Australian Cotton Cooperative Research Centre

November, May & Final Reports

REPORTS

Part 1 - Summary Details

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

COTTON CRC Project Number: 3.1.03 AC

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

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

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

Research Program: 1. Northern Australia

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1. Project Background

Linking crop agronomic, physiology and modelling studies are important for assessing the potential and sustainability of different cropping systems in the Australian Cotton Industry. To ensure that the information collected in these studies is effectively used and understood by the industry it is important that resources are dedicated to facilitating the interaction across these disciplines. This is primarily achieved by ensuring that crop model development is strongly linked to crop agronomic and physiology studies, as well as activities that apply the model for crop management and research, and vice versa. Research and ultimate application of the technology gained in all the fields of study mentioned is often greatly enhanced when consideration is given to the other components. Sometimes, no component is effective or directly applicable without some consideration of the other components (Figure 1).

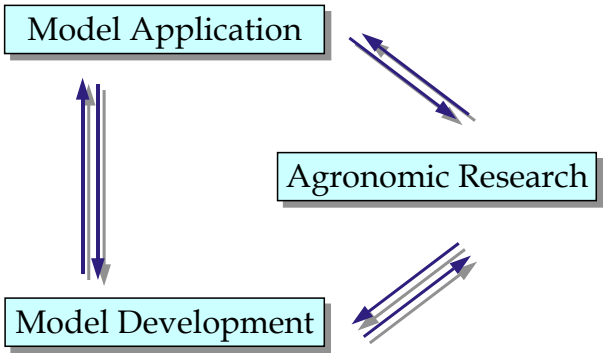

Figure 1: Flow chart demonstrating the links between crop agronomic, physiology and modelling studies.

Some simple examples of what is meant by linking activities are:

- Research activities undertaken to gain grower confidence in the use of models can be also used to collect model validation data.
- Research activities undertaken to assess agronomic practices can also be used to collect data for model validation.
- Model application activities can be used to drive model development and agronomic research.

Activities of the nature described above are crucial to the efforts of the current Cotton CRC. Specific objectives outlined in the Cotton CRC's business plan that will utilise technology derived from these studies are:

1. Program 1
    - Evaluate the potential of sustainable production systems using simulation modelling.
2. Program 2
    - Rigorously evaluate the efficacy and environmental impacts of new transgenic plants – (eg. evaluation of the transgenic lines with waterlogging tolerance).
3. Program 3
    - To develop cotton cropping systems that makes optimal use of inputs.
4. Program 4
    - Develop new decision support systems

In addition to the benefits gained, in the past the rate of development and the application of information and models have been limited by the lack of technical support. In fact, the demands for technical support are increasing with the greater number of projects and activities being undertaken by the scientists mentioned above. Field research into agronomy and crop physiology is necessary to improve our understanding of different crop growth processes to improve crop management directly or either through the application of models. More technical support gives us the ability to respond to industry demands as well as confidence to apply the agronomic, physiology and modelling to a greater range of environments and management scenarios. Technical support for these projects would enable researchers to concentrate on dissemination of information, model development and application with less diversion into managing and conducting field experiments. It will also allow more efficient collection and processing of data so that information can be used more quickly.

A further outcome will be the continued development of a skilled technician in the fields of agronomy and crop physiology at the Cotton Research Unit, which will contribute to a team which will also aims to train a new crop physiologist agronomist. The development of this research and technical skill base is not currently possible with short-term casual appointments.

2. Project Methodology

3. A technical assistant who was employed in **the** last Cotton CRC and funded by **the project** 5.4.3 'Technical support for cotton agronomy, physiology, model development and validation' will continue to be employed to conduct and supervise field experiments, and to collect and perform preliminary analysis on data. Current field experimental programs include:

- The comparative physiology of long and short season cotton genotypes in order to model different cotton varieties.
- Investigations into the effects of foliar nitrogen on photosynthesis in order better simulate crop yields in response to nitrogen.

- Waterlogging studies investigating the crop physiological responses, evaluation of transgenic varieties in the field, and impact of plant hormones.
- Collecting data necessary for benchmarking whole farm water use efficiencies for comparing different crop management regimes.

The OZCOT crop model is currently being applied to assist irrigated cotton growers to make decisions on water use, planting dates, nitrogen management and the use of seasonal climate forecasts. As part of these activities soils are being characterised, frequent measurements of soil and plant characteristics are being measured, and crop yields are monitored to compare actual crop growth with model simulations. This process also contributes towards model validation, which is ongoing process. Part of this work is undertaken in collaboration with the Agricultural Production Systems Research Unit (APSRU) based in Toowoomba Queensland. Future experimental programs will also include testing of the environmental and nutritional effects on fibre quality.

Specific duties and responsibilities of the technician would be:

- Preparation for establishment of cotton field experiments at ACRI or other field sites as required;
- Maintain field experiments and ensure all field operations are performed correctly and on time;
- Co-ordinate and conduct required data collection on plant growth or performance;
- Collect and process plant and soil samples as required;
- Maintain field and laboratory equipment, and ensure work area and vehicles are maintained in a safe and tidy condition;
- Maintain up-to-date computer records of laboratory and field data; and
- Supervise casual staff.

4. Project objectives and the extent to which these have been achieved.

The main aim of this project was to improve interaction of agronomic, crop physiology and modelling research activities. The project in providing additional resources, will contribute to the following specific project objectives:

- To assist with research to quantify differences between cotton varieties.
- The collection and processing of data to demonstrate the value of linking crop and soil monitoring with the predictive capability of simulation models.
- To assist with research to better understand environmental effects on fibre quality.
- To collect data to validate OZCOT and sub-systems of the model including those related to sowing time, water extraction, short and long season cultivar development and fibre quality.
- To undertake research into the relationships between foliar nitrogen and

photosynthesis.

- Assist in collection of data in waterlogging studies investigating the crop physiological responses, evaluation of transgenic varieties in the field, and impact of plant hormones.
- Collect data necessary for benchmarking whole farm water use efficiencies for comparing different crop management regimes.

Specifically, the following research activities utilising this technical support have been conducted:

i) Assist with field experiments to validate model to account for differences between long and short seasoned cotton genotypes.

Technical support during this period assisted in the preparation of a field experiment investigating the physiology of cultivars of different maturity. This field experiment was also used to collect data to address the concept of cultivar determinacy. Measurements conducted in these experiments included frequent biomass samples as well as detailed monitoring of fruit development.

ii) Collect and process data to demonstrate the value of linking crop and soil monitoring with the predictive capability of simulation models (ongoing project in collaboration with APSRU).

Technical support during this period assisted in the sampling of up to 20 sites per year for soil nutrition and water status for the use in simulation modelling exercises.

iii) Assist with studies into research into the relationships between foliar nitrogen and photosynthesis

A field experiment that collected leaf photosynthesis on leaves that had different nitrogen contents was conducted. Technical support also assisted in the maintenance and calibration of the leaf photosynthesis machine.

iv) Assist with collection of data in waterlogging studies.

Technical assistance was provided to support field investigations into the physiological responses of cotton lines to waterlogging. Trials focussed on the timing on waterlogging and it relative impacts on crop growth. Measurements included frequent monitoring of soil moisture, light interception by the canopy, biomass sampling, and measurements of leaf photosynthesis with a portable gas exchange analyser. The outcomes of this experiment showed that cotton crops were more sensitive to waterlogging early rather than later in crop growth. This information will be used to refine the cotton simulations model ability to cope with waterlogging.

v) Assist with collection of data from off station experiments.

In this year the technical assistance provided support to two field experiment conducted at Auscott Narrabri that explored the benefits of frequent irrigation. This information was used to validate the cotton simulation model. The model was then

used to explore he concept across historical climate data sets. The outcome showed that there appeared to be no benefit in this approach.

vi) Collate data, enter in spreadsheets and undertake preliminary analysis

This project provided assistance in compiling and analysing plant map information data collected in the experiments investigating the differences between long and short season cultivars. The information helped to distinguish that the maturity of Australian cultivars differed mainly in their fruiting characteristics (eg. rate of fruiting site production) rather than gross growth characteristics (eg. leaf area index, radiation use efficiency). In addition the technician also assisted in compiling data from the collected from the Canberra Phytotron that came from an experiment exploring the impact of temperature on crop development.

vii) Collect data for the validation of preliminary model that accounts for fibre quality development.

No specific field trials were conducted in project investigating this topic. The technician supported by this project did however; compile the data that had been collected in previous years. This data is now being entered into a database for use with future simulation validation exercises.

Other project activities that the provision of some technical assistance contributed to through the course of the project are:

- Experiments to assess potential cold tolerance of cotton seedlings of Australian cotton varieties.
- Large scale field experiments that imposed drought stress on a range of diverse genotypes to establish understanding of the concept of crop determinacy. To supplement these studies a series of glasshouse experiments were also been conducted. Results of this work so far have been presented at the Australian Agronomy conference and have been submitted to the journal Field Crops Research.
- A number of field experiments across different regions that explored the impacts of temperature on crop growth and development were implemented. Ranges of sowing times were imposed to generate different temperature regimes.
- A series of glasshouse experiments to explore the impacts of cold night on cotton growth and development. Results of this work so far have been presented at the Australian Agronomy conference and submitted to the journal Australian Journal of Agricultural Research.
- A field experiment to ascertain the potential to modify sowing time of Bollgard II genotypes to reduce the effects of high fruit retention by increasing overall plant size.

- Assistance was also provided to PhD student Rose Roche in her project assessing the differences in crop physiology of conventionally grown cotton (1m row spacing) compared with ultra-narrow row systems. Information derived from this study will be used to help identify where UNR systems are most applicable. Results from these studies so far have also been presented at the Australian Agronomy conference.
- An experiment exploring the impacts of Bollgard II with its high fruit retention and the use of limited water in reducing crop maturity. This study forms part of a significant effort in attempting to understand the interactions of crop physiology, crop management, and environment on crop yield and maturity.
- Two large scale field experiments to assess the functionality and the relative value of the irrigation management software 'HydroLOGIC'.

5. Publications arising from the research project.

Technical assistance provided by this project partially contributed information developed for the following publications. Information collected during the course of this project has also contributed to the development of HydroLOGIC and the development of OZCOT crop simulation model and its validation for use in farm management decision making.

PUBLICATIONS:

Refereed Journals:

Bange, M.P. and Milroy, S.P. (2004). Growth and dry matter partitioning of diverse cotton genotypes. Field Crops Research 87(1): 73-87.

Bange, M.P. and Milroy, S.P. (2004). Impact of Short Term Exposure to Cold Night Temperatures on Early Development of Cotton (Gossypium hirsutum L.). Australian Journal of Agricultural Research 55(6)

Bange, M.P., Milroy, S.P. and Thongbai, P. (2004) Growth and yield of cotton in response to waterlogging. In Press Field Crops Research.

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Milroy, S.P. and Bange, M.P. (2003). Nitrogen and light responses of cotton photosynthesis and implications for crop growth. Crop Science 43: 904-913.

Milroy, S.P., Bange, M.P. and Hearn, A.B. (2004) Row configuration in rainfed cotton systems: modification of the OZCOT simulation model. In Press Agricultural Systems.

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http://www.regional.org.au/au/asa/2001/2/b/thongbai.htm

Industry Conference Papers

Bange, M.P. and Milroy, S.P. (2002). Temperature extremes and cotton performance. In Proc. 11th Aust. Cotton Conf. 13-15 August, Brisbane, Aust. The Aust. Cotton Growers Research Organisation, pp. 477-481.

Bange, M.P. and Marshall, J. (2001). Dryland row configurations – balancing yield, quality and costs. In Proc. 1st Aust. Dryland Cotton Grower Workshop 29-31 August, Gold Coast, Aust. Cotton Cooperative Research Centre, pp. 1-15.

Bange, M.P., Milroy, S.P., Thongbai, P., and Richards, D.Q. (1999). Technical support for cotton agronomy, physiology, model development and validation. In Proc. Cotton CRC Research Conf. 21-22 July, Narrabri Aust. Cooperative Research Centre for Sustainable Cotton Production, pp. 340-342.

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Thongbai, P., Milroy, S.P., Bange, M.P., Rapp, G., Smith, T. and Rayner, F. (2002). Waterlogging and its effects on cotton growth and yield. In Proc. 10th Aust. Cotton Conf. 16-18 August, Brisbane Aust. The Aust. Cotton Growers Research Organisation, pp. 415-420.

Conference Abstract

G.N. Roberts, Bange, M.P., and Milroy S.P. (2003). Factors influencing crop maturity in the Australian cotton industry. In Proc. 3rd World Cotton Conf. Capetown, South Africa.

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Bange, M., Carberry, P., and Marshall, J. (2003). Dryland cotton: Balancing yield, quality and costs. The Australian Cottongrower. 24(5).pp. 62-66.

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Others

Bange, M.P. (2002). Dryland cotton potential and risk. Australian Dryland Cotton Production Guide. Third Edition. Cotton Research and Development Corporation and The Australian Cotton Cooperative Research Centre. pp. 7-12.

Bange, M.P. Marshall, J. and Stiller, W. (2002). Dryland cotton agronomy. Australian Dryland Cotton Production Guide. Third Edition. Cotton Research and Development Corporation and The Australian Cotton Cooperative Research Centre. pp. 41-52.