



Contamination and its significance to the Australian Cotton Industry



Cotton Catchment Communities CRC



Acknowledgements

This project was initiated by CSIRO Materials Science and Engineering (CMSE) and was supported financially by CMSE and the Australian Cotton Catchment and Communities Co-operative Research Centre (CRC).

The author gratefully acknowledges the support provided during this project by the Australian Cotton Ginners Association (ACGA), The Australian Cotton Shippers Association (ACSA), PT APAC INTI CORPORATA, Mr. Vijayshankar, and the individual gins that participated in this survey. The assistance of Susan Miller in analysing the contaminants and Stuart Gordon in compiling this report is also gratefully acknowledged.

Correspondence on this report should be addressed to:

Mr Marinus H. J. van der Sluijs
CSIRO Materials Science and Engineering,
Belmont, Victoria 3216,
Australia.

Email rene.vandersluijs@csiro.au
Ph 61 3 5246 4000
Fax 61 3 5246 4057

©2009 Cotton Catchment Communities CRC. This book is copyright. Except as permitted under the Copyright Act 1968 (Commonwealth), no part of this publication may be reproduced by any process, electronic or otherwise, without the specific written permission of the copyright owner. Neither may information be stored electronically in any form whatsoever without such permission. Enquiries should be address to:

Cotton CRC
Locked Bag 1001
Narrabri NSW 2390

Disclaimer: Any information provided in this book is intended as a source of information only and is not advice, endorsement or recommendation.

Table of Contents

Executive Summary	5
Glossary of Terms	6
Introduction	7
ITMF Contamination Surveys	14
All Cottons	14
Australian Cotton	19
Limitations of the ITMF Data	19
The Australian Cotton Mill Survey	21
Detailed Assessment and Management of Contamination in Australian Cotton	22
Contamination in Modules	22
Contamination in Bales	25
Comparison of Contaminants in Modules and Bales	28
Conclusion	29
References	30
Appendix 1	31



Cotton modules waiting to be transported to the gin



Executive Summary

Contamination, even if it is a single foreign fibre, can lead to the downgrading of yarn, fabric or garments to second quality or even the total rejection of an entire consignment and is thus a very important fibre parameter.

The Australian Cotton CRC Mill Survey rated contamination as one of the most favourable fibre properties of Australian cotton. However, there has been concern that incidences of some contaminants are increasing. This was supported by International Textile Manufacturers Federation (ITMF) Contamination Survey findings from 1999 to 2005, which showed an increase in the number of contaminated Australian cotton bales delivered to overseas spinning mills. The major source of contamination in Australian cotton has been organic matter such as leaves, feathers, paper and leather followed by string and fabric made from plastic film and from jute and hessian.

In order to overcome the limitations of the ITMF contamination survey and as a first step towards eradicating contamination levels in Australian cotton, the Australian cotton industry through CSIRO Materials Science and Engineering (CMSE) with the support of the Cotton Catchment and Communities Cooperative Research Centre (Cotton CRC) conducted a survey from 2006 to 2008. Activities included:

- Surveying Australian ginners during the 2006, 2007 and 2008 ginning seasons to determine the degree and type of contamination found in cotton delivered in modules to the gin yards. This is aimed at identifying the magnitude of the problem of foreign matter in Australian cotton and gives a better sense of how contamination events occur in the field and gin.
- Cooperation with a large overseas spinning mill (Apac Inti Corpora) that uses a sizeable proportion of Australian cotton in its mill laydowns, to accurately assess the extent and the amount of contamination being sent in Australian cotton bales.
- Briefing growers and ginning companies on survey outcomes and together identifying and prioritising actions to minimise or eradicate contamination.

- Inclusion of contamination prevention measures in Best Management Practice (BMP) for growers and ginners.

The survey found that the majority of contaminants found in modules were metallic pieces from harvesters, module builders and from the transportation of modules to the gins. The major contaminant found in cotton bales were pieces of cloth from either woven or knitted rags or clothing in various colours made from either cotton or polyester or blends thereof.

The survey showed that in 2006/07 Australian cotton contained the lowest levels of contamination of all growths imported by the spinning mill. The data also revealed that contaminants found in Australian cotton's major competitors such as Brazil, West Africa and some regions in the USA are also decreasing.

There is no doubt that the continued and increasing presence of foreign matter in raw cotton is a serious issue for textile processors and it is pleasing to note that the amount of foreign matter found in Australian cotton bales continues to be small relative to other growths. The challenge for the Australian cotton industry is to provide cotton with zero contamination. In response to this challenge, the Australian ginning sector is implementing Best Management Practices (BMP) and the industry is currently investigating the possibility of integrating decontamination systems into the gin. These measures will reduce and possibly eliminate the occurrence of foreign matter in modules delivered to the gin yard and subsequently the bales delivered to the spinner.

Marinus H.J. van der Sluijs

rene.vandersluijs@csiro.au

May 2009

Glossary of Terms

Bale – 227 kg (500 pounds) of pressed and bound cotton fibre.

Bale Lay-Down – A row of bales opened and blended to ensure a consistent and homogeneous blend.

Carding – Carding individualises and partially aligns the fibres, and then condenses the fibres into a single continuous strand of overlapping fibres called “sliver”.

Short fibres and fibre entanglements (referred to as neps) are removed during carding.

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.

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

Drawing – Drawing is the process where the fibres are blended and straightened. The drawing process also improves the uniformity of the sliver.

Dyeing Ability – A 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 – An indication of uniformity of length distribution.

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

Micronaire – 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.

Modules – Harvested cotton compacted into a big square (about the size of a bus) which is then transported to the gin for ginning.

Nep – Neps are fibre entanglements that have a hard central knot or nucleus that is detectable.

Opening, Blending and Cleaning – Opening, blending and cleaning are the first operations at the spinning mill.

Roving – In preparation for ring spinning, the sliver needs to be condensed into a finer strand, known as a roving, before it can be spun into a yarn. The roving frame draws out the sliver to a thickness of a few millimetres and inserts a small amount of twist to keep the fibres together.

Short Fibre Content (SFC) – The most common definition of SFC is the proportion by mass of fibre shorter than 12.7 mm or one half inch.

Size – Substance applied to yarn which improves their strength stiffness and smoothness which improves weaving performance.

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 – The length of a typical portion of the fibres in the samples as determined by the classer or High Volume Instrument.

Strength – 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.

Warp – Yarns or threads that run lengthwise in a woven fabric.

Yarn formation, or spinning - The process of converting cotton fibres into a yarn structure involving a number of processes. There are three main technologies used commercially to produce cotton and other short staple yarns:

Ring spinning:

The technology for ring spinning was perfected by the end of the 19th century and became the standard for manufacturing short staple yarns world wide and it continues to be the most dominant spinning system. The majority of Australian cotton is spun into yarn using this spinning system. Ring spinning is the process of further drawing out roving to the final count needed, inserting twist to the fibres by means of a rotating spindle and winding the yarn on a bobbin. These processes take place simultaneously and continuously.

Open end (Rotor) spinning:

This technology was introduced in the mid 1960's and together with ring spinning accounts for over 95 % of short staple yarn produced world wide.

Sliver is fed into the machine and combed and individualised by the opening roller. The fibres are then deposited into the rotor where air current and centrifugal force deposits them along the groove of the rotor where they are evenly distributed. The fibres are twisted together as the yarn is continuously drawn from the centre of the spinning rotor. The resultant yarn is cleared of any defects and wound onto packages.

Air jet spinning (vortex):

This technology was introduced in the early 1980's. Sliver is fed into the machine and is further drawn out to the final count and twist is inserted by means of a rotating vortex of compressed air. The resultant yarn is cleared of any defects and wound onto packages ready for use in fabric formation.

Winding – In the case of ring spun yarns, the winding process is a necessity and the final process in a spinning mill. The winding process is needed to transfer the yarn from small bobbins to

larger packages and to remove defects in the yarn. This will ensure more efficient processing during fabric formation. Packages from the rotor and air jet spinning systems can also be given a further winding operation if required.

Yarn count – The count of a yarn is a numerical expression of its fineness, or weight per unit length (linear density). There are two main systems used to determine linear density.

1. The indirect system known as English Cotton Count (Ne) is based on the number of 840 yard lengths in one pound weight of yarn. The higher the English Cotton Count value, the finer the yarn, i.e. the more yarn length in one pound.
2. In the direct system, the yarn count is determined by measuring the number of grams per thousand metres of yarn and is denoted as Tex. The higher the Tex value, the heavier the yarn.

Introduction

Contamination, **even if it is a single foreign fibre**, can lead to the downgrading of yarn, fabric or garments or even the total rejection of an entire batch and can cause irreparable harm to the relationship between growers, ginners, merchants and textile and clothing mills (see Figure 1 & 2). An International Textile Manufacturers Federation (ITMF) study in 2001 [1] reported that claims due to contamination amounted to between 1.4 – 3.2% of total sales of 100% cotton and cotton blended yarns. A study conducted in Pakistan estimates that contamination of cotton is responsible for an annual loss of US\$ 1.4 billion to US\$ 3 billion in export earnings [15].

Most contamination arises from impurities being incorporated into the bale as a result of human interaction during harvesting, ginning and baling. In order to convert a fibre into yarn, cotton passes through a large number of processes in a spinning mill. A large number of machines mechanically reduce the size of most foreign matter clusters into a large number of individual foreign fibres. These fibres can remain undetected under normal mill processing conditions and only become noticeable when the production process is interrupted, by a spinning end break or when the yarn is used to make up fabric and the fabric is subjected to normal quality control inspection. Contamination represents a significant cost to spinning mills and it is thus very important to detect and eliminate contamination as early in the process as possible. This has led to the implementation of a range of methods to cope with contamination. These include:

- The first step, and the most logical, is to avoid or minimise the use of cotton from origins that are known to be contaminated. Contamination survey results and the practical experience of mill staff and industry hearsay should be taken into consideration when purchasing cotton. Ideally, allowable levels of contamination should be stipulated in cotton contracts with ginning and merchant companies. Ginners and merchants could use existing ITMF survey information or be encouraged to develop their own contamination screening protocols in order to assess the contamination risk of their cotton.
- Spinning mills situated in countries where labour costs are comparatively low employ large numbers of people to patrol the bale laydown and

remove contamination from bales before cotton is fed into the blowroom line by the bale opener (see Figure 3).

- A small number of spinning mills are able to manually check and remove contamination from every bale of cotton before it is repacked and released for processing in the mill (see Figure 4 & 5). This manual sorting is either done directly from the bale or the bale is first opened using a bale opener with a spiked lattice to open the cotton prior to manual sorting. The cost for this manual cleaning is estimated at 3.1 to 4.4 US cents per kg of lint depending on the level of contamination [12].

- Although manual intervention is helpful even low labour cost spinning mills have come to realise that it is not always sufficient as generally only the bigger contaminants are removed. Hence, they are equipping blowrooms with systems for detection, separation and measurement of foreign material (see Figure 6). These systems detect contaminants using acoustic, optical and colour sensors that monitor the material as it flows (is processed) through the machinery. When a sensor is activated by a contaminant it is measured (registered) and, depending upon the system, mechanically removed via an alternate material flow outlet. These systems are normally installed at the beginning of the blowroom line before the final cleaning stage, although a number of spinning mills also install a second machine at the end of the blowroom line [11]. It is estimated the installation of foreign matter detectors has cost the spinning industry in excess of \$US150 million over the past 10 to 12 years and that these detectors inspect approximately 30 - 35% of the global cotton consumption [2].

It is estimated that there are approximately 3500 to 4000 systems installed worldwide [3]. However, studies show that these systems only remove 60 – 75% of contaminants [4, 11]. The inclusion of metal detectors in blowrooms has been a standard feature for many years.

- Careful control of waste recycling and maintenance in the spinning mill to avoid the accidental introduction of contaminants and foreign fibres to the process.



Figure 1 – Contaminated Yarns
(photo courtesy of CSIRO Materials Science and Engineering)



Figure 2 – Contaminated Fabric
(photo courtesy of CSIRO Materials Science and Engineering)



Figure 3 – Operators patrol a bale laydown to remove contamination from bales (Indonesia)



Figure 4 – Manual removal of contaminants from cotton before release to spinning mill (Indonesia)



Figure 5 – Manual removal of contaminants from cotton before release to spinning mill (India)



Figure 6 – Blowroom equipped with Jossi detection systems (photo courtesy of Jossi Systems AG)

- There are devices on the market that can be added to the carding, drawing and lapping machines, which detect foreign fibres (of a different colour) and stop the machine for removal by the operator.

- Equipping winding machines with yarn clearers that detect and remove foreign matter from the yarn before it is wound onto packages and delivered to the knitter or weaver (see Figure 7). The types of contamination and the efficiency of removal depend on the sensors employed in these systems, with modern clearers able to detect the finest defects not visible by the human eye. A large number of contaminants will lead to a number of stoppages which will result in loss of production, increased labour costs and increases in waste [5]. It is estimated that approximately 40% of yarn spun in China is cleared using yarn clearers that detect and remove foreign matter versus 75% of yarn in the rest of the world [3, 5]. However, these systems only remove 80 to 85% of contaminants [2].

- Equipping modern, high production spinning machines, such as Air Jet and Open end (Rotor) spinning with yarn clearers that detect and remove foreign matter. These clearers are only able to remove the major contaminants to avoid a dramatic drop in efficiency [5]. It is estimated that only 20% of the yarns spun on the Open end spinning machine are cleared using yarn clearers that detect and remove foreign fibres [3].

- Installing Ultra Violet lights in the packing and inspection departments to detect chemical/oily substances and foreign fibres such as polyester and other synthetic man-made fibres that fluoresce (see Figure 8).

- If a spinning mill is vertically integrated through to fabric production the possibility further exists to remove contaminants manually from the fabric before it is dyed and finished. This is however very time consuming and expensive with some estimates at \$US4/100 meters [5]. Furthermore, contaminants cannot be removed from knitted fabrics as this will cause holes and in woven fabric it is very difficult to remove contaminants from the warp direction due to the presence of size.

- Chemical treatment such as bleaching/scouring in preparation for dyeing reduces the problem of contamination but adds further cost in processing which is not always acceptable to all customers.

In the past there have been attempts to incorporate contamination removal systems in the ginning process. There are currently two systems operating successfully in Greece and ten in India. As the major ginning equipment suppliers, showed little interest in incorporating these systems into their ginning equipment, the manufactures are not promoting or conducting further R&D [13, 14, 17].



Figure 7 – Yarn clearer to remove foreign matter from yarn in winding and open end spinning (photo courtesy of CSIRO Materials Science and Engineering)



Figure 8 – Installation of Ultra Violet lights in the packing and inspection departments

ITMF Contamination Surveys

(a) All Cottons

In order to quantify and highlight the presence of contamination in cotton lint the ITMF conducts a survey of cotton users (spinners) on the amount of contamination found in world growths. The survey has been conducted in its current format since 1989 on a biannual basis. In the survey spinners are asked to rate the degree of contamination in cotton lint according to 16 categories of foreign materials listed in Table I as to whether they were

non-existent/insignificant, moderate or serious. (The perceptions with regard to incidences of stickiness in cotton and seed-coat fragments are also surveyed but not covered in this report.)

As one would expect the degree of contamination varies widely from region to region and between growths. As can be seen in Table 2, the most contaminated cotton continues to originate

Table I – ITMF Contamination sources [6]

1	Fabrics made of	woven plastic
2		plastic film
3		jute/hessian
4		cotton
5	Strings made of	woven Plastic
6		plastic film
7		jute/hessian
8		cotton
9	Organic matter	leaves, feathers, paper, leather, etc
10	Inorganic matter	sand, dust
11		rust
12		wire, metal
13	Oily substances/chemicals	grease/oil
14		rubber
15		stamp colour
16		tar

from India, Turkey and Central Asia (various descriptions). In contrast, as can be seen in Table 3, the least contaminated cotton continues to originate from Zimbabwe, the USA, Israel, Australia and some countries from West Africa (various descriptions) [6]. It is noted that cotton that is mechanically harvested generally has less contamination as there is less interaction between humans and the cotton during harvesting and ginning. It is for this reason that some spinners and even some countries (such as Japan) use no, or very little, hand picked cotton [16].

No growths are contaminant free, even the least contaminated cotton has contamination levels of 4-5%. Analyzing the results of the surveys since 1989 one discovers that:

- The perceived degree of contamination in all growths steadily increased from 14% in 1989 to 26% in 2003, although a decrease to 22% in 2005 was recorded, which was maintained in 2007 (see Figure 9). It is notable from Figure 5 that there is a dramatic increase in contamination worldwide since 1993 which can in all likelihood be attributed to the fact that spinners became more aware of contamination as they started to receive complaints from fabric and garment manufacturers.

A further breakdown (see Table 4) reveals that the major source of contamination in all bales continues to be organic matter such as leaves, feathers, paper, leather, etc., which has steadily increased from 30% in 1989 to 50% in 2003, although it decreased to 40% in 2005 and 2007. It must be noted that some bales can be contaminated with more than one contaminant. The next most prevalent contaminant is fabric and string made from cotton, woven plastic, plastic film and jute/hessian, followed by sand and dust. The incidence of oily substances/chemicals and inorganic matter such as rust and metal has remained fairly consistent since 1989.

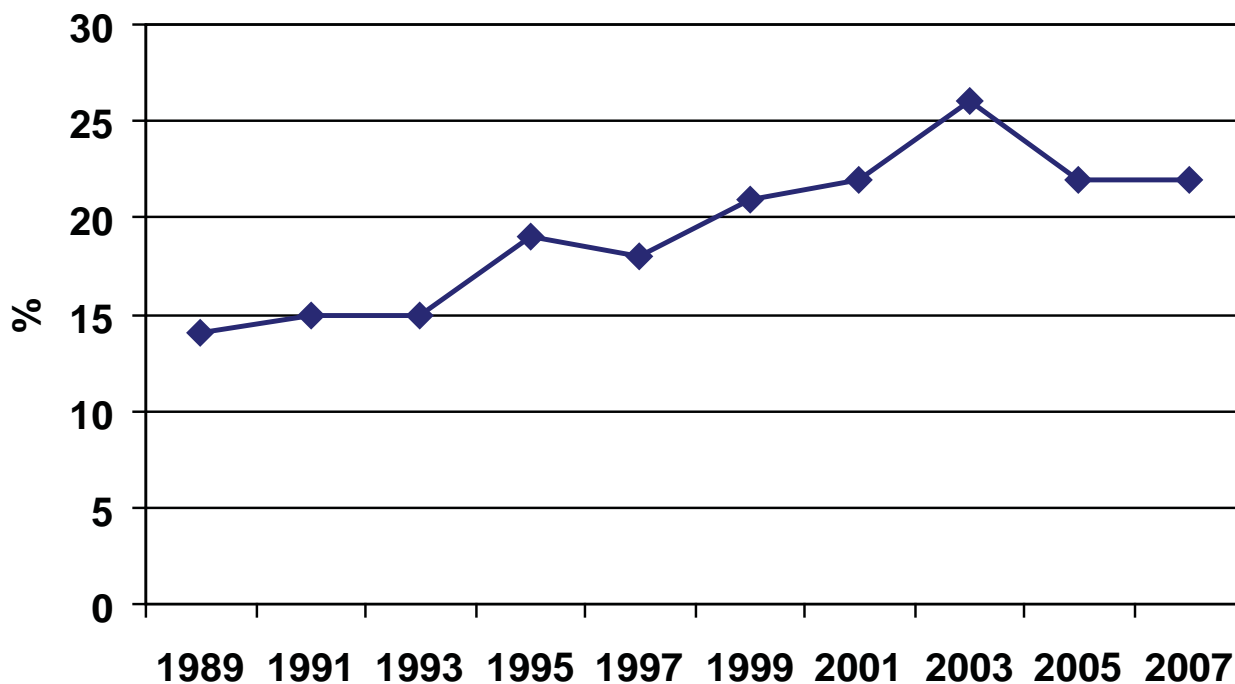


Figure 9 – ITMF Contamination Survey results from 1989 to 2007 [6]

Table 2 – The most contaminated sources of cotton [6]

Ranking	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007
1	India	India	Turkey	India	India	India	Nigeria	India	Turkey	India
2	India	India	India	India	India	Pakistan	Turkey	India	Turkey	India
3	India	India	Tanzania	Turkey	Pakistan	India	India	Turkey	India	India
4	India	Turkey	Pakistan	Pakistan	Pakistan	India	India	Turkey	India	India
5	India	India	Turkey	Pakistan	India	India	India	India	India	India
6	Pakistan	Sudan	Pakistan	India	Turkey	India	India	India	India	India
7	Pakistan	Brazil	India	India	Pakistan	India	India	India	Paraguay	Togo
8	China	India	India	India	India	India	Turkey	India	Nigeria	Turkey
9	China	Turkey	China	India	Iran	Turkey	India	India	India	Mali
10	Turkey	Pakistan	Pakistan	India	Turkey	Sudan	Pakistan	Uzbekistan	Uzbekistan	Uzbekistan

Table 3 – The least contaminated sources of cotton [6]

Ranking	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007
1	Israel	Israel	Zimbabwe	Argentina	Zimbabwe	Israel	USA	Zimbabwe	Israel	USA
2	Guatemala	Mexico	Mexico	Mozambique	South Africa	Zimbabwe	USA	USA	Senegal	USA
3	Mexico	Senegal	Israel	South Africa	Israel	Argentina	Israel	USA	USA	Australia
4	Zimbabwe	Zimbabwe	USA	USA	Australia	Sudan	Ghana	Senegal	USA	USA
5	Iran	Australia	Australia	Australia	Senegal	Australia	Senegal	USA	Zimbabwe	USA
6	Mexico	Colombia	Spain	Zimbabwe	Cameroon	Cameroon	China	USA	Australia	Israel
7	Australia	Benin	Chad	Sudan	Spain	Israel	USA	Chad	Togo	USA
8	USA	Togo	Togo	Cameroon	Sudan	Spain	Australia	Yemen	USA	Brazil
9	USA	Guatemala	Israel	Spain	USA	USA	USA	Australia	USA	Cameroon
10	Colombia	Colombia	Burkina Faso	Israel	CAR*	USA	USA	Israel	Spain	USA

* Central African Republic

Table 4 – Breakdown of contaminants found in % in cotton world wide [6]

Contaminant	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007
Fabrics										
woven plastic	13	15	16	16	19	20	23	29	25	23
plastic film	11	12	11	14	14	16	21	24	25	30
jute/hessian	15	18	19	22	20	25	24	30	21	27
cotton	18	19	19	19	21	24	28	31	32	30
Strings										
woven plastic	15	14	17	20	31	25	24	32	29	25
plastic film	14	13	12	18	18	22	22	28	26	29
jute/hessian	22	21	24	30	25	30	30	38	25	29
cotton	17	16	16	19	18	25	22	30	24	26
Organic matter										
leaves, feathers, paper & leather	30	28	29	34	34	39	39	50	40	40
Inorganic matter										
sand/dust	16	20	19	25	23	30	28	37	29	25
rust	10	13	12	13	13	18	15	20	15	13
metal/wire	15	12	13	14	15	16	18	21	12	17
Oily substances/chemicals										
grease/oil	14	14	15	20	18	23	22	23	16	17
rubber	4	5	4	5	6	6	7	9	7	9
stamp colour	12	15	12	14	14	14	16	17	15	11
tar	3	3	2	4	4	4	6	6	5	5
NonExistent/insignificant	86	85	85	81	82	79	78	74	78	78
Moderate	9	11	11	13	13	15	16	18	15	15
Serious	5	4	4	6	5	6	6	8	7	7

(b) Australian Cotton

Australian cotton is generally viewed worldwide as a quality fibre with low or no contamination and is usually purchased (at a premium) with the intention of producing high quality yarns, normally combed ring spun, for use in the weaving and knitting sector. The results of the ITMF survey confirm this perception with Australian cotton continuing to be one of the best performers in terms of contamination.

However, analyzing the historical Australian data from the ITMF surveys, one finds that while the overall level of contamination is low, over recent years there has been an upward trend (illustrated in Figure 10) i.e. an increase from a base level of approximately 5% being 'moderately or serious contaminated' in 1989 to approximately 13% in 2005, although decreasing to 8% in 2007.

In parallel with the world data, the major single source of contamination is organic matter such as leaves, feathers, paper and leather (see Table 5). The next most damaging source of contamination in Australian cotton is string and fabric made from plastic film followed by string and fabric from cotton woven fabric and jute/Hessian. The main source of plastic film is module covers, which is also a major issue in the USA [10]. It is noticeable that the incidence of jute/hessian contamination in 2007 has dropped by 50% when compared to 2005 which is in all likelihood due to the change in industry practices with a large number of cotton bales now being covered with cotton bale covers [9]. Inorganic matter and oily substances/chemicals remained fairly consistent since 1989 with the exception of tar which increased to 13% in 2003.

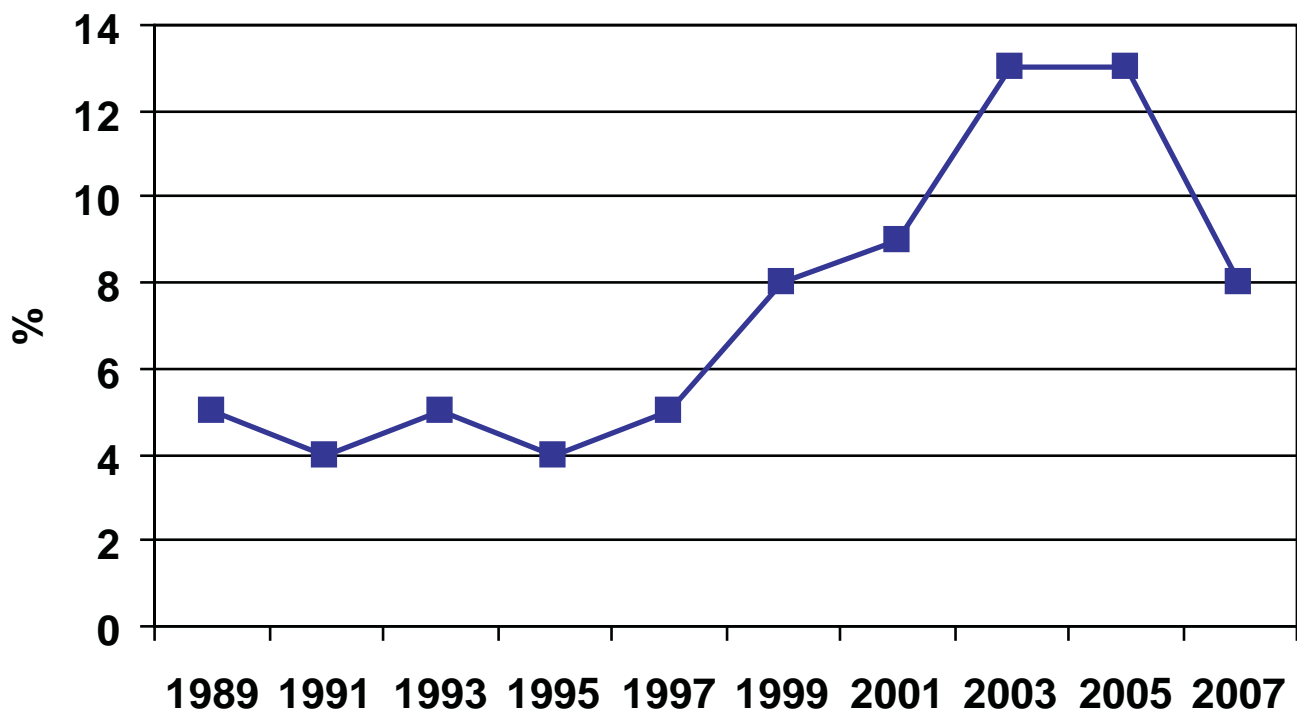


Figure 10 – Australian contamination results from ITMF Contamination Survey from 1989 to 2007 [6]

(c) Limitations of the ITMF Data

It is important to note that there are a number of limitations associated with the ITMF Contamination Survey as follows:

- Participant mills make a largely subjective assessment of the contamination found in a growth and moreover whether the occurrence in a particular growth has been insignificant, moderate or serious. As the ITMF methodology states the “basic statistical unit (the sample) of this survey is a spinners evaluation of a given description, which it had consumed during the last 12 months.”
- On the basis of the previous point the Survey is unable to quantitatively measure the number or proportion of bales actually affected by contamination.
- Low overall numbers of contamination conceal ‘higher levels’ of particular contaminants as each category is given equal weighting in determining the average contamination number.
- With regard to Australian cotton, only a small number of spinning mills in our traditional markets such as China, Indonesia, Thailand, South Korea and Japan participate in these surveys.



Cotton bales ready for shipping

Table 5 – Breakdown of contaminants found in % in Australian cotton [6]

Contaminant	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007
Fabrics										
woven plastic	4	0	3	2	7	7	5	6	13	0
plastic film	8	0	2	4	4	5	5	9	17	5
jute/hessian	6	11	5	11	7	6	10	18	17	11
cotton	8	7	6	4	4	11	8	9	13	5
Strings										
woven plastic	2	2	2	0	11	7	3	6	8	5
plastic film	4	2	6	0	7	11	5	12	13	27
jute/hessian	10	13	9	15	2	9	21	24	17	5
cotton	6	4	5	2	4	7	13	9	13	0
Organic matter										
leaves, feathers, paper & leather	10	6	9	13	13	24	25	36	26	21
Inorganic matter										
sand/dust	10	7	9	6	6	16	18	15	13	11
rust	2	9	5	2	1	5	8	12	17	5
metal/wire	6	0	2	4	1	4	5	6	4	5
Oily substances/chemicals										
grease/oil	10	4	3	0	4	11	8	12	9	5
rubber	0	2	2	0	1	2	3	6	4	0
stamp colour	6	6	0	2	0	2	3	12	13	0
tar	2	0	2	0	0	2	0	6	13	1
NonExistent/insignificant	95	96	95	96	95	92	91	87	87	93
Moderate	5	3	4	3	4	7	8	10	11	6
Serious	0	1	1	1	1	1	1	3	2	1

The Australian Cotton CRC Mill Survey

An independent survey [7] conducted by CSIRO of over 30 international spinners that use Australian cotton, surveyed in 2002 and 2003 (see Figure 11) shows the average response to their perceptions of fibre quality characteristics of Australian cotton. Spinner's responses indicated that contamination was one of the most favourable properties of Australian cotton.

However, despite this favourable response individual spinning mills at the time had concerns that the incidence of contaminants such as polypropylene and jute string (from jute/hessian bags) was increasing. This is in line with the trends noted in Table 5.

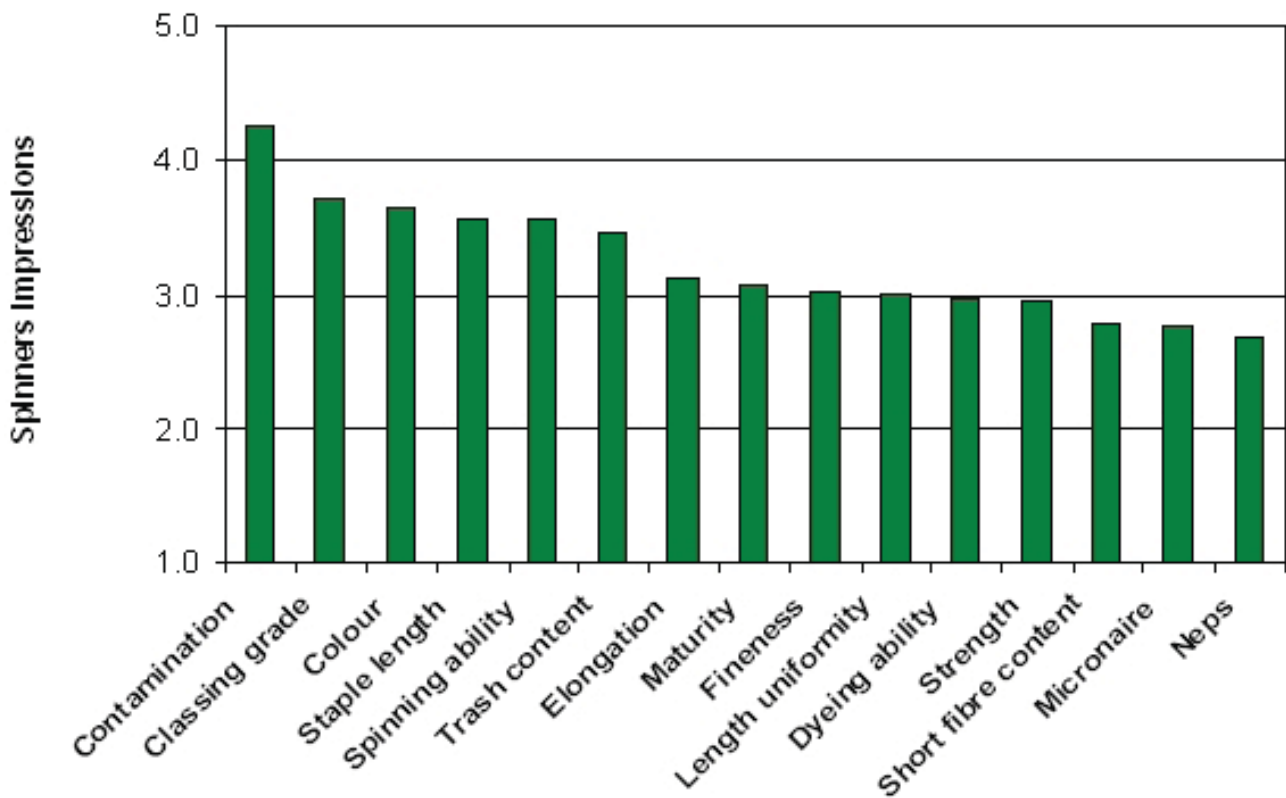


Figure 11 – Spinners impressions of Australian cotton fibre quality (5 = good, 3 = no issue, 1 = bad) [7]

Detailed Assessment and Management of Contamination in Australian Cotton

Due to the importance of contamination and the limitations of the ITMF contamination survey and the need for more comprehensive and objective information a comprehensive survey of not only spinning companies but also of ginning companies was undertaken to obtain more accurate and thorough information on current sources and levels of contamination.

During the past three seasons all operating gins in Australia have participated in the survey, collecting and recording all contaminants found in modules delivered to the module feeding area of the gin. Gins also recorded the costs of repair and replacement of parts due to damage caused by contaminants.

P. T. Apac Inti Corpora (herein Apac Inti) is a large cotton spinning mill situated in Indonesia that performs a unique process at their mill; every bale of cotton is manually inspected before processing and contaminants, even single human hairs, are removed and collated. This allows for a direct measurement by weight and by type of contaminants exported with Australian cotton. Since 2000 Apac Inti has cleaned over 200 million kilograms of cotton sourced from around the world and has generated a large and accurate database on the levels of contaminants found in a wide range of growths.

Contaminants in Modules

Over 770 incidents of contamination were recorded from a total of 158,693 modules processed between 2006 and 2008 (see Table 6). An incidence refers to a single contaminant. The costs quoted in Table 6 refer to the cost of repairing or replacing parts damaged due to foreign objects, but do not include the cost of labour or loss of production. Table 7 and Figure 12 show the breakdown of contaminant type found in modules during the 2006, 2007 and 2008 seasons.

The survey showed that most contamination occurs during picking and to a lesser extent in ginning. The reason we know this is because the majority of contaminants found in modules were metallic pieces from harvesters, module builders and from transportation of modules to the gins. However as

will be seen in the contaminants found in bales, metallic objects are usually not a big issue for spinners as they are generally large and easily removed during the ginning process either manually or by magnets, although they can cause considerable damage to the gin. This was followed by a category 'other', which included items such as mobile phones, shotgun shells, beer cans, oil cans, two-way radios, hats and rubber mats. This was followed by module ropes and plastic which included plastic bags, moisture pads from harvesters, strapping, rakes and a siphon. This was followed by grass and timber, which is followed by grease and oil which is mainly due to hydraulic oil. The fabric category includes all rags and cloth of any description and covers refers to module covers (tarpaulins).

Although the gins recorded a large number of rocks during the survey they were not considered in this survey as they are easily removed during the initial stages of the ginning operation.

Examples of the contaminants removed from modules at the gin are illustrated in Figure 13.

The introduction to the Australian cotton industry of the round modules in 2010 will need to be managed appropriately to ensure that the plastic covers do not contaminate the cotton.

Table 6 – Details of contaminants recorded during past three seasons

STATISTIC	2006	2007	2008
No. of gins	23	27	18
No. of Modules	81,121	53,042	24,530
No. of contaminant incidents	350	127	296
Probability of contamination incident in %	0.43	0.24	1.21
Cost to all gins in \$AUD	46,420	45,313	*

* No information available

Table 7 – Contaminants found in modules

Contaminants	Total	2006	2007	2008
Total	773	350	127	296
Metal	364	125	57	182
Timber	43	24	13	6
Grease and oil	38	16	12	10
Fabric	21	9	24	8
Module Covers	19	11	0	8
Module Ropes	75	58	2	15
Grass	55	41	0	14
Plastic	58	24	18	16
Other	100	42	21	37

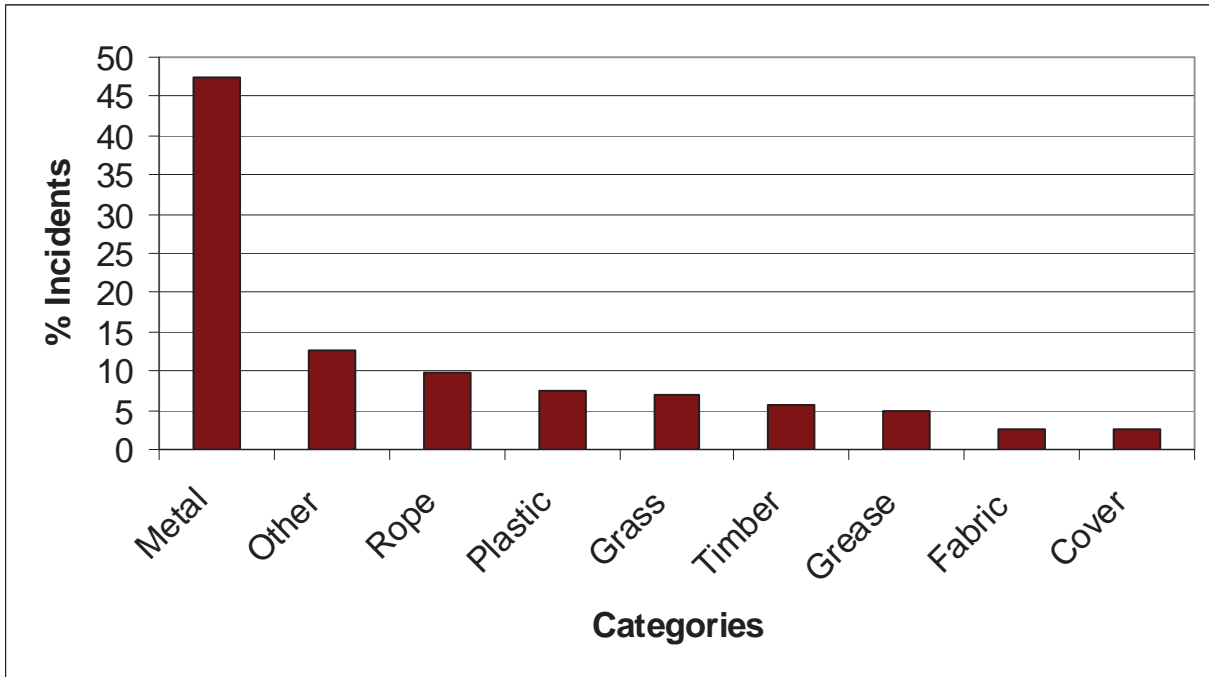


Figure 12– Breakdown of types of contamination found in modules during the 2006, 2007 & 2008 ginning season



Figure 13 – Contaminants collected at gins during a ginning season (photo courtesy of Dunavant Australia)

Contaminants in Bales

In order to accurately quantify the degree and type of contaminants found in Australian cotton bales Apac Inti has been sending data and the actual contaminants removed from shipments of Australian cotton, amounting to over 4,825 tons or 21,256 bales, to CSME since December 2005 (see Table 8). Apac Inti reports contaminants as fibrous and non fibrous. During this study further analysis was conducted at CSME on the contaminants to identify the exact chemical composition of the contaminants with a view to accurately identifying their source. This was done by identifying the foreign fibres on the basis of their melting point using the Reichert–Jung Hot Bench (with electronic stabilization).

Table 9 and Figure 14 shows the proportion by number of fragments found of particular contaminants in Australian bales. The major contaminant found in bales were pieces of cloth from either woven or knitted rags or clothing in various colours made from either cotton or polyester or blends thereof, followed by yarn made from either cotton or polyester or blends thereof. This was followed by polypropylene yarn in various colours, followed by followed by bird feathers jute/hessian yarn, human hair, plastics including shopping bags, lolly papers and garbage bag fragments, paper from newsprint and notepads and metallic pieces such as nuts, bolts and wire.

Table 8 – Australian consignments received by Apac Inti

Consignments	Tons	Bales
December 2005	976	4,301
April 2006	200	881
December 2006	1486	6,546
July 2007	818	3,604
December 2007	1035	4,560
March 2008	310	1,364

Table 9 – Incidences of contaminants found in Australian consignments received by Apac Inti

Contaminants	Total	Dec. 2005	April 2006	Dec. 2006	July 2007	Dec. 2007	March 2008
Total	5,140	482	96	254	583	1,600	2,125
Cloth	2,100	46	0	12	9	33	2,000
Yarn	1893	164	19	76	401	1,186	47
Polypropylene	425	98	16	116	52	124	19
Feather	277	93	7	23	30	112	12
Jute	159	54	28	13	24	21	19
Hair	147	15	24	7	27	70	4
Plastic	113	0	1	5	35	48	24
Paper	13	7	0	0	0	6	0
Metal	13	5	1	2	5	0	0
Bales	21,256	4,301	881	6,546	3,604	4,560	1,364

Figure 15 shows contaminants removed from Australian cotton shipments. Contamination due to jute/hessian only amounted to 3.1% of the total contaminants found which indicates that if care is taken with storing/transporting and removal of the bale covers there should be no problems with contamination.

It is surprising considering the fact the majority of Australian cotton is processed through two lint cleaners that a large amount of vegetable plant material (total of 645.8 grams from the six consignments), mainly from stems and branches was still present in bales delivered to Apac Inti. This vegetable matter was not included in the study as this will be easily removed during the opening and cleaning process in the cotton spinning blowroom. There is also a large amount of stained cotton (mostly brown/orange in colour) present in the bales which could be due to wet cotton, fungal infected cotton and hydraulic oil and grease.

Apac Inti's data [8] (see Table 10) reveals that in 2004/05 some 20% of Australian cotton bales delivered to the mill had some contamination, up from 14% in 1999/2000. Under the Apac Inti system a single foreign fibre defines a contaminated bale. For the same period Apac Inti found that 23% of Chinese, 27% of Brazilian, up to 31% of US, depending on growing region, and 66% of West African cotton bales were contaminated.

The data for 2006/07 reveals a decrease in the level of contamination to only 12% of Australian cotton bales and is the lowest of all growths imported by Apac Inti. The data also however reveals that contaminants found in Australian cotton's major competitors such as Brazil and cotton from Memphis, San Joachim Valley (SJV) and Fiber Max in the US, have decreased over the same period.

Further comparison with historical data from Apac Inti reveals that there was an increase in the rate of contamination from 1.4 grams/ton in 1999/2000 to 1.9 grams/ton in 2004/2005, whilst contaminants found in Australian cotton's major competitors such as Brazil and some growths from the USA decreased over the same period (see Table 11). However, data for 2006/07 reveals contamination found in Australian cotton decreased to 0.6 grams/ton, the lowest of all growths imported by Apac Inti. Reasons for this decrease can be attributed to an increased awareness of the issue of contamination in

Australia and also by the fact that the Australian crop has been decreasing over the past few years due to drought. Other countries in the world have shown that increased awareness can lead to substantial reductions in the levels of contamination in cotton bales [12]. Spinners are also willing to pay a premium for contaminant free cotton and avoid growths that have a reputation for high contamination which has resulted in growers becoming more aware of contamination. It has been suggested that if the rate of contamination in cotton bales is less than 1.0 grams/ton complaints by fabric and garment manufacturers will be minimal [12].

Results from this survey reflect the ITMF Contamination Survey results for 2007, which show that the level of contamination in Australian cotton reduced from 13% in 2005 to 7% in 2007 (back to the levels recorded in 1999 and 2001, but still higher than levels recorded in 1989 to 1997), whilst the degree of contamination in all growths remained steady at 22% (Figure 9 and 10). This improvement also resulted in an improvement in Australia's ranking from sixth to third in terms of least contaminant cotton.

Sixteen percent was contaminated with jute/hessian. This is a major reduction from the 34% recorded in 2005 and is due to the fact that in 2007 at least 50% of the Australian crop was covered with cotton bale covering up from 31% in 2005 [9].

Table 10 – Percentage of bales contaminated received by Apac Inti

Country	1999/2000 (% bales)	2004/2005 (% bales)	2006/2007 (% bales)
Australia	14	20	12
China	20	23	-
Brazil	35	27	15
USA	26	31	15
Uzbekistan	84	86	78
West Africa	58	66	63

Table 11 – Contaminants by country of origin in grams/ton found in bales shipped to Apac Inti

Country	1999/2000 (grams/ton)	2004/2005 (grams/ton)	2006/2007 (grams/ton)
Australia	1.4	1.9	0.6
China	2.2	3.0	*
Brazil	3.2	2.7	2.4
US	2.8	2.0	1.4
Uzbekistan	*	9.1	2.4
West Africa	3.7	7.0	2.5

* No values available

Comparison of Contaminants in Modules and Bales

The data for the contaminants found in modules and bales as presented in Tables 7 and 8 and Figures 9 and 10 shows that the major contaminant found in bales, at 77.7% is cloth and yarn followed by polypropylene at 8.3%, feathers at 5.4%, jute/hessian at 3.1%, hair at 2.9%, plastic at 2.2% and paper and metal at 0.25%. In contrast the major contaminant found in modules at 47.3% is metal followed by other at 12.7%, rope at 9.7%, plastic at 7.5%, grass at 7.0%, timber at 5.6%, grease/oil at 4.9%, fabric at 2.7% and module covers (tarpaulins) at 2.5%.

The difference between the findings can be explained by the fact that the metal and timber will be removed during the ginning process as they are generally large and in the case of metal will be caught by the magnets installed in the system. Grass will also be removed during the ginning process. Any fabric, plastic, rope and feathers that are not detected and removed prior to the ginning process will be disintegrated as the lint goes through a large number of machines during the ginning process which could potentially cause problems for the spinner.

Conclusion

There is no doubt that Australian cotton is under pressure to regain market share after a number of years of drought. Coupled with the current oversupply of cotton world wide and the emergence of other high quality growths on the export market, the only way to make this happen is by offering consistently high quality fibre. The industry will thus need to continue to control contamination, a property which is seen as being one of the most attractive aspects of Australian cotton. Although the amount of foreign matter found in Australian cotton bales is small relative to other growths, it must be borne in mind that during yarn formation cotton is processed through a large number of machines, which can lead to further disintegration of the contaminants, which in turn can subsequently lead to quality and production issues. The study found that

the harvesting/module building operations are the major contributors to contaminants found in modules and the challenge for the industry is to raise the awareness of the causes and effects of contamination.

It is also suggested that BMP's should be developed for harvesting and warehousing/transportation and that contamination should be included in the On-Farm BMP to complement BMP's already in place for ginning and classing.

It is hoped that this report will assist in raising this awareness and convey to our customers that the Australian cotton industry takes contamination seriously and is doing everything practically possible to minimise and even eradicate contamination from its cotton.



Sunset over the Namoi Valley

References

1. Strolz, H. M., 'ITMF Cotton Contamination Survey 2001', *proceedings* International Cotton Conference Bremen, pg. 35, 2002.
2. Strolz, H. M., 'A fresh look at cotton contamination', *Asian Textile Journal*, pg. 29, May 2004.
3. Van der Sluijs, M., Personal communication at ITMA Asia, Shanghai, China, August 2008.
4. Vijayshankar, M, 'Processing Your Product – Using Australian Cotton', 13th Australian Cotton Conference, Broadbeach Queensland, August 8-10, 2006.
5. Furter R., 'Experience with foreign matter removal systems', Application Report, SE 594, June 2006.
6. International Textile Manufacturers Federation, 'Cotton Contamination Surveys 1989 to 2007'.
7. Gordon, S., van der Sluijs, M. and Prins, M., 'Quality Issues for Australian Cotton from a Mill Perspective', *pub* Australian Cotton CRC, June 2004.
8. Vijayshankar, M, 'Extraneous Contamination in Raw Cotton Bales – A Nightmare to Spinners', *proceedings* International Cotton Conference Bremen, pg. 61, 2005.
9. Gordon, S. and van der Sluijs M., 'The Use of Bale Coverings in the Australian Cotton Industry', *report* for CRDC, August 2006.
10. Muzzi, D., 'Contamination eats their lunch', Western Farm Press, December 2003.
11. Balamurugan, S., 'Foreign fibre contamination in cotton Premier Fibre Eye – the right choice', *Asian Textile Journal*, pg 69, March 2003.
12. ICAC/CFC 'Production and Marketing of Uncontaminated Cotton in Mali', (CFC ICAC/32FT), April 2006.
13. Kiechl, W., 'Is there an ideal cleaning point for textile contaminants?' *proceedings* International Cotton Conference Bremen, pg 143, 2004.
14. Nassiou, T., and Buchmann, B., 'Greek spinner goes for outstanding cotton quality', *Melliand International*, pg 18, March 2005.
15. http://www.sbp.org.pk/reports/quarterly/FY05/first/Special_1.pdf.
16. Van der Sluijs, M., Personal communication with Japanese spinners, July 2009.
17. Van der Sluijs, M., Personal communication with Vetal Textiles and Electronics, July 2009.

Appendix 1

Photo's taken by various Australian gins highlighting some of the contaminants found in modules delivered to the gins over the past three ginning seasons.







