Farming for Fibre Quality – Smart Decisions

Grant Roberts, Greg Constable, Michael Bange and Clare Felton-Taylor,
Australian Cotton Cooperative Research Centre and CSIRO Plant Industry, Narrabri, NSW 2390

Abstract

Cotton fibre quality is attracting more attention as growers are receiving increased feedback from endusers that if Australia is to maintain its position as a world leader in machine picked cotton it must minimise poor fibre properties. High or low micronaire, short fibre, neps and sticky cotton are parameters that mills are becoming concerned about. On-farm agronomy can influence fibre quality in many ways, although picking and ginning will determine the final quality characteristics.

Fibre development responds directly to the environment, management and stresses. As a result, correct variety choice for the growing region combined with reduced stress management will optimise fibre quality. Of the manageable stresses, water management is particularly important in determining length, strength and micronaire. Correct defoliation timing is also important in reducing neps.

In the future, new fibre measurement instruments are being developed that will supersede some common HVI measurements and help match the spinning characteristics of the cotton more closely to the measured attributes. This will provide improved feedback for growers and ginners and hopefully build a closer link between the enduser and the grower.

The development of FIBREpak will hopefully encompass all this information and allow growers to manage for both yield and quality.

Introduction

High gross margins are nearly always associated with high yielding fields. This is because yield is the main driving factor on the income side of the gross margin equation. Hence agronomy in the Australian cotton industry has largely tended to focus on managing crops for high yields. The other component is of course price, which has two components; a base price and a fibre quality adjustment price. The world cotton base price is mostly a result of supply, demand and government intervention programs. Adjustments to this base price are then made on fibre quality, with cotton that has excellent spinning and dyeing characteristics being the most sort after and saleable. Premiums or discounts on a bale basis, can make a significant alteration to the income side of a gross margin.

Three components have been identified that affect fibre quality parameters before processing at a mill. These are crop agronomy (variety × management package), picking and ginning. All three are interlinked to some extent and hence practices that affect crop

agronomy may impact on both picking and ginning. An example could be a poor defoliation, coupled with a forced picking time resulting in high levels of trash. This would then affect the type of ginning process, possibly resulting in a downgrade of quality if excessive cleaning was required. Hence field management decisions can be very important to the final quality achieved and the resulting bale price.

There is increasing pressure to ensure that Australia maintains its excellent record for high quality machine picked cotton. An important starting point is ensuring that crop management is not at fault in reducing fibre quality before the picking and ginning processes begin. There are many measures of fibre quality: from a simpler system of grade and staple, we now have instruments to quickly also measure length, strength, micronaire, uniformity, short fibre, elongation and fibre maturity. Increasingly, neps can also been considered as a quality parameter gaining more attention.

This paper aims to discuss the agronomic management options that may influence fibre quality. In reality it is always a balancing act between what is desirable and what is achievable given the need to finish a crop off and get it picked. There would appear to be no evidence suggesting that high yielding crops, if managed correctly, cannot have excellent fibre quality compared to regional or district average crops. On the contrary it is likely that high yielding crops, because of excellent management, will by default also have good quality.

Fibre development

Fibre quality is a combination of two components. The first is the genetic attributes of the variety and the second is the environment in which the fibres develop. The combination of these two, provides the fibre quality up to picking. Breeders to aim continually improve fibre quality, or at least to optimise the balance between yield and quality. The challenge with micronaire is the increasing tightening of the discount parameters. As seasonal conditions have a large influence on micronaire (fig. 1), the only option is to aim for the middle of the acceptable range.

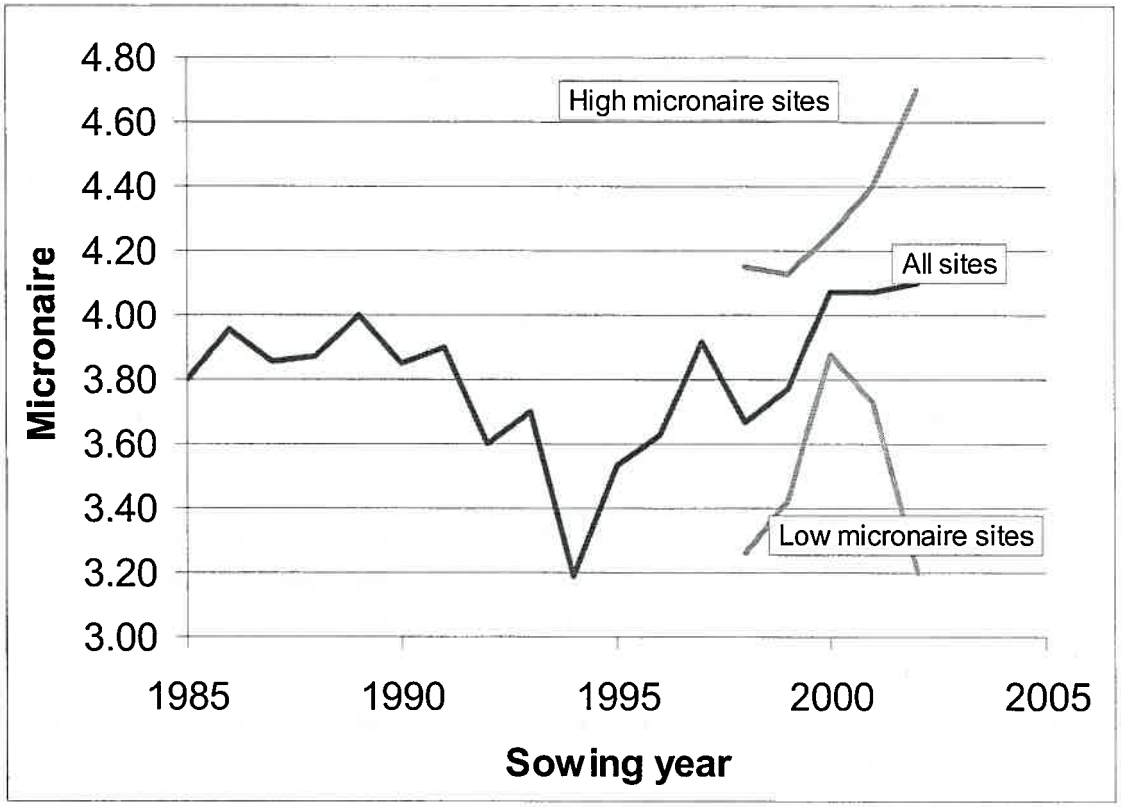

Figure1. HVI micronaire of two old varieties (DP16 and Namcala) for 18 years to 2001/02. Mean of 13 sites including Emerald, Biloela, Theodore, Brookstead, Boggabilla, St George, Collarenabri, Moree, Bourke, Merah North, Myall vale, Breeza, Warren and Hillston.

Immediately after flowering, the development of the fibre follicle starts. From this period until around day twenty after flowering the length of the fibre is being determined. During this period water stress is the critical attribute that will determine how long the fibre is. This is the primary reason that dryland crops, which can have periods of water stress, often have reduced length. Good agronomy practice from the fibre quality and yield perspective is to ensure once flowering begins that water status is good. This requires monitoring of soil water deficits to ensure that watering is optimum. Knowing the soil water deficit and matching this with boll number and growth stage of the plant will allow fine tuning of watering programs.

Fibre thickening doesn't start to occur until around 28 days after flowering. From this period onwards temperature and stress are the main components affecting fibre thickness, although boll load has an influence. Fibre from bolls lower down on the main stem has higher micronaire due to development in optimum growing conditions with minimal stress, allowing good fibre wall thickening. Fibre from bolls towards the top of the plant is not as lucky and the micronaire decreases. Boll position can therefore be important in adjusting micronaire, although in reality because it is a retrospective measurement after the season has finished, nothing can really be done. Attempting to

adjust boll numbers for micronaire would be high risk, unless extremely accurate predictions for the entire fibre development period were available.

Farm management that affects fibre quality

Many factors interact in a cropping system. Direct and indirect effects on fibre growth and cumulative stresses are important to recognise and diagnose so they can be corrected. Stress at one point in a season may have indirect consequences on fibre quality by changing the boll setting pattern for example. Excess nitrogen rates or events which cause late regrowth, can reduce fibre quality by having fibre development occurring in cooler weather (and reducing micronaire). Regrowth can increase trash and reduce grade.

Irrigation

Good plant moisture status is critical in the first 20 days after flowering to allow potential fibre elongation rates. With about five weeks of effective flowering and another three weeks to complete fibre elongation, a total of eight weeks without stress is required to have uninterrupted fibre length in all bolls. Healthy soil and irrigation scheduling to take account of soil water holding capacity and evaporative demand are key approaches to managing plant moisture status.

Crop Growth Habit

A uniform set of bolls is more likely to provide uniform fibre. Late flowering and especially regrowth will cause fibre quality problems directly in fibre properties and indirectly with grade, so agronomy should aim to produce a crop which optimises plant size and sets bolls when possible. The application of large quantities of mepiquat chloride (Pix) at the last effective square has become a common practice in many cotton growing regions. The aim is to reduce top growth of the plant and minimize plant resources going into fruit that is unlikely to be pickable at harvest time. Pix is unlikely to have a negative effect on fibre quality and may help reduce neps in late crops that are going to produce bolls outside the normal harvestable range.

Okra leaf varieties are also known to cause an increase in trash content as the leaf shape stops the leaf from falling easily to the ground. Approximately half a grade decrease can result. A balance between the okra varieties positive attributes and the potential for a small downgrade need to be taken into account.

Defoliation

The type of defoliation product is unlikely to impact on fibre quality.. In a small experiment at St George in 2000/01 Dropp Liquid + Finish, Dropp Liquid + Prep and Dropp WP were compared for neps. No significant differences were recorded between these products in the number of calculated neps/gram.

In contrast the timing of defoliation can have a big impact on the fibre quality of cotton. Table 1 provides data on the effect of time of defoliation with Dropp L in an irrigated crop. Early defoliation can cause a significant reduction in all desirable fibre properties and significantly increases the number of neps. The main effect is the reduction in fibre properties occurring in the upper top quarter of bolls. This can also significantly increase the number of neps, as the top quarter of plant is where the least mature fibres occur. This data shows that length and strength are only affected with very early defoliations. Micronaire is however more sensitive to timing of defoliation as the fibres require the increased time to mature. Extremely early defoliation has the effect of damaging all bolls in all positions and this is evident with the large increase in neps when defoliations were conducted at 5% and 17% timings. The increase in number of neps at the 80% timing is most likely the result of additional bolls being picked that were not open at the 65% timing. Some of these would undoubtedly have less mature fibres, contributing to the increase in numbers of neps.

Table 1. Effect of time of defoliation on fibre properties, as measured by HVI, of Sicot 289i. Neps were calculated using an equation using fineness, maturity and length uniformity.

Defoliation Timing % open	Length (inches)	Strength (g/tex)	Micronaire	Neps neps/g
5%	1.15	29.7	2.8	269
17%	1.16	31.2	3.6	182
30%	1.17	31.7	4.0	130
50%	1.16	31.7	4.4	126
65%	1.18	32.0	4.3	99
80%	1.17	31.8	4.2	127
lsd	0.02	0.6	0.2	22

Figure 2 demonstrates the influence that later bolls have on overall fibre quality. Picking in this experiment started when 5% of the bolls were open and finished when the last harvestable boll was ready. The mean neps number for the crop was 118 neps/gram however the last two picks contributed to nearly a third of this total.

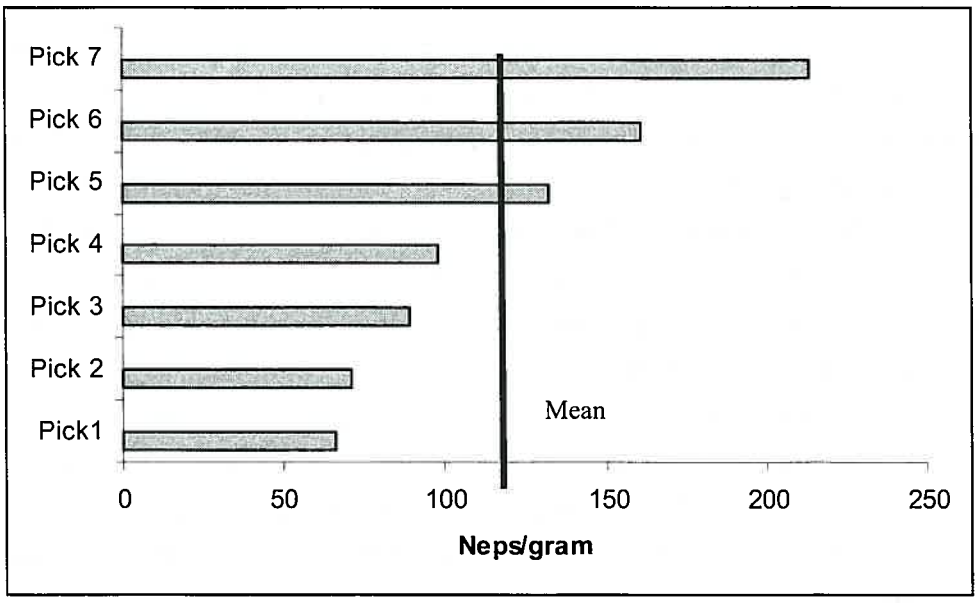

Figure 2. Neps/gram at each picking date. Picking started when 5% of bolls were open and continued weekly until the last harvestable boll was open. Neps were calculated using an equation using fineness, maturity and length uniformity.

Transgenic/IPM Era

The widespread adoption of Bollgard II varieties coupled with more selective *Helicoverpa* targeted sprays and increased resistance to aphicides has the potential to increase late season aphid infestations. This plus the increase in whitefly in some regions could result in an increase in sticky cotton, not liked by spinners. Accurate scouting and appropriate thresholds should be used in managing these pests.

New Decision Support Tools

It is important to note that the methods of measuring fibre properties, classing, evaluating and selling cotton have changed very little in several decades (Hunter 2003). However, this is likely to change due to several new developments in technology and increased feedback from the end users. New instruments that measure fibre properties are being developed and surveys of mills and end user requirements are changing thoughts on quality parameters. CSIRO's Textile and Fibre Technology cotton Unit have been heavily involved in developing improved measures of fineness and maturity. Both polarised light instrumentation and 'Cottonscan' have been developed to provide alternative or better measures of fibre fineness and maturity, than the current industry standard of micronaire (Gordon and Naylor 2004). Although it is likely that high volume instrumentation (HVI) and physical classing will still be the main method of quality appraisal for some years to

come, as the textile industries require confidence in new technology before rapid adoption will occur. Recent surveys of mills has also suggested that refinements to our ginning practices could be made that improve the quality above what is currently been achieved (van der Sluijs *et al.* 2004).

The recent development of a fibre sub-routine for the OZCOT model has now added another output component that can be simulated along with yield. Length and micronaire can now be simulated with possible future developments for strength, maturity, uniformity, fineness and ultimately neps. This will add considerable value to the model's usefulness as it allows experimentation in two gross margin important parameters; yield and quality. Validation is already under way.

The cumulation of all the fibre quality research and extension will be for the Cotton CRC to develop FIBREpak. Similar to the way soil, weed, nutrition, disease and water PAK's were developed. FIBREpak will hopefully embrace all the knowledge we have on fibre quality influencing decisions; agronomic, harvesting and ginning.

Conclusions

In aiming for high yielding crops, growers must continually keep in mind the factors that affect fibre quality. Varietal selection with good fibre characteristics are part of the equation, however minimizing water stress, uniform growth and boll set and correct defoliation timings are also essential to allow fibres to develop properly. To reduce average nep numbers, management should aim to discourage late season bolls. There may be circumstances where late bolls should not be picked as they may introduce low micronaire or high neps which incur a penalty greater than the yield they add. The OZCOT fibre quality module will help us in future systems research questions. Importantly new technology will be introduced in the future that will allow more accurate measures of fibre maturity properties, particularly a replacement for micronaire. This plus feedback from the end users of the product should see a gradual change in the way cotton is assessed and marketed. The final output will be the culmination of this information into FIBREpak.

Acknowledgements

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References

Gordon, S. and Naylor, G. (2004). Instrumentation for Rapid Direct Measurement of Cotton Fibre Fineness and Maturity. Beltwide Cotton Quality Conferernce. Jan 2004.

Hunter, L. (2003). Cotton quality assessment and classing in the 21st century. Abstracts of the Third World Cotton Conference, Capetown, South Africa, 9-13 March.

Van der Sluijs, M. H.J., Gordon, S.G. and Naylor, G.R (2004). Australian fibre quality and international feedback. Proc. 12th Aust. Cotton Conf. 10-12th August, Gold Coast. (these proceedings).