A spinner's perspective on fibre fineness and maturity

By Marinus H. J. van der Sluijs, Stuart G. Gordon and Robert L. Long,
CSIRO Textile and Fibre Technology

While there is no doubt that Australian cotton is viewed worldwide as a quality fibre by overseas spinning mills, the industry faces increased competition in the quality stakes from cotton produced in the US, China, Brazil and West Africa. Coupled with this, feedback from spinning mills has highlighted that in order for Australian cotton to retain its status as a premium growth, some aspects of Australian fibre quality need to be improved.

Recently the production of high micronaire cotton has become a quality issue for Australian cotton. The object of this article is to explain the reasons why micronaire is such a major issue for spinners.

In today's highly competitive and incredibly global textile market where greater demand is being placed on fibres by modern technology and high speed machinery, a spinning mill cannot remain competitive and survive if it does not produce a quality yarn in a cost-effective way.

In order to achieve production efficiency, a spinner needs intimate knowledge of the fibre properties of the cotton lint used in order to control processing performance, operating costs (raw cotton contributes 50–70 per cent to the total yarn manufacturing costs) and the qual-

TABLE 1: Spinner's cotton fibre property requirements

Fibre properties	Preferred value upland	Preferred value ELS
Length	1 1/8 inch (36/32nd)	1 7/16 inch (46)
Uniformity	>81 per cent	>85 per cent
Strength	>29 g/tex	>38 g/tex
Micronaire	3.8 – 4.6	3.5 – 4.1

ity of the yarn and ultimately, the fabric produced from the cotton.

Three different spinning systems are used to convert cotton fibre into yarn:

- Ring spinning system, which is the dominant spinning system world-wide. Sixty per cent of all short-staple (cotton and cotton-blend) yarns and the majority of Australian cotton are spun on this system.
- Open-end or rotor spinning system – upon which around 30 per cent of short-staple yarns are produced.
- Air-jet spinning and Friction spinning systems, upon which around 10 per cent of short-staple yarns are spun.

The important fibre properties for a spinner with respect to these spinning systems include staple length, length uniformity, short fibre content, staple strength, elongation, fibre fineness, neps, trash, maturity, stickiness and contamination, with the most important fibre properties being fibre fineness (currently measured by the micronaire test), staple length, staple strength and trash content.

Australian cotton is generally viewed as a quality fibre and is usually purchased with the intention of producing high quality fine count yarns on the ring spinning system. The most common yarns produced from Australian upland type cottons are 30 tex (20 Ne) to 12 tex (50 Ne) count yarns, of which at least 25 per cent are combed.

These yarns are used to construct a wide range of reasonably high-end woven and knitted fabrics. For comparison, the most common yarns produced from fine, extra long staple (ELS) (Pima) type cottons are in the 12 tex (50 Ne) to 7.5 tex (80 Ne) count range, of which the majority is combed and used in finer, higher quality knit and woven fabrics. In order to produce successful yarns in these count ranges, cotton fibres must have the properties listed in Table I.

MICRONAIRE

Micronaire readings are determined by measuring the air-flow resistance through a plug of cotton fibres of a given weight. Currently, the commercial trade relies on micronaire readings to indicate the fineness of cotton, despite it being well known that the micronaire reading represents a combination of fibre fineness and maturity, and as a result is not a particularly accurate measure of either important parameter. As the needs of spinners become more sophisticated, micronaire will increasingly fail to provide adequate information.

For the spinner there are two potential problems in managing quality using the micronaire value. Low micronaire may (but not always) indicate the presence of immature fibre and high micronaire values may (but not always) indicate that the cotton is coarse. Both situations are problematic for the spinner.

In order to spin medium staple cotton into reasonable quality ring-spun yarn, a spinner needs at least 80 fibres in the yarn cross section, more than 100 fibres in an open-end yarn cross-section and more than 75 fibres in an air-jet spun yarn. To produce light weight fabrics, fine count yarns are required, which means that fine (and

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long) fibres are required to obtain the minimum number of fibres in the cross-section.

For a given yarn count, yarns with better evenness and strength are more easily produced from finer fibres as the yarn cross-section can then contain more fibres than an equivalent yarn constructed from coarser fibres. The physical model for yarn evenness and strength will be discussed in more detail in a subsequent article but for the moment it is important to remember that both yarn count (how fine) and yarn quality (how even and strong) are the main reasons why fibre fineness is so important, and thus why spinners prefer to purchase fibres with a specified fineness.

But without an accurate measure of fibre fineness the spinning industry is forced to adopt a risk minimisation strategy by choosing cottons within a relatively narrow micronaire band, as highlighted in Table 1. Within these bands the spinner can be reasonably assured that the fineness and maturity of the fibre will translate into good quality yarn.

In the international cotton fibre market, micronaire values less than 3.4 and greater than 5.0 are considered to be in the discount range; the range 3.5 to 4.9 is regarded as base grade while 3.7 to 4.2 is considered to be the premium range, for which some spinners are prepared to pay a premium. Cotton in Australia is similarly classed and cotton with micronaire values that fall out of the base grade (also known as the G5 range) are discounted as highlighted in Table 2.

Figure 1 shows the micronaire ranges of the Australian cotton crop from 1992 through to 2007 as published by the Australian Cotton Shippers Association. The percentage of cotton in the 'premium' G5(B) range has fallen since 2000 from around 75 per cent of the crop to 45 per cent of the crop in 2007, while the percentage of cotton in the coarser G5(C) range has increased from 10 per cent of the crop in 2000 to over 40 per cent in the 2007 crop. The reasons for this increase in micronaire are many and outside the scope of this current discussion but a combination of genetic, management and environmental factors over the past few years has combined to produce coarser and more mature fibre at harvest.

FIGURE 1: Micronaire values for Australian cotton crop 1992–2007

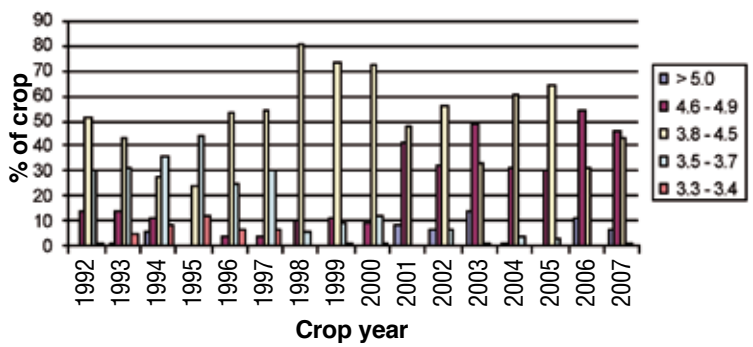

TABLE 2: Micronaire range and discounts for Australian cotton

Micronaire	Description	Discount[1]	$AUD/Bale[2]
> 5.3	G7	850 points	53.10
5.2 – 5.0	G6	550 points	34.40
4.9 – 3.5	G5[3]	Base	0
3.4 – 3.3	G4	500 points	31.30
3.2 – 3.0	G3	1150 points	71.90
2.9 – 2.7	G2	1400 points	87.50
2.6 – 2.5	G1	1750 points	109.40
< 2.4	G0	3000 points	187.50

1 Australian Industry average
2 Using typical exchange rate of $AUD 1.00 to $US0.80
3.The G5 range is split into subgroups G5A (3.5 – 3.7), G5B (3.8 – 4.5) and G5C (4.6 – 4.9), with some merchants willing to pay a premium for cotton in the G5B range.

As mentioned, Australian cotton is purchased to produce premium fine count yarns and in order to do this successfully the spinner needs to purchase cotton that is not only long and strong but has a fibre fineness value in the 'premium' range.

Assuming a constant maturity ratio of 0.85 (considered an average maturity value for commercial cotton), spinners have trouble producing fine cotton yarns (15 tex or lower) when micronaire is greater than 4.5 in ring spinning systems.

CONCLUSION

Yarn quality and processing performance in a spinning mill is of utmost importance and is determined by a number of factors. Predominant of these is the number of fibres in the cross section of a yarn, determined by the fineness of the cotton fibre being used.

The recent high micronaire values of the Australian crop has become a concern to spinners as this means that higher quality finer count yarns (such as 15 tex and lower) cannot be spun from Australian cotton, which means that spinners are forced to source what they require elsewhere.

It is well known and documented that micronaire is a combination of maturity and fineness, and that by itself the micronaire value is unable to properly distinguish premium fine mature cotton from immature, coarser cotton. While there are already a number of methods for measuring fibre maturity and fineness, no one method is able to do so accurately and with the speed requirement for classing purposes.

The development of the Cottonscan (fibre fineness) and SiroMat (fibre maturity) instruments by CSIRO Textile and Fibre Technology is aimed at creating fast and accurate instrument test methods for breeders, merchants and spinners alike to manage fibre fineness and maturity. Part 2 of this article will demonstrate the benefits of using separate fibre fineness and maturity values over the sole micronaire measurement in the management yarn and fabric quality.