Final Reports

Part 1 - Summary Details

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

CRDC Project Number: **CSP176**

Project Title: **Plant Breeding Fibre Quality Laboratory**

Project Commencement Date: 1/7/05 **Project Completion Date:** 30/6/06

Research Program: On Farm

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Part 3 – Final Reports

Background

Fibre quality has always been an important component of Australia's cotton. In the mid 1980's a conscious decision was made by the industry to raise the level of fibre quality to ensure ready demand on the export market from spinners. At that time, some varieties were withdrawn from use because of their reduced fibre length and strength. Since that time, CSIRO's fibre quality selection pressure has gradually increased fibre properties of breeding material and varieties. We made rapid increase in fibre length up to 1990 and continued increase in fibre strength to the present time, both through conventional plant breeding and with a dedicated HVI line to apply selection pressure to segregating populations.

Although it is difficult to estimate the financial benefit of those changes, there is no doubt that better fibre has been a key factor in the success of cotton over the past 20 years; Australia has been able to enter higher quality markets at better prices. The report 12 months ago on this project highlighted in some detail the fibre quality research imperative. It is not necessary to repeat that background at this time for a one year project.

Objectives

This project funded casual labour and the maintenance on a semi automatic HVI 900, a Shirley FMT3 and associated air conditioning equipment at Narrabri. The major **objectives** were providing fibre quality measurements for the CSIRO breeding program and other research projects at ACRI and the Cotton CRC. For 2005/06 one-year project:

a. Screen early generation breeding material for length, uniformity, extension, strength and micronaire by HVI.
b. Screen promising breeding lines for the above plus fibre fineness and maturity by FMT (or similar).
c. Provide HVI testing for other research projects.

These objectives have been met each year as specified in section 4. We have averaged 20,000 HVI samples and 10,000 FMT samples each season, with measurements done in two shifts per day during the harvest period. Small numbers of samples from Canberra and Katherine - Kununurra are processed throughout the year. CRDC funds supported casual staff (sometimes on after hours shifts) and maintenance of air-conditioning, HVI and FMT instruments. The Shirley FMT3 is relatively old and requires constant maintenance. A new HVI was installed for 2004/05.

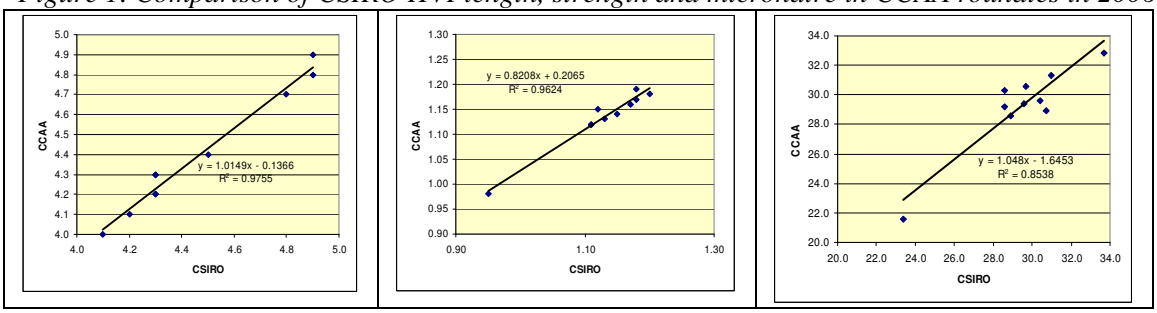
Methodology

CSIRO breeders and other researchers and extension personnel undertake field experiments each year. In most cases it is important to have fibre quality data as well as other results on growth and yield. Given the increasing importance of good fibre quality to ensure our export quality is improving, we need to understand and optimise fibre quality in crops.

Experiments in most cases are replicated. It is equally important to replicate fibre quality samples because of variation within samples and plots as well as the instruments. Early generation breeding material cannot be replicated in field plots, so large numbers of samples are taken. Duplicate HVI samples are done on these to eliminate equipment variability.

Overall, coefficients of variation for fibre quality measurements are much less (and so more reliable) than yield measurements. CSIRO participates in the CCAA roundtests and our results are very good (Figure 1).

Figure 1. Comparison of CSIRO HVI length, strength and micronaire in CCAA roundtes in 2006t.



Results

Experiments have been done at Emerald, St George, Darling Downs, Boggabilla, Moree, Tullona, Myall Vale, Merah North, Breeza, Bourke and Hillston. All sites were sown and harvested with CSIRO's mobile equipment; and sites other than Boggabilla, Moree and Darling Downs were ginned on 10 to 20 saw gins at ACRI; and fibre tested on HVI and FMT at ACRI (or from Fusarium sites, ginned in Toowoomba and fibre tested in Moree).

CSIRO breeder's experiments include a number of control varieties. Of interest in examining trends with season and for more valid comparisons with new varieties, DP16 and Namcala, commercial varieties from the 1980s, are included. Overall, the conclusion has been there is substantially more variation between sites and seasons than there is between varieties – especially for micronaire. The 2005/06 season established a new record for high micronaire in Namcala/DP16 (Figure 3), highlighting the impact warm, sunny seasons and 2006 management have on micronaire.

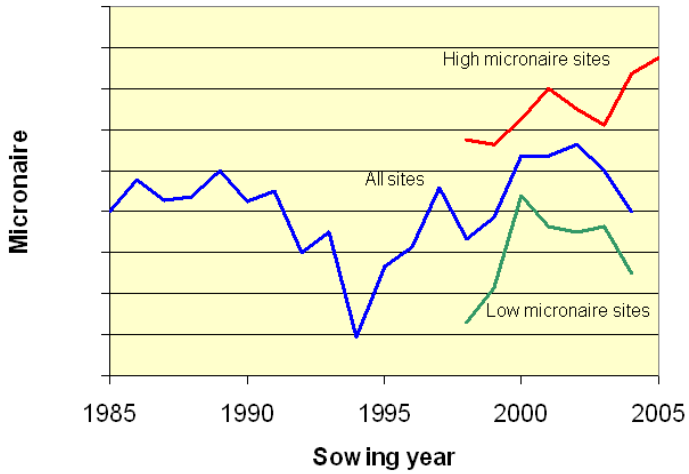


Figure 3: *Trends in measured HVI micronaire of the control varieties DP16 and Namcala in the last 20 cotton seasons to 2004-05 and Emerald data from 2005/06. Mean of up to 13 sites each season including Emerald, Biloela, Theodore, Brookstead, Boggabilla, St George, Collarenabri, Moree, Bourke, Merah North, Myall Vale, Breeza, Warren and Hillston. Graph prepared by the CSIRO Cotton breeding team.*

By far the most important use of a HVI in our breeding program is to use for selecting for improved fibre properties in segregating populations. Even at the early (single plant) stages of our program, heavy selection pressure is applied to lines and they are deleted if their fibre length, strength, uniformity, micronaire and fibre maturity are outside of chosen criteria. We aim for length >1.17 inch; strength >30 g/tex; 3.5< micronaire <4.6. It should be emphasised all these criteria have to be met for a line to be retained (ie a long but weak fibred line is rejected). We know from the literature and our own research that many of the fibre properties have high

heritability, so selection pressure on segregating populations changes the fibre properties in subsequent generations of a population.
Table 3 shows data from 2005/06 from two sites to illustrate the type of new material in the breeding program addressing the target of improved fibre properties. This data shows a number of lines with excellent combinations of length, uniformity and strength. It is important to note the absolute values in this table: yields near 6 b/ac with fibre greatly improved over Sicot 71. In addition, a number of lines are near 40/32 length, 34 g/tex strength and medium micronaire – an excellent combination substantially better than Californian Acala fibre properties - deserving a price premium.

Table 3. Yield (kg lint/ha) and HVI fibre properties of new conventional breeding lines grown at Emerald and Myall Vale in 2005/06.

Entry	Yld	RY	LEN	STR	MIC
62213-89	2732	110	1.22	31.9	4.6
20019-100	2713	109	1.23	32.2	4.6
62213-285	2614	105	1.22	32.3	4.5
62213-55	2603	105	1.24	32.6	4.4
62222-503	2581	104	1.25	32.5	4.4
61211-292	2570	103	1.22	32.4	4.5
20019-317	2565	103	1.22	32.3	4.5
62222-94	2525	102	1.22	31.6	4.2
20019-169	2509	101	1.20	32.9	4.3
62213-303	2509	101	1.21	31.7	4.5
Sicot 71	2487	100	1.16	31.6	4.6
62213-282	2486	100	1.24	34.0	4.3
61211-55	2454	99	1.25	33.0	4.7
62222-572	2338	94	1.29	30.9	4.6
61211-140	2303	93	1.23	34.6	4.3
61211-61	2257	91	1.28	32.8	4.5
62219-53	2207	89	1.27	33.2	4.4
61211-350	2174	87	1.27	32.3	4.5
20019-189	2173	87	1.26	32.5	4.7
61211-216	2117	85	1.29	33.5	4.5

One factor limiting rapid progress in variety development to address fibre quality targets is strong negative correlations between yield and some fibre properties. These most significant correlations in CSIRO germplasm are with fibre length, length uniformity and fineness. Thus aggressive selection for these properties alone would produce varieties with lower yield. The resources required for large population sizes needed to identify lines which combine desirable yield, quality and disease resistance are the biggest constraint for genuine progress with developing premium fibre variety types.

Fibre quality results from other research projects should be reported in each project's report.

Conclusions

We conclude it is possible to further increase fibre properties of Australian cotton varieties. A number of candidate lines have been identified to provide high yielding but better fibre than current varieties and also premium fibre for specialist markets (eg to compete with Californian Acala). Large population sizes are required in breeding to ensure the best combinations of yield,

fibre quality and disease resistance can be identified. The casual labour and operating resources required to support the large populations are a constraint.

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

CSIRO breeding targets have addressed all of these outputs for many years. Economic benefit to growers and industry is through increased yield and fibre properties – a CIE report in 2002 calculated that CSIRO's cotton breeding program has added $4.9b in net present value to Australia's cotton industry. That spin-off is direct to regional economies. Our record on environmental issues is also long: through Host Plant Resistance traits initially, and in more recent times with Bollgard®II, substantial reductions in reliance on synthetic pesticides has benefited the environment and production system sustainability. All of those targets are being maintained, including increased attention to a premium fibre target to maintain competitiveness on the international market.

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

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

This project has supported the fibre testing component of the CSIRO breeding program as well as other research projects. For breeding we continue to provide varieties rapidly adopted by Australian cotton growers and that work continues. New varieties are protected by Plant Breeders Rights by CSIRO when appropriate. Fibre properties are often distinguishing characters for new varieties.

One interesting development is the last year has been evaluation of a high fibre quality Bollgard®II variety, Sicala 350B. Although lower yielding than other varieties, it has attracted a premium from spinners wanting a long fibred upland variety. Test marketing and spinning continued in 2005/06. We now have new lines superior in yield and quality to Sicala 350B (Table 4).

Table 4. Yield and fibre properties of someBollgard II breeding lines. Mean of two irrigated sites in 2005/06.

	Yield	RY	len	uni	sfi	str	el	mic	pm	fin
62404-103B	2756	105.4	1.19	81.7	10.9	30.8	3.9	4.4	82	183
62401-99B	2741	104.8	1.19	82.3	10.1	31.9	3.6	4.4	83	177
62404-110B	2669	102.0	1.20	82.5	9.9	30.4	3.8	4.6	83	194
62404-28B	2642	101.0	1.23	81.9	10.1	31.8	4.4	4.4	82	181
Sicot 71B	2615	100.0	1.21	82.3	9.8	30.4	3.7	4.3	83	172
62401-24B	2597	99.3	1.22	82.0	10.4	32.1	4.1	4.1	82	167
62401-2B	2527	96.6	1.26	82.5	9.6	32.4	3.1	4.4	80	185

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

Methodology has been refined in combining fibre properties of interest – mainly through large segregating populations to ensure the best combinations of quality, yield and disease resistance are identified.

c) are changes to the Intellectual Property register required? No.

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

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

Continued crossing, selection and testing of breeding material to provide future options for variety fibre types in CSIRO germplasm. New varieties will be released as their performance dictates.

(b) for the future presentation and dissemination of the project outcomes.

We will continue to present data from our breeding at all available venues and techniques.

(c) for future research.

We continually examine possibilities for smarter breeding with markers and microarray techniques. Discussions are held with our Canberra biotechnology colleagues on a regular basis.

Publications

Fibre quality results from other research projects should be reported in each project's report.

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

No

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

Economic benefit to growers and industry is through increased yield and fibre properties – a CIE report in 2002 calculated that CSIRO's cotton breeding program has added $4.9b in net present value to Australia's cotton industry.

Our breeding has always kept an active selection on fibre quality traits while breeding for pest and disease resistance and we have a high reputation internationally for fibre quality. It is difficult to put a dollar value on quality as there are few premiums paid for good quality, but many penalties (discounts) for poorer quality. In the past five years, 5% of the Australian cotton crop has been discounted for short fibre, 9% for low strength; 7% for high micronaire and 2% for low micronaire. This annual total cost (loss) to growers of these discounts is up to $21m, but the real value of breeding for fibre is maintaining market demand and possibly also adding some premium fibre types to our export portfolio. If 10% of our cotton was a premium type attracting a 15% price premium, the annual additional benefit could be $18m. Unfortunately, buyers of cotton are always raising the bar for what is acceptable in terms of quality parameters. Maintaining high quality, or preferably raising quality is therefore essential for us to keep our markets in the face of increasing competition and preferably to provide us with an edge in marketing.

Part 4 – Final Report Executive Summary

This project has part funded maintenance of HVI900 and FMT3 cotton fibre testing instruments in CSIRO's fibre testing laboratory at ACRI for the 2005/06 season. The laboratory supports measurements of fibre quality from cotton experiments in CSIRO's breeding program and research projects by other organisations and projects.

More than 20,000 samples were tested by HVI and 10,000 samples by FMT.

Global cotton production and market dynamics indicate Australia needs a future edge with fibre quality to ensure buyers will want our cotton in preference to our competitors. This means developing varieties, management and processing to ensure we deliver better fibre. There may be opportunities for premium fibre products in future. Thus the CSIRO cotton breeding program raised the emphasis on developing improved fibre varieties to address these needs.

Negative associations between yield and fibre quality present challenges for variety development. We have accurately measured these associations and developed breeding population sizes to ensure the rare combinations of high yield and quality can be identified. Accurate measurement of fibre quality is an important component of that work.

A number of new breeding lines have been developed to address the objective of improved fibre quality and at high yield levels. In addition there are lines with excellent fibre properties to potentially target speciality (premium) markets. These lines are under further evaluation and are also used in developing speciality Bollgard®II varieties. Sicala 350B, released in 2005, has very long fibre and is attracting interest in the market. We have identifies possible superior lines of this type.