinity level, low sodicity, but high turbidity throughout the Lower Gwydir Valley.
A broadscale EM 34 survey was completed north of Moree covering an area of approximately 10 x 20km. The EM34 will be used to characterise the shallow stratigraphy and map the spatial distribution of shallow water tables in the area surveyed, in order to evaluate the extent and risk of salinity in the area. Preliminary results of the EM 34 survey have identified soil texture differences and areas where potential irrigation inefficiencies may occur.
An initial bird survey was conducted on the on-farm storages in February 1999. Over 50 different species of water birds were recorded after 2 days of surveying 15 different storages. Since September 1999 bird surveys have been conducted at 2 to 3 week intervals and will continue until April 2001. Environmental variables such as vegetation, water quality and water depths are measured and breeding events recorded. The great majority of waterbirds likely to occur in the Lower Gwydir Valley have been recorded on storages, but there are notable absences. Each storage tends to support a characteristic set of species. This confirms that species respond to attributes of a storage and possible to the presence of other species. Breeding events can be supported by storages, however, water drawdown will terminate the event. The results suggest that storages could be designed and managed to optimise the value as waterbird habitat and still allow irrigation usage.

QUANTITATIVE INVENTORY OF THE IRRIGATED-COTTON SOIL FOR SUSTAINABLE LAND RESOURCE MANAGEMENT

Project Number: 1.2.1

Aims:
- Develop an efficient and repeatable sampling scheme for field survey and for future environmental impact assessment of irrigated-cotton soil
- Obtain a quantitative statement of the current status of cotton soil
- Develop spatial prediction models for relevant soil variables
- Build a soil database for the region, incorporated into a Geographical Information System (GIS)
- Identify the key environmental problem areas in the irrigated-cotton-growing region of eastern Australia.

Milestones for 1999/2000:
- To complete fieldwork in the Upper Namoi, St George and Bourke areas and complete laboratory measurements of samples obtained for the same areas.
- Build soil database for the same areas
- Develop improved spatial prediction for modelling soil attributes and soil types
- Prepare digital soil information maps.

Staff:
Dr Inakwu Odeh,
The University of Sydney, Sydney, NSW
Prof Alex McBratney,
The University of Sydney, Sydney, NSW

PhD Students:
Ms Alison Todd,
The University of Sydney, Sydney, NSW
Ms Marian Dunbar,
The University of Sydney, Sydney, NSW

Masters Student:
Mr Faruque Ahmed,
The University of Sydney, Sydney, NSW

Honours Student:
Thomas Gregan,
The University of Sydney, Sydney, NSW

Progress:
Our focus for the year 1999/2000 was to continue building a quantitative inventory of soil characteristics and extend the work completed for the Lower Macintyre, Gwydir and Namoi valleys to the Upper Namoi, St George and Bourke irrigation areas. From our Laboratory analyses of soil samples we are able to develop maps of soil and its attributes, incorporated with digitised cadastral features for each area. These will be loaded into the ArcView GIS package for easy distribution and dissemination.

Large resolution Landsat imagery is being used to improve our predictive models. This approach is proving better than previous models based on the NOAA-AVHRR data. Using our models we can then highlight potential soil problems areas in soil quality indicator maps linked with the GIS.

DEVELOPMENT OF PEDOTRANSFER FUNCTIONS TO PREDICT HYDRAULIC PROPERTIES OF COTTON GROWING SOIL IN EASTERN AUSTRALIA

Project Number: 1.2.4

Aims:

- Establish water retention, conductivity and shrinkage relationships for cotton growing soils in four geographical regions, and use this as a prediction data set.
- Develop pedotransfer functions to predict these hydraulic relationships from more basic soil properties.
- Verify the developed functions against data from an *in situ* drainage experiment and literature data (the verification data set) using a simple numerical model.

Milestones:

- July 1999: Sampling of first half of 20 sites completed, physical and chemical analyses in the laboratory commenced.
- December 1999: Structure analysis commenced, physical and chemical analyses ongoing
- July 2000: Sampling of all sites completed. Physical and chemical analyses on first half of sites completed. Structure analyses on half of sites completed. Analysis of data commenced. *In-situ* drainage experiment completed.
- December 2000: Physical, chemical and structure analysis completed. Analysis of data completed, leading to the development of pedotransfer functions

Staff:
Dr Stephen Cattle,
The University of Sydney, Sydney, NSW
Dr R. W. Vervoort,
The University of Sydney, Sydney, NSW

Progress:
Significant progress has been made in developing pedotransfer functions to predict hydraulic properties of a range of cotton growing soils. All 14 sites has been sampled with all field data now analysed and stored in a database. Our analysis indicates that the average hydraulic conductivity (K_s) increases when moving from the Macquarie, through the Namoi to the Gwydir valley (Table 1).

Further laboratory analysis for some attributes (eg. soil water characateristics) are continuing. Although in-depth analysis is not yet complete some interesting relationships are immediately apparent. Excluding subsoil samples, K_s is strongly correlated to the effective CEC and the exchangeable K content of the soil. Including subsoil samples, K_s is correlated to the exchangeable Ca and K in the soil. As expected, exchangeable Na and effective CEC have an effect on the shrink-swell capacity of the soil. Total Carbon did not appear to have a direct influence on soil physical properties, however there was an indication that its effect might be complex and not easily determined.

The interpretation of soil structure using the Solicon program showed a clear relationship between soil porosity, measured on large intact columns using image analysis, and K_s for two Cotton CRC farming system sites (Warren and Merah North (Fig 1)).

A similar relationship was found relating shear strength to soil porosity. An *in-situ* drainage experiment was performed next to one of the fields at ACRI. The results indicated drainage of about 10-15 mm water per irrigation event beyond 1.5 m depth. The conductivities calculated from the *in-situ* drainage experiment matched well with the conductivities calculated using the disc permeameter (Fig 2). The data from this and a second similar experiment will be used to verify the developed pedotransfer-functions.

Valley	Sites	K_s (cm/hr)	Sand %	Silt %	Clay %	ECEC Cmol/kg
Namoi	7	14.0ab	15.5a	23.7a	61.2a	33.1a
Gwydir	3	50.3a	12.7a	26.1ab	61.2a	36.6b
Macquarie	4	8.1b	20.1b	28.9b	50.5b	26.0c

Table 1. Some averages for the three sampled valleys

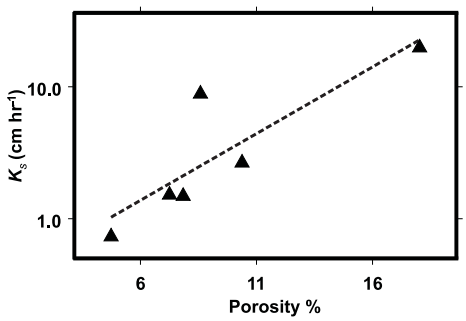
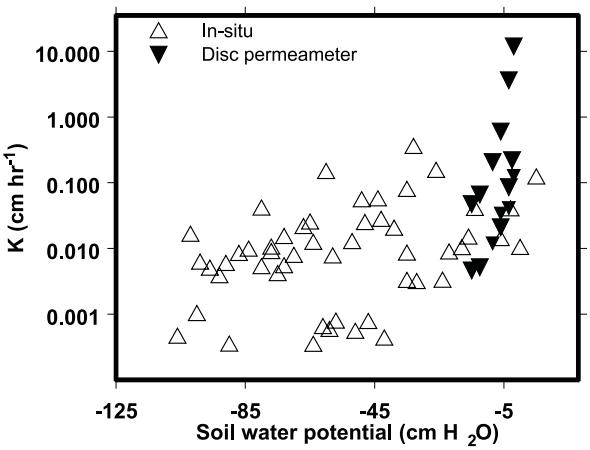


Figure 1. Ks as a function of porosity measured by image analysis

Figure 2. Conductivities calculated using two different methods



IDENTIFYING THE KEY GROUPS OF SOIL FAUNA IN COTTON AGROECOSYSTEMS

Project Number: 2.2.15

Aims:

- Quantify and compare the population densities of beneficial soil faunal groups in commercial irrigated cotton fields that are managed using conventional and Envirofeast® technologies, during two continuous growing seasons.
- Determine the feeding links of key soil dwelling predator species on selected key insect pests of cotton using direct observational approaches (field, glasshouse or laboratory studies) and complementary qualitative techniques (screening of predator gut contents using ELISA).
- Develop a research sampling protocol for estimating the densities of key soil faunal groups in commercial irrigated cotton.

Milestones for 1999-00:

- Determine the mortality of *Helicoverpa armigera* eggs on early season cotton due to predation.
- Continue gut assay experiments to calibrate and validate the ELISA technology for different potential predators found in Australian cotton

Staff:
Dr James Lytton-Hitchins,
CSIRO Entomology, Narrabri, NSW

Progress:

Our research to identify key groups of beneficial soil fauna has two components; direct observation of predator activities and analysis of gut contents using Elisa techniques.

Ants are easily the most abundant predator group found on squaring cotton plants during December. *Pheidole* sp. was 5–25 times greater than any other ant species. Ants were the only predators observed attacking *Helicoverpa* eggs during 51 person hours of direct observation, with *Pheidole* spp. taking 97% of all eggs removed by ants during December 1999. *Pheidole* were present on plants during at least 75–80% of the total observation hours, whilst other species, *I. vicinus* and *R. metallica* climbed plants less than 30% of the time. Each ant species spent the largest proportion of their time in the plant canopy on leaves and regularly visited the extra–floral nectaries (figure 1). *Paratrechina, I. vicinus* and *Pheidole* were all seen tending aphids on the undersides of leaves on at least one occasion.

We completed a series of experiments to calibrate and validate the ELISA technology for gut content analysis different potential predators found in Australian cotton. We use a monoclonal antibody for *H.armigera* as the basis for ELISA studies. Initial results provided no evidence of cross reactivity between the *H. armigera* MAb and the complex of predators found in cotton fields throughout NSW. Considerable refinements to the methodology were clearly needed. So we completed a detailed experiment to investigate the prey detectability of *H. armigera* eggs in the guts of 3 lady beetles and the Red and Blue beetle. Striped and 3–banded ladybirds consumed eggs more readily than the Transverse ladybird and the Red and Blue Beetle. Data for egg detectability was again highly variable. Further labwork will be required to successfully calibrate and validate the *H. armigera* Mab used in the Lepton® kit for the purpose of predator gut assays.

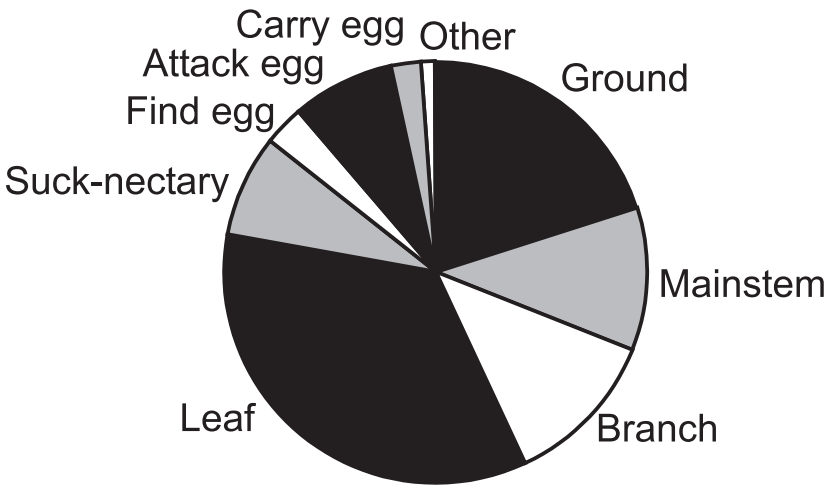


***Figure 1**: Example of the foraging behaviour of* Pheidole *ants as recorded by the Observer ®. Time spent finding, attacking and carrying Helicoverpa eggs is also shown.*

COTTON TEXTILE RESEARCH

PROGRAM FIVE OVERVIEW

INTRODUCTION

Competition in the global textile market is fierce with profit margins in commodity yarn and fabric markets being continually eroded. In these markets, cotton is being replaced by synthetics on the basis of price, perceived quality and diversity of end-uses. The challenge of keeping cotton's market share is being met by manufacturers who look to (i) reduce costs and increase quality and (ii) establish niche markets that trade on cotton's (natural) intrinsic benefits. Opportunities exist for both Australian cotton growers and cotton manufacturers to improve the value of their product through R&D and product development. Successful R&D outcomes include maintaining Australian cotton's position in premium fibre markets and increasing the value (and diversity) of locally processed cotton textiles.

Research and development in the area of cotton processing is needed to meet these opportunities. CSIRO Textile and Fibre Technology (TFT) has initiated the establishment of the Cotton Textile Research Unit (CTRU) based at Geelong to be part of the CRC and to directly address the needs of Australian cotton processing. The CTRU is re-focussing considerable skills already present in TFT. The CRC will also be playing a role in co-ordinating CRDC-funded activities in the processing area.

AIMS AND OBJECTIVES

- To develop dyeing and bleaching technologies to support new products in 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 grower.
- To enhance the ability of cotton fibres to compete - in relation to costs and product versatility - against synthetic fibres.

HIGHLIGHTS AND ACHIEVEMENTS AGAINST MILESTONES

- An improved process has been developed for the bleaching of cotton/wool, giving improved whiteness and seed coat removal. Successful pilot scale trials involving a commercial knitted fabric have been carried out at CSIRO TFT using a jet machine. A process for woven fabrics using a jig machine has also been developed.
- Initial discussions have been carried out with various cotton/wool processors, and also dye manufacturers. Laboratory protocols have been established to reproduce pad-batch dyeing procedures used in industry. A preliminary industrial trial has been carried out with a major textile manufacturer.

Peter Cookson

LINKAGES

Linkages have been formed with cotton processors such as Rocklea, Bonds and Sheridan, and chemical companies such as Ciba and Clariant.

A close association has been formed with the National Centre for Engineering in Agriculture (NCEA). A research framework, based on the field-to-fabric pipeline, has been developed. Research, which is to be funded by CRDC in early-stage cotton processing, will be coordinated through the CRC. Outcomes will be enhanced through joint initiatives between CSIRO TFT and NCEA.

INNOVATIVE BLEACHING TECHNOLOGY FOR COTTON AND COTTON BLENDS

Project Number: 5.1.0 AC

Aims and Milestones:
To develop new technologies for bleaching of cotton and cotton blends that are environmentally and economically favourable. The new technology will retain the natural strength of Australian cotton and further enhance the perceptiveness and attractiveness of Australian cotton products. In Year 99/00, the project was to develop innovative batchwise bleaching processes for cotton/wool blends, which provide significantly improved bleaching effectiveness with minimal fibre damage. The milestones to be achieved in Year 99/00 included:

- Establishment of a suitable bleaching system and conditions for cotton/wool blends, which enables effective bleaching of both cotton and wool components at relatively mild conditions with minimal wool damage and improved removal of the cotton seed-coat fragments.
- Further optimisation of the bleaching methods for an improved bleaching efficiency and industrial viability.
- Laboratory work on cotton/wool blends assessed at pilot plant scale or/and industrial trial.

Staff:
Dr Jackie Cai,
CSIRO Textile and Fibre Technology, Geelong, Vic
Mrs Jill McDonnell,
CSIRO Textile and Fibre Technology, Geelong, Vic
Dr Shaun Smith,
CSIRO Textile and Fibre Technology, Geelong, Vic
Dr Peter Cookson,
CSIRO Textile and Fibre Technology, Geelong, Vic

Progress:
The activated peroxide bleaching systems and conditions were successfully established for bleaching cotton/wool blends. The activators used, namely NOBS (sodium nonanoyloxybenzene sulphonate) and TAED (tetra acetyl ethylene diamine), are able to react with peroxide to generate new bleaching species that are stronger than peroxide at low temperatures. A sequential two-bath bleaching process (i.e. oxidative followed by reductive bleaching) was also investigated.

The bleaching efficiency and industrial viability of the processes have been further improved by utilising special auxiliaries, optimised conditions and the development of a new activator formulation. This formulation showed excellent solubility in cold water and an equivalent bleaching effect compared to the commercial TAED products. (The low water solubility of TAED used to be a problem encountered, particularly in low liquor bleaching conditions). The comprehensive evaluations/ assessments on the developed processes have proved that the new technologies developed are technically superior to the bleaching processes commonly used by Australian industry. Satisfactory bleaching results with overall improved substrate whiteness, cotton seed-coat removal and reduced fibre damage can be achieved at 60°C.

Cotton/wool greige products from Bonds, Sheridan and Bruck Textiles were bleached with the newly developed processes. Positive feedbacks were obtained from these potential industrial partners. In February 2000, pilot scale trials were carried out at CSIRO TFT, and cotton/wool knitted greige fabrics from Brush Textiles were successfully bleached using a jet dyeing machine. A new bleaching process for woven fabrics using a jig machine was also developed based on industrial partner's needs. Further fine-tuning and proving trials with an industrial partner are in progress.

CONTINUOUS DYEING OF COTTON/WOOL BLENDS

Project Number: 5.2.0 AC

Aim: To develop continuous and semi-continuous procedures for the dyeing of cotton/wool blend fabrics.

Milestones:
- Literature and technical survey
- Industry discussions to establish requirements
- Establish laboratory procedures
- Develop laboratory methods for carrying out dyeing of Colana fabrics by these routes
- Scale up laboratory work in industry
- Prepare technical information bulletin

Staff:
Dr David King,
CSIRO Textile and Fibre Technology, Geelong, Vic
Mr Roger Elms,
CSIRO Textile and Fibre Technology, Geelong, Vic
Ms Geni Kozdra,
CSIRO Textile and Fibre Technology, Geelong, Vic
Dr Peter Cookson,
CSIRO Textile and Fibre Technology, Geelong, Vic

Progress:
A literature survey has been completed. Most of the technical literature refers to pad-batch dyeing of 100% cotton, there is a small amount of information on dyeing wool by this method and only one previous work on cotton/wool

Initial discussions have been held with various processors of Colana as well as dye manufacturers. Although the current technologies for dyeing Colana fabrics are suitable for a range of shades and end-uses, there are some restrictions i.e. reproducibility for different lot sizes and poor light stability in certain shades. There is a great deal of interest in having an alternative route to dyeing which overcomes some or all of these defects. Colana users are mostly interested in cold-pad batch methods rather than fully continuous methods because of the smaller volumes of fabrics expected.

Laboratory protocols have been established to reproduce the pad-batch dyeing conditions in industry.

Laboratory methods have been developed for obtaining dyed fabric with satisfactory fastness. There are a number of approaches; one step dyeing using cotton dyes only, one step dyeing using mixtures of wool and cotton dyes and a two stage process where the fibres are dyed separately.

Some initial trials have been carried out with a navy shade on 40kg lots using the facilities of a Melbourne textile manufacturer and in cooperation with a major dye manufacturer. The dyeings were found to have good solid shades and very good appearance, a problem with fastness to rubbing will be looked at in the laboratory before further trials.

EDUCATION AND TRAINING

INTRODUCTION

"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 for land and crop management are being developed every year. To keep pace with this change, effective educational and training programs need to be in place. To achieve this the Cotton CRC, in 1994, established a certificate and post graduate certificate course in cotton production. The course has gained wide spread recognition across the industry for training of advisory staff and consultants. The next stage in formal training is to lift the skills base of cotton growers themselves. A number of grower focused short courses will be designed over the next five years. The first of these courses to be developed will focus on Integrated Pest Management (IPM) and its implementation.

A summer scholarship program provides the opportunity for undergraduate students studying relevant disciplines to work with researchers and extension staff of the Cotton CRC. 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 and students.
- 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 AGAINST MILESTONES

Education
The number of new enrolments and graduates for both the postgraduate and certificate course continues to grow. The course is endorsed by the Cotton Consultants Association of Australia as an essential training program for new consultants entering the industry. The course also provides a key component of the training of new extension staff

Dallas Gibb

with in the Cotton CRC. The majority of industry extension staff have completed or are enrolled in the course.

The course provided through the University of New England has proven to be popular with undergraduate students at the University. These students complete the 'Cotton Production' module of the course. It is encouraging to find that most of the graduates are employed within the industry upon completion of their degree and a majority go onto complete the postgraduate course.

During the first half of 2000 a review of the course was conducted. Outcomes of the review will see the plant protection component of the course being extensively revised to come into line with new advances in integrated pest management and transgenic crop management.

Investigations are being undertaken to provide the undergraduate course to Sydney and Queensland (Gatton) Universities.

The development of the grower focused "IPM" short course received a significant boost with an experienced IPM consultant taking on the position of "Training Co-ordinator". The course is on track to be fully operational by the 2001/02 cotton season. This course will be incorporated into the industries "Best Management Practice" program.

SCHOLARSHIPS

Post graduate Scholarships
We have several PhD students completing their thesis from the previous Cotton CRC with many due to submit late 2000, early 2001. The quality of our PhD students was a feature of the previous Cotton CRC and we will be carrying this work on by committing to train 12 PhD students over the life of the Centre. The exceptional training received by the students is achieved by ensuring they are part of the research team and closely linked to the industry.

Undergraduate Scholarships
We plan to offer two undergraduate scholarships to exceptional students studying agriculture at each of our participating Universities – UNE and USYD over the next four years. The Cotton CRC feels it is very important for not only the cotton industry but for

agriculture, agricultural research and regional Australia to attract high quality students to study agricultural science. One way of attracting students and in the long term improving the industry's skill base is to offer scholarships at an undergraduate level.

Our first undergraduate student Katrina Watson commenced her Agricultural Science degree at USYD in March 2000.

SUMMER SCHOLARSHIPS

The summer scholarship program proved highly successful during the 1999/2000 cotton season. The students covered a diverse range of subjects including parasitoid ecology and the agronomic factors effecting crop earliness. One student worked within the newly established Cotton Textile Research Program of the Cotton CRC. The scholarship examined the use of UV irradiation to enhance the bleaching and dying capabilities of cotton/wool fabrics.

SCIENTIFIC EXCHANGE PROGRAM

To enhance the exchange of ideas, the gathering of innovative technology or practices and overseas collaboration, the Cotton CRC sponsored five overseas trips/visits during 1999/2000. Some of the key benefits gained from the exchange program included:-

- enhanced development of computerised decision support systems;
- understanding crop "earliness" and agronomic factors which influence crop maturity;
- recognition of the value of maintaining a focused extension service with the opportunity to specialise in key aspects of production;
- improved knowledge of cottons responses to heat and water stress, which will help identify the most suitable cultivars for different cropping situations.

Cotton CRC PhD Students

Student	Degree	Commencement Date	Research Project Title/Thesis	University	Supervisors	Org	Funding	Current Status
Becerra Lopez-Lavalle, Augusto	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.
Boydell, Broughton	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	Due to submit March 2001.
Cook, Allison	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	Continuing research, due to submit end of 2001.
Dorahy, Chris	PhD	7 September 1997	Phosphorus nutrition of cotton - *Project 5.3.1*	UNE	Mr Ian Rochester A/Prof Graeme Blair	CSIRO UNE	Cotton CRC	Due to submit March 2001.
Montgomery, Janelle	PhD	21 August 1995	Water Application and Hydrology	UNE	A/Prof Don MacLeod Dr Richard Faulkner	UNE UNE	Cotton CRC	Due to submit end 2001 - currently undertaking a project for the Cotton CRC.
Field, Damien	PhD	1 March 1994	The form, clay mineral characteristics and cementing agents of microaggregates in relation to behavior of cracking clays under cotton production	USYD	A/Prof Tony Koppi	USYD	Cotton CRC	Submited late 2000.
Khan, Moazzem	PhD	14 March 1994	Ecology and management of mirids	UNE	A/Prof Peter Gregg Dr Robert Mensah	UNE NSWA	Cotton CRC	Awarded 2000 - currently employed as an entomologist by DPIQ.
Kvedaras, Olivia	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	Due to submit December 2000.
Rungis, Dainis	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	Due to submit March 2001.
Stiller, Warwick	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.
Ahmed, Mohammed Faruque	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	Due to submit March 2001
Crossan, Angus	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	
Dunbar, Marian	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 2001
Huckle, Andrew	Masters of Science in Agriculture	March 1998	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	USYD USYD	Cotton CRC	Due to submit March 2001.
Kokkoris, Esta	Masters of Science in Agriculture	March 1999	Understand and manage causes of salinity in irrigated farming systems in the lower Macquarie valley - *Project 3.2.5 AC*	USYD	Dr John Triantifilis	USYD	Cotton CRC	Due to submit March 2002
Todd, Alison	PhD	March 1995	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	Faculty Scholarship	Candidature suspended due to recommence 2001
Xiao, Chun	PhD	July 1997	Attractants for adult *Helicoverpa* species - *Project 2.2.14*	SIE	A/Prof. Peter Gregg Prof. Du Jia-wei	UNE SIE	Cotton CRC	Awarded 1999 - currently Director of Wetlands laboratory.
Bedrossian, Sevag	PhD	January 2000	Potassium Status and Mineralogy of Soil in relation to premature senescence	USYD	Dr Balwant Singh	USYD	CRDC	Due to complete in 2003
Davies, Andrew	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	
Britton, Dave	PhD	1 August 1999	Studies of slow release formulations for semiochemicals in cotton pest management	UNE	A/Prof Peter Gregg	UNE	CRDC	
Stewart, Craig	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	
Angelucci, Constanza	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 end 2001
Wade, Mark	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	
Lea, David	PhD	1 March 1999	Risk factors for silverleaf whitefly outbreaks in cotton	USQ	Prof Myron Zalucki	UQ	CRDC	
Johnson, Stephen	PhD	1 July 1996	Ecology and management of the 'take-all' weed, Polymeria longifolia (Peak Downs Curse)	UNE	Dr Brian Sindel	UNE	CRDC	Submitted March 2000
Cottage, Emma Louise	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

LINKAGES

Linkages between organisations within and outside the Cotton CRC have increased over the past year. In respect to the education program, links are being established with other Universities (Sydney and Queensland Universities) and in the development of the IPM short course. Yanco Agricultural College has become involved in ensuring the course reaches state VETAB approval. Links within QDPI and NSWA will see all extension staff become accredited training providers by 2001.

POST GRADUATE CERTIFICATE AND CERTIFICATE IN RURAL SCIENCE (COTTON PRODUCTION)

Project Number: 4.3.1/4.3.2

AIMS AND MILESTONES:

To continue to design, review and run the only specialised university training course in Australia for cotton consultants, advisors and farmers.

The milestones are to run the course (3 units) each year and have about 25 people graduate from the course.

STAFF:

Mr Guy Roth,
The University of New England, Armidale NSW
A/Prof Robin Jessop,
The University of New England, Armidale NSW

PROGRESS AGAINST AGREED MILESTONES:

On 6th April 2000, 30 people graduated from the Course. This is the highest number of graduates since the inception of the course and represents one third of the ninety people who have now completed the course (Table 1).

Table 1 Cotton Course Graduates

Year	1996	1997	1998	1999	2000	**Total**
Postgraduate	12	10	11	14	19	**65**
Certificate	1	4	3	6	11	**25**
Total	**13**	**14**	**13**	**20**	**30**	**90**

This years Post Graduate 500 level graduates were; Michael Boyce, Cameron Clarke, Stuart Doyle, Andrew Dougall, Ken Flower, Catherine Hare, James Hill, Leisa Holden, Matthew Holding, Adam Kay, Shane Kable, David McClure, Amanda Mills, Samantha Millar, James Quinn, Greg Salmond, Peta Slack Smith, Rachael Webb and Hugo Weissen.

This years Certificate 300 level graduates were: Murray Boshammer, Jeremy Dawson, Tim Grellman, Kirsty Hawke, Patrick Jones, Toby Makim, Tony McCumstie, Greg McNamara, Jodie Pedrana, David Ryan, Annabelle Twine, Emma Twine.

Student Enrolments

Historically, it was planned to limit class sizes to 25. However, due to strong demand class sizes have been increased and capped at about 35 people. This has been a trade off between small groups while trying to deal with the strong demand. This year we received about 60 applications, which means about 25 people will be on a waiting list until 2001 and will receive first priority. Certificate level numbers seem to be increasing and for the last two years there has been a 50% split between Postgraduate and Certificate applications (Table 2).

Year	1994	1995	1996	1997	1998	1999	2000
Postgraduate	19	13	14	16	24	17	31
Certificate	8	4	6	12	8	17	30
Total	**27**	**17**	**20**	**28**	**32**	**34**	**61**

Table 2: Cotton Course Student Applications

These strong numbers are the result of the tremendous teamwork of Cotton CRC researchers and staff who contribute to the lectures and course organisation.

The Applied Cotton Production unit (COTT 300) is offered to internal students at The University of New England as an elective unit for Rural Science and Agricultural Economics students. The number of students completing this unit has steadily increased to about 20 students. This year we enrolled our first undergraduate student from another university, University of Western Sydney.

During 99/00 the notes for all units have been reviewed and updated.

Cotton Production Course students studying a soil profile.

SCIENTIFIC EXCHANGE: MR ALEX THOMAS (CSIRO PLANT INDUSTRY)

Project Number: 4.9.1 T16

Aims:

- acquire technical development skills,
- validate the development method being used for the mobile version of 'CottonLOGIC', and
- identify agricultural opportunities.

Summary:

Attendance at Puma Technology's Worldwide Developer's Conference and 3Com's 2nd Worldwide Developers Conference, both in the USA was most useful for our development of support tools for the cotton industry. Of wide significance, in both the short and long term, was the unprecedented growth in handheld devices - of which most run the 3Com Palm computing platform. With compelling statistics on higher adoption rates than TV's, VCR's, PC's, pagers or mobile phones, the message being delivered for the Palm computing platform was that these simple, easy-to-use computing devices would bring useful computing within the reach of far more people than will ever have a desktop PC.

At the Puma conference it was announced that applications developed using version 3.0 of their Satellite Forms development environment (specifically CottonLOGIC) would henceforth require run-time licences. This was an unanticipated announcement, with negative medium to long-term intellectual property implications relating to the use of Satellite Forms as the development tool for CottonLOGIC on the Palm computing platform. The most workable solution is to continue to use Satellite Forms to rapidly develop the application, but to replicate it in the 'C' programming language for distribution.

SCIENTIFIC EXCHANGE: DR MICHAEL BANGE AND MR GRANT ROBERTS (CSIRO PLANT INDUSTRY)

Project Number:4.9.1 T 18 and T 20

Aims:

- Explore the application and development of cotton simulation models and computerised decision support systems.
- To investigate the effects of extreme environmental stresses on cotton physiology with the aim for further model development.
- To examine agronomic and farming systems research relevant to the Australian cotton industry.
- To examine the strategies being adopted with the transgenic herbicide tolerant cotton varieties being made available and the associated research being conducted in weeds research.

Summary:

We visited three distinct cotton areas, they were in California, Texas and the delta region of Mississippi and Arkansas and were given insights into the present social, economic, agronomic and environmental limitations to production in the United States. In many cases we were also shown how cotton, often only formed one part of a diversified farming system and were shown the challenges that this presented.

SCIENTIFIC EXCHANGE: MR GREG SALMOND & MR DAVE KELLY(DEPT PRIMARY INDUSTRIES QLD), MR MARK HICKMAN & MR JAMES QUINN (NSW AGRICULTURE)

Project Number: 4.9.1.T19

Aims:

The purpose of the tour was to study and experience the methods and practices employed by US extension personnel, crop consultants and cotton growers that manage or minimise cotton diseases and weeds within and between districts and regions.

Other issues investigated during the study tour included:

- ultra narrow row cotton production systems;
- technological advances and management of transgenic cottons;
- integrated pest management systems;
- application of Best Management Practice systems.

These are all major issues currently facing the Australian cotton industry. Each member of the tour party had a particular area of interest in the cotton production system.

Staff:

Four senior members of the Australian Cotton CRC - National Cotton Extension Team, undertook the study tour:

Greg Salmond,
Dept Primary Industries Qld, Dalby Qld
Mr Dave Kelly,
Dept Primary Industries Qld, Emerald, Qld
Mr Mark Hickman,
NSW Agriculture, Gunnedah, NSW
Mr James Quinn,
NSW Agriculture, Moree, NSW

Tour Date: 5/7/99 to 26/7/99
Regions visited:

1. California - San Joaquin Valley;
2. Mississippi and Tennessee;
3. Southern Texas.

Conclusions

In comparison to the US Extension System, I suggest the Australian cotton industry is well served and supported by its industry approach (eg CCA, ACGRA and Cotton Australia) and the Cotton CRC. This system represents a united industry approach not evident to us in the USA cotton industry.

We can learn from the experiences from the USA, in particular from the laws and environmental issues facing the Californian farming community. The implementation of BMP in the Australian cotton industry is critical before laws are forced upon our industry.

Our US Extension Counterparts are highly trained and educated. Their technical competence is without question. The Australian situation through the formation of the Australian Cotton CRC National Cotton Extension Team enables our focus to be targeted at national issues, thus allowing specialists ie cotton consultants to concentrate on in-field crop agronomy and insect management.

Recommendations

1. That the Cotton CRC, continue to support and encourage members of the National Cotton Extension Team to undertake the UNE Cotton Production Course, and/or pursue further study to increase their technical knowledge base. This would prepare team members for future leadership roles in the organisation and the Australian cotton industry generally.
2. Those opportunities to source private funds be investigated to fund and improve preparation and delivery of technical materials and extension programs.
3. Members of the '99 Study Tour Party present reports to their peers at the next National Cotton Extension Team Workshop. The benefits gained from the study tour will enhance the knowledge base of the whole team only if shared professionally with the other Team members.

SCIENTIFIC EXCHANGE: DR TOM LEI (CSIRO PLANT INDUSTRY)

Project Number: 4.9.1 (T21)

Aims:

- To bring Dr Mitsutoshi Kitao to ACRI to participate in fundamental research on cotton physiology related to high temperature, low soil moisture and their effect on water use efficiency (WUE).
- Specifically, we investigated the physiological link between leaf cooling through transpiration, carbon assimilation and WUE in a range of Australian cotton cultivars.
- We found significant cultivar differences in WUE and tolerance to water stress but high WUE may be gained at the expense of a lower photosynthetic capacity.
- This research will contribute to understanding the underlying mechanisms of cotton response to high temperature and water stress and could help in determining the most suitable cultivar under different cropping situations.

Staff:
Dr Tom Lei,
CSIRO Plant Industry, Narrabri, NSW
Dr Mitsutoshi Kitao,
Forestry and Forest Products Research Institute, Sapporo, Japan

Summary:
This study was conducted at ACRI Narrabri using cotton plants grown under field and glasshouse conditions. Seeds of eight cotton cultivars representing different leaf types and heat tolerances were sown in early November and grown under irrigated and water limited conditions until late January when physiological measurements were taken. We were interested in how different cultivars deal with long-term and short-term water stress in terms of photosynthesis and transpiration, especially when measured under relatively high temperature. If a cultivar transpires more than others, it is more likely to demand more frequent irrigations and could possibly be more sensitive to drought. But if a cultivar transpires too little, this may conserve water but it will lose the effect of leaf cooling and impair photosynthesis indirectly. Therefore, an ideal cultivar would be one who can maintain high photosynthesis with the lowest possible transpiration under both irrigated and water limited situations. Does such a cultivar exist?

Well, we found Line 94215-442 to have the highest WUE among four intensively studied cultivars (the others were Sicala V2, Siokra V16 and CIM-448) under both irrigated and dryland conditions. But this cultivar does not have the highest photosynthetic rate in either the irrigated (Sicala V2 highest) or the dryland (Siokra V16 highest) situation. These results suggest that high physiological WUE may be compromised by a slightly lower carbon assimilation capacity, which may lead to a lower yield. Preliminary analyses of the data also show it is possible for cotton to keep high rates of photosynthesis without excessive transpiration to cool the leaf surface. This aspect of physiological heat tolerance in cotton is being further explored.

SUMMER SCHOLARSHIP: AUGMENTING PARASITOIDS OF HELICOVERPA SPP.: DOES NECTAR FEEDING INCREASE PARASITOID ABUNDANCE AND PARASITISM RATES?

Project Number: 4.9.3

Aims and Milestones:
The aims of the proposed research were to determine:

- if parasitoids feed on floral and extra-floral nectar,
- if feeding increases adult parasitoid fecundity (egg laying) and longevity (life-span), and
- if an increase in parasitoid fecundity and longevity results in more attacks on *Helicoverpa* spp.

Staff:
Project Supervisor:
Dr Nancy Schellhorn,
CSIRO Entomology, Narrabri, NSW
Scholarship Recipient:
Mr Andrew Manners,
The University of Queensland, Brisbane, Qld

Progress:
The availability of some types of floral and extrafloral nectar can increase egg laying (fecundity) and life-span (longevity) of several species of parasitoids, and increase the attack rate on hosts. However, floral and extrafloral nectar varies is quality and quantity. We conducted a glasshouse

experiment to compare longevity, life-time fecundity and parasitism rates among wasps (the pupal parasitoid, *Ichneumon promissorius*) that had access to feed on a honey solution, cotton extrafloral nectaries, lucerne flowers or water. Our choice of floral and extra-floral nectar was based on preliminary findings where we determined that *P. promisorus* does feed on floral and extra-floral nectar and that wasps spent the most time searching on cotton and lucerne plants. Our expectation was that honey should provide the greatest longevity, life-time fecundity and parasitism rate, water should provide the lowest, and the lucerne and cotton should be in between. Our results show that in general wasps that fed on the honey solution or cotton extra-floral nectar live longer, and parasitise more *H. armigera* than wasps that only had access to water or lucerne floral nectar. Although, wasps were observed to spend similar amounts of time searching on lucerne and cotton, wasps feeding on lucerne floral nectar had parasitism rates similar to wasps that did not have access to nectar. The consequences are that nectar sources vary in quality and wasps that have access to higher quality nectar may live longer and kill more pests. This finding has implications for how we design on-farm landscapes in cotton IPM systems because the crops chosen as refuge crops used to build-up parasitoid populations (and predators) in the spring and early summer should provide hosts and a high quality food source. These findings suggest that although lucerne may be a good habitat for predators, other early season crops may be better for parasitoids. On-farm crop diversity will play a role in cotton IPM systems, however, the right type of diversity will be important.

SUMMER SCHOLARSHIP: AGRONOMIC AND PHYSIOLOGICAL ATTRIBUTES OF EARLY MANAGED IRRIGATED COTTON

Project Number: 4.9.3

Aims and Milestones:
General aims to examine in detail the agronomic and physiological attributes contributing to earliness in irrigated cotton. This includes:

- Comparing the physiological differences between early and conventional managed cotton in relation to the components of yield determination.
- Examine the compensation aspects of cotton between early and conventional managed cotton in relation to the insect pressure status.

Staff:
Project Supervisor:
Mr Grant Roberts,
CSIRO Plant Industry, Narrabri, NSW
Scholarship Recipient:
Mr Sam Duddy,
The University of Queensland, Brisbane, Qld

Progress:
This project linked in directly with the 'Earliness' experiments being conducted in the Cotton CRC project 'Coordination and promotion of innovative farming systems research'. The honours student, Sam Duddy, utilised three of the earliness sites based in the McIntyre valley to conduct additional physiological measurements. The three treatments examined were 1) short season variety with conventional management, 2) full season variety managed for earliness and 3) full season variety managed conventionally. Measurements included plant height, internode length, plant partitioned drymatter (leaf, stem, fruit), leaf area, leaf and stem nitrogen %, boll numbers and preliminary yield estimates. The results showed that the early managed treatments had accumulated dry matter at a different rate to the conventionally managed cotton but did not alter the plants resource allocation to fruit. These results suggest other factors such as insects destroying established bolls are likely to have a bigger impact on yield than the plants initial resource allocation in early managed cotton.
The student has collected and partially analysed most of the data and has conducted a literature review on earliness in cotton. He will submit his honours thesis before October 2000.

SUMMER SCHOLARSHIP: ARCHITECTURAL CONSEQUENCES OF TIP DAMAGE IN COTTON

Project Number: 4.9.3

Aims and Milestones:

- Early season terminal damage in cotton is common, even for well-protected crops.
- Such damage can promote the development of lateral vegetative branches and alter the shape of the cotton canopy.
- Canopy structure has an influence on the ability of cotton to recover from fruit damage later in the season.
- Little is known about variations in the architectural response of cotton following terminal damage
- We assessed the growth and yield consequences of pre-squaring terminal damage among modern cultivars with different leaf type, growth form, phenological and transgenic status.

Staff:
Project Supervisor:
Dr Tom Lei,
CSIRO Plant Industry, Narrabri, NSW
Scholarship Recipient:
Mr Steven Pirlo,
The University of Newcastle, Newcastle, NSW

Progress:
We successfully completed the field trial using seven cotton cultivars:
Sicala V2, Sicala V2i, Siokra V16, Siokra V16i, Sicala 40i, Sicot 189, Siokra S-101, and Sicot 53,
and imposed manual terminal damage at five node ages:
2, 4, 6, 8, and 10 main stem leaf stages plus a no damage control (0).

The timing and degree of vegetative branch development was recorded and related to the leaf area production, light interception, fruiting dynamics

and yield. As Figure 1 shows, in general, tip damage tends to increase lateral branch growth, in some cases 2-3 times more than the control (at 0). But the response varies among age of damage and among cultivars. Tip damage at nodes 4 and 6 seemed to produce the strongest response, its effect declined at node 8 and 10, coinciding with the onset of reproduction. In terms of yield, tip damage consistently produced more bolls per metre of cotton than the control. Seed cotton weight was also higher in tip damaged plants except for Sicala V2 where the undamaged control yielded highest. The differences among cultivars suggest that prediction of architectural modifications should be made on a cultivar specific basis.

With these data, we are confident that pre-squaring tip damage is likely to encourage growth and yield across a wide range of cultivar types. We can begin to predict the yield consequences in a simulation model using the parameters derived in this study. Steven Pirlo has made a solid contribution to this project and has gained valuable research experience in cotton agronomy and physiology.

SUMMER SCHOLARSHIP: ENHANCED BLEACHING AND DYEING OF COTTON/WOOL BLENDS THROUGH UV IRRADIATION

Project Number : 4.9.1

Aims:
To assess the potential of using UV irradiation to enhance the bleaching and dyeing capabilities of cotton/wool fabrics.

Staff:
Project Supervisor:
Dr Jackie Cai,
CSIRO Textile and Fibre Technology, Geelong, Vic
Scholarship Recipient:
Ms Clarice Tshe,
The University of New South Wales, Sydney, NSW

Progress:
This Summer Scholarship project was focused on UV enhanced bleaching and dyeing of natural fibres. A laboratory sample UV machine SQP, which was a conveyor type system, was used for this project. The mercury lamp irradiated a wide spectrum from far UV to visible light.

In this project, we have investigated the effect of UV wavelength, dosage, water and chemicals on cotton and wool components. The results have confirmed that photo-induced changes in substrate colour and surface properties during exposure to artificial light source depend not only on the spectral regions (wavebands) and exposure period, but also on water content and chemicals used. The chemical environment has found to be of great significance in photobleaching and surface modification. The use of chemical additives would accelerate the photochemical process and give the additional advantage of utilising more fully the output of a mercury lamp. The photochemical reactions involved in this study are primarily acid and alkali catalysed.

A full spectral irradiation containing far UV imparted a more pronounced influence on cotton and wool. This was manifested by the following resultant effects: (1) Antipilling performance on cotton/wool could be significantly improved through the UV irradiation. For pure cotton, the presence of a specific chemical was essential to impart the antipilling performance on cotton during the irradiation (2) The irradiated cotton could be bleached much more efficiently, but exhibited a reduced dye uptake. (3) In contrast, the irradiation yellowed the wool and adversely affected the subsequent bleaching of wool, but increased the dye uptake of wool. When far UV was cut-off, a direct photobleaching of both cotton and wool components in the blends occurred during the exposure. This photobleaching effect was substantially enhanced when a selected chemical was padded onto the fabric prior to the irradiation. However, the irradiation in the absence of the far UV content led to a marginal influence in subsequent bleaching and dyeing behaviours, as well as the surface properties. It should be pointed out that as different wavebands produce different treatment effects, a lamp containing extremely high proportions of particular wavebands should be used to achieve a maximum designated effect on a specified fibre substrate. When a cotton/wool blend is treated with UV irradiation, compromised conditions are often used to achieve required fabric properties. For cotton rich blends, the irradiations with both long wavebands and short wavebands, in conjunction with a selected chemical environment, were able to result in an overall enhanced bleaching effect on the blends.

The results from this investigation further indicate a potential in generation of a multifunctional effect on textile substrates through UV irradiation in the presence of specific chemicals.

SUMMER SCHOLARSHIP: HELICOVERPA FLIGHT AND OVIPOSITION BEHAVIOUR IN RELATION TO BLOCKS, STRIPS AND PATCHES OF TRAP CROPS IN COTTON

Project Number: 4.9.1

Aims and milestones:
To quantify *Helicoverpa* flight and oviposition responses to blocks, strips and patches of trap crop.

Staff:
Project Supervisor:
Mr Martin Dillon,
CSIRO Entomology, Narrabri, NSW
Scholarship Recipient:
Ms Sydney Jordan,
The University of New England, Armidale, NSW

Progress:
This Summer Scholarship Project was undertaken over eight weeks from 24 January 2000 to 17 March 2000.

Four field sites were established:
(i) ACRI Field A2 Strips and patches of pigeonpea (var Quest) planted into a background unsprayed INGARD cotton (Sicot 189i).
(ii) ACRI Leitch Block – a 5 Ha block of pigeonpea (Quest) bordered on each side by 40 Ha of cotton.
(iii) "Yarral".Field 11 – a 50 Ha block of pigeonpea (Quest) adjacent to INGARD cotton.
(iv) "Lowana" Field 5 – Two blocks of pigeonpea (Quest) planted 4 weeks apart adjacent to 5 Ha of unsprayed cotton (Sicala 40) and 90 Ha of conventional Sicala 40.

Field and laboratory work undertaken included:
- Twice-weekly counts of *Helicoverpa* egg densities in the trap crops and in the adjacent cotton.
- Eight nocturnal observation sessions using night vision goggles to quantify the behavioural responses of moths to the different trap crop configurations.
- Weekly pheromone trap counts, and Light trap counts associated with each night observation.
- Rearing of field collected eggs and larvae to determine species, sex and parasitism rates.
- Dissection of light trap captured females to determine mated status.

The project went well and generated a lot of data over the eight weeks. The data is still being analysed and a final report is currently being drafted. Preliminary results suggest that small plots and narrow strips of pigeonpea may not be effective as trap crops relative to larger areas of nearby cotton, but that blocks of pigeonpea can be effective as trap crops.
In summary:
- Blocks of pigeonpea attracted higher egg densities than strips or patches.
- Overall average egg densities were substantially higher in the cotton adjacent to the trap crops than in the pigeonpea trap crops at Field A2 and Leitch block.
- Blocks of trap crop at Lowana always attracted substantially higher egg densities than neighbouring cotton.
- The large field of pigeonpea at Yarral occasionally attracted much higher egg densities than the adjacent cotton.
- Moth activity was not significantly different over cotton or pigeonpea strips and patches at ACRI Field A2 and the pigeonpea block at ACRI Leitch block
- Moth activity was significantly higher over the pigeonpea block than the adjacent cotton at Lowana.
- Moth activity was significantly higher over the pigeonpea field than the adjacent cotton at Yarral on one occasion, but was not significantly different on another.
- It was apparent that pigeonpea was most attractive just prior to flowering when mature flower buds had not yet opened. Egg densities tended to decline over subsequent days despite increasing densities of open flowers.
- It will be essential to repeat these experiments before definite conclusions can be drawn.

SUMMER SCHOLARSHIP: PREDATOR ECOLOGY IN THE SOUTH BURNETT DISTRICT.

Project Number : 4.9.1

Aims and Milestones:
The study set out:
- To investigate the mid season abundance of predators in the agroecosystem of the Byee district in the South Burnett.
- To investigate the contribution of various plant hosts to abundance of one or two key predator species.
- To monitor change in the predator abundance as they relate to insecticide use patterns in cotton.

Staff:
Project Supervisor:
Dr David Murray,
Dept Primary Industries Qld, Toowoomba, Qld
Scholarship Recipient
Mr Malcolm Johnson,
University of Adelaide, Glen Osmond, SA

Progress:
In the seven weeks from the start of December 1999 the predator densities in crops and roadside vegetation in the Byee district were sampled by suction sampling and sweep netting. Predator densities were generally low in the study period. The cool season is thought to have contributed to the low densities, not only in the predator populations, but also in the pest populations. The low pest numbers have helped the cotton growers integrated pest management (IPM) program, but made the data for the predators too low for valid statistical analysis. The most abundant predator groups in all of the sampled environments were spiders. Spiders were also more prevalent during the night. Soybeans had the highest densities of damsel bugs and spiders for the seven weeks. The INGARD™ cotton had lower numbers of damsel bugs than the conventional cotton, which had increasing numbers of adults and nymphs through until mid January. Lucerne appeared to be a potential source of bugs early in the season. The roadsides hosted abundant numbers of spiders and beetles, but the beetle densities were variable throughout the different vegetation on the side of the road. Very low numbers of damsel bugs were recorded in roadside vegetation.

The variation in the predators throughout the seven weeks did not appear to be influenced by any of the sprays that were applied to the cotton. This was expected given the highly selective nature of the insecticides used during the study period.

UTILISATION & APPLICATION OF RESEARCH, LINKS WITH USERS

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 base and the environment; reduction in the use of pesticides; and increased export earnings.

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 IPM and Best Management Practice support groups;
- Examining social barriers to technology adoption.

HIGHLIGHTS AND ACHIEVEMENTS AGAINST MILESTONES

The extension and adoption process was considerably enhanced by the CRC Sustainable Cotton Production which provided 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 challenges. The Cotton CRC has funded two officers in the extension team and provided coordination of the team.

The 'Team' has maintained six focus groups which are responsible for identifying and prioritising national issues and planning and resourcing nationally focussed extension programs. They are:

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

Geoff M^cIntyre

During 1999 the cotton CRC, in collaboration with CRDC and Cotton Australia, responded on behalf of the cotton industry to a new initiative of the Department of Natural Resources in Queensland to improve water use efficiency in the cotton and grains industries in Queensland. This four year project provides for an adoption program managed and delivered by a project coordinator and five extension officers in DPIQ.

The extension team now has a core of fifteen Industry Development Extension Officers located strategically throughout the industry. It also includes several farming systems extension officers in NSW Agriculture and DPIQ who contribute part of their time to cotton industry extension activities and the spray application and IPM development extension officers in DPIQ.

The extension team has cooperated with extension staff in the new production areas around Hillston in southern NSW.

The planned appointment of a Trainee Industry Development Officer has not occurred but the project has already achieved success with the consequential appointment of two applicants to cotton extension officer positions in DPIQ and with two other applicants accepting positions elsewhere in the cotton industry.

It is coordinated by a CRC Cotton Extension Committee comprising representatives from New South Wales Agriculture (NSWA), Department of Primary Industries Queensland (DPIQ), the Cotton Research and Development Corporation (CRDC) and the Australian Cotton Growers Research Association (ACGRA). The new National Cotton Extension Coordinator will join the committee when appointed in 2000.

An annual cotton extension planning workshop provides the opportunity for the extension team, researchers and consultants to identify and prioritise national issues. It includes training and technical updates on major issues.

The extension officers work closely with regional grower associations and maintain strong links with all research programs. The core activity of the

program has been centred on regional field trials and demonstrations in collaboration with researchers, consultants and growers to field test, evaluate and adapt the findings of research. The National Extension Coordinating Committee has provided essential support through the development of guidelines and protocols for the conduct of these trials.

Integrated Pest Management (IPM) and the management of transgenic cotton have been a primary issues for the trial program demonstrating the capacity of the extension team to address emerging industry issues in a timely manner.

Major activities of the program have included:

- The establishment IPM and area wide management grower groups;
- A series of insect management, agronomy and farming systems trials in collaboration with research officers and growers;
- Extensive fusarium management workshops and meetings throughout the cotton production regions;
- A large number of pesticide application workshops for growers.

The extension team have been key partners with Cotton Australia and the growers in the implementation of the industry Best Management Practice (BMP) program. The extension officers provide technical resource support for growers developing and implementing management plans whilst 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.

An economic assessment of IPM and insecticide resistance management (IRM) strategies has been based on a data set from one of the IPM grower groups in collaboration with the IPM Training Coordinator during the 1999/00 season.

LINKAGES

The wider extension team is inclusive of personnel in the Cotton CRC Technology Resource Centre, CRDC, Cotton Australia, Cotton Consultants Australia, Cotton Seed Distributors and Deltapine Australia.

The extension officers collaborate with all research officers to ensure strong linkages between the research and extension programs.

Effective linkages have been established with the extension officers of the NSW Agriculture water use initiative and with researchers in DPIQ and DNR Qld involved with irrigation research and development.

IMPROVING ON FARM WATER USE EFFICIENCY IN THE QUEENSLAND COTTON AND GRAIN INDUSTRIES.

Project Number: 4.2.2 AC

Aims:
The objective is to increase irrigation efficiency in the cotton and grain industries by at least 10% and have 70% of growers adopting Best Management Practice guidelines which will be developed for general application for the irrigation of all crops. Milestones are listed (**1** to **8**) below.

Staff:
Mr Geoff McIntyre,
Dept Primary Industries Qld, Dalby, Qld
Dr Phil Goyne,
Dept Primary Industries Qld, Warwick, Qld
Mr John Okello-Okanya,
Dept Primary Industries Qld, Emerald, Qld
Darren Springer,
Dept Primary Industries Qld, Biloela, Qld
Mr Andres Spragge,
Dept Primary Industries Qld, Dalby, Qld
Ms Sandy Cameron,
Dept Primary Industries Qld, Goondiwindi, Qld
Sarah Hood,
Dept Primary Industries Qld, St George, Qld

Progress:
Commence stocktake and benchmarking
The late appointment of staff (delay in project ministerial approval) delayed the commencement.
Project management system established

2.1 Appointment of DEOs
All personnel appointed to work on the program were in place by late February 2000.

2.2 Induction training
Core skills training conducted by USQ/NCEA at USQ was completed in April.

2.3 Consultative committee established
The inaugural consultative committee meeting was held 1st December 1999, next meeting June 2000.

2.4 Regional management committees established
Each officer has been organizing regional committees to steer the Program's activities.

2.5 Demonstration sites selected and grower groups formed
Most sites have now been selected and grower groups formed.

2.6 Issues prioritised in consultation with growers
This has been an on going activity in each region and has resulted in the development of the regional action plans.

2.7 Benchmark reports based on stocktake data prepared and distributed by region**s**
The delays in commencing the Program have delayed the preparation of these reports.
Trial Sites Established

3.1 Monitoring systems installed-data logging commenced
This activity will commence in some regions with grain crops in the forthcoming winter cropping season. Trials in all five project regions will be established in the 2000/2001 summer season.

Desktop stocktake completed
The Stocktake Report draft is completed.
Year 1 trial sites completed

5.1 Data compiled, analysed and benchmarks adjusted

These activites will of necessity be shifted to year 2.

BMP water module draft completed
In early May Phil Goyne met with the cotton BMP Management Committee to plan the development of the module.

Training Program Developed
A workshop is being arranged to draft plans for the development of a training program. Input from all target regions will be requested.

Awards Program developed
The late commencement of the Adoption Program has delayed the development of an awards scheme. This will be an agenda item at the next Consultative Committee meeting planned for June and will be an agenda item for future Regional Committee meetings.

National Cotton Extension Network 'water' team.

EXTENSION TECHNICAL OFFICER - DALBY

Project Number: 4.1.1.

Aims:
- To communicate and have adopted by growers and industry the results of cotton research.

Milestones:
- Wider use of on-farm demonstrations of research benefits;
- Development, incorporation and support of cotton industry information into Regional Information Centres from the CRC Technology Resource Centre, Narrabri.

Staff:
Mr Greg Salmond,
Dept Primary Industries, Dalby, Qld
Ms Jenelle Hare,
Dept Primary Industries, Dalby, Qld

Progress:
Ms Jenelle Hare transferred from DPI - Hermitage Research Station, Warwick, to take up duties as the Extension Technical Officer – Dalby in early October 1999.

Since commencing duties at Dalby, Ms Hare has made a major effort to re-establish the work program at the CRC Farming System Trail at Warra, which was interrupted by the resignation of the previous appointee mid way through the season in 1998/99

This has involved:
- Cotton plant sampling and mapping conducted throughout growing season;
- In-crop soil water use of cotton monitoring weekly (neutron probe);
- Soil sampling of treatments conducted as per schedule;
- Harvesting samples taken from winter and summer treatments;
- Processing of samples and results which have been forwarded to the project leader – Core CRC Farming Systems Experiment Project, ACRI Narrabri;
- Organising crop trial data from previous seasons.

Results from the Farming Systems trial have been reported in the report for that project 5.1 Farming Systems Experiments.

The extensive input needed at the Warra Farming Systems trial site this season has limited opportunities for the implementation of other demonstration trials in the region this season.

Links have been established with the cotton modelling project group at ACRI. Results generated from the whole period of the Warra Farming System trial have been collated and forwarded to Dr Mike Bange, CSIRO/ACRI for the further development of the cottonLOGIC computer model.

Training undertaken:-
- Neutron probe training and licensing– (Qld Health requirement) Nov 1999.
- *Chemsmart* Training Queensland – Agricultural Chemical Application Accredation – Nov 1999

Certificate in Rural Science – Cotton Production

COTTON INDUSTRY DEVELOPMENT OFFICER - GWYDIR

Project Number: 4.1.1

Aim:
Develop and promote the adoption of improved technologies and practices which ensure that the cotton industry is economically and environmentally sustainable.

Staff:
Mr James Quinn, NSW Agriculture, Moree, NSW

Progress:

Cotton IPM Grower Groups.
In the Gwydir Valley this season, as in many other valleys, grower groups were formed to better manage heliothis populations. Four groups were formed in

the Gwydir Valley representing the majority of the cotton area. Groups mostly met on a monthly basis, to discuss various topics regarding the growing of cotton in their area. Attendance at these meetings was very high with an overall attendance of 65% to meetings, the Bullarah farming group had the highest with 82.5% attendance to each meeting.

Members of each group, planted chickpea trap crops to catch the first generation of heliothis moths emerging from diapause. This trap cropping program was a very interesting exercise which growers involved learn a lot from. The trap cropping program will be continued in the coming season.

A highlight of these groups was the small bus tours where growers visited each others farms within the group and discussed problems or successes. These allowed very open and free discussion between members and strengthened the relationship between the members of the group.

Valley Specific Issues.
Continuation of the Gwydir Valley Extension Committee - this committee consists of leading cotton growers and consultants in the Gwydir Valley, and their major role is to prioritise extension activities within the valley.

Insect Management.
As in every year, insect management is high on the priority list with cotton producers. A series of four types of trials were conducted to examine different aspects of insect management during the 99/2000 cotton season.

Three of these trials fell under the area loosely termed “plant compensation for early season damage”. Response from early season damage is a characteristic of cotton which is not fully understood by cotton growers and consultants. Understanding of this characteristic will allow for a reduction in the amount of early season insecticide used. This reduction has benefits on two fronts, firstly the development of IPM programs based on beneficial insects which are disrupted by early insecticides. Secondly the reduction in the use of Endosulfan which has socio -economic problems, especially in the Gwydir Valley.

Two trials were established examining the effects of early tipping of the plant terminal, showing that high amounts of terminal damage can be tolerated without affecting yield or maturity. Three trials were established examining the effects of retention of first position fruit. These trials were carried out to reinforce earlier retention work done in the Gwydir Valley. A further trial was established to examine the merit of prophylactic seed treatments, and whether their use is critical in the warmer season cotton growing environment.

The 4th type of trial involved the use of the NPV product from Aventis (Gemstar®), and dealt with issues relevant to area wide management of heliothis. Trials were established in sorghum and cotton to firstly assess the robustness of these products against heliothis. Secondly, to reduce the number of pupae emerging from under these crops. Both these trials showed very positive results and will be included in the trial program for the coming season to replicate these results.

Fusarium Wilt Awareness.
Conditions were ideal for the build up of disease pathogens this season. Fusarium Wilt was identified on a number of new properties in the Gwydir Valley during this season. Liaison between cotton growers and consultants and plant pathologists was a crucial part of the role this year. Two meetings were held during the season to discuss Fusarium wilt. The first was general meeting informing all cotton industry parties (85 in attendance)about the disease and their responsibilities. The second meeting brought together all growers and consultants in the Gwydir Valley to discuss management and develop a support network for growers having problems managing the disease.

Farming Systems.
Ultra narrow row planting configuration was trialed this season. Two rows per metre were planted 0.2 m apart on top of the bed. Similar yields were obtained with this planting configuration and a major benefit was the six days of earliness achieved during this trial. The earliness margin is thought to be increased with better management when more is learnt about this system.

The use of Mepiquat Chloride to assist with late season management of cotton was continued in the Gwydir Valley this season. Results from the three trials conducted are inconclusive, with no significant difference between treatments in yield and maturity.

IPM TRAINING COORDINATOR

Project Number: 4.1.5

Aims and Milestones:
- Develop a nationally accredited (National Competency Standards - RTCA (Rural Training Council of Australia) and VETAB (Vocational Education and Training Advisory Board) approved) grower short course in IPM for the Australian cotton industry;
- Develop a comprehensive grower focused IPM manual for the Australian cotton industry;
- Co-ordinate the implementation and ongoing development of an IPM short course;
- Have 40% of growers attend the course by June 2001
- Work with industry researchers and extension staff to improve the transfer of information to growers and consultants which aim to increase the level of adoption of IPM strategies within the Australian cotton industry;
- Assist in the training of district IDO’s in IPM strategies.

The aims for 1999/00 were:
- Formation and meeting of an industry reference

group (growers/consultants/IDO's)
- Plan and outline draft IPM Short Course Training Manual
- Complete the first draft of the IPM Short Course Training Manual

Staff:
Mr Greg Kauter,
Dept Primary Industries Qld, Goondiwindi, Qld
Mr Dallas Gibb,
NSW Agriculture, Narrabri, NSW

Progress:
An industry reference group including growers, consultants, Industry Development Officers, CRDC and CRC representatives met in Goondiwindi on 15 September, 1999 to review project progress and facilitate the development of the aims and objectives of the IPM Short Course.
An outline of the draft IPM Training Manual was prepared based on the outcomes of the industry reference group meeting.

The IPM Short Course Learning Outcomes have been developed and mapped against the existing National Competency Standards for cotton production. The IPM Short Course will comply with the existing Rural Training Council Australia guidelines and successful completion of the course will lead to an accredited national qualification in Agriculture. All assessment for national recognition purposes must be undertaken by, or auspiced through, a Registed Training Organisation. Negotiations have commenced with a Registed Training Organisation within New South Wales Agriculture, Murrumbidgee College of Agriculture, to authorise the assessment to be carried out by industry (CRC).

Research, including mapping exiting industry publications and writing of the draft IPM Training Manual has proceeded throughout the year. The Draft Manual currently consists of eleven chapters (approximately 96,000 words) and is 85% complete. The two incomplete chapters are in draft form and work on these is continuing.

Completed Draft IPM Training Manual chapters are under researcher and editorial review with respective researchers of the Australian Cotton CRC.

Editorial assistance and the development of the Assessment Workbook is being undertaken in collaboration with (NSW Agriculture) staff at Murrumbidgee College of Agriculture, Yanco, NSW. The development of the Assessment Workbook has commenced following a planning meeting in April. Preliminary outlines of the Instructional Design of the course have been developed and will be enhanced during the early pilot workshops next year (00/01). Work on an Instructors Manual has also commenced.

The Industry Reference Group will meet on the 23 May, 2000 to review project progress and advance the development of the Assessment Workbook.

Project Officer, Mr Greg Kauter, is currently undertaking (Vocational Training & Education) Certificate IV in Assessment and Workplace Training (50% complete). This qualification is required to deliver Accredited Courses throughout Australia.

AN ECONOMIC ASSESSMENT OF INSECTICIDE RESISTANCE MANAGEMENT STRATEGIES IN THE AUSTRALIAN COTTON INDUSTRY

Project Number: 4.1.6

Aims and milestones:
The broad aim of the project is to evaluate different IPM and IRM strategies within the cotton industry in response to developing insecticide resistance, and to develop an economic value for resistance.
By the end of the June 2000 an initial analysis of alternative management strategies for insecticide resistance will be completed. A further analysis will be done with data from two seasons (1998-99, 1999-00). More detailed bio-economic and dynamic optimisation analyses will be done using the HEAPS and OZCOT models.

Staff:
Mr Ziaul Hoque,
NSW Agriculture, Narrabri, NSW
Mr Bob Farquharson,
NSW Agriculture, Tamworth, NSW
Mr Martin Dillon,
CSIRO Entomology, Narrabri, NSW
Mr Greg Kauter,
Dept Primary Industries, Goondiwindi, Qld

Progress:
A preliminary budgetary analysis has been done with the Boggabilla data for 1998-99. A paper was presented in January 2000 at the 44th annual conference of the Australian Agricultural and Resource Economics Society. Preliminary results were also discussed with growers. Posters have been presented in the ACRI Open-day, Field Day and also will be presented in the Australian Cotton Grower Trade Show and Australian Cotton conference.

A farm-level data set of an area-wide management group of north-west New South Wales was utilised for this research. 'Hard' and 'Soft' management strategies for insecticide use were defined based on spraying information on a paddock basis. A ranked score was allocated to each insecticide applied based on their destructive effects on beneficial insects and a total weighted score (rank x number of sprays) was then derived to categorise each paddock as one where relatively 'Hard' or 'Soft' control options were used. Average Gross Margin (GM), crop yield and insect egg pressure were calculated for each management option. To justify the spray decision and for the comparative analysis of different management strategies *Helicoverpa* pressure was measured based on average egg density. Results are reported in the highlights section of this report.

TECHNOLOGY SUPPORT PROACTIVE INFORMATION SERVICES

INTRODUCTION

The 'Technology Resource Centre' (TRC) forms the centre point for the transfer of information to growers, consultants and extension staff. It also generates information to inform the general public of new advances in cotton production and the activities of the Cotton CRC. The distribution of research review newsletters, info sheets, industry publications and decision support systems all occur through the TRC.

The Cotton CRC Website is maintained and regularly updated. The use of the website has increased significantly over the last 3 years. As well as providing online reference material, the site allows access to weather station data, software upgrades and insecticide resistance monitoring data.

Developing modern decision support systems is a key objective of "Technology Support" programs. Cottonlogic is an award winning decision support system which continues to be enhanced through researchers located at the TRC. Other paper decision support systems are also generated through the TRC. The latest system to be released is the IPM Guidelines which will form the core component of implementing IPM.

AIMS AND OBJECTIVES

- Provide access of information to growers, industry support agencies, other stakeholders and the public.
- New and enhanced decision support systems for crop management.
- Growers using the full range of information available to implement sustainable management practices.

HIGHLIGHTS AND ACHIEVEMENTS AGAINST MILESTONES

Release of New IPM Guidelines for Insects Management in Cotton.

Through extensive collaboration with researchers, growers and consultants new IPM guidelines for insect pest control in cotton were released during 1999. The guidelines provide growers with the latest knowledge on insect pest management and methods to reduce the use of synthetic pesticides. The guidelines have been strongly endorsed by the growers and are incorporated in the industry's "Best Management Practice", (BMP), program. The BMP guidelines are promoted not only to growers within the industry but also to other industries, government and the general public. The guidelines are also made available within ENTOpak, NSWA 'Cotton Pest Management Guide' and CottonLogic. CottonLogic forms an intergral part of the new guidelines.

In addition to the 'IPM Guidelines' growers are developing a clear understanding that insect pest management involves far more than simply making a decision of whether or not to spray a pesticide. Cotton growers are now considering a whole farm approach to insect management. This involves planning and making decisions before the cotton crop is even planted. Some of the cultural factors that need to be considered include, control of weed hosts for pests, location of crops relative to natural refuge areas and the planting of refuge and trap crops across the farm to assist in reducing insect pest populations while increasing the presence of beneficial (predatory) insects such as lady beetles and parasitic wasps.

Within many cotton growing regions, "Area Wide Management" (AWM), groups have been established. The concept of AWM, involves growers across the region working together to implement IPM programs. Cotton CRC extension staff have been heavily involved in facilitating and assisting growers with such groups.

The 'IPM Guidelines' form an important framework on which individual growers and AWM groups can build their own IPM programs. Key features of the guidelines include, crop cultural management, understanding pest / plant interactions, insect thresholds in relation to plant growth and beneficial insect populations, understanding the impact of different pesticides on beneficial insects, refuge and trap crop options and resistant management strategies.

PROMOTION OF NEW TECHNOLOGY TO THE INDUSTRY AND GENERAL PUBLIC

Through the continued upgrading of Cotton CRC Web site the industry and general public have immediate access of the latest technology and research. The site is currently visited on average 250 times a day.

In addition to the web site the TRC maintains an industry address data base which enables information to be sent to growers throughout the industry quickly and effectively. During 1999/2000 some 20 documents and 13 media releases where produced and distributed from the TRC.

In December 1999 a public open day was held at the institute. Through field tours and static displays the public had the opportunity to see first hand the activities of the Cotton CRC. The open day was a very successful receiving excellent media coverage and support. It is planned to have a similar day in 2 to 3 years.

ADVANCED DECISION SUPPORT SYSTEMS

The decision support system 'CottonLOGIC' was recognised for its excellence in receiving the CSIRO Plant Industry Chiefs Award. The package is used widely across the industry as a tool in making pest management decisions and particularly as a farm recording system. This will prove invaluable as grower 'area wide management' groups begin to adopt comparative analysis techniques in assessing their IPM programs.
This technology will be further advanced with the development of the 'hand held version of cottonLOGIC. This will allow real time recording of information leading to greater efficiency in farm operations and crop management. The first release of this technology is planned for the 2000/01 cotton season.

COTTON TECHNOLOGY TRANSFER CENTRE

Cotton CRC Project Number**: 4.2.1**

Aims:
To produce and enhance the delivery of cotton research based extension material to the industry.

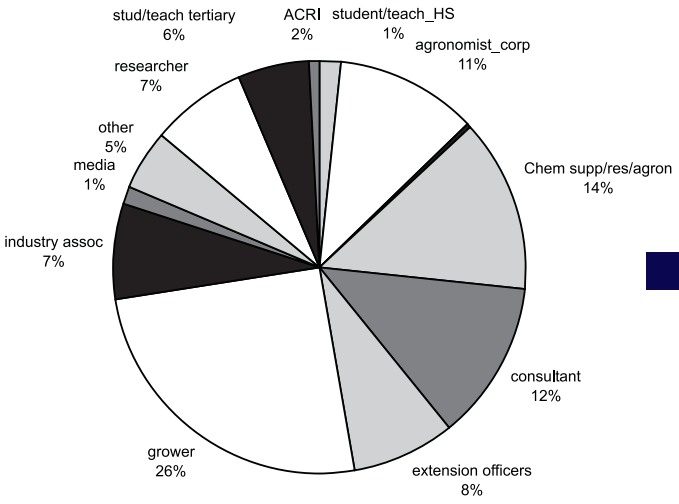
Milestones:
- Maintain industry database mailing / fax list as an integral part of information distribution to the industry.
- Visit all growing regions to promote the Technology Resource Centre and its products and to collect feedback.
- Continue to provide distribution and technical support for decision support packages.
- Produce material in response to special industry needs
- Maintain Cotton CRC internet site
- Continue operation of Centre including responding to individual growers and consultant queries and maintain responsibility for distribution of material including CottonLOGIC

Staff:
Mr David Larsen,
NSW Agriculture, Narrabri, NSW
Ms Maris Rea,
NSW Agriculture, Narrabri, NSW

Progress: Year 3
The milestones for year 3 of the Technology Resource Centre project have been met with the TRC producing and distributing a broad range of material to industry through a variety of means including: direct mail to the whole industry; mail to special interest groups (ENTOpak inclusions); workshops and phone support for the cottonLOGIC package; and provision of the latest information through the CRC web site. The specific year 3 milestones are addressed below.

1. Over 2600 clients now on database (2000+ record updates). Industry - wide mail out coordination of Bunchy Top update; Fusarium Brochures. List used for *Pest Management Guide for Cotton* and ACGRA Cotton Conference notifications.
2. Technology Resource Centre /CottonLOGIC tour of all major regions (12 towns). Field day attendance NSW Regions with Technology Resource Centre information.
3. Package distribution totals EntoPAK (799), SOILpak (439), CottonLOGIC phone support to over 1000 users (160 queries To D.L).
4. Documents produced by Technology Resource Centre with input from CRC researchers: IPM (13), Fusarium (3) and Bunchy Top (2) IRMS Strategy (2).
5. Maintenance of the Cotton CRC web site is ongoing .
6. Over 500 queries responded to from growers, consultants and the public via phone, email and direct visit to Technology Resource Centre.

David Larsen, Chris Plummer and Sandra Deutscher, part of the Cotton CRC's team developing decision support systems.



Query Breakdown by type to Technology Resource Centre

MULTI-PLATFORM DECISION SUPPORT SYSTEMS

Project Number: 4.2.3

Aims and Milestones:

- Extend the availability of computerised decision support systems, including mathematical models of cotton pests and crop production, to all members of the cotton industry.
- Develop portable decision support tools for use by consultants for crop management decisions.
- Make new management systems for transgenic cotton and new IPM technology available to all growers and consultants in a readily accessible form.
- Develop network-based information systems for access by growers making risk based strategic decision, or infrequent tactical decisions in the management of water, nutrition or pests.

Staff:
Dr Michael Bange,
CSIRO Plant Industry, Narrabri, NSW
Ms Sandra Deutscher,
CSIRO Plant Industry, Narrabri, NSW
Mr David Larsen,
NSW Agriculture, Narrabri, NSW
Mr Darren Linsley,
CSIRO Plant Industry, Narrabri, NSW
Mr Tony Pfeiffer,
CSIRO Plant Industry, Narrabri, NSW
Mr Chris Plummer,
CSIRO Plant Industry, Narrabri, NSW
Mr Stewart Whiteside,
CSIRO Plant Industry, Narrabri, NSW

Progress:
This past year has been an exciting year for the team developing computerised decision support tools (DSS) in the Cotton CRC. Winning numerous awards has obviously been a highlight, which recognises the significant efforts of many people past and present. It also acknowledges an industry willing to accept and adopt new technologies. In addition to the awards there has been significant effort by the team to improve the development and support of computerised tools.

CottonLOGIC Release and development -*A major upgrade (Version 3.0) was distributed in Dec. to over 980 registered people. In May 2000 the number of registered copies has reached 1023. Version 3 was year 2000 compliant, and included numerous enhancements with the major feature being the spray ordering system that enables growers and consultants to inform spray operators and neighbours of intentions to apply chemical spray applications. CottonLOGIC Training and Support* - The CottonLOGIC training workshops were conducted from August to September 1999. A total of 17 workshops were conducted in all cotton growing regions and a total of 250 participants attended.

Handheld Development - Development of the Hand-held version of CottonLOGIC is progressing well since the appointment of two new programmers to the team. A pre-release version has been completed for testing over the winter, probably in the Ord. It is hoped that the first release will be available for the start of the next cotton season. Cotton CRC Website -The reliability and access to the Cotton CRC's web site this year has been superb. Significant improvements have been: personal details can now be passed securely; development of a cotton degree-day calculator accessed through the Cotton CRC's website that accesses the Bureau of Meterology's climate database (SILO project); and greater links with the CottonLOGIC software have been established.

Decision Support Direction and Evaluation – To improve the direction of development of DSS a number of specific mechanisms have been implemented during the year, they are: an industry steering committee made up of representatives from all types of users of decision support and from all regions has been formed; implemented formal evaluation after each workshop activity; and hired the services of an independent consultant specialising in DSS to report on the impact of DSS in the cotton industry.

Present activities are focussing on the completion and release of the hand-held.

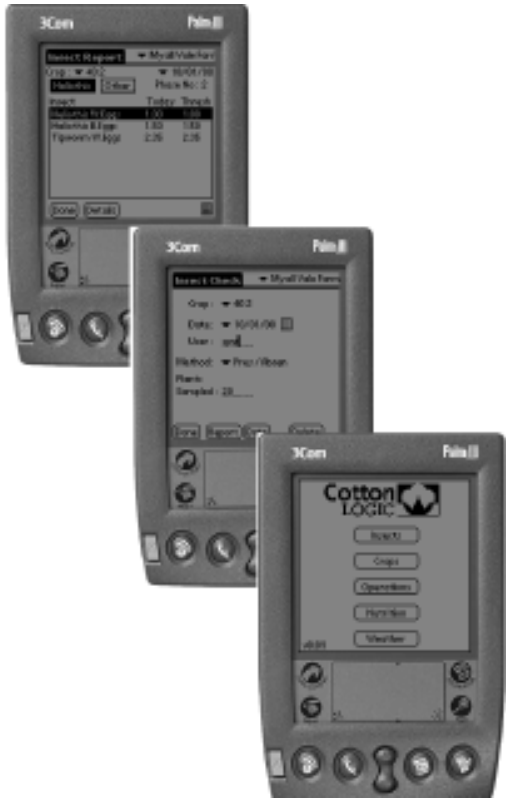


Figure 1: CottonLOGIC software developed for the Palm Pilot Hand held device.

STAFFING AND ADMINISTRATION

Although this financial year was one of transition for the Cotton CRC between completing projects from the previous Cotton CRC and commencing new initiatives, we were still able to recruit some impressive people to the Cotton CRC team during 99/00:

- Dr Jackie Cai was employed by CSIRO TFT in Geelong, Vic to work on innovative bleaching technologies
- Stephen Yeates was employed by CSIRO PI in Darwin NT to act as our research coordinator/ liaison officer for northern Australia
- Greg Kauter was employed by DPIQ in Goondiwindi to develop an IPM training course for growers
- Phil Goyne was employed by DPIQ in Dalby to coordinate the Queensland government's new Rural Water Use Efficiency initiative
- Sandy Cameron, Sarah Hood, John Okello-Okanya, Darren Springer and Adres Spragge were employed by DPIQ as extension officers with the Rural Water Use Efficiency initiative
- Stewart Whiteside was employed by CSIRO PI in Narrabri as a computer programmer in the decision support team.

SPECIFIED PERSONNEL

There has been one change to the specified personnel. Dr Philip Wright, NSWA joint Program Three Leader left the Cotton CRC and was replaced by Prof. Alex McBratney, USYD.

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Oertel, A., Zalucki, M.P., Maelzer, DA, **Fitt, G.P.** and Sutherst, R. (1999). Size of the first spring generation of *Helicoverpa punctigera* (Wallengren) (Lepidoptera: Noctuidae) and winter rain in central Australia. *Australian Journal of Entomology* 38, 99-103.

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Bange, M.P. and **Thomas, A.** (1999). Multi-platform decision support systems. *Proceedings of the Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia.*

Bange, M.P., Milroy, S.P., Thongbai, P., and **Richards, D.** (1999). Technical support for cotton agronomy, physiology, model development and validation. *Proceedings of the Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia.*

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Fitt, G.P. (1999). Invited Symposium Speaker, XIVth International Plant Protection Congress, July 25-30, Jerusalem, Israel.

Fitt, G.P. (1999). Symposium Organiser and Speaker at the Second Pan-Pacific Conference on Pesticide Science. October 1999, Honolulu, Hawaii, USA.

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Figueroa, E. (1999). Assessment of soil fertility indicators and versatility in the lower Namoi Valley. MAgr thesis, The University of Sydney .

Kahn, M (1999). Aspects of the biology, ecology and management of the green mired, Creontiades dilutus, in Australian cotton. PhD thesis , The University of New England.

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Kochman, J., and **Nehl, D.** (August 1999). Northern Australia Cotton Diseases Survey Report.
Mitchell, G., **Kennedy, I.R.** and **Sánchez-Bayo, F**. (1999). Field soil dissipation of pyrithiobac-sodium following application of Staple herbicide. *Report to Du Pont Agricultural Products*, 33 pp.

Quinn, J. (1999/2000). "Cotton Tales".Bi-weekly local newsletter addressing valley issues and providing growers with updates on current crop management issues. 30 newsletters were sent out over the growing season to growers and consultants of the Gwydir and MacIntyre Valleys.

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Editing and production to print stage and distribution *Farm Hygiene for Disease and Weed Control March 2000.* Cotton CRC Information Sheet prepared by pathologists and weed scientists from the Cotton CRC.

*Detergent based degreaser for disinfecting machinery to reduce the spread of Fusarium wilt of cotto*n. Cotton CRC Information Sheet Prepared by Dr Natalie Moore and Mr Wayne O'Neill March 2000.

Fusarium wilt update March 2000. Cotton CRC Information Sheet Compiled by Greg Salmond and pathologists from the Cotton CRC.

Cotton Bunchy Top Update Nov 9. Prepared by virologists, pathologists, and entomologists from the cotton CRC Cotton CRC Information Sheet.

Integrated Pest Management guidelines for Australian Cotton. Compiled by Robert Mensah and Lewis Wilson with 12 supporting documents.
Insect Resistance Management Strategy 1999-2000
Insect Management Plan for INGARD Cotton 1999 - 2000

PUBLIC PRESENTATIONS, PUBLIC RELATIONS & COMMUNICATIONS

CONFERENCE PRESENTATIONS:

Ballard, F.F., Lyon, K.J. and **Lyon, B.R.** (1999). Resistance gene analogue (RGA) families in cotton (*Gossypium* spp.). *Poster session, 39th Annual General Meeting of the Australian Society of Plant Physiologists, Gold Coast, Australia.*

Becerra Lopez-Lavalle, A., and **Lyon, B.R.,** (2000). Molecular genetic markers for accelerated selection of Fusarium wilt-resistant cotton (*Gossypium hirsutum* L.). *Poster session, Plant & Animal Genome VIII, San Diego, USA.*

Boydell, B. (1999). Identifying potential within-field management zones from cotton yield estimates. *2nd EuropeanConference on Precision Agriculture.*

Del Socorro, A.P, Gregg, P.C., Alter, D., Henderson, G., Moore, C., Forrester, N., & Du, J. (1999). Developing attractants for *Helicoverpa armigera* moths. *First Asia-Pacific Conference on Chemical Ecology, 1-4 November 1999, Shanghai, China.*

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Dorahy, C.G., Blair, G.J. and **Rochester, I.J.** (1999). To P or not to P? - That is the question! *Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia*

Gordon, I. (2000). Land and Water Salinity, a threat or reality? *10th Australian Cotton Conference, August 2000, Brisbane, Qld.*

Gregg, P.C., (1999). Chemical ecology in Australian cotton agroecosystems. *Plenary lecture to the First Asia-Pacific Conference on Chemical Ecology, 1-4 November, Shanghai, China.*

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Gregg, P.C., Del Socorro, A.P., Alter, D., Henderson, G., Moore, C., Forrester, N., & Du, J. (1999). Attractants for *Helicoverpa* moths. *Poster presented to the 30th' Australian Entomological Society Conference, 28 Sept - 2 Oct, Canberra, ACT.*

Hoque Z., Farquharson B., Dillon M. and **Kauter G.** (2000). An economic assessment of Insecticide Resistance Management strategies within the Australian cotton industry. *44th Annual Conference of the Australian Agricultural and Resource Economics Society Inc., The University of Sydney, January 23-25, 2000.*

Hulugalle, N. (2000.) *Sodicity Conference, 28 February-1 March, Tatura, Vic., Australia.*

Hulugalle, N. R., Entwistle, P.C., Scott, F., and Kahl, J. (1999). Sowing wheat or grain legumes as rotation crops after cotton in an irrigated Vertisol. 1999 *Conference of GCTE Focus 3: Food and Forestry, Reading, 20-23 September (1999), UK.*

Kvedaras, O.L., Gregg, P.C. and **Del Socorro, A.P.,** Alter, D. & Moore, C. (1999) The response of the cotton bollworm, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae) to host plant volatiles. *30th Annual General Meeting and Scientific Conference of the Australian Entomological Society, Canberra.*

Kvedaras, O.L., Gregg, P.C. and **Del Socorro, A.P., Alter, D.** & Moore, C. (1999). Laboratory and field trials to determine the mating behaviour of *Helicoverpa armigera* in relation to host crops. *Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia*

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Milroy, S. (1999). CSIRO research into cotton agronomy physiology and modelling. *Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia*
Nkem, J.N., Lobry de Bruyn, L.A., Grant, C.D., and

Hulugalle, N.R. (1999). The potential of soil macrofauna activities in reducing soil degradation: the case of mound-building activities of ants (*Iridomymex greensladei. 1999 Conference of GCTE Focus 3: Food and Forestry, Reading, 20-23 September , UK.*

Richards, A.R. (1999). Environmental Impact Assessment of Genetically Engineered Insect Viruses. *Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia.*

Roberts, G.N. (1999). Herbicide tolerant cotton – preparing for change. *The 12th Australian Weeds Conference. September 12-16th, Hobart, Tasmania.*

Rochester, I. (1999). Presentation at *CSD/CSIRO Research Review,* Narrabri.

Silberbauer, L.X. and **Gregg, P.C.** (1999). Ecology of beneficial insects in and around cotton.

Australian Entomological Society, 30th Scientific Conference and A.G.M., Canberra.

Silberbauer, L.X. and **Gregg, P.C.** (2000). Using pollen to trace the movement of beneficial insects in and around cotton. *Australian Entomological Society, 31st Scientific Conference and A.G.M., Darwin.*

Tennakoon, S. (1999). CSIRO research into water use efficiency. *Cooperative Research Centre for Sustainable Cotton Production Research Conference, Narrabri, Australia*

SEMINARS & WORKSHOPS:

Yeates S (28 March 2000). Presentation made to Northern Territory Amateur Fisherman's Association, The Territory Environment Center and Greening Australia representatives.

Yeates S (2 March 2000). Presentation to Ord Cotton Research Review meeting.
Richards, A.R. (1999) *"Regulation and Environmental Impact Assessment of GMOs in Australia - an overview" - a seminar given at CSIRO Land & Water, Albury.*

Richards, A.R. (2000). "Development of a new (field-based) technology for the mass production of a baculovirus insecticide for *Helicoverpa* pest control" - a seminar given at the Cuulong Delta Rice Research Institute, Omon, Vietnam.

Lyon, B.R. (2000). DNA markers for fungal disease resistance in cotton. First Symposium on Molecular Markers in Cotton, Canberra, Australia.

Lyon, B.R., Ballard, F.F., **Becerra Lopez-Lavalle, A., Cook, A.E.,** Ho, K., Kailasapillai, S. and Lyon, K.J. (2000). Cottoning onto Pests: the Answer's in Genes. SCIFEST, The Cotton Store, Sydney, Australia.

Lyon, B.R. (2000). DNA diagnosis of Fusarium wilt in cotton. Cotton CRC Fusarium Working Group Meeting, Goondiwindi, Australia.

Lyon, B.R. (2000). DNA markers for resistance to Fusarium wilt. Cotton CRC Fusarium Working

Rungis. D. (2000). International Workshop on Molecular Markers in Cotton, Canberra, Feb 16-17.

Boydell, B. (August 1999). Precision agriculture in the Australian cotton industry. 3rd Annual Conference of Precision Agriculture.

Boydell, B. (May 2000). GPS for Precision Agriculture Australian Centre for Precision Agriculture

Boydell, B. (May 2000). GIS in Precision Agriculture Australian Centre for Precision Agriculture.

Boydell, B. (May 2000). Remote Sensing for Precision Agriculture Australian Centre for Precision Agriculture.

Dorahy, C.G. (May 2000). Using total soil P levels to predict cotton response to P fertiliser. CSD / CSIRO Research Review, Narrabri

Fitt, G.P .Science Meets Parliament Day (November 24, 1999) Meetings with Deputy Prime Minister, John Anderson and Upper House Speaker, Mr.Garry Nehl.

Fitt, G.P. (2000).NSW Government Salinity Summit, Dubbo, March 16/17. Presentation on Cotton CRC interest in salinity.

Hoque Z., Farquharson B. (1999). An economic assessment of IPM strategies within the Australian cotton industry. A seminar presented at ACRI Conference room on June 9, 1999.
Hoque Z. (2000). A workshop with the growers and consultants of the Area Wide Management group on March 21, 2000.

Hulugalle, N. (1999). Current research in cotton-based farming systems of eastern Australia Merlewood Research Station, Institute of Terrestrial Ecology, Grange-over-Sands, Cumbria (16/9/99), and Silsoe College, Cranfield University, Silsoe (23/9/99) during a visit to the UK during September 1999.

Roberts, G.N. (2000). Herbicide tolerant cotton – Where are we going? 2000 Lower Namoi Valley Cotton Field Day, March 17th , ACRI, Narrabri.

Roberts, G.N. (2000). Earliness farming systems experiments. 2000 McIntyre Valley Cotton Field Day, March 1st, Goondiwindi.

Kochman, J. (May 2000) Fusarium wilt in cotton-the 1999/2000 season. Cotton Consultants Australia Inc. Annual General Meeting, 17 May 2000, Narrabr.i

Rochester, I. J. (August 1999) Lecture to Cotton CRC Cotton Production Course students.

Rochester, I.J. Presentation at SOILPAK workshop on using soil characteristics to identify production potential.

Bange, M. presented CSIRO research review hosted by Cotton Seed Distributors on the cotton agronomy/ physiology research conducted by CSIRO.

Bange , M. Decision Tools for Crop Rotation and Management Systems GRDC Adviser Update, Narrabri.

Richards, D. (1999). Summary of physiological research results from the 1998/99 Ultra Narrow Row trial for DeltaPine field staff at the Dubbo UNR Conference.

Richards, D. (1999). Results of simulation analysis of skip-row cotton potential at the Upper Namoi field day, Mullaley, 22nd March 1999.

Richards, D. (1999). Presented information on crop yield potential with seasonal forecasts on the CSD/CSIRO Dryland summer cropping tour, 7th-8th September 1999.

Wilson, L.J., Rezaian, A., Forrester, N.W. and **Wright, P.** (2000) Bunchy Top – presentation to AGM of the Cotton Consultants Australia, May 17, Narrabri.

Kochman, J. Presentations to 12 Grower meetings addressing Fusarium wilt problems. Locations started from Warren in the south to Theodore in the north and Dirrinbandi and St George in the west. More than 900 growers and consultants attended.

Roth, G. Faculty of Sciences Seminars, The University of New England.
Roth, G. School visits.
Roth, G. Cotton CRC Cotton Course stands at Ag Quip, Wool Expo, Mudgee Small Farm Field Days, Toowoomba Farm Fest.

Kauter, G. Presentation: South Burnett Cotton Field day, Review IPM in 1999/2000 Cotton season and outline the development of the CRC IPM Short Course, Byee, Qld., 23 Feb., 2000.
Organising Committee: Macintyre Valley Field day, BEYOND 2000, The Farming system and The Cotton Protection system, Goondiwindi, Qld., 1 March, 2000.
Presentation: UNE Cotton Production Course, Cotton Protection Summer Residential, Late Season Helicoverpa Thresholds and IPM in cotton, Goondiwindi, Qld., 9 March, 2000.
Presentation: Macquarie Valley Cotton Field day, IPM and Soft Option Management in Queensland, Warren, NSW, 16 March, 2000.
Organising Committee: Macintyre Valley P&A Show Cotton display, GMO's in the Cotton Industry, Goondiwindi, Qld., 28/29 April, 2000.
Presentation: Cotton Consultants Australia Inc. (AGM), IPM Update on Research & Development, Narrabri, NSW, 16 May, 2000.

Goyne, P (1999/2000)Presentations on RWUEI Cotton/Grains Adoption Program*:*
Upper Condamine Irrigators meeting 13/9/99
CRDC WUE workshop Toowoomba 29/10/99
Dirranbandi Cotton Growers Assocn meeting 11/11/99
Progress reports to RWUEI Committee 15/11/99, 22/2/00
Dawson/Callide Growers meeting 29/11/99
Emerald Cotton Growers Meeting 29/11/99
Development Extension Officers Meeting Biloela 28/3/00
BMP Management Committee meeting 8/5/00

Okello-Okanya, J. **Extension Activities:**
Emerald coton growers meetings 24/1/00; 7/1/00; 5/4/00
Nagoa cotton growers 3/5/00
Mixed Grower meetings –Emerald 24/2/00
Cotton/grain/pulse growers- Emerald 3/5/00

Springer, D. Extension Activities:
Dawson Valley Cotton Growers Inc Meeting 3/5/00
Callide Valley Water Reform Unit Meeting 3/4/00
Callide Valley tour by Mackay Cane Growers 20/3/00

Spragge, A. Extension Activities:
Dalby cotton growers 3/2/00
Allora Grain Growers 21/3/00
Macalister Cotton Growers 4/5/00

Cameron, S. **Extension Activities:**
Macintyre Valley Cotton Field Day and Awards Dinner Committee 21/12/99
Meeting for Irrigators and Consultants in the Goondiwindi area. 22/12 99
Meeting for Irrigators and Consultants in the Mungindi/Talwood area. 22/12/99
Macintyre River Basin Water Users Association meeting 7/2/00
Macintyre Valley Cotton Growers Association meeting 16/3/00
Callandoon Area wide Management Group 13/3/00
Lower Weir River Water Users Association 9/5/00

Hood, S. Extension Activities:
St George Cotton Growers 11/1/00, 2/2/00
St George Cotton Growers Assocn. 10/2/00
St George Regional Committee (Adoption Program) 13/3/00

Larsen, D. Mobile TECHNOLOGY RESOURCE CENTRE with CottonLOGIC workshops:, Moree, Goondiwindi, Pittsworth, Dalby, Theodore, Emerald, Walgett, Bourke, Hillston, Warren, ACRI Gunnedah, CCA AGM Narrabri, Field Days Narrabri, Moree, Warren.
17 CottonLOGIC workshops have been conducted throughout the industry with 250 attendees.

Deutscher, S. presented NutriLOGIC trial results at the CSIRO/CSD research review in May 1999

Online and CD-ROM based delivery of Cotton Certificate courses: The project was presented as a showcase to the National Collaborative Frameworks for Flexible Learning Symposium, University of Newcastle, 5-7 December 1999.

Cai, J.Y. (2000) Presentation at a Research Meeting at CSIRO TFT in February.

Cotton Consultants Association IPM Conference, Goondiwindi, August 27/28, 1999.

O'Brien, M.A. (2000) Presentation to Business Managers at the CRC Association conference on successfully bidding for a new CRC.

TRADE SHOWS:

Larsen, D. Promotion of CottonLOGIC & TRC at Wee Waa Show

Larsen, D. Promotion of CottonLOGIC & TRC at Moree Cotton Trade show

GROWER MAGAZINES & ARTICLES:

Bange, M., Carberry, P., and Hammer, G. (1999). Seasonal climate forecasting for cotton management. *The Australian Cottongrower*. 20(3): 36-42.

Bange, M., Deutscher, S., and **Plummer, C.** (1999). CottonLOGIC: Survey shows the way forward. 20 (4). *The Australian Cottongrower*. pp.40-42.

Baskaran, S. and **Kennedy, I. R.** (1999). Herbicides for sustainable cotton production: environmental impact assessment. *Australian Cottongrower* 20 (1), 54-58.

Cameron, S. (2000). Water use efficiency project. *Country Courier* . Issue 11, Jan-March 2000.

Cameron, S. (2000). Water use efficiency. *Macintyre Valley Cotton Tails*. Issue 4, 6th April 2000.

Deutscher, S. (1999). CottonLOGIC Moving towards 2000. 20 (6) *The Australian Cottongrower.* pp. 40-43.

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Fitt, G.P**. ABC Radio Darwin.**

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Kochman, J. Cotton World Video - Fusarium wilt 20 April 2000.

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Lytton – Hitchins, J. (1999) Interview with Dianne Tyson during 'cotton news segment' on 2WE Radio, Bourke on July 1.
Promotion of CottonLOGIC through SBS television Dec. 1999

Quinn, J. (1999/2000) In conjunction with local radio station 2VM based in Moree, twice weekly contributions were made to the Cotton Excellence program. This program assisted with the extension of trial work and notification of field days conducted in the district. It also had a benefit in boosting the profile of the Cotton CRC to the local cotton community.

Richards, D.O. Radio interview for ABC Rural following the Gunnedah CSD/CSIRO Dryland summer cropping tour presentation.

Roberts, G.N. (1999) Radio interviews with Bourke and Tamworth radio station for ACRI Field Day and on Roundup Ready technology.
Roberts, G.N. **(2000) Tape recorder interview for Cotton Outlook series presented to cotton consultants.**

OPEN DAY:

The Cotton CRC in conjunction with participants CSIRO and NSW Agriculture held an Open Day on 8 December 1999 for the public at the Australian Cotton Research Institute, Narrabri NSW. A demonstration field was planted with various cotton trials and laboratories, glasshouses and insectaries were open to the public where over 20 Cotton CRC researchers explained their research. A special program was created for school children. Over 200 adults attended the Open Day and 200 children from four local primary and secondary schools. We also achieved excellent publicity from the event.

COTTON CRC COMMUNICATIONS WORKSHOP:

The Cotton CRC held a workshop of all the Centre's participants at Narrabri on 6 March 2000. The purpose of the workshop was to exchange information on each organisations cotton communications strategy and for the Cotton CRC to put in place guidelines for acknowledging the Cotton CRC in all public communications.

MEDIA RELEASES:

July 1999
"Research helps conserve cotton resources"
"Immense benefits from Cotton CRC research"
"Cotton farming benefits from CRC research"
"Cotton CRC gets the message across"
"Australian bred cottons are cornerstone of industry"
"Cotton crop protection – a gargantuan task"

AUDITOR'S REPORT

MICHAEL A. CARRIGAN & Co.
CHARTERED ACCOUNTANTS

**AUDITOR'S REPORT TO
THE COOPERATIVE RESEARCH CENTRES SECRETARIAT,
DEPARTMENT OF INDUSTRY, SCIENCE AND RESOURCES
REPRESENTING THE COMMONWEALTH IN RESPECT OF
THE AUSTRALIAN COTTON COOPERATIVE RESEARCH CENTRE
FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2000**

Scope

We have audited the financial information of the Australian Cotton Cooperative Research Centre as set out in Tables 1 and 2 of the Annual Report (being the tables showing in-kind and cash contributions for each party to the CRC and cash expenditure) for the year ended 30 June 2000. The parties of the Cooperative Research Centre are responsible for the preparation and presentation of the 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 Cooperative Research Centre

The financial information has been prepared for the parties to the Australian Cotton Cooperative Research Centre for the purposes of fulfilling their annual reporting obligations under clause 14(1) (f) of the Commonwealth Agreement and for distribution to the Cooperative Research Centres Program, Department of Industry, Science and Resources representing the Commonwealth of Australia. We disclaim any assumption of the responsibility for any reliance on this report or on the financial information to which it relates to any person other than those mentioned above, or for any purpose other than that for which it was prepared.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial information is free of material misstatement. Our procedures included examination, on a test basis, of evidence supporting the amounts of other disclosures in the financial information, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion whether, in all material respects, the financial information is presented fairly in accordance with Australian accounting concepts and standards and requirements of the Commonwealth Agreement in terms of Clauses 4 (Contributions), 5(1), 5(2), 5(3) (Application of the Grant and Contributions), 9(1), 9(5) (Intellectual Property) and 12(2) (Financial Provisions), so as to present a view of the sources of funding and the application of the funding of the Australian Cotton Cooperative Research 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.

NARRABRI
WEST WYALONG
Member of the Institute of Chartered Accountants in Australia
Association with Deloitte Touche Tohmatsu

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, with the following exceptions:

		('000's) Amount Committed	('000's) Amount Provided
2000	NSW Agriculture	2058	2052
	Agriculture WA	652	642
	Queensland Cotton	56	13
	Western Agricultural Industries	125	98

The total value of all Contributions for the year under report equaled or exceeded the amount of grant paid during the year (not including advances) [Clause 5].

2. The Researcher has used the Grant and the Researcher's Contributions for the Activities of the Centre and in my professional opinion there appear to be no material reporting irregularities. [Clause 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 $603,000 over the original budgeted figure for the respective heads of expenditure.

   - other expenditure which were $175,000 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 Centre Agreement [Clause 5(4)]

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 Centre 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)]

24th April 2001

Signature: .....

Address: Michael A Corrigan & Co
PO Box 117
NARRABRI NSW 2390

GRANTS

Current Research Grants held by the Director and key Cotton CRC researchers

Reseacher and Researcher's Organisation	Title of Grant	Scheme	Grant Period	Total $'000s
Dr Gary P. Fitt, CEO Cotton CRC	Ecological aspects of Helicoverpa populations related to the successful deployment of Bt transgenic cottons	CRDC	97-00	300
	Ecology of minor Lepidopteran pests of cotton and applications of the HEAPS Helicoverpa Population Dynamics Model	CRDC	96-99	225
	Insect pest resistance and the role of induced responses to damage in Australian cottons	CRDC	99-02	331.3
	A reappraisal of sampling relationships and Helicoverpa feeding behaviour in INGARD cotton	CRDC	97-00	190
	Augmentation and conservation of Helicoverpa parasitoid populations in cotton	CRDC	98-02	310
	Forescast of spring helicoverpa migartion from central Australia	CRDC	99-00	0.4
	Development of agronomic management options for dry season cotton production in NW Australia.	CRDC	98-02	420
Dr John Triantafilis, USYD	Determine salinity threat in irrigated cotton in upper and lower Namoi valley	Salt Action	98-99	65
	Understand and manage causes of salinity in irrigated farming systems south-east of Trangie	Salt Action	99-00	89.3
	Determine causes & controls of salinity in irrigated farming systems in the Bourke irrigation area	Salt Action	99-00	89.3
	Understanding the salinity threat in cotton growing areas of Australia phase III - Implementation and management	CRDC	99-02	173
	Understanding salinity threat in irrigated cotton areas of Macintyre River valley	Natural Heritage Trust	99-00	93.7
Dr Joe Kochman, DPIQ	Ecology and development of management strategies for fusarium wilt in cotton	CRDC	99-00	117.7
Dr Andy Richards, CSIRO	Application of a biological-molecular assay to investigate the distribution and persistence of a baculovirus pathogen of *Spodoptera frugiperda*: the principle pest of maize in Mexico and Central America	Australian Academy of Sciences	00-00	0.6
Janelle Montgomery, UNE	The Environmental Impact of Irrigation in the Gwydir Valley on the Murray Darling Basin	Gwydir Valley Irrigators Association and Natural Heritage Trust	98-01	350
Dr Michael Bange, CSIRO	Enhanching devlopment, support and evaluation of computerised decision support	CRDC	99-02	85
	ACRI computer network support	CRDC	99-00	108
Broughton Boydell, USYD	The applications of precision agriculture techniques to cotton farming systems	CRDC	97-00	16
Dr Philip Wright, NSWA	Physiological and agronomic factors affecting the efficacy of Bt in transgenic cotton	CRDC	99-02	124.9
Dr Nilantha Hulugalle, NSWA	Long term effects of cotton rotations on the sustainability of cotton soils II	CRDC	99-02	108.4
Dallas Gibb, NSWA	Trainee Industry Development Officer	CRDC	99-02	66.3
	National Cotton Extension Coordinator	CRDC	96-99	57.7
Dr Ian Rochester, CSIRO PI	Improving the N nutrition of cotton using rotation crops	CRDC	97-00	156.7
Chris Dorahy, UNE	Improving the sustainability of cotton production with new plant growth regulators	CRDC	97-00	62.4
Dr Subbu Putcha, NSWA	Cotton residue decomposition	CRDC	98-01	67.2
Geoff McIntyre, DPIQ	IPM Traning Coordinator	CRDC	98-01	136.8
	Improving on farm irrigation water use efficiency in the Queensland cotton and grain industries	QDNR	99-03	757.6
Dr Lewis Wilson, CSIRO PI	Bunchy Top Research	CRDC	99-00	21

PERFORMANCE INDICATORS

Nature of Indicator	Performance Indicator	Year 1 Performance 1999/2000
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 ($1.5 million/yr) • Enhanced sustainability of industry will maintain economic benefits to rural communities and Australian exports • Commercialisation 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 $14.54 million (target $13.0 million for Year One) • Total leverage to date > 7.0 vs Commonwealth cash (target > 6.0) • Total cash resources to date - $5.09 million (target $3.87 million for Year One) • Cash 35% of total resources to date (target 24% for life of the Centre)
Process	Program/ Project Management	• Board, Management Committee and Northern Committee established. • Annual plan and budget agreed • Advisory committee established – comprising external scientific, industry and community representatives • Process for formal Annual Review of all projects established with first review in July 2000 • External review of decision support systems commenced.
Outputs	Centre Reports and Publications transferring research outcomes and technology to industry	• Cotton industry IPM Guidelines published • A total of 20 other publications relating to IPM (13), Diseases (4) and Resistance management (2) were produced by the Technology Resource Centre and distributed to all growers, consultants and relevant members of the community • Distribution of 800 EntoPAK's, enhanced with new material, and 450 copies of SoilPAK to growers • Release of new version of CottonLOGIC in Nov 1999, with over 800 registered users across the industry • Northern Australia Scoping document initiated • Cotton CRC Website maintained and averaging 400 visits per day • Website receives 12 out 12 rating with "farmwide.com.au", Australia's farm-related web portal and 11 out of 12 star rating in RIRDC's "Australian Farmers Guide to the Internet" 1999 • CRC receives 1999 National Award for Excellence through information Technology for its Website and the Decision Support package, CottonLOGIC
	Short courses	• IPM Training Co-ordinator appointed. Design of short course in IPM for farmers complete. Development underway. Pilot courses targetted for 2000/2001 season. • Twenty training Workshop s in the use of CottonLOGIC were held at locations from Darwin, NT to Hillston in southern NSW. Over 200 participants were trained.

Nature of Indicator	Performance Indicator	Year 1 Performance 1999/2000
Quality and relevance of the research program		
Outcome	Scientific Status and user satisfaction	• Industry involved in all discipline groups involved with identification of priorities and evaluation of research progress
Input	Research Program Resources	• $10.45 million Cash and in-kind resources on research program to date (target $61.6 million over the life of the Centre). • Distribution of resources across programs in line with Business Plan.
Process	Involvement with Research users and industry	• Twelve discipline groups established in November 99 each with a coordinator, to identify priorities and assess progress. Australian Cotton Growers Research 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 reviews 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 Australian Cotton Industry Council. CRC Chairman elected as deputy Chair of ACIC • CRC provide representatives to Cotton Consultants Australia Inc. and liaises closely with Cotton R&D Corporation Board • Regional Steering Committees established for externally funded projects in Water Use Efficiency (Qld) and Environmental Impacts of Irrigation (NSW)
Outputs	External Publications	• 33 journal papers and book chapters, 65 conference and other publications • >100 presentations at Conferences, Workshops, grower meetings • Numerous technical publications for industry distributed through Technology Resource Centre

Nature of Indicator	Performance Indicator	Year 1 Performance 1999/2000
Strategy for utilisation 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 farming systems sites as demonstrations for specific issues • Twenty demonstration sites established for Water Use Efficiency studies in Qld
Input	User Core Participant Resources	• 2.92 million in cash and in-kind devoted to Technology Transfer and communications in Year One • Technology Resource Centre as key physical resource for packaging and distribution of printed and electronic information • $2.5 million core user Participant resources (target $11.6 million over life of the Centre). • Core Participant Cash 33.3% of cash resources.
Process	Communication and implementation of Centre research outcomes and technology	• National cotton extension network in place with Extension Development Officers in place in most regions • Water Use Efficiency Officers established in 5 regions throughout Qld to support adoption of best Management Practices for irrigation • Research program outcomes proposed for incorporation into industry guidelines for management (IPM Guidelines already produced). • 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	Commercialisation and IP management	• Commercialisation Strategy developed for one project, business plan commenced, talk with potential commercial partners initiated • Assessment made of other Centre IP
	Technology transfer and adoption	• 20 industry publications including IPM Guidelines • Distribution of 1200 information packs • Release of new version of CottonLOGIC in Nov 1999 • Award winning Cotton CRC Website maintained • 20 Workshops • information stand at Australian Cotton Trade Show, Moree • 13 Fields days in established regions, plus Research Update and Field Day in the Ord River Irrigation Area , WA. • Cotton Research Open Day for general public at Australian Cotton Research Institute, Narrabri
	PR/ Press Releases	• 27 media releases in Year One (target 12)

Nature of Indicator	Performance Indicator	Year 1 Performance 1999/2000
Collaborative arrangements		
Outcome	Cooperation in research within Australia and overseas and more efficient use of resources	• Informal linkages to 9 cotton research institutions in the USA and 3 in China • Collaborative projects involving researchers from USA, China and Japan • Joint project negotiations established with two CRC's
Input	Research Providers FTE In Kind	• Year 1 – Researchers 47.84 FTE In kind increased (target 47.7)
Process	Collaboration Between Researchers	• 40% of projects involve two or more participants • Use of Shared facilities • Annual Research Review • 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 • Northern Committee met twice in Year 1 – established clear priorities • Twelve Discipline Groups established – ten met at least once in year 1 with written reports produced • Annual Research Review completed in July
	International Collaboration	• 5 international exchanges in Year 1 – 4 involved Centre researchers and extension staff visiting US research locations and production areas; 1 involved a research visitor from Japan • 6 Centre researcher participation in international conferences • Hosted visits by 3 groups of international visitors and researchers • Student presentations at conferences
Outputs	Collaborating authors on publications	• Collaborating authors on 20 % of centre publications

Nature of Indicator	Performance Indicator	Year 1 Performance 1999/2000
Education and training		
Outcome	Cotton Production Courses	• 30 people graduated from the Cotton Production Course (Certificate and Diploma) in April 2000 – highest number of graduates since the inception of the course • All these students directly employed in cotton industry • 20 undergraduates completed Applied Cotton Production unit at UNE, including one enrolled externally from University of Western Sydney. • Cotton Consultants Australia Inc. adopts Cotton Production Course as requirement for accreditation as Certified Practicing Cotton Consultant
Input	Education and training Program Resources	• $0.65 million cash and in-kind resources committed to education strategies in year one (target $3.3 million over the life of the Centre). • 30 in-kind scientists have input to course delivery
Process	Industry training	• Year 1 - 3 postgraduate scholarships offered, plus 19 continuing students from first round •
Outputs	Students, scholarships, lecturer	• 3 Postgraduates completed in year 1 – commenced in first round • 30 graduated from Cotton Production Certificate Course • 2 undergraduate scholarships commenced • 5 summer scholarships supported • Centre lecturer maintained, at least 30 scientists involved in presentation of course.

Nature of Indicator	Performance Indicator	Year 1 Performance 1999/2000
Management structure and arrangements		
Outcome	Continuity of long term research effort	• Most parties maintain commitment to Centre. • Change of ownership of Colly Cotton to become Twynam Cotton lead to change in focus away from northern Australia and decision to withdraw from Centre by December 2000
Input	Total cash and in-kind resources in general administration program	• $0.51 million cash and in-kind resources for Year One (target $2.2 million over the life of the Centre).
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 (to commence in 2001)
Outputs	Financial Management and Reporting	• Budget reports and cash flow projections provided to Board and Management committee quarterly • Financial systems established
	Monthly, quarterly and Annual Report on time	• Financial reports submitted on time to the Board • Annual report submitted in third quarter

BUDGETS

ATTACHMENT B

RESEARCH STAFF RESOURCES

IN-KIND CONTRIBUTION BY ORGANISATION (PERSON YEARS) 1999/2000

CSIRO	Main Activity	Total % of Time	% 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					
Brubaker, Curt (Dr)	R	100		100			100				
Dillon, Martin	R	100	45		50		95	5			
Schellhorn, Nancy (Dr)	R	100			100		100				
Singh, Dhananjay (Dr)	R	100	100				100				
King, David (Dr)	R	50				50	50				
Bange, Michael (Dr)	R	40	30				30	5		5	
Eastick, Rowena (Dr)	R	40	40				40				
Lei, Tom (Dr)	R	40			40		40				
Milroy, Steve (Dr)	R	40			40		40				
Tennakoon, Sunil (Dr)	R	40	20		20		40				
Wilson, Lewis (Dr)	R	40			35		35	5			
Carberry, Peter (Dr)	R	30	10		10		20			10	
Collof, Matt (Dr)	R	30	15		15		30				
Dalgliesh, Neil (Dr)	R	30			20		20			10	
Hochman, Zvi (Dr)	R	30	10		10		20			10	
Oakeshott, John (Dr)	R	30		30			30				
Christian, Peter (Dr)	R	25		25			25				
Daly, Joanne (Dr)	R	25		25			25				
Constable, Greg (Dr)	R	20	5		10		15	5			
Llewellyn, Danny (Dr)	R	20		15			15	5			
Reid, Peter	R	20			20		20				
Richards, Dirk	R	20			20		20				
Cookson, Peter (Dr)	R	15				10	10			5	
Akhurst, Ray (Dr)	R	10		10			10				
Brown, Tony (Dr)	R	10		10			10				
Smith, Shaun (Dr)	R	10				10	10				
Yeates, Stephen (Dr)	R	8			8		8				
Plummer, Chris	T	40					0			40	
Pfeiffer, Tony	T	40					0			40	
Linsley, Darren	T	40					0			40	
Deutscher, Sandra	T	40					0			40	
		11.83	**2.75**	**2.15**	**3.98**	**0.70**	**9.58**	**0.25**	**0.00**	**2.00**	**0.00**

NSWA	Main Activity	Total % of Time	% 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					
Holloway, Jonathan (Dr)	R	100			90		90	10			
Charles, Graham	R	60			55		55	5			
Nehl, David (Dr)	R	60	2		55		57	3			
Wright, Philip (Dr)	R	53			45		45	8			
Hulugalle, Nilantha (Dr)	R	50			45		45	5			
Khan, Moazzem	R	50			50		50				
Cooper, Jack	R	40			40		40				
Friend, John	R	40			40		40				
Mensah, Robert (Dr)	R	40		35			35	5			
Putcha, Subbu (Dr)	R	40		40			40				
Gunning, Robin	R	30			30		30				
Farquharson, Bob	R	20			20		20				
Hickman, Mark	T	100					0			100	
Rourke, Kirrily	T	100					0			100	
Whyte, Simon	T	100					0			100	
Gibb, Dallas	T	70					0	10		60	
Jenkins, Leigh	T	50					0			50	
Parker, Myles	T	20					0			20	
Tonkin, Cameron	T	20					0			20	
Shaw, Gus	T	10					0			10	
		10.53	**0.02**	**0.75**	**4.70**	**0.00**	**5.47**	**0.46**	**0.00**	**4.60**	**0.00**

	Main	Total %	% Spent on Research Program	% Spent on	% Spent on	% Spent on	% Spent on

ATTACHMENT B

COTTON CRC AND CASH FUNDED RESEARCH STAFF BY ORGANISATION (Person Years)

CSIRO	Main Activity	Total % of Time	% 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					
Cai, Jackie (Dr)	R	100				100	100				
Ellis, Mark	R	100		100			100				
Lytton-Hitchins, J (Dr)	R	100			100		100				
Press, Lexie (Dr)	R	100		100			100				
Richards, Andy (Dr)	R	100		100			100				
Roberts, Grant	R	100			100		100				
Rochester, I (Dr)	R	100			100		100				
Yeates, Stehen (Dr)	R	75	75				75				
Whiteside, Stewart	T	58					0			58	
Thomas, Alex	T	17					0			17	
Fitt, Gary (Dr)	A	100					0		10	20	70
O'Brien, Maxine	A	100					0		20		80
Schick, Nicky	A	100					0		20	10	70
		11.50	**0.75**	**3.00**	**3.00**	**1.00**	**7.75**	**0.00**	**0.50**	**1.05**	**2.20**

NSWA	Main Activity	Total % of Time	% 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					
Hoque, Ziaul	T	100								100	
Larsen, David	T	100							10	90	
Quinn, James	T	100								100	
Rea, Maris	T	100							30	70	
		4.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.40**	**3.60**	**0.00**

DPIQ	Main Activity	Total % of Time	% 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					
Zischke, Rachael	R	50			50		50				
Moore, Chris (Dr)	R	20		20			20				
Kauter, Greg	T	100					0			100	
Goyne, Phil (Dr)	T	90					0			90	
Cameron, Sandy	T	50					0			50	
Hood, Sarah	T	50					0			50	
Okello-Okanya, John	T	50					0			50	
Springer, Darren	T	40					0			40	
		4.50	**0.00**	**0.20**	**0.50**	**0.00**	**0.70**	**0.00**	**0.00**	**3.80**	**0.00**

UNE	Main Activity	Total % of Time	% 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					
Del Soccorro, Alice (Dr)	R	100		100			100				
Douglas, Janelle	R	100			100		100				
Silberbauer, Letitia (Dr)	R	100			100		100				
Lockwood, Peter (Dr)	E	100					0	100			
Roth, Guy	E	100					0	100			
		5.00	**0.00**	**1.00**	**2.00**	**0.00**	**3.00**	**2.00**	**0.00**	**0.00**	**0.00**

USYD	Main Activity	Total % of Time	% 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					
Baskaran, Sundaram (Dr)	R	100			100		100				
Odeh, Inakwu (Dr)	R	100			100		100				
Vervoort, Willem (Dr)	R	100			100		100				
Sanchez-Bayo, Francisco (Dr)	R	50			50		50				
Triantafilis, John (Dr)		100			100		100				
		4.50	**0.00**	**0.00**	**4.50**	**0.00**	**4.50**	**0.00**	**0.00**	**0.00**	**0.00**

TOTAL	TOTAL 99/00	Total % of Time	% 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					
		29.50	**0.75**	**4.20**	**10.00**	**1.00**	**15.95**	**2.00**	**0.90**	**8.45**	**2.20**

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	47.84	9.67	4.78	17.04	0.70	32.19	2.10	0.00	13.55	0.00
TOTAL FUNDED BY CRC	29.50	0.75	4.20	10.00	1.00	15.95	2.00	0.90	8.45	2.20
GRAND TOTAL	77.34	10.42	8.98	27.04	1.7	48.14	4.1	0.90	22.00	2.20
Proportion of total professional staff resources in each activity	**100%**	**13.5%**	**11.6%**	**35.0%**	**2.2%**	**62.2%**	**5.3%**	**1.2%**	**28.4%**	**2.8%**

ATTACHMENT B

SUPPORT STAFF

Contributed	
Organisation	No. Staff (person years)
Agriculture WA	1.85
Cotton Research & Development Corporation	0.00
Cotton Seed Distributors	0.45
CSIRO	9.26
Dept. Primary Industries, Qld	6.95
NSW Agriculture	8.40
NTDPIF	2.30
Queensland Cotton	0.00
Twynam	0.50
University of New England	0.80
University of Sydney	0.00
WAI	0.20
TOTAL	**30.71**

CRC Funded (by employing organisation)	
Organisation	No. Staff (person years)
Agriculture WA	0.00
Cotton Research & Development Corporation	0.00
Cotton Seed Distributors	0.00
CSIRO	6.70
Dept. Primary Industries, Qld	3.33
NSW Agriculture	4.67
NTDPIF	0.00
Queensland Cotton	0.00
Twynam	0.00
University of New England	0.00
University of Sydney	3.00
WAI	0.00
TOTAL	**17.70**

IN-KIND CONTRIBUTIONS FROM PARTICIPANTS (DOLLARS IN '000's)

TABLE 1

PARTICIPANT	EXPENDITURE 1999/00 Actual	EXPENDITURE 1999/00 Agr'mt	CUMULATIVE TOTAL TO DATE Actual	CUMULATIVE TOTAL TO DATE Agr'mt	PROJECTED EXPENDITURE 2000/01 Agr'mt	2001/02 Agr'mt	2002/03 Agr'mt	2003/04 Agr'mt	2004/05 Agr'mt	2005/06 Agr'mt	Total 7 years	GRAND TOTAL Agr'mt 7 years	Diff 7 years
CSIRO													
Salaries	1367	1239	1367	1239	1271	1250	1234	1234	1234	1234	8824	8696	128
Capital	0		0	0							0	0	0
Other	1162	1129	1162	1129	1157	1140	1120	1120	1120	1120	7939	7906	33
Total	**2529**	**2368**	**2529**	**2368**	**2428**	**2390**	**2354**	**2354**	**2354**	**2354**	**16763**	**16602**	**161**
NSW Agriculture													
Salaries	1086	1029	1086	1029	1029	1029	1029	1029	1029	1029	7260	7203	57
Capital	0		0	0							0	0	0
Other	967	1029	967	1029	1029	1029	1029	1029	1029	1029	7141	7203	-62
Total	**2052**	**2058**	**2052**	**2058**	**2058**	**2058**	**2058**	**2058**	**2058**	**2058**	**14400**	**14406**	**-6**
Qld Dept Primary Industries													
Salaries	1195	945	1195	945	945	945	945	945	945	945	6865	6615	250
Capital	0		0	0							0	0	0
Other	1344	1186	1344	1186	1186	1186	1186	1186	1186	1186	8460	8302	158
Total	**2539**	**2131**	**2539**	**2131**	**2131**	**2131**	**2131**	**2131**	**2131**	**2131**	**15325**	**14917**	**408**
Agriculture WA													
Salaries	270	281	270	281	281	281	281	281	281	281	1956	1967	-11
Capital	0		0	0							0	0	0
Other	372	372	372	372	319	315	285	275	265	215	2046	2046	0
Total	**642**	**653**	**642**	**653**	**600**	**596**	**566**	**556**	**546**	**496**	**4002**	**4013**	**-11**
NT Dept Primary Industry & Fisheries													
Salaries	276	211	276	211	211	211	211	211	211	211	1542	1477	65
Capital	0		0	0							0	0	0
Other	166	152	166	152	152	152	152	152	152	152	1078	1064	14
Total	**442**	**363**	**442**	**363**	**363**	**363**	**363**	**363**	**363**	**363**	**2620**	**2541**	**79**
The University of Sydney													
Salaries	136	130	136	130	130	130	130	130	130	130	916	910	6
Capital	0		0	0							0	0	0
Other	235	224	235	224	224	224	224	224	224	224	1579	1568	11
Total	**371**	**354**	**371**	**354**	**354**	**354**	**354**	**354**	**354**	**354**	**2495**	**2478**	**17**
The University of New England													
Salaries	502	292	502	292	292	292	292	292	292	292	2254	2044	210
Capital	0		0	0							0	0	0
Other	236	221	236	221	221	221	221	221	221	221	1562	1547	15
Total	**738**	**513**	**738**	**513**	**513**	**513**	**513**	**513**	**513**	**513**	**3816**	**3591**	**225**
CRDC													
Salaries	69	62	69	62	62	62	62	62	62	62	441	434	7
Capital	0		0	0							0	0	0
Other	43	39	43	39	39	39	39	39	39	39	277	273	4
Total	**112**	**101**	**112**	**101**	**101**	**101**	**101**	**101**	**101**	**101**	**718**	**707**	**11**
Cotton Seed Distributors													
Salaries	151	113	151	113	113	113	113	113	113	113	829	791	38
Capital	0		0	0							0	0	0
Other	174	134	174	134	134	134	134	134	134	134	978	938	40
Total	**325**	**247**	**325**	**247**	**247**	**247**	**247**	**247**	**247**	**247**	**1807**	**1729**	**78**
Queensland Cotton													
Salaries	7	31	7	31	31	31	31	31	31	31	193	217	-24
Capital	0		0	0							0	0	0
Other	6	25	6	25	25	25	25	25	25	25	156	175	-19
Total	**13**	**56**	**13**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**349**	**392**	**-43**
Western Agricultural Industries													
Salaries	52	68	52	68	68	68	68	68	68	68	460	476	-16
Capital	0		0	0							0	0	0
Twynam Cotton													
Salaries	157	120	157	120	120	120	120	120	120	120	877	840	37
Capital	0		0	0							0	0	0
Other	101	65	101	65	65	65	65	65	65	65	491	455	36
Total	**258**	**185**	**258**	**185**	**185**	**185**	**185**	**185**	**185**	**185**	**1368**	**1295**	**73**
TOTAL IN-KIND CONTRIBUTIONS													
Salaries	5267	4521	5267	4521	4553	4532	4516	4516	4516	4516	32416	31670	746
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	4853	4633	4853	4633	4608	4587	4537	4527	4517	4467	32096	31876	220
GRAND TOTAL (IN-KIND) (T1)	**10120**	**9154**	**10120**	**9154**	**9161**	**9119**	**9053**	**9043**	**9033**	**8983**	**64512**	**63546**	**966**

ATTACHMENT C

CASH CONTRIBUTIONS (DOLLARS IN '000s)

PARTICIPANT	ACTUAL 1999/00 Actual	ACTUAL 1999/00 Agr'mt	CUMULATIVE TOTAL TO DATE Actual	CUMULATIVE TOTAL TO DATE Agr'mt	PROJECTED 2000/01 Agr'mt	2001/02 Agr'mt	2002/03 Agr'mt	2003/04 Agr'mt	2004/05 Agr'mt	2005/06 Agr'mt	Total 7 years	GRAND TOTAL Agr'mt 7 years	Diff 7 years
CRDC Cash Contribution	350	350	350	350	350	350	350	350	350	350	2450	2450	0
Cotton Seed Distributors	300	300	300	300	300	300	300	300	300	300	2100	2100	0
Twynam Cotton	50	50	50	50	50	50	50	50	50	50	350	350	0
The University of New England	100	100	100	100							100	100	0
		0	0	0							0	0	0
			0	0							0	0	0
TOTAL CASH FROM PARTICIPANTS	**800**	**800**	**800**	**800**	**700**	**700**	**700**	**700**	**700**	**700**	5000	5000	0
NSW Government	95		95	0							95	0	95
Qld Government	841		841	0							841	0	841
Other	14		14	0							14	0	14
Other (eg Interest)	44		44	0							44	0	44
External Grants	303	100	303	100							303	100	203
CRDC Grants	995	970	995	970	652	448					2095	2070	25
OTHER CASH	**2292**	**1070**	**2292**	**1070**	**652**	**448**	**0**	**0**	**0**	**0**	3392	2170	1222
CRC GRANT	**2000**	**2000**	**2000**	**2000**	**2200**	**2200**	**2100**	**2100**	**1800**	**1000**	13400	13400	0
TOTAL CRC CASH CONTRIBUTION (T2)	**5092**	**3870**	**5092**	**3870**	**3552**	**3348**	**2800**	**2800**	**2500**	**1700**	21792	20570	1222
Cash carried forward	891												
Less Unspent Balance	1562												
TOTAL CASH EXPENDITURE (T3)	**4421**	**3870**	**4421**	**3870**	**3552**	**3348**	**2800**	**2800**	**2500**	**1700**	21121	20570	551

ALLOCATION OF CASH EXPENDITURE BETWEEN HEADS OF EXPENDITURE

SALARIES	2997	2394	2997	2394	2615	2585	1915	1730	1795	1232	14869	14266	603
CAPITAL	167		167	0							167	0	167
OTHER	1258	1083	1258	1083	1042	1022	898	899	847	512	6478	6303	175
TOTAL EXPENDITURE	**4421**	**3477**	**4421**	**3477**	**3657**	**3607**	**2813**	**2629**	**2642**	**1744**	21513	20569	944

ATTACHMENT C

TABLE 3

SUMMARY OF RESOURCES APPLIED TO ACTIVITIES OF CENTRE (DOLLARS IN $'000's)

	ACTUAL 1999/00 Actual	ACTUAL 1999/00 Agr'mt	CUMULATIVE TOTAL TO DATE Actual	CUMULATIVE TOTAL TO DATE Agr'mt	2000/01 Agr'mt	2001/02 Agr'mt	2002/03 Agr'mt	2003/04 Agr'mt	2004/05 Agr'mt	2005/06 Agr'mt	Total 7 years	GRAND TOTAL Agr'mt 7 years	Diff 7 years
GRAND TOTAL (IN-KIND) FROM TABLE 1 (T1)	10120	9154	10120	9154	9161	9119	9053	9043	9033	8983	64512	63546	966
GRAND TOTAL (CASH EXPENDITURE) FROM TABLE 2 (T3)	#REF!	3870	#REF!	3870	3552	3348	2800	2800	2500	1700	#REF!	20570	#REF!
TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE (T1+T3)	#REF!	13024	#REF!	13024	12713	12467	11853	11843	11533	10683	#REF!	84116	#REF!

ALLOCATION OF TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE BETWEEN HEADS OF EXPENDITURE (CASH AND IN KIND)

TOTAL SALARIES (CASH AND IN-KIND)	8264	6915	8264	6915	7168	7117	6431	6246	6311	5748	47285	45936	1349
TOTAL CAPITAL (CASH AND IN-KIND)	167	0	167	0	0	0	0	0	0	0	167	0	167
TOTAL OTHER (CASH AND IN-KIND)	6111	5716	6111	5716	5650	5609	5435	5426	5364	4979	38574	38179	395

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	2729.5	7721.6	32.2	16.0
Education	214.6	438.0	2.1	2.0
External Communications	67.0	0.0	0.0	0.9
Technology Transfer	897.1	1960.4	13.6	8.5
Administration	512.9	0.0		2.2
TOTAL	**4421.2** (T3)	**10120.0** (T1)	**47.8**	**29.5**