

Part 1 - Summary Project Details

Final Report

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Project Title:
(< 15 words)

Development and field testing of micr-computer cotton management packages

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Aims

1. Continue to develop and field test CottonLOGIC and related management packages with particular emphasis on Ingard cotton and later food spray technology.
2. Validate the CottonLOGIC thresholds, sampling systems and decision rules for Ingard and compare the economic performance of Ingard with conventional cotton.
3. Promote the continued adoption of CottonLOGIC programs and provide training and support for growers and consultants in all regions.

Background and Industry Significance

Cotton growers are facing increasing 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 have been developed to provide cotton growers with the best information available from research to assist with their management decisions making. CottonLOGIC is now freely available to assist growers and their advisers in pest management; crop nutrition; insect species identification; plant mapping; growth regulation; spray ordering and notification; and management of INGARD® cotton. Underlying these functions is a powerful database for storing crop management information and an end of season report generator.

The number of registered copies distributed to the industry has risen to over 900. CottonLOGIC is also become an industry benchmark for pest management and thus is recommended in the industry's Best Management Practice guidelines. In addition to this the software has gained significant recognition for its quality and usefulness by winning prestigious awards for excellence in Australian agriculture software and technology transfer in the IT industry

Research Methodology

The research conducted in this project comprised of a number of major aspects:

- (i) Continued development and testing of the CottonLOGIC program as an industry standard for crop management, farm record keeping and reporting.
- (ii) Continued development and testing of Ingard support and large scale field-testing of management systems for Ingard.
- (iii) Development and testing of support for food sprays and virus
- (iv) Continued training of growers and consultants in all cotton growing regions and technical support through the Cotton CRC Technology Resource Centre.

Summary of Outcomes

A brief outline of the major results and outcomes from this project is given below. Outcomes will be discussed under the headings: CottonLOGIC release and development; CottonLOGIC validation and demonstration; CottonLOGIC training and support; and CottonLOGIC impact and evaluation. Where research has been written and published the appropriate reference in the list of publications is given.

CottonLOGIC Release and Development

In August 1998 at the ACGRA conference a new version of EntomoLOGIC was launched under the banner of CottonLOGIC. The decision to change the name was based on the emerging nature of the EntomoLOGIC software to assist with decision support on issues other than just pest management. CottonLOGIC has the capabilities to assist with pest management decisions, nitrogen fertiliser management decisions (NutriLOGIC), and provide accurate record keeping and reporting. Since the release at the conference we now have over 1000 registered copies distributed to the industry. Details of software development issues are presented and discussed in document No. 1.

Since the inception of this project some of the major features included in CottonLOGIC are as follows:

- The inclusion of NutriLOGIC.
- Significant improvement in record keeping and reporting capabilities.
- Improvements to CottonLOGIC so it can access appropriate pages on the Cotton CRC web site (the Home page, the CottonLOGIC upgrade pages and the Day Degree Calculator page)
- Upgrades to CottonLOGIC are now also been distributed via the web and using e-mail.
- The ability to include recording of management of rotation and refuge crops.
- The ability to record beneficial counts from visual and vacuum sampling.
- The inclusion of Ingard thresholds in accordance with the TIMS committee.
- Year 2000 compliant.
- A spray ordering system that enables growers and consultants to inform spray operators and neighbours of intentions to apply chemical spray applications.

The quality of software development and support for the Cotton Industry has been recognised through a number of awards to the Decision Support development team, they were:

- CottonLOGIC won the first prize in the category 'recording and analysis' decision support packages at 1999 Sydney Royal Easter Show. Chris Plummer and Sandra Deustcher presented the software to the judging panel. This was the largest category (12 entrants) and the comments by the panel were that CottonLOGIC was very impressive amongst a field of high standards.
- As recognition of the Cotton CRC's contribution to technology transfer using computerised decision support, the CRC was recently awarded the 1999 National Award for Excellence through Information Technology for Rural and Regional Australia.
- The 1999 CSIRO Plant Industry's Chief's Award for Technology Uptake.

CottonLOGIC Validation and Demonstration

The primary aim was to continue the development and validation of CottonLOGIC using large-scale trials on commercial farms. Over the course of the project trials were conducted to evaluate and demonstrate the capabilities within CottonLOGIC to assist with decision making for nitrogen fertiliser management (NutriLOGIC), and using CottonLOGIC to assist with pest management decisions in experiments utilising food spray technologies (Envirofeast®) and transgenic crops (single and double gene).

Details of trials conducted are summarised below:

- NutriLOGIC trials. The aim of these experiments were to validate the nitrogen fertiliser recommendations made by CottonLOGIC in a number of cotton

growing regions. Details of trials conducted to date are outlined in document number 3.

- Food Spray Trials In collaboration with Dr Mensah (NSW Agriculture) Envirofeast® management trial was conducted in the Namoi Valley the using CottonLOGIC to assist with pest management decisions in treatments with conventional and Ingard cotton and the use of lucerne strips and Envirofeast®.
- Threshold trials CottonLOGIC was evaluated in conjunction with standard industry thresholds for pest management decisions in a number of regions. These trials compare the management of pests using CottonLOGIC to commercial insect management without the use of CottonLOGIC. These trials were conducted in collaboration with the Cotton CRC industry development officers. Information collected and discussion of results are summarised in documents numbers 4 and 5.
- Transgenic Insect Management trial CottonLOGIC with industry standard thresholds were evaluated in the management of single and double gene Ingard experiments. The treatments include a conventional variety (Siokra V-15) a single gene Ingard (Siokra V-15i) and a two Bt gene version of Siokra V15.

In summary analysis of results from field testing of entomoLOGIC have shown that insect pests can be controlled with less sprays when using entomoLOGIC.

CottonLOGIC Training and Support

Since the release of CottonLOGIC in August 1998 members of the decision support development team have devoted a great deal of time to training of users and supporting the product. CottonLOGIC workshops were conducted throughout the industry in each year of the project. The workshops which extend from Emerald to Hillston has increased to 17 and have had up to 250 participants in total.

The workshops content and presentation were thoroughly planned to maintain the professional image of CottonLOGIC. Well-constructed exercises were provided to participants to assist with demonstrating new and existing features. These exercises provided an excellent means for training as well as a useful mechanism for constructive feedback. Sandra Deustcher has attended courses on adult learning and has implemented some alternative approaches to suit a range of learning styles of the participants to workshop participation.

The other main method of support to users has been the phone service provided by Chris Plummer, David Larsen and Sandra Deustcher. On occasions Chris or Sandra have travelled to assist a user if located close to the research station. In order to assist the support process, a help desk application that allows for easy entry of industry member details, queries and solutions has been developed. This will provide a log of queries that the Cotton CRC Technology Resource Centre receives on a daily basis be it by telephone, in person, e-mail or fax. This will also enable someone who is not familiar with CottonLOGIC, the TRC publications, the Cotton CRC web-site or the relevant topic to be able to easily look up the solution from the Help Desk application, if the problem has been encountered previously.

Some simple evaluation conducted in 1999 allowed the participants of workshops to answer some simple questions relating to the delivery and importance of the workshops. Of the total of 250 participants that attended the workshops, 100% of the responses thought that the workshop was useful while 98.7% said that they would attend the workshops in the future. In addition 80% of responses said that they would not like to see any changes in the present workshop format.

CottonLOGIC Impact and Evaluation

While anecdotal, there is evidence to suggest that the demand for CottonLOGIC has increased based on the increase in the numbers of copies of software (be it

entomoLOGIC or CottonLOGIC) being distributed to the industry. The number of registered copies has significantly increased from 205 in 1995 to 1035 in June 2000.

A simple phone survey was conducted at the end of March 1999 to assess to level of use of CottonLOGIC and determine what the software was used for. A total of 153 people were successfully surveyed (81 growers and 72 others which included consultants and agronomists). The sample size was approximately 19.1 % of the total number of registered copies (excluding extension and research personnel) at that point in time. One major issue was to address the level of use of the software for decision making in the context of tactical pest management or determining nitrogen fertiliser rates, compared with using the software for record keeping.

Details of survey and results follow:

- Overall 57% of those surveyed said that they used the package.
- Overall 35% of those surveyed used the package for crop management while 22% used the package solely for farm record keeping.
- 25% of growers surveyed used the package for management decisions; 54% hadn't used it at all.
- 46% of consultants/agronomists use the package for management decisions; 30% don't use it at all.

Survey participants were also given the opportunity to make any comments relating to further development of the package. A detailed list of issues highlighted by the relevant groups was presented in Australian CottonGrower Magazine (Document No. 6).

Most importantly the decision support group employed the services of an independent consultant systems Mr Peter Van Beek specialising in assessing the importance and impact of decision support. Mr Van Beek has conducted

systems.

2. Promote the continued adoption of CottonLOGIC by providing training and support.
3. Facilitate mechanisms to allow industry involvement in the development of computer decision support.

It will provide necessary resources for field evaluation, training, support, and the production and distribution of software. Some of the new areas that will be explored in this project in order to seek opportunities for computerised decision support to assist include:

- Area Wide Management;
- The Best Management Practice Initiative;
- Water Use Efficiency and Water Management;
- Pest Beneficials;
- Virus Spray Technologies;
- Resistance Management Strategies;
- Management of other nutrients in the soil;
- Links with weather databases via the WWW; and
- Links to other software.

The nature of the aims and objectives of this new project facilitate the mechanisms for industry and user feedback while remaining flexible enough to respond to the ever-changing needs of the industry. CottonLOGIC will remain taking a leading role in allowing good science to be passed on easily and effectively to the industry. Further details on future activities in computerised decision support are detailed in Document No. 1.

Publications arising from this Project

Conference papers:

Bange, M.P. (2000). Crop models and decision support – Future developments and applications. In Proc. 10th Aust. Cotton Conf. 16-18 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation, pp. 629-637. (no. 1)

Bange, M.P. and Thomas, A. (1999). Multi-platform decision support systems. In Proc. Cotton CRC Research Conf. 21-22 July, Narrabri Aust. Cooperative Research Centre for Sustainable Cotton Production, pp. 274-178. (no. 2)

Deustcher, S.A. (2000). Validation and Calibration of NutriLOGIC. In Proc. 10th Aust. Cotton Conf. 16-18 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation, pp. 315-319. (no. 3)

Deustcher, S.A. and Plummer, C. (1998). EntomoLOGIC – A Computersied Decision Support System for Cotton IPM Application. In Proc. 6th Australasian Applied Entomological Research Conference. 29 Sep to 2 Oct. Brisbane. pp. 258-262. (no. 4)

Deustcher, S.A. (1998). Field evaluation and validation of cotton IPM systems using entomoLOGIC – a computerised decision support system. Extended Abstract. In Proc. 6th Australasian Applied Entomological Research Conference. 29 Sep to 2 Oct. Brisbane. p. 309. (no. 5)

Grower Magazines and Articles:

Bange, M., Deutscher, S., and Plummer, C. (1999). CottonLOGIC: Survey shows the way forward. 20 (4). The Australian Cottongrower. pp.40-42. (no. 6)

Deutscher, S. (1999). CottonLOGIC Moving towards 2000. 20 (6) The Australian Cottongrower. pp. 40-43. (no. 7)

Other Documents

CottonLOGIC Impact Assessment 1999 – Peter Van Beek (no. 8)

numerous (30+) interviews with a range of different stakeholders in the industry. A comprehensive report of the major findings was completed and presented to the group (executive summary Document No. 8) . The report was 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. 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'.

A decision support team workshop was held to discuss the findings and structure a work-plan to address some of the issues. The results of the workshop were presented to the industry's decision support steering committee for further discussion.

Future

A new project titled 'Continued development and field evaluation of micro-computer cotton management packages' follows on from this project. The aims of the project are:

1. Continue development and field evaluation of computerised decision support

Plain English Summary

Project Title: Development and field testing of micro-computer cotton management packages.

Principal Researchers: Dr Michael Bange, Ms Sandra Deutscher, Mr David Larsen, Chris Plummer, Mr Lance Mckewen

Project Aims:

1. Continue to develop and field test CottonLOGIC and related management packages with particular emphasis on Ingard cotton and later food spray technology.
2. Validate the CottonLOGIC thresholds, sampling systems and decision rules for Ingard and compare the economic performance of Ingard with conventional cotton.
3. Promote the continued adoption of CottonLOGIC programs and provide training and support for growers and consultants in all regions.

Summary:

Cotton growers are facing increasing 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 namely CottonLOGIC have been developed to provide cotton growers with the best information available from research to assist with their management decisions making

The number of registered copies distributed to the industry has risen to over 1000. CottonLOGIC is also become an industry benchmark for pest management and thus is recommended in the industry's Best Management practice guidelines. In addition to this the software has gained significant recognition for its quality and usefulness by winning prestigious awards for excellence in Australian agriculture software and technology transfer in the IT industry.

In order to maintain development of quality, useful and user-friendly software, significant field evaluation and industry consultation providing feedback is required. To back this up appropriate training and user support is needed. This project provided necessary resources for field evaluation, training, support, and the production and distribution of software.

Crop Models and Decision Support – Future Developments and Applications

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Introduction

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 and simulation models are being developed 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' (Fig.1).

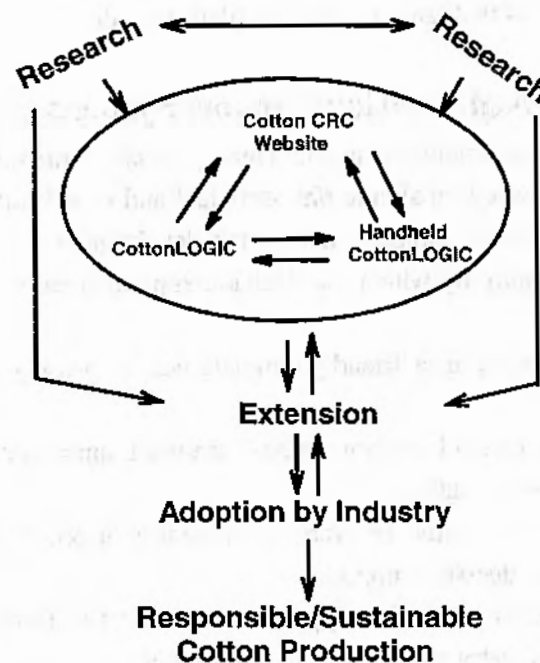


Figure 1. Putting 'Science into Practice' through computerised decision support.

We in the cotton industry are in an enviable position with an agricultural industry rich with successes and failures in computerised decision support, therefore we can call on a number of approaches to assist acceptance, development and evaluation of its products and activities. One principle approach is to use multifaceted skills and knowledge, coordinated effectively with expertise and input of others when available.

The first part of this paper will discuss the operation and means by which the decision support team, which now includes a number of people working on the crop simulation models to deliver decision support tools. The second part of the paper will address the significance of decision support and models to the cotton industry. Finally, the paper will present future activities being undertaken, involving both the decision support team and those associated with modelling.

While essentially there are a large range of tools being developed by the group in Narrabri for different research and industry needs, this paper will discuss the present development and future opportunities of the following:

- CottonLOGIC;
- Handheld CottonLOGIC for in field use;
- The Australian Cotton CRC website (WWW); and
- The OZCOT crop simulation model.

In the context of this paper 'decision support' will refer to the development, operation and application of CottonLOGIC (in all its forms), the WWW and the crop simulation model.

Development of Computerised Decision Support Systems

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

1. Aim to develop effective, useful and user friendly computerised decision support systems backed by good science.
2. Promote responsible crop management based on the best and most appropriate science that is accepted by industry (ala Best Management Practice).
3. Responsibility for the science used in the software is inherently shared by all researchers involved, and not entirely by developers of decision support.
4. Selection of priority areas for effort is based on appropriate constructive feedback and industry input.
5. No group or region within the industry will be favoured nor ignored.
6. Approach each task pragmatically, and only after careful planning and responsible considerations commit to software development.

7. Make activities and decisions transparent to superiors, industry and funding bodies.
8. Produce quality outcomes, thoroughly tried and tested.
9. Decision support systems are just that, they do not make the decisions, but provide information to assist in the decision-making processes. Promote the decision support systems as tools. (e.g. Promote IPM, and CottonLOGIC helps achieve this)

Successful development and delivery of decision support for adoption by industry encompasses many different processes from the conception of an idea through to delivery and support. Some of the important functions and activities of the decision support team are outlined in Table 1.

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

Team Function	Example of activities
Software development	Software engineering, coding, and testing
Education and training	CottonLOGIC workshops, field days
Support	Phone support at the Cotton CRC's Technology Resource Centre (TRC)
Industry Feedback	Workshops, TRC, Industry Steering Committee
Packaging and Distribution	CottonLOGIC packages, and mailouts through the TRC
Promotion	Attendance at trade shows, local shows with the TRC
Scientific Review	Attendance at Scientific Conferences, Peer Review
Field Validation	Regional specific field trials using CottonLOGIC, working with the Industry Development Officers
Project Evaluation	Surveys, Independent feedback from Consultant
Administration	Personnel management, sourcing funding

Significance of Decision Support and Modelling to Industry

CottonLOGIC

The development of any computerised decision support package relies on constructive feedback from its stakeholders. Based on different forms of feedback and assessment it has shown that CottonLOGIC is highly valued and accepted in the industry as a tool to assist with crop management.

Apart from the day to day informal feedback that the decision support team obtains, the group also uses other mechanisms to ascertain importance and industry needs for decision support development. In the past year the group has conducted one phone survey, one workshop survey as well as employing the services of an independent consultant specialising in decision support. While the information gathered has highlighted deficiencies, it has also, demonstrated overwhelming support for computerised decision

support to help assist the industry. The different forms of feedback and assessment are now discussed.

While anecdotal, there is evidence to suggest that the demand for CottonLOGIC has increased based on the increase in the numbers of copies of software (be it entomoLOGIC or CottonLOGIC) being distributed to the industry. The number of registered copies has significantly increased from 205 in 1995 to 1035 in June 2000 (Fig. 2).

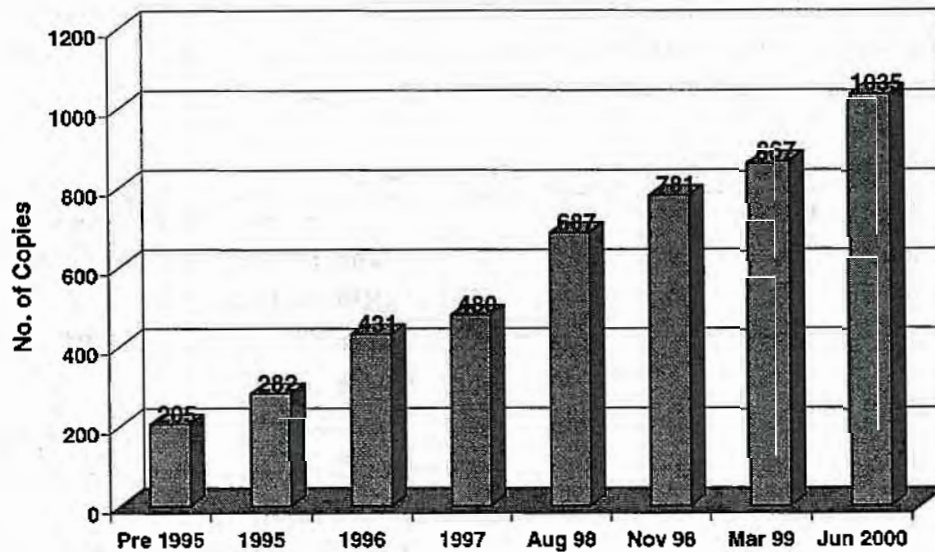


Figure 2: Graph showing the number of registered copies of CottonLOGIC distributed.

A simple phone survey was conducted at the end of March 1999 to assess to level of use of CottonLOGIC and determine what the software was used for. A total of 153 people were successfully surveyed (81 growers and 72 others which included consultants and agronomists). The sample size was approximately 19.1 % of the total number of registered copies (excluding extension and research personnel) at that point in time. One major issue was to address the level of use of the software for decision making in the context of tactical pest management or determining nitrogen fertiliser rates, compared with using the software for record keeping.

Details of survey and results follow:

- Overall 57% of those surveyed said that they used the package.
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Survey participants were also given the opportunity to make any comments relating to further development of the package. A detailed list of issues highlighted by the relevant groups was presented in Australian CottonGrower Magazine (Bange et al., 1999).

In the past year emphasis was also placed on assessing the training given by the decision support group. Significant effort has occurred in redesigning and improving the workshops to cater for the greater numbers attending, and to suit a range of learning styles of the participants. Evaluation was conducted by allowing the participants at last year's workshops to answer some simple questions relating to the delivery and importance of the workshops. Of the total of 250 participants that attended the workshops, 100% of the responses thought that the workshop was useful while 98.7% said that they would attend the workshops in the future. In addition 80% of responses said that they would not like to see any changes in the present workshop format.

Most importantly the past year the decision support group has employed the services of an independent consultant systems Mr Peter Van Beek specialising in assessing the importance and impact of decision support. Mr Van Beek has conducted numerous (30+) interviews with a range of different stakeholders in the industry. A comprehensive report of the major findings was completed and presented to the group. The report was 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. Some quotes taken from the report are below:

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'The new versions come out too late to try changes, familiarise, and train staff in the applications'.

A decision support team workshop has been held to discuss the findings and structure a work-plan to address some of the issues. The results of the workshop will be presented to the industry's decision support steering committee for further discussion.

Crop Simulation Models

Research on the application of crop simulation models such as OZCOT involves both the Agricultural Production Systems Research Unit (APSRU) based in Toowoomba working closely together with researchers from Narrabri. The focus of the research is now on identifying the appropriate means of delivering this technology to industry as well as addressing and identifying appropriate needs for irrigated cotton growers. This has come about after a highly successful project that used this technology with

dryland grain and cotton growers. The success of the past research was again established using similar evaluation methods described above for CottonLOGIC.

As well as establishing credibility through formal project evaluation, significant industry demand (especially from dryland grain and cotton growers) has resulted and has brought about contributions from the GRDC and CRDC to explore the appropriate means of delivering modelling technology. Recently the 'FARMSCAPE' accreditation process was launched to train and accredit four agribusiness companies to allow them access to this technology. In addition to the agribusiness companies key personnel in both the cotton and grains industry will be accredited. Mr Dirk Richards is now being accredited in the cotton industry and will use his skills to train the industry extension personnel in the correct use and function of cropping systems models. It is envisaged that a user-friendly version of OZCOT will be made available to assist the cotton industry's access to this technology.

Future Developments in Decision Support

This section will present some present and future developments that are occurring from both the decision support and modelling teams at Narrabri, involving both CottonLOGIC, the WWW and OZCOT.

CottonLOGIC for Handheld devices

In attempting to resolve issues of some users, significant development has progressed in providing CottonLOGIC on a handheld device using the Palm® operating system. This will allow in-field recording and analysis of insect data and provide a report to the pest manager in the field as opposed to returning to a computer located in an office. The capacity to then down-load data in to a desktop version of the software will be possible for storage and further processing. While the concept was simple when first perceived, significant effort on certain issues has had to be resolved in order to enable this project to reach completion, they were:

1. Identify an appropriate device that will function adequately in the field.
2. Develop software that would be supported by hand-held devices into the future (Palm Pilot; Fig. 3)
3. Develop software to handle data from a central database and be passed and managed between a number of handheld devices (Fig. 3).
4. Taking the science and programming from the desktop version of CottonLOGIC and transfer to the development of the handheld.

- Obtaining numerical weather prediction 5 days in advance improve the Helicoverpa pest population forecast calculated in the CottonLOGIC. Information to be delivered via the Internet. Presently average temperatures generated from historical records are used in the models to generate the pest forecast.

It is hoped that one day that users would be able to directly access and download the information with the click of the button whilst running the CottonLOGIC software.

Another exciting opportunity that the interactions with the SILO project bring is being able to access climate records (PPD) and numerical forecast of weather easily. The decision support team and crop modellers are working with the SILO project linking the climate and weather data with the OZCOT model. Hopefully it will provide the industry with a tool for growers and consultants to monitor crop development, as well being able to predict crop growth in the short term (over the next few days) and for the remaining season (Fig. 4). It is envisaged that this information in the first instance be delivered over the Internet.

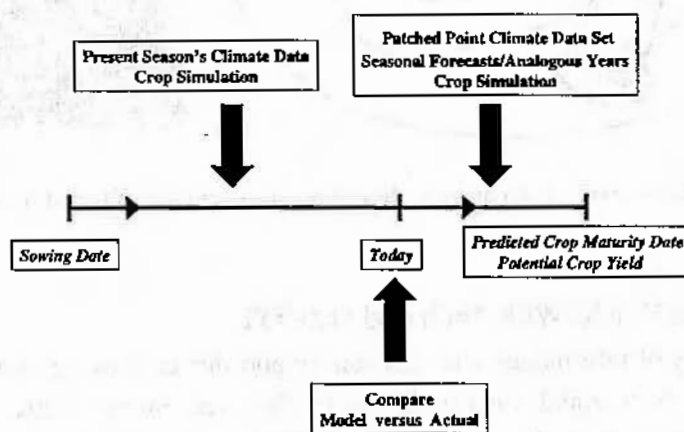


Figure 4: A diagrammatic representation of the use of OZCOT linked with the SILO project climate and weather databases.

Significant Issues facing the Decision Support Development Team

From the evaluation presented above and through continued development of decision support some important issues have been identified, they are:

- Enabling links with 3rd party software, that is to allow easy data transfer from CottonLOGIC to other farm management software packages.
- Investigate the requirements for a water budgeting system with the intent of inclusion into CottonLOGIC.
- Ensuring closer links with existing mechanisms for education, training and support in the industry.
- To enhance development of decision support a significant re-engineering of the CottonLOGIC software is required.

Conclusion

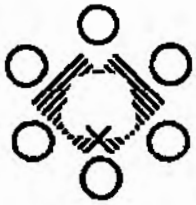
The development of computerised decision support is an ongoing process that is constantly responding to changing industry, biological, environmental and technical issues. The decision support and modelling teams will endeavour to respond to these changes and meet the needs of industry and wider community by assisting the cotton industry to become sustainable and environmentally responsible. For information and free copies of CottonLOGIC contact David Larsen, the coordinator the Australian Cotton CRC's Technology Resource Centre on (02) 679915534.

References

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

Acknowledgments

Components of this research and development is funded by the Cotton Research and Development Corporation, The Australian Cotton Cooperative Research Centre and the Grains Research and Development Corporation.



Multi-platform decision support systems

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Background

Managing sustainable cotton production is becoming more difficult with the ever-increasing demand on limited resources. In addition cotton growers are facing increasing pressures to manage resources more cost effectively and to be more accountable for impact their decisions make on the surrounding environment. Computer based decision support systems are being developed to provide cotton growers with the best information available from research to assist with making their management decisions.

CottonLOGIC is a decision support tool for the Australian Cotton Industry which assists growers and their advisers achieve maximum benefits from the latest cotton research. CottonLOGIC helps make more informed pest management spray decisions by using a life cycle model of the *Helicoverpa* spp. (a major pest in cotton) to predict pest pressure. It can also recommend appropriate control measures for mites by predicting the growth of mite populations and potential impact on crop yield. To make insect identification easier, CottonLOGIC provides information (text and pictures) on all key pests and predators.

CottonLOGIC can also assist in nitrogen fertiliser management by interpreting of soil or petiole nitrate measurements. CottonLOGIC is also a valuable means of recording agronomic data. Information about insect pressures, fertiliser and pesticide applications, and field operations can all be easily stored and accessed.

In attempting to resolve issues of some users, development is continuing on other platforms for delivery of decision support. One area is the development of software tools that can be mobilised with hand-held machines. This will allow in-field recording of insect data and provide a report to the pest manager in the field as opposed to returning to a computer located in an office. The capacity to then download data in to a

desktop version of the software will be possible for storage and further processing. Other opportunities for the use of hand-held platforms are also being investigated.

Another platform for delivery of information and decision support that is showing ever increasing support is the Internet (WWW). The CRC now operates a fully functional and interactive web site that provides information such as: current weather data from the cotton industry's met stations; cotton industry publications; diary of events within the cotton industry; industry contacts; and providing the latest research information available within the industry in a season (e.g. resistance management).

Aims

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

Progress

The successful release of CottonLOGIC at the ACGRA cotton conference in August 1998 was the major achievement for this project. We now have over 870 registered copies, an increase from 480 registered copies of Entomologic prior to the conference in July 1998. Since the release, the members of the CottonLOGIC team have devoted a great deal of time training users and supporting the product. Since September last year 17 CottonLOGIC workshops have been conducted throughout the industry with 254 attendees. In 1997 only 12 workshops were conducted with 130 attending. Locations this year included Narrabri, Theodore, Burren Junction, Emerald, Moree (2), Goondiwindi, Dalby (2), Theodore, Boggabri, Gunnedah, Gurley, Jimbour, Bourke, Warren, Walgett, and Pittsworth. At least four of these workshops were initiated by demand created by users.

A recent (March 1999) survey was conducted to assess the level and type of use of CottonLOGIC. It was decided to only survey the person who had received a copy of CottonLOGIC and had registered it. For example growers who had consultants or agronomists using the package to manage their cotton were not considered, unless they also had a registered copy and had been chosen to participate in the survey. Overall 35% of those surveyed used the package for crop management while 22% used the package solely for farm record keeping.

Since the release of CottonLOGIC in August the following developments have occurred:

- An on-line help facility for CottonLOGIC has been developed using HTML technology.
- More improvements to reporting and graphing capabilities have given the user more flexibility and control in handling information.
- Direct links to the Cotton CRC web site have been incorporated in CottonLOGIC such that degree-day and CottonLOGIC upgrades can be accessed easily.
- Improvements have been made to the end of season reporting and graphing capabilities.
- Three minor upgrades have been released which fix minor bugs and include improvements made since the conference. Upgrades have been distributed via the WWW and using e-mail.

Significant progress has also been made on the hand-held system. The PalmOS was identified as the most suitable hand-held platform because it is cheap, easy to use, is a personal organiser, and has a platform, which allows simple development of software tools. A prototype of CottonLOGIC for the PalmOS now exists (Figure 1), and the conduit to link the hand-held device and the desktop application of CottonLOGIC has also been developed. These components and others are presently being refined to add functions and improve useability. Impediments to the distribution of the software have now been resolved.

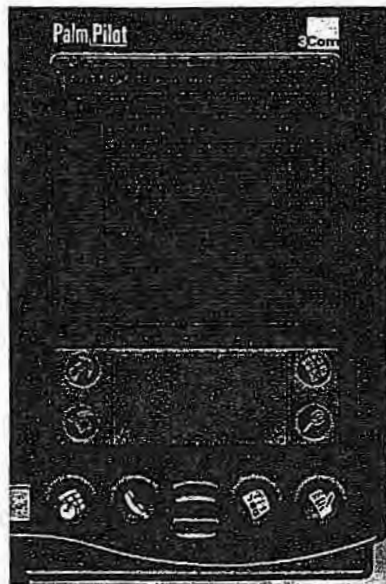


Figure 1: PalmOs handheld device.

Visits to the CRC web have substantially increased since its inception (Figure 2). The increase in visits to the site can be attributed to the additional research information available, as well as improved reliability and useability. The web site is now operating from a dedicated production computer server, which has improved site reliability. There also a dedicated staging computer server which allows more control in the process of managing and coordinating the web site, developing new web applications, and ensuring critical review of new content takes place before it is implemented on the web.

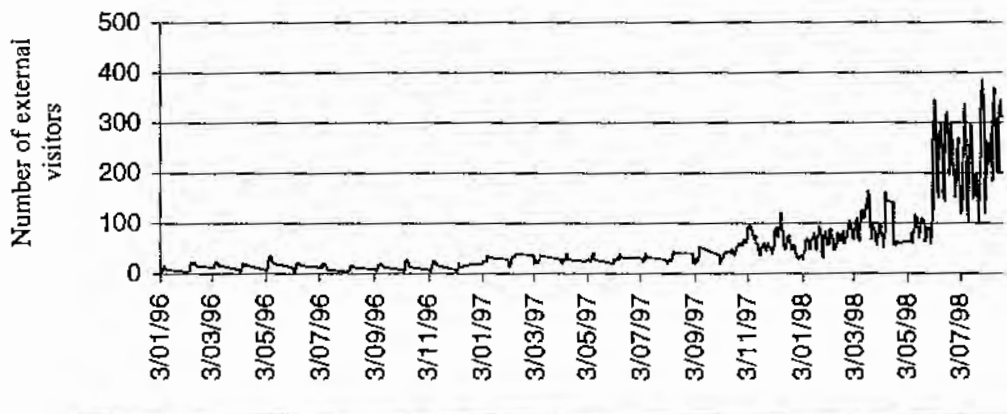


Figure 2: Graph demonstrating the increase in external visitors to the Cotton CRC's web site since 1996.

Other highlights

The Cotton CRC web-site now has full 12 out of 12 rating with "farmwide.com.au" Australia's farm-related web portal.

Awards

CottonLOGIC has won the first prize in the category 'recording and analysis' decision support



packages at Sydney Royal Easter Show. Chris Plummer and Sandra Deustcher presented the software to the judging panel. This was the largest category (12 entrants) and the comments by the panel were that CottonLOGIC was very impressive amongst a field of high standards. Chris and Sandra are also attending the show to demonstrate the software.

Validation and Calibration of NutriLOGIC

Sandra Deutscher

CSIRO Plant Industry, Australian Cotton Research Institute, Narrabri NSW
Australian Cotton Cooperative Research Centre

Introduction

Since 1992, experiments to validate the Decision Support System CottonLOGIC have been conducted. These experiments have focused on insect management and have been located on commercial cotton farms in the upper and lower Namoi Valleys. During the 1998/99 and 1999/00 seasons experiments were conducted on commercial cotton farms within a wider range of regions (Table 1). The reason for conducting experiments on commercial farms is to test the capabilities of CottonLOGIC in a range of environments that represent a commercial system.

In 1998, the NutriLOGIC module was incorporated into CottonLOGIC. This system informs the user of the need for nitrogen (N) fertiliser for a given field or cotton crop based on soil or petiole nitrate analysis.

The science behind NutriLOGIC was derived from calibrations that were developed by Dr. Greg Constable and Dr. Ian Rochester of CSIRO Cotton Research Unit, Narrabri. The program predicts the economic optimum N fertiliser rate based on a calculation of N fertiliser cost and the economic return for cotton lint. Soil or petiole nitrate levels, regional yield responses and sampling time are the main inputs of the program.

The objective of these experiments was to examine the output of NutriLOGIC and to provide further data to adjust the current calibrations and improve the reliability of the recommendations given by NutriLOGIC. This will be achieved by comparing the NutriLOGIC N fertiliser recommendations with the optimum N fertiliser rate derived through N responses in the field.

This paper presents the results of two years of validation and discusses the field performance of NutriLOGIC and the current limitations of its use.

Experimental Design

Table 1. Experiment sites

Season	Region	Farm Name	Soil Type
1998/99	Gwydir	"Caroale"	Grey Clay
1998/99	Theodore	"Nandina"	Heavy Grey/Brown Clay
1998/99 & 1999/00	Lower Namoi	"Leitch Block"	Grey Clay
1998/99 & 1999/00	Upper Namoi	"Milchengowrie"	Grey Clay
1999/00	D. Downs	"Bonwin"	Heavy Grey/Black Clay

Treatments

Treatments were imposed to generate fertiliser response curves to determine the economic optimum rate of N fertiliser which could be compared with the N fertiliser requirement recommended by NutriLOGIC.

The treatments included;

- Treatment 1 = NutriLOGIC Recommendation
- Treatment 2 = NutriLOGIC Recommendation - 40 kg N / ha
- Treatment 3 = NutriLOGIC Recommendation + 40 kg N / ha
- Treatment 4 = Nil

As illustrated in Figure 1, the treatments were replicated and randomised, with nil N strips at either end. Each plot was either 6 or 8m wide and went the length of the field.

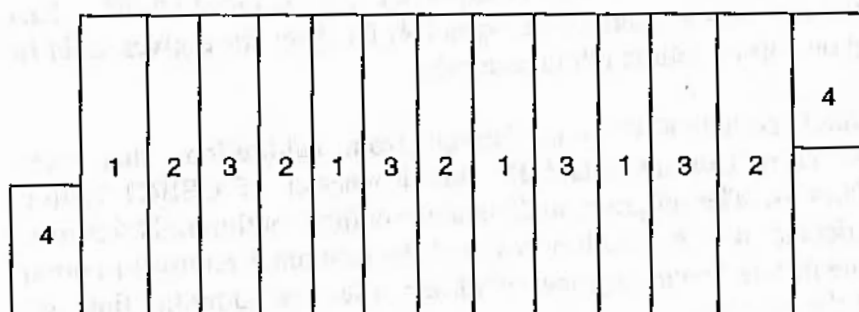


Figure 1. Experiment design.

Measurements

Soil Nitrate Analysis

Fields were selected to cover a range of soil types and rotation systems. Soil samples were taken from these fields in July/August to a depth of 30cm, and analysed for nitrate N. The results were then entered into NutriLOGIC.

The NutriLOGIC program generated an estimate of the required rate of fertiliser in N kg/ha. This became treatment 1, treatment 2 became the required rate minus 40 kgN/ha and treatment 3 became the required rate plus 40 kgN/ha. Not all collaborators agreed to have 2 nil plots.

Petiole Nitrate Analysis

Petiole Nitrate analysis was carried out three times in each plot between 600 and 750-Day Degrees. To obtain a representative sample, 50 petioles were randomly selected from the 5th leaf from the top of the plant. The samples were kept cool before being dried at 60 °C for 24hrs. They were then ground and immediately tested in the laboratory for nitrate N. These results were entered into NutriLOGIC to further assess the N fertility of each treatment and the need for additional N fertiliser.

Yield

The lint yield of each plot was determined by weighing the pickers using trailer scales. R results were then further examined to determine the optimum rate of N fertiliser.

Results

1998/99 season

From the soil nitrate analysis, the NutriLOGIC program was used to indicate the rate of N fertiliser required. Table 2 shows the experimental sites and the treatments that were imposed.

Table 2. Rates of N fertiliser applied in the 1998/99 NutriLOGIC experiments.

Site	Treatment 1 (NutriLOGIC)	Treatment 2	Treatment 3
Upper Namoi	120	80	160
Namoi	150	110	190
Gwydir	130	90	170
MacIntyre	150	110	190
Theodore*	170	130	210

*The NutriLOGIC recommendation at Theodore was 200kg/ha.

Due to a very wet start to the season, applications were delayed until after planting in 4 out of 5 experiments.

Petiole nitrate analysis indicated that extra N applications were not necessary at any site on any of the treatments.

On each site in 1998/99, N response curves were drawn. From this information, we calculated the optimum economic N fertiliser rate. Table 3 compares the optimum N rate with the NutriLOGIC recommendation.

Table 3. 1998/1999 Comparison between NutriLOGIC and the optimum rates and yields.

Site	NutriLOGIC N Rate	NutriLOGIC Yield (Bales/ha)	Optimum Rate	Optimum Yield (Bales/ha)
Upper Namoi	120 kg N / ha	5.1	110 kg N / ha	5.2
Namoi	150 kg N / ha	4.9	100 kg N / ha	5.0
Gwydir	130 kg N / ha	9.0	190 kg N / ha	9.3
MacIntyre	150 kg N / ha	8.1	160 kg N / ha	8.2
Theodore	200 kg N / ha	8.2	190 kg N / ha	8.4

The NutriLOGIC recommendation was comparable to the calculated optimum rate in 3 out of the 5 experiments. Results from the Namoi site showed an unusual trend with the lower rate treatment producing the highest yield. Hence the reason why the calculated optimum rate was a low 100kg N/ha. Results from the Gwydir experiment showed the higher N rate treatments having the highest yields. The calculated optimum rate in this experiment was 190kg N/ha, where the NutriLOGIC recommended treatment was 130kg N/ha.

The lint yield results demonstrated that more nitrogen applied doesn't necessarily result in an increase in yield, and that NutriLOGIC can perform reasonably well under wet conditions and post-plant N applications.

1999/2000 season

Unlike the previous season, all of the experiments in the 1999/2000 season had pre-plant applied N fertiliser.

Three sites from the 1998/99 season were used again, with an additional site in the Darling Downs near Bongeen.

From the soil nitrate analysis, NutriLOGIC predicted optimum N rates as shown in table 4.

Table 4. N fertiliser rates applied in the 1999/00 NutriLOGIC experiments.

Site	Treatment 1 (NutriLOGIC)	Treatment 2	Treatment 3
Upper Namoi	80	40	120
Namoi	90	50	130
MacIntyre	115	70	150
Darling Downs	80	40	120

Results from the Petiole nitrate analysis again indicated that extra Nitrogen applications were not necessary on any treatments at any site.

The following data on Table 5 shows yield results from all treatments with the optimum rate in comparison with the NutriLOGIC recommendation.

Table 5. 1999/2000 Comparison between NutriLOGIC and the optimum rates and yields.

Site	NutriLOGIC N Rate	NutriLOGIC Yield (Bales/ha)	Optimum N Rate	Optimum Yield (Bales/ha)
Upper Namoi	80 kg N / ha	6.7	182 kg N / ha	7.7
Namoi	90 kg N / ha	3.6	224 kg N / ha	4.7
MacIntyre	115 kg N / ha	7.8	260 kg N / ha	9.4
Darling Downs	80 kg N / ha	6.6	100 kg N / ha	6.7

Table 5 shows that at the majority of sites, the optimum N fertiliser rate was substantially higher than those predicted by NutriLOGIC.

Even though the two seasons had many differences in weather and pest pressures, this data has demonstrated the need to further calibrate the relationships in NutriLOGIC.

Conclusion

In 1998/1999, 3 out of 5 experiments gave evidence to suggest that by using NutriLOGIC to help decide on a Nitrogen fertiliser rate, you can achieve optimum economic yield. However the results from 1999/2000 indicated that NutriLOGIC did not closely indicate the optimum N rate.

The cool, slow start to the 1999/00 season, may have limited organic nutrient uptake and fertiliser use efficiency. Due to the poor use of N fertiliser in this season, higher N rates were required.

The petiole nitrate analysis consistently indicated that the crop nitrogen status was adequate. This was true for experiments conducted by other researchers, and reflects the cool, slow start to the 1999/00 season.

NutriLOGIC currently does not compensate for seasonal variation. The program has been designed to predict the optimum N fertiliser rate for an average season for the particular region. Soil nitrate analysis (pre-plant) and petiole nitrate analysis (pre-flower) may not always indicate the N fertiliser requirement accurately. The predications from NutriLOGIC are only as reliable as the nitrate N data that is entered. Further work is underway to calibrate NutriLOGIC and ensure the test results used are reliable so that the program can take variable conditions into account.

Through constant revision and large scale testing, NutriLOGIC is developing into a valuable decision support tool that many growers will use to improve their fertiliser management.

Acknowledgments

Dr. Mike Bange, Dr. Ian Rochester and Greg Roberts provided advice and help in the laboratory. Emma Dorothy and Dale Kirby helped with sample preparation.

I particularly want to extend my thanks to those growers who have collaborated in the 1998/99 and 1999/00 experiments;

- Mick Price
- Rob Evans
- Chris Humphries
- Peter Cross / Peter Corish
- Peter French
- Peter Kummerow

EntomoLOGIC - A Computerised Decision Support System for Cotton IPM.

Sandra Deutscher and Chris Plummer

CSIRO Plant Industry and CRC for Sustainable Cotton Production,
Australian Cotton Research Institute, Narrabri, NSW, 2390, Australia

Abstract

EntomoLOGIC is the entomological component of cottonLOGIC an agronomic decision support system developed by CSIRO for the Australian Cotton Industry. It was first released in 1992 and is continually updated to incorporate user requirements and latest research findings. EntomoLOGIC is primarily a pest management tool, a valuable agronomic record keeping system, an insect identification system and a powerful reporting system. The system caters for a spectrum of insect and plant sampling techniques and provides default thresholds for key pests which are regularly validated through field experiments. EntomoLOGIC provides an objective framework for decision making, but allows growers, consultants and agronomists the flexibility to customise their own management philosophy by changing thresholds.

Models developed by researchers at the Australian Cotton Research Institute have been incorporated into entomoLOGIC and form the basis for decision making. A model of mite populations predicts the rate of increase in mite populations and estimates the potential yield loss incurred, whereas the *Helicoverpa* spp. development model determines survival and mortality rates for the next 3 days. From this information, an appropriate pesticide recommendation can be made.

Future enhancements to entomoLOGIC include a crop yield prediction model, an irrigation management tool and crop nutritional tool, broadening the scope well beyond pest management. A hand-held version of entomoLOGIC is also being developed, allowing in-field recording of insect data and providing a report to the pest manager in the field. The data can then be down-loaded to the desktop version of entomoLOGIC for storage and further processing. Enhancements in entomoLOGIC continue as there are the mechanisms in place to ensure that the development team remain responsive to new research and industry needs.

History and Early Development of entomoLOGIC

EntomoLOGIC, a computer software package, was developed as a replacement product for SIRATAC, a decision support system for pest management produced in the 1980's. SIRATAC evolved from a prototype constructed by Room (1979) with the purpose of synthesising research results into a practical integrated management system which made the best use of information available.

SIRATAC was a dial - up computer based system for pest management decisions in irrigated cotton. With industry concerns on insecticide use and the development of resistance to insecticides, SIRATAC was used to apply research principles in Integrated Pest Management to lessen these risks. The principles included pest natural mortality, plant compensation and the use of economic pest thresholds.

As the use of SIRATAC increased, the demand for the product in 1981/82 lead to setting up SIRATAC Ltd, a company to make the product available commercially to the industry. By 1985 the adoption of SIRATAC had reached a disappointing peak of around 25% (by area) of the cotton industry. As SIRATAC Ltd struggled to survive, the difference between

the company and the product became blurred and this detracted from the important messages that SIRATAC provided on pest management issues (Pyke, 1995).

Through technical and political reasons, SIRATAC Ltd went into voluntary liquidation in June 1989 (Cox, 1995). Although SIRATAC folded it had significant impacts on pest management in the cotton industry. Changing management strategies from prescription spraying to in field checking and the use of thresholds.

To replace SIRATAC, the CSIRO Cotton Research Unit developed a microcomputer based prototype product entomoLOGIC, now a component of cottonLOGIC. EntomoLOGIC, was first released as a DOS version for commercial use in 1992, the program experienced vast improvements over the next three years and was completely rewritten in a windows environment and released as entomoLOGIC 95 for the 1995/96 season. EntomoLOGIC 95 was easier to use and also more capable than the DOS version (McKewen *et al.*, 1996).

Pest management with entomoLOGIC

EntomoLOGIC is designed to help distribute the latest research and technology to the industry and to provide the user with information to enable more informed decision. The program is not a substitute for skilled agronomists or farm managers, but an insect management tool. Better decisions can be made with the experience and understanding gained by good records of what has occurred in the past, and good reporting of what is currently happening on the farm (McKewen *et al.*, 1994) or in the crop.

The primary function of entomoLOGIC is to provide a platform for applying current pest management technology, and to incorporate new technologies as they emerge. The program does not recommend spray applications. EntomoLOGIC recommends when action is required, however it is up to the user to determine what chemistry to use.

Insect data entry within the program can support a range of sampling techniques, for example presence-absence (binomial) sampling, where there is a conversion to the standard numbers per metre. Also available is the facility for suction (D-Vac) or visual samples, this entails a separate data entry screen enabling a wider range of beneficial or predatory insects to be entered. This data can help support 'food spray' technology.

The insect reporting facility incorporates the models of heliothis development and the two-spotted spider mite potential population and yield loss. The heliothis development model predicts the population and life stages of heliothis over three days, taking into account rates of survival and mortality, climatic data, beneficial's present and crop progress. By knowing the dynamics of the population you can keep a step ahead of the potential infestation or of the decrease in heliothis numbers, enabling a more informed pest management decision. The mite model also predicts populations and more importantly yield loss, giving the user information to help guide a decision on the timing of an expensive miticide. Another model included in the program is the HEAPS model, which is the HElicoverpa Armigera and Punctigera Simulation. This is a prediction of the date when heliothis pupae are likely to emerge using long term average temperatures. This model is included in the help menu, not in the insect recording or reporting.

The insect pest populations calculated in the report are compared to the standard pest economic or action thresholds. Action thresholds are pest densities above which the value of the damage caused is greater than the cost of control (Cox, 1995). Industry recommended thresholds or user-definable thresholds are used in entomoLOGIC, giving the user more flexibility in pest management if required.

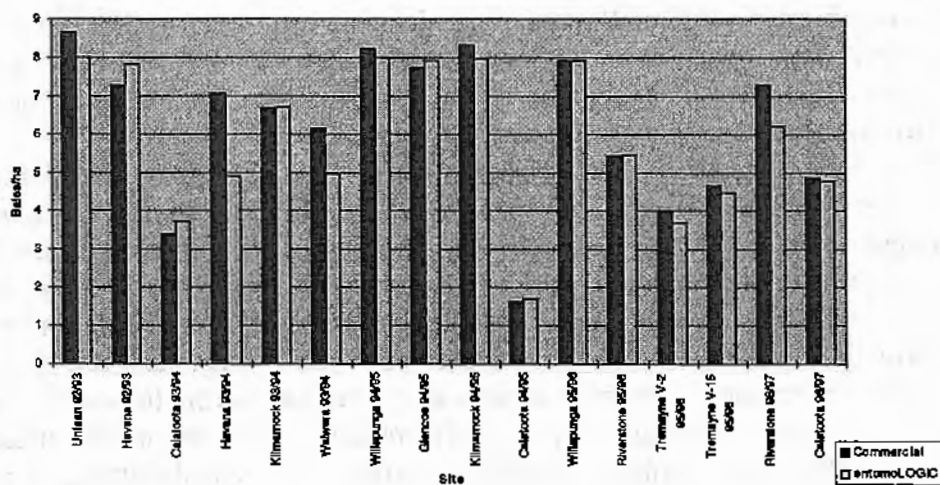
In addition entomoLOGIC supports pest management in Ingard cotton, calculating present populations and comparing it with results from the last check and with the incorporated

Ingard thresholds. These thresholds are updated according to decisions made through the TIMS (Transgenic and Insect Management Strategy) committee.

Other insect facilities within entomoLOGIC include the insect pest and beneficial pictures and descriptions, the facilitation of Lepton test results (a *Helicoverpa* species test), and the graphical feature which can create graphs of insect pressures or chemical usage for the season to date.

Validation and testing

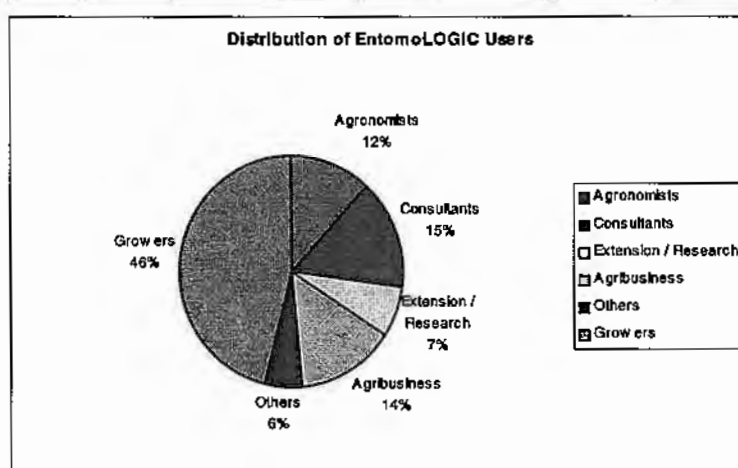
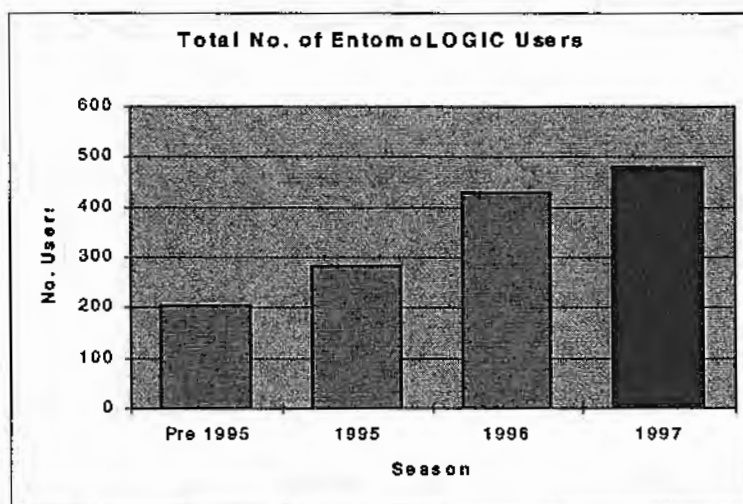
Large scale trials testing the efficiency and functionality of entomoLOGIC have been carried out for a number of years throughout the Namoi Valley. These have been situated on privately owned farms, and managed collaboratively by the farmer, his or her consultant and the entomoLOGIC Field Scientist. Data collected from over six seasons of field trials have demonstrated that entomoLOGIC can be used effectively to manage insect pests on cotton. In comparison with conventional insect management, differences in yield, maturity and quality have been minimal. The trial results demonstrated the effectiveness of entomoLOGIC and relative thresholds to manage insect pests on conventional and transgenic cotton. With the use of the *Helicoverpa* pre-flowering threshold of 2 larvae/m, and the *Helicoverpa* development model to determine if or when numbers will reach the threshold, the first *helicoverpa* spray can be avoided until mid to late December.



On the majority of sites the entomoLOGIC managed treatment has achieved a reduction in the number of insecticide applications as shown in the graph below.

Product Success

There has been a continual increase in the number of EntomoLOGIC users since the 1995 release, continued updates in reply to industry needs and improvements in useability, have increased users to over 450 across the whole of the Australian Cotton Industry.



Advancements in the program received recognition in 1996, coming third in the Decision Support section of the national Farm Software Competition at the Sydney Royal Easter Show.

Adoption and Training

Situating field trials on privately owned farms and managing them on a commercial scale has proven successful in a number of ways. Firstly, by demonstrating on a commercial scale and in a representative environment you can more effectively show the robustness of the program. Secondly, by involving the grower and consultant, you are giving them some ownership over the trial, over new technology and with the development of entomoLOGIC. By their involvement they are more likely to adopt entomoLOGIC or the incorporated technology.

Future trials will be conducted in other cotton growing regions remaining in collaboration with growers, consultants and extension personnel. This will ensure program evaluation in a wide range of cotton growing environments. These trial sites will become the focus for meetings to create discussion and generate feedback for the program developers.

Each year, the cottonLOGIC team travels to many cotton growing regions to train users and promote the products. These workshop meetings are mainly hands-on, giving new and existing users the opportunity to experience the performance of the program. Users also benefit from being in a group situation to share individual experiences and techniques in using entomoLOGIC. For the cottonLOGIC team, the workshops are an ideal opportunity to receive

feedback from a wide range of users, giving the programmers ideas for improvement and new features.

Future Advancements

Cotton consultants make the majority of pest management decisions in the field, yet they only make up 15% of our registered users. The main reason for their lack of support, is because they still may not see it as a tactical tool that can be used in the field (Pyke 1995). Through technology, these logistical problems will be solved with the mobilisation of the product into the crop. Hand-held versions of the program are being developed, which will allow in-field recording of insect data and provide a report to the pest manager in the field. The data can then be down-loaded to the desktop version of entomoLOGIC for storage and further processing.

Future enhancements to cottonLOGIC include a crop yield prediction model, to account for crop compensation to damage.

EntomoLOGIC - A Computerised Decision Support System for Cotton IPM.

Sandra Deutscher and Chris Plummer

CSIRO Plant Industry and CRC for Sustainable Cotton Production,
Australian Cotton Research Institute, Narrabri, NSW, 2390, Australia

ABSTRACT

EntomoLOGIC is a user-friendly decision support system developed by CSIRO for use by the Australian cotton industry. It was first released in 1992 and is continually being updated to incorporate new user requirements and the latest research findings. EntomoLOGIC is primarily a pest management tool, a valuable agronomic record keeping system, an insect identification system and a powerful reporting system. The system caters for a spectrum of insect and plant sampling techniques and provides default thresholds for key pests which are regularly validated through field experiments. EntomoLOGIC provides an objective framework for decision making, but allows growers, consultants and agronomists the flexibility to customise management philosophy by varying thresholds to meet their own needs.

Models developed by researchers at the Australian Cotton Research Institute have been incorporated into entomoLOGIC to provide the basis for decision making. A model of mite populations predicts the rate of increase and estimates the potential yield loss incurred, whereas the *Helicoverpa* development model determines survival and mortality rates for the next 3 days.

Future enhancements to entomoLOGIC include a crop yield prediction model, an irrigation scheduling tool and further advancements in soil analysis and crop nutrition, broadening the scope well beyond pest management. Hand-held versions of entomoLOGIC are also being developed. These will allow in-field recording of insect data and provide a report to the pest manager in the field. The data can then be downloaded to the desktop version of entomoLOGIC for storage and further processing. Additional features are likely to flow as the entomoLOGIC development team remains responsive to industry needs.

CottonLOGIC: Survey shows the way forward

By Michael Bange, Sandra Deutscher and Chris Plummer, CRC for Sustainable Cotton Production

Cotton growers are facing increasing pressures to manage their resources more cost effectively and to be more accountable for the impact that their decisions make on the environment.

Computer based decision support systems are being developed by the CRC for Sustainable Cotton Production to provide

FIGURE 1: Proportion of people surveyed that use CottonLOGIC

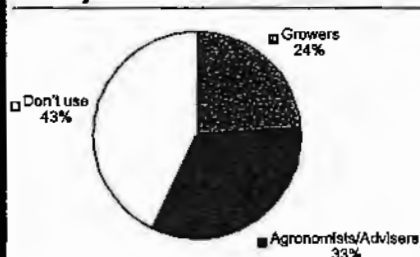


FIGURE 2: Proportion of the type of use of CottonLOGIC by survey participants

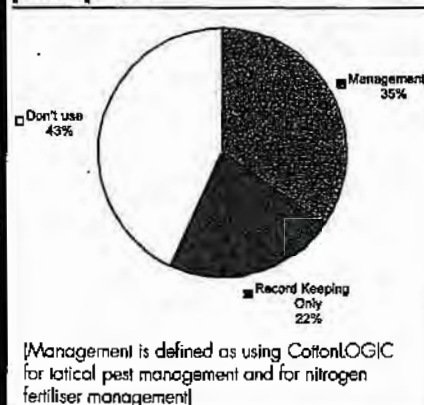
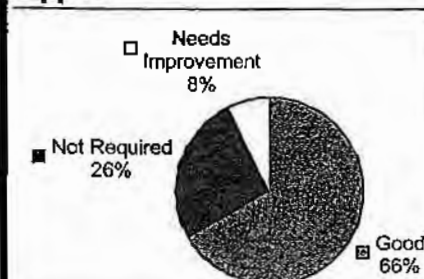


FIGURE 3: Response to question on the adequacy of CottonLOGIC support



cotton growers with the best research information available to assist with their management. CottonLOGIC is now available free to the industry to assist growers and their advisers in pest management, crop nutrition, insect species identification, plant mapping, growth regulation, and management of Ingard cotton. Underlying these functions is a powerful database for storing crop management information and an end of season report generator.

Following the highly successful launch of CottonLOGIC in August 1998 at the ACGRA conference there are now over 870 registered copies — a massive increase from the 480 registered copies of entomoLOGIC prior to the conference. Since the release, the members of the CottonLOGIC team have devoted a great deal of time training users and supporting the product.

Since September last year we have conducted 17 CottonLOGIC workshops throughout the industry with a total of 254 attendees. Locations this year included Narrabri, Theodore, Burren Junction, Emerald, Moree (two), Goondiwindi, Dalby (two), Theodore, Boggabri, Gunnedah, Gurley, Jimbour, Bourke, Warren, Walgett, and Pittsworth. At least four of these workshops were initiated by the demand created by users.

A recent (March 1999) survey was conducted to provide us with information about the level and type of use of CottonLOGIC. We decided to only survey the person who had received a copy of CottonLOGIC and had registered it. For example growers who had consultants or agronomists using the package to manage their cotton were not surveyed unless chosen specifically themselves.

To select the survey group the list of people with registered copies of CottonLOGIC was divided into two groups:

- Growers; and,
- Agronomists/advisers.

Researchers and extension personnel were excluded from the survey. From each of these lists, 200 people were randomly selected. Survey participants were then contacted by phone.

A total of 153 people were successfully surveyed (81 growers and 72 others which included consultants and agronomists). The sample size was approximately 19.1 per cent of the total registered user list of 803 (this excludes researchers and extension personnel).

Questions focused on actual use, whether they used CottonLOGIC for tactical pest management decisions or fertiliser management decisions, on the level of CottonLOGIC support and perceptions of future use. Survey participants were also given the opportunity to make any comments relating to further development of the package.

SURVEY RESULTS

CottonLOGIC use

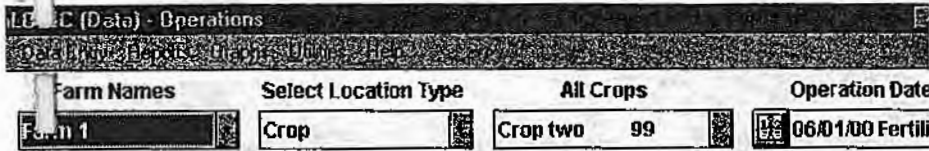
- 57 per cent of those surveyed said that they used the package (Figure 1);
- 35 per cent of those surveyed used the package for crop management while 22 per cent used the package solely for farm record keeping (Figure 2);
- 25 per cent of growers surveyed used the package for management decisions — 54 per cent hadn't used it at all; and,
- 46 per cent of consultants/agronomists use the package for management decisions — 30 per cent don't use it at all.

Support and future use

Of the people surveyed, 60 per cent responded to the question "How do you feel about the support given for CottonLOGIC?" Results showed that people were generally happy with the support provided with CottonLOGIC (Figure 3).

Of the people surveyed, 65 per cent responded to the question "Do you intend to use CottonLOGIC as a management tool on your farm in the future?"

- Of the people who are not using CottonLOGIC presently, 53 per cent said they would use it in future in some capacity; and,
- Of the people who are presently using CottonLOGIC, 94 per cent said they would use it in future.



CottonLOGIC: Moving Forward in 2000

by Sandra Deutscher, CRC for Sustainable Cotton Production

The CottonLOGIC development team has had a busy period presenting at the annual training workshops and developing a new release of the program before the coming season.

Seventeen CottonLOGIC training workshops were held in locations from Emerald in QLD to Hillston in NSW. Over 130 new and existing CottonLOGIC users attended the three hour workshops. People attending also had the opportunity to collect the latest information packages from the Australian Cotton CRC mobile technology Resource Centre.

After the workshops, each participant

was given a chance to express their individual needs and ideas on the workshops. Positive and useful ideas were received from 38 per cent of participants who responded to the questionnaire. Of those who responded, 100 per cent thought that the workshop was worth their while; 99 per cent would like to attend the workshops in the future; and 80 per cent did not want to see any changes to the workshop format.

Of the comments made, 33 per cent mentioned that the workshop was very informative; 19 per cent referred to the need for more information; 18 per cent felt

that a longer workshop would be better; and 14 per cent thought that more computers for training would be an advantage.

At Narrabri, Chris Plummer, Principal Software Developer, has been working on new facilities and enhancing existing features of CottonLOGIC. The latest advancement is the addition of a spray order form for operators and a notification report for neighbours. This has been a request from a number of CottonLOGIC users, who have assisted in the design and specific details for these reports.

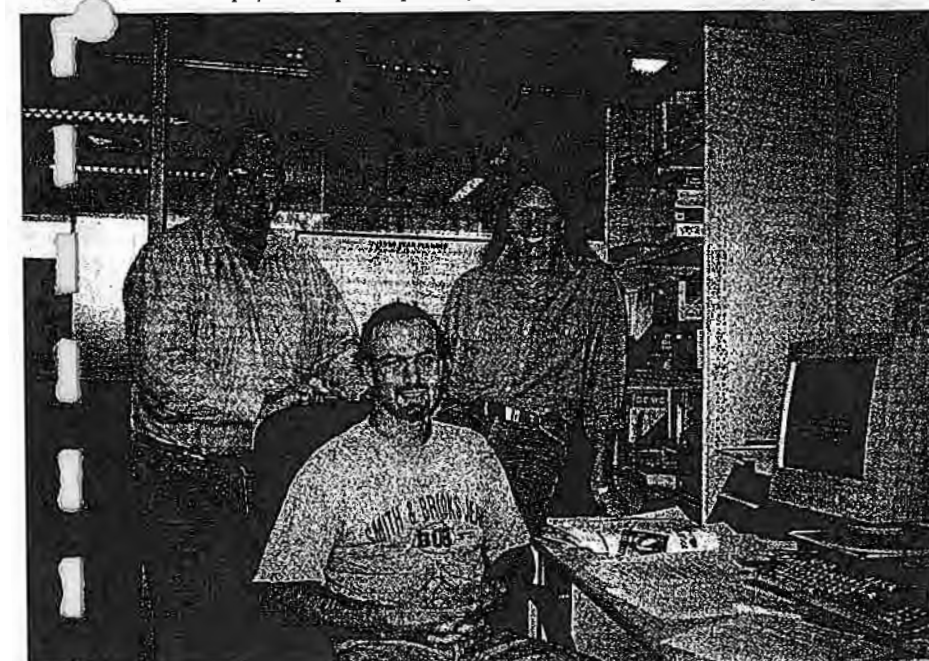
Other important features include the facility to archive data from the previous seasons with the ability to restore them at a later date — and the program has also been sprayed for Y2K bugs, with a 100 per cent kill.

An existing feature of CottonLOGIC that serves as an excellent guide to using the program is the 'on-line' help, which was incorporated into the last version. This provides the user with a quick and easy way to find information on any subject regarding CottonLOGIC.

Alex Thomas, the program developer for the handheld version of CottonLOGIC, left the team in July. This has put a halt on the development of the handheld program, although we are currently in the process of employing two new programmers to satisfy the programming needs.

Mike Bange is investigating the services of an independent consultant for an evaluation of CottonLOGIC. The primary aim of this exercise is to assess CottonLOGIC's impact on the decision making process. This should provide us with both a benchmark of the use of CottonLOGIC and the knowledge to focus on the improvement of particular areas if necessary.

CottonLOGIC will once again be tested in the field during the coming season. Trials to assess the validity of the program regarding nitrogen and insect management will again be conducted. As a new interest for me, I will be also looking at CottonLOGIC's potential role in area wide management.



From left to right David Larsen (TRC Coordinator), Chris Plummer (Software Developer), and Sandra Deutscher (Support Scientist).

Issues raised by growers and agronomists/advisers

During the survey, growers raised a number of issues they would like to see addressed:

- The need for assessment of crop compensation;
 - Improved report generating/graphing capabilities;
 - Sharing data with other programs;
 - Linking BMP with CottonLOGIC;
 - More evaluation of CottonLOGIC;
 - Improved ease of data entry;
 - Allow more operations to be entered;
 - Training more women;
 - Allow gross margins to be calculated;
 - Improve information relating to spray recommendations — for example, effect of beneficials;
 - Some useability issues; and,
 - Tools for irrigation management.
- Likewise the consultants/agronomists raised many issues including:
- Allowing more operations to be entered;
 - Improved report generating/graphing capabilities;
 - Coverage of other crops;



The CottonLOGIC development team. At back (L to R) David Larsen (TRC coordinator), Chris Plummer (software developer), and Sandra Deutscher (support scientist). In front, Alex Thomas (software developer) and Mike Bange (project leader).

- GIS capabilities;
- Tools for irrigation management;
- Linking BMP with CottonLOGIC;
- Some useability issues;
- Merging data sets; and,
- Improved time to record insects and making decision with CottonLOGIC (complete hand-held device).

MECHANISMS FOR INDUSTRY FEEDBACK ON COTTONLOGIC

The development of any computerised decision support package relies on constructive feedback from its users. The CottonLOGIC development team and the Technology Resource Centre of the Cot-

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COTTONLOGIC

on CRC are focused on providing a multifaceted approach to CottonLOGIC support and industry feedback. Direct mechanisms already in place include:

- Dedicated CottonLOGIC workshops held in each region once a year (more conducted if requested);

- A help-desk operated by Chris Plummer (02 6799 1591) and David Larsen (02 6799 1534) at the Technology Resource Centre Cotton CRC;

- Ideas can be faxed to the Technology Resource Centre on (02) 6799 1582;

- The CottonLOGIC development team can be contacted using email — CottonLOGIC@mv.pi.csiro.au;

- Information can be obtained and ideas left at the dedicated CottonLOGIC web pages on the Cotton CRC's website — www.cotton.pi.csiro.au; and,

- Grower/adviser participation in CottonLOGIC validation trials.

In addition to these, other opportunities for feedback are being sought. A 'decision support' steering committee has recently been formed with representatives of different types of users and regions to discuss major issues and direction. In future we hope that users may contact members of this steering committee to raise issues of importance. Members of the committee are:

- Sandra Deutscher, steering committee facilitator;

- Dr Michael Bange, research scientist;

- Mark Hickman, CRC industry development officer;

- Bruce Pyke, Cotton Research and Development Corporation;

- Prof Greg Constable, Director CRC;

- Dr Lewis Wilson, research scientist;

- Andrew Campbell, dryland grower;

- Peter Kummerow, irrigated grower;

- Tony McKnab, Agribusiness;

- Kym Armytage, independent consultant; and,

- Stefan Hengeller, corporate cotton grower.

PRESENT ACTIVITIES

In attempting to resolve issues with some users, development is continuing on other platforms for delivery of decision support. One area is the development of software tools that can be mobilised with hand-held machines. This will allow in-field recording of insect data and provide a report to the pest manager in the field as opposed to returning to a computer located in an office.

It will then be possible to download data into a desktop version of the software for storage and further processing. Other opportunities for the use of hand-held platforms are also being investigated.

Another platform for delivery of information and decision support that is showing ever increasing use is the internet. Substantial improvements in the operation, management, and appearance of the Cotton CRC's web site have occurred. The Technology Resource Centre now oper-

ates a fully functional and interactive web site that provides information such as:

- Current weather data from the cotton industry's met stations;

- Cotton industry publications;

- Diary of events within the cotton industry;

- Industry contacts; and,

- The latest research information available within the industry.

Large scale CottonLOGIC validation trials are still being conducted on commercial farms collaborating with growers and advisers. One concern that had been raised in the past is that these trials have been region specific.

To help counteract this concern, we are conducting application experiments in most cotton growing regions this season. The 1998-99 season trials evaluated and demonstrated the capabilities within CottonLOGIC to assist with decision making for nitrogen fertiliser management (NutriLOGIC), and using CottonLOGIC to assist with pest management decisions in experiments utilising food spray technologies (Envirofeast) and transgenic crops (single and double gene).

Major development activities planned for CottonLOGIC software in 1999 are:

- To ensure all software is year 2000 compliant;

- Release a new CottonLOGIC version incorporating on-line help;

- Program CottonLOGIC to accept data transferred from the hand-held device;

- Maintain CottonLOGIC and incorporate improvements and distribute a major upgrade to all CottonLOGIC users before the 1999-00 cotton season;

- Improve the performance of the insect data entry screen or provide the ability to do batch mode processing of insect checks; and,

- Investigate the requirements for a water budgeting system with the intent of inclusion into CottonLOGIC.

The CottonLOGIC development team is committed to promoting responsible crop management, and to developing effective, useful and user friendly computerised decision support systems backed by good science. Please feel free to contact us at the Technology Resource Centre with your ideas.

For free copies of CottonLOGIC contact David Larsen, coordinator the Technology Resource Centre; Phone 02 6799 1534.

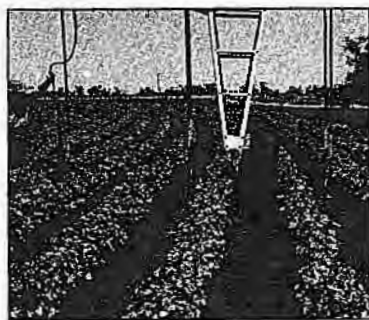
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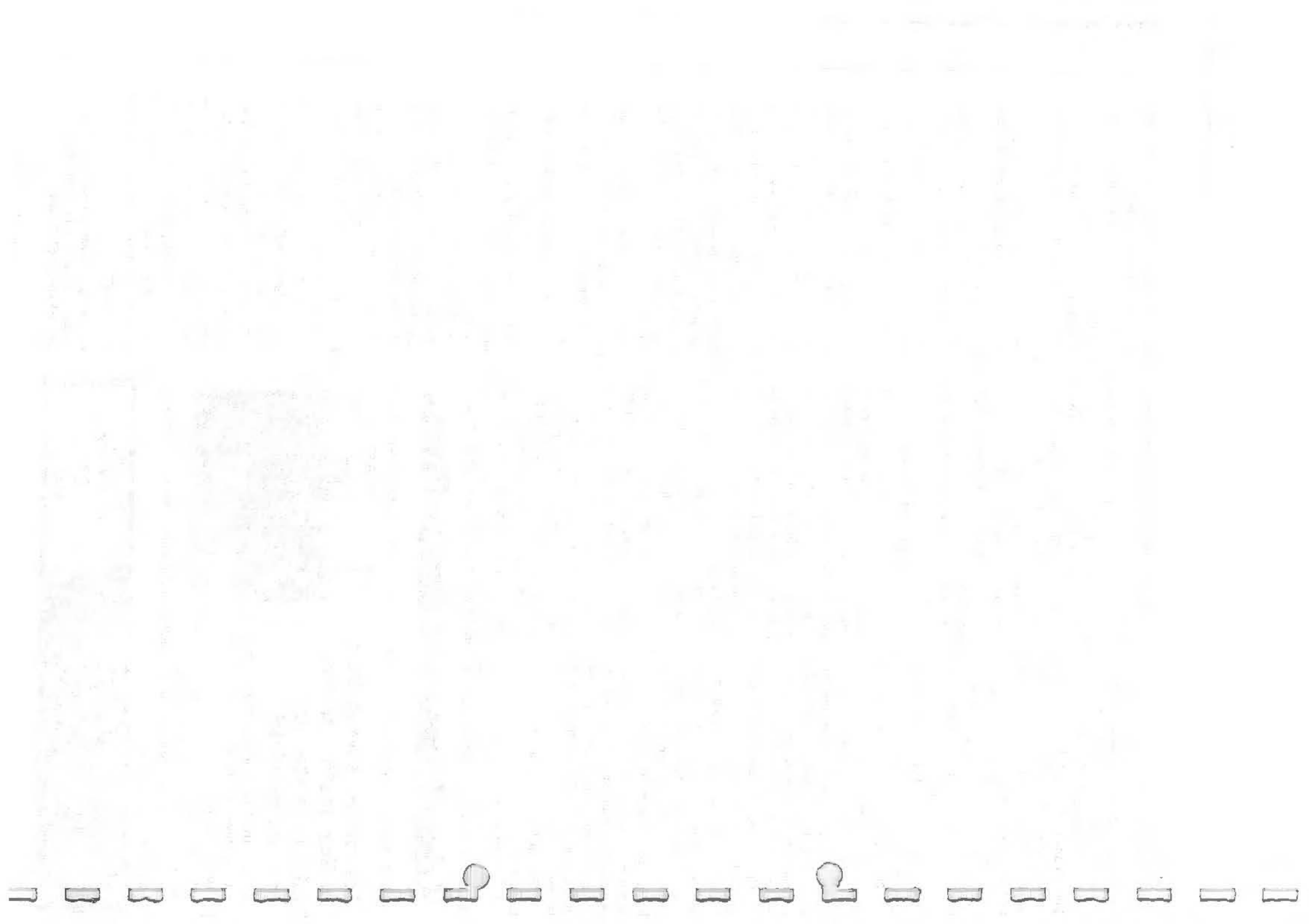


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CottonLOGIC - IMPACT ASSESSMENT

SECOND REPORT - March 2000

By Peter Van Beek

◀ 40...COTTONLOGIC

While some trials are still in the preparation phase, nitrogen trials have been implemented from the Upper Namoi to the Darling Downs. During the season, petiole and leaf blade nitrogen levels will be determined and final yields will be measured to validate the nitrogen recommendations made in CottonLOGIC.

Please feel free to contact any of us at the Australian Cotton CRC Technology Resource Centre regarding CottonLOGIC issues or for a free copy of CottonLOGIC.

For further information contact David Larsen, Coordinator, Technology Resource Centre; Phone 02 6799 1534; Fax 02 6799 1582.



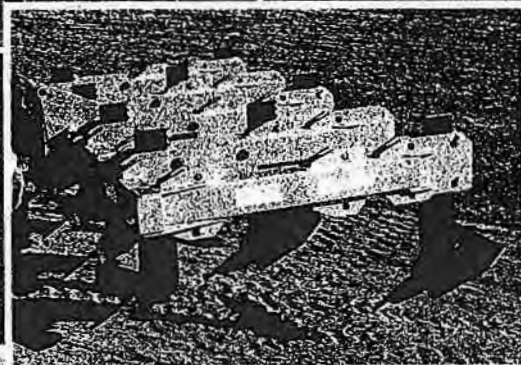
The Dirranbandi CottonLOGIC workshop group. From left to right Kathy Burrell, Megan Deshan, Penny Hardie and David Wacker.

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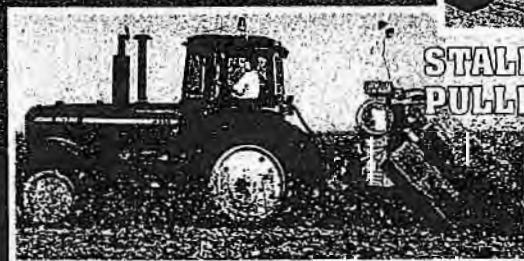
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SHORT VERSION CottonLOGIC - IMPACT ASSESSMENT
SECOND REPORT - March 2000
by Peter Van Beek

Introduction

This is a short version of the *Second Report* of an assessment of the impact of CottonLOGIC, which aims to provide feedback over three years to help achieve widespread application. This report focuses on how users view, use, experience, benefit from, and want to use CottonLOGIC. The author fulfils three roles in this study: as an 'un-biased' recorder during interviews and overviewing of data, as an experienced observer when commenting, and, justified by the findings, as a product-champion / coach when formulating recommendations. While the report has been discussed with the CottonLOGIC team prior to it being finalised, the responsibility for anything in it remains entirely the author's.

Between 13 January and 14 February 2000 20 interviews were conducted with seven farmers, three company agronomists, five consultants, four extensionists, and three agri-business staff. Appropriate data from nine interviews for the *FIRST REPORT, December 1999* is included.

Overview of the data

Farmer interviewees used CottonLOGIC to record farm operations (4), chemical use (3), identify insects (3), support decisions about insect control (1), work out yields (1) and inform neighbours (1). Many intended to use more facilities next year and several mentioned the learning value of CottonLOGIC. All were aware of the thresh-holds used in CottonLOGIC and most believed that these influenced the consultants and / or themselves. The 'science behind CottonLOGIC' was seen as one of its valuable aspects.

Interviewees also used FarmOffice, FarmBook, CashConcepts, PAM, Weatherwizard and spread sheets, while some collect data from weather stations and the cotton Gin. All would prefer to use a single computer package. Most appeared to favour CottonLOGIC, certainly if additional capacity of specific value to them would be included. These included links with Gross Margins per field, including yields, machinery and irrigation cost, prices, transport and commissions, and ability to do budgets and cash-flows. These were mentioned by five interviewees. Better recording of water use and efficiency, and inclusion of weather data were mentioned three times, crops other than cotton twice, and six other topics once.

Interviewees suggested one:one visits as follow-up to the initial workshops and / or forming a local CottonLOGIC-users group. Two believed industry or FARMBIZ funds should be used for a short period for this purpose and one that consultants should be trained to provide one:one assistance. The use of CottonLOGIC had effected relationships with consultants. One now did his own agronomy and one checked recommendations against CottonLOGIC while others believed their relationship to be stronger or looked for more advanced advice.

Company Agronomists-interviewees. Two used CottonLOGIC, the third had a copy on the company computer but did not use it as it did not fit company procedures. On one property it was used daily by two agronomists and occasionally by three other staff. They use it to collate and record their data and that from five bug checkers, monitor crop growth, and record farm operations and chemicals but not irrigations. Both users valued CottonLOGIC as it challenges or confirms their opinions and adds to their mental models and overall pictures.

One interviewee said that the development process of CottonLOGIC being so open and public was in itself good education, another that new versions come out too late to try changes, familiarise, and train staff in the applications. As additional capacity they would like to see OZCOT and Hydrologic included, mortality rates made visible, weather information and options put in, and crop physiology explained better. Some expected more consultants to do fewer farms and a gradual process of growers taking control back. In this process CottonLOGIC is seen as a tool for co-learning. One disagreed with consultants that CottonLOGIC takes too long or that computers are not being suitable for use in vehicles.

Consultant-interviewees Use of CottonLOGIC by the five consultants ranged from having relied on it heavily when becoming a self-taught consultant, to very little if at all. One believed that at one stage it was seen as a tool to replace consultants. All interviewees used paper systems to record insect numbers, and none put the insect checks into CottonLOGIC, except data about the two-spotted mite. However, four used it for keeping spray records, one to help to stick with the resistance management strategy. Several used it to provide detailed end-of-year reports to clients, and two to collate data for CCA and company surveys.

The reason given by all for not putting insect-data in was time. The Palmtop option was seen as having potential to stimulate more daily use of CottonLOGIC. One saw CottonLOGIC as good back-up and verification, and would be very upset if it was not regularly upgraded.

No interviewee followed the CottonLOGIC default thresh-holds, the ones they used are flexible and vary widely between valleys. However, most acknowledged that CottonLOGIC thresh-holds have influenced the industry and that people are now more insect-tolerant. Some occasionally ran numbers through CottonLOGIC to check what they do in the paddock. Many had been in contact with CSIRO since Siratac. They did not use other parts of CottonLOGIC, except the insect library.

Consultant-interviewees would like to see the glitches in costing removed, HydroLOGIC added for water and weather inputs and yield outputs, more information on weeds and diseases, improved fruit counts and graphing of these, ability to work out the cost for each field or farm without complications, and a number of simplifications. Two said that upgrades and improvements 'Are slow to get here' but need to be presented as fully functional working programs, not 'Work-in-development'. One believed that CottonLOGIC had helped to 'Create a base level understanding we never had and is worthwhile as a discussion support tool in area-wide management'. Consultants would survive without CottonLOGIC, but not having it would be a disaster for the industry, as it is important in disseminating information.

CottonLOGIC had effected relationships between consultants and other stake-holders. In one dispute the consultant managed for growers to get in excess of \$150,000 back in product claims from a chemical company, based on arguments backed by CottonLOGIC..

Extensionists / Industry Development Officers-interviewees. Two had used CottonLOGIC in previous jobs for insect applications, forecasting insect pressures, early recommendations, spray records, and crop physiology. None now used CottonLOGIC routinely, but all support it as a training and decision support tool, and some used outcomes in their IPM program. Interviewees knew of growers who would not make a decision until the data has been processed through CottonLOGIC. They had seen increased use amongst growers to record operations and related this to the introduction of Best Management Practices. However, one believed that: 'CottonLOGIC needs something unique: "It now has insects and N records but

not yet the whole package approach: 'agronomy predictions', 'what-if scenarios', 'are we on track with the crop'? That would provide growers with something they are crying out for".

Interviewees looked forward to inclusion of irrigation scheduling and water efficiencies, weather data, more alerts to poor crop development, more seasonal development, rapid report generation on an area-wide basis including availability over the Internet, more dynamic benchmarks, easier ways to look back over the whole management and learn from that, ability to pull together area-wide management data and information, guides for trap-crops, and a table of nutritional elements and their critical values at different stages.

They believed that CottonLOGIC had taught growers about insect management and thresholds, allowed them to question their consultants more, and take more control. One stated that: 'People would not have to use CottonLOGIC to change their attitude, but they will need it to maintain their confidence levels. You cannot take their risk perceptions away and not replace them with something better.' The potential use of CottonLOGIC in area-wide management was looked forward to, but one obstacle to this was that: 'People use different techniques to measure beneficiaries which all give different results'. Most interviewees expected discussions to benefit from 'what-if' potential in CottonLOGIC.

Reseller-interviewees had no experience with CottonLOGIC. One company had recently appointed a consultant who used CottonLOGIC. The second interviewee wanted a copy after seeing CottonLOGIC in a consultant's office and being impressed by its user-friendliness, the reports produced, and its apparent relevance. The company was looking for a program to keep scouting records and spray logs needed to do reviews, comparisons and budgets, to record usage and pest pressures, and to have all this available without massive paper storage and retrieval problems. At that moment they used a self-designed manual spread-sheet for an area-wide management group. They stated that a lot of people still use Excel and other spread sheets. They saw CottonLOGIC as a tool for communication between area-wide management groups. Their one desired addition was data about with-holding periods.

Personal observations

The CottonLOGIC team was highly regarded by all and seen as very good to work with.

Interviewees used those parts of CottonLOGIC which they believed will help them solve pressing needs, while many desired additions relate to needs not currently covered in CottonLOGIC. Uses can be seen as falling into five consecutive types: *administrative use*, recording activities which provides data for *educational use*, which is a precursor to *support for tactical decisions*, *analysis of current management* and *exploring management options*.

One farmer and two company interviewees used CottonLOGIC for its intended purpose: immediate recording and support for insect management. All others relied on consultants who made limited use of this intended purpose. The process of how spray decisions are made when consultants are involved appears to be standard in all areas: insect counts carried out by scouts and the consultant, an immediate hand-written report to the farmer, discussions about when and what to spray, deciding (some farmers leave this entirely to the consultant), warning of neighbours, and ordering of sprays by farmers. Aerial operators report back to the consultant, who also collects spray data about ground sprays from farmers.

The obstacles mentioned by consultants to using CottonLOGIC in that process are: lack of time to enter the insect counts, a need for immediate decisions, familiarity with its outcome anyway, the need to adapt decisions to local circumstances, and reluctance to provide staff with expensive equipment in dusty vehicles. The development of Palmtop was looked at as a possible way to overcome some time constraints, but did not generate much enthusiasm yet.

The educational value of CottonLOGIC was clear and highly valued: many interviewees stated that it had made people aware of, and think about, thresh-holds and had generated debate. The most desired additions were: HydroLOGIC, weather, OZCOT, nutrition and benchmarking, more cost and budgeting-related capacity, easier change of details, and better graphs of insect cycles. The total list is a lot to ask for but other organisations may be brought in to help. Interviewees did not expect all additions immediately and see the development of CottonLOGIC as-a-whole as on-going.

There seems to be a gap between attending the workshops and people contacting the help line (which received praise from those who used it). Some of the problems had to do with setting-up, and some with not seeing how particular capacities relate to individual farms.

Interviewees in all groups, except consultants, stated that the consulting industry has to change and mentioned pressures forcing these changes. No consultant appeared to explore ways in which CottonLOGIC can help add new value to the businesses of their farmer clients.

Extension interviewees were very supportive of CottonLOGIC. Their role in extending it seems limited to ad-hoc demands and it did not yet appear to play a big role in their core-projects. All appeared open to exploring the benefits of using CottonLOGIC in their work.

At this stage CottonLOGIC does not appear to offer much additional value to resellers.

Comments and recommendations

To me, the two outstanding features are CottonLOGIC's core value of being based on science, and its versatility to be useful for many purposes. In addition, environmental obligations and requirements for Best Management Practices provide incentives to keep detailed records. This combination creates unique opportunities to meet a wide range of private, industry and government objectives through the one instrument. This would create opportunities to achieve industry goals which otherwise could be beyond reach, one of which is using CottonLOGIC in area-wide, real-time monitoring and managing insects.

CottonLOGIC is becoming more than the originally intended Decision Support Tool, as expressed in Figure 1 (p 18). It is also beginning to fulfill the four conditions for relevance highlighted by the APSIM work (point 1.3 First Report): *indications of potential significance* (eg for insect management, record management, cost control, general crop management and water use), *a meaningful simulation framework* (its core simulation framework of thresholds is widely accepted), *credible simulations* (simulations are used either as a basis from which to adjust, or as a benchmark against which to test, people's own practices) and *practicality*.

While CottonLOGIC's practicality was subject to conflicting opinions, this may be due partly to it being seen as a threat to consultants while its potential to add value is not yet recognised. While that fear prevails, new problems are likely to be found, based on fear rather than fact.

Area-wide IPM needs wide-spread use of common features, while most interviewees made limited use of CottonLOGIC. This suggests that its significance may need to be increased, especially to farmers and consultants, and more widely recognised.

Significance to farmers can be further improved by easier recording and transfer of daily field data (as intended by Palmtop), linking chemicals-used with Gross Margins per field, ensuring easy transfer of gross margin data to other financial programs, and creating compatibility with, and transferability of data to, programs such as OZCOT and HydroLOGIC. These could be included on the disk as separate, but compatible programs.

Practicality and ease of use of CottonLOGIC can possibly be improved by consulting experts in distant education, helping to form a number of CottonLOGIC users groups, employing a person for a limited time to get a core of farmers, consultants and extension officers in each valley up to high standards of competence, and finding a use of CottonLOGIC for extension officers and IDOs in one of their core-projects to entice them to become totally competent in its use. Once this knowledge has been shown to be useful, it will spread via social contacts.

User-groups, and adequate communication structures, processes and support, are likely to be needed as social foundation for area-wide management. Discussion in groups helps people to recognise how certain parts of a program relate to individual farms, discover how this can be used to advantage, and discuss strategic farm and area options. In such groups, a science-based integration tool is likely to contribute basic scientific data and relationships, help avoid perception problems, crunch numbers, and present outcomes in easy-to-understand formats.

Significance to consultants can be improved by exploring and explaining its potential to increase the capability of consultants to add value to their client's businesses. Recommended actions are to work closely with some younger and positive consultants in identifying new business opportunities created by using CottonLOGIC, and spread the word about these throughout the industry. Competition is then likely to change attitudes and turn the consulting industry into a powerful ally for CottonLOGIC.

Potential *significance to education* can be increased by including on the disk the basic information and scientific principles of growing cotton on which the model is based. This would need to be put together by an experienced educationalist to have credibility and become a standard reference in the education of future cotton growers and consultants.

These developments are, in my view, precursors for widespread, uniform and long-term sustainable use of CottonLOGIC. Once achieved, the future *significance to research* in eg area-wide insect management and environmental impact is hard to over-estimate.

Widening the roles of CottonLOGIC needs to be accompanied by further *increasing the ownership, role and responsibility of the industry-as-a-whole* in its development, including some responsibility to find funds and / or cooperators. An expanded role of the steering committee appears to be the most effective way to achieve increased ownership. Industry-ownership also involves further accountability about the development processes. A published and progressively updated development plan, but not containing time-frames or budgets, is likely to fulfil the accountability requirements.

New uses of a product, and changing the balance of its ownership, can cause mixed feelings and need to be handled tactfully and with full recognition of past and present contributions.

Conclusions

CottonLOGIC is valued for its scientific base and used for a range of purposes. This demonstrates that it is starting to fulfil the four criteria for relevance.

CottonLOGIC's appears to have unique further potential, which is in part created by the obligations for record keeping related to environmental requirements and Best Management Practices. It is potentially able to link this detailed daily data with: pro-active insect management; reflective analysis of total cotton management on farms and testing of options; and area-wide insect management. This would make it a unique tool to simultaneously achieve private, industry and government goals. That would be something every industry would wish to have.

However, to realise this potential CottonLOGIC's significance to key stakeholders can and needs to be strengthened in the following areas:

- linking insect and other data with Gross Margins per field;
- establishing a core of farmers, consultants and extensionists in each valley who are fully familiar with how to drive CottonLOGIC and how its components relate to cotton management and farm business;
- exploring and explaining the potential for consultants of using CottonLOGIC to add value to their clients' businesses;
- strengthening the self-educational value of CottonLOGIC by involving experts in distance education;
- developing CottonLOGIC as a basic reference for students; and
- increasing the whole-of-industry ownership of CottonLOGIC and the industry's involvement in its development.

Much of the data confirmed, but some challenged, the perceptions held by the CottonLOGIC team. The team accepted in-principle the validity of the above needs, and intends to explore the potential actions needed to achieve results.

The interviews will be repeated next year to assess further impact and changes.