Australian Government

Cotton Research and Development Corporation

Annual, Progress and Final Reports

Part 1 - Summary Details **REPORTS**

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

CRDC Project Number: **CSP151C**

Annual Report: ☐ Due 30-September

Progress Report: ☐ Due 31-January

Final Report: ☒ Due 30-September 2005
(or within 3 months of completion of project)

Project Title: Support Development and Independent Evaluation of Cotton Management Packages

Project Commencement Date: 01/07/2002 **Project Completion Date:** 30/06/2005

Research Program: 1 People and Knowledge

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Plain English Summary

Project Title: Supporting development and independent evaluation of cotton management packages.

Principal Researchers: Dr M.P. Bange, Mr D. Linsley, Mr S. Johnston and Mr. D. Larsen

Project Aims:
To maintain additional programming and support capabilities for computerised decision support in the cotton industry.

To continue evaluating the impact and nature of use of computerised decision support in the Australian cotton industry to assist in planning and future development of these capabilities.

Summary:
Managing sustainable cotton production is becoming more difficult with the ever-increasing demand on limited resources. In addition cotton growers are facing increased pressures to manage resources more cost effectively and to be more accountable for the impact that their decisions make on the surrounding environment. Computer based decision support systems (DSS) and simulation models are being developed and used to provide cotton growers with the best information and tools available from research to assist with their management decisions. A primary aim of the decision support and modelling teams in the cotton industry is to utilise sound and up to date technology, and integrate this technology across different electronic platforms and mechanisms, and finally delivering it to the industry for adoption 'Science into Practice'.

While the flagship of cotton decision support is CottonLOGIC (registered copies 1175 Dec. 2001), there are many other tools that are being developed by the group such as the handheld version of CottonLOGIC, HydroLOGIC and the Cotton CRC's website. Supporting existing products, changing computer systems (eg. Windows 3.11 to Windows 95, 98, 2000 and now Windows XP), and continued demands for other computerised decision support tools to be developed and demands by industry to explore new opportunities, place significant pressure on the resources of the decision support team to meet all these needs. Presently, one full time programmer is assigned to developing CottonLOGIC decision support tools, however, much of his time can be dedicated in supporting and refining CottonLOGIC to meet users requirements.

Importantly the support provided by this project has been crucial to not only maintaining development of CottonLOGIC, but has provided the resources for other development activities that have been long demanded by the industry to occur. It also gives the decision support group some scope to explore new opportunities.

A range of DSS activities that this project provided additional support to were:

- NutriLOGIC Online;
- HydroLOGIC version 1;
- Commencement of CottonLOGIC redevelopment;
- Maintenance of the Cotton CRC's website;
- Implementation of the CSIRO's common modelling protocol;
- Completion of the online pest and beneficial guide.
- Assistance in completion of the revised IPM guidelines;
- Release of the online Early Season Diagnosis Tool;
- Delivery of Myall Vale (ACRI) weather data online;
- Completion of a new version of the CottonLOGIC insect check cards;
- Field validation of the Early Season Diagnosis Tool and sucking pest sampling methodologies; and
- Conduct of CottonLOGIC/HydroLOGIC training workshops and provision of a decision support helpdesk.
- Completion of upgrades to CottonLOGIC for Palm® OS handhelds
- Development of a OZCOT scenario generator and graphical display tool

The evaluation component of this project has provided an extremely valuable and independent process in which to gauge the DSS software needs of the industry. This information has directly assisted future developments of software, promotion, training, support and distribution.

1. Outline the background to the project.

Cotton growers are facing increasing pressure to manage resources more cost effectively and to be more accountable for the impact their decisions have on the surrounding environment. Decision support systems (DSS) have been developed to provide cotton growers with the best information available from research to assist with their management decision-making. A range of DSS are now available to assist industry in crop management, they are:

- CottonLOGIC – Pest management, nitrogen nutrition management, data recording and analysis (Over 1200 copies distributed annually).
- CottonLOGIC for Palm OS ® – In field electronic data recording and decision tools.
- OZCOT – user friendly version used by extension personnel and APSRU's Commercial FARMSCAPE initiative. OZCOT is also extensively used in research.
- HydroLOGIC – Tactical and strategic water management tool – prototype released during 2002/2003 cotton season. Full release 2003/2004.
- WUEcalc – Field and whole farm WUE calculator used by extension personnel – ultimately to be incorporated into HydroLOGIC
- Cotton CRC's website – aims to be central repository of research based information generated by the CRC and its participating organisations.
- Cotton CRC's industry database – developed by the Cotton management support systems team and used to distribute extension material.

This project follows on from CRDC project CSP108C 'Enhancing, Development, Support and Evaluation of Computerised Decision Support. The aim of this project was to provide additional programming and support capabilities for computerised decision support in the cotton industry and to provide independent evaluation of decision support to assist with planning and future development.

The project proposed here also has strong links to the CRDC project CSP125C 'Continued development and field evaluation of micro-computer cotton management packages. This project supports the salary of Sandra Deutscher (CSIRO Experimental Scientist). Sandra is responsible for software testing, field validation of software once it is developed, software training, and contributing to software support. Project CSP125C also provides resources for the production costs of the CottonLOGIC package as well as some resources that contribute to overall software development.

It is important to note that this support has been crucial to not only maintaining development of CottonLOGIC, but has provided the resources for other software development activities that have been long demanded by the industry. It also gives the decision support group some scope to explore new opportunities. The evaluation component of this project has provided extremely valuable information to help gauge the DSS software needs of the industry.

2. List the project objectives and the extent to which these have been achieved.

The focus of the Cotton Management Support Systems Team is to take a leading role in ensuring that good science is passed effectively 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 needs and also in the rapidly changing world for up-to-date information. The aims of the project are:

- To maintain additional programming and support capabilities for computerised decision support in the cotton industry.
- To continue evaluating the impact and nature of use of computerised decision support in the Australian cotton industry to assist in planning and future development of these capabilities.

Specific objectives and milestones are listed below:

Objectives and Milestones Year 1:

(i) Assist in the development of CottonLOGIC to enable merging of user data from different paddocks/farms for overall analysis of pest management and farm operations for area wide management concerns.

(ii) Provide support to industry and assist with distribution of decision support products

(iii) Assist in the development of HydroLOGIC software for assisting growers' irrigation management.

(iv) With the assistance of a specialised independent consultant conduct industry consultations (outlined in background of this proposal) to evaluate the current impact and nature of use of computerised decision support. This year the particular focus is on evaluating the Hand-held version of CottonLOGIC.

(v) Submit a report and evaluation activities to key industry stakeholders.

Objectives and Milestones Year 2:

(i) Provide support to industry and assist with distribution of DSS products

(ii) Assist in the development of HydroLOGIC software for assisting growers' irrigation management.

(iii) Develop a CottonLOGIC part of the Cotton CRC website dedicated to assisting with development and support of computerised decision support.

(iv) Investigate new ideas for feasibility for implementation into CottonLOGIC.

(v) With the assistance of a specialised independent consultant continue evaluation activities to assess the impact and nature of use of computerised decision support.

(vi) Submit a report and evaluation activities to key industry stakeholders.

Objectives and Milestones Year 3:

(i) Provide support to industry and assist with distribution of decision support products

(ii) Assist in the development of CottonLOGIC and other computerised decision support tools

(iii) Investigate new ideas for feasibility for implementation into CottonLOGIC.

(iv) With the assistance of a specialised independent consultant continue evaluation activities to assess the impact and nature of use of computerised decision support.

(v) Submit a final project report.

Due to reductions in project funding associated with the drought activities designated to evaluate the impact of cotton decision support were only completed in the first year of the project.

3. Detail the methodology and justify the methodology used.

Supporting existing products, changing computer systems (eg. Windows 3.11 to Windows 95, 98, 2000 and now Windows XP), and continued demands for other computerised decision support tools to be developed and demands by industry to explore new opportunities, place significant pressure on the resources of the decision support team to meet all these needs. Presently, one full time programmer is assigned to developing CottonLOGIC decision support tools, however, much of his time can be dedicated in supporting and refining CottonLOGIC to meet users requirements. The provision of resources to fund an additional programmer has allowed and will continue to allow significant development to occur in the following areas:

- The completion of the handheld version of CottonLOGIC to be released to industry at the 2002 ACGRA conference.
- A prototype of water budgeting software which has been made available to IDO's and water use efficiency officers for field validation.
- A revamped version of HydroLOGIC in the process of being developed.
- Significant progress towards the reengineering of all software to meet the future needs of the industry and software development.
- Providing documentation of CottonLOGIC's database structure to enable third party software to access data contained in CottonLOGIC used for other purposes (e.g. GIS).
- Development of a new Australian Cotton CRC's website.
- Software tools to assist processing large amounts of data generated by the OZCOT crop simulation model.
- Jointly developing software with APSRU (Agricultural Production Systems Research Unit) tools to assist with storing model validation data, and to be able to compare this data with crop simulation model output.

Maintaining this programming support will allow some of the tasks that are necessary for continued progress of decision support to be completed and thus allow the benefits of these tools to be passed on to industry much quicker whilst maintaining support.

Evaluation of the impact of computerised decision support to assist in decision-making processes is important for planning and future development of such products. In the past the cotton management support systems team has attempted to quantify the usage of products such as EntomoLOGIC, but the accuracy of internal evaluations is often questioned. This part of the project aims to utilise the skills of an independent consultant specialised in evaluation of decision support to assess the impact and use of CottonLOGIC and other decision support technologies to influence management practice and attitudes within the

industry. The basic approach to all such evaluations is to combine several of the following methods:

1. The consultant to meet with people closely involved in the development of the package to evaluation strategies.

2. The consultant to conduct a series of semi-structured interviews with three to four people in each key stakeholder group, e.g. CSIRO, Govt. Depts., consultants, growers (a mixture of companies and family businesses separately), and representatives of grower organisations. The data collected will be condensed into an interim report.

3. With the assistance of the consultant conduct another survey to put quantifiable data behind the key findings of the interim report.

4. Again with the assistance of the independent consultant co-ordinate a number of focus-group discussions to identify precise meanings, cause and effects, alternative solutions and opportunities for decision support development

5. The consultant to prepare a report and presentation on findings for key-stakeholders.

This activity has been ongoing over the past three years. The inpendant consultantMr Peter Van Beek has conducted numerous (50+) interviews with a range of different stakeholders in the industry. Comprehensive reports of the major findings have been provided to the CRDC and industry. The reports have been extremely positive, highlighting the importance of CottonLOGIC and decision support to the industry both directly and indirectly. The assessment also played a significant role in identifying the problems and deficiencies in decision support development and provides a basis on which to improve. Where possible much of the recommendations in the reports have been acted upon by the decision support development team. Some quotes taken from the report are below:

- 'The science behind CottonLOGIC was seen as one of its valuable aspects'.
- 'The use of CottonLOGIC had effected relationships with consultants and other stakeholders'.
- 'One saw CottonLOGIC as a back-up and verification, and would be upset if it was not regularly updated'.
- 'Consultants would survive without CottonLOGIC, but not having it would be a disaster for the industry, as it is important in disseminating information'
- 'The new versions come out too late to try changes, familiarise, and train staff in the applications'.

Continuation of this evaluation will lead to a more complete qualitative and quantitative assessment of decision support while adding understanding to the depth of learning and appreciation of the environment in which computerised decision support has to work, and of the effects it has.

4. Detail and discuss the results

This project supports part of the overall effort of the CSIRO Plant Industry Cotton Management Support Systems team based in Narrabri. Financial support is also provided by CSIRO Plant Industry and the Australian Cotton Cooperative Research Centre. 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 through the additional support provided by this project assisted in the completion of the following tasks:

- NutriLOGIC Online
- HydroLOGIC
- Cotton CRC's Website
- Implementation of the CSIRO Common Modelling Protocol
- Online Pest and Beneficial Guide and IPM Guidelines
- The Early Season Diagnosis web tool
- Online Myall Vale Weather Data

Details of these activities are documented in more detail in the CRDC final report for project CSP163 'Delivering Science to Agribusiness - Novel Decision support tools'.

Other specific tasks that this project assisted with are documented below.

CottonLOGIC Redevlopment

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. Constant input and feedback has been sort from all CottonLOGIC stakeholders (researchers, growers and industry) during the planning and design of the new CottonLOGIC software. This process has included a review of existing CottonLOGIC software, the creation of functional specification documents, technical specification documents and a software prototype. Further details of specifications for the new CottonLOGIC are contained in the appendix of this report. The result of this input has seen the inclusion of new ideas and also the refinement of existing concepts into a non-functioning prototype which is being used to assist in gathering feedback from users (see Figure below).

Redevelopment of EntomoLOGIC software has begun. It is anticipated that a desktop and handheld version will be made available to industry in the 2006/2007 cotton season.

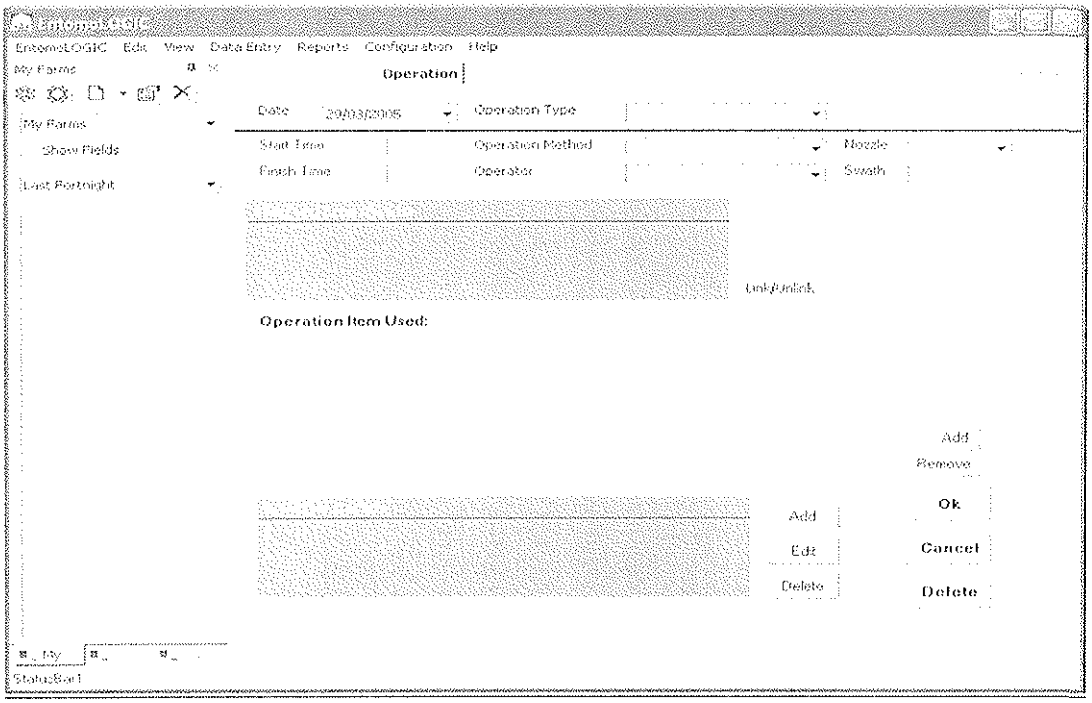

Figure: Screen shot of the CottonLOGIC prototype which is being used to assist in gathering feedback from users.

Scenario Generator

Software to run multiple simulations of the OZCOT crop simulation model was developed. This enables the researcher to generate quickly large amounts of information from the OZCOT simulation model and compile it into a database for interrogation (see Figure below). We have also modified an existing database interface that can be used to display and present this information. It is intended that these tools will be used to construct databases of information generated by OZCOT for a range of irrigation management options for different cotton growing regions. Information can be displayed graphically and account for variation in yield, water use from historical perspective for different management options (see Figure below). This decision tool has been tentatively named 'Cotbase'.

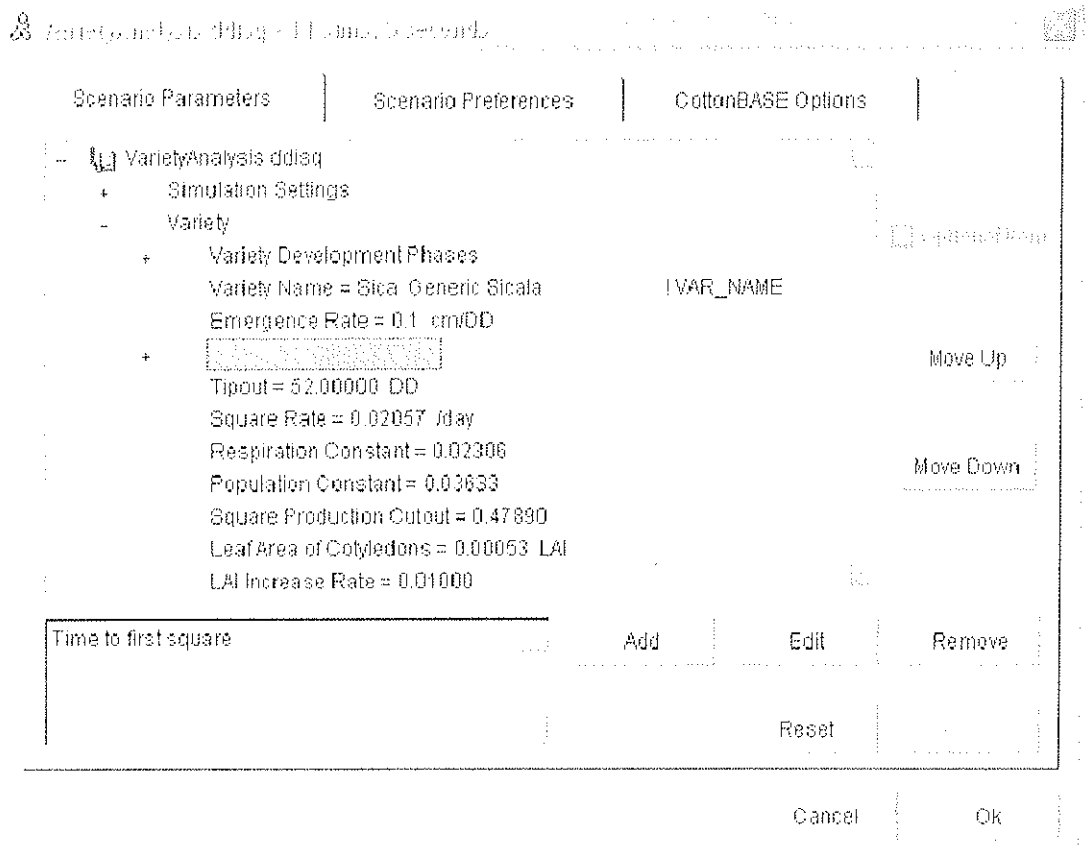

Figure: Screenshot of the OZCOT scenario generator used to generate multiple runs of the OZCOT cotton crop simulation model.

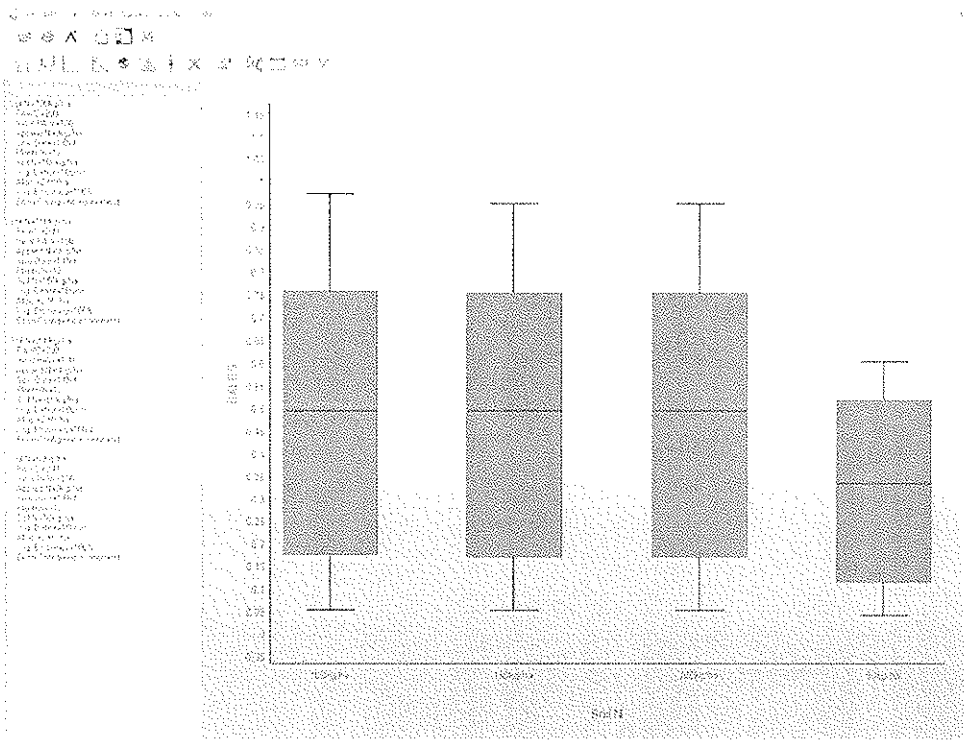

Figure: Screenshot of the Cotbase decision tool used to present and analyse information generated from multiple simulations of the OZCOT cotton crop simulation model.

CottonLOGIC Handheld

Two additional tools were developed as part of CottonLOGIC handheld system: GPS capability and whitefly data entry (see Figure below). In addition to these tools the CottonLOGIC handheld version was upgraded to run on new Palm® operating systems.

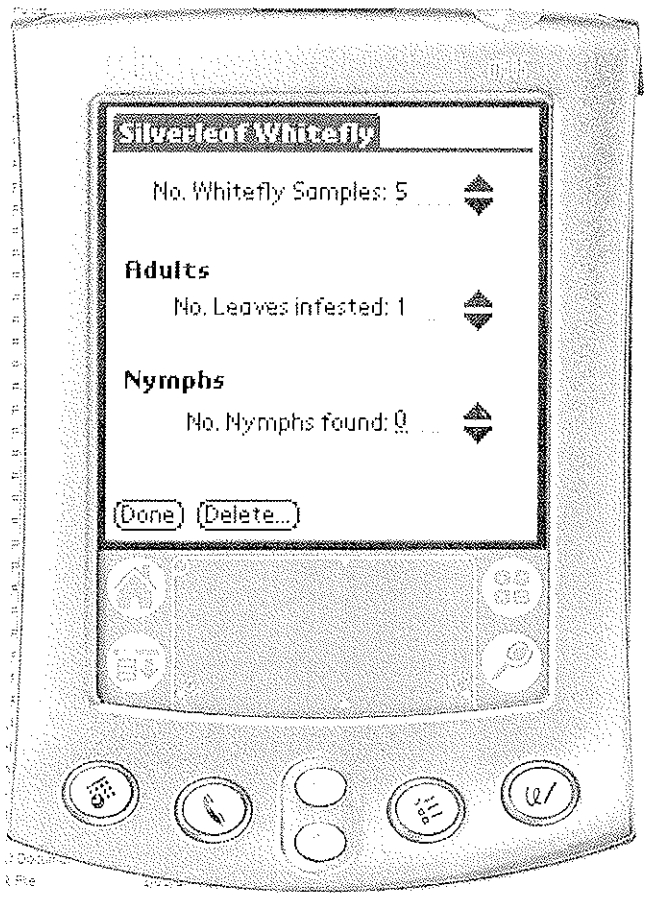

Figure: Screenshot of CottonLOGIC for Palm OS® whitefly data entry screen.

Decision Support Evaluation

Due to reductions in project funding associated with the drought activities designated to evaluate the impact of cotton decision support were only completed in the first year of the project.

The evaluation commissioned was the fifth idependant assessment done on the impact of decision support systems for the cotton industry for the Cotton Management Support Systems team. The assessments have provided progressive feedback aimed at helping to develop these decision support tools. The two earlier reports focussed on CottonLOGIC, while the other two focussed on the hand-held system. The reports of all four assessments are available on request from Dr M Bange, Australian Cotton Research Institute (ACRI) Narrabri.

This report has a wider focus. At the time of commissioning this assessment, CottonLOGIC required a major rewrite on to a different platform in order to remain current. This would incur substantial cost. In addition, some parts of CottonLOGIC were highly specific to cotton and/or pest management while other parts were of a more general record-keeping nature.

During the past few years, the rural software industry had consolidated around a smaller number of commercial suppliers of software for general farm records. The Support Systems team thus questioned how appropriate it would be to spend industry money on transcribing and updating the general record-keeping parts in CottonLOGIC. They also wanted to assess if the cotton/insect specific sections of CottonLOGIC were still wanted by the industry and if these would be worth transcribing onto another platform.

The author of the evaluation report was asked to conduct interviews with a wide range of users to obtain insights about where and how computer-based decision support tools fitted into interviewees' management. The aim was to assist the team in directing its (limited) resources to best serve the cotton industry with computer-based decision support tools. Section 3 of the report contains a summary of the findings. Detailed synopses of the interviews are given in Section 6. Transcripts of the full interviews have been made available to Dr Bange. The report was discussed with the CottonLOGIC team prior to finalising it.

The author conducted 24 interviews between 26 May and 2 June 2003 – 14 were face-to-face, 10 by phone. A team member selected the interviewees: growers (6 interviewees), company agronomists (3), company managers (3) consultants (9), and others (3). Interviewees lived in Central and Southern Queensland and in Northern NSW down to Narrabri. Some were known to be keen users of computer-based programs; others preferred paper-based systems.

The data strongly indicated that:

- There will be few if any objections if CottonLOGIC was made compatible with, and linked to, other programs – such a decision will be strongly supported.
- There will be little objection if CottonLOGIC would leave the recording of general farm operations to the commercial programs.
- There is likely to be very strong protest if the insect part of was no longer available.
- Work on other science-based programs such as HydroLOGIC is supported and expected.
- Work related to quality is expected to become important.

More inferred than indicated is the need to continue with the Palmtop. Given the amount of data to be entered, it will be essential for efficiency and avoiding mistakes in transcribing. Linkage of the Palmtop with either GPS and / or a mobile telephone is most desirable.

A full copy of the report is provided in the Appendix of final report.

5. Provide a conclusion as to research outcomes compared with objectives. What are the "take home messages"?

A take home message is that this project was able to deliver a large range of world class cotton decision support tools. There is strong evidence to suggest that these tools are considered valuable to the industry. A range of DSS activities that this project provided additional support to were:

- NutriLOGIC Online;
- HydroLOGIC version 1;
- Commencement of CottonLOGIC redevelopment;
- Maintenance of the Cotton CRC's website;
- Implementation of the CSIRO's common modelling protocol;
- Completion of the online pest and beneficial guide.

- Assistance in completion of the revised IPM guidelines;
- Release of the online Early Season Diagnosis Tool;
- Delivery of Myall Vale (ACRI) weather data online;
- Completion of a new version of the CottonLOGIC crop check cards;
- Field validation of the Early Season Diagnosis Tool and sucking pest sampling methodologies; and
- Conduct of CottonLOGIC/HydroLOGIC training workshops and provision of a decision support helpdesk.
- Completion of upgrades to CottonLOGIC for Palm® OS handhelds
- Development of a OZCOT scenario generator and graphical display tool

6. Detail how your research has addressed the Corporation's three Outputs - Economic, Environmental and Social?

Economic

Improved technologies to assist with optimising strategies for pest and irrigation management have the benefit to increase fibre quality and yield. Optimising inputs such as fertiliser, water and pesticides will also reduce costs and increase profitability.

Environmental

Sensible and logical decisions based on sound science and utilising information technology demonstrates a willingness to optimise use of inputs such pesticides fertiliser and water. Less pesticides and fertiliser will benefit the riverine environment. Appropriate timing of irrigation practices lessens the chance of deep drainage.

Community

Demonstration to community of the Australian cotton industry readily adopting innovative information technologies to improve regional economic and environment sustainability. The decision support software produced by the Cotton Management Support Systems Team can also be used for education and training.

7. Provide a summary of the project ensuring the following areas are addressed:

a) technical advances achieved (eg commercially significant developments, patents applied for or granted licenses, etc.)

Software was provided free to industry so no direct commercial implications at this stage are envisaged.

b) other information developed from research (eg discoveries in methodology, equipment design, etc.)

c) are changes to the Intellectual Property register required?

A summary of IP that was used and generated as part of this project is presented in the table below:

Project Participant supplying Background IP.	Description of IP. All Software Tools
CSIRO Plant Industry	CottonLOGIC Software; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	HydroLOGIC Software; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	EntomoLOGIC software; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	OZCOT crop simulation model Software; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	Early season diagnosis/day degree calculator; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry/Cotton CRC	CottonLOGIC for the Palm® handheld software; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Entomology	HEAPS- Helicoverpa; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	NutriLOGIC; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	Cotton Scenario Generator; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes
CSIRO Plant Industry	WUEcalc; IP Situation – Copyright; Conditions of Use – Research Agreement; Freedom to Operate - Yes

8. Detail a plan for the activities or other steps that may be taken:

(a) to further develop or to exploit the project technology.

(b) for the future presentation and 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 TRC. A key outcome of this project will be the provision of new tools in a number of formats (written, CD ,WWW) to meet the needs of industry. This will ensure industry-wide to the industry. Minor releases or improvements to software are constantly been made available through the Cotton CRC's website. Other initiatives include:

- The formal release of HydroLOGIC will occur during the life of this project.
- A redeveloped HEAPS will be made available to researchers.
- Improvements to the user-friendly OZCOT will be made available to extension personnel
- The CRC's website will be maintained.

The Decision Support Team is a component of the Cotton Extension Team and through this group effective methods of updating industry about advances in DSS will be developed and training provided for cotton extension team. In addition to this regular publications in the Australian Cottongrower are developed highlighting the development and use of decision support technology. Regularly members of the Cotton Management Support Systems team also present at field days and at industry conferences and forums. In order to maintain the quality of our work we also publish outcomes of our decision support development in international journals.

This project 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.

(c) for future research.

A project titled 'Delivering science to agribusiness – Cotton management support systems' has been supported by the CRDC and Cotton CRC that combines this project and the project 'Supporting the development and independent evaluation of cotton management' also supported by the CRDC, and one by the Cotton CRC. The new project will become the principle project that supports the cotton industry's investment in decision support development.

The new project will build on existing tools and software and develop new infrastructure in the case of CottonLOGIC, but will also exploit opportunities to develop a range of smaller focussed tools that may be delivered by CD, handheld or the Web and to further the development of some existing tools that are currently not being used effectively, such as HEAPS. Some specific examples of other activities and opportunities that will be undertaken include:

- Undergo routine maintenance of CottonLOGIC software infrastructure to meet future needs of all sectors of the industry.
- Scope opportunities to allow CottonLOGIC to support fibre to fabric, BMP and CCA initiatives.
- Redevelop EntomoLOGIC to meet current and future IPM systems.
- Upgrade HydroLOGIC and the handheld version of CottonLOGIC.
- Research advanced approaches for effective information dissemination and collection eg. wireless technologies (eg. 1XRTT technology by Telstra).
- Exploit the capabilities of the science based modelling capabilities (eg. OZCOT and HEAPS)
- Enhance NutriLOGIC for management of other nutrients in the soil.
- Explore opportunities to develop a 'DiseaseLOGIC'.
- Develop tools to optimise yield and quality of Bollgard II and future transgenics.
- Develop other online decision tools such as the early season diagnosis tool.
- Enhance and maintain Cotton CRC website infrastructure
- Facilitate an industry advisory committee
- Conduct independent evaluation of the impact of computerised decision support.
- Provide software support and dedicated training.

9. List the publications arising from the research project and/or a publication plan. (NB: Where possible, please provide a copy of any publication/s)

Not Applicable

10. Have you developed any online resources and what is the website address?

Online decision support tools developed by the Cotton Management Support Systems team delivered via the web include:

Name	Purpose	Address
CottonLOGIC Support	Provision of support, upgrades and feedback	www.cotton.crc.org.au/CottonLOGIC
SILO day degree calculator	Calculates day degrees and provides historical analysis	http://www.cotton.crc.org.au/Tools/Agronomy /SILODayDegCalc.htm
Early season diagnosis tool	Crop monitoring tool based on SILO day degree calculator	www.cotton.crc.org.au/esd
Pest and Beneficial Guides	Online resource for cotton insects	http://www.cotton.crc.org.au/insects.htm

11. Provide an assessment of the likely impact of the results and conclusions of the research project for the cotton industry. Where possible include a statement of the costs and potential benefits to the Australian cotton industry or the Australian community.

This project explicitly addresses the CRDC outputs: Sustainability by empowering people with technologies that enhance the latest and best knowledge generated by latest cotton research. Technology can assist with complex decisions that can integrate knowledge that optimise production and inputs that are sensible, profitable, and have the lowest impact on the surrounding environment. CottonLOGIC and many of the software generated by the Cotton Management Support systems team are already industry standards in record keeping and pest management and aspects of irrigation management, and thus its use is recommended in the many components of Best Management Practice guidelines.

Appendices

EntomoLOGIC Re-Development Documentation

The re-development of EntomoLOGIC has produced numerous documents to assist our group in defining exactly the functionality contained within our existing tools as well as the desired behaviour from our new tools.

CottonLOGIC Suite Functional Specifications (FS) Document (17pages)

This document contains non application specific details.

This includes common application support functionality:

- data import/export
- backing up/restoring
- data upgrade mechanisms

EntomoLOGIC FS Document (47 pages)

This document contains details that relate to the EntomoLOGIC application.

This will details features of the underlying Application Components that will be implemented in EntomoLOGIC as well as any application specific functionality.

As each sub-sequent application is developed an associated specification document will be created.

EntomoLOGIC Technical Specifications (34 pages)

This document details more technical aspects regarding the proposed implementation of application, including screen layouts, user navigation diagrams, folder structure application preferences etc.

Application Components

Our analysis to date has identified three key segments present in both our existing tools and the requirements of our future development. The functionality and details of each segment has been documented as follows:

- **Farm Component FS Document (19 pages)**

  This component deals with farm, field, crop and associated reference data.

  The Farm component document details the aspects of the software relating to farm, field, crop and associated and crop information

- **Observations Component FS Document (19 pages)**

  Observation data includes such things as insect samples, data sampling, fruit counts and retention, LAI readings, soil moisture readings and in-crop rainfall.

- **Operations & Spray Ordering FS Document (47 pages)**

  This component details the functionality of operations, spray orders, operation products, active ingredients plus associated meta data for grouping etc.

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A report to the CSIRO Cotton Research Unit

at the

Australian Cotton Research Institute

June 2003

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TABLE OF CONTENTS

ACKNOWLEDGMENT

I thank the team for inviting me to do this evaluation and arranging contacts, and the interviewees for their time and frankness. As always, any mistake in this report is entirely my responsibility.

1 INTRODUCTION

This report is the fifth external assessment done on the impact of decision support systems for the cotton industry for the Cotton Management Support Systems team. The assessments have provided progressive feedback aimed at helping to develop these decision support tools. The two earlier reports focussed on CottonLOGIC, while the other two focussed on the hand-held Palmtop pilot. The reports of all four assessments are available on request from Dr M Bange, Australian Cotton Research Institute (ACRI) Narrabri.

This report has a wider focus. At the time of commissioning this assessment, CottonLOGIC required a major rewrite on to a different platform in order to remain current. This would incur substantial cost. In addition, some parts of CottonLOGIC were highly specific to cotton and/or pest management while other parts were of a more general record-keeping nature. During the past few years, the rural software industry had consolidated around a smaller number of commercial suppliers of software for general farm records. The Support Systems team thus questioned how appropriate it would be to spend industry money on transcribing and updating the general record-keeping parts in CottonLOGIC. They also wanted to assess if the cotton/insect specific sections of CottonLOGIC were still wanted by the industry and if these would be worth transcribing onto another platform.

The author was asked to conduct interviews with a wide range of users to obtain insights about where and how computer-based decision support tools fitted into interviewees' management. The aim was to assist the team in directing its (limited) resources to best serve the cotton industry with computer-based decision support tools. Section 3 of the report contains a summary of the findings. Detailed synopses of the interviews are given in Section 6. Transcripts of the full interviews have been made available to Dr Bange. The report has been discussed with the CottonLOGIC team prior to finalising it.

2 METHODOLOGY

2.1 The interviewees

The author conducted 24 interviews between 26 May and 2 June 2003 – 14 were face-to-face, 10 by phone. A team member selected the interviewees: growers (6 interviewees), company agronomists (3), company managers (3) consultants (9), and others (3). Interviewees lived in Central and Southern Queensland and in Northern NSW down to Narrabri. Some were known to be keen users of computer-based programs; others preferred paper-based systems.

2.2 The interviews

The interview route was determined in consultation with the team. The interviews were semi-structured and where appropriate covered the following aspects:

- what knowledge interviewees had of CottonLOGIC or what experience they had with it;
- (for those who used it) for what decisions they used it and what records they kept on it;
- if interviewees used other cotton or farm-software and, if so, what they used;
- (if they used no computer) what system they used;
- what needs they had for cotton oriented software that were not being fulfilled;
- what their reactions would be if CottonLOGIC was made compatible with commercial farm-software;
- where the CSIRO programmers should focus their efforts for the cotton industry;
- any other comments in relation to these topics or any questions for the interviewer.

The interview route worked well and needed no changes.

3 SUMMARY OF THE DATA

This section provides a summary of the data in tabular format. It provides an overview of three main aspects: 1) the purposes for which computer-based decision-support tools were used, 2) other programs used and 3) the main comments. The full data is presented as detailed synopses of individual interviews in section 6. More compact formats were tried but led to unacceptable loss of detail. The data is presented in five categories: growers (sub-divided into users, past-user and non-users of CottonLOGIC); company-agronomists; managers of company farms (users and non-user); consultants (users, past-users and non-users) and others. Interviewees ranged from consultants working for only one cotton-grower to managers of company farms supervising 15,000 and more hectares.

3.1 Growers

Grower	*Used CottonLOGIC for*	*Other programs used*	*Comments*
1	Insect data and pest pressures Spray applications Comparing CL with recommendations from consultant	Paper records. Cashbook+ Farmbook Mapsource Digital camera Beeline	Not enough beneficials, too many under 'other' Format different from consultant's. Beneficial figure not in box Preferred 'half-guess' over drop down. Preferred all typing, no mouse *Would like to download CL updates from Internet.* *Fabulous if they link CL into Farmbook*
2	One-page reports Product report Order form Insect model	IPM guide from Internet. Own beat sheets Excel for cropping details, weather data and flight patterns Petiole testing	CL needs predator/prey ratios Order form does not link with map Can't enter counts by metre **and** visual Changing individual records is difficult More details needed about over-wintering May use Palm when it can dump twice and there is good technical service Had rejected PAM and Farmoffice Couldn't overlay eggs, larvae and sprays Wanted a progressively updated crop report with expenditure-to-date Wanted a dollar figure at end of season Wanted area-wide data on insect movements Suggested to put Gross Margins into CL Suggested to put CottonLOGIC on line Did not mind compatibility but would hate to see CL commercialised

3.1.1 Growers using CottonLOGIC (CL)

3.1.2 Grower who no longer used CottonLOGIC

The interviewee had stopped using CottonLOGIC when stopped employing an agronomist full-time; he now left all insect work to his consultant.

Grower	*Had used CottonLOGIC for*	*Other programs used*	*Comments*
1	Decisions about sprays Graphing insect numbers Get reports at end of year	PAM QA+ for all data except insect data (the consultant keeps that). C-probes HydroLOGIC TOPCROP	Wanted a seamless program with access to the best of all programs Would like entomology in CL to cover other crops as well Would like to include diseases in CL Saw a need to decide if CL was for farm-use or for consulting practices

3.1.3 Growers who had not used CottonLOGIC

Grower	*Other programs used*	*Comments*
1	Used Phoenix financial accounts Used PAM for farm operations and cost control Used Excel for fuel and Payman for wages Had used neutron probes May use C-probes if water became scarcer Used Viewpoint for paddock levelling, yield mapping and Gross Margins Shared a weather station with five others	Phoenix linked to bank accounts Found PAM excellent Neutron probe not needed, had 25 years experience Will get a Palmtop as he could see enormous benefits Palm will need to be able to download on farmer's and consultant's computers Palm needs GPS link Research info must be in simple format so **farmers** can make decisions, not leave it to consultants It would be great if these programs were compatible
2	Used paper records for simplicity Had used PAM, but was too much work and crashed too often	Had great doubts about the quality of data from 20 employees System may work if it gets voice-recognition Would be lovely to have it all on computer for 58 fields
3	Used a paper-system, bought a computer only recently Consultant also used paper-only Used C-probes for irrigation	Interested in CL Works out Gross Margin per ML irrigation and mm rain

3.2 Company agronomists

All three company-agronomists used CottonLOGIC.

Agro nomist	*Used CottonLOGIC for*	*Other programs used*	*Comments*
1	Insect records on cotton, wheat chickpeas and linseed Decision-making	Excel spreadsheets for paddock records. CCA survey.	Can't enter pesticide as volume per ha for e.g. wetting agent Paddock records and some reports difficult in CL Definitely make CL and CCA survey compatible Would look at PAM if it became compatible with CL
2	Insect records Palmtop, worked quite well	CCA to generate end-of season reports. Company spreadsheets for paddock records.	Some difficulty when running more than one data set on Palmtops CL not up-to-date for secondary pests. Can come unstuck if he followed CL recommendations for these PAM too expensive for 18 farms Would help if PAM and CL became one Combining CL with CCA would be very productive
3	Insect records Reports about spray decisions Spray orders Reports at end of season about chemicals used Insect library	Spreadsheets with allocation function for irrigation Paddock records on paper and summaries on computer C-probes	Difficulty with end-of year report, can't separate the years, comes up in bulk Did not use NutriLOGIC Did not use Palm, can't see benefits Had not looked at PAM and could not comment on linking the two Hoped to interface CL with the accounting program Would like to have map go with spray-order Would like to have tick-a-box checks for environmental aspects Likes to use CL

3.3 Managers of company farms

3.3.1 Managers of company farms who used CottonLOGIC

Manager	*Used CottonLOGIC for*	*Other programs used*	*Comments*
1	Records of spray Records of operations Work out Gross Margins	Probes for irrigation	Consultant keeps insect records; interviewee would like to do it. Could not keep rainfall records on CL. Needed note book for cultivation cost. Did not use NutriLOGIC. Would be interested in Palmtop if consultant used it and downloaded on the farm. Had a copy of PAM but did not use it Would be great if they combined CL with PAM.
2	Records of spray Records of operations	Spreadsheet for watering GPS for sampling, but not integrated with other records Had rejected Farm-Office as too big	Consultant keeps insect records, beneficials, thresholds etc Would like to use CL for water budgeting instead of spreadsheet Spray-order not flexible enough May use Palmtop if it downloaded in farm and consultant's offices Would like to e-mail reports out of CL Would be good if CL had GPS Would be good if CL linked with PAM or Farm-Office CL must remain free of charge

3.3.2 Manager of a company farm who did not use CottonLOGIC

Manager	*Other programs used*	*Comments*
1	Diaries Field sheets PAM	Wanted urgent integration of CL and PAM Needed to consolidate data across 12 farms, 2 consultants and head-offic. Needed to be able to pick up and download data in any of 15 places Data needed for daily management, safety, accountability, analysis CSIRO should continue with insects and the Palmtop

3.4 Consultants

3.4.1 Consultants who used CottonLOGIC

Consultant	*Used CottonLOGIC for*	*Other programs used*	*Comments*
1	Gross Margins	Paper-based syste.	Comparative Gross Margins easier than before Never used it for decisions Saw no need for Palmtop Entering field operations not easy HydroLOGIC will be useful
2	Record keeping Data presentation Pictures	Field sheets	Not for decision-making, decisions based on gut-feel Not used NutriLOGIC, fertiliser is a minor cost Did not want a Palmtop yet, maybe in the future Had not heard about PAM

3.4.1 *Consultants who no longer used CottonLOGIC*

Consultant	*Had used CottonLOGIC for*	*Other programs used*	*Comments*
1	Palmtop only	Paper-based system, mainly field reports Difficult to access and find specific info Neutron probes BIX testing CCA report	Palmtop too cumbersome Synchronizing two machines too time-consuming Can't put in four checks for one field Not enough beneficials included Would like to include up-to-date labels of chemicals Wanted to get one again once it has been perfected CSIRO to provide standardised formats for industry Any system needs to be easy and comprehensive
2	Insect records Spray data Simulations for curiosity	Paper-based system, enormous amount of counting sheets Hard to retrieve data	Frightened of relying on technological systems Needed to overcome that fear, saw benefits in computers Saw secondary pests as likely to become important No problem with linking CL with PAM and others
3	Spray records, six years ago	CCA report PAM	Never used it for thresholds Program kept jamming Not interested in Palmtop until it works / shows benefits Bollgard will make CL superfluous Other insects becoming more prevalent
4	Only for insect reports	Spreadsheet CCA program.	CL had been good to have, there had been nothing like it Would be happy to use CL if it did not come up with all those error messages and difficulties inputting data Did not include plant-height and status Farm-office had become too big Had not used the Palmtop Combining CL with PAM and CCA would be ideal CL needs to keep the insect bit, leave the rest to others Keep CL free of charge

3.4.3 *Consultants who had not used CottonLOGIC*

Consultant	*Other programs used*	*Comments*
1	Paper-based system Spreadsheets Diviner for water scheduling	Had helped others to set-up CL. Linking CL with PAM would be very sensible No need for Palmtop, it would make a simple thing more complex
2	Basic spreadsheet	Had run through CL a few times Had only one grower May use C-probe, so will be interested in HydroLOGIC Would like more on plant monitoring CL must be farmer friendly so they become independent from consultants Saw more impact emerging from insects other than Heliothis Quality might become an issue
3	Paper-based system Soil-pack Nutri-pack	Did not do insect scouting, but only big picture, summer strategies etc CL not comprehensive enough but good in its narrow field Parts of CL and especially Palmtop should be kept CSIRO to hone in on insects, nutrition and other options and integrate these Role of linking research with farm management only just starting

3.5 Others

One interviewee in this category checked for only one grower. He focussed on Gross Margins and used a paper-based system. One other did not work with cotton and used Soil Nutrient Advantage and Terra Grow for contents of labels. The third had a wide overview of the industry. He said CottonLOGIC was a good product that modelled what science had proven, but it took too long to input data. Its general use had been for back up of ideas and end-of-season reports. It would be fine if CottonLOGIC could talk to PAM and other programs but he would hate to see the entomology lost. He saw the Palmtop as the way of the future.

4 DISCUSSION

4.1 Knowledge and uses of CottonLOGIC

All 24 interviewees knew about CottonLOGIC especially the fact that it dealt with insects. Nine used it for one or more purposes, five no longer used it, seven had not used it, while the three interviewees in the '*other*' category had no reason to use it. Seven of the nine users used it for insect reports, four for recording operations and Gross Margins, three for spray decisions, two for end-of-year reports and two for other reports. Spray records, order forms, the insect-library and the Palmtop were mentioned once.

The three company-agronomists and two of the three managers of company farms used CottonLOGIC for insect and/or spray records. The third manager wanted linkage between it and PAM urgently so their company could use it on their 15 farms. The three growers who had not used CottonLOGIC were interested in it or the Palmtop.

The Palmtop was commented upon nine times. Some interviewees did not see a necessity for it, while others were looking forward to when it could download twice: on the farm and in the consultant's office, or had voice recognition. One grower-interviewee who was using CottonLOGIC said he will get a Palmtop as he saw enormous benefits.

Personal comments. An interesting aspect was the number of consultants who did not use CottonLOGIC but mentioned that they used *Industry standards* for tolerances. Related to this was a remark by a grower: *'Our mentality has changed from 'bomb them' to being more tolerant; manage them, not eliminate them'*. These remarks suggest that, in addition to supporting daily insect management, an important impact of CottonLOGIC could have been on long-term strategic decisions (undoubtedly as part of a wider range of influences). While this aspect was not followed up in these interviews as it was outside their focus, I believe that it is an important factor to consider when deciding its future.

Another telling remark was: '*I frequently look back at figures, want to know what the species were ... what beneficial works best in which part of the season.*' Recording data is important for legal (e.g. Endosulfan) and administrative reasons (the CCA survey). However, a stronger daily motivation to keep records would be if users wanted and knew how to review the data for forward planning. This ability to easily review data on a seasonal basis needs to be a core guideline if CottonLOGIC were to be redesigned and when a new version will be extended.

4.2 Experiences with CottonLOGIC

Experiences with CottonLOGIC were very mixed. There were about the same number of people mentioning difficulties in entering operational data as a reason for not using CottonLOGIC as there were people using that section. That applies to other comments too. I believe that many experiences especially with the Palmtop were based on older versions. It was not possible to explore this without appearing partisan and influencing the information.

The *Comments* in the tables in Section 3 contain a number of suggested improvements. I cannot comment on whether the suggested improvements relate to 'shortcomings' in CottonLOGIC or in the ability of the commentator to use it. Nor do I have a clear view of the details or the importance of many suggestions. I have to leave it to the team to consider them.

Personal comment. I believe that the negative comments need to be qualified somewhat. These were coloured by interviewees' attitude towards and familiarity with computers.

Comparing the uses and comments from growers and company-based agronomists / managers with those of consultants also suggests that the perception of interviewees' own role also influenced the comments. Many consultants seem to have a much narrower perspective than people in managerial roles and this may affect their comments.

4.3 Paper-based and other cotton or farm-software being used

Paper-based systems were the main system for seven consultants, and were part of all other systems in one form or another. Two consultant-interviewees mentioned difficulty with the enormous amount of paper that had accumulated and this made finding precise data and identifying trends very difficult. Eight interviewees mentioned Excel spreadsheets for either general or specific records.

General farm software used included PAM (used by four interviewees, and tried and rejected by two others as it was too big) and Farm Office (not used but rejected by two interviewees), while one interviewee used Cashbook+ and Farmbook. Farmtractor was mentioned but not used by any interviewee. Five interviewees used the CCA software. I did not explore how interviewees using paper-systems dealt with the CCA survey.

Special purpose programs included NutiLOGIC, HydroLOGIC, TOPCROP, Nutri-pack, Soilpack, Viewpoint and Mapsource. Technology with a strong computing component included GPS, C-probes, neutron probes, Beeline and a digital camera.

Personal comments. Apart from the CCA being common to consultants and company managers, there appears to be no pattern or commonality in what systems interviewees used or how they used them. Recording systems ranged from simple paper-based systems in consultants' offices with minimal processing and analysis to highly detailed mixed systems on large private and company owned farms. Section 6 is worth reading for that aspect alone.

The interviews show that a large scale and high precision industry such as cotton needs huge amounts of data. Even on the most advanced farms this data was only partly collected and not well integrated or analyzed. Interviewees indicated this need for data is likely to get worse. Efficient and effective data collection and processing on a whole-farm basis is emerging as a significant challenge. **I believe that this challenge should be a major focus for the team.** Meeting this challenge together with private industry can potentially save much time and cost involved in data management, and lead to improved productivity and reduced risk. One manager had called together his boss, a fellow manager and one of their consultants to press that point and offer assistance in meeting that task. The progressive owners and managers should be the focus during future development of CottonLOGIC and the Palmtop. They are at a point of development where the rest of the industry will be in a few years. Some consultants saw their own work-focus moving towards similar farm-wide management.

4.4 Reactions if CottonLOGIC were compatible with commercial software

Most interviewees welcomed the idea of linkage CottonLOGIC with other programs, especially PAM and CCA. It was generally seen as a sensible idea. To some it did not matter either way, while a few had no opinion as they had too little data. A few interviewees suggested the need to link Palmtop with GPS as well; one interviewee saw no need for that.

There were **no** negative reactions to the suggestions of compatibility and linking. The only concern for two interviewees was that CottonLOGIC itself should remain free of charge, as the industry had poured millions of dollars into it.

The responsibility to coordinate the mechanism through which the programs can be linked was not explored. In my view the CSIRO team is best placed to take the lead in this.

4.5 Focus for CSIRO programmers

Many interviewees suggested leaving the general farm records to the commercial companies. CottonLOGIC should focus '*on the science*', linking research with farm management. In the area of insects it was seen as without peer and that section should not be abandoned. Some suggested to widen this section to include other crops as well. This suggestion came mainly from farms and regions where cotton is one of many crops. One interviewee said the Palmtop especially should be kept.

Several interviewees mentioned the general adoption of IPM and the introduction of Ingard and Bollgard. While the latter had helped in reducing the number of sprays required (together with the dry seasons), problems were said to be emerging with secondary pests: rough bollworms, green vegetable bug, Rutherglen bug, aphids, jassids and myriads. Interviewees differed in their expectations of the consequences of this for CottonLOGIC. One suggested that it will not be needed anymore, but several others saw a need to expand and adjust CottonLOGIC to deal with the new mix of insects. This would include expanding the number of beneficials.

HydroLOGIC was seen as becoming important with increasing scarcity and cost of water. Linking it with C-probe data may be worth exploring. NutriLOGIC was not used much, as the cost of fertiliser was seen as relatively minor. Some interviewees suggested keeping these programs separate but linked with the insect section to keep each program small. Simplicity of single programs was mentioned a few times as being important and the large size of some current programs had turned several interviewees away from those.

Quality was seen as a potential issue and one in which CottonLOGIC or other programs could play a role. One interviewee believed CSIRO should put out standards for the industry and that the Palmtop was doing that to some degree.

4.6 Other comments

Two interviewees raised the need for CottonLOGIC to be simple enough for farmers to be able to use it and reduce their dependence on consultants. One mentioned that farmers should take more responsibility for decisions.

5 CONCLUSIONS

The data strongly indicated that:

- There will be few if any objections if CottonLOGIC was made compatible with, and linked to, other programs – such a decision will be strongly supported.
- There will be little objection if CottonLOGIC would leave the recording of general farm operations to the commercial programs.
- There is likely to be very strong protest if the insect part of was no longer available.
- Work on other science-based programs such as HydroLOGIC is supported and expected.
- Work related to quality is expected to become important.

More inferred than indicated is the need to continue with the Palmtop. Given the amount of data to be entered, it will be essential for efficiency and avoiding mistakes in transcribing. Linkage of the Palmtop with either GPS and / or a field telephone is most desirable.

6 SYNOPSES OF THE INTERVIEWS

6.1 Growers

6.1.1 Users of CottonLOGIC

Two of the six grower-interviewees used CottonLOGIC. One used it to record insect data and spray applications (mainly Endosulfan) and pest pressures. He sometimes compared the recommendations from his consultant with the insect model. He did his own beat-sheets on top of normal checks. '*It is worth it; we now work closer to thresholds. Our mentality has changed from "bomb them" to manage them*'. He used Cashbook+ for accounting and Farm-book made by Practical Systems for physical farm records and to work out Gross Margin and yields. '*I would have liked to do it on CottonLOGIC but some options about operations and crops are a bit difficult, especially if you want to include rotational crops.*'

The interviewee used GPS to make maps using Mapsource. He had a digital camera, which he thought would come in handy to '*take a photo and GPS and discuss it with consultant*' and used Beeline technology to put up hills. He had not used the Palmtop but saw a bit of it with consultants. He saw no need for a GPS link with CottonLOGIC. He still worked a lot with paper '*which is double entry, but you get a better look that way, see every figure*'.

The interviewee said entries of IPM beneficials were a bit cumbersome. '*Many beneficials go in as 'other' as they are not specified. Also the mite numbers are asked for in a different format than our agronomist gives us. And the figures don't appear in the box, but do appear in the report.*' He was not clear what warnings about checks meant or about correlations between pests and beneficials per metre. And as he typed faster than he could use the mouse, '*having to use the mouse and the keyboard is a bit of a nuisance*'.

He believed that CottonLOGIC needed to be rewritten. '*It needs to be a lot more user-friendly. But don't scrap it; its insect reports are good.*' He said it would be '*absolutely fabulous if they can fold the insect stuff into Farm-book and (if we could) download the latest in CottonLOGIC from the Net into Farm-book*'. It would also be good '*if it can half-guess as per Excel, rather than drop down menus, as each field has to be entered individually*'.

The second interviewee in this category used CottonLOGIC for one-page reports. He used the insect model to see what would happen in the next three days and to generate product reports. He did petiole testing, which he put on CottonLOGIC. He did his own beat-sheets for beneficials and believed CottonLOGIC '*needs predator-to-prey ratios*' so he could better use that data. He got the IPM-guide from the website and used it extensively. He used the order form but could not link that with maps.

The interviewee had found that data input in CottonLOGIC had limits. '*Sometimes we count by metre and sometimes visually; we can't do both on CottonLOGIC. And I can't always put % in, I want both numbers and %.*' Changing a record was difficult as '*it brings all records back, not just one year's*'. He believed that he needed to know more about over-wintering of beneficials. He did not yet use the Palm: '*Maybe when there is a good dumping system with an ability to dump more than once, and a good backup*'. Also needed would be a good technical service and rapid replacement if a unit got lost.

He used Excel to record fertiliser and herbicides used, and dates of chipping, irrigation, planting, emergence and other things: '*I did not get anywhere with CottonLOGIC with those*'.

He also recorded flight patterns and weather data '*I need those for BMP accreditation*'. He used C-probes, the data of which came back via Internet. He thought the program developed by consultants to replace CottonLOGIC had far more problems than CottonLOGIC itself. He had looked at PAM and Farm Office but found them too complicated and expensive.

The interviewee frequently looked at the recorded data to know what the species had been and what beneficials had worked best in which part of the season. However he said '*I can't get the figures back at the end of a season. And I can't overlay Heliothis eggs, larvae, predators and sprays.*' And in addition to the insect data he needed '*a (progressively) updated crop report with expenditure-to-date. Ideally we would do counts, analyse the IPM things and then run scenarios on say three alternatives, cost them out and look at effects on beneficials*'. He needed easy access to cost so he would know he did the right thing.

The interviewee would like a dollar figure per paddock at the end of the season, be able to compare yields for varieties and penalties, and work out how they relate to and link with management. '*The biggest potential advantage to me of any program would be to assist in my decision-making by being able to effectively analyse large numbers of data.*' He would also like to get statistics on an area-wide basis about movements of both Heliothis and beneficials, and believed that '*that area needs more research*'. Other suggestions were to expand the list of beneficials, put Gross Margins into CottonLOGIC and put CottonLOGIC on line so users can upgrade it continuously and access the latest model.

The interviewee did not mind compatibility with other programs, but would '*hate to see CottonLOGIC commercialised considering the amount of money the industry has spent over time*'. But looking at the low percentage of growers using it made it hard for him to say '*spend more or less*'.

6.1.2 Past-user of CottonLOGIC

One had used it when he had employed his own agronomist '*for decision-making about sprays, graphing of insect numbers especially beneficiaries to see what impact sprays had, and to get useful records at the end of the year*'. However, he now left all that to his consultant. He used PAM QA+ for all records except insect and spray data, which his consultant keeps. He had found PAM '*excellent.*' '*They are able to include other crops and livestock and we grow cotton, seed crops, and have cattle*'. It also picked up rainfall data, assigns a field to a rainfall station and works out what percentage has actually been used. '*It would be ideal if we can integrate CottonLOGIC with PAM*'.

The interviewee had just started using yield mapping. '*It would be good to get GPS reading from where they take the insect counts. That could produce insect maps in the future and we may be able to associate those with actual yields. It needs to be based on a GIS system, associated with whole-of-farm plans.*' The interviewee used C-probes and Agri-link to monitor moisture, but found the time lag of 46 minutes too long. He had done a course in HydroLOGIC and was learning to use TOPCROP for his cereals. He thought the hydrology and cotton programs in CottonLOGIC were more sophisticated than those in PAM.

The interviewee said that the entomology section of CottonLOGIC needed to include other crops, even vineyards, so bug checks could be done for those too. And it would also be good to include diseases. Decision support needed to be seamlessly integrated, using the best of each program. However, this may lead to a very big set of programs, probably more suited to consultants than to individual farmers. He thought that CSIRO staff needed to make a

strategic decision as to where to place CottonLOGIC: on the farm or in consultants' offices. He also believed '*The CSIRO cotton people need to be mentally adaptable to integrate farming as a system rather than just cotton as a system; then we go a long way.*'

6.1.3 Non-users of CottonLOGIC

Three grower-interviewees did not use CottonLOGIC, but one interviewee's consultant used it. The consultant's reports were handwritten and then typed into different formats. The interviewee used Excel spreadsheets and Phoenix Gateway for accounts. Phoenix was linked by Internet to his bank accounts. Since last year he used PAM for all farm operations for cost control and found it useful. '*It would be great if these programs were compatible.*'

The interviewee had used neutron probes for a year, but believed that he did not need those after 26 years irrigating. He might use C-probes if he had a manager or water became scarcer. '*You just got to be careful with technology; it can run away with you. (But) while we believe we are efficient with water, we must make sure we do. Farming is turning water into dollars.*'

He used a program called Viewpoint. '*For every field we have a map with the area, the original cut and fill from when we do surveying, land levelling etc. We can see low spots and refill them. It can do surveys, soil testing, yield mapping and Gross Margins. We can see low yields, which can be a lead for variable rate seeding, fertilising, gypsum etc.*' He used Payman for wages, super etc '*it includes reports*' and Excel for fuel etc.

The interviewee shared a weather station with five other growers; the data was used when irrigating, insect-spraying and applying herbicides. He will get a Palmtop as he could see '*enormous benefits*'. '*The Palm needs GPS; that goes without saying. It also needs to link up with weather data, both current and forecasts.*' He believed downloading Palm data on farmers' computers is important. '*Farmers need that information immediately, when a decision is due. Farmers must take more responsibility, not leave it to others. Agronomists and consultants can or should only recommend from options.*'

The interviewee said that the industry needed innovative thoughts, concepts etc from the programmers in this team. '*There is a lot of research that needs to become accessible yet. That research information must be in a form that* ***farmers*** *can make decisions; that data must not be so complex that it is all too difficult and left to the agronomist.*'

The second interviewee left all incest work to the agronomist. He had used PAM '*but in the end it crashed too often and was too much work*' and he had gone back to paper records. A major problem for him was the quality of data collected by his 20 employees as '*these guys are good at driving tractors but hopeless at paperwork. Any comparison based on their data is worse than useless, as you could be totally wrong'*. He thought any system might work once it has voice recognition. '*It would be lovely to have it entered on computer and have good reports at the end of the year'* for all of his 58 fields.

The third interviewee had heard about it but knew little of it. He had only recently bought a computer and his consultant used a paper-based system and fax. He used a diary for all records: plantings, herbicides and insecticides. He had not used Endosulfan for four years. He used C-probes for irrigation and works out his Gross Margin per ML for irrigated crops and per mm rain for dryland crops. He would like to look at CottonLOGIC now that he had a computer, especially for paddock records and Gross Margins, as '*records are pretty handy, especially when things are unusual*' and in case he would get into variable rate fertilizing.

6.2 Company agronomists

All three company-agronomist interviewees used CottonLOGIC to keep insect-records in cotton. One also used the decision making part for up to 1,200 ha of irrigated cotton and kept insect-records for all crops where he used pesticides: wheat, chickpeas, linseed, and coriander. '*And we use it sometimes for fertiliser. Not for anything else.*' He used their own Excel spreadsheet for paddock records '*as CottonLOGIC does not allow putting paddock records in easily*'. He did not use the Palmtop.

The interviewee said he had no need for other things. He had found some minor problems with CottonLOGIC e.g. pesticides could only be put in as a rate/ha, '*so we can't put in wetting agent, as that goes volume for volume*'. He thought the customised report was a bit confusing. '*It is hard to create the report*'. He said that CottonLOGIC should definitely be made to match the CCA survey for format and data. And he would look at PAM if it and CottonLOGIC matched and he could input data only once.

The second interviewee used CottonLOGIC, but said during the last two years with low insect-pressure '*we have not been relying as much on it as we should have. For secondary pests we decide in the paddock, that is a gut-feel decision mainly, CottonLOGIC lacks a model for those*'. He said the Palmtop worked quite well, but '*it can give problems if you run more than one data set, e.g. on a corporate farm with 2 or 3 agronomists*'. He used the CCA database to generate reports at the end of a season and the company's own spreadsheets for paddock records. '*Record keeping in CottonLOGIC has still not been upgraded. But they also worked on HydroLOGIC and NutriLOGIC.*'

The interviewee expected that there might be less need for CottonLOGIC for Heliothis decisions with Bollgard 2. But there might be a need for more research and thus new/better decisions making processes for IPM for secondary pests. '*The CottonLOGIC section on those is not up-to-date; we found we can come unstuck with its recommendations.*' He said that myrids, jassids, green vegetable bus, aphids, and white fly all needed '*a better guidance system. E.g. low myrids in two consecutive checks can do more damage than one high count.*' Secondary pests required him to be in the field more as they are far more '*dynamic*'.

The interviewee had heard of PAM but said it became costly to buy for 18 properties. He said it would help if CottonLOGIC and PAM would be combined,' *it would offset several programs we use now*'. Combining CottonLOGIC with the CCA program '*would be a very productive step, have my full support. They should go hard for that.*'

The third agronomist-interviewee put insect checks into CottonLOGIC, generated reports for spray decisions and spray orders, and put in completion dates. At the end of a season he generated reports on chemicals used to check on the bills. He had found this difficult, as CottonLOGIC can't separate years. He used the insect library with new spotters, who also had the books in their car. He did not use NutriLOGIC or the Palmtop. '*I can't see any benefits; they check from 7-12 and then put the data in. That only takes a few minutes.*'

The interviewee kept records for irrigation, fertiliser etc on his own spreadsheets, which had an allocation function for irrigation: '*It follows how much water there was, how much has been used, what storm water we got, and what is left.*' He kept details of paddock activities on sheets in a folder and put summaries on computer. He used C-probes during the season. He had a demo disc of PAM but had not used it yet, so he could not comment on potential benefits of compatibility with CottonLOGIC.

The interviewee hoped to interface CottonLOGIC with an accounting program, '*so an order goes automatically to our accounting system to set aside enough money to pay*'. He would also like to be able to pull up a map to go with a spray order, '*mark the field to be sprayed*' but could not get that to work. And he would like to have tick-boxes in the environmental considerations '*to check that we have considered them all*'. He did not want to have a lot of cotton programs. '*I like to use CottonLOGIC*'.

6.3 Managers of company farms

6.3.1 Users of CottonLOGIC

Two of the three interviewees who manage cotton farms for companies used CottonLOGIC to keep records of field operations and sprays. One interviewee also used it to work out Gross Margins, while his consultant kept insect records on it '*but he does not generate reports*'. The interviewee found CottonLOGIC '*all right*' for what he used it for. But he could not record rainfall in CottonLOGIC as '*there is nothing in there and the whole water program is difficult*'. While he had all the chemicals and cost on the operations-side on computer, for cultivation cost he needed a notebook next to it. It was the same with harvesting. '*We got to work it out every time; it should have a drop-down menu*'. The interviewee thought it was hard for NutriLOGIC to capture the variability for the whole industry. He stuck to local knowledge instead, '*local fertiliser reps and consultants to help us with nutrition*'.

The interviewee used probes for irrigation and had test-run a program for the Rural Water Use Efficiency team. While it had been designed for corn, he had also used it on cotton and thought it had been working well. He would like to have enough time to use the insect part of CottonLOGIC as '*they have done a fairly good job*'. He would be interested in the Palmtop '*if our consultant used it and we could download data here instead of handwriting. That would make the insect part of CottonLOGIC more relevant. The insect side is its real guts*'.

The interviewee used no other programs. He had bought a copy of PAM but never used it. '*It was not up to scratch for cotton, CottonLOGIC was better.*' But he thought that '*it would be great if they can combine PAM and CottonLOGIC; they both got stuff the other has not got*'.

The second interviewee used CottonLOGIC to record field operations and sprays. His agronomist used CottonLOGIC for insect records, beneficials, thresh-holds, damage, and crop-data such as fruit retention. The interviewee would like to use irrigation scheduling as a record for water budgeting, supported by models to indicate when the next irrigation would be coming up. He used a spreadsheet for this. The spray order in CottonLOGIC was not flexible enough: '*I book one spray in for three fields, but the computer can't do that*'.

He would like to be able to e-mail reports out of it but found that difficult. '*Transfer of data between my boss, the consultants and me is important, but it needs to be in small files, summaries.*' CottonLOGIC does not support a wheel-mouse as Window-based programs do, '*which is a bit painful as I have 30 odd fields and there are many chemicals.*' A good thing about CottonLOGIC was the upgrading; '*although slow, they eventually sort problems out*'.

The interviewee had looked at the Palmtop for his bug checkers. While the bug-checkers prefer to enter data in office, the interviewee could see benefits. '*It reduces duplication of entering data. But I would like to download its data in my own and the consultant's office.*' He would like to link the Palmtop with GPS and record points of soil tests and insect checks.

The interviewee used GPS for sampling, '*but none of it is integrated into one record system, which collects all data relevant to an individual point*'. He had looked at Farm Office. '*It is a huge time-consuming program that tends to demand a lot of data. I only want to keep records that I have to keep legally or need for making decisions.*' He had no experience with PAM.

The interviewee said it would be good if CottonLOGIC could talk to GPS to do mapping and get layers of farm maps. And while it would be logical to link CottonLOGIC with PAM or Farm Office, '*CottonLOGIC has not cost us anything. It is OK to link it with other programs, as long as it still works on its own and remains free. Software can get very expensive.*'

6.3.2 Non-user of CottonLOGIC

The interviewee did not use CottonLOGIC but wanted it to be integrated with PAM as a matter of urgency. '*We love PAM's record keeping and their palm pilot is easy to work with. But our agronomists refuse to use it because it does not have CottonLOGIC on it. So we can't link with them.*' The interviewee thought that CSIRO should continue with insects and the Palmtop. '*Their niche is insects, hydrology, and nutrition*'.

The interviewee said that consultants and field workers kept many records: every farm operation, insect count, and time it took for irrigation. All that was entered into a diary and then formatted for the secretary to enter onto PAM. Hence the company used worksheets, diaries and the PAM management program which '*is time consuming, data gets lost and there are inaccuracies*'. Another problem was to analyse it, '*masses of data never get used*'.

The interviewee said they had many farms in the group and wanted the head office as the central part, but with consultants being able to download locally. Ideally they wanted to consolidate data to compare and exchange it across 12 farms, 2 consultants and head office. '*It needs a seamless information flow. Consultants should be able to pick up the latest data from any office before going into the field*'. And it needed to be linked to GPS as '*we have 5 sets of data for every paddock in the form of maps, measurement of slope, tissue testing etc.*'.

The interviewee said consultants and managers did not always know what each had done. '*Mutually informing is important, e.g. some of the consultants' recommendations may not have happened.*' It was also important for Occupational Health and Safety, e.g. bug checkers need to know what had happened. '*But there is not enough time to talk about every field.*'

The interviewee said that records were needed for accountability, analysing for efficiencies, administration, and daily management. The first priority would be to build in immediate benefits for daily managers otherwise the data would not be collected. They also needed records for auditing e.g. for Endosulphan: the date, temperature, wind direction etc.

6.4 Consultants

6.4.1 Users of CottonLOGIC

Two of the nine interviewees in this category used parts of CottonLOGIC. One used it for Gross margins but not for making decisions or for checking up on decisions. He said it was still not easy to enter every field operation: slashing, root cutting, ground operations, water as an operation, the number of ML's, fertiliser, planting, spraying, weed control etc. However, some changes had made it easier to get comparative Gross Margins between fields and farms. He had to use an average cost as some farmers used contractors. '*And I can't use precise figures per farm, as you can change a price from time to time but not use multiple prices*'.

He used a paper-based system, no other programs. He saw no need for a Palmtop as he could always use a laptop. *Our scouts use paper and a calculator. I follow them, look at the figures, talk to the farmer and his wife, and they decide*'. He did not use NutriLOGIC or got involved in Petiole testing. He thought that only one out of his 12 growers used CottonLOGIC, while some used PAM. '*The others use Farm-tractor or whatever their accountant says*'.

The interviewee understood that HydroLOGIC was being reborn and said that should be useful. He believed that ACRI needed computer programmers to support researchers. They should also work on HydroLOGIC and '*make CottonLOGIC easier for how I want to use it*'. He had tried to get day-degrees from the Internet, but '*I wasted my time looking for it.*'

The second interviewee used CottonLOGIC for record keeping and data presentation, but not for decision-making. '*I use experience and industry standards for that.*' Those standards were changing; *others and I push thresholds quite a bit, we experiment a lot. We push the threshold up.*' He also used the pictures. He did not use NutriLOGIC as '*fertiliser is a small component of total cost. Growers rather put on a bit more than is needed, as insurance.*

The interviewee did not use the Palmtop yet but might get it in future. He used a desk computer and laptop. He used field-sheets to record first flowering and first open ball and transferred that data by hand. He did not record cultivations and only sometimes irrigations. '*My focus is very much on insect management.*' He had not heard about PAM.

The interviewee said his growers get 3.6+ bales/ha and '*were deep into IPM. We don't spray until Xmas. That is where we make money*'. He believed the best decision-making was often by gut-feel. '*Gut-feel is made up of lots of experience. I don't see much value to develop an expensive computer program that can't do that as well.*' He knew that CCA had written something but did not know how good it was. Queensland Cotton had also written a program for '*paddock maps for precision farming, yield mapping and adjusting fertiliser*'.

The interviewee thought that success with IPM could lead to other types of insects becoming a problem, such as sucking insects. '*But other sprays can manage these. It is a matter of getting on top of them before they become a problem.*' The most outstanding research priority in his view was the fluctuation in effectiveness of Ingard. '*But Bollgard may make it superfluous. With Bollgard 2 there is no need for spraying with larvicides.*'

6.4.2 Past-users of CottonLOGIC

Four consultant-interviewees had used or tried CottonLOGIC in the past but did not use it anymore. One had used it to record insect and spray data, and to present growers with end-of-year data. He occasionally had run simulations for curiosity. He said the local industry consisted mainly of small farms with paddocks of often less than 60 acres. It was never clear what spray went on when, as it could take more than 3 days to spray with ground rigs.

The interviewee said some growers used PAM but he used a paper-based system. But he now had an enormous amount of counting sheets. '*I have had to hunt for data but it takes so long to find it.*' It also made it difficult to analyse data: '*to see what the water deficit was, and why some fields yield much better*'. Basically he had '*this terrible fear for relying on (computer) technical systems, about their reliability*'. Other than that he had no major problems with computers and he realised he might have to overcome his limitations as he could see benefits. The interviewee believed Central Queensland had higher insect pressures than down South, except for the last two years. '*We can't even get back to thresholds after spraying, so what*

good are industry thresholds to us? Cotton is a minor crop here and there are many other crops where we can't spray for insects, and so have a constant influx of insects as well as faster life cycles.' He had gone back to 135-140 day varieties and tried to get as much fruit early on to get a bit of a buffer, as they virtually could not spray after Christmas.

The interviewee said Ingard and Bollgard had worked but they still used three sprays. These varieties had changed the picture and will further reduce Heliothis populations. He expected that a change to Bollgard would increase the green vegetable bugs. '*Aphids and thrips may come up as well. I have also seen a lot of damage from thrips*'. He believed that the industry would need to relearn IPM. '*How we scout, treat etc; there will be new stumbling blocks*'.

The interviewee had no problem with CottonLOGIC linking with PAM or others. He believed that the major local impediments were water and nutrition.

The second interviewee said when CottonLOGIC first came out she had tried it but it had not been feasible. She had put in spray-records only. She had never used thresholds, only normal paddock data, but it was not user-friendly as it kept jamming. '*I saw the staff then but the problems kept occurring.*' She said the insect side of it was not practical, as they could not go back to the office to enter and see what should be done. Their clients were mainly ground sprayers who wanted recommendations immediately. '*I had such a bad run with it that I would not be interested in its Palmtop. It needs to show good benefits.*'

She used the CCA program and PAM and found them very good. '*The CCA gets better and better.*' She used PAM for all paddock records, as it gave whole-farm recording. '*It is fairly new and we are getting components just for us, they are still setting it up.*' She used PAM mainly for broad acre clients, but had not used the insect side of yet and planned to put insect sprays in. She also had a PAM Palmtop.

The interviewee expected that with IPM and more beneficials, the industry might not need simulation runs much longer, '*Bollgard will make CottonLOGIC more superfluous, at least for Heliothis*'. There had been few Heliothis problems during the last few years, but other insects were becoming more prevalent and a concern: Rutherglen bugs, aphids, jassids, myriads. Rough ball worms were becoming a problem and they had to spray more for them.

The third interviewee had used the Palmtop two seasons ago. He had found it cumbersome and had problems putting figures in. Synchronising several Palmtops took time and was complicated. He could not put in four checks for one field and they liked to see each check separately. The interviewee said that beneficials in Palmtop was a major issue as '*it does not have all insects on it, or it has them grouped differently. There are often different insect in different years.*' Also handy would be an up-to-date label of all chemicals on the Palmtop.

The interviewee said he would wait for it '*to be perfected, as the Palmtop would be useful here; it has the big advantage that it is easy to record into computers*'. The interviewee saw the Palmtop-of-the-future as being voice-activated and linked to GPS. He believed that the industry needed to standardise what people did – '*the Palmtop is doing that to some degree*'.

His firm used only a paper-base for insects and had used it for 26 years. They kept records of some other inputs e.g. date of last irrigation, foliage spray, and last insect spray. Their record system consisted basically of field reports. '*That is a problem; we feel we need five years of records for each field. Accessing and finding them takes time.*' They employed casuals to do

insect counts '*while the two of us make decisions. Every field gets looked at by one of us at least once per week.*' Decisions were based on experience and feel, and were about insects, irrigation, growth regulator, fertiliser rates and types, and weed control.

The firm used neutron probes, which gave another set of figures to be faxed to or left with farmers. They did fruit-retentions for some farmers, petiole testing and BRIX testing. That information also needed to be sorted. He said: '*if we had records of several seasons on computer we could follow changes and get an idea of future needs*'. He put spray applications on computer and compiled the CCA survey from those, but the CCA report did not collect any insect data. The interviewee said that the majority of his farmers filed field inspection reports. He did not know of farmers who used PAM, CottonLOGIC or other programs.

The interviewee saw a need for CSIRO to get standardised formats out into the industry for consultants to base their own design on. He believed that as farmers were becoming very time-limited, any innovation needed to be time-efficient. '*80% of farmers don't keep records but they will need to. So any system must be easy and comprehensive.*' He thought the ACRI Website was good and needed to be kept up to-date. He used the QDPI Website regularly.

The interviewee saw their future work go more towards irrigation and nutrient management, especially for new varieties. He believed that '*quality will be the challenge of the future; we need a system to help us get a quality product all the time*'.

The fourth interviewee had tried CottonLOGIC and would be happy to use it '*if it did not come up with all those little error messages*'. He had not used it for decision-making. '*By the time we write the data down and find a computer the decisions have been made.*' It also did not have the report writing facilities he needed. The interviewee only needed insect records with written reports of what should happen. He had no need for paddock records. Growers needed those but some had found it infuriating to get an error message and be told to ring CRDC, which in summer ran on a different time and was only open during office hours.

The interviewee said CottonLOGIC had been good to have, as there was nothing else like it but it needed an update. It had become easier to use but he still had issues with inputting data and it did not take into account plant height and status. He thought that with the advent of IPM it had become dated. He had not used the Palmtop: '*but knowing CottonLOGIC I was not going to buy a Palm until I got other uses as well. I also looked at the economics.*'

The interviewee currently put pests, beneficials, plant, temperature, visually access, fruit size, and numbers (using a fruiting index) onto a spreadsheet. He thought that the quality of the CottonLOGIC information was less than that of the information he used. '*We are ahead of the IPM section in CottonLOGIC.*' He would love to graph beneficials over time, but can do it easier on Excel. He used the CCA program for chemical records.

The interviewee said that some farmers used a spreadsheet (for farm-operations), as it was easy. Some used CottonLOGIC and had problems, while others used nothing. Farm Office had become too complicated and threw up too many error messages. '*They were trying to put everything in that anyone wants.*' He had heard of PAM, but had not used it. He questioned if there was '*a survey that shows that growers do use PAM?*'

The interviewee thought that combining CottonLOGIC with CCA and PAM would be ideal, but '*any program needs to be basically simple with options to make it relevant.*' He believed

that CottonLOGIC '*needs to keep the insect bit and make that relevant again, but leave the rest to others*'. And it needed to be kept free of charge. In his view, other issues for CSIRO staff to focus on were water and nutrition. He had just looked at a program analysing paddock by paddock for yield mapping, EMC, satellite pictures, paddock records etc, to work out Gross Margins. It used GPS for insect counts, aeroplane data, precision fertilising etc. '*That is the sort of stuff CottonLOGIC needs to fit into and where the future of consulting is.*'

The interviewee would like to '*get a summary of the range of replies to the interviewees*', see what others had said and where he stood in relation to that. '*We have spent a truckload of money for something only a few people in the industry use. But it is also our responsibility and that of farmers to co-decide where research and this group should be going.*'

6.4.3 Non-users of CottonLOGIC

Two of the three consultant-interviewees had a copy of CottonLOGIC but had never used it. One had helped people to set up CottonLOGIC but she used a spreadsheet for insect counts, herbicides, insecticides, defoliation and other details as she saw no need to put them on computer. Her reports are '*simple and one page, which shows expenditure by field name and number. It has also got a yield component.*' If someone wanted to go back she would dig the data out and do a report on Excel. '*We give growers what they want, something simple.*'

For decision-making she used counts, damage and farmers' acceptance of thresholds, be that high or low. '*But with IPM there is now more acceptance.*' She looked at other insects, crop stage, available moisture and variety, as some compensated more than others. '*Basically we use experience I guess, not much out of a book. It comes from years in the field.*'

The interviewee used a software package *Diviner for Water Scheduling* but only for three growers. She said she had no need for more programs: '*I am happy with what we got.*' She did not keep records of paddock operations and said growers used all types of different programs. She thought linking CottonLOGIC with PAM and other programs would be very sensible. '*I think my growers will be happy with linking what they have with CottonLOGIC.*' She had never seen the Palmtop, but thought there was no need for it. '*It would make a simple thing more complex. Farmers don't want to sit in front of a computer for hours.*'

The second interviewee in this category looked after one cotton-grower. He had run through CottonLOGIC a few times. '*It is good general background, but not much practical use.*' He used a spreadsheet with insect numbers and checks, irrigation dates, fruit charts etc for each field, and gave a copy to the client. '*Punching it into CottonLOGIC would take more time. I don't need it for record keeping.*' He used industry threshold figures as a guide.

The interviewee used no other computer programs for paddock activities; the farmer used a work diary. The interviewee expected to be looking more at nutrition, varieties, weed control, and irrigation management. And he '*will probably use C-probes in future, so HydroLOGIC will be needed.*' He would like more plant monitoring. His client had started remote sensoring and '*we want to go back into a field, look at potential yields and find out what stops it.*'

The interviewee thought that researchers might need to review the need for this software given Bollgard. '*One would anticipate vastly less impact from Heliothis but maybe more from other insects.*' He expected insect scouting to fall by up to 60% '*so the need for monitoring and recording and thus CottonLOGIC will be different*'. He said that if CottonLOGIC were

still needed, it must be made very farmer-friendly '*so farmers can become independent from consultants. I sometimes think consultants are becoming solutions in search of a problem*'.

The interviewee thought that CSIRO might move more into cost/risk work to explore alternatives e.g. more cotton or more other crops. And quality might become a major issue. He was concerned about the legal position of the data and recommendations. E.g. if a young agronomist made a recommendation based on CottonLOGIC and the farmer did not understand it and had lower yield than the neighbours, the farmer could blame the consultant. '*How would the consultant stand legally? Will CottonLOGIC stand in the box with (him)?*'

The fourth interviewee in this category did not use CottonLOGIC or palm-held technology, as he did not do insect counts. He did the bigger picture. '*I help people develop strategies through summer e.g. water availability, agronomy etc.*' He used soil-pack, nutri-pack and other packages, and his own and other people's experience to fine-tune strategies. He used websites to get information to support decisions, but not on a daily or regular basis.

The closest he came to keeping records was in water-use for irrigation. '*But with C-probes, growers access data directly on their PC.*' Most growers he knew used Excel formatted by them or by other people to plan, record and analyse across all aspects. He knew some who used CottonLOGIC '*about 3 or 4 out of 12*', mostly for record keeping. He was not aware of anyone using PAM. One grower still used a derivative of Farm Office.

The interviewee said most programs were still time-consuming and people were not sure that they took them to the right decisions. Given the social and political issues, cotton-growing decisions were becoming more and more complex. He thought CottonLOGIC was not comprehensive enough but said '*it is good in its narrow field. It helps people decide in what situation to treat or not to treat.*'

The interviewee believed parts of CottonLOGIC (especially the Palmtop) were very useful and should be kept, '*as that data is important.*' He thought a niche for CSIRO would be to '*hone in on special packs eg irrigation, insects, nutrition, and options to manage these inputs. Then work out ways to integrate the packages and highlight different strategies.*'

The interviewee saw the basic role for the programmers as linking research with farm-management decisions. '*Their role is just starting (given) new sophisticated hardware. They ought to let outside resources cater for general needs, and use industry resources for cotton-specific needs. If that is their view they have a pretty good idea of the situation.*'

6.5 Others

All interviewees in this category were aware of CottonLOGIC, but only one knew much about how it was used. That interviewee said that CottonLOGIC was a good product. '*I like it but I don't do bug checking for a living*'. He believed it had been used generally by people who wanted to '*back up ideas*' and by consultants for end-of-season reports, but not much as a management tool as '*it takes too much time to input*'. He believed it had to be made simpler so that '*it can run scenarios in the paddock*', do '*what ifs*' easily and quickly.

Complaints in workshops had been that it took too long to enter fields and farms and was too difficult to split fields, watering, replanting etc. '*While it can handle those by setting up different fields, that is a lot of bother and requires confidence and familiarity.*'

The interviewee said that CottonLOGIC very much modelled what science had proven. He would like it to concentrate on insect management and records of chemical use, as '*the more complete (they make it), the more complex it will be*'. He would '*hate to see the entomology lost*'. He liked to keep CottonLOGIC small by '*keeping HydroLOGIC separate but linked, and by linking with PAM and other such programs.*' A link between HydroLOGIC and CottonLOGIC would be good as '*we see cotton diseases linked with water movement*'.

The interviewee said the Palmtop had come some way (in making CottonLOGIC accessible in the field) but '*may still be a bit expensive*'. There had not been a huge adoption of it, as '*the drought kept crops low and insects few, so it was not the season to push it*'. He saw the Palmtop more as the way of the future, but believed an office computer would still be needed for reports'. '*Ideal is to connect (the Palmtop) to a phone and send the data back to the office before you leave the paddock; it needs that link as backup.*' He said the battery power was too limited: '*if you don't charge it regularly it goes flat when you can least afford it*'.

The interviewee said that the integrity of CottonLOGIC was in its backup by research. '*They should not compromise on that. It is a selling point that does not come across enough.*' Another highlight was the strong backup by the team. '*Sandra has the knowledge and personality and is keen and does it very well indeed. I had very good feedback about that, so don't prune that; that backup is essential.*' The interviewee said he had a lot of respect for CottonLOGIC and warned not to '*expand it to attract more users; don't spread the resources too thinly.*' But it would be fine if '*CottonLOGIC can just talk to PAM*'.

The second interviewee had a copy of CottonLOGIC but had received no training. He had worked out roughly how to use it but preferred recording on paper. He used a spreadsheet to record eggs, larvae, predators and other pests, using different sheets for three stages of the growing season. He checked for one grower only and mostly looked at yield and quality, and the Gross Margins at the end of the year, seeing if he could make money for the grower. He did cotton trials with other people e.g. on defoliates. He checked many summer crops for pests, tested new products and tried old ones in new situations. He had not seen anything to give him an idea of where the CottonLOGIC team should go next.

The third interviewee did not check cotton and did not know how many of those who do, used CottonLOGIC. A main decision support program he used was Soil Nutrient Advantage by Incitec, which had a decision support manual. He did soil tests for growers and sent the results to Incitec for analysis. The program then gave fertiliser recommendations for each crop, '*but a lot of our cotton blokes used the same fertiliser every year anyway*'. He used Terra Grow to find out what chemicals were registered for a crop.

Most farmers he knew used general accounting and record keeping programs. He knew only one grower using PAM and only two growers who did their own spraying. They did not use CottonLOGIC.

He used to do GPS mapping when it was still unknown to growers, '*they wanted to be shown but they did not want to pay*'. In his view, CSIRO staff '*need to stick to science. Anyone can do accountancy but when it comes to scientific stuff, well that is different*'. He said CSIRO should put all trial data together and work on any product that made it easier for people to make decisions. One niche for would be in the management of water and fertiliser as '*there is a lot of probability there. Insects are easy, but timing of water and fertiliser is uncertain.*'