

Quality Issues for Australian Cotton from the Mill Perspective

Acknowledgements

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GLOSSARY OF TERMS

Bale – 227 kg of pressed and bound cotton fibre

Bale Lay-Down – Cotton bales set in a row for the start of mill processing. The start of mill processing is called ‘opening’.

Carded Yarn – Yarn spun from carded and drawn sliver. Carding and drawing are steps in the mill used to clean and parallelise fibre in preparation for yarn production. Carded yarn is less expensive than ‘combed’ yarn but is inferior in terms of yarn quality because short fibres and neps are still present.

Colour – Colour is a primary indicator of grade. Discolouration is due to range of influences including trash and dust content, rain damage, insect secretions, UV radiation, heat and microbial decay. Colour in cotton is defined in terms of its reflectance (Rd) and yellowness (+b), which are measured by a photoelectric cell.

Combed Yarn – Sliver from the card is combed to remove short fibre and nep and to make fibres parallel to the sliver axis. Combed sliver translates into more uniform and stronger yarn.

Contamination – The International Textile Manufacturers Federation (ITMF) identifies 18 sources of contamination in its bi-annual survey of spinning mills [20].

Cotton wax – Exists as a layer on the cotton fibre surface and is composed of natural waxes, fats and pectins [16]. The wax layer is a water resistant coating that protects and lubricates the fibre during mechanical processing.

Dyeing Ability – A qualitative description to describe how evenly or unevenly a cotton dye is taken up by yarn or fabric.

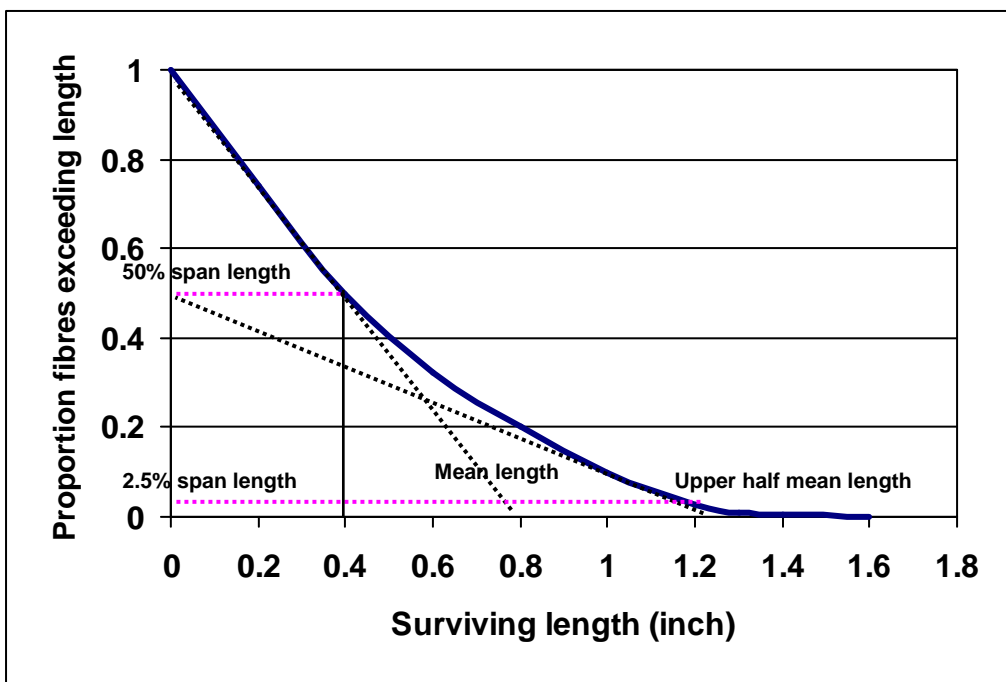
Extension – Also called elongation, this value is the percent extension (elongation) of a fibre bundle before it breaks.

Fineness – Cotton fineness is described in terms of linear density or weight per unit length of fibre, the unit for which is usually milligrams per kilometre (mtex).

Ginning – The separation of fibre (lint) from cotton seed.

Grade – Historically grade is a subjective interpretation of fibre colour, preparation and trash content against ‘official’ standards.

Length Uniformity (UNI) – This measurement is expressed either as the uniformity index or uniformity ratio. Both terms are ratios of measurements from the fibrogram, where uniformity index refers to the ratio between the mean length and the upper half-mean length and the uniformity ratio refers to the ratio of the 50% span length to the 2.5% span length (Figure A).



Figure

A – Fibrogram showing length measurements

Maturity – The cotton fibre is single elongated plant cell and maturity refers to its degree of cell wall thickening.

Micronaire (MIC) – Airflow measurement based on the pressure difference obtained when air is passed through an accurately weighed plug of cotton fibres. Originally calibrated to give fineness (in micrograms per inch) the method actually measures specific surface area (surface area per unit mass) and therefore reflects a combination of the sample’s fineness and maturity.

Nep (NEP) – Neps are fibre entanglements that have a hard central knot or nucleus that is detectable. There are a variety of test instruments and methods to measure nep content although the Uster Advanced Fiber Information System (AFIS) nep module has the status of being the only method with a recognised standard procedure.

Short Fibre Content (SFC) – The most common definition of SFC is the proportion by mass of fibre shorter than one half inch. Short fibre content is not measured directly by any instrument employed in high volume instrument (HVI) lines. Instead SFC or short fibre index (SFI) is estimated indirectly using the 2.5% span length and 50% span length or the 2.5% and uniformity index (Figure A) as the main variables in prediction equations.

Spinning Ability – There is a wide range of indices used to measure spinning ability. The most commonly applied index is the number of (yarn) ends down per thousand spindle hours.

Staple Length – This measurement is usually based on a photoelectric scan of fibres protruding from a 'Fibrosampler' comb. The fibres protruding from a comb make up the figrogram from which the upper half-mean length or 2.5% span length are measured (Figure A). Both of these measures correspond closely with the physical classer's staple or modal length of the sample.

Stickiness – A reference to when cotton is made sticky from cotton plant and/or insect exudates. Sticky cotton does not process well especially through the card and drawframe. Stickiness can be objectively measured although none of the current methods determines the source of the sticky exudate. Exudate from insects such as whitefly and aphids is the cause of most 'stickiness' problems in mills.

Strength (STR) – The strength of cotton fibres is usually defined as the breaking force required for a bundle of fibres of a given weight; the test value being a measure of breaking stress or tenacity, expressed in terms of grams per tex (g/tex).

Trash – Any material other than cotton fibre in a sample is referred to as trash or non-lint content. Trash in cotton usually consists of leaf and other parts of the cotton plant. Trash can be measured in number of ways although the most common method, in HVI testing, involves measuring the area of trash (leaf) in a compressed bale sample image using image analysis software.

Yarn Count (Ne) – Yarn count is a measure of yarn linear density or mass per unit length. Cotton spinners use English cotton count system or Ne to measure yarn linear density. Ne is equivalent to the number of 840 yard lengths (wraps) in one pound of yarn. The metric unit grams per kilometre (or tex) is obtained by dividing 590.5 by the Ne yarn count.

EXECUTIVE SUMMARY

The increased success of Australia's cotton in the Asian market has increased the focus on its quality. If Australia is to maintain and grow its quality customer base it will need to extend the description of its product beyond the current USDA classing and shipper type models and define the fibre more in terms of Australia's customers needs. In order to understand the current needs of its customers, the Australian Cotton Industry through the CSIRO Textile and Fibre Technology Division (CTFT) and with the support of the Australian Cotton Co-operative Research Centre (CRC) and the Australian Cotton Shippers Association (ACSA) conducted a survey during 2002 and 2003 to determine how customers of Australian cotton, i.e. spinning mills, perceived the quality of Australian cotton fibre.

The broad aims of the survey described in this report were to:

1. Understand quality issues related to the use of Australian cotton from the spinners perspective.
2. Identify fibre quality problems and other textile processing problems associated with Australian cotton.
3. Prioritise research and development to address textile processing related problems in Australian cotton in order to improve its export potential.

UNDERSTANDING QUALITY ISSUES

Over thirty spinning companies that purchase Australian cotton were interviewed in regard to its quality in yarn production. A survey-interview approach, which entails person-to-person interviews conducted around a set of scripted questions, was used to ensure a high and consistent response. Spinning companies from Japan, South Korea, Thailand and Indonesia were surveyed as well as four companies in Australia. The survey consisted of a series of background questions about each spinning company's production, raw fibre use and spinning facilities followed by a series of more open-end questions about the quality of Australian cotton fibre. Information gathered during the survey interviews was enhanced by objective measurement of fibre samples gathered from bale lay-downs in mills of more than half the spinning companies surveyed.

Despite the range of spinning systems and yarns produced in the spinning companies surveyed, the average impression of Australian cotton fibre properties was quite consistent. All countries rated neps and Micronaire, along

with short fibre content as properties that needed improvement. The low level of contamination, colour, grade, spinning ability and staple length of Australian cotton created the best impressions.

Whilst it is difficult to be accurate about the exact proportion of Australian cotton that meets preferred specifications, from the bale lay-down test results it can be said that in general less than a third of Australia's cotton in 2003 met spinner's preferences with regards to Micronaire and nep values, and less than 20% met spinner's preferences with regards to short fibre content. Australian cotton was better in regard to strength, length and uniformity.

IDENTIFYING QUALITY ISSUES

Even though the fibre length and strength of Australian cotton has improved markedly over the last 30 years, coarse fibre (high Micronaire) and high nep and SFC have the potential to keep Australian fibre out of quality markets.

The issue associated with Micronaire is really based around the question of whether the fibre is fine and mature, or coarser and immature. Micronaire is a measure of specific surface area and maturity and fineness together define this property. Ideally, most mills would prefer to buy the fibre that is fine and mature. This combination reduces the propensity of fibre to nep and break (creation of high SFC) during mechanical processing (especially lint cleaning) and ensures good spinning stability and quality of fine count yarns. It also ensures that a good lustrous appearance is achieved once the yarn and fabric is dyed.

It might have been expected that the high Micronaire (coarseness) of the last two to three years might have mitigated the effects of mechanical cleaning, i.e. reduced nep and SFC, but the survey showed these properties have remained unfortunate characteristics of Australian cotton. Part of the problem appears to be the traditional way that cotton is 'classified' according to established standard grades, which often forces ginners to over clean fibre (in the gin) to gain a higher price for the grower's cotton. Whilst grade, trash and colour rated highly with spinning companies the consequent effects, i.e. the high nep and SF contents, of processing the cotton to obtain these grades did not.

PRIORITISING RESEARCH AND DEVELOPMENT

To conclude the report, the authors have proposed R&D activities that address the quality issues raised from the survey. The central focus of these activities should be the production (and measurement) of fine and mature fibre, from

varietal selection to understanding the ripening of the boll to measuring fineness and maturity quickly and accurately for the market. Focus should also be given to improving mechanical processes, especially ginning such that the fibre is cleaned without being damaged. Better management and handling of fibre susceptible to damage through these processes is required in order to avoid high nep and SFC in baled cotton.

Attention also needs to be applied to the issue of contamination. The ITMF Contamination Surveys [20] have shown that although contamination in Australian cotton is low, incidences of some contaminants are increasing. Furthermore, whilst stickiness and seed-coat fragments were not raised as issues with Australian cotton some spinners had encountered processing and quality problems due to their presence.

It is recommended that the Australian Cotton Industry regularly gathers formal and independent appraisals of its fibre quality using the same or similar approach used in this survey in order to check its progress against other world growths. This benchmarking is particularly important with regards to neps, SFC and to the increased incidences of contamination. The Australian cotton industry should also be pro-active in benchmarking instances of stickiness and seed coat fragment contamination.

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INTRODUCTION

World consumption of cotton fell 0.5% in 2003 to 21 million tonnes and its current share of the world textile market is now estimated to be less than 40% with current projections that its share will decline to 38% by 2010 [1] (Figure 1). There have been only small increases in overall cotton consumption and, despite a reversal during the late 1980s, a continuous decline in cotton's share of the world textile fibre market since the late 1960s. For cotton to reverse this trend it will need to become more competitive, particularly with respect to its quality and diversity of end-uses.

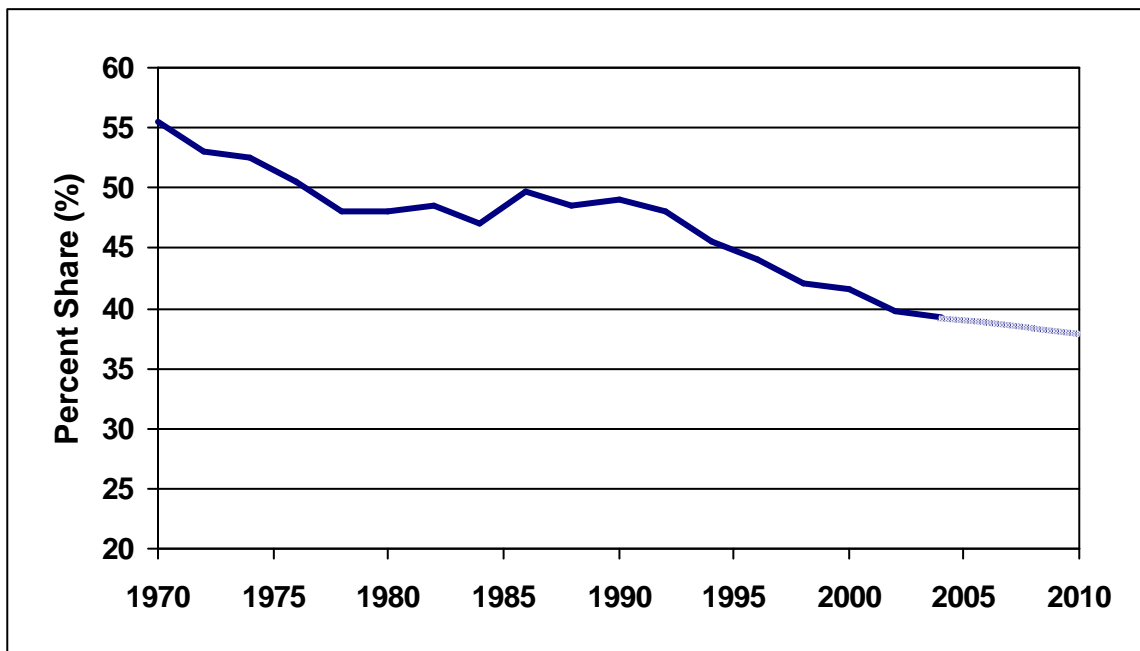


Figure 1 – Cotton's share of the World Textile Market [1]

Against this picture of declining market share is the success story of the cotton industry in Australia. Up to 95% of the crop is exported and between 1998 and 2002 Australia was the third largest exporter of cotton lint after Uzbekistan and the USA. Moreover, Australian exports made up nearly 21% of the high-medium grade cotton volume in the 2002/03 export market [2]. The chief destinations of Australian cotton are spinning mills in the Asia-Pacific region with major destinations being Indonesia, Japan, Thailand and South Korea (Figure 2).

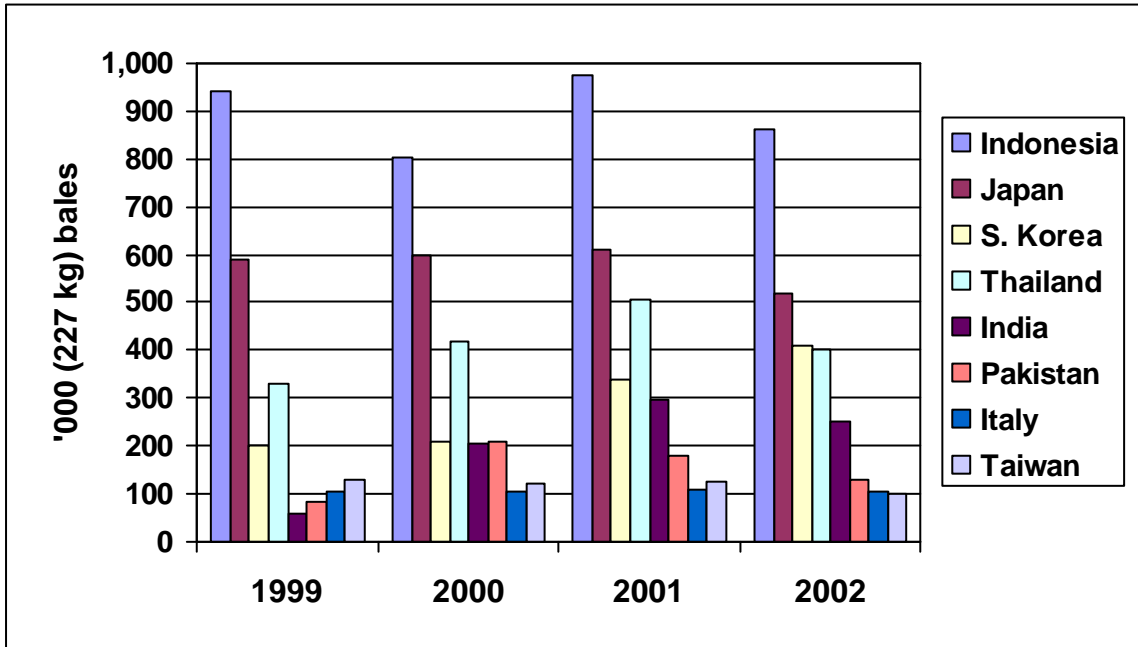


Figure 2 – Australian cotton exports by destination [ABS]

Australian cotton yields rank amongst the highest in the world and its fibre has a reputation for being of good strength, length and colour, and of being largely contaminant free. The increased volume of Australia’s cotton crop and its quality has seen Asian spinning mills in particular use Australian cotton as their base fibre in bale lay-downs.

The increased exposure and success of Australia’s cotton in the Asian market has increased the focus on its quality. Currently, quality is measured relative to competitive growths such as San Joaquin Valley (SJV) cotton from California, long regarded as the premium Upland growth in the world export market. While comparisons with other growths are important it is equally important that the Australian industry becomes proactive in the specification of its own product. If Australia is to maintain and grow its quality customer base it will need to extend the description of its product beyond the current USDA classing and shipper type models and define the fibre more in terms of Australia’s customers needs. This means the Australian industry must create its own quality benchmarks and specify and provide fibre properties more relevant to its customers.

In 1997 a review of Australian Cotton Classing Industry Standards [3] was conducted in response to grower concerns with aspects of the classing system. Although focussed mainly on the thoughts of growers and local merchants, the

review also canvassed the opinion of overseas spinning mills that used Australian cotton. The main points arising from the spinners were that high nep and SFC were the principal problems associated with Australian cotton. Related to this was the importance spinners placed on knowing where a bale had been ginned.

Amongst recommendations from the review was that:

- The flow of information and dialogue from spinners to growers should be improved as a matter of urgency.
- Investigation of fibre maturity should be initiated (as part of the ginning research that had been commissioned at the time).
- Thought should be given to changes in the current 'G5'¹ Micronaire range.
- Ginning researchers should attempt to benchmark nep and SFC.

Properties such as maturity and fineness (which have a large bearing on whether fibres will break, nep or take up dye) SFC, length uniformity and nep content are not specified on sale contracts because, although these properties are valuable to spinners, there are no agreed or practical test methods for them. Other properties that are less well defined, but of importance to mills, include fibre elongation, fibre friction, cleaning ability, seedcoat fragment content, dust content, stickiness, microbial infection and spinning and dyeing ability indices.

Also important for the cotton industry to understand is that different fibre properties are required for different spinning systems. Table 1 lists the number of spinning positions in use for short-staple spinning and an estimate of the proportion of world yarn produced on each system. Cotton is the dominant fibre processed on these spinning systems with a share of more than 70% [4]. Table 2 lists the fibre properties required by each system to process high quality yarn efficiently. Eighty percent of all spinning machines installed produce yarns in the Ne 5 to Ne 30 range with the emphasis lying between Ne 18 and Ne 30 [4].

Table 1 – Number of World Short-Staple Spinning Positions [11]

Spinning System	Ring Spinning	Rotor Spinning	Air-Jet Spinning*
No. of positions	166 million	7.6 million	276,000
Yarn prod. (% est.)	> 60%	> 30%	< 10%
Max. delivery	25 m/min	200 m/min	450 m/min

*Includes Murata Vortex Spinning (MVS) positions

¹ 'G5' is the Micronaire range from 3.5 to 4.9 (Figure 8)

Table 2 – Important Fibre Properties [5]

Importance rank	Ring Spinning	Rotor Spinning	Air-Jet Spinning
1	Length	Strength	Length
2	Strength	Fineness	Cleanliness
3	Fineness	Length	Fineness
4		Cleanliness	Strength

Project Objectives

The broad aims of the survey described in this report were to:

1. Understand quality issues related to the use of Australian cotton from the spinners perspective.
2. Identify fibre quality problems and other textile processing problems associated with Australian cotton.
3. Prioritise research and development to address textile processing related problems in Australian cotton in order to improve its export potential.

The report is set out under each of these objectives. In Section 1 the survey methodology and data is discussed. This section provides an accurate snap shot of Australian fibre quality and fulfils the first objective of understanding the quality issues related to the use of Australian cotton. The issues raised in the survey are discussed in more depth in Section 2 as fulfilment of the project's second objective. In Section 3 opportunities for research and development (R&D) to enhance the quality of Australian cotton from the mill perspective are identified.

SECTION 1 – UNDERSTANDING QUALITY ISSUES

SURVEY METHODOLOGY

Survey Interviews

Over thirty spinning companies that purchase Australian cotton were interviewed in regard to its quality in yarn production. The survey-interview approach, which entails person-to-person interviews conducted around a set of scripted questions, was taken to ensure a high and consistent response. The questionnaire developed for the survey provided a standardized and consistent structure to the interviews, whilst the person-to-person contact ensured questions were not only answered but properly clarified with interviewees. The personal contact also gave interviewees the opportunity to ask questions about the study and provide more detail about particular aspects of fibre quality that

affected their business.

The questionnaire was written by CSIRO Textile and Fibre Technology (CTFT) in consultation with members of the Australian Cotton Shippers Association (ACSA) (Appendix 1). It consisted of a series of background questions about each spinning company's production, raw fibre use and spinning facilities followed by a series of more open-ended questions about the quality of Australian cotton fibre. In these questions, interviewees were asked: "What do you think of Australian cotton in terms of 15 different properties including: Micronaire, staple length, uniformity, short fibre content, strength, extension, maturity, fineness, nep content, grade, colour, trash, contamination (including handling and biological contamination), spinning ability and dyeing ability?" Answers to these questions were able to be qualified during the person-to-person interviews. Interviewees were also asked: "What were the optimum values for each of the 15 fibre properties, and what problems or processing issues would they expect if the cotton they used was outside these values?"

Interviews were between one or two of the company personnel responsible for raw fibre purchases and two CTFT researchers. The positions of persons interviewed varied between companies from line managers in the cotton department of a particular company to the company's CEO or owner. Where required questionnaires were translated and the interviews attended by a local Austrade representative acting as an interpreter. Survey interview data was collected in note form by CTFT researchers. In most cases spinning companies received the questionnaire in advance and had answered most of the questions prior to the interview.

To achieve consistency between interviews, interviewee's responses were reviewed by CTFT researchers at the conclusion of each interview. A score was given to represent a particular spinning company's (spinner's) impressions of the 15 fibre properties reviewed. Impression scores were used to quantify the spinner's impressions of individual fibre properties. Scores were scaled from 1 to 5 with 5 representing *a good impression* of the fibre property, 3 *no impression* of the fibre property and 1 *a bad impression* of the fibre property (Table 3). A rating of 3 meant that the fibre property did not cause any problems in the mill or that there was no issue with the quality of that parameter. Spinner's impressions were generally based on their experiences with Australian cotton over several years and measured in relation to other growths they had used in their mills.

Table 3 – Spinner’s impression scale applied post-interview to rank (score) responses to questions on the 15 fibre properties surveyed

Scale Range	Impression
5	Good
4	
3	Indifferent
2	
1	Bad

Survey of Bale Lay-Downs

In addition to survey-interviews, fibre samples were gathered from bale lay-downs in mills. These samples were analysed by objective measurement and provided an objective benchmark of Australian fibre quality against the quality of other growths, with which it competes in the marketplace. Samples were collected four times from spinning companies from September 2002 through to February 2004. Tables 4 and 5 below; list the number of mills that participated, the number of lay-down samples tested and the origins of bales in mill laydowns. Of the 31 mills surveyed only 19 contributed bale lay-down samples, with only two mills supplying samples for all testing rounds. Test results on fibre samples from lay-downs surveyed were averaged for each growth, i.e., country or area of origin, and expressed with the 95% confidence interval. Confidence intervals were not expressed for averages of three or less test results.

Australian cotton is typically laid down with bales from the USA, China and West Africa. Fibre samples from each bale in a lay-down were collected by the spinning companies using a formal sampling procedure developed by CTFT and demonstrated during the visit to each spinning company (Appendix 2).

Lay-down samples were sent by spinning companies to CSIRO TFT where they were checked before being sent on to Auscott Classing Offices in Sydney Australia. At the Classing Office fibre properties were tested on the same HVI line and neps were tested using an Uster Nep Tester 720. The HVI results are from one repetition and nep results are the average value for five repetitions. Tests were carried out under standard temperate atmosphere according to ISO 139. All samples followed this sampling and testing routine.

Table 4 – Number of mills supplying lay-down samples

Mill Country	No. of Mills
Australia	3
Japan	5
Indonesia	3
Thailand	4
South Korea	4
Total	19

Table 5 – Origin of bales in mill lay-down samples

Country	No. of Samples
Australia	69
USA California	19
USA SJV	13
USA Other	4
China	15
West Africa	9
Zimbabwe	8
Uzbekistan	3
Greece	1
Total	141

Selection and Background of Survey Companies

Spinning companies represented in the survey were selected on the basis that a significant proportion of the cotton they processed was from Australia. On this basis companies from Japan, South Korea, Thailand and Indonesia were approached for the survey. Spinning companies were contacted for interviews by Austrade officials in Japan, South Korea and Thailand, whilst contact for interviews in Indonesia and Australia were made directly by CTFT. With one exception, all spinning companies contacted agreed to the request for an interview.

Visits to conduct interviews were made between August 2002 and April 2003. Due to travel restrictions imposed by the Australian Government at the time, interviews with Indonesian spinning companies were delayed and in the end all interviews except for one were conducted by phone. These interviews occurred

between September 2003 and March 2004. Australian spinning companies were interviewed between August 2002 and March 2003. In most cases interviews were with people responsible for buying or over-seeing cotton purchases rather than the mill production managers.

A total of 31 spinning companies were included in the survey; Japan (8), South Korea (8), Thailand (7), Indonesia (4) and Australia (4). The majority of spinning companies surveyed operated ring spinning mills although open-end (rotor) and air-jet spinning (including MVS) mills were also included. The mills included in the survey consumed more than 220,000 tonnes or 960,000 bales of Australian cotton in 2001/02. Spinning company details are listed in Appendix 3.

Japanese Spinning Companies

Seven of the eight spinning companies surveyed in Japan are large public companies with annual sales in 2002 ranging between \$US460 million and \$US3.2 billion dollars [6]. These public companies have traditionally operated multiple large vertically integrated broadloom textile mills but in the last 25 years have diversified their income base into other manufacturing sectors such as chemicals, plastics, electrical components, health care products, paper and services, such as real estate, environmental management and trading. The diversification has been important with the diminishing competitiveness of traditional textile industry due mainly to the expansion of textile industries in developing countries, particularly in China.

Over the last 10 years the number of cotton spindles operating in Japan has decreased dramatically from just over 5 million in 1993 to less than 1.6 million in 2004 [7]. Japanese mills today are more likely to buy yarn direct from China or through subsidiary companies based in China or other low wage countries such as Indonesia, Brazil and Thailand.

Even though the Japanese companies are moving their spinning offshore, they remain important buyers of Australian cotton as the purchasing decisions for foreign subsidiary companies tend to be made in Japan. It is also noted that Japanese companies make large investments in R&D. Of the eight companies surveyed four had dedicated R&D departments focussing on the development of new fibres, yarns and fabrics.

All the spinning companies surveyed in Japan operate ring spinning mills to produce, in general, fine count combed yarns, i.e. Ne 40 and finer, for the high end domestic and export market. Only two of the eight used other spinning

systems such as open-end and air-jet spinning, and yarn production on these systems was limited by the small number of positions in operation.

The proportion of Australian cotton used in lay-downs of the mills surveyed varied from 30% to 100% with lint from the USA and to a lesser extent China making up the remainder of the blend. Blends with Australian cotton are used predominantly to spin combed Ne 40, with Ne 60 being the finest reported. All Japanese mills require HVI data with cotton shipments and all except one retested incoming bales on their own HVI lines. Retesting is conducted predominantly to check the quality of incoming bales against sales contract specifications, although test results are also used to manage bale storage and lay-downs and to help in the prediction of yarn quality. The percent of incoming bales retested in Japanese mills was between 5% and 10%, although two companies retested 100%.

South Korean Spinning Companies

Six of the eight companies surveyed in South Korea are medium sized public companies with annual sales in 2002 ranging between \$US86 million to \$US295 million. The cotton spinning industry in South Korea is facing similar pressures as the Japanese industry. Since 1990 the number of spindles in South Korea has decreased from a peak of over 3.6 million spindles to 1.6 million spindles today [8]. Whilst some South Korean companies are diversifying into other manufacturing sectors and services most remain textile based and as a consequence of competitive pressures are closing down or transferring to low wage countries such as Uzbekistan, China and Vietnam. Despite this environment Australian cotton exports to South Korea have increased as a proportion of total South Korean cotton imports. In 2002 Australia supplied 32% of South Korea's cotton imports up from 17% in 1999 [8].

All spinning companies surveyed operated ring spinning mills and five of the eight also operated open-end spinning frames. In general, yarn production in South Korea is based around carded and combed medium, i.e. Ne 14 – Ne 30, and fine count yarns for vertically integrated fabric and garment production businesses.

The proportion of Australian cotton used in lay-downs of the mills surveyed varied from 20% to 100%, with cotton lint from USA, China and to a lesser extent Uzbekistan and Zimbabwe making up the rest of the blend. All South Korean mills require HVI data with cotton shipments and all except for one retested incoming bales on their own HVI lines. Retests were conducted to check the

quality of incoming bales with the proportion retested varying between 5% and 20%.

Thai Spinning Companies

Six of the seven spinning companies surveyed in Thailand are privately owned small or medium size enterprises (SMEs) that operate vertically integrated mills for production of knitted garments and woven fabric. The remaining company is a public company with diversified textile and chemical businesses and which had annual sales of \$US490 million in 2002 [9]. Traditionally a low cost production country, Thai textile exports are facing fierce competition from other low cost countries. There are currently around 3.6 million spindles and 58,000 rotors operating in Thailand [10] of which nearly 1 million spindles and 45,000 rotors have been added in the last 10 years [11]. It is expected that spinning capacity in Thailand is unlikely to grow in the current environment.

All spinning companies surveyed operated ring spinning mills and five of the seven also operated smaller numbers of open-end spinning frames, and one operated a small number of air-jet spinning frames. In general, yarn production in Thailand is based around carded and combed medium to fine count yarns for export and for vertically integrated fabric and garment production businesses.

The proportion of Australian cotton used in mill lay-downs surveyed varied from 20% to 70% with cotton from USA and to a lesser extent West Africa making up the rest of the blend. All Thai mills require HVI data with cotton shipments and all retested incoming bales on their own HVI lines. Like mills in other countries retests were conducted to check the quality of incoming bales, although the percent retested tended to be higher and in most cases 100% of incoming bales were retested.

Indonesian Spinning Companies

Of the countries surveyed in this project Indonesia has the largest spinning capacity with around 7.8 million spindles [12] and 56,000 rotors [11]. Over the last 10 years Indonesia added 1.5 million spindles and 26,000 rotors [11] although this expansion has recently been curtailed except for the transfer of used spinning frames from Taiwan and Japan [12]. Indonesia is also the largest customer of Australian cotton with 31% of the 630,000 tonnes of lint imported into Indonesia in 2002 being from Australia [12].

Of the spinning companies surveyed in Indonesia three are large public companies with annual sales in excess of \$US215 million. One of the companies

is a very large and diversified company of which textiles represent less than 5% of their annual sales. The fourth company is a privately owned SME.

The four spinning companies surveyed operated ring spinning mills and one also operated a large open-end spinning mill. The structure and costs of yarn production in Indonesia are similar to those in Thailand and the two countries are close competitors for yarn and textile markets in Japan, the Americas and Europe. In general, yarn production is based around carded and combed medium to fine count yarns for export and for vertically integrated fabric and garment production businesses.

The proportion of Australian cotton used in mill lay-downs surveyed varied from 15% to 60% with cotton from USA, China and to a lesser extent West Africa making up the rest of the blend. All Indonesian mills require HVI data with cotton shipments and three of the four retested incoming bales on their own HVI lines. As in mills in other countries retests were conducted to check the quality of incoming bales, although the proportion retested tended to be higher and in most cases 100% of incoming bales were retested.

Australian Spinning Companies

The four spinning companies surveyed in Australia were privately owned SMEs. When surveyed the companies operated around 10,000 rotors and 2,000 air-jet (including MVS) spinning positions, with the MVS spinning capacity being the third largest in the world. In 2001/02 Australian spinning consumed in excess of 27,000 tonnes of Australian cotton annually. Australian spinning companies are restricted to using 100% Australian cotton due to the cost impost of importing small volumes of foreign cotton, although the unavailability of cost competitive lower grades has forced one company to import cotton from Brazil.

Except for a small amount of fine count combed yarn² (Ne 40) the yarn produced in Australia is coarse (Ne 2 – Ne 12) to medium count carded yarn. Australian spun yarn is used by domestic knitters and weavers and a small amount is also exported on the basis of its high quality. Two of the four spinning companies in Australia are vertically integrated fabric manufacturers and their fabrics are used domestically and exported. All Australia mills require HVI data with cotton shipments and two of the four mills retested a percentage of incoming bales.

² Since the survey the spinning company producing these yarn counts has ceased operations

RESULTS AND DISCUSSION

Survey Interviews

Spinner's impressions of the 15 fibre properties defined in the questionnaire were averaged (n = 31) and the standard deviation across all companies calculated. Despite the range of spinning systems and yarns produced in the spinning companies surveyed, the average impressions of Australian cotton fibre properties was consistent between countries. All countries rated neps, Micronaire and SFC as properties that needed improvement whereas the low level of contamination, good grade, good colour, spinning ability and staple length of Australian cotton created the best impressions (Figure 3).

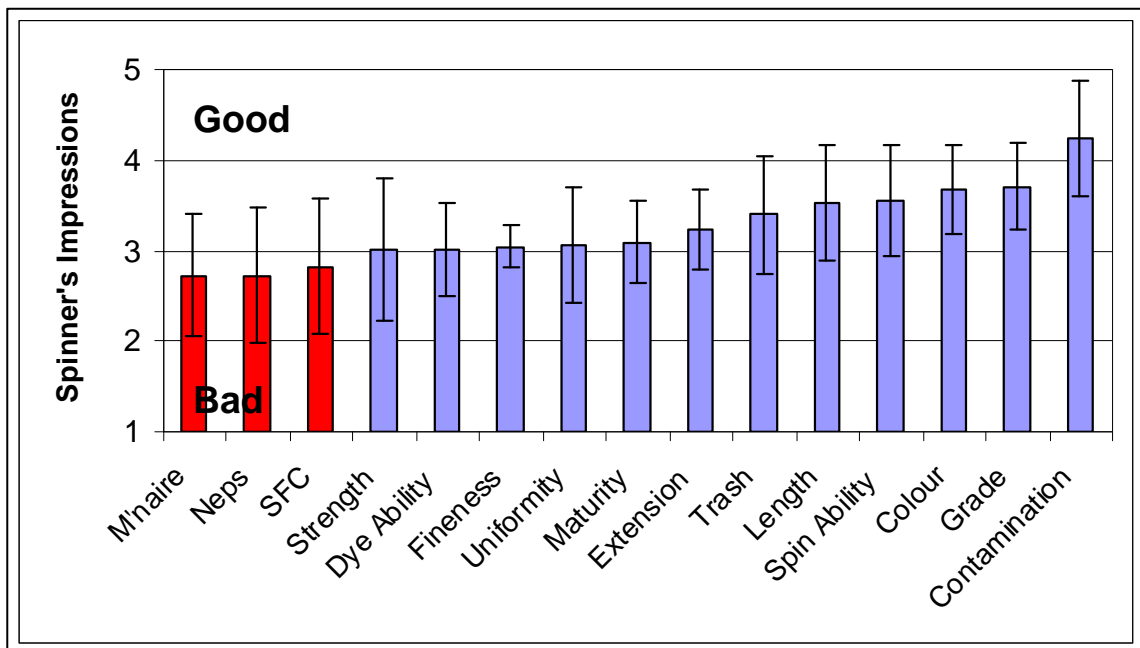


Figure 3 - Average spinner's impressions of Australian fibre quality

The results show Australian cotton rates highly for its low contamination, which includes biological contaminants such as stickiness and seed coat fragments (average spinner's impression = 4.2), and its good classing grade (3.7), colour (3.7), spinning ability (3.6), staple length (3.5), trash (3.4) and to a lesser extent extension (3.2). Spinner's impressions indicated that other fibre properties such as maturity, fineness, dyeing ability, strength and length uniformity were less critical, as these properties all had ratings between 3.0 and 3.1. There are concerns regarding high nep (2.7), Micronaire values (2.7) and SFC (2.8).

Neps in particular remain an adverse feature of Australian cotton. Neps affect the appearance of cotton yarns and fabric and are usually associated with lower yarn strength, poorer spinning performance and a more irregular yarn. The appearance of dyed or printed fabrics is negatively influenced by the presence of neps, as neps, which often comprise immature or 'dead' fibres, absorb dye and reflect light differently and appear as spots or 'flecks' on finished fabrics. This causes fabrics to be downgraded or rejected, as there are no cost effective means of covering or removing them once they are present in fabric.

The high Micronaire of Australian cotton over the last two to three years is also a particular issue with mills, especially those that spin fine counts (Ne 40 and finer). The problem with high Micronaire, or fibre that is too coarse, is that a minimum number of fibres are required in a yarn cross section for it to be spun efficiently. The number of fibres required is also dependent upon fibre length and other factors such as fibre strength, fibre friction and sliver quality, however fibre fineness or linear density, i.e. the mass per unit length usually expressed in mg/km (or mtex), is a major determinant in how fine a yarn can be spun from cotton.

In ring spinning the minimum number of cotton fibres required in the yarn cross-section is around 80 and for open-end (rotor) spinning the number is 100 fibres. This means that cotton with a fineness of 160 mtex is limited to yarn counts as fine as Ne 50 on the ring system or Ne 40 on the open-end system. Figure 4 shows the relationship between yarn counts in ring and open-end spinning and fibre fineness.

Excessive SFC is also perceived as a problem in Australian cotton. Excessive SFC leads to, especially in medium to fine ring and air-jet counts, poorer spinning performance, an increase in yarn irregularity, a decrease in yarn tenacity, increases in yarn hairiness and fly generation (i.e. fibres liberated to the atmosphere) and more rapid deterioration of fabric appearance.

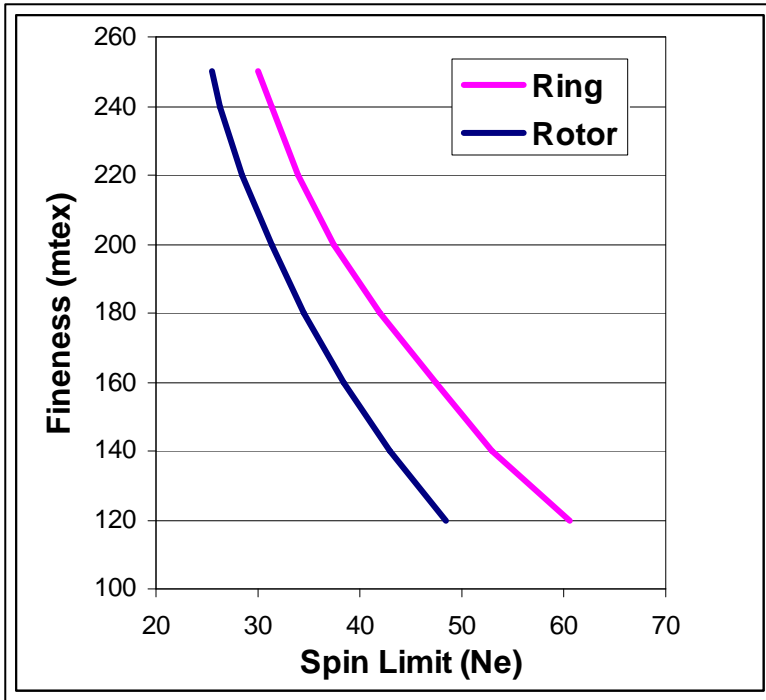


Figure 4 – The relationship between yarn count and fibre fineness [5]

Spinner’s impressions were also depicted as the number of responses out of the 31 spinning companies surveyed that were negative about a fibre property, that is had a spinner’s impression ranking of less than 3.0. The number of companies that commented adversely about one or more of the 15 fibre properties surveyed is shown in Figure 5.

Of the 31 companies surveyed 20 commented negatively about coarse Micronaire experienced in Australian cotton over the last three years; 16 companies thought that neps were also a particular problem with Australian cotton; 13 companies thought that Australian fibre strength was not as good as SJV cotton; nine companies thought that SFC and dye ability were problems with Australian cotton and seven companies thought that length uniformity was a problem.

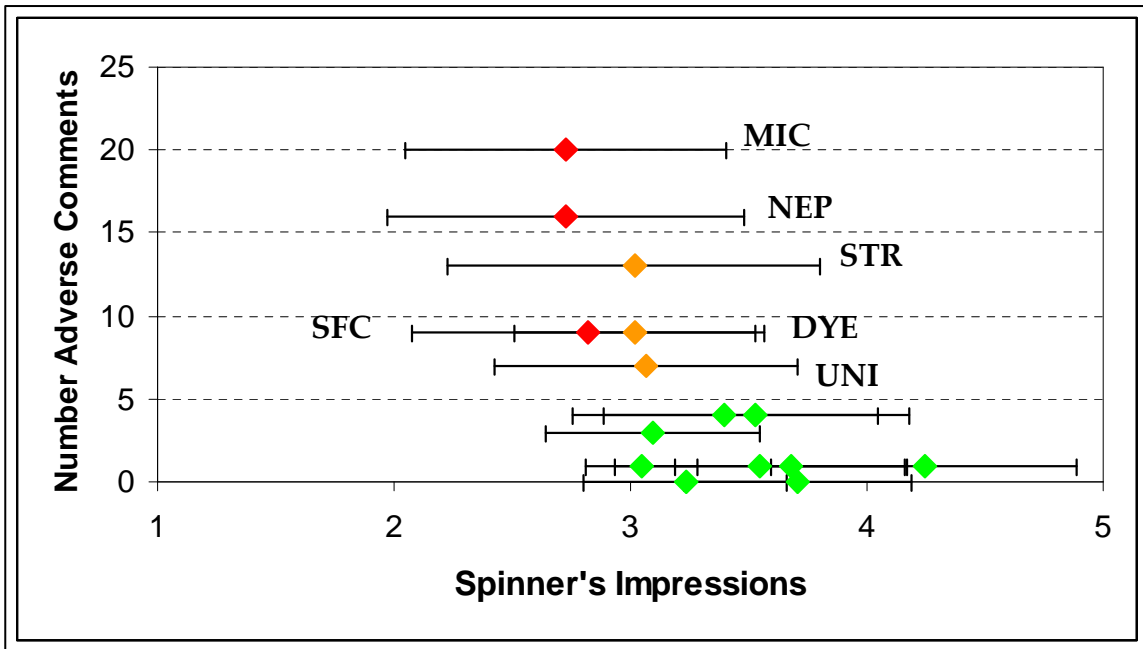


Figure 5 – The number of adverse comments about Australian cotton quality (error bars indicate one standard deviation of spinner’s impressions)

Japanese Spinner’s Responses

Five out of eight Japanese spinning companies complained about the current Micronaire range of Australian cotton. This was followed by dyeing ability, strength and neps. However SFC was, on average, less of an issue for Japanese companies than for other countries surveyed.

The perceived merits of Australian cotton were its good bright colour, low trash, reasonable staple length and low contamination.

These responses reflect the high demands of Japanese spinning companies on their suppliers in order to spin high quality fine count yarns. According to Japanese spinning companies, Australian cotton is currently too coarse (Micronaire values too high), is not as strong as SJV cotton and does not give the same lustre or dyed fabric appearance as cotton from West Africa or Zimbabwe.

South Korean Spinner’s Responses

The impressions of Australian cotton amongst South Korean spinning companies were similar to Japanese companies (four out of eight companies complained about Micronaire and neps) except that greater importance was placed on SFC and uniformity and less importance was placed on dye ability and strength, although these two properties did not rank highly.

Contamination, grade, colour and staple length were again highly rated.

Thai Spinner's Responses

Thai spinning companies had similar perceptions of Australian fibre quality as Japan and South Korea with strong views on the high nep content (five out of six companies) and coarse Micronaire (four out of six companies). Thai companies like Japanese companies thought that dye ability with respect to the final appearance of dyed fabric was not as good as other growths, and strength and SFC also rated poorly.

Increased contamination from jute bale wraps and blue polypropylene module covers was an issue for one particular mill, although the average impression was that Australia was one of the better suppliers of contaminant free cotton.

Indonesian Spinner's Responses

Micronaire was again prominent in the amount of adverse comment it attracted. The four companies surveyed made negative comment about the coarse Micronaire of the last three seasons. Neps also rated badly although only one of four companies made particular negative comment. The same company also gave a similar rating for SFC and uniformity.

Australian Spinner's Responses

In Australia where direct comparison could not be made with other growths and the average yarn counts spun are coarser the rankings of fibre properties were only slightly different from overseas mills. Australian spinning companies rated SFC, length uniformity, maturity, fineness and neps as being problems (spinner's impression < 3.0). Micronaire was rated as less of a problem partly due to the higher test rate of maturity and fineness in Australian mills, and because Australian mills spin coarser yarn counts. At the time of the survey three of the five mill sites regularly tested maturity and fineness in order to avoid maturity related problems with dyed fabric appearance.

Negative ratings for SFC and uniformity were surprising given that the bulk of Australian yarn is rotor spun. However, two of the four companies had previously operated ring spinning plants in Australia and their impressions of these properties may have been a reflection of those times. These impressions no doubt affected the negative nep rating as well.

Measurement of Bale Lay-Down Samples

During interviews spinners indicated their preferred, or optimum, values for each fibre property and these are indicated graphically in Figures 10 to 15 along with the measured averages as a benchmark for the particular growths used in lay-downs. Table 6 summarizes the optimum fibre values nominated by spinning companies as being required to spin high quality yarn consistently. The Table also lists the performance of Australian cotton in reaching these values against recent ACSA and ITMF data, and more directly with regards to nep counts and SFC, the test results on samples from spinning company mill lay-downs.

Whilst it is difficult to be accurate about the exact proportion of Australian cotton that meets the preferred specifications, in general less than a third of Australia's cotton in 2003 met spinner's preferences with regards to Micronaire and nep values, and less than 20% met spinner's preferences with regards to SFC. Australian cotton was better in regard to strength (> 50% of the crop had bundle tenacity greater than 29 g/tex), length (61% of the crop had a staple length greater than 1.125 inches) and uniformity (> 80% of the crop had a uniformity of 80% or better).

For further detail on HVI quality of the Australian cotton crop readers are referred to the ACSA website at: <http://www.austcottonshippers.com.au>.

The performance of Australian cotton as measured by the data above concurs with the test values on bale lay-down samples tested during this survey (Figures 10 to 19). These tests define the actual quality of Australian cotton and the growths with which it competes. The results on the bale lay-down samples show that other export growths also failed to meet preferred specifications.

Table 6 – Spinner’s cotton fibre property requirements

Fibre Properties	Preferred Value	Performance of Australian Cotton
Micronaire	3.8 - 4.2	56% of crop in 2002 & 34% in 2003 in 3.8 – 4.5 range ²
Length	>1.13 inches	76% of crop in 2002 & 61% in 2003 \geq 1.125 inches ²
Uniformity	> 81%	In 2002/03 <u>crop</u> averaged 82.1% with 24% \geq 83% ³
SFC	< 8%	In 2002/03 <u>crop</u> averaged 10.1% with 20% < 8% ³
Strength	> 29 g/tex	54% of crop in 2002 & 53% in 2003 > 29 g/tex ²
Grade	> 31-3	94% of crop in 2002 and 88% in 2003 graded \geq 31-3 ²
Neps ¹	< 250 neps/g	In 2002/03 nep counts av = 276 neps/g with 32% < 250 neps/g. Range extended from 164 – 496 neps/g ³
Contamination	Low/none	Considered part of the least contaminated destinations in the world ⁴
Stickiness	Low/none	Considered part of the least affected by stickiness destinations in the world ⁴

1. As tested by the Uster Nep Tester 720
2. Fibre properties of the Australian crop (ACSA)
3. Results from mill lay-down samples
4. ITMF Contamination Surveys 1989-2003.

Other Issues Raised During Interviews

In discussions with spinning company personnel the following points were raised as issues associated with Australian cotton. These concerns also applied to other growths purchased by mills.

Price:

- Most spinners felt that Australian cotton was too expensive.
- Some spinners are either paying a premium for extra information regarding growing and ginning, or have invested in cotton growing and/or ginning businesses to gain control of this information.

Bales:

- Variation in bale sizes and densities causes problems when the bales are opened in the blow-room. Bales of different densities open to different heights in a bale lay-down and this leads to variations in blending.
- There is some concern with the way bale identification tags are fastened to the bale wrapping. Tags are usually fastened with a wire tie that often breaks off during handling, ending up in opening machinery where it can cause damage.

- Torn and broken jute and Hessian bale wraps are a big issue with regards to contamination. Jute and Hessian string that is fibrillated into fibre and incorporated into yarn and fabric is difficult to remove.

Cotton Contract Information:

Spinners felt they should be supplied with more information regarding the cotton they buy such as the:

- Fibre properties of each bale (HVI).
- Area or region where the cotton was grown.
- Where and how it was ginned.

Technical Support:

- HVI data on shipments is sometimes not supplied.
- Spinners appreciated the technical (fibre and mill) assistance provided by Cotton Incorporated technicians and felt that a similar service for Australian cotton would be worthwhile.
- Faster response to complaints is desirable.
- The attitude of merchants towards local Australian spinners was considered poor, especially in light of the service the spinners performed in reporting the quality of Australia fibre from a spinner's perspective to merchants.
- Exporters, in particular those with markets in Europe, are starting to be pressured into producing eco-friendly products and need assurances from suppliers that the cotton used is produced under environmentally sustainable practices, e.g. Best Management Practice.

Supply:

- Consistency of supply. Some spinners noted that there is sometimes variation in fibre quality from the beginning to the end of the season.

SECTION 2 – IDENTIFYING KEY ISSUES AFFECTING AUSTRALIAN COTTON FIBRE QUALITY

While the overall report card from local and international spinners is good, surveys and anecdotal reports over the last decade suggest that Australian fibre has a number of problems that need resolving. This survey has measured these problems using subjective and objective scales. Even though the fibre length and strength of Australian cotton has improved markedly over the last 30 years (Figures 6 and 7) coarse fibre (high Micronaire) and high nep and SFC have the potential to keep Australian fibre out of premium markets.

The following are summaries of the issues associated with fibre properties that attracted adverse comment during survey interviews with spinning companies.

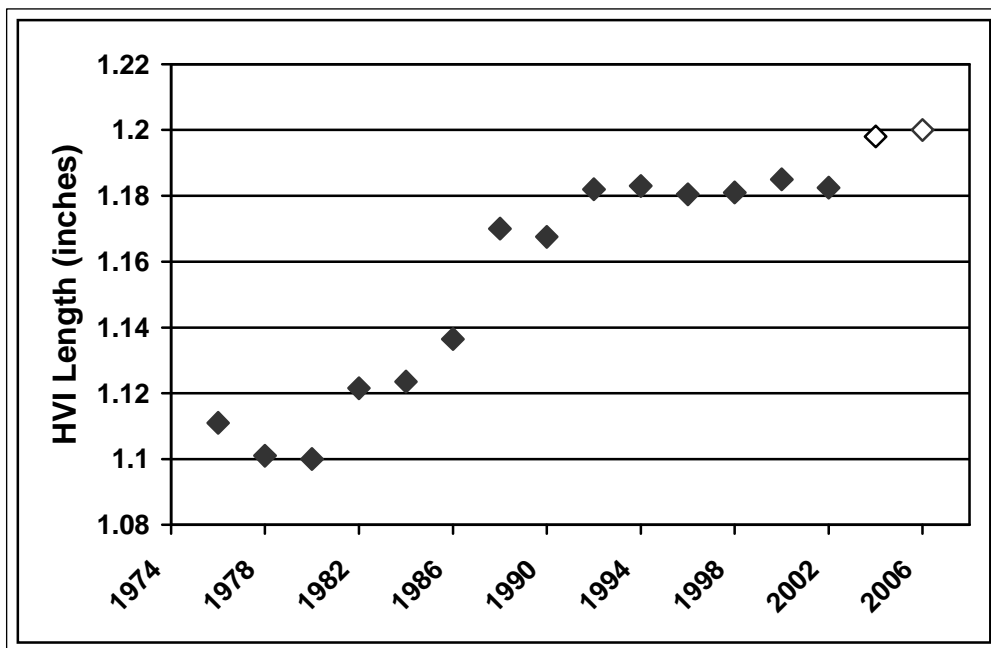


Figure 6 – The improvement in fibre length in Australian cotton [ACRI³]

³ ACRI = Australian Cotton Research Institute

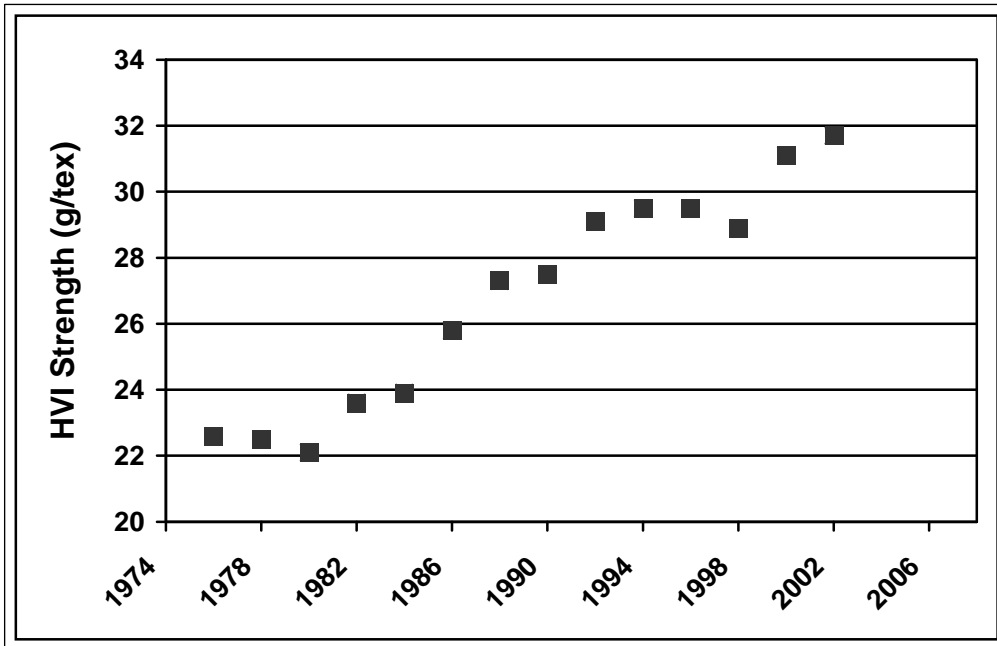


Figure 7 – The improvement in fibre strength in Australian cotton [ACRI]

Micronaire

The issue associated with Micronaire values, whether they are high or low, is the fibre’s fineness and maturity. Micronaire is a measure of specific surface area and maturity and fineness together define this property. Ideally, the fibre most mills would prefer to buy is one that is both fine and mature. However, where a fine and mature fibre lies on the Micronaire scale is unknown unless further information about the cotton is provided. In practice, the Micronaire value can describe the maturity of cotton when its growing conditions and genetic fineness are also known. However this information is not always available to the buyer. Furthermore, the only premium cotton that is offered to the spinner is that which falls within the broad ‘G5’ range. Figure 8 below illustrates the wide range of fineness and maturity values that the ‘G5’ range of Micronaire measurement can describe.

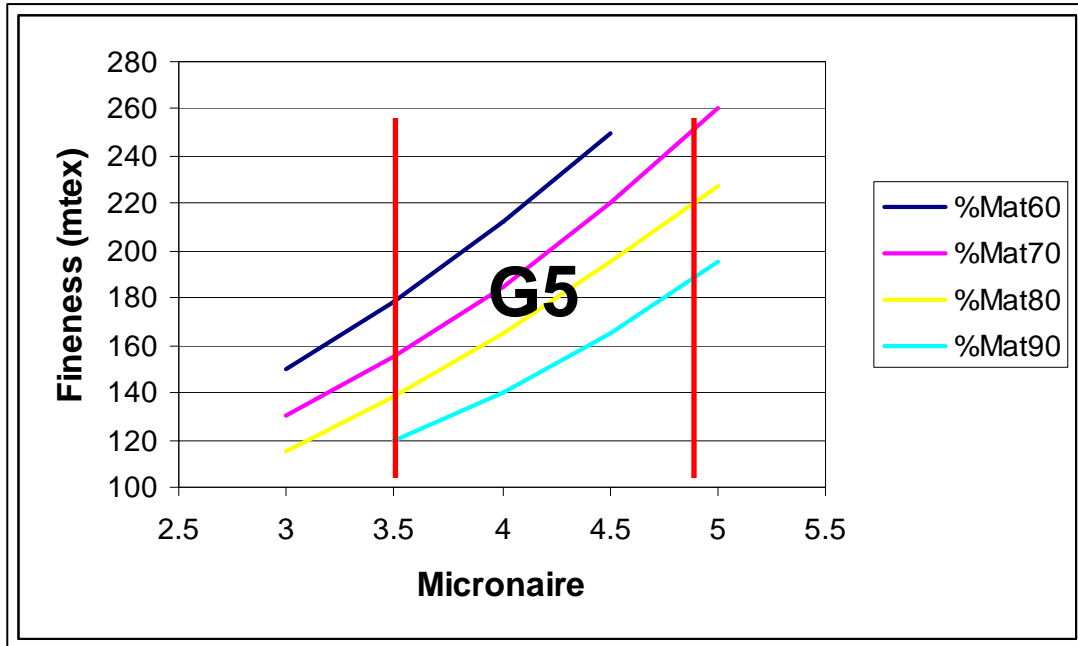


Figure 8 – The relationship between Micronaire, fineness and maturity [5]

The importance of fibre maturity is defined through its direct and indirect correlation with a wide range of physical (and chemical) properties of commercial and technical importance [13]. These properties included the high nep and SFC and the relatively poor lustre of yarn and fabric before and after dyeing.

Neps

Neps occur in all ginned cotton but rarely in unpicked seed-cotton. Neps are fibre entanglements that have a hard central knot that is detectable. The hard knot or nucleus of a nep may consist of entangled mature or immature fibres, very immature fibres cemented together and/or plant parts such as seed coat fragments and bark. Harvesting, ginning (particularly lint cleaning), opening, cleaning, carding and combing in the mill are mechanical processes that affect the amount of nep found in cotton. The propensity for cotton to nep is dependent upon its fibre properties, particularly its maturity and the proportion of immature fibres present. It is also dependent upon the level of biological contamination, e.g. seed coat fragments and bark, fibre fineness, length, moisture and stickiness.

Neps downgrade the value of cotton because their appearance on finished yarn and fabric cannot be hidden. Furthermore neps removed at the carding and combing steps in the mill increase the amount of fibre lost to the spinner. Better

management and handling of the fibre through harvesting and ginning processes is required in order to avoid neps in baled cotton.

SFC/Uniformity

Some spinners are concerned that Australian cotton produces more short fibre waste or noil (up to 4 or 5% more noil) during combing in order to achieve yarn quality standards. A uniformity index of 81 or greater does not appear to be a sensitive measure of this problem and it is noted that the USDA AMS⁴ pay incremental premiums for uniformity indices above 81 through to 86 [14].

Again, better management and handling of the fibre through harvesting and ginning is required to avoid high SFC in baled cotton.

Strength

Whilst fibre strength did not rank highly on spinner's impressions, test results on bale lay-down samples showed that the strength of Australian cotton fibre easily met spinner's requirements. However, SJV lay-down samples had an average strength of 31.1 g/tex and thus the issue of strength appears to be less about the physical requirements of fibre and more about spinners being able to buy stronger fibre for a similar price. Selected Cotlook Far Eastern quotations in early July 2004 for 04/05 delivery had Australian Strict Middling 1-1/8 inch at less than 1.5US cents/lb cheaper than California Acala⁵ SJV Strict Middling 1-1/8 inch cotton [15]. Spot prices were closer again.

Dyeing ability

Some spinners have received feedback from customers or their dyeing and finishing departments regarding dyeing issues. Fabrics produced from predominantly Australian cotton have less lustre and hence appear duller than yarn or fabric made from other growths, particularly those from West Africa and Zimbabwe.

The lustre of cotton, whether of raw fibre or finished dyed fabric, is determined by its ability to reflect light. This ability is determined by the cross-sectional shape of fibres, which in turn is determined by fibre maturity. Mature fibres tend to be smooth and rounded and reflect light whereas immature fibres are convoluted and cause reflectance to be more diffuse, which in turn causes the cotton to appear dull.

⁴ USDA AMS = USDA Agricultural Marketing Service

⁵ Acala is a Californian cotton variety traditionally grown in the SJV

Shade differences caused by improper blending of fibre of different maturity and fineness in the spinning mill was not a specific problem associated with Australian cotton although two spinning companies reported dye uptake differences over time that could not be attributed to maturity or fineness (or Micronaire) differences. These differences occurred after the fabric had been bleached and were attributed to differences in wax content and the inability of the bleach treatment by itself to remove the wax layer before dyeing. A survey of the surface waxes on Australian cotton found evidence that suggested low Micronaire cotton that had been water stressed could sometimes contain higher concentrations of heavy hydrocarbon waxes that resist bleaching [16].

Classer's Grade

The traditional way that cotton is 'classified' according to established standard grades, often forces ginners to over-clean fibre to gain a higher price for the grower's cotton. Moreover, classer's grade is often a poor indicator of the true spinning value of the fibre, to such an extent that some textile mills now offer price premiums for cotton that is harvested, ginned and shipped according to their specifications, i.e. custom ginned.

Whilst grade, trash and colour rated highly with spinning companies the side effects, namely high nep and SFC, caused by processing the cotton to obtain these grades, did not. Grade is generally improved with the application of two or more lint cleaning passages after ginning. Many studies have shown the positive effects of reducing the number of lint cleaners in ginning [17, 18, 19]. Generally these studies show that reducing the number of lint cleaners reduces grade in terms of trash and appearance but improves fibre length uniformity, staple length and reduces nep and SFC.

Contamination

Low contamination rated as one of the most favourable fibre properties of Australian cotton, although it could be argued that low contamination is a product of the process rather than a fibre property, concerns have been raised that incidences of some contaminants are increasing. Concerns raised in interviews for this survey are supported by the ITMF Contamination Survey for 2003 which shows that, as is the case world wide, contamination of Australian cotton is on the increase, increasing from 5% in 1989 to 13% in 2003 [20] (Figure 9).

The chief contaminants found in Australian cotton bales were string and fabric made from jute and Hessian and organic matter, in which the ITMF includes

leaves, feathers, paper and leather. Plastic film, sand and dust, woven plastic and oil and grease were also listed as contaminants that occurred in serious or moderate amounts in Australian cotton bales.

Both stickiness and seed-coat fragments in Australian cotton were not really issues although some spinners had encountered processing and quality problems due to their presence. The ITMF reported [20] that only 3% of respondents reported any stickiness in Australian cotton.

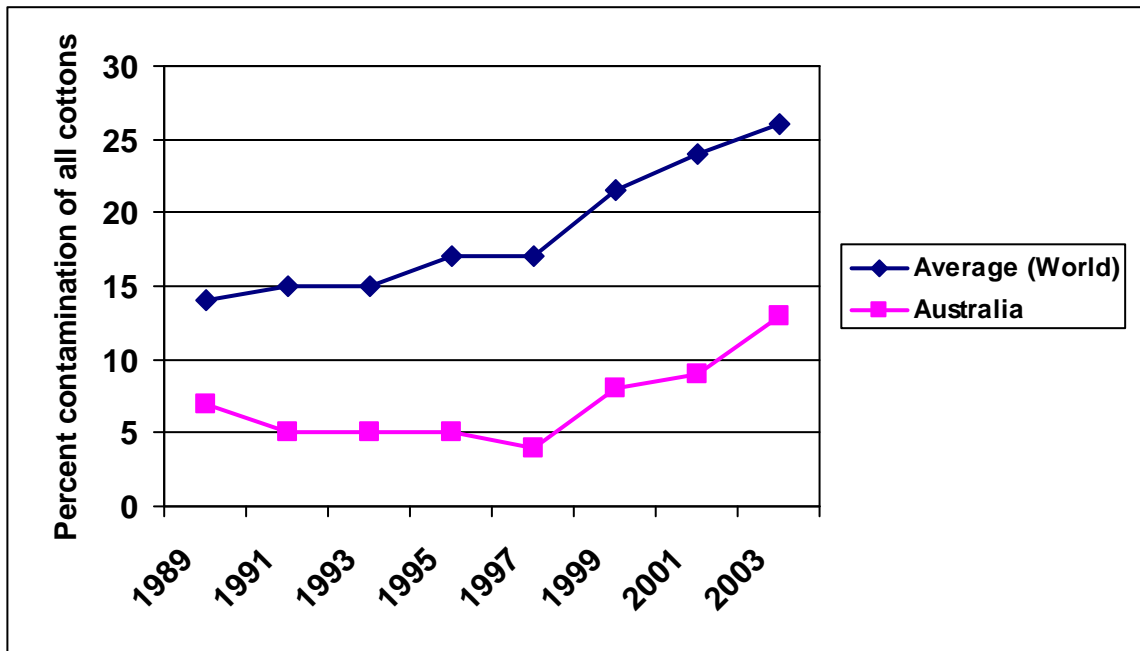


Figure 9 – Increasing degrees of contamination in world and Australian cotton

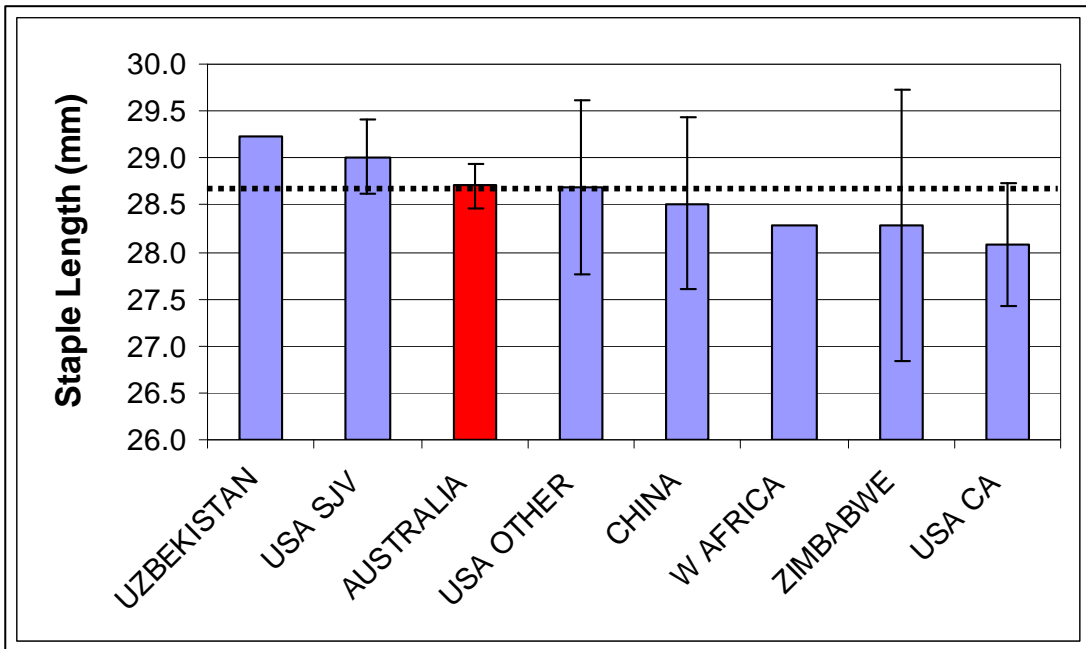


Figure 10 – Average staple length of bale lay-down samples

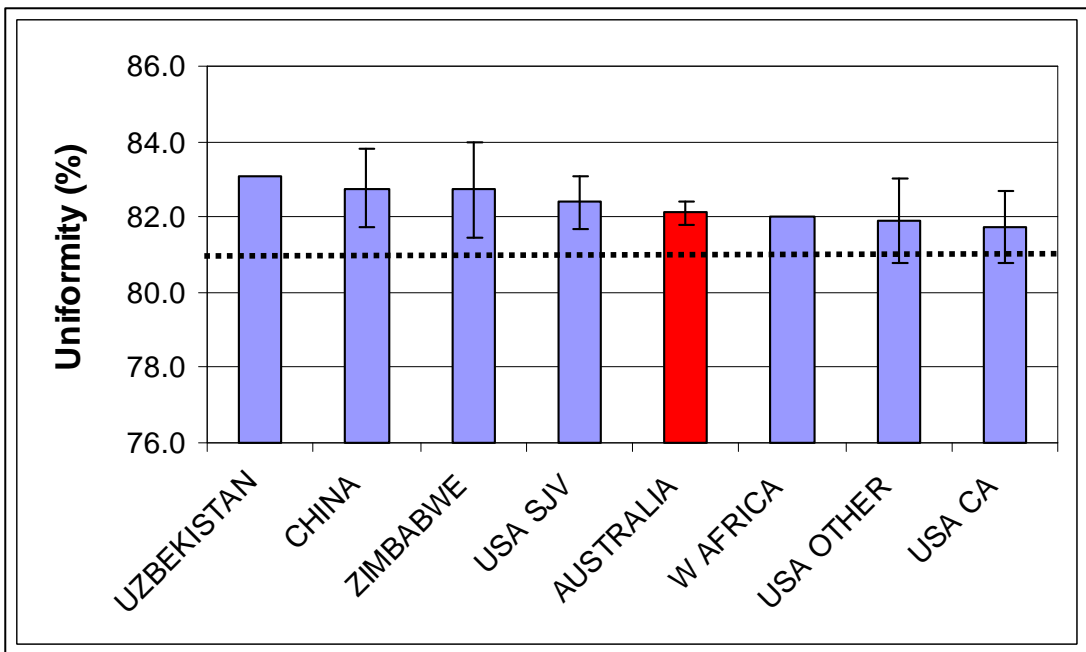


Figure 11 – Average length uniformity of bale lay-down samples

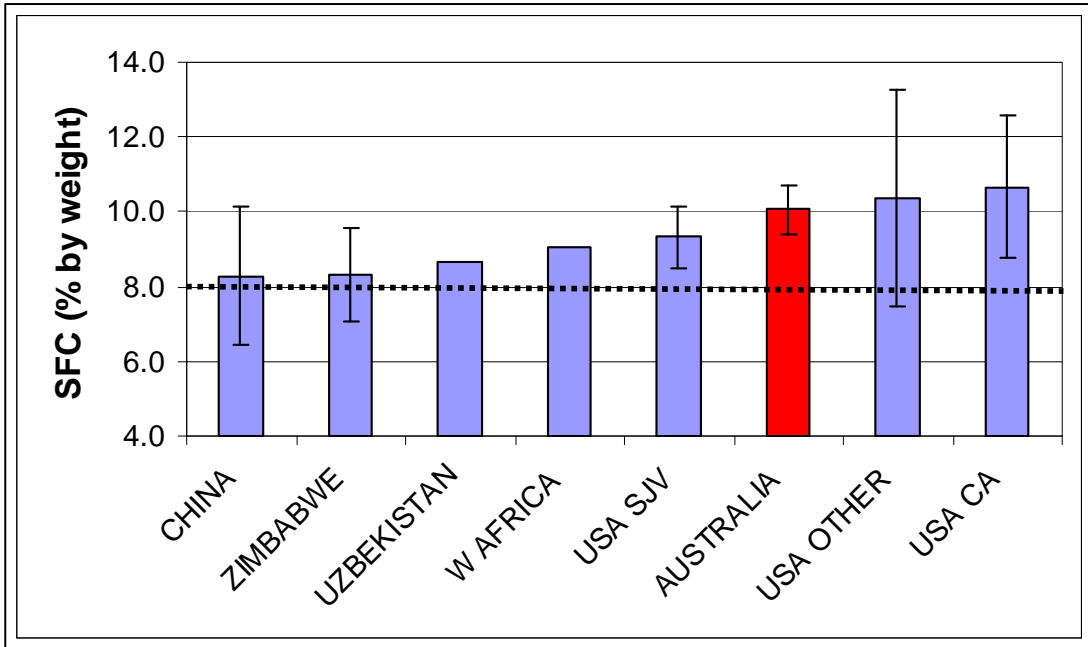


Figure 12 – Average SFC of bale lay-downs samples

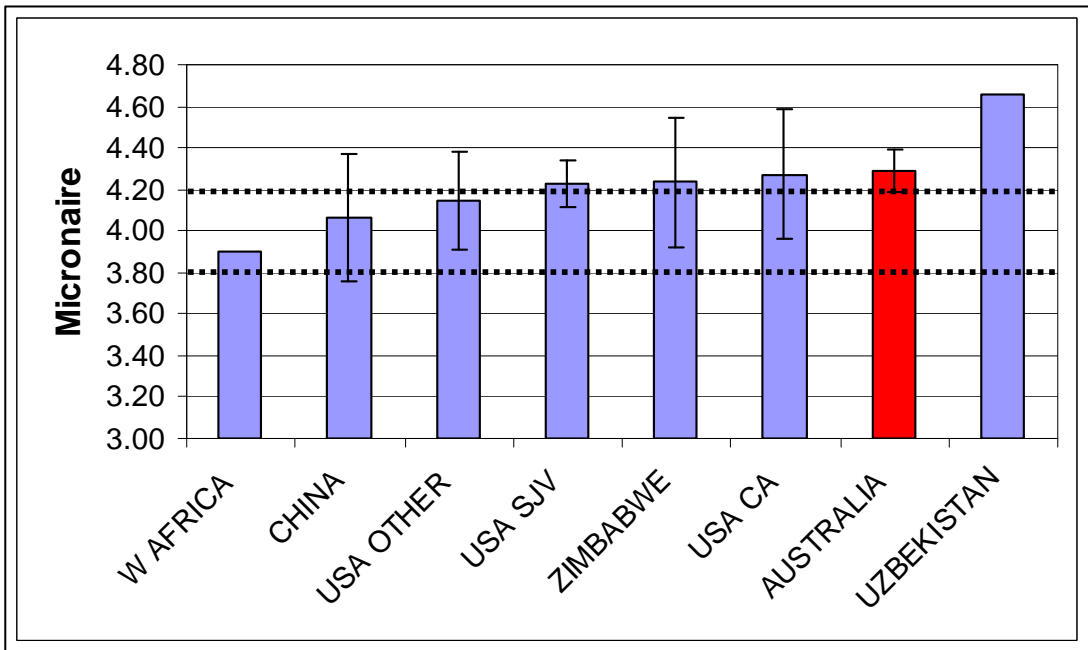


Figure 13 – Average Micronaire values of bale lay-down samples

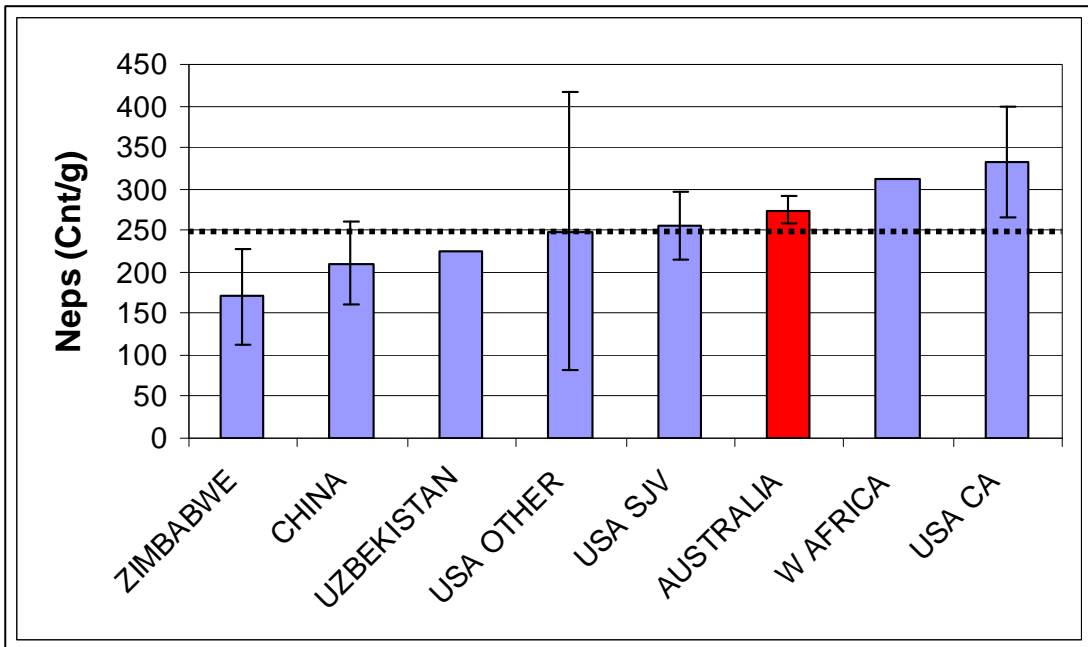


Figure 14 – Average nep count in bale lay-down samples

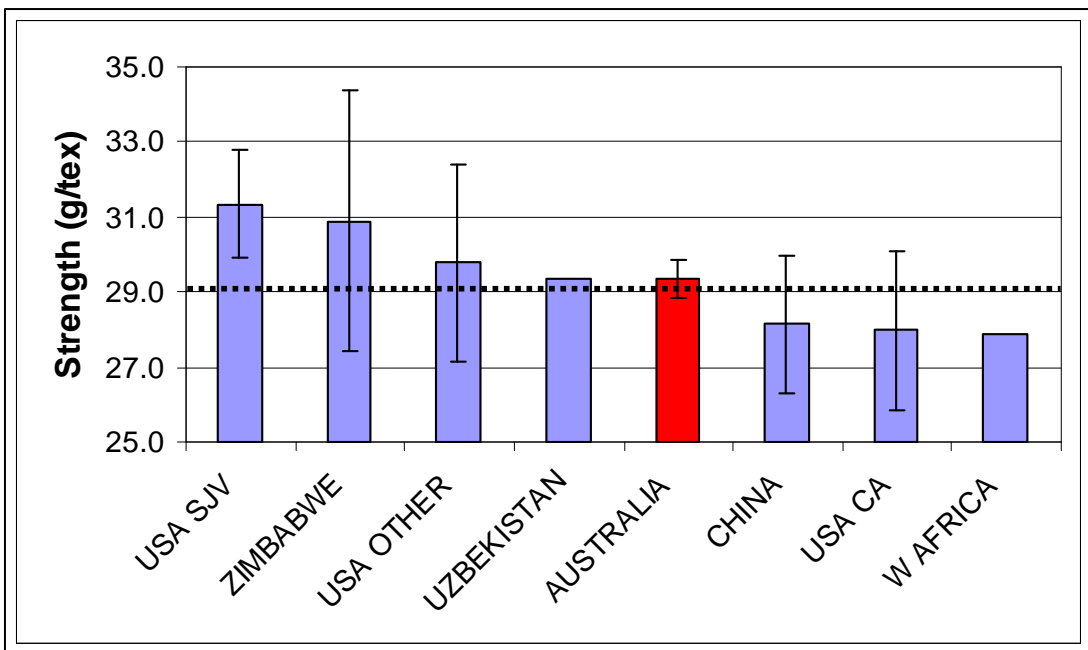


Figure 15 – Average fibre strength in bale lay-down samples

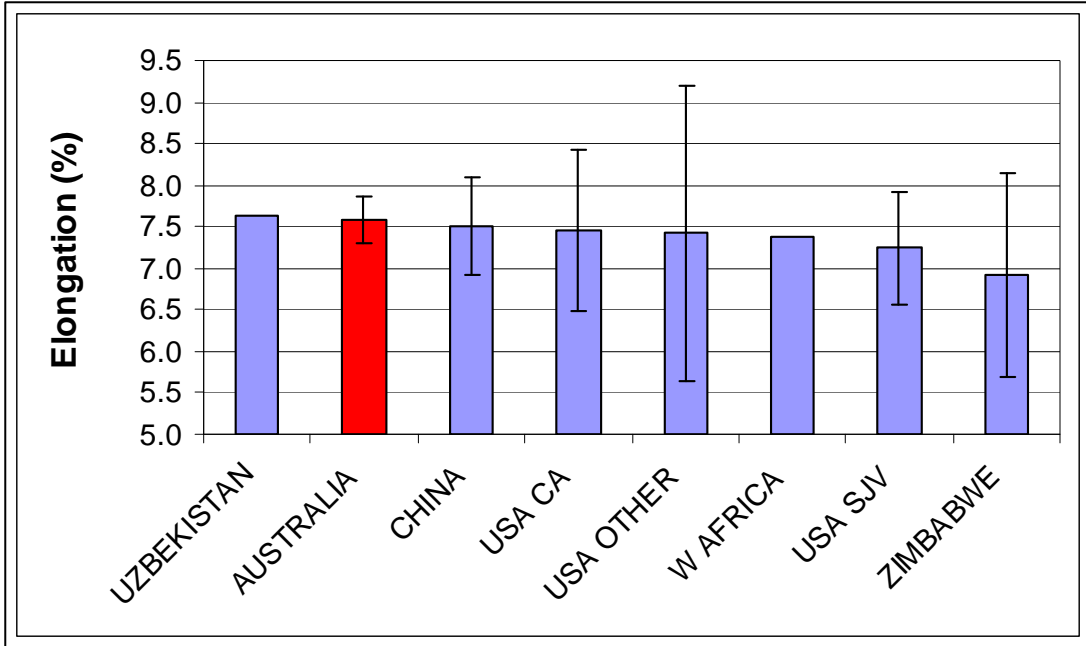


Figure 16 – Average fibre elongation in bale lay-down samples

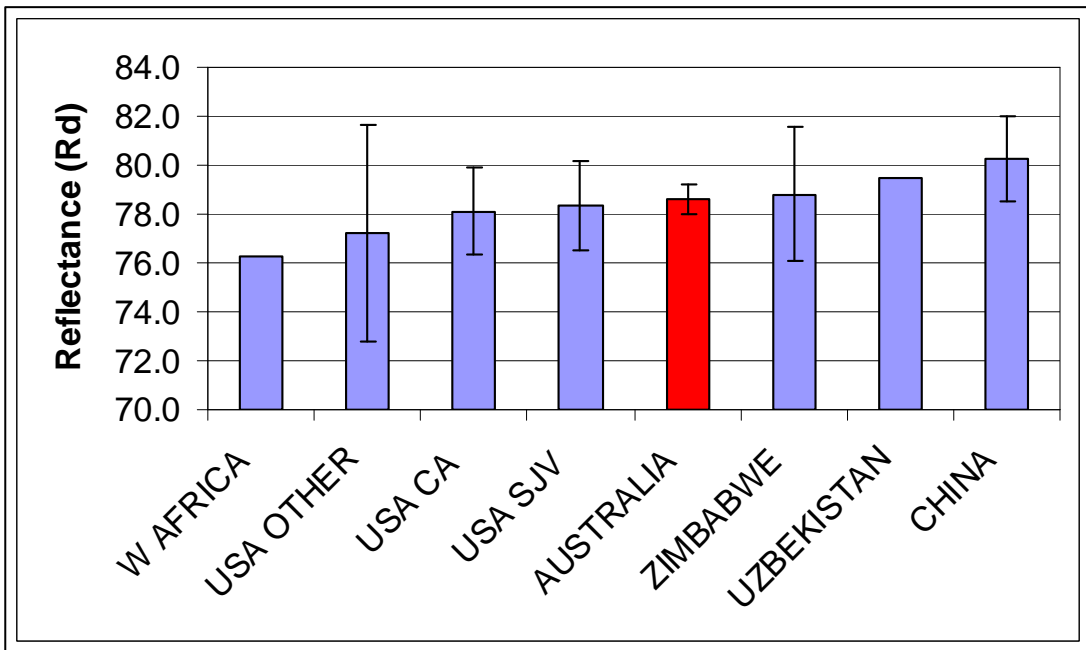


Figure 17 – Average reflectance (whiteness) in bale lay-down samples

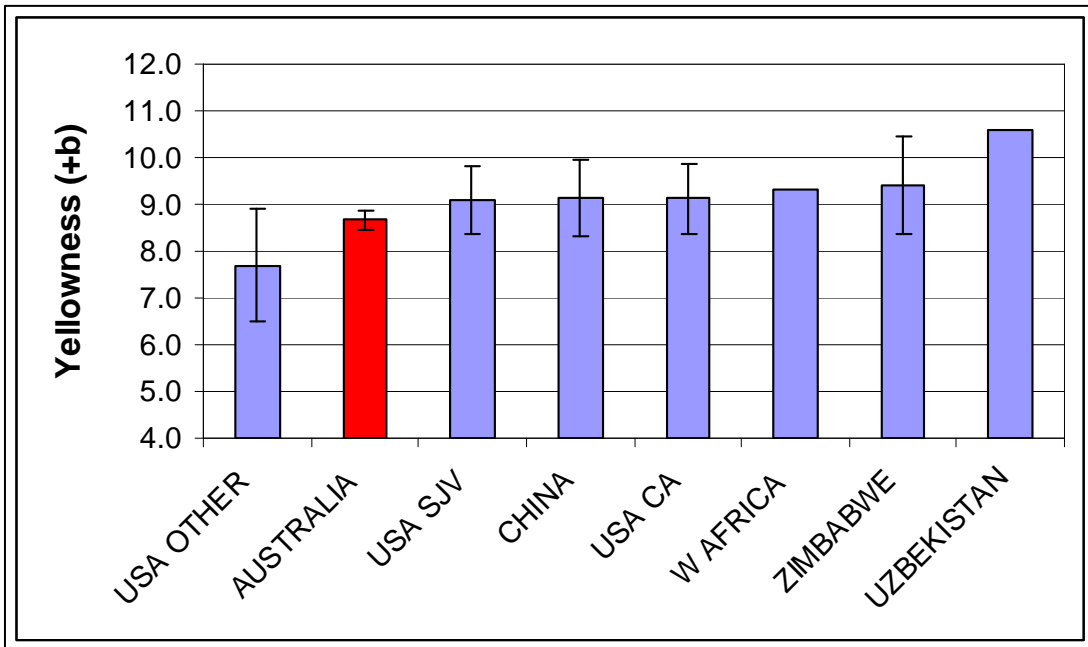


Figure 18 – Average yellowness in bale lay-down samples

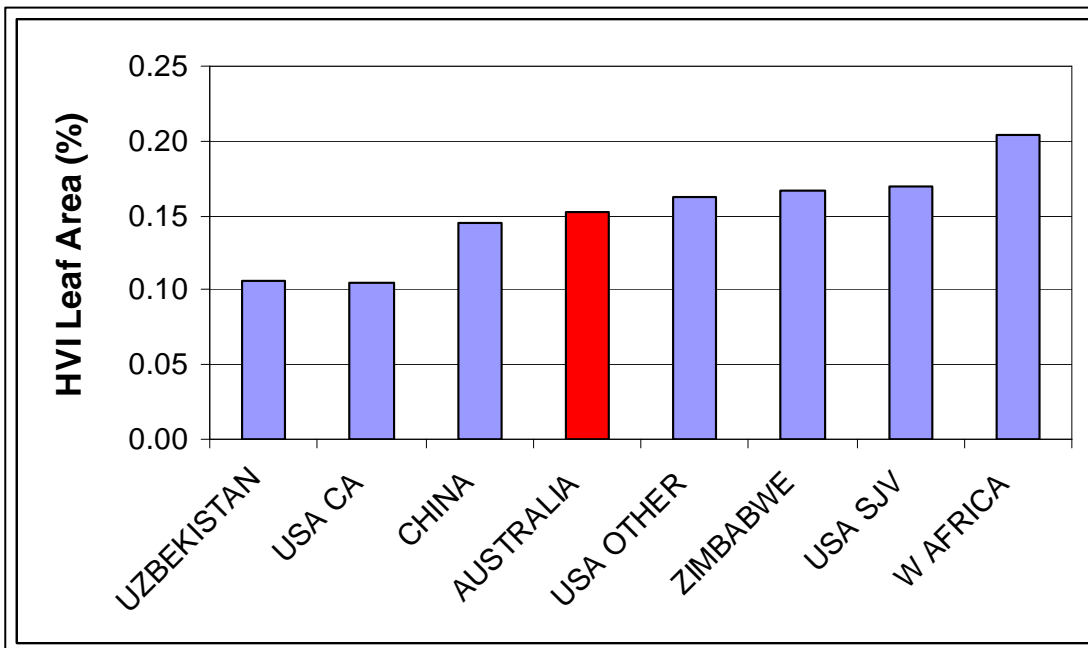


Figure 19 – Average HVI leaf area in bale lay-down samples

SECTION 3 – PRIORITISING RESEARCH AND DEVELOPMENT

Taking into consideration the fibre property areas that attracted criticism during the survey interviews, a number of R&D activities have been proposed (Table 7). Some areas are already under investigation (shaded rows). Descriptions of the proposed activities are cursory and focussed mainly on R&D in post-harvest areas, i.e. fibre after harvesting. It is acknowledged, however, that agronomists and plant breeders have a significant role in understanding the plant and environmental variables that control the fibre ripening process. Without a full understanding of this process there will always be large potential to compromise the quality of fibre sold to spinners.

It is recommended the Australian Cotton Industry standardize HVI testing and sales contract specifications and determine, and demonstrate, the validity of module averaging protocols used by Australian shippers. These recommendations are made in light of responses to questions in the survey regarding the availability and use of HVI data by mills.

It is recommended that the Industry regularly gathers formal and independent appraisals of its fibre quality using the same or a similar approach to that used in this survey in order to check progress against other growers and customer perceptions.

Table 7 – Recommended ‘Post-Harvest’ R&D Activities

Fibre property	Objective	Proposed R&D Activity
Micronaire	Produce fine and mature fibre	1. Development of direct, accurate and quick methods for measuring fibre fineness and maturity.
		2. Application of the above test methods to cotton variety selection, crop harvest management and the specification of Australian cotton.
		3. Investigate the main variables (nutrient, weather, water) affecting cellulose synthesis and fibre ripening in the cotton field.
Neps	Reduce nep in baled fibre	As per R&D Activities 1 & 2 4. Measure relationship between nep and fibre maturity.

		5. Benchmark nep type and level in Australian cotton using standard test method; including growing areas, varieties and gin treatments.
		6. Investigate and develop better (gentler) handling of fibre in harvesting and cleaning processes during ginning.
		7. Develop new harvest and/or ginning technology that reduces nep creation.
SFC	Reduce SFC in baled fibre	As per R&D activities 1 & 2 8. Measure relationship between SFC and fibre maturity.
		9. Investigate methods for measuring SFC with focus on methods that are more direct and accurate.
		10. Benchmark SFC levels in Australian cotton using current standard test method; including growing areas, varieties and gin treatments.
		As per R&D Activity 6
		As per R&D Activity 7
Strength	Improve fibre strength	11. Selection of high strength varieties and examination of these with respect to cellulose lay-down and environmental factors.
Dyeing ability	Improve fibre lustre	As per R&D Activities 1 & 2 12. Measure progress in industrial dyeing trials.
		13. Investigate relationship between light reflectance and fibre maturity.
	Improve dyeing consistency	14. Investigate the constitution of wax on Australian cotton particularly on cotton produced under water stress conditions.
		15. Investigate wax removal via bleaching and scouring.
Contamination	Contaminant free fibre	16. Identify best management practice to reduce contamination from farm, module covers, gin floor and bale wraps.
		17. Investigate replacing jute/Hessian bale

		wraps with 100% cotton bale wraps.
		18. Investigate prevalence and type of stickiness in Australian cotton; including growing areas, insect exudate and varieties.
		19. Benchmark seed-coat neps in Australian cotton; including growing areas, varieties and gin treatments.
New varieties		20. Assess new cotton varieties in terms of their spinning and dyeing characteristics before commercial release.

REFERENCES

1. Becerra, C. A. V., 'The World Cotton Market: A Long Term Outlook', WTO African Regional Workshop on Cotton, Cotonou, Benin, March 23-24, 2004.
2. Estur, G., 'Cotton Prices Recovered in 2002/03', International Cotton Advisory Committee (ICAC), **56** July-August, 5-8, 2003.
3. Curran, J., 'The Curran Report: A Review of the Australian Cotton Industry Classing Standards', report commissioned by the Australian Cotton Industry Council (ACIC), 51 pp, May 1998.
4. ITS Newsletter website [Error! Hyperlink reference not valid.](#)
5. Duessen, H., 'Rotor Spinning Technology', Schlafhorst Inc. (pub), 127 pp, 1993.
6. Toyo Keizai website <http://www.toyokeizai.co.jp>
7. 'Japan Cotton and Products Annual Cotton Report 2004' GAIN Report Number JA4710, USDA Foreign Agricultural Service, 8 pp, May 2004.
8. Spinners and Weavers Association of Korea (SWAK) website <http://www.swak.org>
9. Saha-Union Public Company Limited website <http://www.sahaunion.co.th>
10. Vidtayasuk, P and Tekacharin, B., 'The Textile Industry in Thailand', 7th Asia-Pacific Textile and Clothing Industry Forum, Chinese Tapei, December 9-11, 2002.
11. 'International Textile Machinery Shipment Statistics', International Textile Manufacturers Federation (ITMF) (pub), **26**, 2003.
12. 'Textile and Apparel Indonesia 2002-03', Japan Textile News (JTN) Special Edition, Osaka Senken (pub), 35 pp, 2003.
13. Woo, J. L. and Postle, R., 'Maturity and Dynamic Elastic Modulus of Cotton Fibers', *Textile Res. J.*, **48**, 68-72, 1978.
14. USDA AMS website <http://www.ams.usda.gov>
15. Cotlook website <http://www.cotlook.com>
16. Gordon, S., Evans, D., Church, J., Petersen, P., Thom, S. and Woodhead, A., 'A Survey of Cotton Wax Contents in Australian Cotton', project report to the CRDC, November 2002.
17. 'Cotton Ginners Handbook', Anthony, W. S. and Mayfield, W. D. (eds.), USDA Agricultural Research Service, 337 pp, December 1994.
18. Roberts, G., 'Cotton Ginning with Emphasis on Quality', project report to the CRDC, 2002.
19. Van der Sluijs, M., Gordon, S. and Naylor, G., 'Australian Fibre Quality and International Feedback', 12th Australian Cotton Conference, Broadbeach Queensland, August 10-12, 2004.

20. 'Cotton Contamination Survey 1999 – 2001 - 2003', International Textile Manufacturers Federation (ITMF) (pub), June 2003.

Appendix 1

Australian Cotton Industry Fibre Quality Mill Survey

CSIRO Textile and Fibre Technology

August 2002

Background to Survey

The Australian Cotton Industry through the Commonwealth Scientific and Industrial Research Organisation Textile and Fibre Technology Division (CTFT) and with the support of the Australian Cotton Co-operative Research Centre (CRC) and the Australian Cotton Shippers Association (ACSA) is conducting a survey to find out how customers of Australian cotton, i.e. spinning mills, perceive the quality of Australian cotton fibre.

The survey involves visits by CTFT staff to nominated spinning mills in your country with the list of questions attached below. We hope that CTFT can conduct interviews with mill management and quality control staff about the quality of Australian cotton used in their mill.

The survey questions to be asked are divided into two areas:

1. Background.
2. Perceptions and Needs.

In the Background section there are 12 questions about the mill and its current use of Australian cotton. In the Perceptions and Needs section there are 19 questions about the mill's perceptions of Australian fibre quality in relation to specific fibre properties. The questions in this latter section ask for the mill's perception about the quality of a range of parameters, the minimum or maximum value of the particular parameter required for satisfactory quality and production and the effects in the mill with regards to yarn/fabric quality/production if that parameter does not meet the specified minimum or maximum.

At all times the identity of the mills and their responses will be confidential and subject to a non-disclosure agreement between CSIRO TFT and each mill.

Survey Questions

Background Questions

1. Country?
 - a) Indonesia Thailand Japan S. Korea
2. What type of spinning systems are used in your mill?
 - a) Open End
 - b) Ring
 - c) Air-Jet
 - d) Vortex
 - e) Other
3. What type of fibres and blend ratios are spun?
 - a) Cotton
 - b) Polyester
 - c) Viscose
 - d) Acrylic
 - e) Wool
 - f) Other
4. What is the annual yarn production?
5. What range of yarn counts does the mill spin?
6. What percentage of Australian cotton does the mill use in its bale laydown/mix?
7. What is the annual volume of Australian cotton used?
8. How is the Australian cotton you buy described?
 - a) Shipper Type
 - b) USDA Grade
 - c) Other
9. What fibre properties are specified on the sales contract?
 - a) Micronaire
 - b) Staple length
 - c) Short fibre index

- d) Length uniformity
- e) Strength
- f) Extension
- g) Other

10. Do you require HVI data for Australian cotton?

11. Is the HVI data you require supplied by your Shipper or measured at your mill?

12. How does the mill use the HVI results that are provided?

- a) To check against the sales contract
- b) To help bale laydown management
- c) To help predict yarn quality
- d) To help predict yarn production

Perception and Needs Questions

Quality of Australian Cotton with respect to:

13. Price?

14. Micronaire

- a) What do you think of Australian cotton in terms of its average Micronaire?
- b) What Micronaire values or range of Micronaire values do you use in your bale laydown to be able to spin high quality yarns?
- c) How does Micronaire affect the quality of your yarn (or finished fabric)?

15. Staple Length

- a) What do you think of Australian cotton in terms of its staple length?
- b) What is the minimum staple length you must use in your bale laydown to spin high quality yarns?
- c) How does staple length affect the quality of your yarn (or finished fabric)?

16. Length Uniformity

- a) What do you think of Australian cotton in terms of its length uniformity?
- b) What is the minimum length uniformity you must use in your bale laydown to spin high quality yarns?
- c) How does length uniformity affect the quality of your yarn (or finished fabric)?

17. Short Fibre Content?

- a) What do you think of Australian cotton in terms of its short fibre content?
- b) What is the maximum short fibre content you can allow in your bale laydown so that you can spin high quality yarns?
- c) How does short fibre content affect the quality of your yarn (or finished fabric)?

18. Strength?

- a) What do you think of Australian cotton in terms of its strength?
- b) What is the minimum strength you must use in your bale laydown to spin high quality yarns?
- c) How does strength affect the quality of your yarn (or finished fabric)?

19. Extension?

- a) What do you think of Australian cotton in terms of its extension?
- b) What is the minimum extension you must use in your bale laydown to spin high quality yarns?
- c) How does extension affect the quality of your yarn (or finished fabric)?

20. Classers Grade?

- a) What do you think of Australian cotton in terms of its grade?
- b) What is the minimum classer's grade allowable in your bale laydown to spin high quality yarns?
- c) How does classing grade affect the quality of your yarn (or finished fabric)?

21. Colour?

- a) What do you think of Australian cotton in terms of its colour, i.e., in terms of its whiteness and its yellowness?
- b) What is the minimum colour grade allowable in your bale laydown to spin high quality yarns?
- c) How does colour affect the quality of your yarn (or finished fabric)?

22. Trash Content?

- a) What do you think of Australian cotton in terms of its trash content?
- b) What is the minimum trash content allowable in your bale laydown to spin high quality yarns?
- c) How does trash content affect the quality of your yarn (or finished fabric)?

23. Contamination?

- a) What do you think of Australian cotton in terms of its contamination levels?
- b) How does contamination in Australian cotton affect the quality of your yarn (or finished fabric)?

24. Maturity?

- a) Do you measure cotton fibre maturity?
- b) What do you think of Australian cotton in terms of its fibre maturity?
- c) What is the minimum fibre maturity allowable in your bale laydown to spin high quality yarns?
- d) How does fibre maturity affect the quality of your yarn (or finished fabric)?

25. Fineness?

- a) Do you measure cotton fibre fineness?
- b) What do you think of Australian cotton in terms of its fibre fineness?
- c) What is the minimum or maximum fibre fineness allowable in your bale laydown to spin high quality yarns?
- d) How does fibre fineness affect the quality of your yarn (or finished fabric)?

26. Number of Neps?

- a) Do you measure cotton neps?
- b) What do you think of Australian cotton in terms of neps?
- c) What is the maximum number of neps allowable in your bale laydown to spin high quality yarns?
- d) How do neps affect the quality of your yarn (or finished fabric)?

27. Types of Neps?

- a) What type of nep causes the most trouble in terms of yarn or fabric quality in your mill?
- b) How do you measure these neps?

28. Dyeing ability?

- a) What do you think of Australian cotton in terms of its dyeing ability?
- b) How do you measure or assess the dyeing ability of Australian cotton?

29. Wax Content?

- a) Is the level of cotton wax an important issue for you in your mill?
- b) If so, how does it affect the quality of your yarn (or finished fabric)?

30. Spinning Ability?

- a) Do you measure cotton spinning ability?
- b) What do you think of Australian cotton in terms of its spinning ability?

31. Other properties of Australian cotton that interest or concern you?

- a) Are there any other fibre properties of Australian cotton that interest or concern you?
- b) How do these properties affect the quality of your yarn (or finished fabric)?

Appendix 2
CSIRO AUSTRALIAN COTTON
LAYDOWN SAMPLING PROCEDURE

Procedure to collect fibre samples from bale lay-downs containing Australian cotton

Before starting the sample collection, the following information is required.

1. Mill name and address
2. The total number of bales in the lay-down.
3. The number of Australian bales in the lay-down.
4. The proportions of cotton from other countries in the lay-down.
5. The intended yarn counts to be spun using this lay-down.

A separate sheet is provided to enter this information.

A minimum of 100 grams of cotton is required from the lay-down being sampled. For example, for a twenty-bale lay-down, 5 grams (a small handful) per bale should be collected and for a ten-bale lay-down, 10 grams per bale should be collected.

All bales in the lay-down should be sampled whether or not they come from Australia. Please keep cotton samples from different countries separate. Six plastic bags are supplied in case the lay-down should contain cotton from six different countries. Please place the cotton samples from each country in a separate plastic bag and label the bag with the country of origin and variety or type of cotton, if this is known.

The sample bags should be sealed and placed together with information sheet in the Fedex Post Pack supplied. Please ensure that the Shipment information on the Post Pack is filled out correctly.

Please call Fedex to pick up the Post Pack.

Thank you

Lay-down Background Information

1. Mill name and address?
2. The total number of bales in the lay-down?
3. The number of Australian bales in the lay-down?
4. The proportions of cotton from other countries in the lay-down?
5. The intended yarn counts to be spun using this lay-down?

Appendix 3
SPINNING COMPANIES SURVEYED

Spinning Company Address	Phone	Fax
Japan		
UNITIKA TEXTILES LTD., 3-5-13, Kyutaro-machi, Chuo-ku, Osaka 541-0056, Japan	81-6- 6253 7105	81-6- 6253 7124
SHIKIBO LTD., 3-2-6, Bingomachi, Chuo-ku, Osaka 541-8516, Japan	81-6- 6268 5505	81-6- 6262 0945
NISSHINBO INDUSTRIES LTD., 2-4-2, Kitakyuhoji-machi, Chuo-ku, Osaka 541-0057, Japan	81-6- 6267 5550	81-6- 6267 5689
KURABO INDUSTRIES LTD., 4-31, 2-Chome, Kyutaro-machi, Chuo-ku, Osaka 541-8581, Japan	81-6- 6266 5213	81-6- 6266 5380
TOYOBO CO. LTD., 2-8, Dojima Hama 2-Chome, Kita-ku, Osaka 530-8230, Japan	81-6- 6348 3642	81-6- 6348 3800
FUJI SPINNING CO. LTD., 8-12, 1-Chome, Honmachi, Chuo-ku, Osaka, Japan	81-6- 6268 9815	81-6- 6268 2532
DAIWABO CO. LTD., Midosuji Daiwa Building, 6-8, Kyutaromachi 3-Chome, Chuo-ku, Osaka 541-0056, Japan	81-6- 6281 2407	81-6- 6281 2527
DAIICHI CO. LTD., Hokoku Building, 1-6-28 Nakatsu, Kita-ku, Osaka-shi, Japan	81-6- 6377 1575	81-6- 6377 1590
South Korea		
KABOOL LTD., Kabool Building, 149, Seoul-dong, Choongno-gu, Seoul, Korea 110-726	82-2- 3701 7270	82-2- 3701 7100~7
CHOONGNAM SPINNING CO. LTD., Chung-Hwa Building, 62-5 1-Ka, Taepyung-ro, Choong-ku, Seoul, Korea	82-2- 724 1571	82-2- 720 6215
YOUNGNAM TEXTILE CO. LTD., Kwang Hee Building 15F, 216, 1-Ga, Kwang Hee Dong, Chung-Ku, Seoul, Korea	82-2- 2278 0451	82-2- 2278 2344
ILSHIN SPINNING CO. LTD., 15-15, Yoido-Dong, Youngdeungpo-ku, Seoul, Korea	82-2- 3774 0252	82-2- 786 5892

TAIHAN TEXTILE CO. LTD., Taihan Building, 25, Yeoeuido-Dong, Youngdeungpo-gu, Seoul, Korea 150-878.	82-2- 368 0302	82-2- 368 0344
KYUNGBANG LTD., 441-10, 4-Ka, Youngdungpo-Dong, Youngdungpo-ku, Seoul, Korea	82-2- 2639 6241	82-2- 2639 6248
PUNGHAN CO. LTD., 11th Floor Doosan Building, 105-7, Nonhyun-Dong, Kangnam-ku, Seoul, Korea	82-2- 3218 1790	82-2- 3218 1880
PANGRIM CO. LTD., 54, 3ka Munrae-Dong, Youngdeungpo-ku, Seoul, Korea	82-2- 2630 2290	82-2- 2636 2377
Thailand		
NAN YANG KNITTING FACTORY CO. LTD., 71 Moo 12 Phetkasem 71 Rd., Nongkham, Bangkok 10160 Thailand	66-2- 421 2150	66-2- 421 1066
KANGWAL TEXTILE CO. LTD., 1426/18-20 Soi Yossae, Krungkasem Rd., Pomprab, Bangkok 10100 Thailand	66-2- 226 0037	66-2- 224 7204
SAHA-UNION PUBLIC CO. LTD., 1828 Sukhumvit Rd., Bangjak, Phrakanong, Bangkok 10250 Thailand	66-2- 311 5111	66-2- 331 5668
THAI INDUSTRIES DEVELOPEMNT CO. LTD., 710/5-6 Sukhumvit Rd., Near Soi Aree 26, Bangkok 10110 Thailand	66-2- 259 0123-8	66-2- 258 6275
K. COTTON & GAUZE CO. LTD., 3 rd Floor 95 Suapa Rd., Pomprab, Bangkok 10110 Thailand	66-2- 225 0060	66-2- 224 0716
NUMKRAI CHEMICAL CO. LTD., 109 Moo 7, Soi Onnuj 77, Latkrabang, Bangkok 10520 Thailand	66-2- 329 1440-1	66-2- 329 1217
S. R. SPINNING CO. LTD., 729/77-78 Ratchadapisek Rd., Bangpongpan, Yannawa, Bangkok 10120 Thailand	66-2- 683 8723-6	66-2- 683 8721
Indonesia		
PT. SINAR CENTRAL SANDANG Spin. Mills, Setia Building 27, K.H. Hasyim Ashari, Jakarta 10130 Indonesia	62-21- 632 8071	62-21- 632 8371
PT. APAC INTI CORPORA,	62-21-	62-21-

GRAHA BIP 10 th Floor, Jl. Jend. Gatot Subroto Kav. 23, Jakarta 12930 Indonesia	522 8888	525 8300
PT. INDORAMA SYNTHETICS, Kembang Kuning, Ubrug Post Box 7, Jatiluhur Purwakarta, Indonesia	62-264- 202 311	62- 264- 201 431
PT. SUNRISE BUMI TEXTILES, Menara Batavia Level 16, Jl. K. H. Mas Mansyur Kav. 126, Jakarta 10220 Indonesia	62-21- 572 2442	62-21- 572 2441
Australia		
ROCKLEA SPINNING MILLS PTY. LTD. ⁶ , Unit 15 'ALMA' 663 Victoria St., Abbotsford Victoria 3067 Australia	61-3- 9428 9264	61-3- 9251 9860
LEADING SPINNING PTY. LTD., 43-45 Tullamarine Park Rd., Tullamarine Victoria 3043 Australia	61-3- 9335 1288	61-3- 9330 1713
BRADMILL PTY. LTD., 341 Francis St., Yarraville Victoria 3013 Australia	61-3- 9274 6200	61-3- 9274 6201
A.W. SPINNING PTY. LTD., 16- 22 Maffra St., Broadmeadows Victoria 3047 Australia http://www.whitepages.com.au/wp/search/redirect.jhtml?url=	61-3- 9302 1122	

⁶ Company ceased operations in late 2003