

# Australian Cotton Cooperative Research Centre

November, May & Final Reports

## Part 1 - Summary Details

## REPORTS

Please use your TAB key to complete part 1 & 2.

**COTTON CRC Project Number: 4.3.01 AC**

**November Report:**  Due 14-November-03  
**May Report:**  Due 29-May-03  
**Final Report:**  Due within 3 months of project completion

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

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**Project Commencement Date:** 01/07/2000 **Project Completion Date:** 30/06/2003

**Research Program:** 4. Education, Transfer of Technology

## Part 2 - Contact Details

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**Other Staff & Collaborators - Please list** Darren Linsley (CSIRO), Sandra Deutscher (CSIRO), Scott Johnston (CSIRO), David Johnston (CSIRO), Dirk Richards (CSIRO), and David Larsen (NSW Agriculture).

**Signature of Research Provider Representative:** \_\_\_\_\_

**Final Report - Developing innovative computer based technologies for effective delivery of information and cotton management decision support.**

## **Executive Summary**

This project forms part of the overall achievement of the 'Cotton Management Support Systems' team responsible for the development of cotton decision support based at Narrabri.

During the course of this project we have been able to complete or attain:

- A handheld version of CottonLOGIC that will run on the Palm OS ® operating system for in field electronic data collection and decision-making. Many minor releases of CottonLOGIC were distributed that improved functionality of the software and fix software bugs.
- A cotton irrigation management tool HydroLOGIC was developed and released to industry for testing.
- Water budgeting software based on the research of Dr Sunil Tennakoon and Dr Stephen Milroy was made available to the industry development and water use efficiency officers.
- The CottonLOGIC database structure was documented to enable third party software to access the data contained in CottonLOGIC to be used for other purposes (e.g. GIS).
- During the course of this project the Cotton Management Support Systems team have been also responsible for the technical development of the Cotton CRC's website.
- Developed a user-friendly version of the cotton crop simulation model OZCOT.
- Various other software tools have been developed for research purposes. Some examples include software to assist in operation of experimental pickers, Fusarium assessment using the Palm handheld in the field, and tools to compile validation data for simulation model testing (e.g. compensation research).
- Two additional tools were developed as part of CottonLOGIC handheld system: GPS capability and whitefly data entry.
- Significant planning into the future infrastructure of software development to maintain and improve functionality of DSS had also commenced during the course of this project.
- Maintained a fully functional Cotton CRC website with additional features added.

A brief outline of the major results and outcomes from this project are given below under the general headings of: Decision support development and distribution; Field validation of

decision support; Decision support training and support; and Decision support industry feedback.

Present development in areas of DSS (e.g. CottonLOGIC), research information dissemination (e.g. Cotton CRC's website), and cotton simulation modelling (OZCOT) has been outstanding compared with the past. This has primarily occurred because of enhanced resources provided by CSIRO, the Cotton CRC, and CRDC for the employment of additional programmers over the course of the project.

A new project titled 'Delivering science to Agribusiness - novel decision support tools' that addresses current and future initiatives of information technology to assist cotton research dissemination and decision support has been funded by the Cotton CRC and CRDC.

## **Research Staff**

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Mr Scott Johnston Software Developer CSIRO Plant Industry Cotton Research Unit

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Mr David Larsen Coordinator Cotton CRC Technology Resource Centre New South Wales Agriculture.

## **Background and Industry Significance**

Managing sustainable cotton production is becoming more difficult with the ever-increasing demands for limited resources, not to mention the pressure of managing crops more efficiently and responsibly. To do this effectively requires managers to access, collect, store and process reliable and useful information. As with other businesses computer based technologies are seen as a reliable alternative to handling large amounts of information. The Australian Cotton Industry has a proud reputation in accepting innovative computerised decision support systems to assist with these tasks. The reliance on this technology has been increasing. Since 1995 when there were approximately 200 registered users of EntomoLOGIC, this number has increased to over 900 now with CottonLOGIC. In addition

since the inception of the Cotton CRC's web site, visits have substantially increased and can be attributed to the additional research information available as well as improved reliability and useability. Demand from the industry for computer based solutions have also increased especially with industry initiatives such as revamped IPM guidelines, Best Management Practice, Water Use Efficiency, and a coordinated Cotton CRC extension network.

In attempting to resolve issues of some users and to improve decision support, development is continuing on other platforms. One area is the development of software tools that can be mobilised with hand-held machines. This will allow in-field recording of insect data and provide a report to the pest manager in the field as opposed to returning to a computer located in an office. The capacity to then download data in to a desktop version of the software will be possible for storage and further processing. CottonLOGIC on the Hand-held is nearing completion through support of the last Cotton CRC in the project 'Multi-Platform decision support systems'. This task has also identified by the industry decision support steering committee as been one of the top priorities for the developers of computerised decision support. Other opportunities for the use of hand-held platforms are also being investigated.

Another platform for delivery of information and decision support that is showing ever-increasing support is the Internet (WWW). Substantial improvements in the web infrastructure, management, and appearance occurred since its inception in the last cotton CRC. The Technology Resource Centre now operates a fully functional and interactive web site that provides information such as: current weather data from the cotton industry's met stations; cotton industry publications; diary of events within the cotton industry; industry contacts; and providing the latest research information available within the industry.

This project aims explicitly to meet objectives of Program 4 of the Cotton CRC 'Education, Transfer and Adoption of Technology' sub-program 3 'Support – Proactive information services', which are:

- Develop new decision support systems; and
- Enhance Web-Site facilities including access to decision support systems.

## **Research Proposal Summary**

This project followed on from the project funded in the last Cotton CRC ‘Multi-Platform decision support systems’ that contributed to the development of the hand-held version of CottonLOGIC as well as providing resources to maintain (i.e. both looks and functionality) the Cotton CRC’s web site. The project will provide funds to support a programmer with specific skills in web site development as well strong skills in object oriented programming. Skills in object oriented programming will allow certain tasks relating to the handheld to be completed

Following the completion of the hand-held the person will be responsible for implementing new and innovative applications for the Cotton CRC’s web site. In addition the person will be specifically assisting in implementation the ‘Cotton Industry Database’ across different organisations and platforms (especially the WWW). The ‘Cotton Industry Database’ is being developed to provide contact details and other information on industry participants to the members of the Cotton CRC, CRDC, and Cotton Australia and to prevent duplication of this information across organisations.

Other areas in which this project may assist are:

- Exploring multimedia opportunities for training in decision support products and dissemination of information.
- Developing web forums for use by specific research and extension groups.
- Developing a more functional and up to date database, accessed via the web of CRC staff details.
- Exploring the use of E-commerce.
- Linking the OZCOT crop simulation model to the web in an interactive capacity.
- Improving links with CottonLOGIC and the web.
- Developing other tools for the Hand-held.
- Developing an early season crop diagnosis tool to be accessed via the web.
- Providing Helicoverpa pheromone trap data via the web.
- Providing a facility on the web site to provide dates of Helicoverpa diapause induction for each region using real weather data.
- Developing a cotton-replanting guide accessed via the web site.

Located at the Technology Resource Centre at Narrabri, the person will complement the skills of the other programmers, and work as part of a team achieving these and other objectives.

Specific outcomes from this project will be:

- Employ a competent programmer to assist with the development of computerised decision support systems.
- The development of CottonLOGIC software running on a hand-held device for use by the cotton industry.
- A 'Cotton Industry Database' accessed via the Cotton CRC's web site.
- Provide an effective functional and responsive Cotton CRC web site.
- The development of an cotton crop early season diagnosis tool for the Cotton CRC's web site, which includes the following features:
  - Soil temperature analysis for planting;
  - crop development versus degree day calculations;
  - herbicide damage symptoms;
  - seedling diseases;
  - seedling pests and their damage;
- The development of a facility on the web site to provide dates of Helicoverpa diapause induction for each region using real weather data.
- The development of a cotton-replanting guide accessed over the Cotton CRC's web site.
- Improved links between CottonLOGIC and WWW services.
- The provision of web discussion forums to research and extension staff.
- The provision of a database to allow CRC staff to up date and change their details that are presented on the Cotton CRC's web site.

Many of these aspects will be more important as the cotton industry expands to new regions, especially northern Australia. The cotton CRC web site would become a vital communication medium.

The nature of the aims and objectives of this project facilitated the mechanisms for industry and user feedback while remaining flexible enough to respond to the ever-changing needs of the industry. The Cotton Management Support Systems team with the CottonLOGIC software

will take a leading role in allowing good science to be passed on easily and effectively to the industry.

Specifically the project aims were to:

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

Maintaining the level of resources needed to develop and deliver effective DSS is a significant challenge. The factors where resources are allocated to a task for developing decision support are summarised by the need to maintain five key elements. They include:

1. Creating innovation (developing new solutions for decision support);
2. Software development to address strategic industry issues (e.g. water and environment);
3. Industry software support (addressing day to day needs and current issues);
4. Maintaining a software development environment so that new and existing software can be developed and will function. (e.g. making sure that CottonLOGIC will run on different Microsoft windows operating systems); and
5. Developing mechanisms to gain industry feedback and input in the development of decision support.

## **Objectives to be achieved in each year of grant**

### ***Year 1***

- Maintain the functionality of the Cotton CRC's web site.
- Complete the hand-held version of CottonLOGIC.
- Assist with the development and delivery of the 'Cotton Industry Database'.
- Complete a database provide CRC staff access to their information to enable changes to what is presented on the Cotton CRC's web site.
- Monitor acceptance of web-based information and review objectives and achievements in the light of changing technology and needs of the industry and the Cotton CRC.

### ***Year 2***

- Maintain the functionality of the Cotton CRC's web site.
- Provide web forums to research and extension staff.
- Complete an early season diagnosis tool.
- Explore opportunities and implement where possible better links between CottonLOGIC and the web.
- Monitor acceptance of web-based information and review objectives and achievements in the light of changing technology and needs of the industry and the Cotton CRC.

### *Year 3*

- Develop a replanting guide accessed via the web.
- The development of a facility on the web site to provide dates of Helicoverpa diapause induction for each region using real weather data.
- Explore opportunities and implement where possible the use of multimedia for training and dissemination of information.
- Monitor acceptance of web-based information and review objectives and achievements in the light of changing technology and needs of the industry and the Cotton CRC.
- Produce a final report.

## **Summary of Outcomes**

A brief outline of the major results and outcomes from this project are given below under the general headings of: Decision support development and distribution; Field validation of decision support; Decision support training and support; and Decision support industry feedback.

### *Decision support development and distribution*

The Cotton Management Support Systems Team during the course of this project completed the following tasks:

- A handheld version of CottonLOGIC that will run on the Palm OS ® operating system for in field electronic data collection and decision-making. This software was formally release to industry at the Australian cotton conference in August 2002. We consider this a world first for this technology.
- Many minor releases of CottonLOGIC were distributed that improved functionality of the software and fixed software bugs.

- A cotton irrigation management tool HydroLOGIC was developed and released to industry for testing. The HydroLOGIC software utilises the capabilities of the OZCOT crop simulation model.
- Water budgeting software based on the research of Dr Sunil Tennakoon and Dr Stephen Milroy was made available to the industry development and water use efficiency officers. Later this functionality was included in the release of HydroLOGIC.
- The CottonLOGIC database structure was documented to enable third party software to access the data contained in CottonLOGIC to be used for other purposes (e.g. GIS).
- During the course of this project the Cotton Management Support Systems team have been also responsible for the technical development of the Cotton CRC's website. Over the course of this project the CRC's website has been upgraded to be a fully database driven website that enables improved functionality and management. Other significant improvements to the Australian Cotton CRC's website are:
  - Improved SILO day degree calculator
  - NutriLOGIC on the web.
  - Dedicated CottonLOGIC/Decision support sub-website
  - Improved search capabilities through the website.
  - Development of a Cotton CRC Staff Database
  - Web driven interface for researchers at the Australian Cotton Research Institute to enable access to weather data collected at the site.
  - Dedicated sub-website for the Cotton CRC's northern research effort.
  - Assisted in the technical development of a weed identification and information sub-web.
  - Improved ability for recent media releases/cotton tales to be loaded on the Cotton CRC's website in a more timely fashion.
- Developed a user-friendly version of the cotton crop simulation model OZCOT. All industry development officers have this tool and have been trained to use it.
- Various other software tools have been developed for research purposes. Some examples include software to assist in operation of experimental pickers, Fusarium assessment using the Palm handheld in the field, and tools to compile validation data

for simulation model testing (e.g. compensation research). It is important to note this has enabled other research activities to proceed much more efficiently.

- Collaborated with Canberra CSIRO and APSRU colleagues in implanting the common modelling protocol as well accessing a range of tools that will assist with simulation model development.
- Two additional tools were developed as part of CottonLOGIC handheld system: GPS capability and whitefly data entry.
- Sandra Deustscher has been assisting in the Facilitation of the development of the updated Pest IPM guidelines.
- Significant planning into the future infrastructure of software development to maintain and improve functionality of DSS had also commenced during the course of this project.

Present development in areas of DSS (e.g. CottonLOGIC), research information dissemination (e.g. Cotton CRC's website), and cotton simulation modelling (OZCOT) has been outstanding compared with the past. This has primarily occurred because of enhanced resources provided by CSIRO, the Cotton CRC, and CRDC for the employment of additional programmers over the course of the project.

### ***Field validation of decision support***

Validating decision support systems in real situations is important for developing effective and useful tools. Field validation of decision support during the course of this project consisted primarily of two components: finalising validation of NutriLOGIC and field validation of the handheld version of CottonLOGIC.

Ms Deustscher has also completed a draft manuscript which has been reviewed by colleagues analysing the significant amount of data collected in EntomoLOGIC field validation trials conducted over many years funded in previous projects. It is envisaged that this information will be published in refereed journals and then distributed widely across the industry.

### **NutriLOGIC**

Large scale field trials on commercial farms have been fundamental in the validation of CottonLOGIC. A final set of NutriLOGIC trials were conducted in the 1999/2000 season. These trials have been located throughout the major cotton growing regions to validate and demonstrate the benefits of using NutriLOGIC recommendations for Nitrogen management. In summary these trials showed that with the use of NutriLOGIC significant savings in the amount of nitrogen fertiliser could be attained without losses in yield. It also highlighted significant limitations in the use of petiole sampling for the use in nitrogen fertiliser management. Ms Deutscher has published some these results in industry publications and is currently processing all information for publication in a refereed scientific journal. The collated information will then be used to promote the use of NutriLOGIC for nitrogen fertiliser management across the industry.

#### CottonLOGIC for Palm OS handhelds

To evaluate a system such as the handheld version of CottonLOGIC, it was important to involve the end users such as consultants and agronomists. Scientific colleagues in Kununurra and Katherine in northern Australia evaluated the first version of the handheld followed by a pilot test group formed across the industry. The pilot group consists of 4 agronomists, 3 consultants and 1 grower. The system was tested in a group which varied in terms of the size of the enterprises and they way they endeavoured to use the software. Using this pilot group rigorous in-field validation and project evaluation activities were carried out over a period of 18 months prior to release. The majority of ideas and concepts generated from this field validation were implemented for the formal release.

In addition to large-scale field evaluation, smaller trials were also conducted to address specific concerns. For example, a major benefit of using CottonLOGIC for the Palm OS® was thought to be its time saving ability. To confirm the potential time saving advantage, small time trials were conducted. The time taken by users was measured entering the same insect data into the handheld and then on the insect checking cards using a pencil. Time was also measured entering the insect data from the cards into CottonLOGIC on a desktop computer, compared with downloading automatically to the desktop with the handheld system. The results showed that on average, the time taken to enter insect data into the handheld was considerably more than the paper (card) system, although this depended on the level of skill of the person using the handheld. A skilled Palm handheld user could enter data

as quickly as the traditional method. On average the time taken to synchronise the palm to the desktop was 45% less than the time taken to enter data from the cards into the desktop. The added benefit was that during this time other activities could be undertaken.

Another major concern was the durability of using the handheld devices in the field, particularly when the field was wet. To alleviate these concerns, a plastic water-resistant pouch was sourced that protected the device, and made it easier to carry and use.

In addition to in-field validation, the services of an independent consultant were employed to assess the value of the technology in assisting with cotton management decisions (Van Beek, 2002). The general expectation captured prior to the use of CottonLOGIC for Palm OS handhelds, mentioned by all interviewees, was that it would save time with data entry. Other expectations were that it would provide better quality data with fewer mistakes, provide a set format for data collection, and add value to the service that a consultant could provide. Following the season where the majority of the users had persisted in using the software, the evaluation showed that most had believed that it had met their expectations, and believed with improvements in some areas, the product would be successful. Some of the comments made by people who had used the system were:

‘The Palm-top is only new and of course there are hick-ups and extra things we want. But it improves our lifestyle as much as it improves our business’

*An interviewee said that using the handheld ‘had not affected decisions much this year but it will make them quicker next year, less guesstimating and sorting manually through files. It is quicker especially on the CottonLOGIC side for forecasting insect populations, and that will give better decisions. It will definitely be an improvement. And it gives more confidence’.*

*‘You get the info in your pocket, the history, and you become able to make decisions in the field, and get the application quickly, rather than have to go home and go look for the info. It speeds up the process and that is important especially in sensitive areas.’*

The concepts and ideas expressed from these evaluations set the foundation for promoting and developing future developments of CottonLOGIC for the Palm OS handheld.

### *Decision support training and support*

With over 1090 registered copies of CottonLOGIC now within the industry, and with growers realising the necessity to exercise best management practices, the number of people who require CottonLOGIC training has remained very high. Each year of this project the Cotton Management Support Systems group conducted dedicated workshops for CottonLOGIC software in each of the major cotton growing regions.

In September 2000 there were a total of seventeen workshops held from Emerald in QLD to Hillston in NSW. The new areas covered were Murgon and Condobolin. A total of 250 participants attended these workshops, which were similar figures to the 1999 workshops.

Eleven CottonLOGIC training workshops were held during 2001 from Emerald to Hillston. Over 100 new and existing users attended the workshops. With very few major changes in CottonLOGIC in this year the main aim was to train new users and for the CottonLOGIC team to come up to speed with local and regional issues.

In September 2002 a total of 14 workshops were again conducted from Emerald to Hillston. Over 100 participants attended these workshops. These workshops focussed on training users in the use of CottonLOGIC for Palm OS handhelds.

During the course of the project Sandra Deutscher also conducted a CottonLOGIC workshop in Darwin for the researchers involved in the Northern Australia program of the Cotton CRC. At the completion of each of these workshops participants were given the opportunity to comment on the conduct and content of the workshops. Feedback showed that the workshops style and format were appropriate. Suggestions on other training in decision support were also ascertained.

We have also been working with more Universities and colleges (Warren TAFE, UQ, UNE, Emerald Ag, and Sydney University) to enable CottonLOGIC to be included in their courses. Currently CottonLOGIC is been used in the Cotton CRC's cotton production course, plant protection at The University of Queensland, and the cotton production certificate through Warren TAFE.

In addition to the training the Cotton Management Support Systems has maintained a phone help desk available approximately 3 days per week through the Cotton CRC's Technology resource centre.

### ***Decision support industry feedback***

Constructive feedback is imperative for the development of useful decision support systems. The Cotton Management Support Systems uses the following mechanisms to assist in feedback from the industry:

- Facilitating an industry advisory committee for decision support;
- A dedicated CottonLOGIC/decision support website;
- CottonLOGIC training workshops;
- A dedicated phone help desk through the Cotton CRC's Technology Resource Centre;
- Attendance at industry conferences and forums;
- Evaluation using an independent consultant;
- On-farm field validation of decision support systems ;
- Involvement in the Cotton CRC's extension network; and
- Formal surveys.

The decision support advisory committee was formed in July 1999 to play an important role in assisting the development of decision support tools such as CottonLOGIC. The committee is made up of a range of stakeholder representatives, to ensure that the industry has direct contribution to the development of decision support.

During the course of this project three committee meetings were held. The first in July 2000, focused on providing crucial input needed for the development of the CottonLOGIC hand-held system. The second meeting held in early 2002 discussed the re-engineering of CottonLOGIC and other software to meet the future needs of the industry, demonstration of water management software HydroLOGIC, and demonstration of CottonLOGIC handheld. The third meeting specifically reviewed the IPM elements of CottonLOGIC. Many ideas and opportunities for the Cotton Management Support Systems team were identified.

In April 2001 a 'science into software' workshop was facilitated by members of the Cotton Management Support Systems team to discuss ways of improving the science in CottonLOGIC, as well as discussing means of ensuring new science is incorporated. Standard procedures were identified as well as highlighting the science in CottonLOGIC that needs reviewing by the scientists specialising in the particular areas. Dr Bange has constructed a working document outlining some processes that may be put in place to address the issue of maintaining the science component of CottonLOGIC.

**How has your research addressed the Corporations three outputs: Sustainability, profitability and international competitiveness, and/or people and community?**

Providing cotton managers with the latest research via CottonLOGIC and other decision tools, enables decisions to be made that are sensible, profitable, and have the lowest impact on the surrounding environment. CottonLOGIC has become an industry standard in record keeping and pest management, and thus its use is recommended in the Best Management Practice guidelines. This project has also been integral in enabling the redevelopment of the decision support system HydroLOGIC which has been released to assist with increasing yields and improve water use efficiency of irrigated cotton crops.

**Dissemination of the Project Outcomes**

Development of DSS is specifically aimed at research dissemination. CottonLOGIC and other decision support software are continually being released or upgraded via the Cotton CRC's website or distributed through the Cotton CRC's Technology Resource Centre. This project also has strong links with the operation of the Technology Resource Centre of the Cotton CRC and delivery of research outcomes from both CRDC and Cotton CRC funded projects.

Software is provided free to industry.

***Publications arising from this research project***

### Journal Papers

Bange, M.P., Deutscher, S.D., Larsen, D., Linsley, D., and Whiteside, S. (2003). Handheld decision support system facilitates improved insect pest management in Australian cotton systems. *Computers and Electronics in Agriculture*. 43(2): 131-147.

Hearn, A.B. and Bange, M.P. (2002). SIRATAC and CottonLOGIC: persevering with DSSs in the Australian Cotton Industry. *Agricultural Systems*. 74 (1) pp. 27-56.

### Conference papers

Bange, M.P., Deutscher, S.A., Plummer, C., Larsen, D., Linsley, D., Richards, D. and Whiteside, S. (2000). Crop models and decision support – Future developments and applications. In Proc. 10th Aust. Cotton Conf. 16-18 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation, pp. 629-637.

Deutscher, S.D., Bange, M.P., Johnston, S., Larsen, D., Linsley, D., and Whiteside, S. (2002). Introducing CottonLOGIC for the Palm OS® handhelds. In Proc. 11th Aust. Cotton Conf. 13-15 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation, pp. 831-835.

Deutscher, S.D., and Bange, M.P. (2003). Advancements in computerised decision support for Australian cotton systems. In Proc. 3rd World Cotton Conf. Capetown, South Africa.

Deutscher, S.D., Bange, M.P. and Rochester, I. (2001). Testing NutriLOGIC, a decision aid for nitrogen fertiliser management in cotton. Proceedings of the 10th Australian Agronomy Conference, Hobart, TAS. 2001. [www.regional.org.au/au/asa/2001/3/c/deutscher.htm](http://www.regional.org.au/au/asa/2001/3/c/deutscher.htm)

Deutscher, S.A. (2000). Validation and Calibration of NutriLOGIC. In Proc. 10th Aust. Cotton Conf. 16-18 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation, pp. 315- 319.

### Conference Abstract

Bange, M.P. (2003). Building and Maintaining the Bridge: From Research to Technology Transfer. In Proc. Integrated Biological Systems Conference. 14-16 April, San Antonio, Texas, USA. Biological Systems Simulation Group. pp. 28-29.

### Grower magazines and articles

Bange, M.P. (2002). Palm-off cotton pests with new computer tool. 131. *Farming Ahead*.

Deutscher, S.A. (2001). Supporting science through CottonLOGIC. *Australian Cotton Grower magazine*. Nov/ Dec issue 2001.

- Deutscher, S.A. (2001). NutriLOGIC Trial Results 1999/2001 (Boggabri) Upper Namoi Valley Cotton Trials Booklet.
- Deutscher, S.A. (2002). NutriLOGIC – optimising your N fertiliser rates. Proceedings of Lower Namoi Field Day.
- McKinnon, C., Deutscher, S. A., Dillon, M., Mansfield, S. and Staines, T. (2003) Comparison of the beat sheet technique with established methods for sampling pest and predator abundance in cotton. Lower Namoi Field day booklet Feb 2003.
- Deutscher, S.D., Bange, M.P., Johnston, S., Larsen, D., Linsley, D., and Whiteside, S. (2002). Handheld decision support takes science to the field. 23(4). The Australian Cottongrower pp.18-20.
- Deutscher, S.D., and Bange, M.P. (2003). Cotton decision support – What does the future hold? The Australian Cottongrower. 24(4). pp. 6-8.

### ***Presentations and public relations***

#### Conference presentations

- Bange, M.P. (2003). Building and Maintaining the Bridge: From Research to Technology Transfer. In Proc. Integrated Biological Systems Conference. 14-16 April, San Antonio, Texas, USA. Biological Systems Simulation Group.
- Bange, M.P. (2000). Crop models and decision support – Future developments and applications. 10th Aust. Cotton Conf. 16-18 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation.
- Bange, M.P. (2002) Cotton Decision Support Systems and OZCOT Development. Cotton Consultants Australia Annual Meeting Narrabri.
- Deutscher, S.D. (2000) Useful Internet Sites. 10th Aust. Cotton Conference, 16-18 August, Brisbane Aust. Women in Agriculture session.
- Deutscher, S.D. (2001). Testing NutriLOGIC, a decision aid for nitrogen fertiliser management in cotton. 10th Australian Agronomy Conference, Hobart, TAS. 2001.

#### Promotional Activities

- Promotion of CottonLOGIC at the 2000, 2001, and 2002 Moree trade shows.
- CottonLOGIC was promoted at the Macquarie food and fibre festival 2001.
- Promotion of CottonLOGIC at the August 2000 and 2002 Australian Cotton Conference, Brisbane.

Cotton research and CottonLOGIC was promoted at the 75th anniversary celebrations of CSIRO at Black Mountain Canberra (2002).

#### Media interviews

Michael Bange interviewed by radio 2WEB on the application and success of CottonLOGIC (2001).

Michael Bange was interviewed by Diamond Media following the formal release of CottonLOGIC for the Palm OS handhelds (2002).

Michael Bange was interviewed by the ABC Country Hour following the formal release of CottonLOGIC for the Palm OS handhelds (2002).

Michael Bange interviewed by radio 2VM on the release of the Palm OS handheld version of CottonLOGIC (2002).

#### *Awards*

CottonLOGIC for Palm OS handhelds won the Natural Resource category of the Australian component of the Asia Pacific Information and Communication Technology Awards (2002).

CottonLOGIC for Palm OS handhelds was a finalist in the Australian Museum Eureka Science Awards for IT innovation (2003).

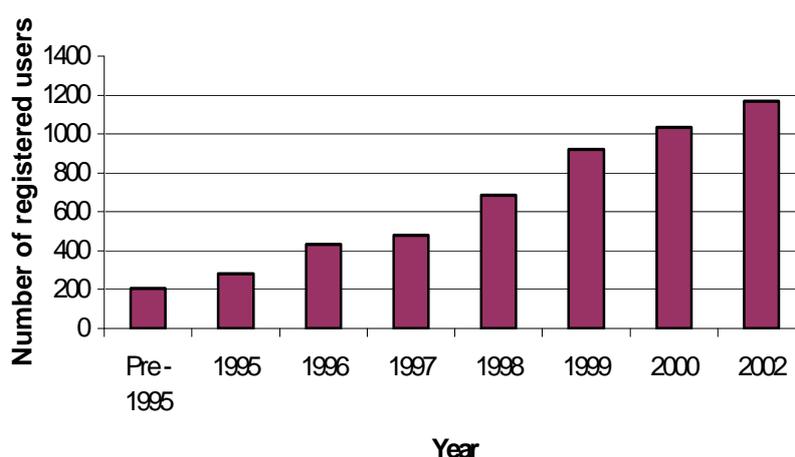
#### *Other*

Michael Bange prepared a discussion paper for the ACGRA and CRDC on present issues impacting on development and delivery of decision support and OZCOT (2002). (Appendix 1)

### **Project Impact and Evaluation**

The Australian Cotton Industry has a strong reputation for accepting and adopting innovative computerised DSS to improve crop and pest management and have benefited from doing so (Hearn and Bange, 2002). A recent independent assessment of the cost benefits of the pest management component of CottonLOGIC adopted in the Australian cotton industry found a benefit:cost ratio of 18.5 (The Centre for International Economics, 2003). The demand for

reliance on this technology is also increasing. The number of registered CottonLOGIC users has steadily increased from 200 in 1995 to over 1100 presently (Fig. 1). In addition, a recent survey (August 2002) showed that CottonLOGIC had been used across 51% (207 208 ha) of the total area of cotton grown in Australia in the 2001/2002 cotton season (404 000 ha; Dowling, 2002). Of this area where CottonLOGIC was used, 93% of use was for record keeping (insect and operational data) elements of the software, while 69% was to assist with management decisions using research models embedded in CottonLOGIC (Table 2).



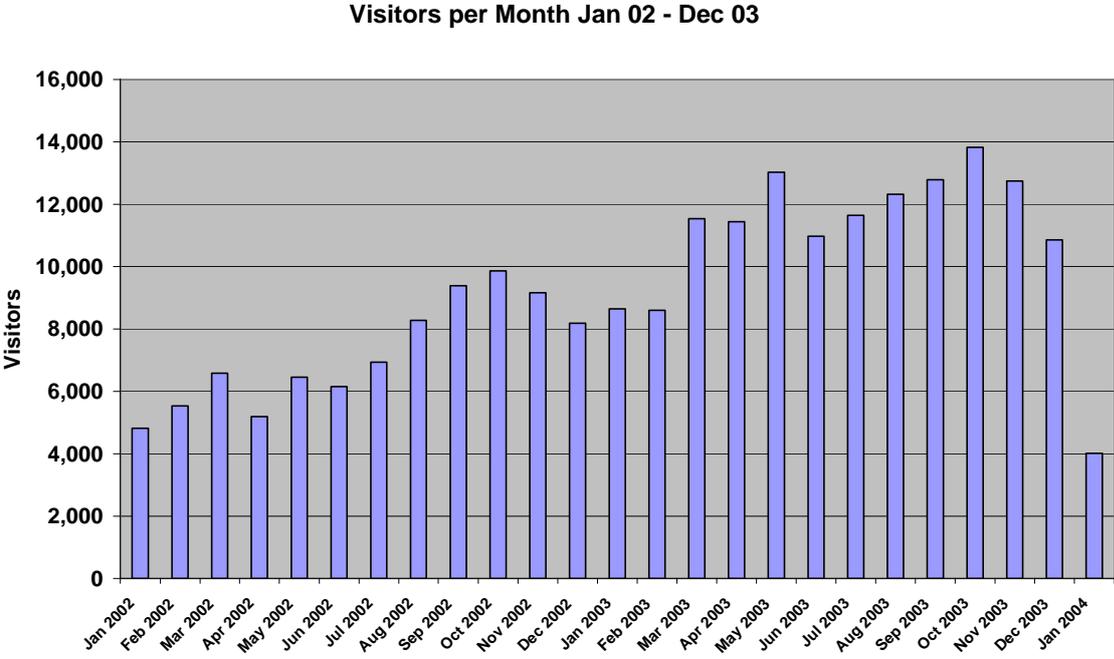
**Figure 1:** Increase in registered copies of *CottonLOGIC* distributed to the Australian cotton industry.

**Table 2:** Results of a survey measuring *CottonLOGIC* use (in area) in the Australian cotton industry (August 2002; 135 survey respondents).

CottonLOGIC Function	Area Used (ha)	Proportion of total
Insect identification tool	84811	41
Record keeping capabilities	193348	93
<i>Helicoverpa</i> spp. prediction model	63452	31
Two spotted spider mite model	39210	19
NutriLOGIC – Nitrogen model	21950	11
Spray ordering capabilities	33756	16
Decision Support (excluding record keeping and spray ordering)	142072	69
<i>Total Area of Cotton Industry</i> <sup>†</sup>	<b>404000</b>	

<sup>†</sup> Source Dowling (2002)

Cotton CRC web usage has significantly increased over the duration of the project (Figure 2). Software that tracks usage of the website shows that the number of unique visitors to the site has increased from approximately 4000 visitors to over 12 000 per month. Peaks in usage occur just prior to cotton seasons.



**Figure 2:** Number of unique visitors per month to [www.cotton.crc.org.au](http://www.cotton.crc.org.au)

In addition to the information collected above some independent evaluation activities were conducted by Peter Van Beek, a consultant specialising in the evaluation of decision support. Results of his findings collected during the course of this project are presented in the final report for the CRDC project CSP106C ‘Enhancing development, support and evaluation of computerised decision support’.

**Future Research Needs**

The focus of the Cotton Management Support Systems Team is to take a leading role in ensuring that good science to be passed on easily and effectively on to the industry. Some outcomes of science can be delivered affectively via written documents, but increasingly there is a demand for more interactive information delivery that enables growers to tailor the information to their need and also in the rapidly changing world for up-to-date information.

Advances in information technology through improvements in desktop software, handheld devices and the Internet have provided significant opportunities to enhance the development of DSS. Current and ongoing developments of DSS aim to utilise and integrate these technologies to improve cotton management with research outcomes. Some of these initiatives are:

- HydroLOGIC. A cotton irrigation scheduling and management tool, which allows users to explore the consequences of irrigation management on cotton development, yield and water use.
- Crop compensation. Incorporating knowledge of the ability of cotton crops to compensate for pest damage into DSS.
- Area wide management. Improving the ability of farmers and advisers to share knowledge to address regional issues relating to pest management.
- Farm water accounting. Providing irrigated cotton growers with software to track the movement of the water resource on their farm and calculate efficiencies (e.g. irrigation efficiency).
- HEAPS. Exploit the capabilities of the HEAPS (Helicoverpa Armigera and Punctigera Simulation) model, which simulates Helicoverpa spp. population growth and dispersal over a region, to specifically support resistance management for transgenic cotton and conventional insecticides.
- 3rd Party software integration. Improve the ability of the CottonLOGIC software to share information with other software.
- Improved information delivery. Engage the use of multi-format software tools that allow rapid publication of Web, hardcopy and CD based information. This initiative has the ability to make information widely available, easier to access, navigate and upgrade, and more cost effective as information changes.

A new project titled ‘Delivering science to Agribusiness - novel decision support tools’ has been supported by both the Cotton CRC and the CRDC to address the issues presented above.

The aims of the project are:

1. To interact with researchers, extension personnel and industry to identify critical issues where decision support tools can help growers.

2. To investigate innovative ways to process, integrate and present the complex research outcomes to provide these tools and facilitate efficient delivery and updating of this information on different media (written, CD, WWW).
3. To provide support for researchers and to facilitate industry involvement in the development of computer decision support.
4. To maintain and support existing software packages to ensure their ongoing development, relevance and performance.

Present major issues facing DSS development are as follows:

- A critical link needed to drive the future of DSS is to have resources that canvas the research being undertaken, and further develop this research into a form that can be used for assisting with crop management decisions.
- Software, support is a crucial factor in its adoption and success. While the cotton management support systems group endeavours to provide this as best as possible, it is difficult to maintain at a high level because of the resources required.
- IPM in CottonLOGIC is lacking. Resources will be required to help develop any initiatives needed for implementation into DSS. This includes area wide management.
- Presently our present DSS products (especially CottonLOGIC) have been developed in an environment, which is no longer supported within present computer operating systems and may not function in the near future.
- Considerable resources for the next two years, without any direct visible outcomes are needed to prevent this situation. Will need support from the industry before committing.
- There has been general agreement within the Cotton CRC that the role of its website is to deliver research information.
- As with any research program maintaining funding is important. A situation arises when there are many projects funding a similar initiative. It becomes very difficult to get new initiatives started when there is pressure to maintain existing ones.

It is envisaged that that in consultation with the CSIRO Cotton Research Unit's Cotton Management Support Systems Team a business plan supported by the CRDC and the Cotton CRC will be developed. A discussion paper presented to the ACGRA and CRDC that discusses these issues in more detail is attached (Appendix 1).

## **Intellectual Property**

CottonLOGIC for PalmOS® handhelds – IP CSIRO Plant Industry and the Australian Cotton Cooperative Research Centre.

HydroLOGIC – software to assist cotton growers with strategic and tactical irrigation – IP CSIRO Plant Industry

## **Final Report Summary - Developing innovative computer based technologies for effective delivery of information and cotton management decision support.**

**Principal Researchers:** Dr Michael Bange Research, Ms Sandra Deutscher, Mr Scott Johnston, Mr Darren Linsley, Mr Stewart Whiteside, Mr Dirk Richards (CSIRO Plant Industry Cotton Research Unit), and Mr David Larsen (New South Wales Agriculture).

### **Project Aims:**

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

### **Summary:**

This project forms part of the overall achievement of the 'Cotton Management Support Systems' team based at Narrabri. During the course of this project we have been able to complete or attain:

- A handheld version of CottonLOGIC that will run on the Palm OS ® operating system for in field electronic data collection and decision-making. Many minor releases of CottonLOGIC were distributed that improved functionality of the software and fix software bugs.
- A cotton irrigation management tool HydroLOGIC was developed and released to industry for testing.
- Water budgeting software based on the research of Dr Sunil Tennakoon and Dr Stephen Milroy was made available to the industry development and water use efficiency officers.
- The CottonLOGIC database structure was documented to enable third party software to access the data contained in CottonLOGIC to be used for other purposes (e.g. GIS).
- During the course of this project the Cotton Management Support Systems team have been also responsible for the technical development of the Cotton CRC's website.
- Developed a user-friendly version of the cotton crop simulation model OZCOT.
- Various other software tools have been developed for research purposes. Some examples include software to assist in operation of experimental pickers, Fusarium assessment using the Palm handheld in the field, and tools to compile validation data for simulation model testing (e.g. compensation research).
- Two additional tools were developed as part of CottonLOGIC handheld system: GPS capability and whitefly data entry.
- Significant planning into the future infrastructure of software development to maintain and improve functionality of DSS had also commenced during the course of this project.

Present development in areas of DSS (e.g. CottonLOGIC), research information dissemination (e.g. Cotton CRC's website), and cotton simulation modelling (OZCOT) has been outstanding compared with the past. This has primarily occurred because of enhanced resources provided by CSIRO, the Cotton CRC, and CRDC for the employment of additional programmers over the course of the project.

**Field Validation of DSS** - Validating decision support systems in real situations is important for developing effective and useful tools. Field validation of decision support during the course of this project consisted primarily of two components, finalising validation of NutriLOGIC and field validation of the handheld version of CottonLOGIC.

**DSS training and support** - With over 1090 registered copies of CottonLOGIC now within the industry, and with growers realising the necessity to exercise best management practices, the number of people who require CottonLOGIC training has remained very high. Each year of this project the Cotton Management Support Systems group conducted dedicated workshops for CottonLOGIC software in each of the major cotton growing regions.

**Decision support industry feedback** - Constructive feedback is imperative for the development of useful decision support systems. The Cotton Management Support Systems uses the following mechanisms to assist in feedback from the industry: Facilitating an industry advisory committee for decision support; a dedicated CottonLOGIC/decision support website; CottonLOGIC training workshops; A dedicated phone help desk through the Cotton CRC's Technology Resource Centre; Attendance at industry conferences and forums; Evaluation using an independent consultant; On-farm field validation of decision support systems; Involvement in the Cotton CRC's extension network; and Formal surveys.

A new project titled 'Delivering science to Agribusiness - novel decision support tools' that addresses current and future initiatives of information technology to assist cotton research dissemination and decision support has been funded by the Cotton CRC and CRDC.

## *Appendix 1 Discussion Paper on Decision Support Issues*

### **Cotton Decision Support Systems and OZCOT Development**

Dr Michael Bange CSIRO/Cotton CRC Mar 2002

#### **Summary**

The purpose of this discussion paper is to update ACGRA on the present issues relating to cotton decision support development (DSS) and OZCOT. The issues presented and discussed more fully are:

#### *1. Development of Cotton Decision Support Systems (DSS)*

- In general terms decision support systems discussed in this paper are computer-based systems to aid crop management decisions.
- We do not only develop CottonLOGIC, but also develop tools that aim to assist research and information transfer.
- DSS direction comes about by recognising the needs of the groups that represent both the Australian Public and the cotton industry.
- Successful development and delivery of decision support encompasses many different processes from the conception of an idea through to delivery and support.

#### *2. Current resourcing of DSS development*

- Currently, funding for cotton decision support development comes from three different sources, CSIRO appropriation, CRDC, and the Australian Cotton CRC. CSIRO provides the majority of funding.
- Industry input is critical to research and development, and the emphasis is to work alongside with industry to achieve progress.
- Resource allocation based on a need to maintain four key elements. They include: Creating innovation; Strategic Software development; Industry software support; and maintaining a useful software development environment.
- An extremely important lesson that has been learnt from developing DSS or any software for that matter is not to let one of these elements dominate.

#### *3. Progress of DSS and OZCOT development*

- Present development in both areas DSS and OZCOT has been outstanding compared with the past.
- This has primarily occurred because of enhanced resources provided by CSIRO, and the CRDC for the employment of additional programmers over the last three years.
- A list of major developments are included in paper.

#### *4. Present major issues facing DSS development*

- A critical link needed to drive the future of DSS is to have resources that canvas the research being undertaken, and further develop this research into a form that can be used for assisting with crop management decisions.
- Software, support is a crucial factor in its adoption and success. While the cotton management support systems group endeavours to provide this as best as possible, it is difficult to maintain at a high level because of the resources required.
- IPM in CottonLOGIC is lacking. Resources will be required to help develop any initiatives needed for implementation into DSS. This includes area wide management.
- Presently our present DSS products (especially CottonLOGIC) have been developed in an environment, which is no longer supported within present computer operating systems and may not function in the near future.

- Considerable resources for the next two years, without any direct visible outcomes are needed to prevent this situation. Will need support from the industry before committing.
- There has been general agreement within the Cotton CRC that the role of its website is to deliver research information.
- As with any research program maintaining funding is important. A situation arises when there are many projects funding a similar initiative. It becomes very difficult to get new initiatives started when there is pressure to maintain existing ones.

## Development of Cotton Decision Support Systems

### *Definition of Cotton Decision Support Systems*

**In general terms decision support systems discussed in this paper are computer-based systems to aid crop management decisions. A primary aim of the decision support and modelling teams in the cotton industry is to utilise sound and up to date research and technology, and integrate this technology across different electronic platforms and mechanisms, and finally delivering it to the industry for adoption, ‘Science into Practice’.**

The ‘Cotton Management Support Systems’ group based at Narrabri leads the CSIRO Cotton Research Unit’s effort into DSS. An important point to note is that this group develops a range of computer tools, which come under the definition of computerised DSS (Fig. 1). We do not only develop CottonLOGIC, but also develop tools that aim to assist research and information transfer.

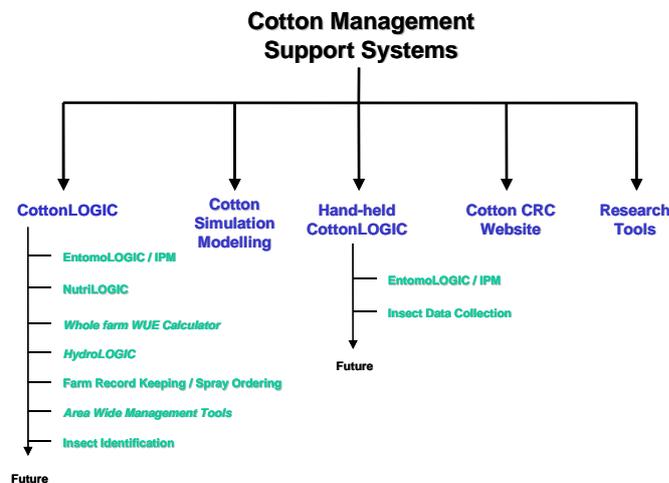


Figure 1: Cotton management support systems developed by CRU (Italicised products are under development).

### *Who are we developing decision support for?*

The Cotton Management Support Systems team at Narrabri believe their primary role is to serve the Australian Public through provision of technology that assists in maintaining a sustainable cotton industry that is both economically and environmentally viable. This direction comes about by recognising the needs of the groups that represent both the Australian Public and the cotton industry. The groups we directly operate with are:

- The Australian cotton grower;
- The cotton consultant (they help cotton growers);
- CSIRO's scientists to further enhance their work;
- The Cotton Research and Development Corporation; and
- The Australian Cotton Cooperative Research Centre.

***What is required to develop decision support?***

Another important aspect when considering the process of development of computerised decision support is that does not only include the programming of the software. Successful development and delivery of decision support for adoption by industry encompasses many different processes from the conception of an idea through to delivery and support. Some of the important defined functions and activities of the decision support team presently undertaken are outlined in Table 1. Each role requires resources and is critical to the overall success of the products delivered by the team.

**Table 1: Team functions and examples of activities of the decision support team.**

Team Function	Example of activities
<b>Software development</b>	- Software coding, and testing
<b>Software engineering</b>	- Investment in maintaining software development platform
<b>Education and training</b>	- CottonLOGIC workshops, field days
<b>Support</b>	- Phone support at the Cotton CRC's Technology Resource Centre (TRC), direct support
<b>Industry Feedback</b>	- Workshops, TRC, Industry Steering Committee
<b>Packaging and Distribution</b>	- CottonLOGIC packages, and mail outs through the TRC
<b>Promotion</b>	- Attendance at trade shows, local shows with the TRC
<b>Scientific Review</b>	- Attendance at Scientific Conferences, Publications, Peer Review, Scientific Journals
<b>Field Validation</b>	- Regional specific field trials using CottonLOGIC, working closely with the Industry Development Officers
<b>Project Evaluation</b>	- Surveys, Independent feedback from specialist DSS Consultant
<b>Administration</b>	Personnel and project management, sourcing funding, strategic planning

In an endeavour to achieve a focus on developing and delivering decision support, it is important to define a consistent and equitable strategy based on simple philosophical and moral principles to meet the needs of all stakeholders relevant to the cotton industry, and to the development of decision support. Points which try to encompass the philosophy by which the decision support team attempts to function are as follows:

1. Aim to develop effective, useful and user-friendly computerised decision support systems backed by good science.
2. Promote responsible crop management based on the best and most appropriate science that is accepted by industry (e.g. Best Management Practice).

3. Responsibility for the science used in the software is inherently shared by all researchers involved, and not entirely by developers of decision support.
4. Selection of priority areas for effort is based on appropriate constructive feedback and industry input.
5. No group or region within the industry will be favoured nor ignored.
6. Approach each task pragmatically, and only after careful planning and responsible considerations commit to software development.
7. Make activities and decisions transparent to superiors, industry and funding bodies.
8. Produce quality outcomes, thoroughly tried and tested.
9. Decision support systems are just that, they do not make the decisions, but provide information to assist in the decision-making processes. Promote the decision support systems as tools. (E.g. Promote IPM, and CottonLOGIC helps achieve this)

## ***Current Resourcing of DSS Development***

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### ***Who funds DSS projects?***

Currently, funding for cotton decision support development comes from three different sources, CSIRO appropriation, CRDC, and the Australian Cotton CRC. CSIRO provides the majority of funding from appropriation; while Cotton CRC funds are federal monies provided to research, separate from grower levies. The relative proportion of funding is represented in Figure 2. Industry input is critical to research and development, and the emphasis is to work alongside with industry to achieve progress. CSIRO also commits funds to research where industry provides contribution to development.

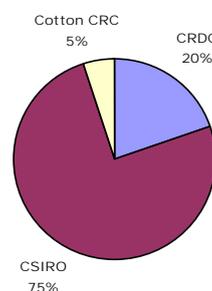


Figure 2. Relative proportion of funding from respective sources for cotton research and development in DSS and OZCOT.

### ***What projects do we have who do they support and what is their purpose?***

Current projects funded by the CRDC for DSS (including OZCOT) are:

- Enhancing Development, Support and Evaluation of Computerised Decision Support - This project provides funding for employment of one programmer (Darren Linsley), provision of services of an independent consultant for DSS evaluation, and a small amount of operating.
- Continued development and field evaluation of micro-computer cotton management packages - This project provides funding for employment of Sandra Deutscher who's

role is to conduct field validation of DSS, training and some support. The project also provides some operating, and funding for the duplication of software and costs for distribution.

- Application of crop simulation within the Australian Cotton Industry – This project provides funding for the employment of Mr Dirk Richards who is researching the application of the crop simulation model OZCOT in assisting crop management as well as collaborating with other projects, which use the model as a tool in research.

Current project funded by the Cotton CRC is:

- Developing innovative computer based technologies for effective delivery of information and cotton management decision support – This project supports one programmer (Stewart Whiteside) whose role is to support development of the Cotton CRC's website and the development of the Handheld CottonLOGIC.

It is important to note that the project 'ACRI Computer Network Support' is not a defined as a decision support project. This project supports all research at ACRI in providing continuous and reliable access to computing services to all staff. Dr Michael Bange is the supervisor of the Tony Pfeiffer who undertakes this key role.

#### *Who are the people and what are their roles?*

Dr Michael Bange – CSIRO Senior Research Scientist (Project Leader) - CSIRO funded

Mr Darren Linsely – CSIRO Software Developer (CottonLOGIC) - CRDC funded

Mr Scott Johnson – CSIRO Software Developer (Water Management Tools) – CSIRO funded

Mr Stewart Whiteside – CSIRO Software Developer (Web based tools and software engineering issues) – Cotton CRC funded

Mr David Johnson – CSIRO Programmer (Cotton Crop Simulation Model OZCOT) – CSIRO funded

Mr Dirk Richards – CSIRO Experimental Scientist (Application of cotton simulation model and HydroLOGIC) – CRDC funded

Sandra Deutscher – CSIRO Experimental Scientist (CottonLOGIC evaluation and field validation, support and training, Agronomist) – CRDC funded

David Larsen (NSW Agriculture, Coordinator Australian Cotton CRC's Technology Resource Centre) – Cotton CRC funded

#### *How are resources allocated?*

Along with time and resources needed to maintain those tasks described in Table 1. There are other factors that determine how resources are allocated to a task. Simply the decision to undertake a task and thus allocate resources is based in the need to maintain four key elements. They include:

- Creating innovation (developing new solutions);
- Software development to address strategic industry issues (e.g. water and HydroLOGIC);
- Industry software support (addressing day to day needs and current issues); and

- Maintaining a software development environment so that new and existing software can be developed and will function. (e.g. making sure that CottonLOGIC will run on different MS windows platforms).

An extremely important lesson that has been learnt from developing DSS or any software for that matter is not to let one of these elements dominate. They must be considered equally for the success and future of the significant investment in DSS. To allow one to dominate is at the expense of another, but ultimately resources are needed to bring the other elements in line. The quandary is that in doing this other elements again suffer.

## Progress of OZCOT and DSS development

Present development in both areas DSS and OZCOT has been outstanding compared with the past. *This has primarily occurred because of enhanced resources provided by CSIRO, and the CRDC for the employment of additional programmers over the last three years.*

In the case of computerised decision support systems in the past two years we have been able to complete:

- A handheld version of CottonLOGIC that will run on the Palm OS ® operating system for in field electronic data collection and decision-making. This is currently being tested with a large group throughout the industry before the release at the next ACGRA cotton conference. We consider this a world first for this technology.
- A prototype whole farm and field water accounting package and water use efficiency calculator. The water use efficiency officers in Queensland and New South Wales are presently testing this. To be included in CottonLOGIC.
- Redevelopment of a functional and visually improved Cotton CRC website. Deployed early Dec 2001.
- Dedicated resources to the redevelopment of cotton crop simulation model OZCOT. The model is pivotal in the research effort into farming systems, HydroLOGIC, compensation and fibre quality.
- Publication of specifications to allow other programmers to develop software that can communicate and access CottonLOGIC information.
- Development of a Beta version of HydroLOGIC (Irrigation scheduling and management) for preliminary testing this summer. To be included in CottonLOGIC.
- Resources to work with SILO to improve Cotton Industry's access to weather data through the Internet and CottonLOGIC software.
- Development of a user-friendly version of OZCOT. All industry development officers have this tool and have been trained to use it.
- We have also managed to maintain general support for CottonLOGIC. Fixing bugs and some improvements in reporting capabilities.
- Enhanced training in the use of CottonLOGIC. We are working with more Universities and colleges (Warren TAFE, UQ, UNE, Emerald Ag) to enable CottonLOGIC to be included in their courses.
- Compiling and publishing the results of validation experiments conducted over the past 10 years for promoting CottonLOGIC, IPM and nitrogen management.
- Various other software tools developed for research purposes. Some include software to present weather data on the Internet, software to assist in operation of experimental pickers, Fusarium assessment using the Palm handheld in the field, tools to compile

validation data for simulation model testing. *Important to note this has enabled other research to proceed much more efficiently.*

- Significant planning into the future infrastructure of software development to maintain and improve functionality of DSS.

## Present major issues facing DSS development

### *Generating Innovation*

An extremely critical link needed to drive the future of DSS is to have resources to canvas the research being undertaken by other researchers and further develop this research into a form that can be used for assisting with crop management decisions. In this case inclusion into computerised decision support. Essentially the person who would undertake this responsibility would be a farming 'systems' scientist with their focus on meeting the needs of decision support. This position is the link between the fundamental research and the development of the software.

An important aspect of this link is that the technology being developed or assessed has a scientific basis on which to draw, as well as being able to withstand scientific scrutiny. For example, when a methodology to monitor crop 'cutout' is developed it should be substantiated with appropriate understanding of crop physiology and crop agronomy.

Some of the key areas in which the scientist could undertake research are:

- Integration of sampling and crop monitoring methodologies to meet the needs of IPM and other crop management decisions (e.g. growth regulators, irrigation and crop defoliation).  
Assess the relevance of current pest management methodologies and compare new technology for inclusion in decision support.  
Assess the relevance of American crop monitoring techniques and establish the relevance to the Australian Cotton Industry. It is also important to substantiate the scientific basis of the methodology for Australian farming systems and cotton cultivars.
- Integrating the science of different water management tools and establishing simple methodologies to meet the needs of growers for the use of these tools

Presently the efforts of the Cotton Research Unit from this perspective in this area are limited. The cotton management support team are working on ways to enhance this area, but at some stage may require industry support for this type of role, if present initiatives put forward do not succeed.

### *Enhancing Software Support*

With all software, support is a crucial factor in its adoption and success. While the cotton management support systems group endeavours to provide this as best as possible, it is difficult to maintain at a high level because of the resources required. When time is devoted to support, resources are taken away from development. To add to this, software support has traditionally not been defined as a role of the organisations that employ the members of the cotton management support systems team.

One proposal that has been put forward is to obtain resources specifically to meet the day-to-day programming needs of the industry provided through a support desk based at Narrabri. These resources would essentially be independent to software development.

Software Support is an issue that the ACGRA may be able to discuss in context of the other needs of the industry.

### **Progressing/Protecting the Investment in DSS**

An important element that needs to be considered in the development of DSS is that software development itself comes with a certain level of overhead. Essentially with a group as large as we are, we need to develop procedures and protocols, so that software is developed effectively. We have suffered from not doing this properly in the past and are now paying the price.

Presently we are faced with a situation where our present DSS products (especially CottonLOGIC) have been developed in an environment, which is no longer supported within present computer operating systems. This poses two major problems:

- The first being is that we can no longer guarantee for instance that CottonLOGIC will even work with future releases of Windows. The software is considerably dated and users are finding this frustrating.
- Secondly, because of the way CottonLOGIC is programmed it is becoming more difficult to enhance its features. There are some features that we cannot include.

The solution is a challenge in itself. For our software to meet the future needs of the industry it will mean a major rewrite of CottonLOGIC. We have put considerable planning and thought into this and come up with a solution that will both meet the future needs of the industry and preventing a similar situation from happening again. We need to have software suitable for the future computer environments, not necessarily on what we have now. To undertake this task although, will mean considerable resources for the next two years, without any direct visible outcomes.

Maintaining resources without direct outcomes will be a considerable challenge for the cotton management support systems team, and will need support from the industry before committing.

### **Defining the role of Cotton CRC's website**

There has been general agreement within the Cotton CRC that the role of its website is to deliver research information. Some frustration often occurs because of the lack of understanding of this role, which defines the boundaries of what it aims to deliver. Focus has been redirected to enhance this role and remove distractions that come about by trying to undertake other tasks. ACGRA could play a role in promoting this message.

## **IPM and Area Wide Management**

It is widely recognised that CottonLOGIC in some areas of IPM is lacking. A workshop in the near future being planned by Lewis Wilson, Ingrid Christianson and some members of the cotton management support team will be conducted to develop a blueprint for IPM for CottonLOGIC for the future. It has also been recognised that resources will be required to help develop any initiatives that come out of this workshop for implementation into DSS.

Presently the DSS group is getting a number of enquiries about assistance in developing tools to assist with Area wide management (AWM) initiatives. Most proposals are not clearly defined and there is no path for any software development. A scoping study may need to be undertaken to develop a plan for software development to meet a wider range of industry needs. The Cotton CRC potentially will undertake the role of facilitating the exploration and development of the needs of AWM.

## **Maintaining Funding**

As with any research program maintaining funding is important. A situation arises when there are many projects from a few different sources funding a similar initiative. It becomes very difficult to get new initiatives started when there is pressure trying to maintain existing ones.

Another issue is the ramping down of the Cotton CRC funding and where the Cotton CRC it is heading in the future. A question remains how does cotton decision support fit into any future planning and what role if any will require funding to the CSIRO cotton management systems support team.

The way cotton decision support is funded may be an issue ACGRA wish to discuss.

## **Conclusion**

We in the cotton industry are in an enviable position with an agricultural industry rich with successes in computerised decision support. With an agreed and coordinated approach, working close with industry we can help seek to maintain this success now, and into the future.