The impact of colour discounts to the Australian Cotton Industry

A report for

by Matthew McVeigh

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Executive Summary

Australian cotton growers produce a high quality upland cotton that is highly regarded by spinning mills in many countries around the world. After ginning, most Australian cotton is exported to Asian markets where it is processed into yarn and fabrics. Increasing competition from synthetic fibres and improving cotton fibre quality in other countries has meant a more competitive market place in which Australia must contend.

Australia's fibre quality has improved over time however it is important that this improvement continues in order to maintain a high-quality reputation. At present, Australia receives a premium for cotton that meets all base fibre property levels. This premium is well respected and appreciated by the industry as input costs rise.

When Australian cotton colour is below base grade, heavy discount values apply. Colour degradation of cotton fibre costs Australian farmers and the industry a substantial amount of money. The major reason for colour degradation is excessive rainfall when the cotton boll is open. Environmental factors such as rain are beyond the control of producers and there is no guaranteed way of rectifying the problem.

The current grading system of Australian cotton is widely used around the world and is based on a USDA classification process. Information gathered from visits to the USDA cotton laboratories is presented and shows the sometimes arbitrary and subjective nature of the classification process.

During travels throughout the USA, Brazil and China, a variety of management practices that can be utilised to help preserve cotton colour were observed. This report details some of those practices that can be adopted to ensure quality downgrades are limited.

Growers should always speak to merchants and discuss Premium and Discount (P&D) values before selling cotton. Cotton moisture at harvest should ideally be kept below 11%. A potential solution in the field may be hand sampling and using a miniature gin after weathering and

before picking to ensure fibre quality levels are satisfactory to the grower. While visiting China, a miniature cotton gin was purchased which is now used on the family farm. This system may be useful when used in conjunction with consideration of discount levels and weather forecasts.

Growers would benefit from better communication from cotton gins about the importance of uniform moisture in the module stages. Cotton quality should be the key priority for the cotton gin and moisture management and drying technology should be utilised if available and not currently used. Many Brazilian cotton gins that were observed during the Nuffield travel were in the process of updating their moisture control systems with great success.

Collaboration in the supply chain from the farmer to the spinning mill is encouraged to gain an understanding of the issues faced by each sector. This can also provide valuable feedback as to why downgraded cotton has been allocated the current value. Many growers would appreciate the ability to investigate the current P&D sheet or at least be provided with the rationale behind those values. A graduate system for colour downgrade values would also make this process more equitable and simpler for the cotton industry.

When colour degradation causes the main fibre parameters to decrease, a severe penalty can be expected and there is a valid reason to support this. If fibre discolouration has occurred and other properties are base, this can lead to growers questioning the system. Many end users have limited processing issues with this cotton and are using it very successfully, yet a severe penalty to the grower seems unreasonable. Neps, short fibre content and micronaire appeared to be the greatest concerns to the end users throughout Vietnam and China.

Colour downgrades are not the sole responsibility of any one stage of the supply chain. Each sector should ensure better management and handling of the fibre and utilise new technology to reduce colour issues where possible. At times, the quality may be very low and growers should accept the fair reason for downgrades.

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Foreword

I am a 28-year-old third generation cotton and grain farmer from Dalby, Queensland, Australia. Dalby is on the Darling Downs, an area of highly fertile soils which grows a wide variety of summer and winter crops. Our farming operation is a mixture of family owned, leased, and share farmed country consisting of approximately 6,000 ha of cultivation. Part of this area is irrigated and the remainder dryland. Our crop rotation consists of cotton, sorghum, corn, mungbeans, chickpeas, wheat and barley using zero-till farming methods.

From a young age, I knew that farming was for me and especially after leaving home for boarding school, I just could not wait to get back to the family property. I always had a great interest in cotton and found the crop fascinating and the industry very resilient to challenges that they faced along the way. The cotton industry has given me many opportunities and rewards along the way and I am very grateful for this.

During the past 10 years while being at home and having a direct financial interest in farming, there have been many difficult years and rewarding seasons also. One thing that has frustrated me the most has been weathering on crops and especially cotton. A very profitable crop can lose value overnight after a small amount of rain or less than ideal weather. The resulting downgrades to the fibre quality have always been a big challenge to the industry. I have always found it difficult to see why the downgrade value have been so large for a single colour grade drop. This is a concern shared by many growers.

In 2015, I was very lucky to receive a Nuffield Scholarship to research the problem of colour downgrades in cotton and how important quality is in the world market. With the decrease in oil prices and technology, manmade fibres are even more competitive than ever against cotton's market share. The Nuffield Scholarship has been a tremendous insight into the world markets and production in other countries. I have been able to study and look at cotton quality into more detail than I ever thought possible.

Through this program, my goal was to deliver some suggestions to growers and the industry on management strategies and ideas that may help to keep Australian cotton at the elevated standard it is recognised and highly regarded for by end users.

During my travels on the Nuffield adventure, I was able to visit many amazing places including Singapore, India, Qatar, Turkey, France, USA, Mexico, Brazil, Argentina, Vietnam, and China. During these visits, I met with farmers, corporate businesses, agribusiness partners, finance, and banking operations, commodity traders, cotton processing factories, spinning mills, textile exhibitions, warehouses and cotton brokerage companies. I would have never in all my life thought I would get a chance to go on such a journey.

Acknowledgments

I would like to sincerely thank all the wonderful people and organisations that have helped make the Nuffield Scholarship a very enjoyable and rewarding experience.

Special thanks to my sponsors Cotton Australia and Cotton Research and Development Corporation (CRDC). They have given me a chance to research something I love and I am very grateful for that.

In particular, I wish to thank my parents Neil and Sonya McVeigh, and my brothers Craig and Lachlan McVeigh who have carried on with the hard work in my absence.

My fiancé Allyse Morris has supported me 100% through this journey and has been a great sounding board for my crazy ideas. For this, I am very grateful.

Many thanks to Russell, Vince, Brock, Ben and Alexander at home on the farm, as they have worked very hard and been understanding of my travels.

In addition, many thanks to all of the Nuffield group, 2015 Scholars and especially the India GFP group. It has been a pleasure to meet all of you and I wish you all the best in the future, and that we can keep in touch.

A final thank you to all the people, businesses, and organisations that I visited along the journey. It was fantastic to meet so many of you and thank you for opening your doors and sharing your knowledge.

Abbreviations

CA	Cotton Australia
CRDC	Cotton Research and Development Corporation
AUD	Australian Dollar
P&D	Premium and Discount sheet
SFC	Short fibre count
USDA	United States Department of Agriculture
HVI	High Volume Instrument
SLW	Silverleaf whitefly
IPM	Integrated Pest Management
Bale	227kg of pressed and bound cotton fibre
Module	Harvested cotton pressed into a square or round module
Seed cotton	Cotton that is harvested before the ginning process
Upland cotton	Gossypium hirsutum, also known as upland cotton or Mexican cotton
Pima cotton	Gossypium barbadense, also known as extra-long staple cotton

Objectives

- Identify how end users currently view Australian Cotton fibre the challenges they face.
- Identify which fibre properties are most important to the spinning mills.
- Identify the main cause of colour degradation in cotton fibre.
- Identify what technology may be available to assist in preserving cotton colour.
- Provide recommendations to help the industry move forward and minimise the risk of colour downgrades in cotton.

Chapter 1 Introduction to upland cotton

Cotton history

Cotton is one of the oldest fibre crops in the world and possibly one of the first domesticated non-food crops. In Egypt, China, West Pakistan, and Mexico, archaeologists have found evidence of cotton cloth dating back 3,500 to 5,000 years with some believing it may have been used as far back as 12,000 BC (Cotton Incorporated, 2016; Cotton Australia, 2016; Cao, Zhu, Pan, Zhu & Tu, 2009, Cotton's Journey, n.d.).

Cotton is still an important commodity fibre crop today with over 100 countries around the world growing it commercially (Cotton Australia, 2016). The largest producers of cotton are China, India, United States, Pakistan, and Brazil with a combined annual production of approximately 100 million bales. The average annual Australian cotton crop of 2.8 million bales is relatively small in comparison to China's production of 33 million bales (Cotton Australia, 2016). However, 99% of Australia's crop is exported (mainly to China) making it the second largest exporter of cotton in the world (Cotton Australia, 2016). Australian cotton plays a key role in the global market due to its high quality and white colour.

History of Cotton Classing

In 1907, a group of international cotton industry representatives met in Atlanta, Georgia, to discuss some major issues in relation to the marketing of cotton (Cotton Incorporated, 2016). From that day, a recommendation was made to establish a uniform cotton standard to *"eliminate price differences between markets, provide a means of settling disputes, make the farmer more cognizant of the value of his product, and, therefore, put him in a better bargaining position, and in general be of great benefit to the cotton trade"* (Cotton Incorporated, 2016). From this meeting, the United Stated Department of Agriculture (USDA) developed standards for classing cotton which are still used in many parts of the world today (Cotton Incorporated, 2016). Australia uses the current classing system of the USA as do other countries such as Pakistan, Bangladesh, China, Uzbekistan, Brazil and Greece (Cotton

Incorporated, 2016). In India, they have their own grading system (Cotton Incorporated, 2016).

To improve efficiency and objectivity, cotton classing has moved from visual checks made by certified classers to the utilization of High Volume Instrument (HVI), precision instruments which perform different fibre measurement parameters in a matter of seconds (Cotton Incorporated, 2016).

Key cotton fibre characteristics

In Australia, cotton fibre is classed using key characteristics based on the standard set by the USDA. A sample of cotton lint is collected from each side of the bale when the cotton is being baled at the ginnery.

There are six key characteristics used in cotton classing:

- Colour - Colour is currently measured either visually by a trained cotton classer or by HVI machine and is compared to universal USDA standards.
- Leaf - Is a measure of the amount of leaf material remaining in the cotton sample.
- Staple length - Length is measured on a sample of fibres and is measured to the nearest 1/32 inch. (HVI)
- Micronaire (MIC) - Micronaire is measured by placing lint in a chamber, compressing it to a set volume and subjecting it to a set pressure. It is often used an indication of fibre fineness and maturity. (HVI)
- Strength (GPT) - Reports the force, in grams, required to break a bundle of fibres that is one tex unit in size. A tex unit is the weight in grams of 1,000 m of fibre. (HVI)
- Extraneous matter- Is any substance present other than fibre or leaf. (Bark, grass, spindle twist, dust, and oil). (Manual/Visual)

Other fibre properties important to end users include:

- Neps - Small entanglements or knots of fibres. Generally, there are two types of neps; seed coat neps and fibre neps.

- Short Fibre Count (SFC) - Defined as percent by weight of fibres of 12.7 mm or less of cotton, and all of them essentially require some type of measurement of the distribution of total length.
- Moisture - Generally seed cotton moisture content between 6 and 10% is ideal. Anything above 12% is considered excessive.
- Contamination - Foreign matter such as plastic or hair that is present in the sample.
- Stickiness - The result of infestation on growing cotton by “aphids and whitefly” spreading randomly distributed droplets of highly concentrated sugars causing stickiness.
- Elongation - Cotton fibre is flexible and can be stretched. The increase in length or deformation of the fibre before it breaks because of stretching is called elongation.

Fibre quality in Australia

Australia provides over 10% of the volume of world trade for medium/high grade cotton despite the relatively small size of the crop and challenging climatic conditions (Long, Gordon, Bange, 2009). Over the past 15-20 years, Australian cotton quality has greatly improved and has earned great respect in the world market. Australian cotton fibre is regarded as one of the top-quality fibres in upland cotton. Most Australian cotton is exported to mills in South East Asia and is primarily used for producing high quality fine to medium count yarns for use in the woven and knitted apparel sectors. Australia has an excellent climate to grow cotton and the fibre often receives a premium for these characteristics. Good quality characteristics result from a combination of climate, management, breeding and genetics, varieties, modern machinery and research.

Premium and Discounts for cotton quality

Currently when a grower sells cotton to a merchant, they will receive a document that states the level of premium or discount they will get for the cotton they produce if it is above or below the base grade. Australian cotton in the present market receives a small premium for

its high quality. However, there are no further significant premiums for even the best cotton grown in the country.

Currently colour is the largest concern for Australian growers as it is one characteristic that is often out of the farmers control and can also be a sheer drop from a 31 to 41 colour which may result in losses around $75/bale or up to a staggering $1000/ha in some high yielding situations. *(These figures are an average across merchants at time of writing.)*

Below are some other discounts per bale which growers may experience. These figures are an average and can often change daily depending on individual merchant needs and AUD rate (AUD = $0.76 at time of writing).

The base grade characteristics for Australian cotton are as follows:

- Colour- 31
- Leaf- 3
- Length- 36
- Strength- 28-33.9
- Micronaire- G5

Discount Values

- 41 colour- $75
- 51 colour- $100
- 4 leaf- $32
- 35 Staple length- $38
- G4 Micronaire- $50
- 27.0-27.9 strength- $6

(Source: These figures are an average across P&D sheets from a range of merchants at time of writing.)

On average, the highest premium that an Australian grower can currently receive is for an 11 colour, 1 leaf, 40 Staple and above 34 strength. This premium equates to approximately $12/bale.

Why below base grade cotton is a problem

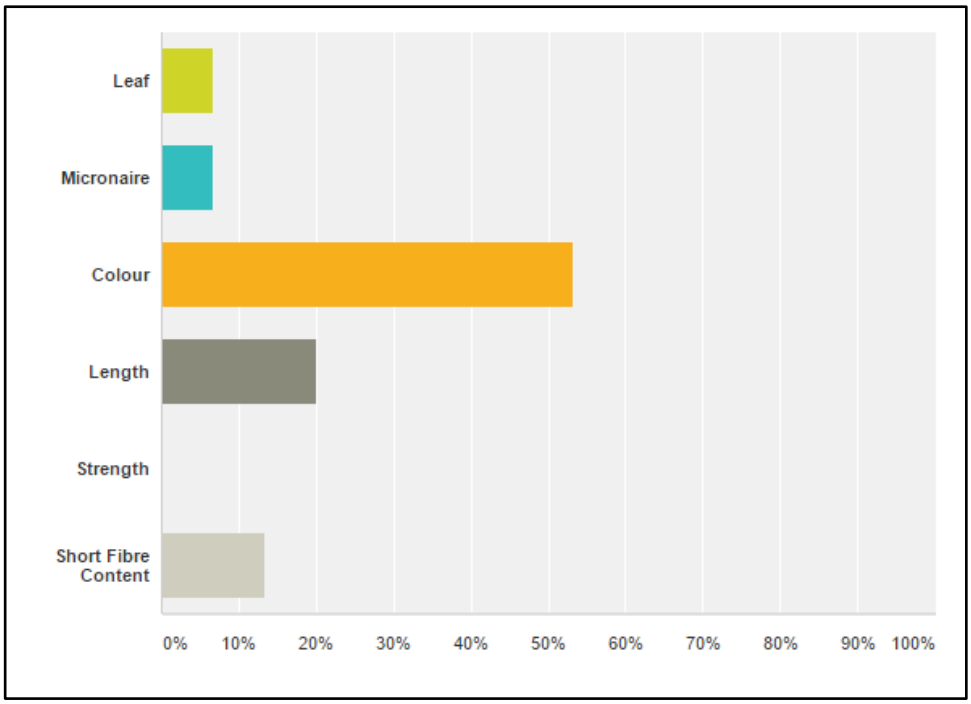
Together with yield, fibre quality is a major factor that determines the returns from growing cotton. Cotton that is below base grade presents several problems not only to the grower but to the Australian industry. These problems include but are not limited to:

- A major and sudden drop in the returns to the grower.
- The cotton does not process in the ginnery as well and there is more waste.
- Negative impact on sales and exports.
- Below grade quality can represent entire Australian standard quality to end users.
- Can have a negative impact on the reputation of Australian cotton.
- Can cause problems with dye uptake and spinning mill performance.
- Can only be used in a low value garments.
- There is a large amount of low quality cotton in the world market that would be in direct competition.

For these reasons, it is of utmost importance to Australian growers and the industry to be focusing on quality and yield to ensure the industry can remain competitive for many years to come. The rest of the world is beginning to catch up in terms of better quality cotton and Australia needs to be at the forefront as a country that can supply a premium and consistent product. Management, marketing and new technology options will be examined to assist in producing a better fibre and ensuring the industry's reputation.

In order to understand what the rest of the industries experience with quality discounts was, the other conducted a survey of Darling Downs growers. Growers responded to the survey and the results clearly indicated that colour was the major concern (Figure 1).

Figure 1: *Survey results to determine the quality concerns for growers*



Source: Matt McVeigh, Survey Monkey Results, 2016

Chapter 2: Positives and negatives of Australian cotton fibre – End user perspective

As with any commodity there are many challenges faced in keeping up with consumer demand. Australia is known to produce a high-quality cotton fibre. Visiting spinning mills highlighted that to maintain this reputation, a significant focus needs to be kept on continually improving fibre quality. To remain competitive with other countries and against synthetic fibres, Australia needs to have a concentrated effort on improving fibre quality.

After visiting end users of cotton in China, Vietnam and India, a list of the advantages and disadvantages for using Australian cotton fibre was compiled (Table 1).

Table 1: *Advantages and disadvantages for end users when using Australian cotton fibre*

Advantages	Disadvantages
● Great overall quality	● Expensive for some
● Free of contamination	● Irregular and sporadic supply (due to water availability)
● Easily and quickly accessible to Asian markets	● Neps are high (250 neps/gram and below is ideal)
● Good staple length	● Short fibre content is slightly high (would like to see below 7%)
● Good strength generally	● Bale traceability is limited
● Reliable and safe to do business with	● Stickiness seems to be increasing
● Sustainably grown	● Some micronaire issues
● Good colour	
● Leaf content is low	

Source: Matt McVeigh, 2016

Although the list of negatives may seem extensive, in this study the end users were encouraged to be honest in their appraisal and to postulate potential future problems. Australia is fortunate it has many strong points such as low contamination and good staple length. For a prosperous future, the concerns of the end users need to be addressed as far as practicable to ensure Australian cotton is better placed to meet the key the needs of the client.

Australian cotton currently receives a small premium for these positive fibre characteristics. With the high cost of production, Australian growers need this premium to remain competitive with low cost production countries.

The cost of the Australian cotton appeared to be a major consideration for the mills. To counteract the cost, mills were blending it with cheaper cotton from other origins. The inconsistent supply of Australian cotton was identified as a significant problem for mills. Unfortunately, this issue is mainly based on water availability and is out of the growers control. There are many growers in Australia that would grow cotton every year if water was guaranteed.

Neps were an issue for almost every spinning mill visited. Mechanised processing of cotton is a major reason for increased neps; the cotton picker and the ginning process can cause them. More research is needed in this area to identify improvements to the processing that limits or reduces the problem of neps.

Short Fibre Content (SFC) was another common topic and many mills would like to see this improved as it contributed to higher waste and lower manufacturing efficiency. At present Australia ranges from 7.5-9% SFC.

Traceability was an issue that some mills raised in relation to the ability to track quality and to utilise the provenance of the commodity. Increased traceability could have both disadvantages and advantages to the Australian industry as it may separate each growing region and could result in a competitive market amongst Australian growers.

Stickiness was a concern for the mills however this is very dependent on the season. This increase in stickiness is being caused from either Silverleaf whitefly or aphid infestation. Discussion with mills highlighted that they will be monitoring stickiness in the future. Farmers need to be vigilant with late season insect infestation to help prevent this problem. More research in integrated pest management strategies for the future would be beneficial to farmers.

Vijay Shankar (2014) stated ‘the major constraints to why most spinners are not able to use 100% Australian cottons in mixing are: the high micronaire of Australian cotton which imposes limit on spinability and yarn strength, and a high level of neps’. Even though the fibre length and strength of Australian cotton has improved markedly over the last 30 years, coarse fibre (high Micronaire), high neps, and SFC have the potential to keep Australian fibre out of quality markets (Van der Sluijs, 2011).

The research indicated that while Australian cotton is high quality, it is also at an important stage in its history that improvements in various areas could strengthen its place in the market into the future.

Chapter 3: Causes of colour degradation to cotton

Cotton that is severely damaged or exposed to extreme weather is undesirable in textile production because the lint surface has deteriorated which leads to dye uptake problems. In addition, it can also increase the roughness of the fibres which alters its frictional properties and thus how the fibre performs in the spinning mill. (Bange, Long, Constable & Gordon, 2009).

Cotton colour degradation can be caused by several factors, some that are within the control of the grower and some that are not. Colour is a quality issue that is usually determined near or at the end of the crop and can in some cases change overnight especially when related to weather. With significant discounts at stake, these abrupt drops in price can be very frustrating and stressful to growers and have a massive impact on their gross margin.

Cotton colour is determined by growing conditions, plant breeding, genetic modification, environmental factors, and harvest and processing conditions. The main factor affecting the Australian crop colour is primarily field conditions after boll opening and prior to harvest, such as rainfall and moisture, microbial action and insect honeydew. (IDF,2016)

Plant breeding

Cotton is a natural fibre and breeding can be difficult to create or enhance the plants defences against weathering. Improving water repellence or resistance to weathering of cotton fibres has not yet been achieved through breeding (Dr W. Stiller, personal communication, 26 August 2016).

Australian cotton is generally very white with good reflectance and good lustre when compared to cotton from the USA that tends to have more of a cream base colour. The whiteness of Australian cotton may also be a reason why it is affected to such a degree by weathering. Despite this, visits to spinning mills revealed that the whiteness of Australian cotton is a trait that end users want and are willing to pay a premium for.

It may be possible in the future through the use of GM technology to introduce water repellence to cotton fibre that would help preserve the colour of cotton through weathering events. Cotton fibre does have a form of natural wax on it which helps repel water but if this wax level is too high it can create problems for the end users similar to sticky cotton (Dr W. Stiller, personal communication, 26 August 2016).

The CSIRO cotton breeding program has improved yield, HVI quality and has enhanced performance in the textile industry (Bange & Long, 2012). While quality characteristics have been improved through breeding, any efforts to improve weathering of varieties need to ensure the natural fibre attributes are not lost.

Weather conditions

With Australia's erratic climate pattern and unseasonal rainfall, a dry and successful cotton pick cannot be guaranteed. Weather is out of the growers control and is always a risk, however there is no direct link between the amount of rainfall and the degree of discolouration. With all weathering, there is a drop in fibre quality, and especially colour.

As cotton weathers, it loses reflectance, becoming grey due to moisture from both humidity and rain, exposure to ultraviolet radiation and from fungi and microbes that grow on the lint or wash off the leaves. (Bange, Constable, Gordon, Long, Naylor & van der Sluijs, 2013 CSIRO). When mature cotton first opens, the lint is very white and clean due to the highly reflective nature of the cellulose and the lack of microbial degradation. If the boll development is ceased or opened early by causes such as frost, drought, or early application of boll opening chemical, this can often cause a yellow colour to the fibre.

When the cotton boll opens during humid conditions, microbes begin to feed on the sugars of the lint. During this process, the surface of the fibre will encounter staining and causing a dull or grey colour to the fibre *(FIBREpak, 2010).*

Table 2 shows the average reduction in fibre quality traits in relation to the number of days of weathering. The figure indicates that the two colour related traits, Rd reflectance and +b yellowness, are more affected by weathering than the other four fibre qualities (Table 2).

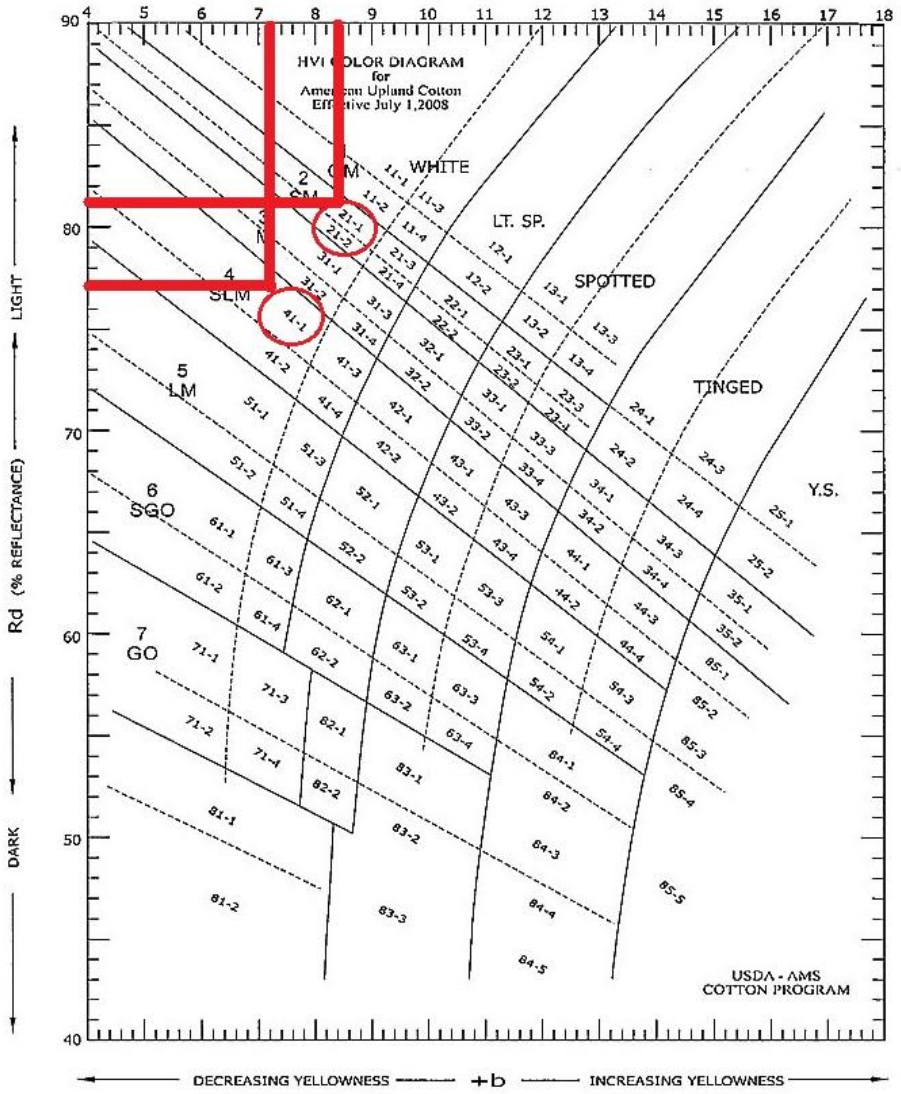
Table 2: *Reduction in fibre quality traits in relation to average days of weathering*

Fibre quality traits	Average number of days weathering			
	0	8	21	50
Rd reflectance	81.1	79.3	78.2	77.1
+b yellowness	8.4	8.2	7.5	7.2
Length (decimal inches)	1.10	1.10	1.10	1.09
Uniformity Index	83.4	83.3	82.8	83.0
Strength	25.6	25.4	26.1	25.3
Micronaire	4.7	4.7	4.2	4.3

Source: Meredith 1988, Cotton Incorporated.

The colour values in Table 2 for zero days and 50 days have been plotted onto a HVI colour chart to show the downgrade in colour due to weathering (Figure 2). The impact of 50 days of weathering results in a 41 colour compared to zero days with a 21 colour (Figure 2). This can lead to a significant reduction in price for the grower.

Figure 2: *HVI colour grades for American upland cotton*



Source: Cotton Incorporated, 2016. ***http://www.cottoninc.com/fiber/quality/Classification-Of-Cotton/Classification-Upland-Cotton/***

The weather following a rainfall event, can determine cotton colour. Factors such as bright sunlight and wind may bleach the lint and recover one colour grade. However, this can be a great risk if more rain is forecast in the future, as this can further affect the fibre quality. Often weathering of cotton is only associated with rainfall, although this can be a complex mixture of rain, frosts, moisture stress, humidity, sunlight and microbial activity (FIBREpak, 2009*).* Of these, moisture is the key factor beyond the control of growers.

Insects and Honeydew

The introduction of genetically modified Bollgard® technology has had many benefits to the cotton industry with a significant reduction in the use of broad-spectrum insecticides. This has meant that beneficial insects are often used to control pests. Much of the crop is now Roundup Ready® making volunteer and ratoon plants harder to control. These plants are hosts to pests during the off-season which leads to increased insect populations. Increased late season insects such as aphids and Silverleaf Whitefly (SLW) can have a negative influence on fibre colour due to the impact of sticky residues known as honeydew.

SLW and aphids prefer to feed on the bottom of the leaf allowing the small transparent droplets of honeydew to fall below and onto open bolls (Bange, Constable, Gordon, Long, Naylor & van der Sluijs, 2013).

High levels of sugar exudates from these insects lead to significant problems throughout the spinning process that include a build-up of residues on the textile machinery. When honeydew is present on the fibre late in the season, it can lead to colour grades because of fungal spore growth known as ‘sooty mould’ (Figure 3). Humid conditions promote the fungal growth leading to increased grey colouring of the lint. In addition, honeydew can attract or trap dirt, sand and plant debris which can lead to several negative factors associated to poor fibre quality.

Figure 3: *Cotton Bolls with Sooty mould growing on honeydew from insects.*

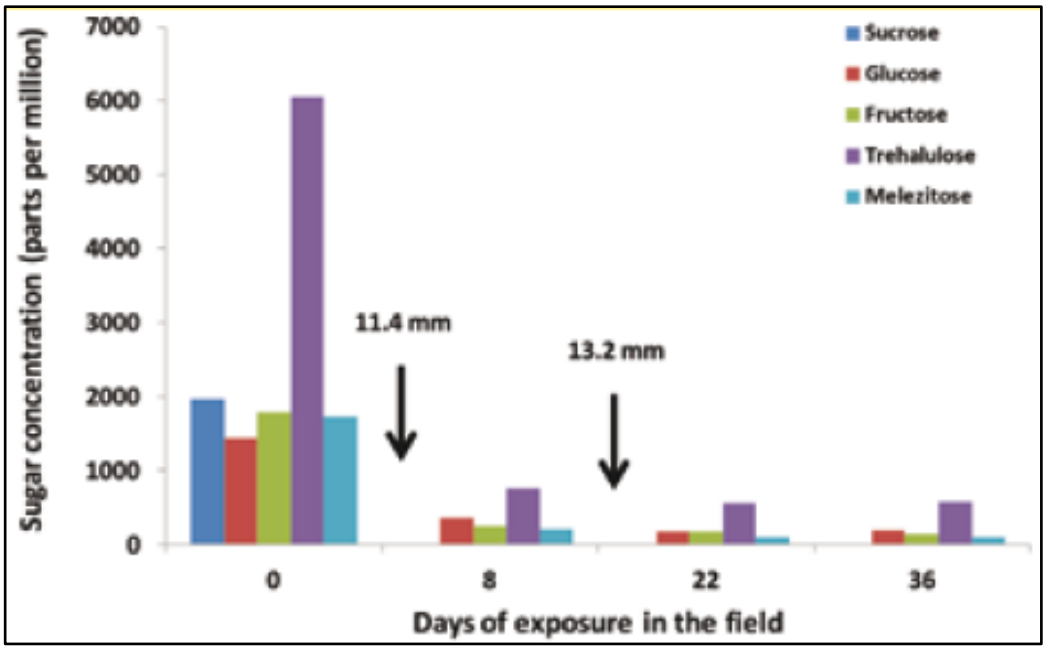
Source:

http://www.insidecotton.com/xmlui/bitstream/handle/1/222/SLW%20late%20season%20newsletter%20article.pdf?sequence=1&isAllowed=y

At low levels, honeydew may not cause obvious fibre colour discounts. An example of this was seen during the last season on a farm at Dalby where small areas of fields were infected with sooty mould causing the grey discolouration. Results provided after ginning showed a base colour of 31 was achieved (N.McVeigh, personal communication, 16 August, 2016). Depending on the severity, sooty mould can diminish throughout the picking and ginning process although this may not be the case for all fields and certainly should not be relied upon to improve colour.

Despite the impact of rain, in some cases it has been found to reduce honeydew (Figure 4). In contrary to the other quality issues associated with rainfall events and weathering, if honeydew is present and a small amount of rain falls on the crop, followed by sun and wind it may also help to wash off and remove honeydew. Figure 4 shows the reduction in the various sugar concentrations in honeydew following two small rainfall events.

Figure 4: *Example of honeydew reduction following rain.*



Source: Heimoana & Wilson, 2015. The Australian Cottongrower, page 50, February-March 2015.

Harvesting, Ginning and storage

Harvest

As the cost of quality discount have become larger and the introduction of the round module building picker such as the John Deere 7760, there has been more research and awareness of harvest, ginning and storage processes that affect the overall fibre quality. High moisture cotton may lead to below base colour or combustion of the modules and bales.

During the picking process, moisture monitoring is very important and can make ginning much easier if attention is given to the fibre in the paddock stage. Monitoring needs to be carried out often when moisture and humidity is increasing or when above 70% humidity. Van Der Sluijs (2013) states that 'moisture can increase from 4% to 6% within 10 minutes as night and dew point temperature fall rapidly'. Extra care should be taken when using round module pickers due to their increase in horsepower, fan speeds, and smaller module size. If modules are placed in low-lying areas or have tears in the covering, it can also allow moisture to enter

the module and cause discolouration. Picking at high moisture or a tear in the module wrap can cause downgrading to the cotton fibre and discolouration (Figure 5).

Figure 5: *A round module showing colour degradation due to moisture.*

Source: Andrew Vanderstock, Australian Cottongrower, page 15, Oct–Nov, 2012.

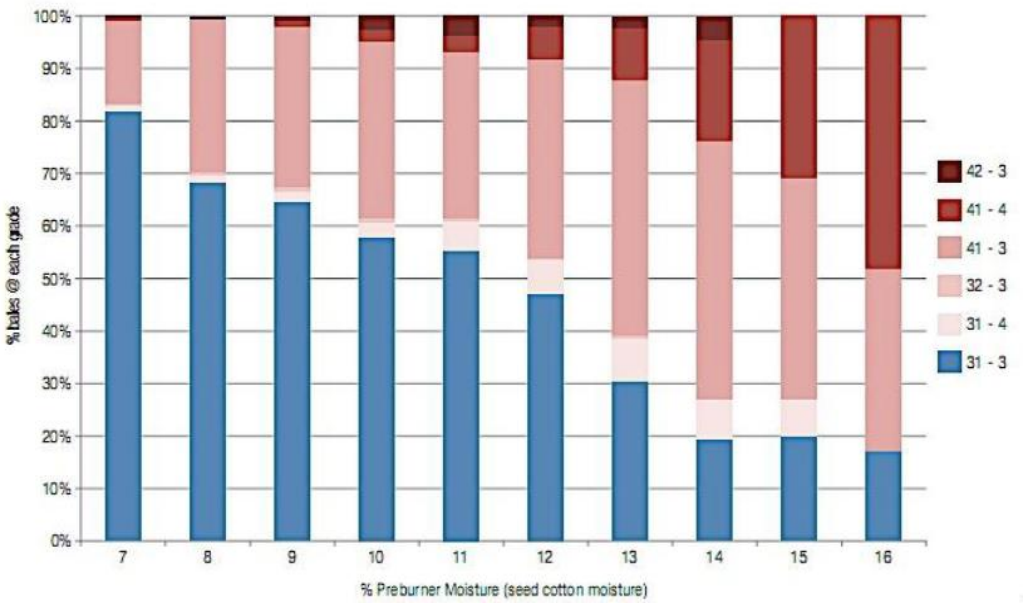
Poor defoliation management of the crop will result in excess leaf or regrowth leaf at picking time. This can add green moist leaf to the module. This can raise the moisture content of the seed cotton, affect colour and lead to green staining of the fibre.

Colour degradation occurs in seed cotton stored at a moisture level above 11% (myBMP.com.au 2016). At high moisture levels, bacterial action causes temperature increases within 48 hours, resulting in discolouration. Moisture content levels above 13% cause yellowness to increase, especially when storage in module exceeds 45 days (CRDC, IDF 2016).

Ginning

Ginning is a highly technical part of the cotton lint process and if poorly executed it can cause significant damage. Supplying a good consistent product to the gin will assist with the efficiency of the ginning operation. Moisture fluctuations between modules or incoming cotton moisture over 12% can be difficult for a cotton gin to control and increased drying temperatures can cause fibre damage (Figure 6).

Figure 6: *Grade versus pre-burner moisture %.*



Source: Andrew Vanderstock, Australian Cottongrower, page 15, Oct–Nov 2012.

Figure 6 represented over 13,000 bales of cotton at one gin in a season. Although moisture is not the only determinant of colour, it is clear that increased module moisture can have a substantial negative effect on fibre colour. (Cotton Australia, 2013)

Monitoring moisture at the gin is critical and communication between the gin and grower is very important. Gin yards need to be sure that modules are placed on well drained areas and covers are well maintained.

The ginning process cannot be relied on to manage colour issues. At the gin, moisture needs to be set at a level to minimise fibre damage. Moisture at the lint cleaner, and in the gin, should be close to 7% although not exceeding that level (Van Der Sluijs. R, 2013)

At the completion of ginning, one final moisture check is important for the life of the cotton bale during storage and shipping. At the bale press, prior to packing, moisture should be approximately 7% for ease of press operation, long-term bale storage and fibre preservation (Anthony, Van Doorn & Herber, 1994)

On arrival at the gin, if the moisture of the seed cotton is between 5% and 11% it can make the ginning operation more straightforward and in most cases a better-quality fibre results.

Storage

Based on end user preferences, Australian cotton is wrapped in a cover bag made from cotton. This means the cover is not waterproof and should be kept in weatherproof storage to avoid contact with moisture. Cotton should be kept in a well-ventilated area that is not high in humidity to ensure the fibre quality is kept in good condition. If exposed to high humidity and moisture during storage, shipping, or transport, the quality cannot be guaranteed as the cotton may absorb moisture. This can have a detrimental impact on the colour.

Chapter 4: Technology and methods to assist in preserving cotton colour

The constant issue of downgrades to cotton has plagued growers for many years. To combat this, research has examined various technologies which may assist growers or improve their knowledge relating to colour preservation.

Available Now

On board and hand held Moisture meters

Moisture meter technology has become more available since the introduction of the 7760 cotton picker and with better knowledge about colour related discounts.

On board moisture meters such as the Vomax 760 meter, can be expensive but they are very reliable. These units are fitted to the rear of the machine where they measure the moisture content of the module as it is ejected onto the module handler (Figure 7). They measure moisture using high frequency electromagnetic waves between two antennae. This technology allows the grower to measure the moisture of each module and there is no need to stop the machine to do so. Precision of these units is typically around 1% (www.vomax.com.au, 2016). These type of moisture meters are also available for cotton ginning operations.

***Figure 7**: An on-board moisture meter fitted to a round module picker.*

Source: http://www.vomax.com.au/sg_userfiles/130321_VOMAX_760_Brochure_05_web.pdf

Another option which can give an accurate reading at a fraction of the cost is a handheld unit such as Delmhorst C-2000. There are many other units available on the market. These handheld units provide reasonable accuracy, are reliable and give the grower a good guide on cotton moisture. Unlike the on-board systems, these units need to be used manually by testing the loose cotton or by inserting a probe into the cotton module.

Miniature cotton gins for hand samples

One of the main problems is that cotton quality is not known until after the picking and ginning process. At that stage, the grower does not have control over the fibre quality and has to accept the classing results provided. If picking was to commence too soon after a rainfall event, the grower would receive a discount. To alleviate this issue, it would be beneficial to have a method of hand sampling the cotton, ginning it and testing the colour. This would provide the grower with a better indication of the grade of the fibre and assist with the decisions regarding the timing of picking.

Several suppliers were identified during the travel in China that could provide mini hand sample gins. Field-testing of this equipment was undertaken last season and the results provided a fair indication of quality.

Advances with field sampling and testing for colour would be a huge benefit to the growers by giving them more control to reduce the likelihood of discounts. This sampling could also improve communication between the grower and the gin. Miniature gins can be purchased for a minor cost and could be an effective tool in the future.

Figure 8: *Miniature portable cotton gin.*

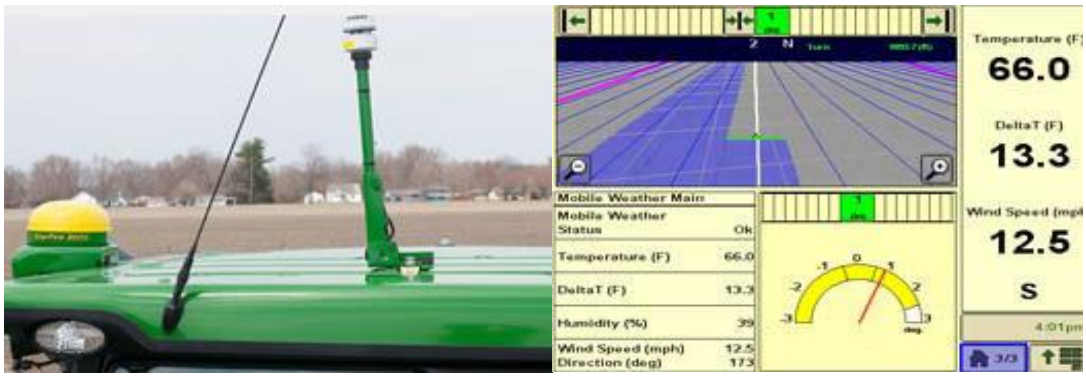
Source: Matt McVeigh, 2016

On board weather stations

Another tool that growers can now use to monitor moisture and weather conditions is a mobile weather station that attaches to the cotton picker and links to the monitor in the cab. Units such as the John Deere mobile weather station can display current weather conditions including temperature, humidity, wind speed, and direction. These factors are important when picking cotton and can help determine the point when the operator should be preparing to stop operations for that period. There are other weather stations available on the market also such as the WatchDog® sprayer station that will provide the same data as well as dew point which is helpful during cotton picking.

A variety of handheld weather stations are available that can also provide the operator with data on the weather conditions. Kestrel® is a common brand of handheld weather meter that will provide accurate and reliable readings. However, using handheld units requires stopping the machine which is not time efficient.

Figure 9: *On board weather station and the monitor in the cab showing the readings.*



Source:*https://www.deere.com.au/en_AU/products/equipment/agricultural_management_solutions/field_and_crop_solutions/john_deere_mobile_weather/john_deere_mobile_weather.page*

Machinery improvements

Machinery improvements such as the release of the Case IH Module express 635, John Deere 7760 and CP690 have given growers the opportunity to harvest cotton much quicker and cleaner and with less staff. This on-board module building operation has also seen less contaminants in seed cotton at the ginning stage. Objects such as clothing, metal, oil, and plastic were found regularly in the ginning process but are now reduced due to round bale pickers. In terms of fibre quality, there were challenges in the beginning from picking cotton at high moisture. Growers now have a better understanding of the moisture constraints with this machinery.

Ginning operations

Although the basic principle of cotton ginning has not changed over time, many parts of the operation have been improved to keep up with modern practices and fibre quality. The major changes have been in relation to moisture management. This has been a positive change for the industry and led to better fibre quality post ginning as well as improved fibre preservation.

The company Samuel Jackson from Texas, USA, is an industry leader in moisture management and drying. Their systems provide protection of the fibre at ginning when either moisture is in excess or the cotton is too dry. Technology such as this is always improving and is helping protect the fibre for the farmer and the end user.

> *"Cotton growers benefit from fibre moisture control when the gins handling their cotton use it. Losses due to unpredictable weather and growing conditions can be eliminated or significantly reduced at a gin equipped with fibre moisture control systems"*. (Samuel Jackson Inc, 2016).

The author observed in both Brazil and the USA that cotton gins do not use moisture control systems. Some of these gins find it difficult to process the cotton to get a high-grade result when compared to the operations that use this type of technology. Those gins that had recently installed moisture-controlling systems were satisfied with the products and the resulting fibre quality.

Recently there has been interest in using roller ginning for upland cotton, a process normally used on Pima cotton. Upland cotton is generally processed using saw ginning. Roller ginning is more gentle on cotton resulting in an improvement in length and overall fibre preservation. River Gin in Coolidge, Arizona, USA, is running both roller ginning and saw ginning in the same gin. The results indicated a minor improvement in overall fibre quality although not specifically related to better colour. With the higher cost in roller ginning operations and slower throughput it was uncertain whether roller ginned upland cotton was justifiable at this stage.

Figure 10: *A roller gin stand in Arizona, USA.*

Source: Matt McVeigh, 2016

Overhead irrigation

As stated previously in the report, overhead sprinkler Irrigation can assist in plant water requirements and help to minimise stress at boll fill that will ensure bolls will be near their potential. This can help in minimising yellowish cotton or tight locked bolls. Another method that has been used with sprinkler irrigation is to wash off certain amounts of honeydew and minimising dark mould on the cotton fibre. This may not work for all scenarios and should be looked at on a case by case basis.

IPM strategies

Due to increasing research and knowledge IPM continues to evolve and is used to control pests that cause damage to cotton crops and their development without harming beneficial insects. Thresholds numbers are very important to monitor as in some cases beneficial insects will eradicate the pest. Basic knowledge around these pests can be found on such websites as on the link below. https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/integrated-pest-management/ipm-information-by-crop/cotton

New and patented technologies

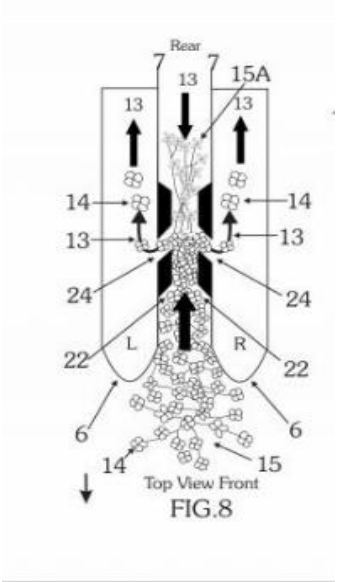
Drying while harvesting cotton (US Patent 8356389B2)

A method that would be helpful to ensure wet cotton is not harvested is that of drying the cotton while harvesting if needed by the heat from the exhaust and/or engine or by incorporating a heating device. This may allow the grower to pick for longer periods of time when early evening moisture is an issue. This method could help speed up the process of cotton picking and minimize excessive moisture in modules although it is not clear if this treatment would help recover any grade loss from excessive moisture levels in the field.

Cotton picking via vacuum (Cotton Air Harvester) US Patent 8407975

Harvesting cotton via vacuum has great theory behind it and would lead to less maintenance for the grower, a lower weight machine, less cost on parts and take away the need to use water for spindle cleaning, grease and poly doffer replacement. A method like this may also lead to increased fibre quality and less Neps and staining due to no contact with the spindles and the low contact with green leaf if there is any present. In terms of colour preservation, vacuum picking doesn't appear to have any clear advantages apart from perhaps less staining from bark and green leaf. A successful operating method as such though would be welcomed by many growers.

Figure 11: *Vacuum cotton picker head design.*



Source: http://www.cottonairharvester.com

"A top view of cotton air harvester's row units 6 entering cotton row. Cotton plants 15 are compressed together to approximately 9 inches as row units enters cotton row and are furthered compressed together to approximately 5 inches by extractor unit's front panel 22. Cotton plant's limbs 15 are folded together in order to bring seed cotton 14 into close contact with self-cleaning extractor units openings 24, where seed cotton 14 is removed from cotton plants 15A. Cotton is harvested from both sides of the cotton plants using air flow 13 (wind, vacuum, atmospheric pressure). The large amount of plant material moving thru extractor units create a self-cleaning environment using cotton plants 15A, as a cleaning method to continually push unwanted material past harvester's self-cleaning extractor units" (Bell. J 2013)

Applying a water repellent to cotton fibre ahead of rainfall

A technique which could help colour damage would be to apply a water repellent before rain on open cotton. Superhydrophobic water repellent sprays could repel water off the cotton to minimise discolouration. Obviously, this method would need to include something that is bio-degradable, affordable and easy to apply via large machines and not affect the fibre properties.

US Patent 5188224A may inspire other attempts of potential field applications to form protection against wet weather. "This method uses a certain amount of Polyorganosiloxane adhesively attached to seed cotton or lint during ginning to reduce its hygroscopicity. This method can address microbial damage and discolouration during storage and transportation. The treatment was also tested on cotton contaminated with honeydew." (IDF, CRDC 2016)

Harvest of mature cotton bolls while closed

Another method that should be given some thought, is the harvesting of cotton while the boll is still closed and then dried out before ginning. This fibre would be safe from weather affects, microbial damage, insects and dust thus preserving the colour of the fibre. Some study has been done around this process with encouraging results and a patent exists for a machine that would harvest the cotton boll only. (US 4470245)

Work has been carried out by the USDA and below is an Abstract from their work:

> *"Harvesting cotton in closed bolls may be a method of excluding biologically active byssinotic agents from seed-cotton and reducing textile mill dust levels. The closed-boll cotton would be machine-stripped, dried, and stored in modules until ginning. Estimates of cost and performance, from harvesting through yarn manufacturing, suggest that using cotton from closed bolls may be economically feasible". (USDA 2016)*

Thermal defoliation

Thermal defoliation of the cotton plant has great potential and has been trialled by the USDA-ARS since 2001 in various locations across the USA. There are large commercial units now operating in these areas that have been operating since 2008. There are many benefits of thermal defoliation that include the following:

- Greater control over harvest timing and can in some cases be harvested the day following the treatment.
- Cotton defoliation process can bring crop in ahead of rain to minimise fibre damage and value.
- Is effective even if rain or cold weather follows treatment.
- Lint has the same fibre quality and value as chemical defoliation.
- Late season insects that can cause stickiness are eradicated by the heat.
- Can be applied in windy conditions and close to sensitive areas.
- A single treatment can be sufficient for most crops.
- Total costs have been estimated to be similar to defoliation with chemicals.

Figure 12: *Commercial thermal defoliation unit that treats 6 rows per pass. The rows on the left were treated 12 hours before and are easily visible.*

Source: http://web.nmsu.edu/~pfunk/DEF.html

Combined cotton picker and cotton gin (US 1314437 A (1919))

If one machine could pick seed cotton and then separate the seed and trash from the lint, this could be a cotton farmers dream and the next step in value adding or increasing productivity. A machine such as this could change the way cotton is processed and handled and may improve fibre quality. If cotton lint could be separated from seed and leaf almost instantaneously it could mean less chance of discoloration from moisture within the seeds and any green leaf. Cotton could possibly then be transported from farm to shipping leading to less time for the cotton quality to change or to be at risk of the weather.

Quote from the Patentee from 1919:

> *"An object of my invention is to provide a cotton handling machine in which the most important feature resides in the combination of cotton picking, ginning, condensing and compressing mechanism on a vehicle to render the machine portable and capable of being moved into a field as an entire unit so that the complete operations from the picking of the cotton to the baling thereof, may be finished on the field". (M.W. Silverthorne)*

Chapter 5: Colour degradation costs

Cotton that has been downgraded due to weathering, but has only lost its colour can cost growers a large amount of money and is beyond their control. The authors research found that some spinning mills would prefer to purchase an Australian cotton of 41 colour when all other fibre attributes are at base level. This was because many believed, that colour was not the major concern and could be managed through other processes such as bleaching. If the poor colour had a combination of other below base grade fibre qualities, this became a problem and the fibre could not be used in a premium product. The sudden drop between a 31 and 41 colour was in many cases the difference between HVI number scale or a subjective view which resulted in large discounts to growers.

Figures from a recent report noted that colour grade loss from weathering has been estimated on average at $33.5 million annually, translating to $13.75/bale or $137 per ha over the last 10 seasons. In 2014, the figures were the worst for a single season and equated to $119 million or $24/bale and $240/ha across the industry (IDF, CRDC 2016).

Table 3 shows discounts in relation to colour only. These figures are taken as an average across different merchants and are current the time of writing. They may be subject to change and are in no way representative of an individual merchant. Average yield is based on 2016 Australian average irrigated yield. (Cotton Australia, 2016)

Table 3: *Average colour discounts from Australian merchants 2016.*

Colour grade	Discount in Points	Discount per bale at 76 cents exchange rate	Lost gross income per ha to the grower (11.5 B/ha)
31-3 (Base)	0	0	$0
41-3	1200	-$78.94	-$907.81
51-3	1600	-$105.26	-$1,210.49

The figures in Table 3 clearly indicate the significant losses that growers can incur due to colour downgrades. Cotton farming is a high-risk business and all growers should be aware of this before planting the crop.

Table 4 shows the premium currently received for colour above base. From the above it can be seen that there are currently no premiums paid for any colour above base grade. However, this is not the worry for the grower as most are currently aware that Australian cotton receives a small premium at present for the base grade.

Table 4: *Premium for colour above base for Australian cotton 2016.*

Colour grade	Premium in Points	Premium per bale at 76 cents exchange rate	Extra Income per ha to the grower (11.5B/ha)
11-3	0	$0	$0
21-3	0	$0	$0
31-3 (Base)	0	$0	$0

Even though there are strong points for these premium and discount figures, it would be a solid argument that the large drop between 31 and 41 colour may require review. A more equitable value would give fair representation to the industry and its growers.

Conclusion

Cotton quality and colour discounts are issues that growers are concerned about as they are costing the industry a considerable amount of money. The industry's reputation is also at stake and it is important that it can continue to set a standard and be recognised as a premium fibre in the world market. Competition from synthetic fibres has also increased and many up and coming importing countries appear to be price driven before quality at this point as they are producing yarn that doesn't require high quality cotton.

The difficult issue is that many end users at this stage don't seem to be prepared to pay a premium for high quality upland cotton and issues such as Neps, SFC and length were the main issues of the spinning mills visited.

There are many management techniques and control measures that are now available to produce a better-quality cotton and most growers are doing their best to grow this high-grade cotton. However, issues associated with rainfall at harvest are at many times out of the growers control and some are being penalised for a cotton that still displays good fibre characteristics and has a slightly different colour. Severely weathered cotton that suffers increased fibre breakage and higher SFC along with dye uptake problems is the issue that should be the discounted. With new technology and improved practices this in time may be minimised although time will be the only judge of this.

Not one person or organisation can be at fault for this issue and the cotton industry is very well known for its collaboration and problem solving. The issue around colour is a very complex one and can be mainly due to weather issues which are out of any person's control. Communication between growers, ginners, merchants and spinners should be improved as many of these sectors appear to have little knowledge at times of what the others require. With each of these industries working together closely and the continued great work of Industry bodies I believe that the Australian Cotton Industry can continue to grow a premium fibre product that is in high demand from end users and that they have the resources,

knowledge and environmental conditions to go forward and rise to the challenges that may be faced in the future years.

Growers would be encouraged to think about quality issues when selecting their fields and varieties and that their management practices are also focused on this. This is where the crop's quality begins and if a good quality product is grown it can make the other processing jobs a lot easier when they are provided with a good product. "Yield is King and quality is Queen" although going forward this role may be reversed to keep up with future demands.

Recommendations

- Growers should select a planting date that is suited for their region so that picking can be carried out at a time of year that is typically drier.

- Monitor insects regularly and control to minimise the risk of Aphid and Whitefly infestations to avoid sticky cotton.

- Install moisture meter equipment and/or weather stations to monitor seed cotton moisture and don't go above 12%. (Remember that machine picking can add 2% moisture to the cotton) (Seed should be hard and crack between your teeth).

- More research and development toward improved weather forecasting so growers can avoid rain at harvest when possible. If rain is forecast extra picking capacity may be an option to maintain fibre quality.

- Regular and strict maintenance of cotton picking equipment should be carried out to ensure a good quality pick and breakdowns and downtime are kept to a minimum.

- When staging modules leave small gaps of at least 200 mm to provide airflow.

- Pre-gin small hand samples of cotton if unsure of cotton quality after weathering. Samples could be tested for colour and a decision made from this based around weather. This could also help with communication to the cotton gin.

- Stage modules and loads according to moisture and separate any problem modules or high moisture modules so these can be ginned quickly if possible.

- View P&D sheets of merchants and speak with them about any queries before marketing cotton.

- Further research into current P&D levels and if current discounts are fair for all industry groups.

- An opportunity or possibility to grade colour levels in steps and be dependent on other fibre properties and not colour only.

- Bring the gap closer between growers, merchants and spinning mills to ensure all groups know what is wanted from one another.

- A collaboration and trial between growers and processors of a roller ginned or premium upland product and whether there is any demand and premium price available.

- Visit a spinning mill if possible and the cotton process after the field, it is a great experience and an appreciation for the whole supply chain is better understood.

- If weather is concerning or the risk is too great, consider rainfall downgrade insurance.

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Plain English Compendium Summary

Project Title:	**The impact of colour discounts to the Australian Cotton Industry**
Nuffield Australia Project No.:	1517
Scholar:	Matthew McVeigh
Organisation:	Nuffield Australia Cotton Research and Development Corporation Cotton Australia
Phone:	0427 577 879
Email:	matt@mcveighpartnership.com.au
Objectives	• Identify how end users currently view Australian Cotton fibre the challenges they face. • Identify which fibre properties are most important to the spinning mills. • Identify the main cause of colour degradation in cotton fibre. • Identify what technology may be available to assist in preserving cotton colour. • Provide recommendations to help the industry move forward and minimise the risk of colour downgrades in cotton.
Background	Cotton colour discounts can result in a major reduction in income to Australian cotton growers and the Industry. This report aims to identify techniques and guidelines that can minimise this discount. An investigation into what quality is desired and the fairness of current Premium and Discount levels will also be studied.
Research	The current classing system that is used, the current qualities that are desired from spinning mills and how can colour discounts be minimised.
Outcomes	A detailed report on Cotton classing, positives and negatives of Australian cotton quality, fibre degradation causes, technology and methods to assist in fibre quality preservation and the potential costs of discounts to growers and the Industry. This report can provide guidance and suggestions to improve fibre quality and minimise fibre discounts. A snapshot of the supply chain and important feedback will also be provided.