Cotton Catchment Communities CRC

FINAL REPORT

Part 1 - Summary Details

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

Cotton CRC Project Number: **1.03.01**

Project Title: Cotton Crop Management for Improved Fibre Quality

Project Commencement Date: 01/07/2004 **Project Completion Date:** 30/06/2007

CRC Program: The Farm

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Background

This project aimed to fill a gap that existed in developing management strategies in the field that optimised cotton fibre properties.

Australian cotton fibre is exported into a dynamic and competitive market and we need to ensure an ever-improving product to meet the demand from spinners. This pressure has led to fibre quality becoming just as important as yield is for maintaining the viability of the industry. Crop agronomy decisions such as choice of variety, nutrition management, irrigation management, disease, insect and weed management can significantly affect fibre quality. In addition, seasonal or environmental factors out of the control of growers can also contribute to reductions in quality.

In recent years spinners have complained about the high micronaire, short fibre and high neps of Australian cotton. Some are suggesting that the increasing micronaire is related to problems associated with varieties. The CSIRO breeding team have shown that increasing micronaire was associated with seasonal effects, not change in varieties. A recent analysis showed that 30% of the increase in micronaire in these seasons was related simply to the high temperatures experienced during boll filling.

Confusion relating to these issues highlights our lack of understanding of the impacts of management and environment on fibre development. This has impeded our capacity to develop alternative management opportunities to improve profitability (both from a yield and fibre quality perspective). Quantitative descriptions of the effects of management and environment on cotton fibre quality are needed. Only then can the genetic, crop management and environmental sources of fibre quality variability be quantified and modulated to produce the high-quality cotton fibre demanded by a modern textile industry and ultimately the consumer (Bradow 2003). A report commissioned by the CRDC titled 'Fibre Quality Management/Post Farm Gate - maintaining Australia's premium markets' highlighted the need to develop an information package that would provide information about how cotton fibre is formed and what management practices and/or environment factors affect it.

CSIRO Plant Industry has fibre quality as one of our major focus subjects for plant breeding and for agronomic management. This project will be aimed at strengthening/enhancing the cotton research efforts to better understand the links between climate, variety, agronomic management and fibre quality and to use this knowledge to improve the way we grow cotton to avoid producing poor quality. Dr Constable has developed a module in OZCOT to simulate fibre quality development. This model however needs data to improve its accuracy and robustness. This project will collect data that will improve the fibre quality module so it will be valuable for predicting and understanding the effects of climate and management on fibre quality. Better guidelines to produce high quality cotton will be one significant outcome.

This project led on from a project measuring temperature extremes on cotton performance. As temperature plays an important role in fibre development some investigations exploring extreme cold and hot temperatures on fibre development had commenced. This project became an integral part of the industry's 'Fibre to Fabric' initiative and would contribute to the development of an information package that would aim to enhance management for fibre quality.

This project was a main source of technical support and operating funds for Dr Michael Bange who has significant responsibilities for supervision of Cotton Decision Support initiatives. Dr Bange maintains a significant research portfolio in crop physiology, agronomy and farming systems across the industry.

Objectives

This project aimed to fill a gap that existed in developing management strategies in the field that optimise cotton fibre properties. The specific aims were:

1. Initiate targeted research to improve the understanding of the effects of different climate, plant and management factors on fibre properties.

2. Utilise agronomy and physiology research tools such as OZCOT simulation to develop guidelines to assist in the management of cotton to optimise yield and fibre quality.

3. Strengthen agronomic research to meet the needs of the 'Fibre to Fabric' initiative.

Specific Objectives were:

Objectives, Milestones, Performance Indicators Year 1:

1) Compile literature on the effects of crop management and environmental effects on fibre development – *completed*.
2) Establish field experiments to quantify the effects of temperature and radiation – *completed*.
3) Establish field and glasshouse experiments to quantify the differences in fibre quality between high and low boll loads, including Bollgard II and conventional varieties - *completed*.
4) Working with CSIRO TFT identify and evaluate instruments that could be used to measure fibre quality of small lint samples collected from physiology/agronomy field experiments – *completed*.
5) Participate in the 'Fibre to Fabric' Initiative by providing agronomic research support - *achieved*

Objectives, Milestones, Performance Indicators Year 2:

1) Continue experiments exploring the impacts of temperature and radiation on fibre development - *completed*.
2) Establish field experiments across the industry to explore the relative benefits of using skip-row configurations for improving fibre quality in dryland cotton production systems in relation to yield - *completed*.
3) Develop simple web based tools to allow growers to estimate whether environmental factors such as temperature and radiation have affected their fibre quality – *not achieved*.
4) Compile field measurements to further validate the fibre quality simulation routines in OZCOT. Use information collected from field studies to improve model if needed – *achieved*.
5) Participate in the 'Fibre to Fabric' Initiative by providing agronomic research support - *achieved*.

Objectives, Milestones, Performance Indicators Year 3:

1) Initiate experiments exploring the impacts of water stress on fibre development– *not achieved*.
2) Continue field experiments across the industry to explore the relative benefits of using skip-row configurations for improving fibre quality in dryland cotton production systems in relation to yield - *completed.*

3) Conduct a preliminary sensitivity analysis using the OZCOT simulation model that identifies management practices or environments that contribute to poor fibre quality – *significant progress towards objective achieved*.
4) Participate in the ‘Fibre to Fabric’ Initiative by providing agronomic research support - *achieved*.
5) Produce a draft document that outlines crop management practices and environmental effects that affect fibre quality- *achieved*.
6) Prepare a final report – *achieved*.

Performance Indicators

- New understanding developed on the effects of management and environment on fibre quality of cotton.
- Successful management strategies for enhanced fibre quality recommended.

Methods

This project supported detailed physiology/agronomy studies that quantified the effects of climate and management on fibre development. It had a strong focus on field experiments in a range of climates. Where necessary complementary studies under controlled environment conditions were conducted. Genotypes used in this study were current commercial cultivars as well as premium fibre genotypes selected for possible release and their potential adaptation for different environments. Measurements included accurate recording of crop developmental stages, daily climate variables, crop growth rates, fruit development, crop maturity, yield and quality. This allowed us to:

i) Derive field based response functions for a range of key environmental processes affecting fibre quality (temperature, radiation, water).
ii) Derive better understanding of the effects of agronomy on fibre quality.
iii) Quantify the differences in fibre quality between Bollgard II (high fruit retention crops) and conventional varieties. Fundamentally we needed to quantify the effects of boll load on fibre properties.
iv) Establish the relative benefits of using skip-row configurations for improving fibre quality in dryland cotton production systems in relation to yield.

This project contributed to the industry's *'Fibre to Fabric'* initiative by helping to quantify seasonal and crop management effects. Specifically this project helped:

(i) *Link crop physiology and agronomic studies to systems experiments conducted by other researchers of the Cotton CRC.*

Many of the samples needed to support the physiology/agronomic studies in this project were collected from existing studies undertaken by other researchers spread through the cotton growing regions. Collecting these samples will provide an important link to interpreting how different farming system impact on fibre quality.

(ii) *Identifying instrumentation that will assist in measuring fibre quality traits.*

In order to develop relationships between environment and crop management easily it was important to identify instrumentation that will measure the fibre traits of small samples of lint. In collaboration with CSIRO Textile and Technology (CSIRO TFT) we identified processes and instrumentation that will allow us to do this. Currently large samples are needed to enable fibre traits to be analysed.

In addition CSIRO TFT is also developing new reliable techniques for accurately measuring cotton fibre maturity and fineness. The availability of these new measurement techniques opens up the possibility of in-depth studies of the effects of on-farm practices and environment on fibre maturity, neps, short fibre content and other important processing performance measures. This project contributed in providing fibre samples to test this technology.

(iii) *Providing agronomic research support*

We collected and collated information needed to conduct crop simulation analyses to be able to use the OZCOT cotton simulation model to interpret outcomes at the field level of the effects of management and environment. We were then to use OZCOT to help explore management practices that may have produced better fibre quality outcomes without affecting yield. This process will help in developing management options that improve the farming system to meet fibre quality and yield targets.

(iv) *Development of fibre quality management guidelines and tools*

This project initiated important research that will help develop guidelines for the management of fibre quality in the field. This project assisted in the initiation and facilitation of an industry extension initiative focusing on management for enhanced fibre quality (eg. FIBREpak – Fibre production guidelines).

(v) *Facilitate stronger links across research in fibre quality*

Ultimately this project facilitated and strengthened relationships with Geelong and other participants of the ‘Fibre to Fabric’ initiative by providing research and support focusing on the agronomic and environmental effects of fibre development in the field.

Results and Outcomes

A brief outline of the major results and outcomes from this project is given below under the major heading associated with aims. Where research has been published the appropriate reference in the list of publications is given.

Initiate targeted research to improve the understanding of the effects of different climate, plant and management factors on fibre properties.

Specific research undertaken investigating the effects of environment and management factors on fibre quality included issues of: Bollgard II vs conventional cultivars, row configuration dryland production, plant population, sowing time, temperature effect on micronaire, radiation x temperature effects on micronaire, and agronomy of premium fibre varieties. The results of these studies are presented below:

Sowing time

Results of sowing time experiments conducted at Narrabri have been summarised in a recent paper submitted to the journal Field Crops Research: Bange, M.P., Milroy, S.P. and Caton, S.J. (2007). Managing high fruit retention in transgenic cotton (*Gossypium hirsutum* L.) using sowing date (Appendix 1).

These results were presented at the Australian Cotton Conference 2006, CSD/CSIRO science review 2005 and 2006, and a Cottongrower magazine article is planned. The abstract of the paper is presented below with references to the graphs that highlight the results.

Paper Abstract

Recently, genetically engineered (transgenic) cottons expressing genes from *Bacillis thuringiensis* (Bt) have been made available to cotton growers throughout the world. In Australia cotton growers have access to Bt cotton that contain genes that express the insecticidal proteins Cry1Ac and Cry2Ab (Bollgard II®). Bollgard II offers significant potential to reduce pesticide use for the control of major Lepidopteran pests (particularly Helicoverpa spp. in Australia). As a consequence of the improved insect control, retention of squares (flower buds) and young bolls is higher in Bollgard II varieties than non-Bollgard varieties. A concern raised by cotton growers is that in some regions yield potential for Bollgard II may be limited because the demands of earlier high fruit retention reduces resources for continued growth and fruiting, thus leading to earlier maturity and reduced yield.

Three field experiments that varied sowing date and compared non-Bollgard II and Bollgard II cotton cultivars were conducted to test the hypothesis that delaying sowing date in Bollgard II will increase canopy size and alleviate the potential concerns for the effect of higher fruit retention of Bollgard II on yield. Results showed that delayed sowing did not increase the yield of the Bollgard II cultivar through increased LAI when comparing with normal sowing dates. However, in comparison with the conventional cultivar which had yields that became lower with later sowings, Bollgard II maintained its yield presumably through the shorter fruiting cycle (because of its consistent higher earlier fruit retention) allowing the time to support development and growth of the same number of bolls as earlier sowings (Figure 1). Improvements in fibre quality were also recorded with later sowings for both cultivars (Figure 2). Assessing sowing dates in for Bollgard II in different production regions offers a potential 'systems solution' to help optimise yield, fibre quality, and reduce risks of associated with poor crop establishment.

There was no evidence to support the hypothesis that delayed sowing increased the yield of the Bollgard II cultivar compared with early sowings through increased LAI. Bollgard II maintained its yield with later sowings, through the shorter fruiting cycle of this cultivar allowing the time to support production and development of the same number of bolls as earlier sowings. Following the adoption of Bollgard II in different production regions, recommendations for optimal sowing date need to be re-examined. Modifying sowing date for Bollgard II offers a 'systems solution' that could provide benefits both in terms of: maintaining yield; improving fibre quality; and reducing the risk of adverse effects of low temperatures on seedlings.

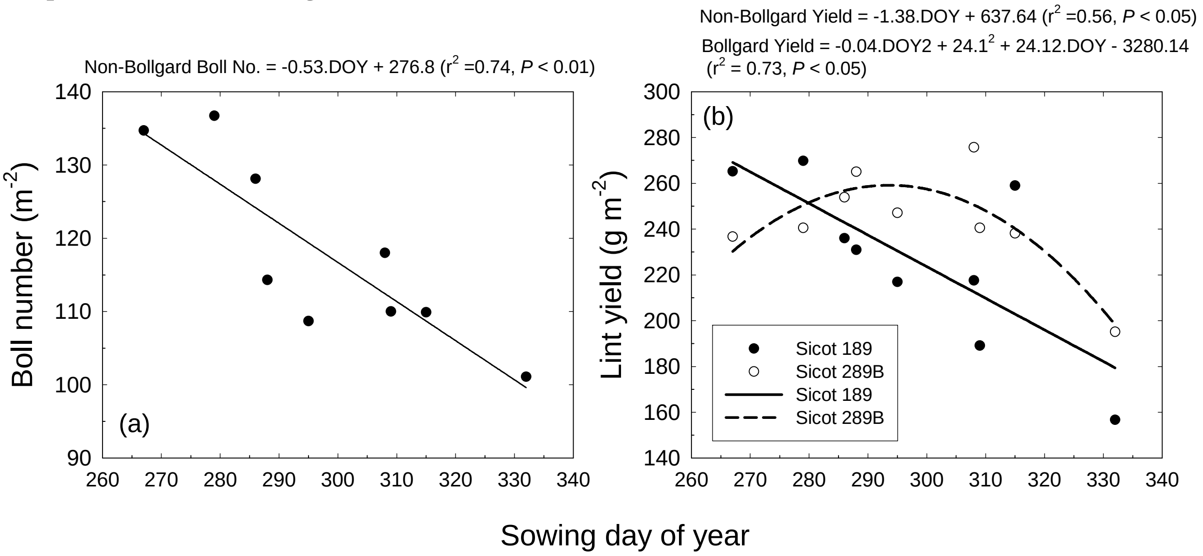

Figure 1. Relationships of (a) boll number for non-Bollgard II cultivar and (b) lint yield of both cultivars versus the day of year (DOY) on which the treatment was sown. Treatment means from all experiments are included.

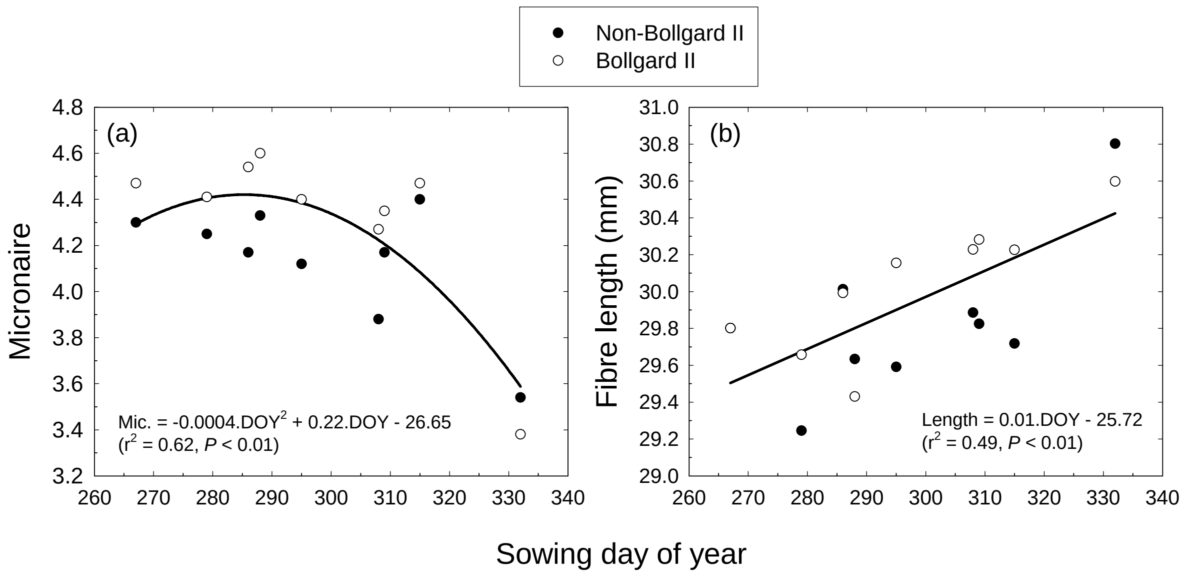

Figure 2. Relationships of (a) micronaire and (b) fibre length versus the day of year (DOY) on which the treatment was sown. Treatment means from all experiments are included.

Row Configuration Dryland Production

Performance of Bollgard II, Conventional and Premium Fibre Cultivars

Results of investigations into row configuration effects on yield and fibre quality of Bollgard II, conventional and premium fibre cultivars have been summarised in two published conference papers.

Bange, M.P. Roche, R. and Caton, S.J. (2006). Impact of row configuration on high fruit retention (transgenic) rain-fed cotton systems. Proceedings of the 13th Australian Agronomy Conference, 10-14 September 2006, Perth, Western Australia. (Appendix 2)

Bange, M.P. and Roche, R. (2006). Cotton Crop Management for Better Fibre Quality in Dryland Situations. In Proc. 13th Aust. Cotton Conf. 7-10 August, Gold Coast Aust. The Aust. Cotton Growers Research Organisation. (Appendix 3)

These results were presented at the Australian Cotton Conference 2006, Upper and Lower Namoi field days 2006, Australia Agronomy Conference, Quirindi grains research update, and a Cottongrower magazine article is planned. Excerpts from these papers which present and discuss the results are presented below:

Cotton Conference Paper Summary

Australian cotton fibre is exported into a dynamic and competitive market and we need to ensure an ever-improving product to meet the demand from spinners. Periods of insufficient soil water not only reduce the amount of lint produced but also impact on fibre characteristics. The use of skip row configurations provide some insurance against poor fibre quality by increasing soil water reserves available to the crop, delaying water stress. This paper presents some recent research in dryland situations that aim to optimise the balance between yield and fibre quality. Specific issues include comparing Bollgard II and non Bollgard II crops in different row configurations and including premium fibre varieties. Results show that high fruit retention Bollgard II® cotton did not perform any differently to conventional cotton when grown in skip configurations (Figures 3 and 4). Fibre length was improved using the skip configurations compared with solid. The yield of a premium fibre variety was less but fibre length was significantly improved, so this variety would only be beneficial if there was a significant likelihood in attaining large discounts for fibre length. Further research is being done with a range of different row configurations to further develop guidelines that will help growers select the best option for each situation.

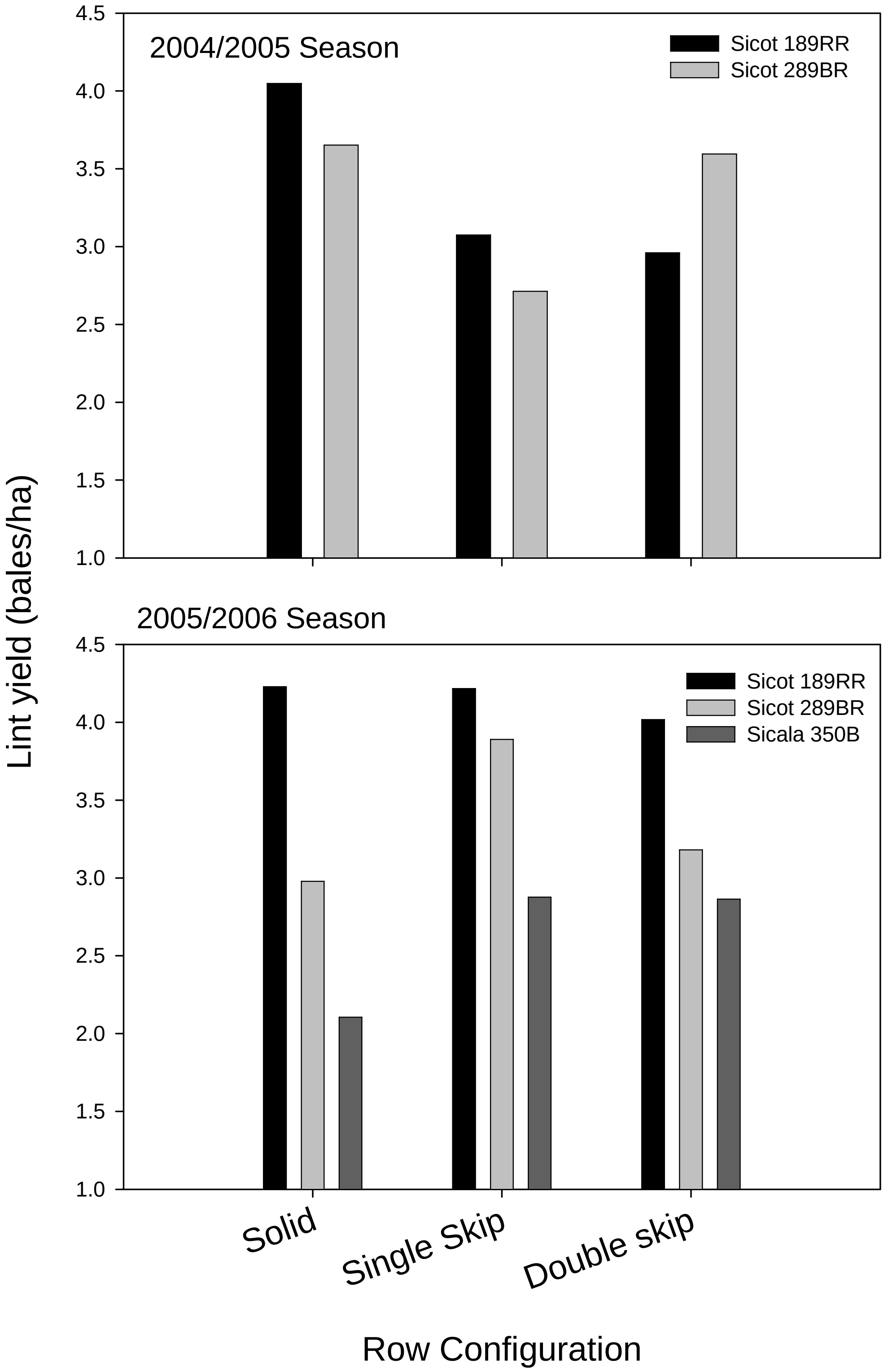

Figure 3: Handpicked lint yields for experiment 1 (sown 2004) and experiment 2 (sown 2005)

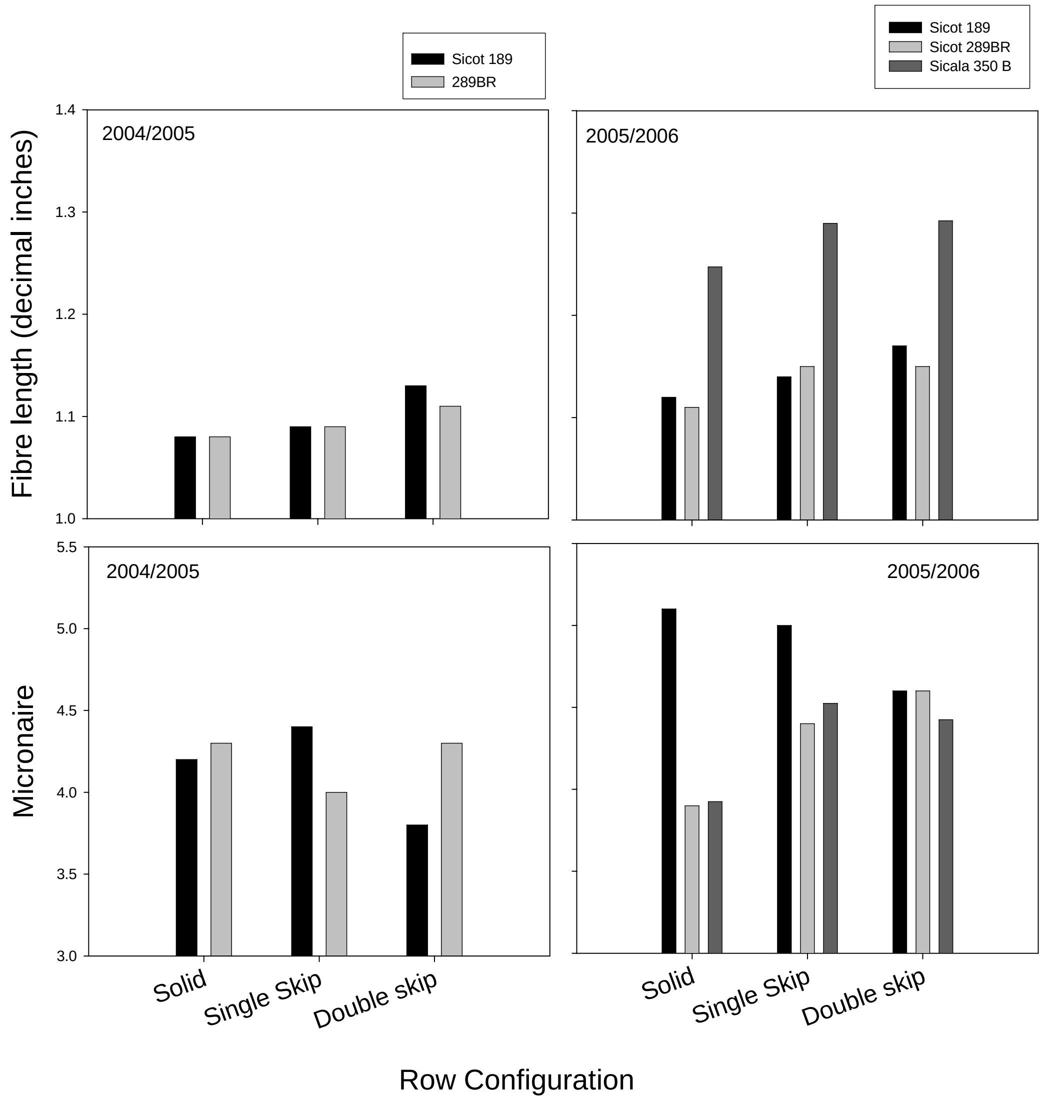

Figure 4: Fibre length and micronaire for experiment 1 (sown 2004) and experiment 2 (sown 2005).

<u>Assessing Super Single Row Configurations</u>

A large scale on-farm trial was conducted at 'Iffley' managed by Bernie Bierhoff near Rowena to assess the performance of super single row configurations compared to other skip row configurations. The trial was planted on the 27th October 2005 with Sicot 289BR, The row configurations tested were: single skip (2 in 1 out); double skip (2 in 2 out); super single (1 in 2 out); 2 in 4 out; and 1 in 1 out. The trial was a randomised block design with 4 replications. Plots were 12 m wide and were approximately 850 m in length. Results were published in the Gwydir field day trial handbook (Appendix 4), and presented by Peter Birch (B&W Rural) at the Australian Cotton Conference in a specific presentation on super single performance.

Yields were greatest in the super single treatment (1.1 bales/ha) and lowest in the single skip (0.3 bales/ha) (Figure 5). Differences in yield were primarily through differences in boll size, with the super single having larger bolls (2.3 g seed cotton/boll) and single skip having smaller bolls (1.8 g seed cotton/boll). No differences in boll number on an area basis were measured (average 32 bolls/m2).

Fibre length was longest in the '2 in 4 out' treatment (1.21 decimal inches) followed by the super single treatment (1.18 decimal inches) and the '1 in 1 out' treatment (1.15 decimal inches (Figure 6). Single skip had the shortest fibre length (1.13 decimal inches). Only the

‘1 in 1 out’ treatment and the single skip treatments may have incurred discounts for fibre length. No significant differences in micronaire (average 4.6) and fibre strength (average 33.7 g/tex) were measured.

Measurements of soil water extraction during the season from the middle of the skip configurations showed that different amounts of moisture were present towards the end of the season (Figure 7). Single skip had extracted the most moisture at the end of the season while the ‘2 in 4 out’ had extracted the least amount. The super single treatment approached similar levels of extraction to that of the single skip treatment.

In this very dry season at Iffley (total of 106mm rain for the season), the super single configuration outperformed the traditional skip row configurations of both single and double skip in yield and fibre length. Although the ‘2 in 4 out’ configuration provided the best insurance for fibre length it did not yield as well as the super single configuration. Measurements of soil water in the middle of the skip indicated that it was not able to use the space efficiently for extracting soil moisture. Water extraction in the super single configuration approached similar levels to that of the single skip configuration, highlighting that there was no impediment for root exploration and water extraction during the season. Super single offers significant promise as an alternative system for dryland in those areas that have low potential rainfall.

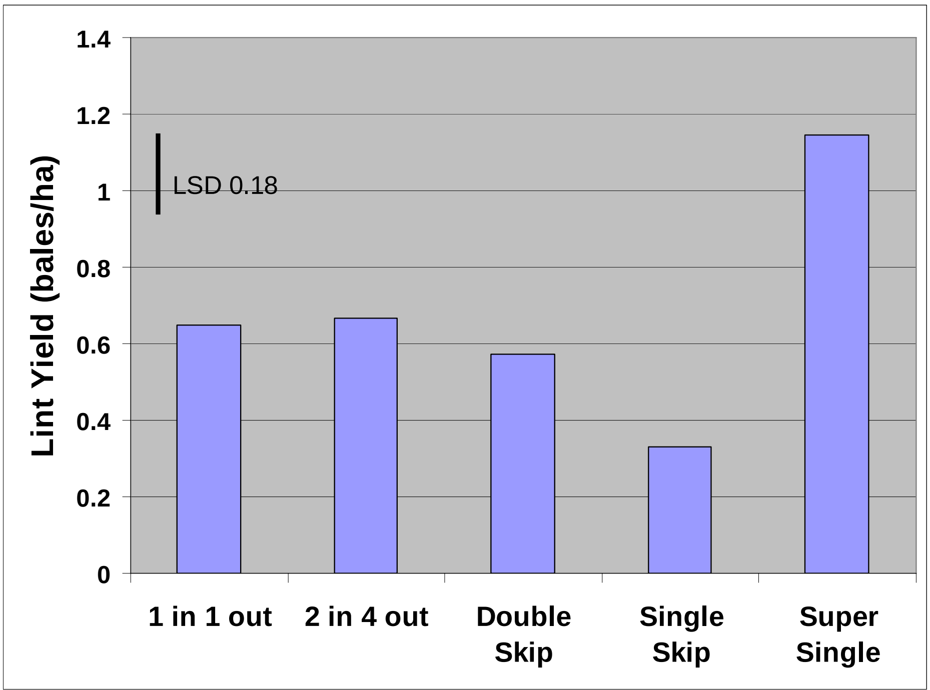

Figure 5. Lint yield for different row configurations sown at ‘Iffley’ near Rowena

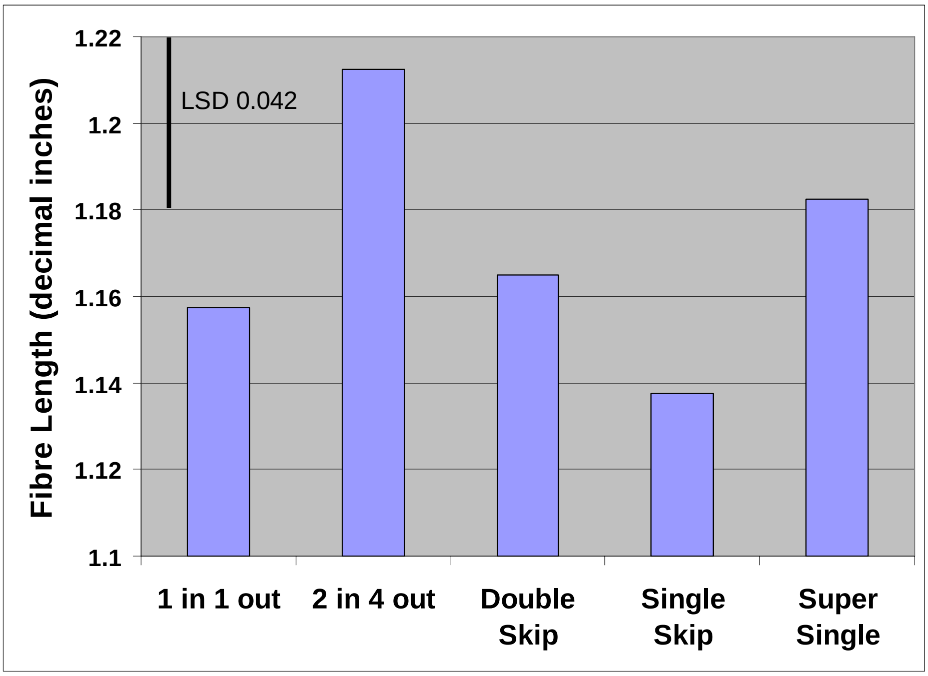

Figure 6. Fibre length for different row configurations sown at 'Iffley' near Rowena

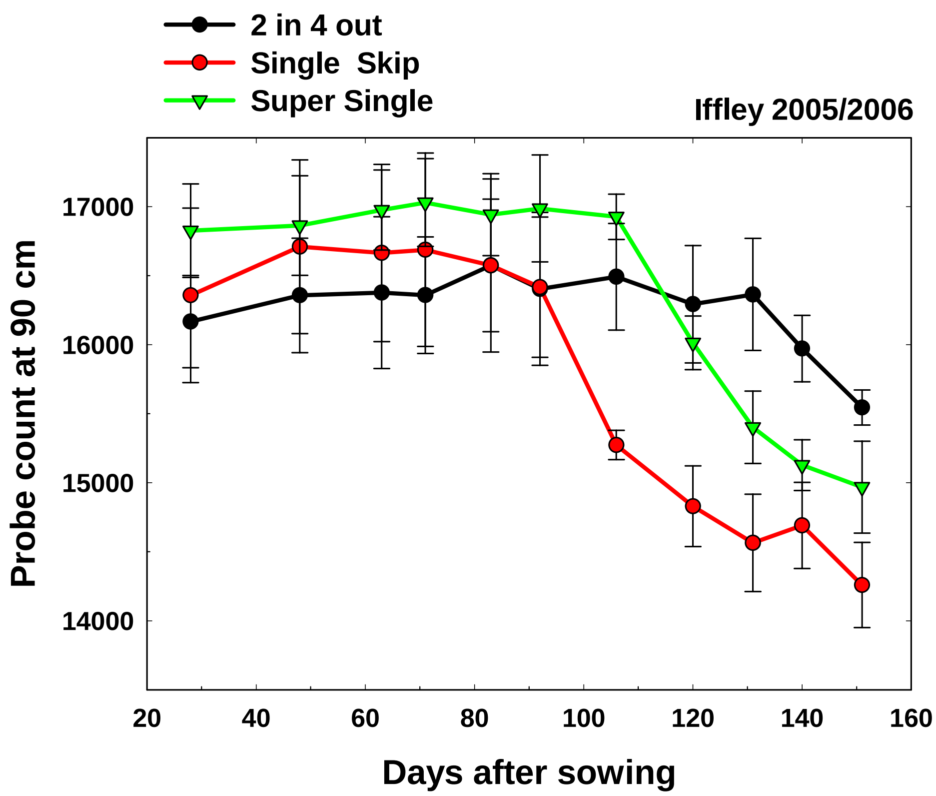

Figure 7. Moisture extraction from the centre of the skip of selected treatments throughout the growing season.

Integrating the Effects of Row Configuration on Yield, Quality and Gross Margins

Data collated from years of dryland row configuration experiments including data collected from the experiments described above was used to develop an information framework that could be used to assist growers in deciding which row configuration to choose considering their: yield potential for their fields; costs of growing cotton in different configurations; and penalties associated for fibre quality with different configurations. The framework considers the yield potential for a particular scenario for solid row configuration and estimates the associated potential yield for single and double skip (Figure 8). By accounting for any potential discounts in quality associated with the different configurations (Figure 9) and any differences in costs associated with the different configurations the gross margins ($/ha) can be calculated. Given that gross margins for a range of potential yields for the different configurations can be determined growers can use this information to help them choose when to move from configuration to another and optimise returns (Figure 10).

These results were presented at the Australian Cotton Conference 2006, Upper and Lower Namoi field days 2006, Australia Agronomy Conference, and the Quirindi grains research update. A spreadsheet has been developed that incorporate the functions presented below. CSD are using this information as part of their dryland workshops in 2007, and it envisaged that a simple web tool maybe developed in future.

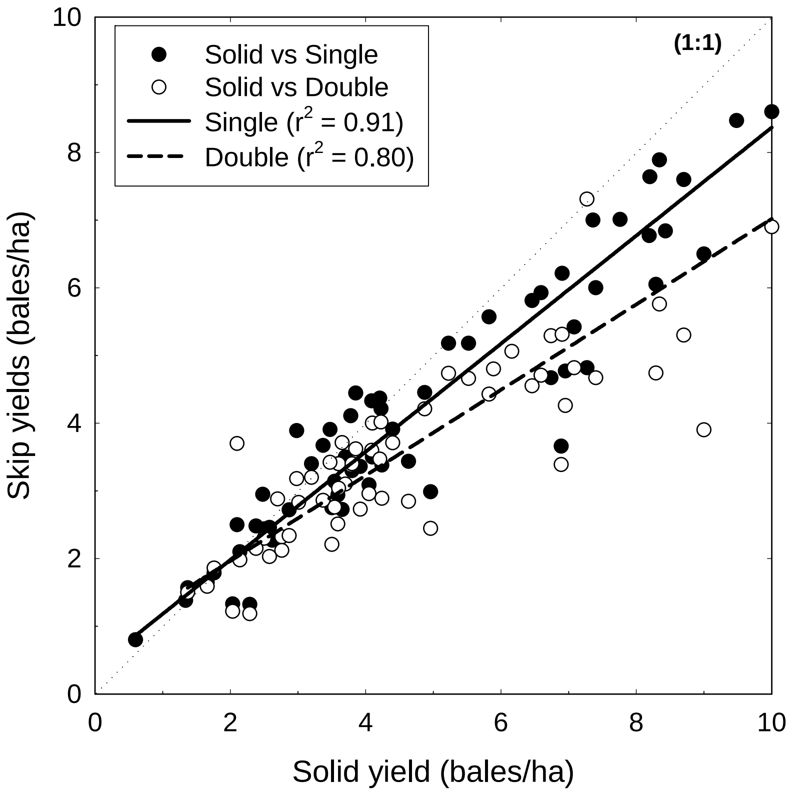

Figure 8. Responses derived from measured field data that show the relationship of lint yield (bales/ha) of skip row configurations versus lint yield (bales/ha) of solid row configurations. Solids lines are single skip row configurations and broken lines are double skip row configurations. Also shown are the 1:1 lines (dotted).

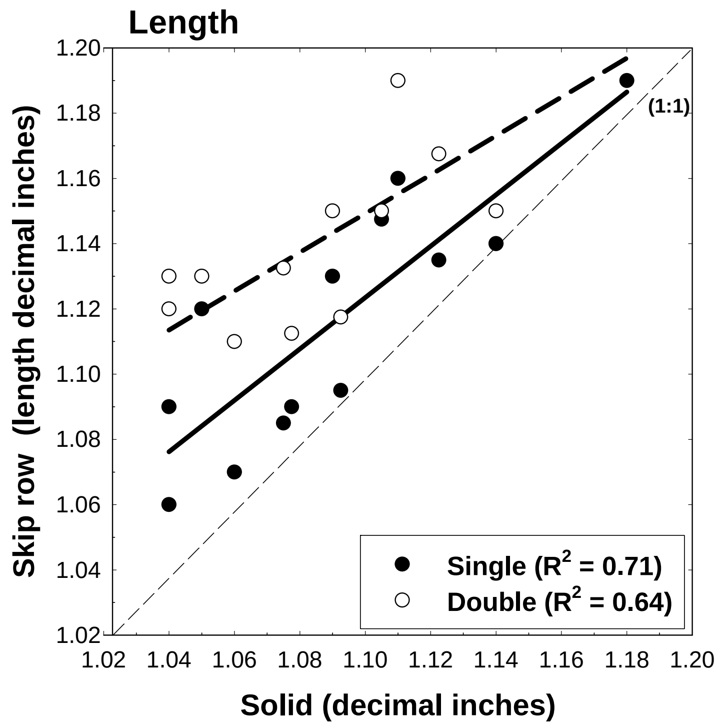

Figure 9. Response derived from measured field data that show the relationship of fibre length of skip row configurations versus fibre length of solid row configurations. Solids lines are single skip row configurations and broken lines are double skip row configurations. Also shown are the 1:1 lines (dotted).

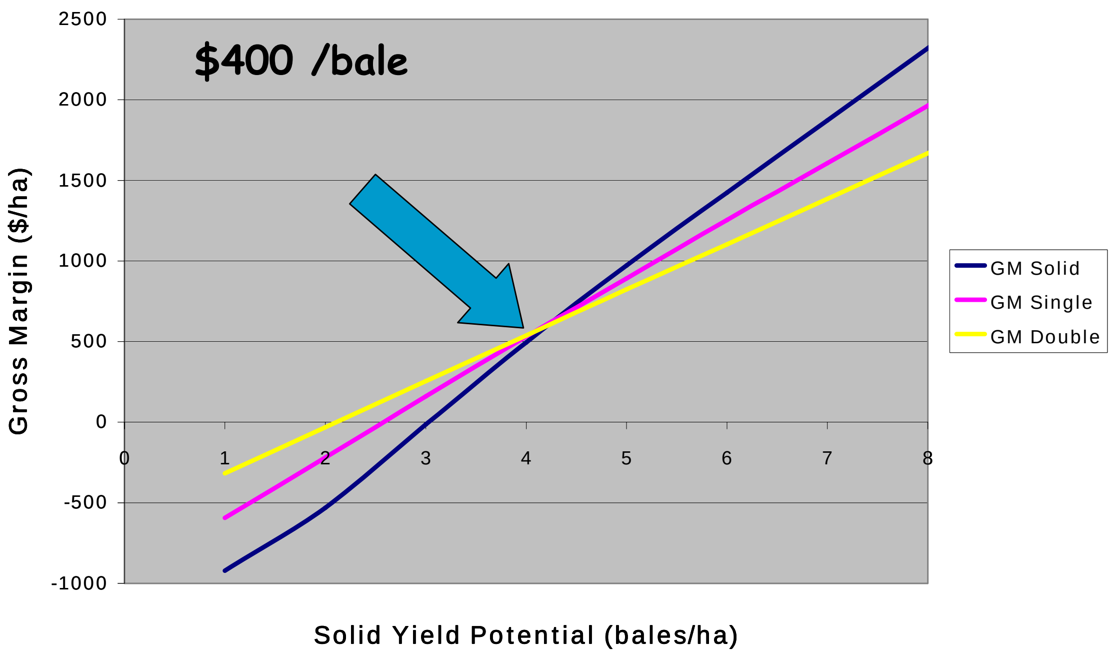

Figure 10. Economic comparison of skip row configurations to solid configuration, accounting for differences in costs, quality and yield.

Plant Population

In Australia the optimum population for cotton grown with 1 m row spacing was found to be around 8-12 m^{-2}. In the 1970s, studies investigating the optimum population in different cotton growing regions in the US found that there was a fairly small yield response and ideal populations were similar to those in Australia: Mississippi – 7-12 plants m^{-2} (Bridge et al. 1973), Texas – 8-15 plants m^{-2}, Georgia – 9.5-14.5 plants m^{-2} (Buxton et al. 1977). Research in the early 1980s the San Joaquin valley in California found that around 10 plants m^{-2} had the highest yield (Kerby et al. 1996a).

Despite the reported flexibility in maintaining cotton yields with plant density, there is a concern that yield potential for Bollgard II may be limited at the recommended (8-12 m^{-2}) and at lower plant densities. This maybe because of the demands of high early fruit load (due to the high retention) reduce resources available for continued growth and fruiting. This may thus lead to smaller plants with less fruit per plant, and earlier cutout lowering yield (Kelly et al., 2004). A management option being considered in Australia for Bollgard II is to increase plant densities above the recommended 8-12 plants m^{-2} to potentially compensate for the supposed smaller plants with less fruit. No studies have explicitly explored the response of Bollgard II to plant density and compared this to non-Bollgard II cotton to establish if there are differences.

Another recent issue facing Australian cotton is the increasing concern of a higher proportion of production being discounted for high micronaire (ACSA 2007). It has been suggested that improvements in agronomic practices (e.g. soil and plant nutrition) that encourage better growth and yields along with adoption of integrated pest management strategies with the introduction of Bollgard II that improve fruit retention, coupled with years with warmer than average seasons have all contributed to this high micronaire issue.

Similar issues have been reported by Bednarz et al. (2005) for cotton grown in Georgia USA. These authors investigated changes in plant population to improve fibre quality and profitability. They found that plant populations of 12.6 and 21.5 plants m^{-2} micronaire was reduced by 0.1 and 0.2 respectively, compared with micronaire of crops with populations of 3.6 and 9.0 plants m^{-2}. The changes in micronaire were associated with reductions in both fibre fineness and maturity (measured with AFIS – Advanced Fibre Information System). Later Bednarz et al. (2006) in a detailed analysis of fibre quality in these studies found that the higher plant densities had: less mature fibres on the inner fruiting positions in the middle part of the canopy; and that these were the positions that were contributing most to overall fibre quality. They postulated that the reasons for these differences were associated with changes in the source to sink ratio during boll filling caused by changes in plant population. The fruit located in the mid canopy region having less competition for resources resulting in more mature and less fine fibres thus causing higher micronaire. No study in Australian growing conditions has explicitly tested for change in fibre quality with different plant populations (in 1 m row spacing) especially with changes in timing of fruit retention and distribution associated with the introduction of Bollgard II cultivars.

Studies were instigated in this project to investigate whether the response of Bollgard II (high fruit retention) differs from non-Bollgard II (non-Bt) cultivars with different plant densities and assess whether plant population in the Australian environment could be used to reduce fibre micronaire. To test this comparison we conducted four field experiments that varied region and season.

Four field experiments were conducted to compare the performance of transgenic Bollgard II cotton with non-Bollgard II cotton with different plant densities. Three experiments (Exps. 1 to 3) were sown in 2005. Experiment 1 (Exp. 1) sown 25 October 2005 was at the Australian Cotton Research Institute (ACRI) at Narrabri, while Experiment 2 (Exp. 2) sown 6 October

2005 was located near Moree. Experiment 3 (Exp. 3) sown 1 October 2005 was located near Hillston while the fourth experiment (Exp. 4) was sown 18 October 2006 also at ACRI in Narrabri.

All experiments were sown with four target plant densities (4, 8, 12, and 16 plants m^{-2}) and two cultivars arranged factorially. Final established plant densities are presented in Table 1. All experiments used a randomized complete block design with four replications for Exps. 1, 2 and 4, and three replications for Exp. 3.

In Exps. 1, 3 and 4 the Bollgard II® cultivar Sicot 71BR (CSIRO Australia) was compared with its non-Bollgard II® equivalent Sicot 71RR (CSIRO, Australia). In Exp. 2 the Bollgard II® cultivar Sicot 71B (CSIRO Australia) was compared with its non-Bollgard II® equivalent Sicot 71 (CSIRO, Australia). All these cultivars are described as having full season maturity with compact growth. (P. Reid, CSIRO, personal communication).

Across all experiments Bollgard II had higher retention than the non-Bollgard cultivars, but this was only significant in Exps. 1 and 2 (Table 1). Retention was not measured in Exp. 3. No differences were measured that indicated that Bollgard II with its higher fruit retention changed the yield and fibre quality responses to population compared with its non-Bollgard equivalent (Figure 11). There were no indications that plant population recommendations needed to be modified for Bollgard II, nor plant population be used as a measure to manipulate fibre micronaire in either Bollgard II and non-Bollgard II cultivars.

Table 1: Final total fruit retention (expressed as the percentage of open bolls remaining relative to the number of total fruiting sites present). LSDs are presented for comparison between Bollgard II and non-Bollgard II cultivars, differences in plant density, and the interaction between plant density and cultivar. Retention was not measured in Exp. 3.

Experiment/Treatment	Final fruit retention (%)		
	Non- Bollgard II	Bollgard II	Density Mean
Experiment 1 Narrabri			
Density (4.4)†	31.9	45.0	38.5
Density (8.3)	29.5	43.6	36.5
Density (10.5)	27.2	42.5	34.8
Density (14.1)	24.8	42.8	33.8
Cultivar Mean	28.4	43.5	
LSD Cultivar			2.8**
LSD Density			4.0
LSD Cultivar x Density			5.6
Experiment 2 Moree			
Density (4.7)	37.5	45.7	41.6
Density (7.2)	42.3	42.9	42.6
Density (11.4)	39.0	40.1	39.5
Density (15.2)	33.0	41.3	37.1
Cultivar Mean	37.9	42.5	
LSD Cultivar			4.4*
LSD Density			6.3
LSD Cultivar x Density			8.9
Experiment 4 Narrabri			
Density (5.2)	41.9	44.3	43.1
Density (8.1)	37.7	45.5	41.6
Density (12.2)	37.3	40.5	38.9
Density (16.4)	35.2	37.9	36.5
Cultivar Mean	38.0	42.0	
LSD Cultivar			5.8
LSD Density			8.2
LSD Cultivar x Density			11.6

† Plant density (plants m^{-2})

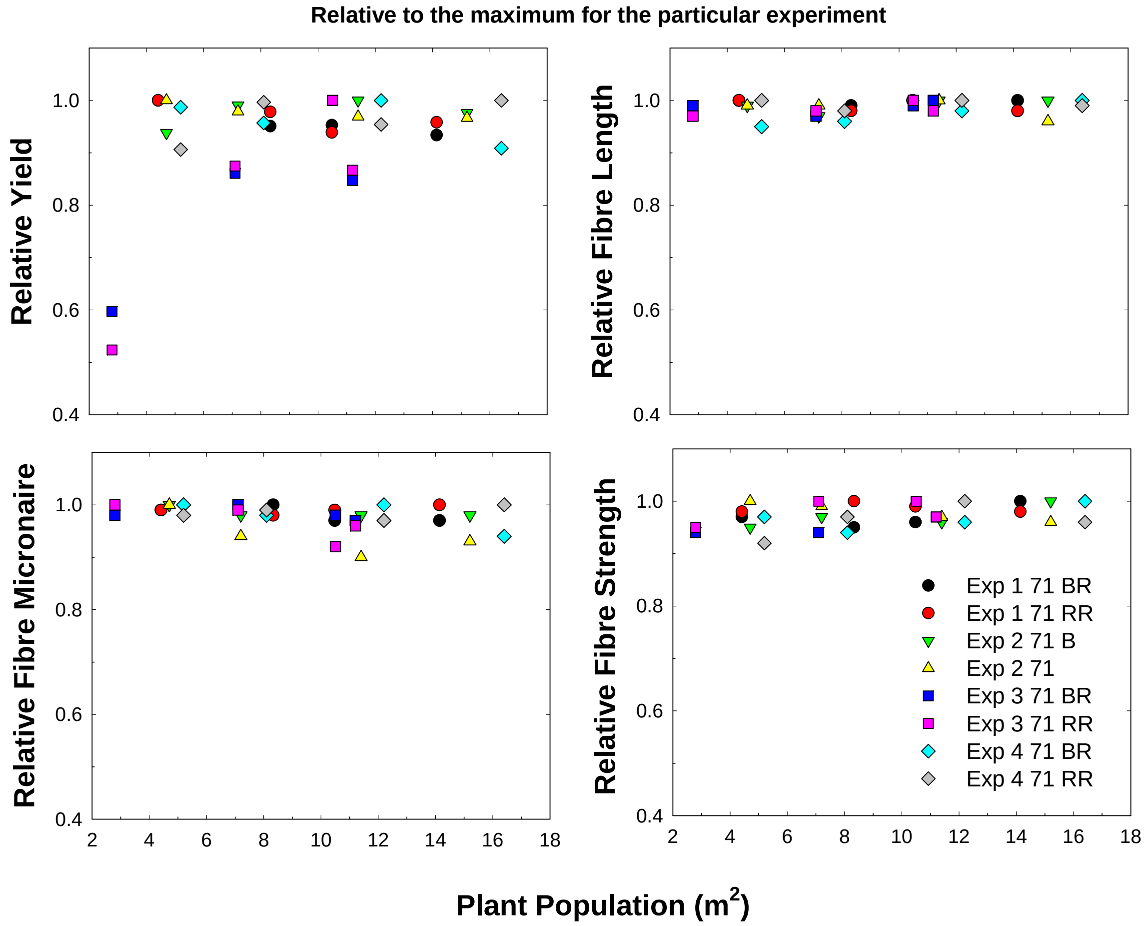

Figure 11. Relative yield and fibre quality traits for the four field experiments that investigated the impact of plant population on Bollgard II and non–Bollgard II cultivars.

These results were presented at the Australian Cotton Conference 2006 and at a Gwydir field day in 2006. Results of the trial conducted in Moree were published in the Gwydir trial handbook (Appendix 5). Results are being complied for a refereed journal article which will be followed by a Cottongrower magazine article.

Temperature Effects on Fibre Micronaire

Fibre thickening in individual bolls doesn't start to occur until around 28 days after flowering and involves daily deposition of layers of cellulose on the inner surface of the fibre wall. From this period onwards temperature and stress are the main components affecting fibre thickness leading to differences in micronaire; although boll load has an influence because of competition for assimilates in the plant. Fibre from bolls lower down on the main stem has higher micronaire due to development in optimum growing conditions with minimal stress, allowing good fibre wall thickening.

In recent years spinners have complained about the high micronaire, short fibre and high neps of Australian cotton. Some are suggesting that the increasing micronaire is related to problems associated with varieties. Although the CSIRO breeding team with the use of their control varieties have shown that increasing micronaire is also most likely associated with seasonal and management effects, not just change in varieties (Figure 12). Confusion relating to these issues highlights our lack of understanding of the impacts environment on fibre development. This has impeded our capacity to explore alternative management opportunities to improve profitability (both from a yield and fibre quality perspective). Quantitative descriptions of the effects of environment on cotton fibre quality are needed. Only then can the genetic, crop management and environmental sources of fibre quality variability be quantified and modulated to produce the high-quality cotton fibre demanded by a modern textile industry and ultimately the consumer (Bradow 2003).

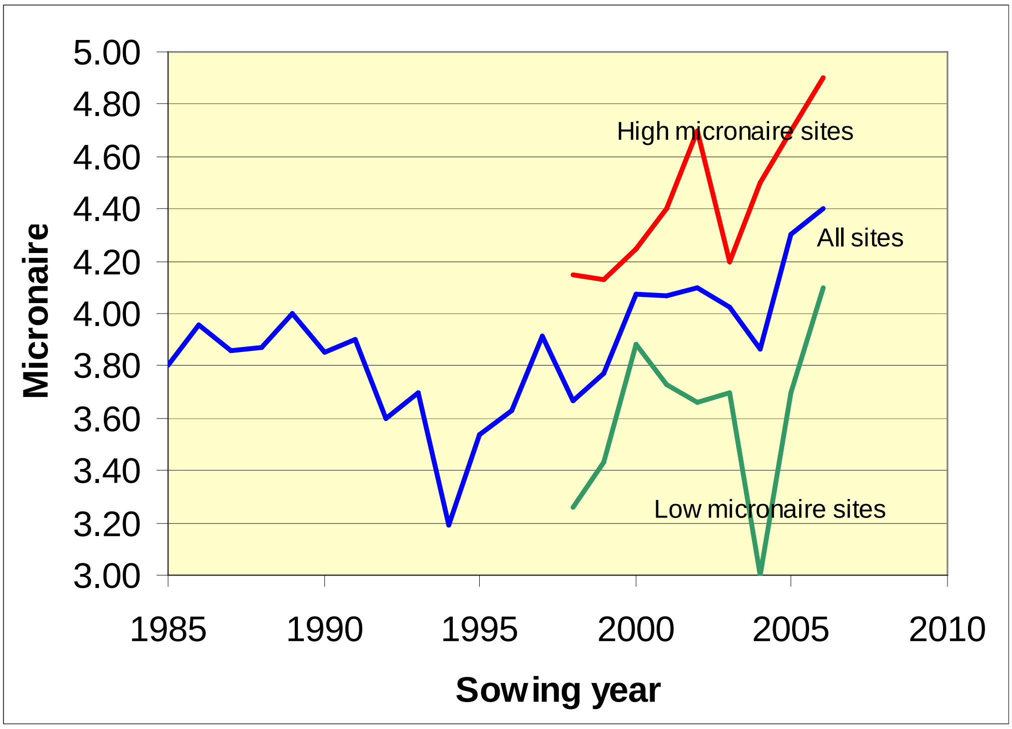

Figure 12: Average HVI micronaire of control varieties (DP16 and Namcala) from the CSIRO breeding program to 2006/07 highlighting seasonal impacts and management changes. Mean of up to 13 sites each season including Emerald, Biloela, Theodore, Brookstead, Boggabilla, St George, Collarenabri, Moree, Bourke, Merah North, Myall Vale, Breeza, Warren and Hillston.

In this project we evaluated a simple methodology to assess the impact of temperature during boll filling on fibre maturity leading to differences in micronaire. Simply we estimated the period when the majority bolls were thickening their fibres and related this to the average temperature experienced during this period. Using day degrees to estimate flowering, node development, fibre lengthening period, and the fibre thickening period we were able to calculated the average temperature that was experienced for a particular crop during their fibre thickening period. The methodology employed is summarised below:

Step 1: Estimate flowering 777 day degrees (using cold shocks)

Step 2: Estimate mid flowering (+5 nodes * 42 DD) based on the assumption of 10 fruiting nodes.

Step 3: Add period for fibre lengthening 220 DD

Step 4: Estimate Fibre thickening period (add 440DD)

Step 5: Calculate climate variables during fibre thickening period and relate to HVI micronaire.

To substantiate the methodology we collated micronaire data from sowing time experiments that had known flowering dates, and were fully irrigated. Data used was from those sowing time experiments described above, Greg Constable's sowing time experiments, and sowing time experiments conducted at Hillston and Breeza in a previous project measuring temperature extremes on cotton performance (Figure 13). We employed the methodology described above and were successful in establishing a significant response of average daily temperature to micronaire (Figure 14).

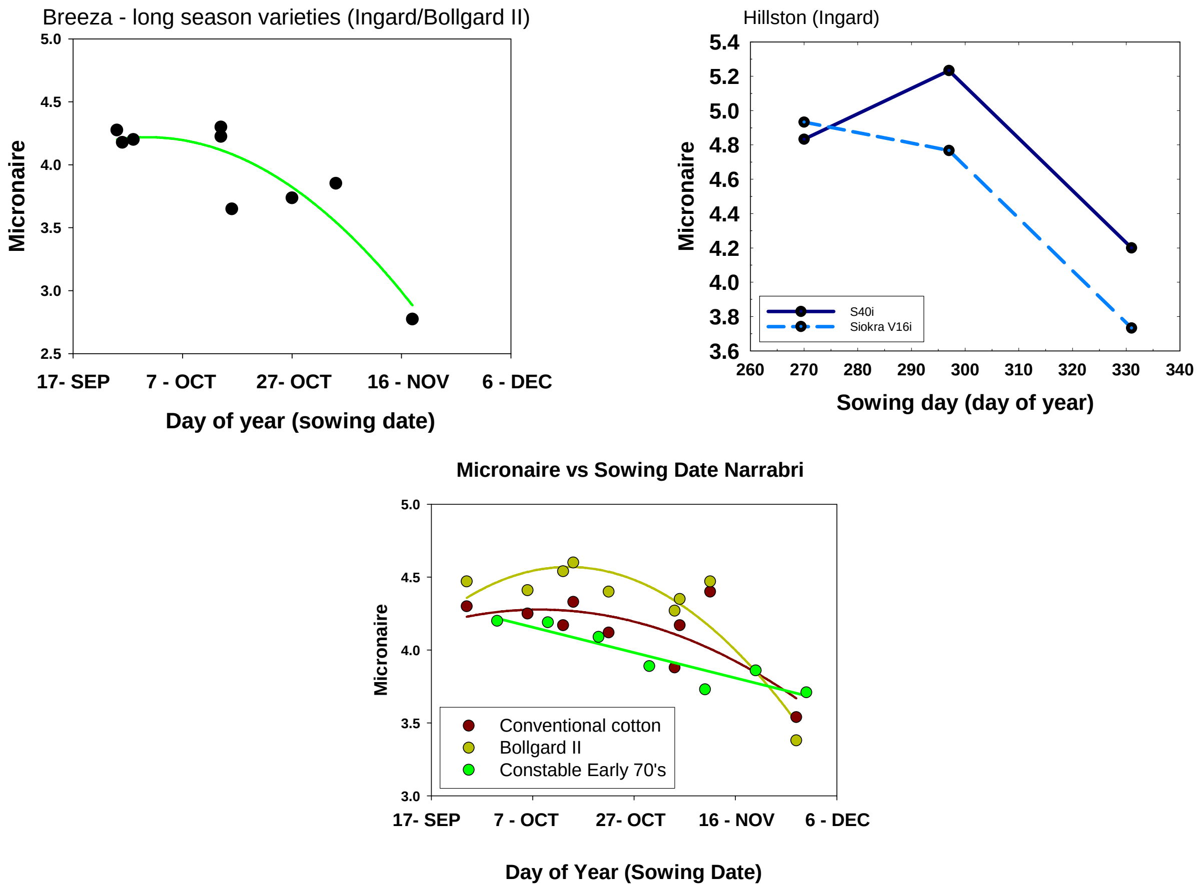

Figure 13. Impact of sowing time on fibre micronaire for Narrabri, Breeza, Hillston.

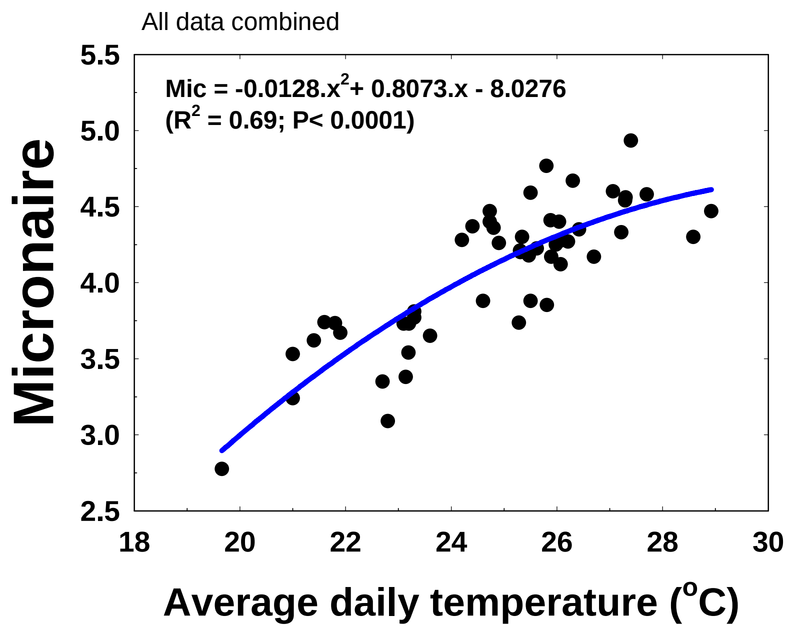

Figure 14. Response of micronaire to average daily temperature generated from the sowing time data presented in Figure 13.

Over the course of the project this information was presented the Australian Cotton Conference, during the field to fabric road show (over 2 years) and at the Geelong fibre course conducted by CSIRO TFT. The methodology was used by Cotton Seed Distributors to assess the performance of cultivars across regions within a season (Figure 15), and was used to assess the impact of temperature on control varieties (DP16 and Namcala) grown in the CSIRO breeding trials (Figure 16). This graph showed that a significant amount of the variation in fibre micronaire across regions and seasons. A slightly modified approach was applied to the same CSIRO dataset to establish if temperature had any affect on fibre length and was unsuccessful (Figure 17). Results of these analyses have been published in an Australian cotton grower magazine article (Kelly et al. 2006; Appendix 6) and at the Australian cotton conference (Bange and Constable 2006; Appendix 7). We anticipate publishing this methodology in a refereed journal.

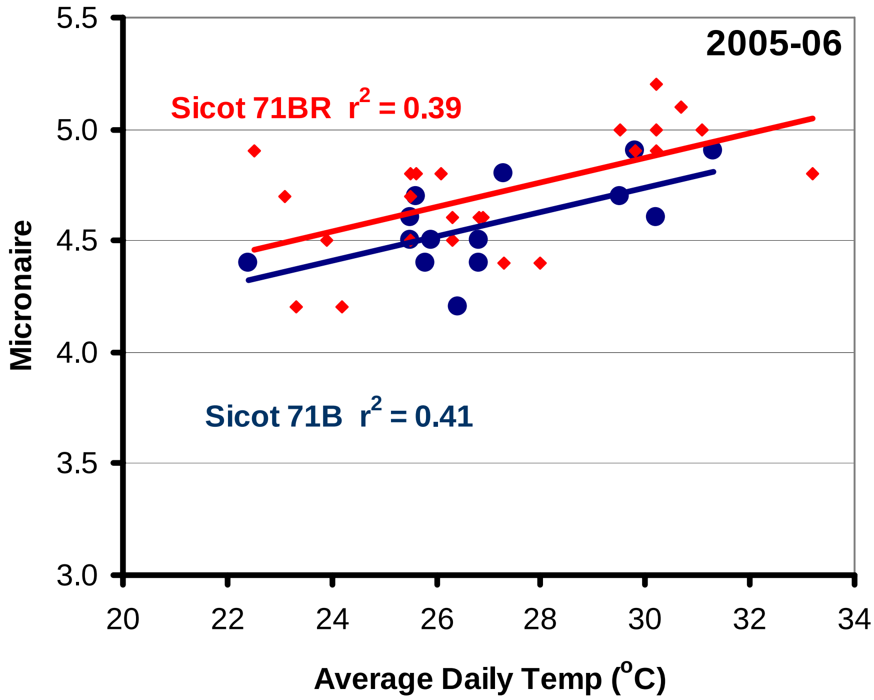

Figure 15. An analysis conducted in 2006 by Dave Kelly (Cotton Seed Distributors) where the methodology for assessing temperature impacts on micronaire developed as part of this project was applied (Kelly et al. 2006).

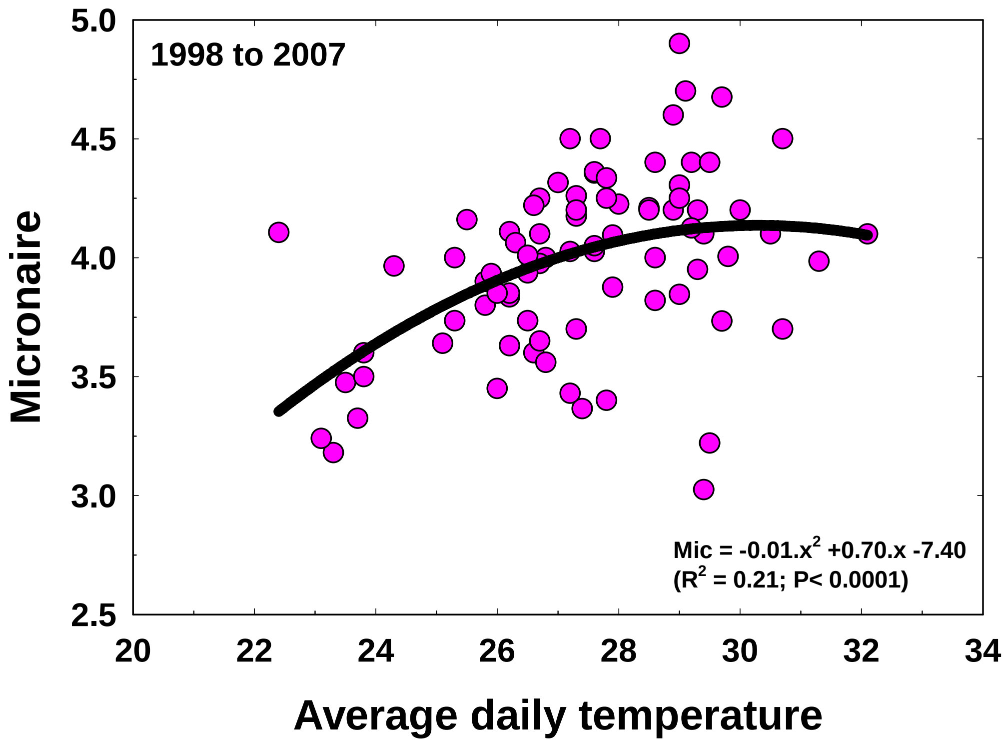

Figure 16. The methodology to assess impacts of temperature on micronaire developed in study was used to assess the relative effects of temperature on the control varieties (DP16 and Namcala) grown in the CSIRO breeding program.

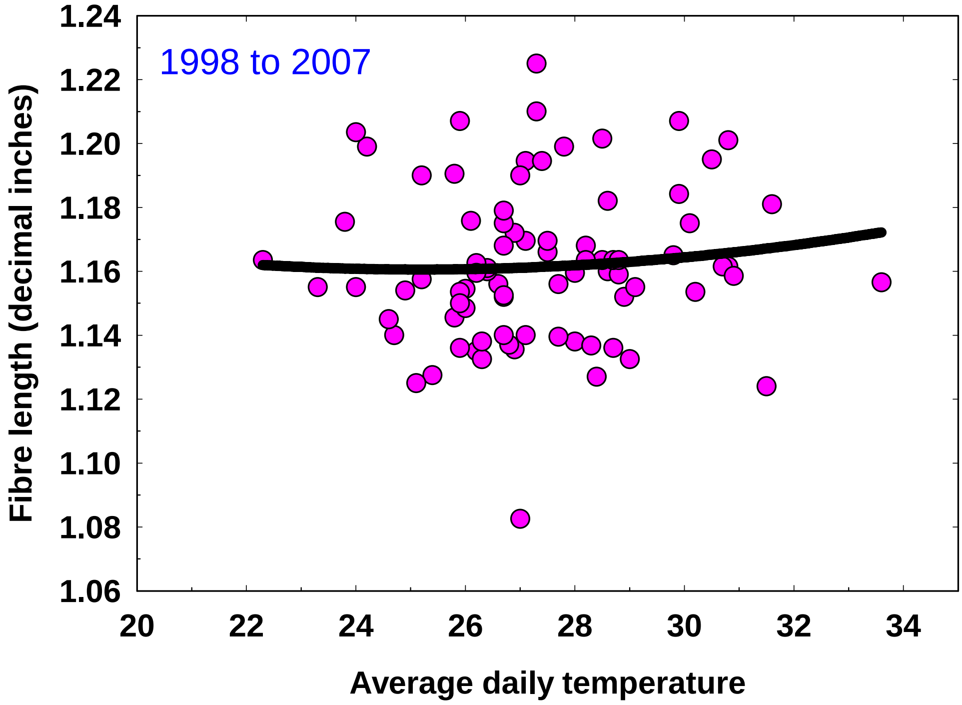

Figure 17. A slightly modified methodology used for the assessment of temperature on fibre micronaire was used unsuccessfully to assess temperature effects on fibre length.

Radiation by Temperature Effects on Micronaire

Fibre quality varies considerably among years and locations depending on both environmental and management conditions. The research presented above highlights the importance of temperature affecting fibre maturity leading to differences in micronaire. However, not all variation in micronaire can be accounted for by temperature alone (see Figure 16). This is because secondary wall thickening is affected by large alterations in crop photosynthesis. It is therefore plausible that other factors that affect photosynthesis such as changes in radiation (caused by changes in cloud conditions) will also affect micronaire. Pettigrew (1995) in his studies into source sink manipulation effects on fibre quality showed that reducing the level of radiation by 30% (photosynthetically active radiation) reduced micronaire by 7% when shade was applied later in the boll filling period. However, micronaire responded differently with the time of application of the treatment and in fact in one instance micronaire was higher in the shaded treatment. Wang et al. (2007) in their studies also showed micronaire was reduced from shading applied at any stage during boll filling.

Inconsistencies within and between studies are most likely a result of environmental components affecting micronaire not accounted for. As photosynthesis and hence fibre maturity (affecting micronaire) are a result of a number of factors, some environmental factors may in fact enhance or mitigate the influence of others (Pettigrew, 1995). Therefore it is necessary to study the complexity and interactions of a number of environmental factors together on fibre development to fully understand their level of impact.

Research was initiated in this project to better understand and quantify the relative impact of radiation and temperature on changes in fibre micronaire. Three field experiments utilising cultivar Sicot 289BR were conducted over three seasons. Treatments had different sowing times (3 times) to change temperature while shade cloth was applied during boll filling to simulate cloudy conditions. In the first two years of experiments shading was applied to at different stages during boll filling: control (no shading); early fibre growth (around the first 20 days after flowering; mid fibre length growth/early thickening (30-40 days after flowering); and late fibre thickening (40 – 60 days after flowering). In the third year shading was applied for the whole duration of the boll filling period.

During the season flowers on first positions were tagged randomly and date recorded to note their age and determine precisely when they had been exposed to shading treatments. At the end of the season all tagged bolls were harvested and grouped according to node position and fibre quality to be measured using HVI and AFIS (Advanced Fibre Information System). In addition measurements included a final handpick to determine yield and overall fibre quality.

Individual fibre samples are still undergoing measurement by the HVI and AFIS. Overall fibre quality and yield will only be presented in this report.

In all years sowing time affected micronaire, with the latest sowings reducing the micronaire. In the first two experiments there was no consistent effect of the application of the shading treatment (stimulating cloudy conditions) on micronaire (Figure 18). Similarly there was also no consistent effect of shading on yield, although yield was not always reduced by latest sowings (Figure 19). These combined results however did not clearly show the effect of temperature and shading on micronaire as they included bolls that were not exposed to the shading treatment. Following measurements taken by HVI and AFIS we will conduct further detailed analysis focusing only on those bolls that were developing during the shading treatment.

The third experiment did confirm that shading (stimulating cloudy conditions) persisting during the whole boll period will reduce micronaire (Figure 20). Micronaire on average across all sowings was reduced by 0.29. Similarly yield was reduced by shading across all sowings by an average of 831 kg/ha (Figure 21). Knowledge generated from this study will be used to refine the predictive capability of OZCOT.

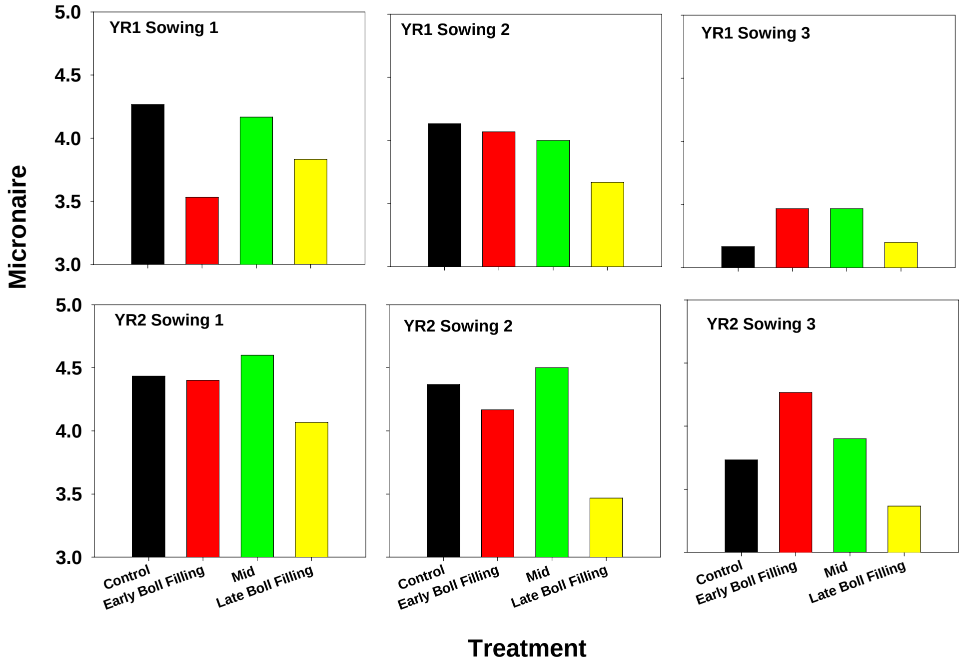

Figure 18. Micronaire of cotton from the first two field experiments that varied sowing time (to modify temperature) and applied a shading treatment to simulate cloudy conditions at various stages during boll filling.

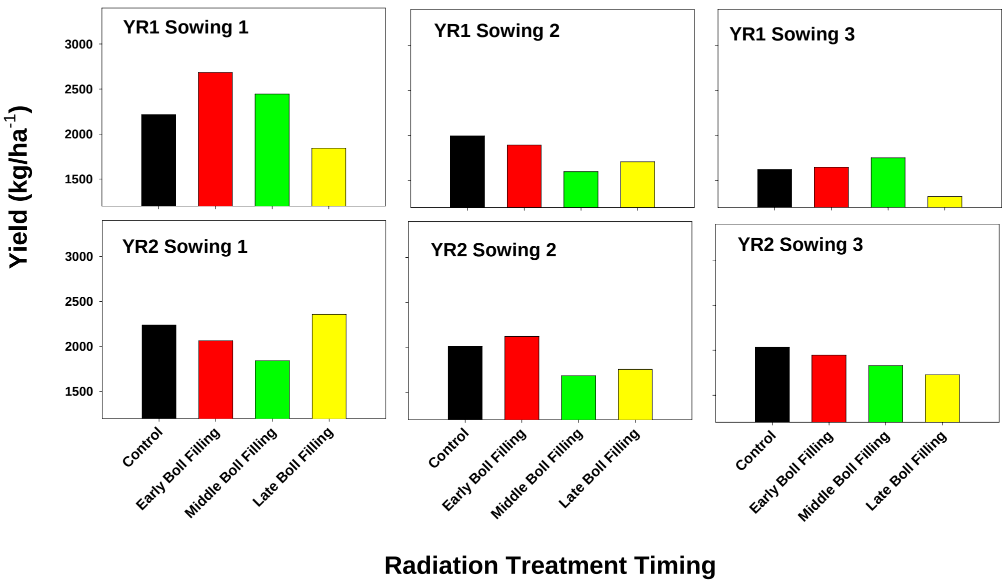

Figure 19. Yield of cotton from the first two field experiments that varied sowing time (to modify temperature) and applied a shading treatment to simulate cloudy conditions at various stages during boll filling.

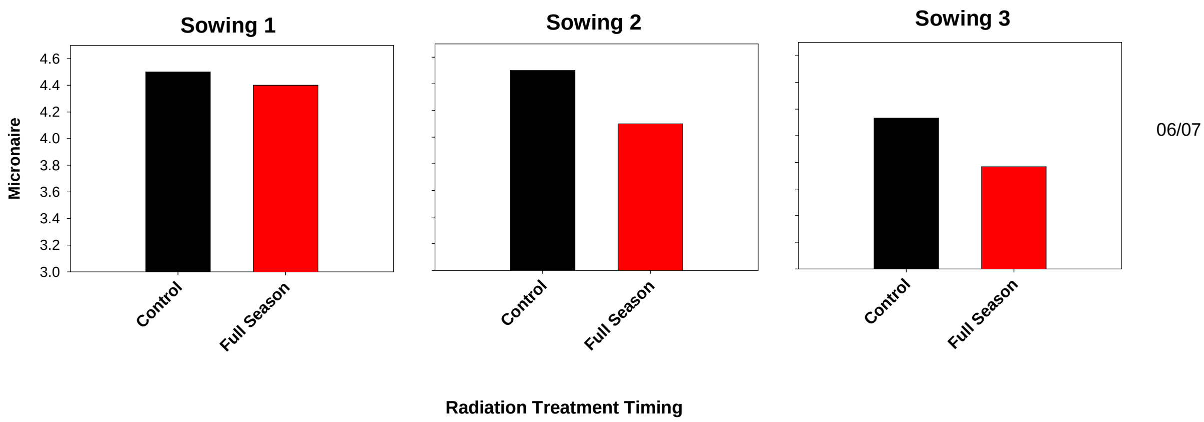

Figure 20. Micronaire of cotton from the third field experiment that varied sowing time (to modify temperature) and applied a shading treatment to simulate cloudy conditions for the full duration of boll filling.

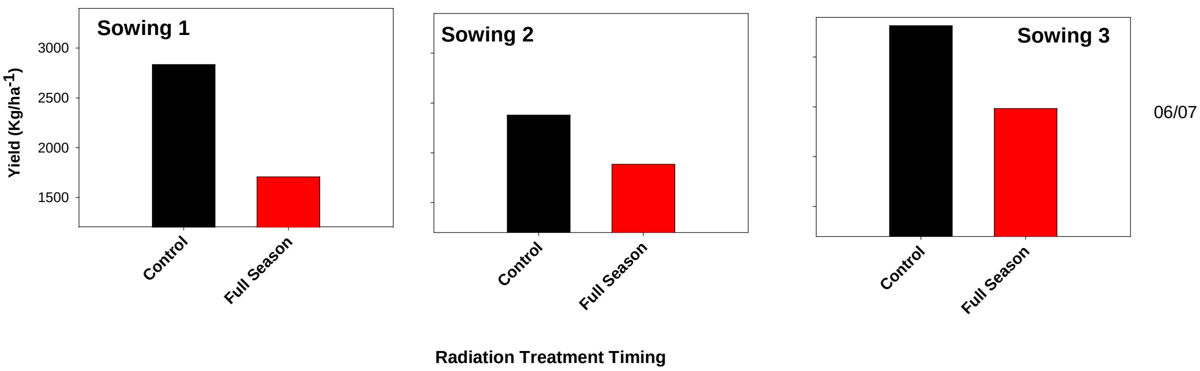

Figure 21. Yield of cotton from the third field experiment that varied sowing time (to modify temperature) and applied a shading treatment to simulate cloudy conditions for the full duration of boll filling.

Utilise agronomy and physiology research tools such as OZCOT simulation to develop guidelines to assist in the management of cotton to optimise yield and fibre quality.

Research tools such as the OZCOT cotton simulation model can be used to develop guidelines to assist in the management of cotton to optimise both yield and fibre quality. Previous to this project Dr Constable had developed a module in OZCOT to simulate fibre quality development. This component of the model however needed data to improve its accuracy and robustness. The model was simulating fibre length well, but not micronaire. During the course of this project we have reviewed the way the model estimates micronaire and have utilised the temperature function developed from the sowing time studies discussed previously in this report in an attempt to improve predictions of micronaire.

Figure 22 shows the ability of OZCOT to simulate yield, fibre length and micronaire. We can use these graphs that plot the response of the predicted values from OZCOT with the measured values to ascertain the effectiveness of the model to simulate quality. The predicted versus actual response for fibre length indicates whether the model is sensitive to changes in environment as indicated by the slope of the response.

We know can improve the predictive capability of the model and improve the closeness of the response to the 1:1 line by accommodating the inherent differences in fibre length of varieties. However, in the case of fibre micronaire the fit and slope of the line were both poor. On further investigation we found the major issue where OZCOT was under-predicting micronaire was mainly for many of the dryland datasets that were collated (Figure 23). On further investigation we have established that the datasets (crops) had concerns relating their management that would not have been accounted by OZCOT. We are currently in the process of collating more datasets for dryland crop situations. Once the model is simulating micronaire well we will proceed to test the model on independent datasets and will publish the results in a peer reviewed journal.

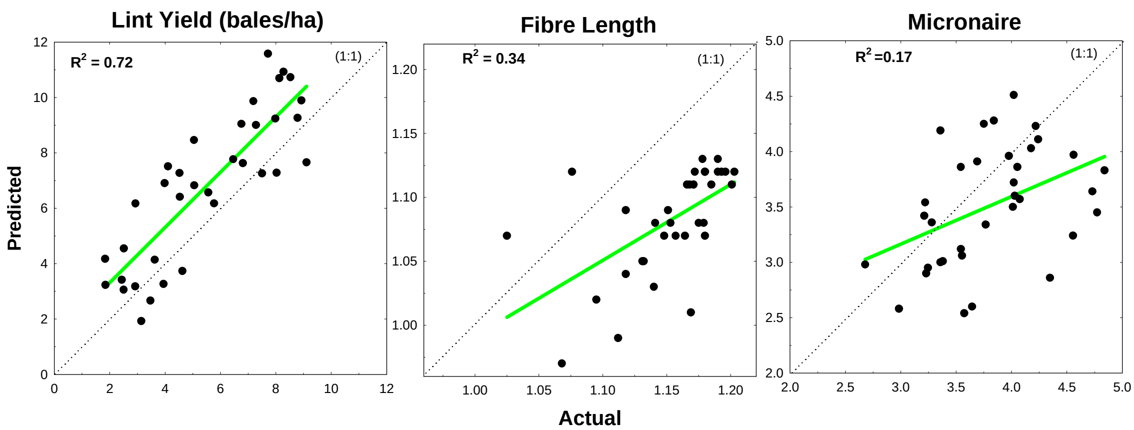

Figure 22. Response of predicted values of yield, fibre length, and micronaire estimated by OZCOT versus actual measured values.

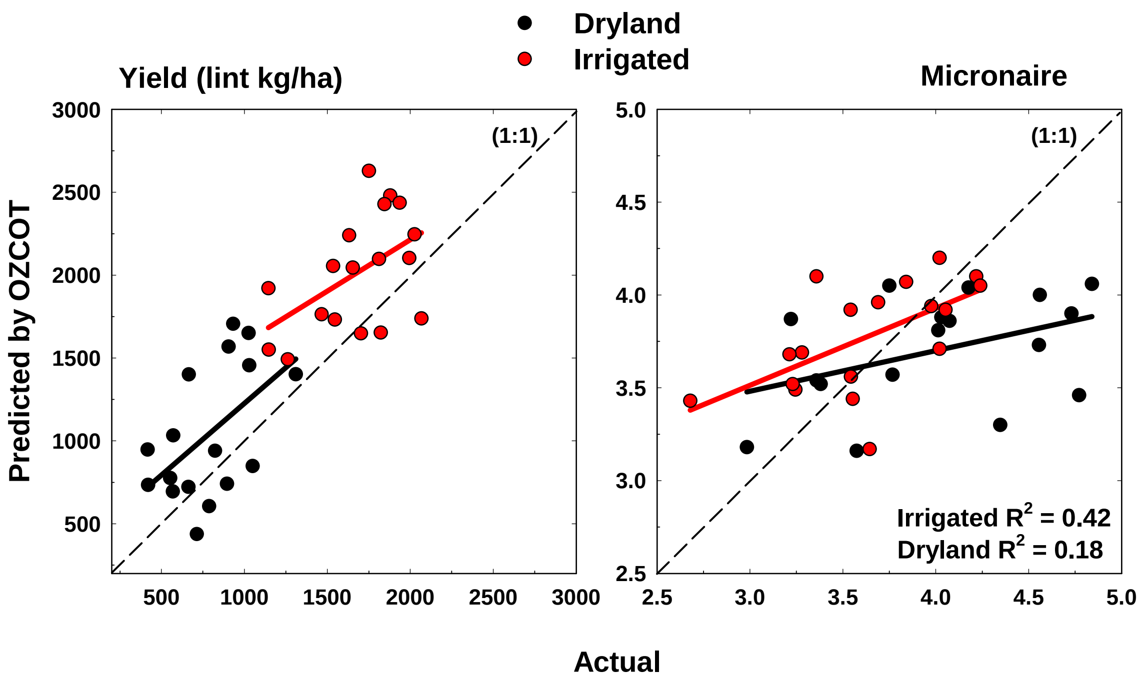

Figure 23. Response of predicted values of yield, fibre length, and micronaire estimated by OZCOT versus actual measured values highlighting irrigated and dryland datasets.

Strengthen agronomic research to meet the needs of the 'Fibre to Fabric' initiative.

This project supported field experimentation of the 'Linking farming systems with textile performance' project. This 'linking farming systems project is aimed at strengthening cotton research efforts to understand the links between breeding, agronomic management and post harvest fibre quality, and to extend this knowledge to industry in order to improve the quality of Australian cotton. This research is conducted in collaboration with Dr Robert Long and Dr Stuart Gordon of CSIRO.

Information on fibre quality and processing performance is vital to breeders and agronomists so that they can determine which varieties and farm practices are most beneficial in producing a quality product. Information on the textile performance of new varieties can be used strategically in marketing. An additional scientific benefit is the development of consistent textile test protocols and a significant database that can be used to test new varieties and crop management strategies. The project will further support the use of other fibre quality parameters important in predicting or elevating textile performance, e.g. fineness, maturity, inter-fibre friction, fibre elongation, and cellulose and wax chemical properties that affect dyeing and chemical processing of fibre.

During the course of this project we assisted in the conduct of two large scale experiments over two seasons that compared the performance of new elite cotton breeding lines with existing varieties to highlight improved fibre quality for cotton processing. The experiments were conducted at the Australian Cotton Research Institute in Narrabri. Five varieties (including a Pima variety) were sown in the first experiment, and six (including a Pima variety) were sown in the following year. The varieties were grown in large plots at the same time and with full irrigation, and pests were managed using requirements for the conventional varieties. Cotton was machine harvested with a single row spindle harvester. Upland varieties were saw ginned at Cotton Seed Distributors (CSD) in Wee Waa.

As expected results showed that yields varied between the varieties (Figure 24). In the first year CHQX12B yielded the highest followed by Sicot 71BR. In the second year Sicot 71BR was the highest yielding variety. In terms of fibre length only Sicot 71BR fell below the spinners preferred values in the second season. There were instances where short fibre index exceeded spinners preferred value: Sicala 350B and CHQX377 in season 1 and Sicot 71BR, CHQX12B and CHQX90 in season 2. Only CHQX90 in season 2 fell within the preferred range for micronaire, while fibre strength was exceeded for all varieties in both seasons (Table 2). It must be recognised that each variety was not managed separately so this may have influenced the final results.

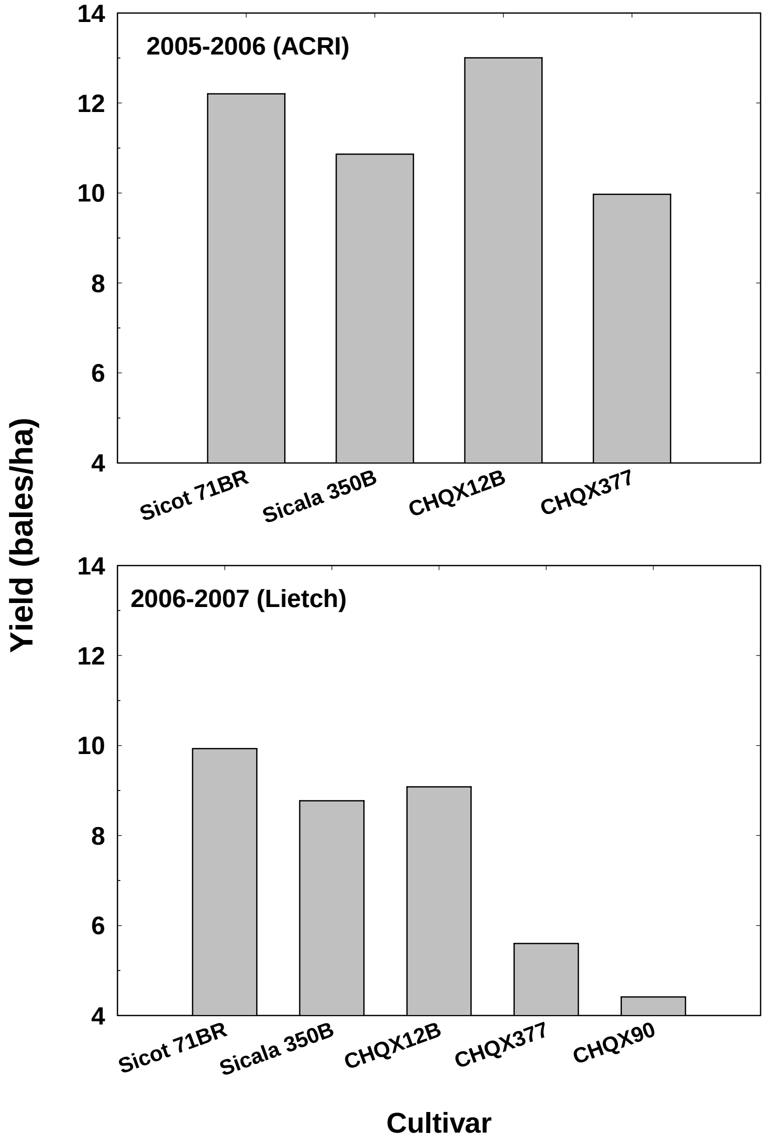

Figure 24: Yields of varieties grown in large scale plots for the 'Linking farming systems with textile performance' project.

Table 2: Fibre quality (measured with HVI) of varieties grown in large scale plots for the 'Linking farming systems with textile performance' project.

High Volume Instrument fibre bundle quality parameters

2005-2006

Variety	Length (inch)	se	Uniformity index (%)	se	Short fibre index (%)	se	Strength (g/tex)	se	Elongation (%)	se	Micronaire (ug/inch)	se
Sicot 71BR	1.16	0.03	83.1	0.05	8.9	0.75	29.8	0.65	6.1	0.25	4.50	0.10
Sicala 350B	1.28	0.03	84.8	1.60	7.6	0.85	31.5	1.35	5.5	0.00	4.25	0.05
CHQX12B	1.26	0.01	84.1	0.05	8.2	0.05	32.0	0.95	4.1	0.15	4.35	0.05
CHQX377	1.22	0.01	85.5	0.25	7.1	0.50	34.0	0.90	5.3	0.05	4.35	0.05

Mean and standard error

2006-2007

Variety	Length (inch)	se	Uniformity index (%)	se	Short fibre index (%)	se	Strength (g/tex)	se	Elongation (%)	se	Micronaire (ug/inch)	se
Sicot 71BR	1.11	0.01	82.75	0.66	9.68	0.58	30.38	0.44	7.55	0.10	4.90	0.08
Sicala 350B	1.28	0.02	85.65	0.47	7.03	0.34	33.95	0.21	5.45	0.06	4.45	0.05
CHQX12B	1.23	0.01	84.20	0.55	8.58	0.37	33.18	0.21	5.25	0.09	4.70	0.06
CHQX377	1.24	0.02	85.50	0.46	6.70	0.44	35.35	0.48	5.65	0.13	4.35	0.06
CHQX90	1.22	0.01	82.80	0.65	8.73	0.69	33.58	1.06	7.35	0.10	3.98	0.09

Mean and standard error

Spinner's preferrred value	>1.13	>81	<8	>29		3.8-4.2

The testing of yarn and fabric from these experiments is still on-going to test the yarn and textile performance attributes of these varieties. Preliminary results were reported on a Cottongrower article: Long, R., Bange, M., Gordon, S., Van der Sluijs, M., and Constable, G. (2007). Linking farming systems to quality and textile performance. The Australian Cottongrower 28(1). pp.28-30.

The 'Linking farming systems to quality and textile performance' project is also exploring other avenues to link farm management practices with fibre quality and textile performance. For example, we are currently processing yarn and fabric from lint harvested from field experiments examining defoliation timing treatments. This work will help to address the issues relating to the effects of immature cotton on yarn and textile quality, such as neps and associated white spec in fabric.

Conclusion

Research on crop management can be applied to optimise fibre quality. This project was successful in providing important technical and operating resources for research and extension into cotton fibre quality in-field management issues through:

- Demonstrating that modifying sowing date for Bollgard II can offer a 'systems solution' to provide benefits in terms of maintaining yield and improving fibre quality.
- Demonstrating that manipulation of plant population in both conventional and Bollgard II systems does not lead to improvements in both yield and quality.
- Providing further knowledge of the interactions of Bollgard II and row configurations in dryland cotton systems and their impacts on both yield and quality. A spreadsheet was developed that compared the yield, quality and cost associated with different row configurations and is being used by CSD for their dryland workshops.

- Developing a functional relationship between temperature and fibre micronaire which was used to improve the fibre quality predictive capability of OZCOT.
- Collecting data that will help to understand the impact of cloudy conditions and variations in temperature on fibre micronaire.
- Supporting the 'Linking farming systems with textile performance' project.
- Raising the awareness of the effects of climate and management on fibre quality through the fibre to fabric road show and Geelong course, FIBREpak introduction, and various other industry forums.

An example of the impact that research and extension can have on realised fibre quality can be demonstrated in the ACSA data for fibre length. Despite warmer seasons and higher adoption of Sicot 71 types (with shorter fibre than most varieties), the industry has delivered a greater proportion of cotton in the desirable length category (Figure 25). This result can be attributed to increased promotion and adoption of management for fibre length, for example by CSD with support and material provided by CSIRO.

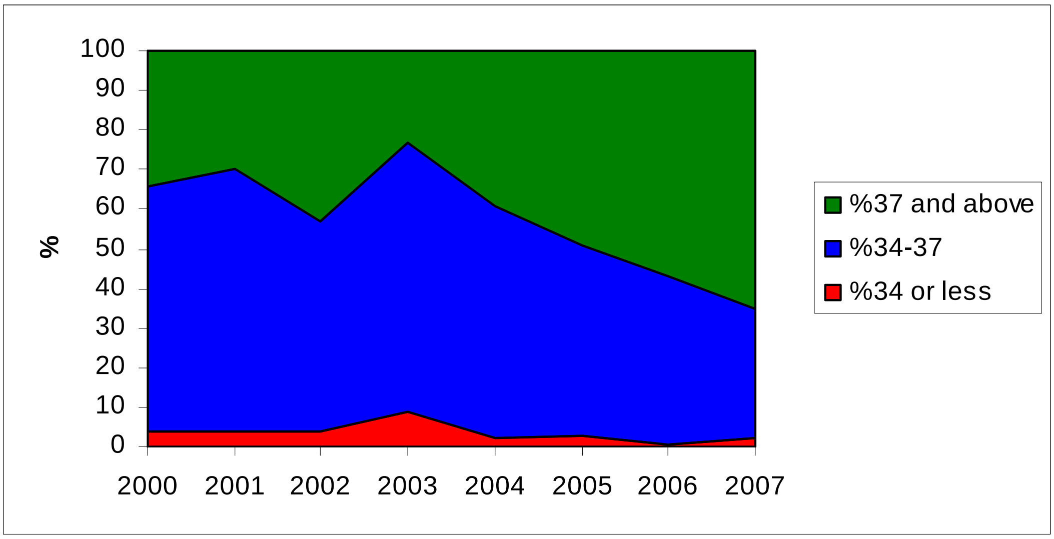

Figure 25. The proportion of Australian cotton in different fibre length categories in the past eight years. Data from www.acsa.com.au

Ongoing on-farm research into fibre quality has been supported through the ongoing project 'Linking farming systems with textile performance' supported by CSIRO, the Cotton CRC and CRDC. Along with new on-farm research, Michael Bange, Greg Constable and Jane Caton will continue to support the provision of new initiatives and resources for the post harvest research component of this project.

The on-farm component of this research will:

i) Derive a better understanding of the effects of crop management and climate on micronaire. Field experiments in a number of regions will quantify the interaction of management practices that affect micronaire (region x variety x sowing time x plant size x boll load) (60% research effort).

ii) Identify if environmental effects influence fibre fineness (5%).

iii) Validate crop management guidelines for neps reduction (20%) through on-farm experiments.

iv) Extend research findings through involvement in fibre to fabric and BMP initiatives and contribute to the fibre simulation capabilities of the OZCOT crop simulation model (15%).

This project was a main source of technical support and operating funds for Dr Michael Bange who also had significant responsibilities for supervision of Cotton Decision Support initiatives. Dr Bange maintained a research portfolio in crop physiology, agronomy and farming systems across the industry during the course of this project.

Publication List

Journal Articles

1. Bange, M.P. Milroy, S.P. and Caton,S.J. (2007). Managing high fruit retention in transgenic cotton (*Gossypium hirsutum* L.) using sowing date. Field Crops Research Submitted.

Refereed Conference Papers

2. Bange, M.P. Roche, R. and Caton, S.J. (2006). Impact of row configuration on high fruit retention (transgenic) rain-fed cotton systems. Proceedings of the 13th Australian Agronomy Conference, 10-14 September 2006, Perth, Western Australia.
3. Constable, G.C. and Bange, M.P. (2007). Producing and preserving fiber quality: from the seed to the bale. In Proc. 4th World Cotton Conf. Lubbock USA.

Conference Papers

4. Bange, M.P. and Constable, G.A. (2006). Crop Physiology – Producing a Better Fibre. In Proc. 13th Aust. Cotton Conf. 7-10 August, Gold Coast Aust. The Aust. Cotton Growers Research Organisation.
5. Bange, M.P. and Roche, R. (2006). Cotton Crop Management for Better Fibre Quality in Dryland Situations. In Proc. 13th Aust. Cotton Conf. 7-10 August, Gold Coast Aust. The Aust. Cotton Growers Research Organisation.
6. Bange, M.P., Milroy, S.P., and Roberts, G.N. (2006). Factors influencing crop maturity. In Proceedings Beltwide Cotton Conference 2-5 January, San Antonio, Texas.
7. Bange, M.P., Brown, E. Caton, J. and Roche, R. (2004). Sowing time, variety and temperature effects on crop growth and development in the Hillston region. In Proc. 12th Aust. Cotton Conf. 10-12 August, Gold Coast Aust. The Aust. Cotton Growers Research Organisation, pp. 441-447.
8. Gordon, S., Long, R., Bange, M.P., Lucas, S. and Phair-Sorensen, N. (2007). Measurement of average maturity and maturity distribution statistics by Siromat in cotton fibre picked from plants subjected to defoliation timing treatments. In Proceedings Beltwide Cotton Conference January, New Orleans.
9. Roberts, G.N., Constable, G., Bange, M.P. and Felton-Taylor, C. (2004). Farming for fibre quality – smart decisions. In Proc. 12th Aust. Cotton Conf. 10-12 August, Gold Coast Aust. The Aust. Cotton Growers Research Organisation, pp. 175-182.

Grower Magazine Articles

11. Bange, M.P. (2007). Effects of climate change on cotton growth and development. The Australian Cottongrower. 28(3). pp.41-45.
12. Bange, M., Milroy, S., and Roberts, G. (2006). Managing for crop maturity. The Australian Cottongrower. 27(7). pp. 53-56.
13. Kelly, D., Bange, M.P., and Constable, G.A. (2006). Micronaire and heat in 2005-06. The Australian Cottongrower. 27(4). pp. 8-12.
14. Long, R., Bange, M., Gordon, S., Van der Sluijs, M., and Constable , G. (2007). Linking farming systems to quality and textile performance. The Australian Cottongrower 28(1). pp.28-30.
15. Richards, D.Q., and Bange, M.P. (2005). Warm and dry: a perfect recipe for high (irrigated) cotton yields. The Australian Cottongrower 26(3) pp.12-15.
16. Richards, D.Q., and Bange, M.P. (2006). 2005-06 seasonal climate review. 27(3) The Australian Cottongrower pp. 8-15.
17. Richards, D.Q., Bange, M.P., Linsley, D. and Johnston, S. (2004). Challenging weather conditions during the 2003-4 cotton season. The Australian Cottongrower 25(3) pp.54-56.
18. Richards, D.Q., Bange, M.P., Linsley, D. and Johnston, S. (2007). 2006-2007 seasonal climate analysis. The Australian Cottongrower 28(3) pp.12-16.

Others

19. Bange, M.P. (2006). The potential for dryland cotton with Bollgard II® under various row configurations on the southern Liverpool Plains. In Proceedings of the GRDC Adviser Update Seminar. Qurindi NSW. Grains Research and Development.
20. Bange, M.P. (2006). The potential for dryland cotton with Bollgard II® under various row configurations on the Liverpool Plains. Upper Namoi trial book.

Extension Activities

- 18 Conf. papers (Aust Cot Conf, Aust. Agronomy, Beltwide)
- 16 Cottongrower Articles
- 12 field day and trial book articles
- 6 cotton field days
- Field Quality Roadshow (2 yrs) – 19 presentations
- Fibre to Fabric Course (Geelong) – 5 times
- 2 cotton conference presentations
- Various CSD publications (3Web on Wednesday's)
- Facilitated FIBREpak introduction release at cotton conference 2004.
- 2 presentations at CSD/CSIRO forums.

Final Report Executive Summary

Cotton Crop Management for Improved Fibre Quality

Principal Researchers M.P. Bange and G.A. Constable (Researchers)/J. Caton (Technical Officer)
Supervisor G.A. Constable

Australian cotton fibre is exported into a dynamic and competitive market and we need to ensure an ever-improving product to meet the demand from spinners. This pressure has led to fibre quality becoming just as an important factor as cotton yield for maintaining industry viability. Crop agronomy practices such as choice of variety, nutrition management, irrigation management, disease insect and weed management can significantly affect fibre quality. In addition, seasonal or environmental factors out of the control of the growers can also contribute to reductions in quality.

CSIRO Plant Industry has fibre quality as one of our major focus subjects for plant breeding and agronomic management. This project aimed at strengthening/enhancing the cotton research efforts in delivering initiatives that focus on management aspects of fibre quality (other than breeding and processing). This project aimed to fill a gap that exists in developing management strategies in the field that optimise cotton fibre properties. The specific aims are:

1. Targeted research to improve the understanding of the effects of different climate, plant and management factors on fibre properties.
2. Utilise agronomy and physiology research tools such as OZCOT simulation to develop guidelines to assist in the management of cotton to optimise yield and fibre quality.
3. Strengthen agronomic research to meet the needs of the 'Fibre to Fabric' initiative.

This project was successful in providing important technical and operating resources for research and extension into cotton fibre quality in-field management issues through:

- Demonstrating that modifying sowing date for Bollgard II can offer a 'systems solution' to provide benefits in terms of maintaining yield and improving fibre quality.
- Demonstrating that manipulation of plant population in both conventional and Bollgard II systems does not lead to improvements in both yield and quality.
- Providing further knowledge of the interactions of Bollgard II and row configurations in dryland cotton systems and their impacts on both yield and quality. A spreadsheet was developed that compared the yield, quality and cost associated with different row configurations and is being used by CSD for their dryland workshops.
- Developing a functional relationship between temperature and fibre micronaire which was used to improve the fibre quality predictive capability of OZCOT.
- Collecting data that will help to understand the impact of cloudy conditions and variations in temperature on fibre micronaire.
- Supporting the 'Linking farming systems with textile performance' project.
- Raising the awareness of the effects of climate and management on fibre quality through the fibre to fabric road show and Geelong course, FIBREpak introduction, and various other industry forums.

Ongoing on-farm research into fibre quality has been supported through the project 'Linking farming systems with textile performance' supported by CSIRO, the Cotton CRC and CRDC. Along with new on-farm research, Michael Bange, Greg Constable and Jane Caton will continue to support the provision of new initiatives and resources for the post harvest research component of this project.

This project was a main source of technical support and operating funds for Dr Michael Bange who also had significant responsibilities for supervision of Cotton Decision Support initiatives. Dr Bange maintained a research portfolio in crop physiology, agronomy and farming systems across the industry during the course of this project.