

Faserinstitut Bremen Bremen Cotton Exchange

28th International Cotton Conference Bremen

March 22 – 25, 2006

Proceedings



artwork: T. Sloomaker

Editor

Friedrich Marquardt, Bremer Baumwollbörse

Published by

Faserinstitut Bremen e.V. and Bremer Baumwollbörse

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Preface to the Proceedings 2006

This is the 28th International Cotton Conference organised by the Fibre Institute Bremen and the Bremen Cotton Exchange.

The main topics of the conference are the international harmonisation of cotton testing, fibre properties and fibre processing including “new products”. The keynote speaker this time is a well known marketing expert who will give an overview on new products made from cotton, focussing on healthcare in clothing.

This time we also have a report from Africa, which is playing a growing role in cotton trading to the international market.

Modern automated cotton classing systems and globally accepted solutions for the international harmonisation of rapid cotton classing systems are included in the program and will be the main topic of this conference. There will be a panel discussion on this issue.

Another session is set aside for an overview of new products made from cotton or a mixture of cotton and manmade fibres.

Of course, the latest research findings and practical developments in fibre properties and processing efficiency will be presented, the results of the latest ITMF Contamination Survey will be available and the ITMF Committee on Cotton Fibre Testing will present a summary of its latest deliberations, held on the two days preceding the conference.

These proceedings contain the manuscripts of the papers presented at the conference. The ITMF Cotton Fibre Testing Committee summaries will be published separately in a special ITMF Report.

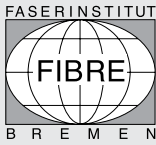
We would like to thank all of the authors, especially those whose native language is not English, for delivering their manuscripts in due time. Many of the manuscripts contain much more detail than can be exposed in the limited time available for oral presentations, so the written proceedings are worthy of study.

It is worth saying that this year’s conference is again of interest to every individual and company involved in the cotton business. The scientific basis of most of the presentations is necessary to lead to acceptable international rules for the harmonisation of testing procedures and reliable progress in processing. The focus on cotton, the social event “Bremer Abend”, as well as the trust of all the participants, are the important foundations for the success of the conference.

A great deal of hard work has been done by many people behind the scenes. We would like to thank all those who have contributed to this effort.

Th. Schneider
Fibre Institute Bremen

J. Wellmann
Bremen Cotton Exchange



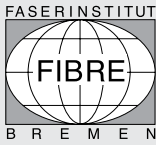
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Session I: Cotton Production and Economies

- ***Textiles and Healthcare in Clothing and Home Fashion Products: An Outlook on the Innovative Power of new Technologies and Finishings for Health and Wellness***
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TEXTILES AND HEALTHCARE IN CLOTHING AND HOME FASHION PRODUCTS: AN OUTLOOK ON THE INNOVATIVE POWER OF NEW TECHNOLOGIES AND FINISHINGS FOR HEALTH AND WELLNESS

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ABSTRACT

During the last six years a variety of new textile based solutions have been developed, which are applied to the marketing-wise, overstrained wellness area, the broad field of health & care and in medical diagnosis and therapy. Due to the fact of a constantly growing life expectancy, the well-known cost explosion in the health service sector and the growing pressure of “health activists”, textile products with special features to maintain, protect and foster health conditions are likely to meet growing demands in the next five to ten years. New functional opportunities for the application areas of sports, lifestyle and disease management have been explored particularly in surface modification and finishing as well as in textile based electronics to control vital parameters, some of them already more or less successfully commercialized. This lecture will give an outlook on existing and future functional assets and application fields with a special emphasis on biofunctional textiles used in medical therapy and cosmetic care. A special insight is given in antimicrobial and antifungal finishings of textiles, which are used for wellness and well-being purposes mainly to avoid bad odors or to prevent infectious diseases.

INTRODUCTION

How will the cotton industry manage the splits between ecology, environmental issues and economy in the next ten to twenty years? The introduction of biotech cotton varieties in several developing countries and the positive impact on human health, as well as further access to new technologies in developing countries opens up new horizons. Synthetic fibers are steadily gaining ground and with a world production of 37,9 million tons in 2004 have by far overtaken the cotton production. Man made fibers gain ground above all because of their advantages for technical applications. That means new opportunities for cotton have to be defined to cope with the growing competition. The increasing awareness with regard to environmental offences and ecologically harmful processes should be taken seriously into consideration. Companies who want to be successful need to envision doing business in a much more sustainable way in the next decades, proving their responsibility for the environment. Cotton, one of the oldest natural textile fibers may combine the natural feel with the performance of synthetics.

Cotton is a fibre that enjoys a high degree of acceptance on the consumer side. It is distinguished by a series of positive properties like good absorption, biodegradability, breathing activity, heat resistance, non-allergenic properties and many more. There are numerous intelligent textiles and technologies that might be associated with cotton – a lot of them are ready for commercialization. The variety of functions cover protection (UV, ray protection, climate control), healthcare (antimicrobial or antifungal finishings, transfer systems with medical or cosmetic substances, electronic-based systems for monitoring of vital parameters etc.) and well-being (deodorizing effects, easy care, climate control) or medical applications.

INTELLIGENT TEXTILES – A TYPOLOGY BY FIVE LEVELS

What are intelligent textiles? I-wear in the garment sector. Before we take a look at concrete products in the various fields of application, permit me to briefly sketch a typology of this area of application. The Hohensteiner Institute in Germany sub-divide the field into five large sections beginning with so-called transfer systems. In this case, specific active substances are released from molecular depots or micro / nano capsules, which are anchored to the surface of the textile, by pressure, humidity or warmth. The intervals at which the substances are released can be programmed via the thickness of the capsule. This is an important prerequisite in the field of medical textiles. Besides their use in therapy, transfer systems are also employed as a diagnostic aid. On the other hand, the depots can absorb secretions from the patient's skin for medical tests. A variety of areas of application can be predicted for medical purposes. For instance, textiles can be used to alleviate skin conditions. Fragrances, vitamins, cosmetics and numerous other substances can be stored. The depots are anchored firmly to the textile and the textile products can be recycled.

As the name suggests, the second section – adaptive systems – adapt automatically to changing physical and environmental conditions. They react to changes in heat, light and moisture. A visionary example is variable thermal insulation whereby the garment, i.e., a pullover or jacket, adapts automatically to take account of the ambient temperature. An example of this, that is already on the market is the so-called phase-change material (PCM). Other functional principles involving the storage and later release of thermal energy are possible and I will discuss some examples a little later. Conceivable are new clothing systems in which the fibres, yarn and fabric design ensure thermal insulation and breathability. Also imaginable are new, intelligent surface systems that automatically identify changing ambient conditions and react to them. Specialists also talk about self-organising or switchable surfaces that can change from a hydrophilic to a hydrophobic surface and vice versa. In this case, we can conceive of a variety of applications in the medical field, such as wound treatment or in connection with textile implants.

The third section – the smart-clothing section – refers to textile-based information and communication technology whereby electronic components are integrated more or less invisibly into garments. The components can range from computer keyboards, mobile phones, microphones, MP3 players, radios and video cameras to satellite navigation systems. People's increasing need for mobility is also generating a certain affinity to the mobile office. 'Wearables' enable the user to call up data independent

of the location and create opportunities for new, knowledge-intensive services. In the health-care sector, new kinds of garment textiles have come into being. They will keep track of vital body functions, such as blood pressure, heart rate and blood sugar, and give the alarm should the values move into critical areas. Increasing longevity is opening up completely new markets for textile systems that make it possible to look after ill people and high-risk patients on an out-patient basis, in other words, in the comfort of their own homes. Imaginable in the sport sector are intelligent garment textiles that enable participants to optimise their training patterns. In the outdoor segment, there will be technologies with a warning function, which can be used, for instance, in extreme sports, such as free climbing or paragliding. These systems identify bad-weather zones, abrupt drops in temperature or other dangerous climatic changes and send out an alarm signal. Indeed, safety and security functions are now set to play a vital role. Smart clothes with integrated GPS and local positioning systems are already on the market.

The fourth section comprises transponder systems. Transponders are miniaturised electronic storage devices, the content of which can be called up or changed via radio-frequency waves or laser codes. In this case, too, a huge range of areas of application is conceivable. Product information, such as fabric parameters for the clothing manufacturer, can be transmitted along the textile value-added chain. In the protective-garment segment, care cycles could be stored and documented. Last but not least, futurologists are discussing intelligent washing machines that set the wash programme to suit the properties of the items to be washed.

In the fifth technological stage – micro and nano technology – textiles and electronics are being merged at an ever-increasing rate. Integrated invisibly into textiles, extremely small electronic components and sensor systems take care of a variety of control and regulation functions. Textiles are becoming a medium for mobile, electronic, high-tech systems. Remote monitoring of people working under extreme conditions, elderly people or risk patients are foreseen in a short period of time.

HEALTH & CARE – ONE OF THE MOST PROMISING FIELDS OF APPLICATION

Already three years ago, experts conceived the healthcare area as a booming sector for textile applications. Raising health costs due to chronic diseases such as cardiovascular problems, cancer, arthrosis, diabete, obesity and an ageing population are major reasons. In Europe over 20% of all citizens suffer from a chronic cardiovascular disease (CVD) and 45% of all deaths are due to CVD and the expenditure for treatment and care are tremendous. Around 1,3 million people are in need of care in Germany. Thus, prevention is a crucial theme in health politics. It is commonly accepted, that a healthy and preventive lifestyle, as well as early diagnosis could systematically fight the origin of chronic diseases. Therefore, the market for health monitoring seems one of the most promising. Over the past twenty years, the development of telemedicine and healthcare systems has been the objective of many EU research programs and new biomedical clothes are being explored.

The starting point is to gain knowledge on a citizen's actual health status. Continuous monitoring of vital signs is mandatory. The approach is to integrate system solutions into functional clothes with integrated textile sensors. The application covers health monitoring for active sports and fitness, prevention and rehabilitation, baby monitoring to prevent sudden infant death, sensors in wall and floor coverings to protect from harmful substances or with integrated warning systems or luminous stripes.

The "time to market" is the question of prime importance when new product concepts and application scenarios are discussed. Four major market segments gaining steadily in complexity start with private households, sports/wellness going towards medical techniques, clinical application and finally military protection. A three-year product cycle is required for the consumer sector, whereas due to admission restrictions, professional medical application will need at least five years to gain market relevance.

BIOFUNCTIONAL TEXTILES

A variety of innovative textile developments as a result of new fiber types, new material and processing techniques have come to the market. They are primarily applied to the fields of wellness and medicine. The so-called biofunctional textiles contain active ingredients, medications or cosmetics which are released to the skin more or less directly. Stockings with aloe vera finishings, garments with vitamin C or other substances belong to the group of skin treating biofunctional textiles. Biotherapeutic wound healing through living organisms, such as textile-integrated maggots or maggot secretion are being tested in clinical studies. A variety of coatings promise antimicrobial and antibacterial properties. They may be on a silver or seaweed basis and have a purifying and anti-inflammatory effect on the skin or kill bacteria and fungi on contact.

Hygiene and cleanliness, including protection against moulds and mites are becoming increasingly important factors in the home textile and contract sectors. Bioactive fibers with antimicrobial properties reduce the formation of bacteria in textiles and particularly their multiplication. This action is achieved by carrier-bound silver which is integrated in the fiber polymer and therefore considerably reduces the risk of undesirable side effects. The antimicrobial property is permanent, since it is built into the fiber.

The more complex they are, innovative product concepts require above all new marketing tools. Never before has the vision for the textile sector been more exciting than today, when we see numerous product developments taking place in the fields of hygiene, wearing comfort, health care and prevention, protection against environmental influences, work & safety and sports & leisure. Only by being permanently a step ahead in terms of innovations will it be possible to generate new growth in the medium term.

IMPORTANCE OF EXCHANGE RATE FLUCTUATION TO THE COTTON TRADE

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Editor's Note

A written paper was not provided by the author prior to the conference.

KEY ISSUES IN THE WORLDWIDE COTTON BUSINESS

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ABSTRACT

Developments over the past five years in the world cotton market have surprised observers. After a decade of relatively sluggish growth in supply and demand in the 1990s, there has been a rebound. This raises questions about how far we should change our thinking about future trends. The world market has been increasingly dominated by the role of China and India. However, at the same time, there has been growing discussion of the role of government support to cotton production and the prospects for its reduction. This report considers some of these developments and what effects that they might have on trends in the next few years.

RECENT TRENDS IN SUPPLY AND DEMAND

Aggregate statistics for cotton supply, demand and trade are good by comparison with those for some other commodities. However, statistics from the different published sources (ICAC, USDA , FAO) often differ for the same magnitude. More important, they are frequently updated - especially for recent years. We should therefore be cautious in interpreting what has happened since 2000.

Over the past 45 years, world supply and demand for cotton lint has grown rather slowly – by an annual average 2.1% - from about 9.5 mn tons in 1960 to 24.5 mn tons in 2005. Annual average **world production** growth was 2.6% in the 1960s, but decelerated to 1.5% over the following two decades. Of particular interest is an apparent rebound since the end of the 1990s: for the period 1999-2001 to 2003-05 a 5.6% annual growth rate was recorded.

Using three year averages to reduce the effects of annual fluctuations, the acceleration between 1999-2001 and 2003-05 represented a volume of more than 4.5 mn tons. On this basis, production rose in India by 2 mn tons, at an annual rate of more than 20%, and by 1 mn tons in China. Meanwhile, growth in the USA was 0.8 mn tons. Admittedly, weather conditions were relatively favourable in the Northern Hemisphere, especially the monsoon in India, but this factor is unlikely to have caused most of the growth.

The dominance of the three very large producers – China, the US and India – has increased: their combined share of world production rose from 45.3% in the 1970-71 period to 58.7% in 2003-05. With Pakistan included, the top four producers now have more than two thirds of world production.

Most of the world growth has come from rising yields rather than crop area. Over most of the past 45 years, the area devoted to cotton globally has hardly changed: in both 1960 and 2003 it was about 32 mn hectares (ha). And in 2004 and 2005 (based on provisional estimates), it was only about 2 mn ha higher.

Average cotton yields, however, have more than doubled since the early 1960s - from about 300 kg/ha in 1960 to more than 650 kg/ha in 2003-05. And, despite inevitable variations from year to year caused by climatic conditions, world average yields have been above 600 kg/ha in each year since 2001.

Average yields vary considerably between (and within) countries: in the 2003-05 period, they were more than six times higher in Australia than in India. The Indian average yield estimate, 285 kg/ha in 2003-05, is easily the most important in interpreting what could happen to world production.

The average area of cotton cultivation in India in 2004 and 2005 was close to 9 mn hectares - about one quarter of the total world cotton growing area. If India were to be excluded from the data, world average yields would have been about 100 kg/ha higher (???during 2003-05). Indian yields fluctuate considerably from year-to-year, mainly due to fluctuations in the annual monsoon and insect infestations. "Crop management" is generally poor by international standards - partly because cotton competes with other crops for labour inputs according to weather and market conditions. Also, the statistics may be unreliable: the average yield is probably calculated mainly as a residual figure from production and area statistics.

An optimistic view would be that average Indian yields have risen significantly recently, from 201 kg/ha in the 1999-01 period to 285 kg/ha in 2003-2005. Some of this may be due to the spread of GM seeds (reviewed below). Some is due to improved crop management. The growth in yield should continue.

A less optimistic view would be that cotton is often a marginal crop competing with food grains on scarce arable land. Shifting (even conflicting) government agricultural policies may be important in determining what happens. As noted above, yield increases have helped to lift world production by about 8%.

As noted above, **world consumption of cotton lint** (mill use) has risen very slowly – by an annual average of slightly over 2% - over the past 45 years. Consumption per head has been just about static. Over the decade of the 1990s, growth in annual average world consumption fell to 0.7%. But since then it has risen to 3.8%. Again, this raises the question as to what (if anything) is changing in the world cotton market.

Cotton's share of the total textile fibre market, on the other hand, does not seem to have increased. At the beginning of the 1990s it was 47.6% - depending on which series for total textile fibre use is employed. In 2003 and 2004 it averaged 36.4%, the same market share as in 2000. So, it seems to be the case that total fibre consumption has increased over the past five years, rather than cotton's share.

The most striking development in cotton production has been the increasing share of the top three consuming countries – China, India and Pakistan. Between 1990 and 2000 this share moved from 42% to almost 50%. And in 2005 it rose to an estimated 64%. China alone consumed about 9.4 mn tons in 2005 which was some 4.3 mn tons more than in 2000 and represented over 38% of world consumption.

Importantly in considering the recent past and future developments, world **stock levels** seem to have moved towards a position where supply and demand are more or less in balance. The stock/utilisation ratio, which relates total stocks to consumption plus trade, has averaged about 0.33 over the past 45 years. However, in the 1990s it rose to a peak of 0.49 in 1998. In the three year period 2003-2005 it averaged 0.35.

GENETICALLY MODIFIED (GM) COTTON

Commercial genetically modified (GM) cotton was only started about five years ago. Since then, it has spread rapidly in the USA and, more recently in China and India.

The only statistics available relate to the areas planted to GM cotton - and these are somewhat suspect. Importantly, we do not yet have any reliable systematic data on yields or production. The available statistics suggest that the total world area planted to GM cotton rose from about 6.5 mn hectares in 2001 to almost 10 mn ha in 2005. Of the 2005 total the USA contributed 4.5 mn ha, while China contributed an estimated 3.7 mn ha and India 1.3 mn ha.

The US area figures are probably reliable, not least because cotton is only grown in the USA on approved acreages and US farm statistics are normally reliable. Moreover, the rate of adoption in the USA seems to have reached a plateau at about 80% of total area – a figure accepted by most observers.

However, almost all other area figures come from the International Service for the Acquisition of Agri-biotech Applications (ISAAA), and are compiled using reports from various sources, mainly in China and India. ISAAA is a not-for-profit organisation but is avowedly a promotional agency for GM crops. It extols the potential benefits of GM crops by saying that they reach poor farmers and ensure food security. In the bitterly ideological world of GM, critics claim that ISAAA is “sponsored” by the big seed companies.

That being said, it is difficult to dispute that there has been, in the past 2-3 years, a substantial introduction of GM cotton in China and India. The estimates suggest that some 67 % of the cotton area in China in the 2005/06 crop year is GM, while the proportion in India is 14 %. That would suggest that about 28 % of world cotton planting is now GM. Moreover, almost all cotton production in China and India is on a small-holder basis, which means that poor farmers are adopting the seeds.

Given the political systems in both countries, there is a strong aversion to multinational firms becoming closely involved in farming. It is unlikely therefore that poor farmers are being bribed to adopt GM seeds by Monsanto – an allegation sometimes made by the critics. Moreover, both countries have the R&D capacity to develop new seeds, which is central to the future of GM cotton.

However, there is as yet no reliable evidence on GM's effect on cotton yields with small-holdings and very poor farmers. In crop trials, with supposedly "normal" crop husbandry conditions, yields have been shown to rise significantly, especially with the second generation Bt seeds - which incorporate a toxin that is lethal to boll insects, the most serious cotton pest. Such trials have persuaded some observers to make the extrapolation that average yields could rise by more than 100 kg/ha.

The most important country is India, both for the future of GM and for interpreting its impact on world production. Unfortunately, India is also the most difficult to assess at present.

Average yields, as noted above, are very low in India - in relation to the world average and to areas with similar agronomic conditions. GM introduction in India was more recent than in the USA and China. If it proves a success with small farmers there, then world production could move sharply and sustainably upwards.

The 2006/07 growing season should provide further evidence. If the area planted in China and India continues to increase, and if average yields increase - in India at least, notwithstanding the fact that they are also subject to climatic variations - then we shall have to accept that GM is here to stay and take it into our assessment of world supply and demand prospects.

It is important to recognise that cotton is by no means the most important GM crop. Indeed, of the estimated 90 mn hectares devoted to GM crops globally in 2005, cotton accounted for less than 10 mn ha whereas soybean represented 54.4 mn ha and maize 22.2 mn ha. Moreover, while the USA had the largest area, the other principal growing countries - Canada, Argentina and Brazil - do not (at present) grow significant quantities of GM cotton.

Thus the future for GM technology does not depend upon developments in cotton. Instead, because cotton is not the major crop, cotton seed stands to benefit from a much larger pool of technology and experience covering GM as a whole.

GM cotton is likely to be used soon in Brazil, assuming that its commercial use is authorised, as expected, in 2006. When this occurs, the rate of adoption is expected to be rapid. Also, China, which already has developed GM cotton and soybean seeds for commercial use, will probably continue to develop new seeds with "stacked" GM inputs.

However, the greater usage of GM beyond cotton does in fact threaten the growth of cotton production as farmers turn to other crops. So far there is no commercially grown GM rice, although field trials in Iran have been reported. Much more important, China is reported to have developed GM rice seeds whose commercial use is imminent. If GM rice becomes commercially successful, it will compete directly for scarce land in China, India and other countries. Admittedly, it is too early to judge how the competition will work out in practice. To some extent it will depend on government policies - at least in China and India - including food self-sufficiency objectives. However, recent trends for GM crops suggest that small-holder adoption rates can rise rapidly.

GOVERNMENT SUPPORT FOR COTTON

Following the WTO Ministerial meeting in Hong Kong in December 2005, it is time to take stock of all the cotton-related discussions and analysis of the past few years. Unfortunately, nothing much is clear.

Two separate strands in the debate have become entwined - at least in the political rhetoric which surrounded the build-up to Hong Kong - namely the Brazilian WTO case and the C4 initiative

The Brazilian WTO case

In 2003 Brazil brought a case against the USA under WTO procedures. It alleged that US cotton support policies breached the WTO Agreements to which both countries were signatories. Brazil argued that US support policies had depressed the world cotton price and caused measurable damage to Brazil's exports.

In response the WTO established a "disputes panel" in May 2003 to adjudicate. This was followed by four bilateral consultations but none of these initiatives led to any resolution of the conflict. In fact the WTO adjudicated in favour of Brazil, but the USA appealed. The appeal was finally rejected in March 2005.

The USA is, thus, clearly in breach of an international legal agreement. Two specific US policies were identified:

- the exports credit guarantee programme, which gives soft credit terms for exports; and
- the "Step 2" programme, which directly benefits export trading companies rather than farmers.

So far, the US government has done nothing officially to change these programmes. Nor has Brazil done anything to introduce trade measures in retaliation to redress the damage - which would be its normal recourse. The situation remains unresolved.

It should be said that there are now several precedents for these WTO procedures which the USA has approved of – including one concerning action against the EU. Such approval may be significant for the eventual US response in the cotton case.

The C4 initiative

In April 2003 a group of four Francophone African cotton producers (the C4) – Benin, Burkina Faso, Chad and Mali – lodged a "Sectoral Initiative in Favour of Cotton" with the WTO's Director-General. Its aim was to initiate a special emphasis on cotton in its negotiations on agricultural trade reform. The initiative was quite separate from the Brazilian legal procedure but, again, it was aimed at US cotton subsidies,

In 2001 WTO trade negotiators had agreed, under the Doha Development Agenda, to address the special needs of developing countries. The C4 claimed that developed country cotton support policies (essentially, the USA and the EU) were depressing world cotton prices and were damaging the exports and economies of developing (and very poor) cotton producers.

They introduced the notion that the WTO should sponsor “financial compensation” for developing country countries which were damaged by developed country support policies. This spawned (see below) a very large amount of economic analysis and modelling of the extent of damage - some of which gives useful insight into the analysis of future trends in the world cotton economy.

The resulting cotton initiative attracted important political interest involving support from non-cotton developing countries as well as shame in the developed world. By the end of 2005, negotiators at the Hong Kong WTO Ministerial accepted that “doing something for cotton” would be a crucial test of success or failure. Because failure was unacceptable, they duly produced an agreement.

The headline agreements were that developed country “export subsidies” would be ended in 2006, as would “import restraints” on lint exports from the least developed countries (LDCs). This does not affect the EU. The latter does not subsidise exports, but simply pays its producers more than twice the world price. It does, however, target the US subsidy programmes and the US response is eagerly awaited.

However, the debate raises wider issues about how far subsidy programmes are “trade distorting” and about “coupled” and “decoupled” programmes. There can be more or less strict notions of how far a payment programme is “distorting” or “decoupled”. An area related payment, as in the US and the EU’s new Single Area Payment, is said to be “decoupled” if it is not attached to the production of a specific crop. The situation is similar in the case of subsidised crop insurance programmes, which are important for US cotton. For a “pure” free trader, any subsidy which led a farmer to produce one crop rather than another (or not to produce a crop at all) could seem potentially “trade distorting” or “coupled”.

Arguments about how far different programmes are classified in accordance with the extent to which they are trade distorting could go on for months or years. However, it should be noted that, in the WTO agricultural negotiations, cotton is only one crop - even if it is to be given priority.

The EU may not be worried about cotton, but it certainly is worried about sugar and livestock products.

For both the USA and the EU, agricultural policies in general are under political scrutiny. In the USA the 2002 Farm Act expires in 2007 and its replacement needs Congressional examination in 2006. (Also, there are national elections in view). This could work either way: cotton could be “fast-tracked” because it is judged that some progress is needed at the WTO, or it could get bogged down in more general discussions.

As noted above, the Doha Development Agenda has taken on board the notion of “compensation” for the least developed countries (LDCs). This involves the very difficult problem about what would have been the level and value of LDC cotton exports if US and EU subsidies had not been (and were not) in place.

This is a two part problem about volumes and the world price. The price problem is taken up below. The volume problem involves making assumptions how much of world production would be taken up by different producing countries if US subsidies were judged to be “trade distorting” and therefore removed – leading to reductions in US production. The LDC exporters (essentially, poor sub-Saharan African countries) together produce about 1.2 mn tons of lint, about 5% of world production and 15% of world trade. Any incentive that led the LDCs to increase production – and the incentive would have to be a price rise (see below) - would encourage the other producers.

Let us suppose that the LDCs could have raised their production by 10 % at the implausibly high price of US\$150 a ton. Overall, they would benefit to the tune of around US\$200 mn annually. (Some other estimates are as high as US\$350 mn.) This would be welcome foreign exchange for them and might contribute to development and poverty reduction. However, with subsidies in developed countries running at around 10 times as high annually, it would still pay developed countries to compromise and buy off the LDCs by offering some compensation (even at US\$200 mn +) in exchange for retaining most of their subsidies.

Indeed, there are signs that the US cotton lobby and Western donor organisations are considering a new “cotton initiative” for poor African countries. It was reported in February 2006 that the US government has pledged US\$7 mn for a “West Africa Cotton Improvement Program”.

MODELLING THE WORLD COTTON MARKET

As noted above, the policy discussions over the past few years about cotton support policies have encouraged economic modellers to ask “what if” questions and, in some cases, make predictions. Inevitably, such modellers have produced wildly varying estimates for the same variables. Discussing the different models would go way beyond the scope of this paper, but it may be worth taking up some of the issues that they raise.

In the case of the developed world support programmes and their elimination, the different models produce unhelpfully divergent conclusions about the effects of subsidy removal on the world price of cotton. A total removal of developed world (US and EU) subsidies could raise world prices by anything from 2% to 35%!

Much depends on the base period chosen for the analysis. One study based on ICAC models, and subsequently used publicly by ICAC, estimated that without subsidies the world price would have been 30% higher in 2000/01 and 72% higher in 2001/02. Another - using the same models but taking a five-year average (1997/98 to 2001/02) as the base - estimated that the world price would have been between 2.9% and 13.4% higher.

Much also depends on the supply responses of farmers – including those who lose subsidies and those who stand to benefit from a more competitive cotton market. It is

more difficult to predict how farmers would react in the longer term to prices that they expected to remain higher.

It is possible to derive price elasticities by correlating sowing levels in one year with the previous year's price. But reactions to last year's prices may not give a reliable indication as to the future. The model results are very sensitive to what is assumed.

More generally, the supply response of farmers will reflect the price they expect to receive - as opposed to the world price. Because farmers sell seed (not lint) to ginneries and the world price is for lint, it is difficult to know with confidence what the data published on "producer" or "farm-gate" prices actually refer to.

There is an even bigger problem about the response of cotton consumers in terms of demand. At the retail level, it is often assumed that the volume of demand for cotton is relatively "inelastic" to the price of lint, because the fibre represents a very small part of the cost of the finished product. However, all the evidence (outlined below) suggests that cotton lint consumption is very responsive to the price of polyester. Some studies have simply not considered the problem: in analysing the effects of removing subsidies, these studies tend to give unrealistically high results for the volume of trade and price levels.

To go back to the starting point of this paper, none of the published modelling studies, nor the published forecasting exercises (from ICAC, the USDA or the World Bank), has adjusted fully to the events of the past five years. That is not a criticism: it simply reflects the uncertainties about what is happening. In this context, the emerging preponderant role of China and India - and to a lesser extent Pakistan - as producers and as consumers is central. We simply do not know enough in aggregate.

Both China and India are also very big players in the world polyester market: China alone has some 55% of world polyester production.

PRICE DEVELOPMENTS

The whole subsidy discussion and, in particular, the discussion about the future for LDC African producers, assumes that the world price of cotton could recover to some "normal" level, above 200 US cents/kg (91 US cents/lb), which would allow an acceptable standard of living for small peasant farmers. This needs to be challenged.

Over the past 45 years, lint prices (Cotlook A Index) have shown a long-term decline, masked by large year-to-year fluctuations. At current prices, lint declined slightly in the 1960s from about 80 cents/kg to 70 cents/kg, and rose sharply in the 1970s to peak in 1980 at 208 cents/kg. Since then, prices have declined (with large fluctuations) by more than a third, to average 133cents/kg in the 2003-2005 period.

The extent of decline is better understood by looking at constant prices. In real terms, lint prices have declined since 1970 by 56%. They rose sharply in 1973 and 1976 in response to the petroleum price shocks: all commodity prices rose during the 1970s

by much more than the general level of price inflation. However, since 1976, real cotton prices have declined by more than two thirds.

Cotton prices (in both current and constant terms) fell sharply in 1985 and 1986, prompted by a shift in US farm support policies and, especially, the liquidation of US government-held stocks. Chinese support policies coincidentally produced cotton surpluses, which were exported. Current prices then recovered for some ten years, to peak in 1995, at almost 218 cents/kg. However, in constant terms, prices declined almost continuously from 1982 to 2002, with inflections in 1994 and 1997. In 2003 and 2004 they seemed to be above the trend decline, and (provisional) estimates for 2005 seem to be also above the long term downward trend.

If one wants to be even more gloomy, the constant price trend is still in US dollars and does not reflect the long-term decline of the dollar in relation to the yen, the German currency (DM then Euro) or even the £ sterling. Other commodities, which have been less influenced by the weight of US production and exports, have declined less in dollar terms.

However, the central price issue has become the relationship between cotton and polyester prices and cotton's share in total fibre consumption. Using a US polyester price series (accepted by the NCC and USDA as representative), polyester prices fell rapidly in the 1960s, as the costs of the fibre fell and its market share increased, to reach parity with the Cotlook A price in 1971 (at 82 cents/kg). Since then, the polyester/cotton annual price ratio has varied little within the range 0.8-1.3.

One detailed World Bank analysis (Baffes) concludes that "the co-movement between cotton and polyester prices is much higher than ...typically observed when these two prices are compared to 18 other highly traded primary commodities": so, the "co-movement reflects factors specific to these markets". Also, and perhaps more surprising, "the econometric evidence shows that the effect of polyester price changes on cotton price changes is stronger than *vice-versa*".

This would suggest, but does not prove, that while cotton prices could rise, it would be at the expense of a further loss of cotton's share of the total textile fibre market. Alternatively, it would suggest that, if cotton production continues to rise as it has over the past five years (see above), it will lead a continuing downwards price trend, at constant prices.

What actually happens will be determined in China and India, but we do not know enough about what is happening there. One particular question would be about whether there is some sort of "floor price" for polyester – for economists, a Long Term Marginal Cost of production including the costs of new capacity. For the medium term, there appears to be no shortage of capacity: so, polyester prices could fall to levels which do not include the capital costs of new capacity.

China's cotton production is subject to significant government protection, which raises the domestic cotton prices paid by mills to levels that are above world prices. With imports expected to remain well above the current Tariff Rate Quota (of 0.89 mn tons annually), the effective domestic price should be raised by the 40% ex-TRQ

import tariff rate. However, it is uncertain when (and if) the TRQ levels will be raised or phased out. If the domestic price came down to the world price, cotton would gain significant competitive advantage and market share from polyester (and other man-made fibres). The outlook in India is also uncertain. Both cotton and polyester face (10%) import tariffs, but polyester also faces excise duties which tend to raise its price.

Two of the more recent (and probably more plausible) modelling exercises consider China directly (CERI, Texas Tech University). One tries to compare the effects of removing government support in the USA versus China's TRQ system and then considers the effects of removing both. The 2004/05 to 2008/09 base case – no changes – has world production regaining its 2004/05 peak by 2008/09, while consumption rises by 6% and world trade by 0.4 mn tons. The world price rises by 3% over the period. None of the three liberalisation scenarios has a large effect. Removing Chinese TRQs lifts the world price by less than 2% over the period, while the removal of US subsidies would raise it by less than 0.5% and both changes would raise it by 2.3%. World production would hardly change in all three cases, while world consumption would fall marginally because of the higher price. World trade would rise by 0.1% with Chinese TRQ removal, and would fall by 0.14% with the removal of the US subsidy. With the removal of both, trade would rise by 1.4%. Even if both countries liberalised trade and US exports fell, none of the major exporters would see their exports rise by more than 5% (Brazil). West African exports would rise by only 1.3%

EXCHANGE RATES AND MACRO-ECONOMIC DEVELOPMENTS

The other recent modelling exercise from CERI considers what might happen to the world cotton market if China allowed its currency to appreciate by 30% against the US dollar. In fact, the Chinese authorities announced in July 2005 that the renminbi would be subject to a “managed float” against a basket of currencies (including the yen and the euro) – thus ending its peg against the dollar since 1993 at Rmb8.28:US\$1. So far, the appreciation has been about 2%, but powerful US lobbies (including those in Congress) are looking for something closer to 30%.

Using the same model but with a base running to 2013, the results suggested that world prices (in US\$) might be some 3-5% higher through the period to 2013. Chinese cotton production would fall by 2.5-6%, which would be compensated by a 12% rise in Chinese imports. These imports would be met by a 4-8% increase in exports from Brazil and corresponding increases in exports from Australia (2-5%) and the USA (1-2%). Chinese textile exports would fall by 15%, and the fall would be mainly offset by rising domestic consumption.

In all the modelling exercises referred to above, there are implied assumptions about which exporting countries or regions will benefit most from any increase in world trade. In formal modelling terms, these assumptions are expressed in terms of “supply elasticities”. In some of the models, elasticities are constant for all exporters, although they may be varied in sensitivity analyses. In others, they vary between producing countries and regions. However, in making forecasts one would like to

relate the formal results to judgments about what is known to be happening (or expected) in different producing countries and regions.

Two cases seem troubling here: the African and the CIS countries. The African “problem” has, in most recent discussions (see above), been seen as relating to the Francophone West and Central African cotton producers - who, as a group, are considered to represent some 15% of world trade. What is very rarely discussed (and is difficult to represent in the formal modelling) is that part of their problem comes from the fact that their common currency (the CFA franc) was tied to the French franc (with a devaluation in 1994) and is now tied to the euro. The dollar has lost around 13% against the euro since 2001 and, since world cotton prices are quoted in dollars, this has driven down the CFA value of cotton. Worse, most observers expect some further depreciation of the dollar against the euro. Of course, the CFA franc could be devalued again or be floated, but (perhaps, understandably) this does not seem to be on anyone’s public agenda.

In the CIS there is much uncertainty as to what is happening. This is especially true for Uzbekistan, the largest cotton exporter. In that country, the cotton sector is sufficiently important to be part of the whole uncertain political process. For an outsider, it is difficult to assess how much anyone gets paid in the whole process - from farming to the export market. For an insider, it might be imprudent even to try.

CONCLUSIONS

This paper looked initially at annual production and consumption statistics for cotton lint to see whether the data for the past five years represent a “shift” from earlier trends. Accepting that large annual fluctuations are inevitable from the production side, there does seem to be an upward shift from the earlier trends. For production, this is almost entirely due to rising average yields. It seems increasingly likely that part of the shift is due to the adoption of GM seeds and that this, coupled with related gains in management efficiency, may sustain substantial rising yields for the next few years. China and India, given their size and their growing dominance of world production, are the key countries to consider in this respect - although their data are difficult to analyse.

Consumption growth also seems to have accelerated, although cotton has not gained market share in total fibre consumption. China and India are even more preponderant in consumption, since they are big importers and their dominance of man-made fibre use is greater than for cotton.

The paper then considers the recent international discussions of government support for cotton production and the likely impact on the world market. The two strands – the Brazilian legal move against US subsidies and the African exporters’ moves to create a “special initiative” for cotton – were both played out in WTO negotiations. They succeeded in generating considerable international public awareness and discussion of trade-distorting agricultural policies, culminating at the Hong Kong Ministerial meeting in December 2005. However, in spite of a declaration to end developed country export subsidies during 2006 and to “fast track” cotton negotiations, it is not

clear what has been achieved. Negotiations will continue. The USA will probably make some changes to its policies, at least to meet the successful Brazilian legal challenge, but any changes will meet strong domestic US resistance.

The negotiations and the surrounding economic analysis have shed some light on how far different policies are “trade distorting”, not only in the developed countries but also in other important producer countries. China, again, seems very important.

However, the economic analysis suggests, on balance, that the quantitative effects of reducing support to cotton may be much less important than some protagonists have claimed – in terms of production, trade and, crucially, world prices.

Importantly, this is because the analysis and discussion may have underestimated the effects of world prices on consumption, through substitution between cotton and polyester. This paper considers the close link between polyester and cotton prices. It raises questions about how much lower the prices of both fibres could go if cotton production continued to rise at recent rates. Polyester production capacity seems plentiful at present. Again, China and, to a lesser extent, India are where this likely competition will be played out.

Cotton would gain some modest competitive advantage if China reduced its import protection, which seems to raise domestic prices substantially. The same effect would be observed, albeit more modestly, if there were an appreciation of the Chinese renminbi against the dollar – which is expected. Any further depreciation of the dollar itself would have some direct effects on world cotton trade and, possibly, on consumption.

Other, consequential currency realignments would affect the competitiveness of different producers. For example, a further appreciation of the euro against the dollar - which is considered likely - would continue to have an adverse effect on CFA franc producing countries.

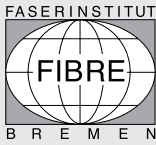
In all of this, though, more attention will need to be paid to what is happening in China and India. In both countries, and especially China, there is great uncertainty.

**COTTON PRODUCTION IN INDIA INCLUDING ASPECTS FROM THE
CHINESE MARKET**

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Editor's Note

A written paper was not provided by the author prior to the conference.



28th International Cotton Conference Bremen
March 22 – 25, 2006



Session II: International Harmonization of Instrument Testing of Cotton, Task Force on CSITC, Panel Discussion

- ***The Commercial Emphasis on Standardisation of Instrument Testing of Cotton (CSITC)***
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THE COMMERCIAL EMPHASIS ON STANDARDISATION OF INSTRUMENT TESTING OF COTTON (CSITC)

A G Macdonald

***Chairman CSITC
Associate Director ICA
Chairman ITMF Spinners Committee
President Brazilian Cotton Association.***

Ladies and Gentlemen,

I shall leave it to my distinguished colleagues on this panel to describe the technical progress that the Task Force of ICAC has achieved since we met here two years ago, as I would like to discuss the commercial aspect of the CSITC program, especially since the idea was actually born from the commercial requirement to test cotton with instruments in a reliable and repeatable manner.

The fact is, that Commercial Standardization of Instrument Testing of Cotton -, has caught so much interest internationally, that it has almost become a question of the "International Instrument Testing of Cotton". Clearly the cotton world has accepted, as inevitable, that over the next years classing of cotton by instruments will be the norm. As the business of buying and selling cotton becomes more and more electronic and data oriented, rather than the traditional system of exchanging, or checking visually samples of each bale, and the administration and documentation of such sales is accompanying the same electronic path, certainly classing must be included in this evolution.

Initially the justification for the move towards instrument classing was, "the textile industry requires the information", and that "no spinning unit can function efficiently without such data". However this was a rather a unsatisfactory justification, bearing in mind that every self respecting spinning mill will already have their own instrument testing equipment, and the more so will continue to use instruments in their mills, since the information provided overall is far greater than the basic data which the CSITC is proposing to use initially. In this respect the parameters chosen for the project, so far, are those with the highest record of repeatability, which is needed initially to create confidence in any international system.

Today I believe the justification is, in fact, much closer to home.

Firstly, the good reliable hand and visual classers will become more and more a feature of the past, except in regard to the special cottons. After all 70% of all cotton is spun in 30/1 counts and below, which represents the bulk of the cotton traded.

Secondly, today the cost of manual classing means that it is unreasonable for a merchant to justify maintaining a fully fledged visual classing organization with many classers.

Thirdly, without a doubt it levels the playing field for the grower, by knowing exactly the specifications of their cotton and therefore what it is worth, whilst the buyer knows exactly what he is getting, thereby allowing him to provide a full service to his final customer.

Fourthly, it allows the merchant quicker and more accurate data to plan the shipments to his respective buyers, ensuring that the right qualities are sent to the right customers

Fifthly, the spinning industry today is especially concerned as regards consistency in the lay downs day after day, however this requires extensive forward planning. Therefore to be able to receive the basic quality data at time of shipment, i.e. well before arrival, allows time to plan the mixes and lay downs without having to wait for the cotton to arrive at the final destination or mill warehouse. Thereby needing to make only some fine tuning once their own final test results are known on arrival.

Sixthly, all the above permits the growers, merchants, and spinner to have a full evaluation of their inventory either in stock or in transit, allowing it to be maintained as low as possible, so as to control costs in warehouses as well as financial costs.

So in the end it is not so surprising that the work of the Task Force has attracted much interest. Certainly the system must hinge on the accuracy of the instruments being utilized, and so it is important to achieve confidence in the repeatability and accuracy of the instruments in different locations. This is being undertaken by a proposal to certify or "grade" any given laboratory. The requirements for such "certification" will be firstly, the evidence that the laboratory has the necessary equipment and the climatic control for sample preparation and within the laboratory. Secondly, the laboratory will undergo a complete set of round tests to gauge their accuracy and repeatability, on a given set of samples. Based on this data the lab will be graded, either for the specific characteristics of the cotton, or on an overall basis. It is intended that such grading will be under the auspices of the ICAC, using the USDA and the Bremen Fiber Institute as their evaluation bodies.

However it must be clear that the certification will only certify that a given laboratory has the capability to produce results within its grade level, but that the results will have no legal backing unless the parties involved in the transaction have so agreed in writing in their contract. Otherwise any variation outside of the tolerances stipulated in the contract, which the parties are unable to resolve amicably, would go to a dispute settlement organization or association, as stipulated in the contract. Such arbitration could be undertaken by various organizations, the prime example being the International Cotton Association, whose award or final decision would be legally enforceable throughout the world in the event the losing party failed to pay the claim. The claim would represent the difference in the quality stipulated in the contract and the arbitral authority's evaluation. As with all arbitral bodies final appeal procedures would also be available.

So it can be seen that the Task Force has sparked interest throughout the cotton trade and support is coming from all quarters, apart from those personas or organizations who participated initially, like the USDA, Bremen Institute, Cirad,

Australia Research, International Cotton Association, Bremen Cotton Association, Gdynia Cotton Association, the International Textile Manufacturers - Spinners Committee and Joint Cotton Committee and many others. Provide this good will and intention to support the progress in a positive manner continues, the outcome will ensure the future of cotton as a major textile fiber though out the world.

**NECESSITY OF INTERNATIONALLY HARMONIZED INSTRUMENT TESTING OF
COTTON**

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Editor's Note

A written paper was not provided by the author prior to the conference.

BENEFITS OF CSITC

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Cotton classification and standardization on a global front is changing from a traditionally manual and visual classification to one of technologically advanced instrument testing. Although instrument testing has been occurring in the United States for many years, it is just now gaining prominence worldwide. As countries, organizations, and laboratories enter into this new arena of testing, it is essential that an effort be coordinated to ensure that consistent and equitable testing is maintained everywhere. The Task Force of the CSITC is taking a leadership role in moving the world's classification laboratories forward toward standardized instrument testing methodology and performance. Using the U.S. Department of Agriculture's (USDA) Cotton Program classification and standardization systems as the core basis for the initiative, CSITC has a reliable reference to use in moving the world's laboratories toward consistent and accurate testing levels.

INTRODUCTION

Since its inception in 2003, the Task Force of the Commercial Standardization for Instrument Testing of Cotton (CSITC) has worked to facilitate widespread use of instrument testing systems at the producer level while upholding the standards and tolerances that maintain the integrity of high quality testing. At the U.S. Department of Agriculture, we have been providing classification services to the U.S. cotton industry for decades and over many years of research, development, and implementation, we have a system that is the benchmark that many countries currently use or strive to use as a basis for classification and standardization. We at USDA are very proud of this system and very cognizant of its importance. At the cornerstone of our instrument testing system is the operation and maintenance of our instruments at a level of the highest accuracy, precision and integrity. Accurate and reliable instrument test results provide all of the segments of the marketing chain, especially the spinners, with the information necessary to allow more efficient use of cotton. This efficient utilization of cotton, in turn, enhances the demand for cotton and cotton products. Instrument test results provide information to seed breeders, cotton producers, and ginners enabling the production of cotton with characteristics desired by the spinning industry. Utilization of instrument measurements in bale acquisition and mill laydowns provides the spinning mills with the information necessary to precisely manage the equipment processes to produce specific results with little variance. Using instrument data, bales can be purchased and spun according to the specific attributes or characteristics desired in the finished product, whether it be yarn or fabric.

In the United States, high volume instrument data is utilized by virtually all spinning mills to predict yarn and fabric quality and minimize problems such as ends down, barre, and others that hinder the optimization of the final product. Manufacturers have become experts in focusing in on how specific quality factors can affect mill

efficiency, product quality, and outturn. They realize that just slight variations can result in quality deficiencies or lost time in the mills so it is imperative that the data they utilize is accurate and consistent. At USDA, we have worked to perfect our system of high volume instrument classing over the last 25 years. As many other countries now begin to implement and utilize instrument measurements, it is imperative that consistency be established between testing laboratories to efficiently capture and use the abundance of accurate fiber data potentially available through instrument testing.

The CSITC Task Force is trying to facilitate the adoption of instrument testing standards and procedures established by the USDA through education and collaboration with testing centers throughout the world. As instrument-based classification spreads throughout the world, it becomes more and more important that the core basis for testing remains anchored in proven and reliable procedures and materials. From the design and maintenance of controlled environment laboratories, to the calibration cottons and materials used, to the classification practices and procedures, to the handling of data – all facets require maximum attention to detail and accuracy. Through the work of the CSITC using the USDA system as its basis, these ongoing efforts will introduce the use of instrument testing language in the trading of cotton so that traditional descriptions of grade or type are replaced with instrument test values and the marketing of cotton for greater specificity and utilization can broaden. There are 17 members of the Task Force panel representing both exporters and importers and all segments of the world cotton industry.

From the USDA perspective, I see the three major benefits of the CSITC in promoting standardized instrument testing of cotton. These are leadership, education, and collaboration.

LEADERSHIP

As many countries progress forward toward utilizing instrument testing in some capacity, it becomes essential that these efforts follow some proven level of leadership. Within the CSITC are some of the most experienced technical experts and organizations in the world in the arena of fiber instrument testing. Additionally and most important in my opinion is that the basis for the CSITC initiative is the recognition of the current USDA classification and standardization system to serve as the model for other countries and laboratories to follow. The USDA system is based on science, scientific research, and a lot of history. Our procedures and especially our system of quality assurance has evolved over many years and stood the test of time to ensure accuracy, repeatability, and consistency in our nationwide operations. Together, the leading experts within the CSITC Task Force including those from the USDA, Bremen Fiber Institute, CIRAD, worldwide academic and fiber research institutions, U.S and international industry segments, and others, can work collectively to utilize this proven system and broaden its acceptance to perpetuate global standardization of instrument testing. The leadership exhibited by the CSITC Task Force instills trust, reliability, and examples to follow to those entities entering the instrument testing arena.

EDUCATION

One of the key benefits of the CSITC is role it plays in educating the world in the methods, procedures, and standards affiliated with instrument testing. The CSITC Task Force's leadership role involves a great deal of education in not only the operation of fiber measurement instrumentation but everything that affects the testing procedures. This includes atmospheric conditioning, moisture testing, instrument calibration procedures and materials, verification tools, and data utilization. It is through this education to participating laboratories and organizations that the CSITC can assist in working toward a standardized methodology for instrument testing. This education comes through explanatory materials and discussions of the USDA system and collaborative initiatives to produce comparative studies and recommendations for aligning with successful laboratories. As countries venture into the technological arena of instrument testing, it is imperative that each has an example from which to learn and follow. Using the USDA as the basis along with solid round test analyses from USDA and Bremen Fiber Institute gives credence to the international efforts.

COLLABORATION (ROUND TESTING)

Collaborative study and analyses is another important benefit of the CSITC and its mission. The most important collaboration to date has been the round testing conducted by the USDA and Bremen Fiber Institute between 30+ laboratories with the distribution of testing materials and corresponding results analyzed jointly by the USDA's Cotton Program and the Bremen Fiber Institute. Round testing must be firmly based in science with an accurate reference point in order to effectively analyze each participating laboratory's performance and pinpoint problematic areas with which to focus. The CSITC Task Force used the USDA's HVI Check Test as a basis for establishing an effective round test to gauge the performance of laboratories around the world in testing cottons with known values. This and future round tests will assist in determining how consistent testing laboratories and instruments perform around the world and what measures can take place to improve the accuracy and consistency between labs. The USDA Cotton Program believes that effective collaboration such as round testing is essential to progressing toward global standardization of instrument testing.

CONCLUSION

It is the mission of CSITC and many laboratories and organizations throughout the world to broaden the demand and utilization of cotton. Regardless of country or organization, it is the advancement of cotton and its utilization and marketability that should remain the key focus in trying to standardize instrument testing. Without a consistent means to first, measure cotton fiber and second, market and use cotton in a universal language, there will always be a disconnect between international industry segments that hinders the fluid expansion of demand. It is still manmade fiber that continues to be the largest competition for cotton and all of cotton's marketing components. The USDA Cotton Program supports the efforts of the CSITC and willingly serves on its Task Force to assist in standardizing instrument testing

methods, procedures, materials, and performance so the world's cotton industry can continue to grow and benefit.

CSITC-BENEFITS TO TRADE

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Editor's Note

A written paper was not provided by the author prior to the conference.

INTERNATIONAL HARMONIZATION OF COTTON STANDARDS

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ABSTRACT

The globalization of business and commerce, of which textiles is only one entity, is paralleled by the need for global standards. Each geographic region or country has developed standards for their business interests. Standards provide the framework for measurement and practices that are specific to the production, processing, marketing, and distribution of goods and services. For cotton fibre producers and its customers this is no less important and a case can be made that the harmonization of cotton standards is paramount to those parties involved with the international cotton trade. This paper will provide a perspective of the international cotton standards' arena.

INTRODUCTION

The cotton chain has been described as a pipeline. [AMTEX (2001)] From seed, harvesting, ginning, bale opening, cleaning, spinning, fabric manufacturing, dyeing/finishing, apparel/product production, shipping, distribution outlet and ultimately to the individual consumer. At every stage of the business pipeline, attributes of a raw material, processing step, handling, packaging and multiple steps between each stage must be measured, value assessed and verified for quality and performance.

The word "standard" is widely used in the business community but is misused in many incidences. For this paper, the definition of a standard is *something set up and established by authority as a rule for the measure of quantity, weight, extent, value or quality*. [Webster (1980)] Product specifications for performance are sometimes thought of as a standard but they become a standard only when it is accepted broadly by all parties involved with the product's production or commerce. Further, the definition stated implies that a standard is an instruction for how something is to be measured and judged. It can be implied from the definition that terms and words used to describe the measurement process must have accepted, widely understood meaning. In addition, the processes and conditions under which something is measured also must be standardized. From the cotton fibre viewpoint, its weights and measurements are fairly clear and understood but the value and quality aspects need to have international standards agreed upon for the benefit of all parties. Further, the equipment, machines and instruments utilized in the classification process must have standard procedures and calibration checks to verify the operation of the classification operation. Globally, all cotton fibre interests would benefit if cotton standards in individual regions could be harmonized to facilitate international commerce and trade.

STANDARDS

Commerce and trade are built on a system of communication, overriding different cultures and languages, based on standards. The “language of commerce” is standards. Standards come in many formats and structures. Test standards describe how a measurement is to be made. Terminology, whether stated in the test method standard or in a separate standard glossary, defines the terms that are critical to understanding what and how something is being tested. A standard practice or guideline provides prescribed procedures for accomplishing a function. The old adage of comparing “apples to apples” rather than “apples to oranges” can be applied to the utilization of standards. It is imperative that the business stakeholders use agreed-upon test methodology for the measurement of cotton properties, test under the same conditions and utilize an agreed-upon rating system. This supports the concept that we, in the global cotton community, must speak an international “standard” language.

Standards are developed by business segments within countries and regions. For example, the “authorities” in a business segment such as manufacturers of intravenous medical devices may choose to develop common practices for manufacturing. This assures that each supplier can provide what their mutual customers (hospitals) with uniform sizes, fittings and materials. The standards developed by the manufacturers of medical devices and the federal regulators chose to work together to develop the standards which help each supplier to compete in a non-biased (different standards) situation from the product specification perspective.

Individual countries have developed their own standards for many businesses within their geographic region(s). Many countries have standard institute(s) under which their regional or national standards are housed. When manufacturers of products wanted to market their products in other countries and global sourcing for goods and services became an economic practice, the need for international standards evolved.

INTERNATIONAL STANDARDS BODIES

The American Society for Testing Materials-International (ASTM) was established in 1898 in Philadelphia, Pennsylvania, USA and published its first technical standard in 1901 (steel rails) followed by standards for cement, petroleum, rubber, and later in the 1900s, standards for aeronautics, construction, medical, textiles and consumer product businesses. All USA standards are housed under the authority of the American National Standards Institute for its cooperation in ISO activities. ASTM has seven technical committees with 211 specialized committees with 36,000 members. [American Society for Testing Materials (2006)]

The International Electrotechnical Commission (IEC) was founded in 1906 in London, England to develop standards for nomenclature and ratings for electrical machinery and rotating machines (motors and transformers). IEC is the source of the comprehensive system for physical units of measurement, “Systeme International” or SI. Later in the century it developed standards for radio frequencies, capacitors, resistance, lasers, lighting, fibre optics, and currently, fuel cell technologies, and avionics. [International Electrotechnical Commission (2006)]

International Organization for Standardization (ISO) officially began operations in 1947 with participants from twenty-five countries. The founders knew that when the name “international organization for standardization” was translated into many languages, the abbreviation would be varied, for example, in English the abbreviation would have been “IOS”, in French, it would have been “OIN”. To solve the dilemma and standardize the name of the organization, the founders agreed to use “ISO”, derived from the Greek word “isos” meaning “equal”, as its acronym. Today, ISO and its international partners, IEC, and the International Telecommunication Union, (ITU) are based in Geneva, Switzerland. ISO members are national partners, such as, the American National Standards Institute (ANSI). ANSI partnership with ISO can be viewed on ISO’s internet home page where ANSI’s website is hyperlinked. Therefore, ASTM-International standards are directly accessible. ISO has 229 technical committees and 156 member bodies. [International Organization for Standardization (2006)]

INTERNATIONAL COTTON STANDARDS

It should be noted that there are regional (country) cotton standards that have evolved from businesses or trade associations within countries. However, the two main repositories for international cotton (fibre) standards are ASTM-International and ISO.

Under the ISO technical committee structure, cotton fibre standards fall into two technical committees. ISO Technical Committee (TC) 38 *Textiles* has two sub-committees with cotton standards. Those sub-committees (SC) are: SC23 *Fibres and yarns* and SC 24 *Conditioning atmospheres and physical tests for textile fabrics*. ISO TC 72 *Textile machinery and accessories*, SC 1, *Spinning preparatory, spinning and doubling (twisting) machinery*. Standards for TC 38 SC 23 and SC 24 are shown in Table I. Table II shows those cotton standards under the domain of TC 72.

Table I: ISO Standards for Cotton in TC 38 *Textiles* SC 23 and SC 24

ISO Designation *	Title
1130:1975	<i>Textile fibres</i> – Some methods of sampling for testing
1973:1995	<i>Textile fibre</i> -- Determination of linear density- Gravametric method and vibroscope
2403:1972	<i>Cotton fibres</i> – Determination of micronaire value
3060:1974	<i>Cotton fibres</i> – Determination of breaking tenacity of flat bundles
4911:1980**	<i>Cotton fibres</i> – Equipment and artificial lighting for cotton classing rooms
4912:1981	<i>Cotton fibres</i> – Evaluation of maturity – Microscopic method
4913:1981	<i>Cotton fibres</i> – Determination of length (span length) and uniformity index
5079:1987	<i>Textile fibres</i> – Determination of breaking force and elongation at break of individual fibres
6741:1987	Technical Report – Determination of commercial mass of consignments—Part 4—Values used for the commercial allowances and the commercial moisture regains
6989:1981	<i>Textile fibres</i> – Determination of length and length distribution of staple fibres by measurement of single fibres
10306:1993	<i>Cotton fibres</i> – Evaluation of maturity by the airflow method
139:1973***	<i>Textiles</i> – Standard atmospheres for conditioning and testing

* Number:year denotes year of the original publication, reviewed every five years

** ISO 4911:1980 will be balloted for withdrawal in 2006

*** TC38 SC24

Table II: ISO Standards for Cotton in TC 72 *Textile machinery* SC 1

ISO Designation *	Title
8115:1986	Part 1 -- <i>Cotton bales</i> – Dimensions and density
8115:1995	Part 3 – <i>Bales of cotton</i> – Packaging and labelling

* Number:year denotes year of the original publication, reviewed every five years

Cotton Incorporated, under the auspices of ANSI, currently holds the ISO secretariat for TC 38 SC23. No new cotton fibre test methods have been presented to SC23 for consideration for ISO standardization process since the late 1990s. The sub-committee's last meeting was in Sao Paulo in November 2005. A report of the meeting ISO N147 can be viewed by SC23's member bodies. SC 23 has twenty-seven member bodies. Each member body has numerous experts from national institutes, companies, businesses, trade associations that volunteer or as government-supported representatives to support ISO work.

ASTM-International is the other repository for international cotton fibre standards. The committee that handles cotton standards is D13 Textiles Sub-committee 11 Cotton. D13.11 has twenty-seven members registered representing five countries: Canada, India, United Kingdom, Sri Lanka, and the USA. The cotton standards under D13.11 authority are shown in Table III.

Table III: ASTM International Standards for Cotton in D13.11

ASTM *	Title
D1440-02	STM**for Length and Length Distribution of Cotton Fibers (Array Method)
D1441-00	Standard Practice for Sampling Cotton Fibers for Testing
D1442-00	STM for Maturity of Cotton Fibers (Sodium Hydroxide Swelling and Polarized Light Procedures)
D1445-05	STM for Breaking Strength and Elongation of Cotton Fibers (Flat Bundle Method)
D1447-00	STM for Length and Length Uniformity of Cotton Fibers by Fibrograph Measurement
D1448-05	STM for Micronaire Reading of Cotton Fibers
D1464-02	STM for Differential Dyeing Behavior of Cotton
D1684-02	Standard Practice for Lighting Cotton Classing Room for Color Grading
D2495-01	STM for Moisture in Cotton by Oven-Drying
D2811-02	STM for Non-Lint Content
D3025-01	Standard Practice for Standardizing Cotton Fiber Test Results by Use of Calibration Cotton Standards
D5332-00***	STM for Fiber Length and Length Distribution of Cotton Fibers
D5866-05	STM for Neps in Cotton Fibers (AFIS-N Instrument)
D5867-05	ST Methods for Measurement of Physical Properties of Cotton Fibers by High Volume Instruments
D7139-05	Standard Terminology for Cotton Fibers
D1776-04	Standard Practice for Conditioning and Testing Textiles

* Number:year of its latest revision and publication

** STM= Standard Test Method

*** Balloted for withdrawal in 2006

New cotton standards being developed in D13.11 are: new work (NW) items NW8919 Standard Practice for Establishing Standard Values for Reference Cottons and NW8920 Standard Practice for High Volume Instrument Qualification. The United States Department of Agriculture has two groups working with D13.11: Agricultural Marketing Service (AMS) and Agricultural Research Service (ARS). USDA offers their extensive experience of classifying more than 200 million cotton bales with automatic cotton classing systems to the international cotton community and to the international marketplace. The new standards under development will be critical to world cotton commerce.

The world production of cotton fibre is changing with China becoming an exporter of cotton as well as an increasing consumer on cotton fibre. Further, India, Pakistan, and Turkey have seen increased cotton consumption since 2003 whereas the US and Brazil have not seen increased usage. European Union countries have experienced a decline in cotton consumption in the same period. [Cotton Incorporated (Feb 2006)] This trend is shown in Table IV. Table V shows the same list but with SC23 members highlighted. Greece and Spain are the only two EU countries that grow cotton. Greece's standards body is not a member of SC23. Sixteen EU countries out of the total number of twenty-seven national member bodies of SC 23 have a vote.

Table IV: World Consumption (millions of metric tons) of Cotton, 2003 – 2006

	2003/04	2004/05	2005/06 February 2006
China	7.0	8.4	9.8
India	2.9	3.2	3.6
Pakistan	2.1	2.3	2.6
Turkey	1.3	1.5	1.5
US	1.4	1.5	1.3
Brazil	0.9	0.9	0.9
EU*	0.8	0.7	0.7

* Greece and Spain are the only producers of cotton fibre in the EU.

Table V: ISO TC 38 SC 23 Member Bodies by World Cotton Consumption (millions of metric tons), 2003 – 2006

	2003/04	2004/05	2005/06 February 2006
China	7.0	8.4	9.8
India	2.9	3.2	3.6
Pakistan	2.1	2.3	2.6
Turkey	1.3	1.5	1.5
US	1.4	1.5	1.3
Brazil	0.9	0.9	0.9
EU*	0.8	0.7	0.7

* EU – ISO TC 38 SC 23 member bodies – Spain, Italy, Portugal, France, UK, Germany, Switzerland, Sweden, Finland, Denmark, Belgium, Poland, Hungary, Romania, Yugoslavia, Czechoslovakia, Switzerland

STANDARDIZATION PROCESS

How the two main repositories for international cotton standards manage their standardization processes can offer some insight into understanding the differences between them. Frequency of meetings, project development, leadership, ballot stages, resolution of negative ballots are some of the areas that will be compared. The major differences are noted in Table VI.

Table VI: Standardization Process Differences Between ISO and ASTM-International

Process Function	ISO	ASTM-International (ANSI)
Membership (fee)	National standards bodies organizations	Individuals represent companies, government agencies, universities, institutes, and trade groups
Vote	One/member body(country)	One/individual – committee One/company – final approval stage, paid members only
Approval rate, final standard	75%	100%
Frequency of TC/SC meetings	Every 2 or 3 years	Two/year
TC/SC administration	Member bodies (fee)	Same
Participation	National standards bodies	Open
Development time	3-5 years	3 years or less
Types of standards	Test methods, technical reports, glossaries	Test methods, practices, guidelines, performance specifications, terminology
Certification of conformity to its standards	No*	Proficiency programs on limited standards

* Including ISO 9001:2000 and 14000:2004

INTERNATIONAL HARMONIZATION OF COTTON STANDARDS

The international standards community can be a labyrinth to navigate as technical standards proliferate. Cotton, as one of the global textile trading commodity products, not to mention the apparel, home, and industrial products traded, has its share of standards. Another factor in cotton and cotton goods trading are the regulations required by government for goods to cross borders. Requirements to meet regulations then forces entities to deal with political issues such as, trade agreements, trade disputes, increasing globalization of companies, increasing influence of non-governmental agencies, the demand for social accountability, and responsibilities to developing countries and the environment where harmonization of standards supports the communication for mutual benefit and advancement. [ISO (2005)]

There are strategies that need to be considered and used to advance international harmonization of cotton (or any product) standards. First, the interested parties must agree that harmonized standards benefit all parties. Individual agendas are counter-productive to the standardization process. Inertia is also counter-productive to the standardization process, as those who are ready to go forward will not wait for others. Secondly, interested parties should agree to cooperate for their mutual benefit and for preventing the duplication of efforts. Lastly, cooperators should select the standard organization under which its needs are likely to succeed in a fastest time period.

However, there should be overriding principles that guide any harmonization process. In the December 8, 2005 United States Standards Strategy states "It is well established in the community of nations that standards should meet societal and market needs and should not be developed to act as barriers to trade. In approving the World Trade Organization Technical Barriers to Trade Agreements, WTO members recognized that goal and established globally accepted principles as a framework to promote cooperation and discourage the use of standards as trade barriers." [ANSI (2005)] Those principles are: transparency, openness, impartiality, effectiveness and relevance, consensus, performance based, coherence and due process.

At this time, cotton trading issues are focusing on the emergence of China as a producer and as an exporter of cotton and cotton goods. China's influence is being felt around the world in almost every aspect of the world's economy. It is imperative that the global cotton community including China must have a common objective to create harmonized international cotton standards.

REFERENCES

American National Standards Institute, *United States Standards Strategy*, p.6, 2005.

ASTM–International web site, <http://www.astm.org>, 2005.

Cotton Incorporated, *U.S. Cotton Market Monthly Economic Letter*, February 9, 2006.

International Electrotechnical Commission, <http://www.iec.org/history>, 2006.

International Organization for Standardization, web site, <http://www.iso.org>, 2005

International Organization for Standardization, ISO Central Secretariat, *My ISO Job: Guidance for delegates and experts*, p.3, 2005.

United States Department Energy, AMTEX Partnership, *Demand activated manufacturing architecture*, September 2001.

Webster's New Collegiate Dictionary, G. & C. Merriam Company, p. 1125, 1980

Session III: Fibre Properties

- ***Relationships between Micronaire, Fineness and Maturity***
Joe Montalvo
- ***The ITMF Cotton Contamination Survey 2005***
Christian Schindler
- ***Extraneous Contamination in Raw Cotton Bales - A Nightmare to Spinners***
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Thomas Kerby

RELATIONSHIPS BETWEEN MICRONAIRE, FINENESS AND MATURITY

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Diagnostic models of the specific relationships between: (a) fineness/perimeter and the product of maturity x perimeter, (b) micronaire and fineness/perimeter, and (c) micronaire and the product of maturity x perimeter were tested on experimental data from U.S. cottons. The diagnostic models provide a tool for analysis of data related to the definition of maturity and fineness and Lord's micronaire equation. Perimeter's role in the model is to normalize the data and stabilize model output. Model output includes the linear regression coefficient of determination, slope and intercept. Two groups of cottons were evaluated in this study. One was analysed by the Southern Regional Research Center (SRRC) upgraded Fineness and Maturity Tester (FMT) for all fibre properties (fineness, perimeter, maturity and micronaire). The other group was analysed by the Advanced Fibre Information System (AFIS) for fineness, maturity and perimeter, and by a high volume instrument (HVI) for micronaire. Example results are as follows: Diagnostic model plots of the FMT data produced a high R^2 and with slopes and intercepts that conform to predictions. By contrast, the plot of the HVI micronaire and AFIS maturity x perimeter data gave results that were significantly different compared to model predictions. Simulation data with added error was used to help interpret the findings. The study indicated that the AFIS fineness and maturity values are biased compared to Lord's micronaire model. Recalibration is recommended.

Models have been developed and computer simulated to understand the variability in coefficients of determination (R^2) between cotton fineness and maturity, micronaire and fineness, and micronaire and maturity (Montalvo, 2005). All plots of the simulated fibre properties produced families of lines rather than a single line because cross-sectional perimeter plays a significant role in interpretations of the relationships.

To enhance the R^2 values, additional models referred to as diagnostic relationships were derived to fit to a simple linear model (Montalvo and Von Hoven, 2005). These new expressions incorporate perimeter in each model in a way that families of lines collapse into a single line plot. The diagnostic criteria for fitting data to a specific model are that plots of the data yield a single line with high R^2 and predictable slope and intercept values. A fit of the data provides a proof of the Lord equation for micronaire (Lord, 1956) and for the definitions of fineness and maturity in equation form.

Three diagnostic models have been tested on 305 cottons with experimental data produced by the Southern Regional Research Center (SRRC) upgraded Fineness and Maturity Tester (FMT). For all diagnostic relationships, plots of the FMT data produced a single line with high R^2 and with slopes and intercepts that conform to simulation predictions (Montalvo and Von Hoven, 2005).

Additional testing of the three diagnostic models has revealed that only one or two carefully selected models, depending on the application, are sufficient to adequately evaluate a data set. This is the case with the applications in this paper. In the first application, the data set is examined by two of the three diagnostic models. In the other application, the data is examined in more detail with the remaining model.

In this paper, there are four objectives. First, present the classical and diagnostic models. Second, demonstrate the fit of two of the three diagnostic models to FMT data on 36 cottons with different perimeters. Third, apply the remaining model - between micronaire and maturity x perimeter - to the HVI micronaire and AFIS data on 21 cottons representing the 2001 American Textile Manufacturers Institute (ATMI) leading varieties study. Demonstrate that results do not conform to model predictions. The data is probed for perimeter, random error and bias effects on model output. The lack of fit of the ATMI data to the diagnostic model is shown to be due to bias in the AFIS fineness and maturity measurements, compared to the more traditional Lord's micronaire model. For the final objective, the practical aspects of the findings are discussed.

MATERIALS AND METHODS

Fineness and Maturity Tester (FMT)

Thirty-six U.S. cottons were selected for this study. Each was a different cultivar so a distribution of perimeters is expected. The cottons were cleaned with two passes on a Shirley Analyser.

The SRRC upgraded FMT (Shirley Developments Ltd. Charlotte, NC) was calibrated with 12 cottons tested for fineness and maturity by image analysis (Boylston, 1991), and the British Standard Methods (British Standard BS 3085:1981, BS EN ISO 1973:1996). From this data, Lord's fineness and maturity models were back calculated to produce the FMT *PL* and *PH* measurements that were subsequently used to calibrate the FMT instrument (Lord and Heap, 1988).

The cleaned cottons were tested on an upgraded FMT (Von Hoven *et al.*, 2001, 2002). A fixed mass of cotton is placed in the FMT sample chamber and the cotton is compressed (dual stage) while air is drawn through the fibres. The initial pressure drop at low compression is referred to as pressure low (*PL*, mm water). Then the airflow is reduced and compression increased; the second stage pressure drop is referred to as pressure high (*PH*, mm water).

For all cottons, six replications of 4-gram specimens were hand carded using Louete cards with 100 picks per inch. Each specimen was then rolled and inserted into the FMT with a mechanical tool (Montalvo and Von Hoven, 2003). Throughout testing, a strict quality control protocol was followed that included physical standards that mimic mid-micronaire cotton used throughout the testing. The six replications were then averaged to give mean *PL* and *PH* values. Mean micronaire, maturity, fineness and perimeter values were computed from algorithms that are functions of *PL* and *PH* (Montalvo and Grimball, 1994) and used to construct the graphs in this paper.

Advanced Fibre Information System Fineness and Maturity Module (AFIS A-2)

U.S. cottons from the ATMI leading varieties study were used in this research. There were 21 treatments representing the combinations of 13 varieties grown in one, two, or three locations (Georgia, Mississippi, and Texas) in 2001. Harvesting produced eight bales per treatment or 168 bales total.

All of the bales were analysed for fineness and maturity on the AFIS-A2 module (Uster Technologies, Knoxville, TN) using the procedure recommended by the instrument manufacturer. Perimeter was calculated from the data. Micronaire measurements were produced on a high volume instrument (HVI). For the AFIS determination, there were three replicates per bale and 10,000 fibres analysed per run. Ten replicates per bale were analysed for micronaire. The number of replicates per treatment were: micronaire, 10 reps/bale x 8 bales = 80 reps and AFIS, 3 reps/bale x 8 bales = 24 reps. The AFIS and micronaire data were averaged within each of the 21 treatments to produce mean values that were used to construct the plots in this paper.

RESULTS AND DISCUSSION

Models Development and Interpretation

The classical and diagnostic models are shown in Table I. The first two classical models give the definitions of fineness and maturity in equation form. Fineness (H) is gravimetric fineness or linear density of fibres expressed in millitex ($mtex$, micrograms per meter). The density of the cell wall is taken as 1.52 g/cm^3 (Ramey, 1982). Maturity (M) in this context is the maturity ratio and is dimensionless; it is the cell wall divided by 0.577 multiplied by the area of a circle having the same perimeter (Lord and Heap, 1988). To derive the 3rd classical equation, Lord's micronaire (Mic) equation (Lord, 1956) was combined with the other two classical models.

Table I. Models^{*,#}.

Classical	Diagnostic
$H = 1.52A_w$	$\frac{H}{P} = aMP$
$M = \frac{4\pi A_w}{0.577P^2}$	$Mic = a\left(\frac{H}{P}\right) + b$
$Mic = a\sqrt{\left(\frac{A_w}{P}\right)^2} + b - c$	$Mic = aMP + b$

^{*} H (fineness), A_w (wall area), M (maturity ratio), P (Perimeter), Mic (micronaire), and a, b, c are constants. [#](Montalvo and Von Hoven, 2005).

Note that the cotton fibre wall area (A_w) appears in all three classical models in Table I. The equation for A_w (μm^2) as a function of wall thickness T (μm) and cross-sectional perimeter P (μm) is given by (Montalvo, 1991): $A_w = T(P - \pi T)$. Plots of H , M , and Mic versus T at constant P all give families of lines (Montalvo, 2005).

Highly variable R^2 may result if one plots data *within* any one of the three classical models or *between* any two of the classical models in Table I. Incorrect interpretation of results is probable. This is because the unexplained variance may be due to: (a) an underlying family of lines, each at a fixed perimeter, which greatly suppresses the R^2 , (b) random error, and (c) bias.

The first two diagnostic models in Table I were derived from the classical equations. The remaining diagnostic model was derived algebra manipulations of the other two (Montalvo and Von Hoven, 2005). To plot data with the diagnostic models, use the correct expression *within* a model (e.g., plot H/P vs. MP or H vs. MP^2) and assign the parameter(s) to the left of the equal sign to the y -axis. This will allow for comparability of experimental slopes and intercepts to the theoretical values. Plotting data with the diagnostic models results in an improved R^2 if the perimeter values are variable. Perimeter is incorporated in each of the three models in a way that families of lines collapse into a single line. Thus, if the R^2 is significantly less than one, the unexplained variance is due to random error and/or bias.

Table II shows the effects of random error and bias on diagnostic model plots. Random error changes only the R^2 . Bias may reduce the R^2 as a result of changes in output slope, intercept and linearity. Simulation with added random error allows for isolation of random error effects on the diagnostic model R^2 . If the random error effects on R^2 are not significant but a reduced R^2 is observed, look for a change in slope, intercept or linearity as supporting evidence of bias in the data. Confirmation of bias results by independent studies is the best way to check on interpretation of model output.

Table II. Perimeter, random error and bias effects on diagnostic models.

Entry	Effects
Perimeter	none
Random error	reduces R^2
Bias	changes slope, intercept and linearity

Practical use

The discussion on models development and interpretation should help in understanding the application of the models to real data sets. Two data sets (FMT and AFIS) are examined in this paper. In the FMT application, the first two classical and diagnostic models in Table I are tested with the data. Use of the third diagnostic model does not provide additional independent information. A very poor fit is

observed with one of the classical models and good fits are obtained with both diagnostic models that conform to model predictions. In this case, however, the extremely bad fit with the classical model provides useful information in coming to the correct interpretation of results. In the AFIS application, only the third classical and diagnostic models are applied to the data. Diagnostic model output does not conform to expectations. This complicated case is presented in sufficient detail to determine the cause of the poor fit.

Fineness and Maturity Tester (FMT)

Figure 1 depicts the classical plot of fineness versus maturity. The R^2 is only 0.0442. In contrast, the diagnostic model plot (Figure 2) produced a high R^2 (0.9931). The slope (0.071) and intercept (0.0592) are consistent with a good fit to the ideal model, 0.0698 and 0, respectively. Figure 3 shows the classical plot of micronaire versus fineness ($R^2 = 0.849$).

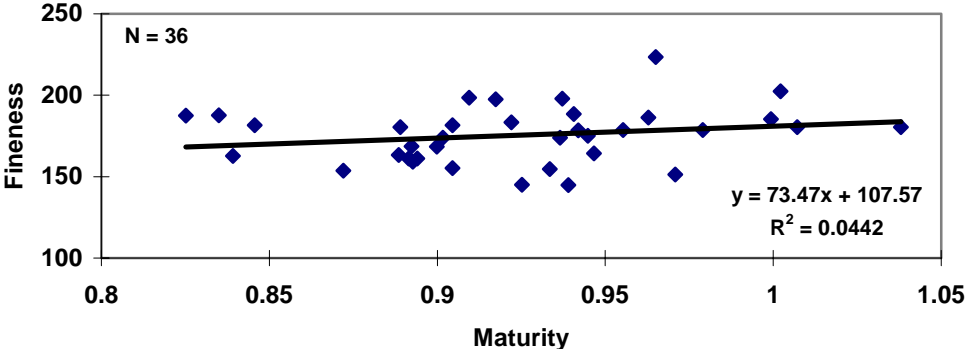


Figure 1. Regression of FMT fineness versus maturity (classical plot).

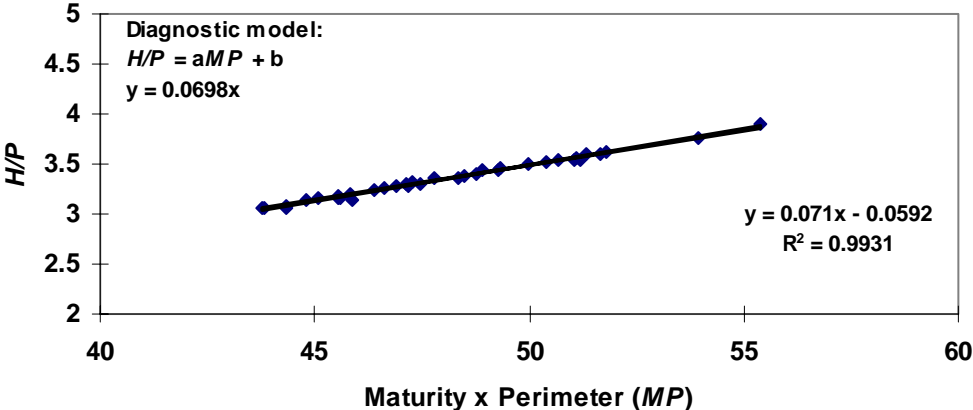


Figure 2. Fit of diagnostic model between fineness/perimeter and maturity x perimeter.

The relative order of the R^2 values for Figures 1 and 3 is consistent with simulated data findings (Montalvo, 2005). When Figure 3 data was graphed with the appropriate diagnostic model, a high R^2 is observed (0.9946, Figure 4). The slope (1.9467) is within 5% of the ideal model value of 1.864; the intercept (2.2729) is within 15% of the model value. Thus, for the two diagnostic plots, the FMT data produced a single line with a high R^2 and with slopes and intercepts that conform to model predictions.

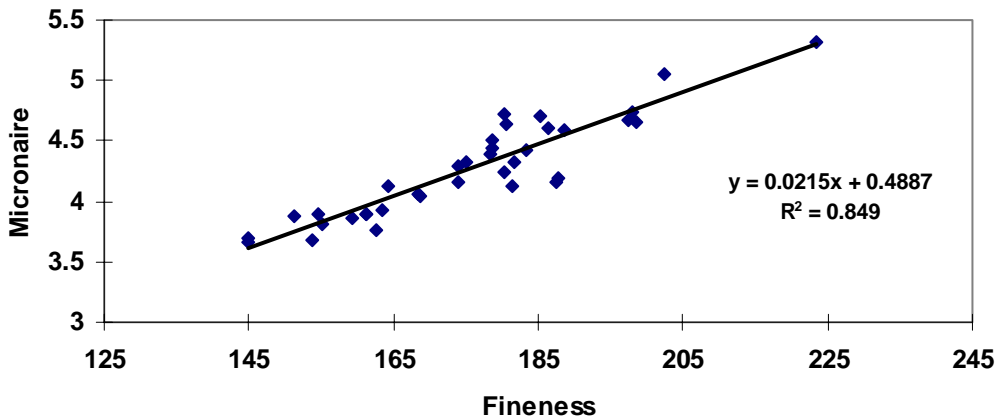


Figure 3. Regression of micronaire versus fineness (classical plot).

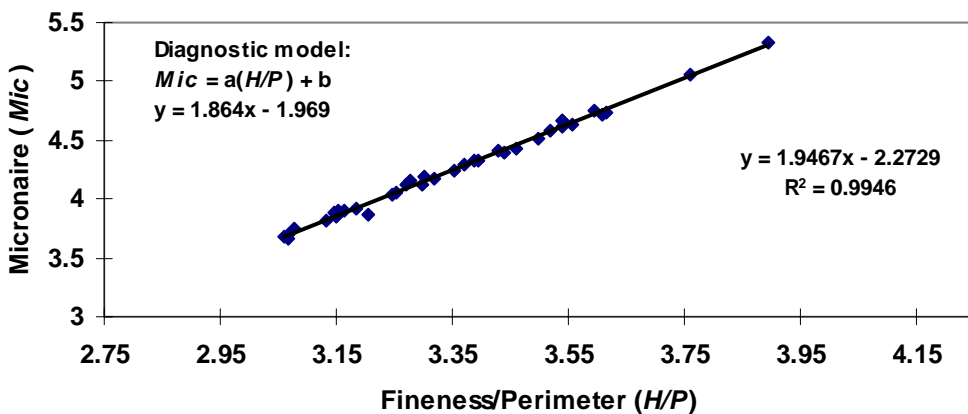


Figure 4. Fit of diagnostic model between micronaire and fineness/perimeter.

The poor R^2 for the classical plot between fineness and maturity, and the high R^2 with the two diagnostic models, rules out random error and bias as causal factors in explaining Figure 1 results (see Table II). This suggests that variability in perimeter values alone is responsible for an unexplained variance of $> 95\%$ in the classical plot. Descriptive statistics of the perimeter distribution is shown in Table III. The range of perimeters is $> 10 \mu\text{m}$, the standard deviation is $2.67 \mu\text{m}$, and the kurtosis value is negative. Kurtosis characterizes the relative peak spread or flatness of a distribution

compared with the normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution.

Each sample represented a different variety of cotton. The perimeter or biological fineness of a fibre is a characteristic of the cotton variety (Ramey, 1982), thus a relatively flat distribution of perimeters is expected. As a consequence of the flat distribution, the R^2 between fineness and maturity is very poor because the 'true' relationship is really a family of lines, each at a

Table III. Descriptive statistics of perimeter (μm) distribution of FMT data.

Statistic	Result
Minimum	47.2
Maximum	57.4
Range	10.2
Mean	52.3
Standard deviation	2.67
Kurtosis	-0.264

constant perimeter. The diagnostic model expressions in Figures 2 and 4 allow for variance in perimeter values and, as a result, the R^2 is high.

Advanced Fibre Information System Fineness and Maturity Module (AFIS A-2)

The classical model plot for micronaire versus AFIS maturity is shown in Figure 5. Note the poor R^2 value. Examination of the perimeter values in the data set shows a range of values rather than a fixed value. The poor R^2 is due, at least in part, to an underlying family of lines, each at fixed perimeter (Montalvo, 2005).

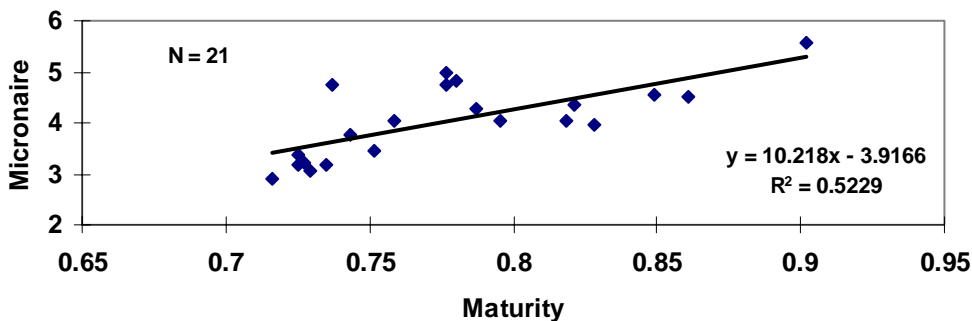


Figure 5. Regression of micronaire versus AFIS maturity (classical plot).

If the micronaire and AFIS maturity and perimeter data fit the appropriate diagnostic model ($Mic = aMP + b$) then a single line plot is expected with high R^2 and slope and intercept of predictable values. The actual plot (Figure 6) gives an improved R^2 (0.8545) compared to the previous figure ($R^2 = 0.5229$). However, the coefficient of determination is still not close to 1. For the ideal model, the predicted slope and intercept are, respectively, 0.1301 and -1.969. The observed slope of 0.224 is almost twice that of the expected value and the intercept of -5.3517 is more than twice that value.

Is the diagnostic model output in Figure 6 due to random error or biased data? To determine the effect of random error on the coefficient of determination, the pooled standard deviations were calculated from the replicate micronaire, maturity, and perimeter data. That amount of random error, based on the same number of replicates was added to simulated data. The resultant R^2 was > 0.99 for the simulation. Thus, the unexplained variance in the diagnostic model R^2 is associated with AFIS bias and not random error effects.

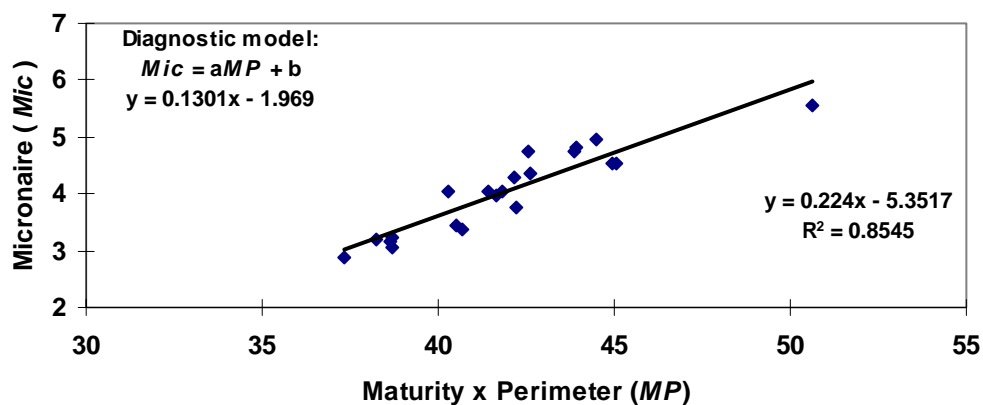


Figure 6. Fit of diagnostic model between micronaire and maturity x perimeter.

Clarify AFIS “bias”

To clarify what the AFIS is compared to, this is a direct attempt to analyse experimental data for bias (i.e., a difference) between the AFIS fineness and maturity module and the more traditional Lord model (Lord, 1956). This model relates the product of maturity x fineness to micronaire; the equation is a quadratic and has been modelled extensively (Montalvo, 2005; Montalvo and Von Hoven, 2005).

Any bias is assumed to be in AFIS results rather than the Lord model or micronaire results. Both the Lord model and micronaire data were probed for bias and there is no evidence to support any bias other than in the AFIS results. Under the heading below **“Confirmation of AFIS results”** updated coefficients in Lord’s model produced the same findings. As to micronaire, it was measured on two different HVI systems. Paired differences were not significantly different. This means that the

diagnostic model output for the experimental data (poor R^2 and elevated slope and intercept in Figure 6) can be traced to bias in AFIS results.

Deconvolute AFIS diagnostic model plot

To understand the effect of biased data on the Figure 6 plot, plotting Mic versus MP at constant P deconvolutes the plot. In the absence of bias, overlapping straight lines are observed at each P value. In the presence of bias, the lines do not overlap and may be nonlinear.

In Figure 7 the experimental data are plotted for two small ranges of P : between 51.9 to 52.9 μm , 6 data points and between 56.1 to 57.3 μm , 5 points. In place of overlapping straight lines, the lines cross and are nonlinear. There is a good fit to a nonlinear model. In other words, the data conform to some other model, but not the diagnostic model.

Computer simulations were run with fixed and systematic bias in maturity and fineness. The experimental plots in Figures 6 and 7 have been produced with the following simulation conditions: The relative bias in maturity and fineness is fixed at 1:1; the bias direction is negative; and the bias increases with decrease in micronaire. The AFIS fineness and maturity module senses these properties based on the light measured by two optical detectors as the fibre moves past the sensors. The existence of a bias in both parameters seems more reasonable that a bias in only one of the properties.

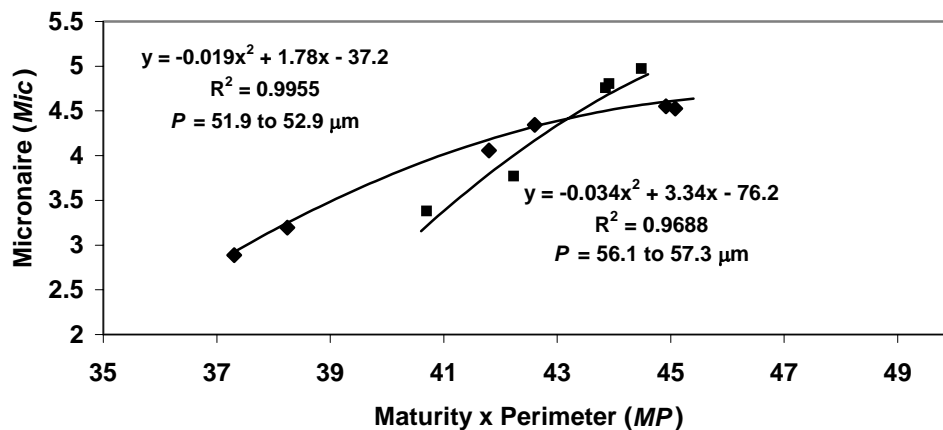


Figure 7. Micronaire versus maturity x perimeter at constant perimeter.

Micronaire relation to biased AFIS data

The relationship is shown in Figure 8 with fitted line for $N = 20$ points (one outlier in the data set). Maturity (M) and fineness (H) are expressed as the ratio of the AFIS value to the calculated value; this ratio relates to micronaire (Mic). The starting point

for the calculated M and H values is the Lord equation, which in the context of this paper, relates the product mh (maturity x fineness by the Lord formula) to experimental Mic values. (The constants a , b and c in Lord's equation are the published values (Lord, 1956); updated constants developed from image analysis maturity and gravimetric fineness data produced essentially the same results shown in the figure and will be reported elsewhere.)

Next, the relative AFIS M and H fineness bias is taken as 1:1. This simplifies calculation of β , the bias coefficient and makes it the same for M and H . It follows that for maturity and fineness, the ratio of the AFIS value to the calculated value is given by $M/\beta M = 1/\beta$ and $H/\beta H = 1/\beta$. If $1/\beta < 1$ then a negative bias exists.

No bias is indicated in Figure 8 at low micronaire values since $\beta \approx 1$. As micronaire increases, the extent of negative bias increases ($\beta \ll 1$). In other words, the AFIS values are too small at the higher micronaire values. This results in compression in the range of maturity and fineness values produced by the AFIS.

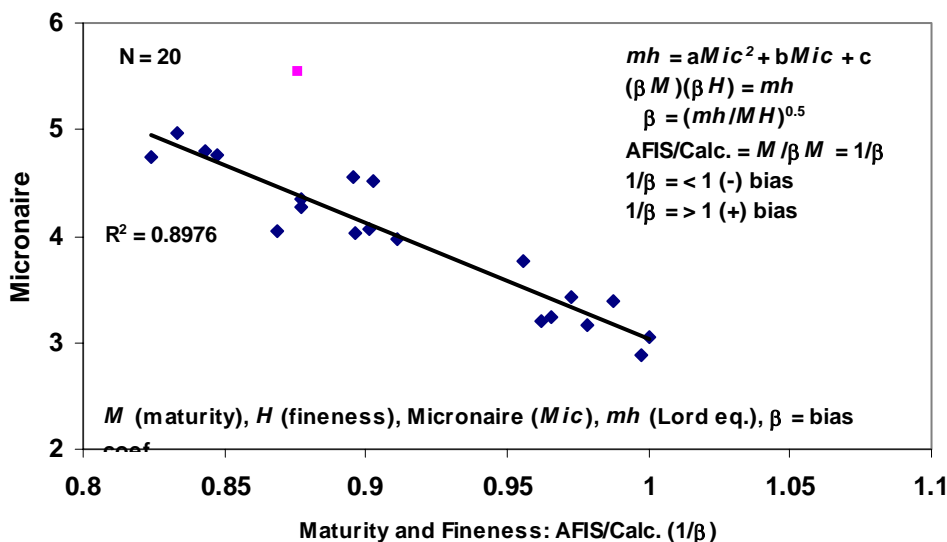


Figure 8. Micronaire vs. maturity and fineness: AFIS/Calc. Assume M and H bias 1:1.

Confirmation of AFIS results

To confirm the AFIS-A2 results, the cottons were analysed on the AFIS PRO and micronaire was analysed on a different HVI unit. The β values were computed and the plot constructed. A strong relationship ($R^2 > 0.94$) was found between Mic and $1/\beta$ for $N = 21$ points. An increasing negative bias was found at $Mic > 3.8$, which agrees with the A-2 results. However, for $Mic < 3.8$ a positive bias is indicated, in contrast to no bias found with the A-2 module. Therefore, at high micronaire values the AFIS PRO maturity and fineness values are lower than expected and at low micronaire values the results are higher than anticipated. This means there is a compression of the data set at both ends of the scale, resulting in a significant

reduction in the range of experimental values. This work will be reported in detail elsewhere.

Additional confirmation was provided by an independent study reported at the 2006 Beltwide Cotton Conferences (Hequet, 2006). Based on reference cottons analysed for maturity and fineness by image analysis, a reduced range in values was found for both the AFIS A-2 and AFIS PRO. The relative maturity to fineness bias was about 1:1, which supports that assumption in this paper.

CONCLUSIONS

When plotting the FMT and AFIS data by the classical approach, poor correlations emerged that are difficult to interpret. The need for the diagnostic relationships to probe the quality of the data is clearly demonstrated with the example applications in this paper. The FMT data conform to the two diagnostic models tested but showed a very high degree of unexplained variance between the classical fineness and maturity plot. This suggests perimeter variability alone rather than random error or bias as the causal factor. This is confirmed by descriptive statistics and the fact that each sample in the set is a different variety. In contrast, the AFIS A-2 maturity and fineness values do not conform well to the one diagnostic model tested, indicating adverse random error or bias effects. Random error did not have a significant effect on the results. The causal factor is a systematic bias that relates to micronaire and results in a reduced range of experimental values. The findings have been confirmed on the AFIS PRO and by an independent study. Recalibration of the AFIS is recommended.

REFERENCES

Boylston, E. K.; O. Hinojosa, and J.J. Hebert. 1991. A quick embedding method for light and electron microscopy of textile fibres. *Biotechnic Histochem*, 122-124.

British Standard BS 3085:1981. Method for evaluation of the maturity of cotton fibres (Microscopic method). British Standards Institution, London.

British Standard BS EN ISO 1973:1996. Textile fibres-Determination of linear density-Gravimetric methods and vibroscope. British Standards Institution, London.

Hequet, E. Calibration of the AFIS maturity measurement. Presented to the 2006 Beltwide Cotton Confs., San Antonio, TX, Jan 3-6, 2006.

Lord, E. 1956. Airflow through plugs of textile fibres. Part 2 – The micronaire test. *J. Textile Inst.* 47:T16-T30.

Lord, E. and A.A. Heap. 1988. The origin and assessment of cotton fibre maturity. Int. Institute for Cotton, Technical Research Division, Manchester, England.

Montalvo, J.G., Jr. 2001. A comparative study of NIR diffuse reflectance of cottons grouped according to fibre cross-sectional dimensions. Part I. Fundamentals. *Appl. Spectrosc.* 45:779-789.

Montalvo, J.G., Jr. 2005. Relationships between micronaire, fineness and maturity. Part I. Fundamentals. *J. Cotton Sci.* 9:81-88. Online at <http://journal.cotton.org>.

Montalvo, J.G., Jr., and R. Grimball. 1994. SRRC maturity and fineness equations, version 1.0 software.

Montalvo, J.G., Jr. and T. M. Von Hoven. 2003. Improved FMT precision with new sample insertion technique. *In* P. Dugger and D.A. Richter (eds.) *Proc. of the Beltwide Cotton Confs., Natl. Cotton Council Am., Memphis, Tennessee*, p. 1961-1966. On CD-ROM.

Montalvo, J.G., Jr. and T.M. Von Hoven. 2005. Relationships between micronaire, fineness and maturity. Part II. Experimental. *J. Cotton Sci.* 9:89-96. Online at <http://journal.cotton.org>.

Ramey, H.H., Jr. 1982. The meaning and assessment of cotton fibre fineness. Int. Institute for Cotton, Technical Research Division, Manchester, England.

Von Hoven, T. M., J.G. Montalvo, Jr., S. Reed, D. Francois, S. Bucu, and S. Faught., S. 2001. Calibration of upgraded FMTs. *Proc. of the Beltwide Cotton Confs., National Cotton Council of America.* II:1307-1309.

Von Hoven, T.M., J.G. Montalvo, Jr., D.L. Francois, S. Reed, and S. Faught. 2002. Calibration of upgraded FMTs. Part II. Expansion of results. *In* P. Dugger and D.A. Richter (eds.) *Proc. of the Beltwide Cotton Confs., Natl. Cotton Council Am., Memphis, Tennessee*, paper no. J032.pdf. On CD-ROM.

THE ITMF COTTON CONTAMINATION SURVEY 2005

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ABSTRACT

The ITMF survey on cotton contamination in 2005 showed that in the perception of spinners from around the world contamination is an ever increasing problem. During the past 16 years the degree of contaminated cotton was rising steadily from 14% to 22%. Organic matters are still the main contaminants, followed by fabrics of cotton, strings of woven plastic and plastic film. Cotton growths from Turkey and India are still among the most affected ones, while cottons from Israel (Pima), Senegal, the USA (Pima and Others), Zimbabwe and Australia are least affected. On the other hand, the situation on stickiness has improved significantly during the same period. The percentage of sticky cotton world-wide fell from 21% in 1989 to 17%. The most sticky cotton in 2005 originated from Cameroon, Sudan, Uzbekistan, Mali and the USA (Pima). Not affected at all by stickiness were cotton varieties from Zimbabwe, Zambia, Senegal, Togo, India (Shankar-4/6, J-34 and MCU-5), Turkey (Izmir), Spain and the USA (South Eastern). The level of seed-coat fragments reached 37% in 2005 which was significantly lower than in 2003 (44%) but still higher the record-low of 32% in 1997. Cotton from Nigeria was 100% affected by seed-coat fragments, followed by India's J-34, with 86% and Turkmenistan's long-staple cotton with 83%. On the other side of the range were the descriptions from Togo (0%), Zimbabwe (7%), Paraguay (10%), the Ivory Coast (14%) and US-Arizona (15%).

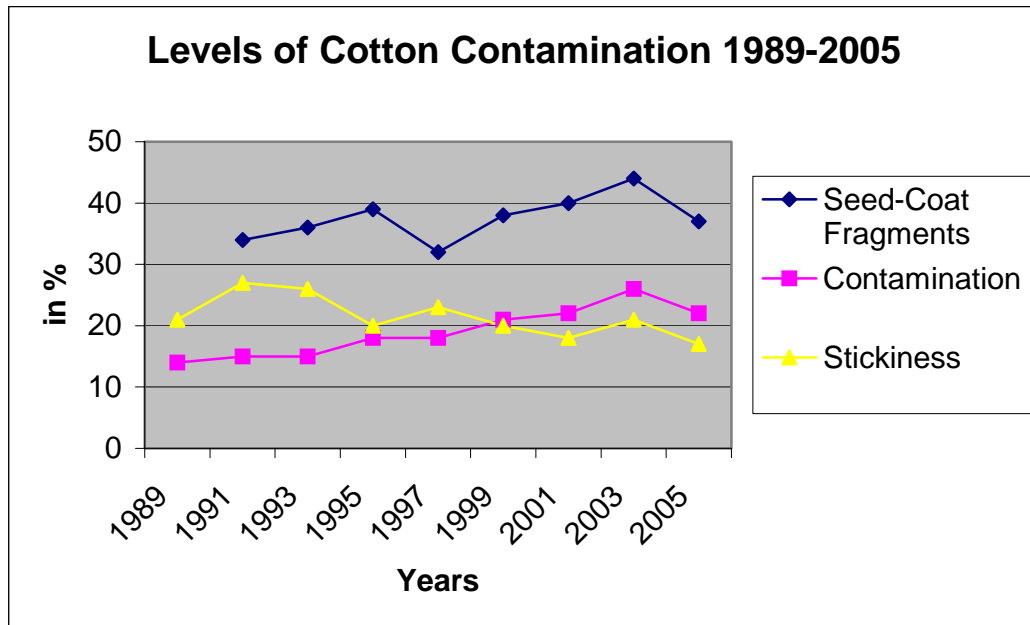
INTROCUPTION

In 2005 ITMF has once again conducted a world-wide survey on cotton contamination - the ninth survey since the set up of a solid methodological basis in 1989. The survey is based on a questionnaire and the respective answers show how cotton spinners from around the world perceive the quality of the cotton as far as contamination is concerned.

By looking at the latest results and comparing them with the previous ones it is possible to identify short-term changes as well as long-term developments. The main trends since 1989 are the following:

- The level of contamination rose from 14% to 22%, an increase of almost 60%.
- With 17% the level of stickiness reached an all time low. Compared with 1989 it was 20% lower.

- The occurrence of seed-coat fragments dropped significantly in 2005 to the level of the long-term average. In 2005 37% of all cotton were affected by seed-coat fragments thus being above the initial level of 34% in 1991.



Participation in 2005 fell from 220 to 152 spinning mills, a reduction of around 30%. The decline was mainly the result of fewer Indian mills participating in the survey. The 18 countries covered by the survey represent approximately 37% of total world cotton consumption at mill level.

The total number of evaluated samples continued to drop to 716 from 1,092 in 2003, which is mainly due to rising concentration of the cotton spinning industry in cotton producing countries where mills consume mostly domestic varieties. The 27 spinning mills from Egypt only evaluated 27 samples, a ratio of 1:1, the 16 Brazilian spinning mills evaluated 27 samples, a ratio of 1:1.7 and the 10 US spinning mills evaluated 35, a ratio of 1:3.5. In contrast to these cotton producing countries the ratios of cotton importing countries were significantly higher. Korea had a ratio of 1:7, Germany of 1:8.2, Belgium of 1:9.3 and Taiwan even one of 1:13.8.

The 152 participating spinning mills have evaluated a total of 716 samples from 68 varieties, of which 41 were considered for the survey. The remaining 28 were neglected since the number of evaluations were less than 5 for each of them.

CONTAMINATION

After a continuous increase of cotton contamination since 1989 the level of contamination fell for the first time in 2005 but remained on the second highest level. In 1989 only 14% of the cotton was considered to be contaminated by at least one of the 16 sources identified in the survey. This number rose steadily to 26% in 2003 and

declined to 22% in 2005. The biggest source of cotton contamination in 2005 remained organic matter (leaves, feathers, paper, leather, etc.), though its level dropped considerably from 50% in 2003 to 40%. On the other side of the range one finds tar whose percentage fell from 6% to 5%. Other sources of high contamination in 2005 were fabrics made of cotton (32% - slightly higher than in 2003), strings made of woven plastic (29% compared to 32% in 2003). A strong reduction could be observed in regard to strings made of jute where the level of contamination dropped sharply from 38% in 2003 to 25%.

In 2005 Turkey was the country with the highest degree of contamination. 45% of all Turkish varieties were affected (2003: 48%). The level of contaminated Indian cotton growths fell significantly from 49% in 2003 to 40%. After a slight improvement in 2003 (25%) the cotton of the Central Asian countries have been downgraded again reaching 28%. In West Africa the situation improved slightly. In 2005 19% of the region's cotton was contaminated compared to 21% in 2003. The level of cotton contamination rose in Brazil to 21% from 17% in 2003. On the top Zimbabwe dropped from first place in 2003 with only 8% contamination down to fifth place with 13%, while the growths from both Israel and Senegal proved to be the least contaminated (10%).

Considering the main cotton growing regions in the period between 1989 and 2005 it becomes obvious that the extent of contamination has increased significantly in most regions. The development in Central Asia since 1989 shows a clear trend of deterioration, which continued also in 2005. The same applies to Turkey though on a lower level. The degree of contamination of West African cotton increased steadily between 1995 and 2003 but improved again slightly in 2005. US and Brazilian cotton growths reached the highest levels of contamination since 1989. Only India and Egypt were able to reduce contamination below their levels of 1989, though in the case of India the absolute level of contamination is still high.

STICKINESS

In the past cotton growths from Sudan showed by far the highest level of stickiness reaching sometimes 100%. In 2005 though cotton from Cameroon was the most affected by stickiness (64%). With 44% Sudan's Bakarar cotton was also quite high but significantly less affected by stickiness than in 2001 and 2003, when its level reached 100% and 56%, respectively. Descriptions not affected at all by stickiness came from different areas around the world such as US-Southern Eastern, Zimbabwe, Izmir from Turkey, Shankar-4/6 from India, Senegal or Spain.

In all the larger growing areas the level of stickiness could be reduced. The Central Asian cotton proved to be less sticky in 2005 (29.16%) than in 2003 (44.33%). Stickiness of West African growths fell from 28.88% to 21.56%, of US varieties from 22.11% to 18.43%, of Brazil from 20% to 12% and of Indian descriptions from 12.43% to a record low of 5.6%.

In the historical perspective the degree of stickiness of all cotton growths covered in the survey reached a record low in 2005 (17% compared to 21% in 1989). Already

from a low level India could reduce the stickiness of its cotton descriptions in 2005 to 42% of its 1989 level. In Brazil the level declined to 57%, in West Africa to 62% and in the US to 87%, while in Central Asia it remained unchanged.

SEED-COAT FRAGMENTS

The overall level of seed-coat fragments fell for the first time in 2005 since 1997. After a record high in 2003 it dropped considerably to the long-term average.

With 100% of all evaluated cotton affected Nigeria was topping the list in 2005. With over 50% Central Asian, Turkish and Indian descriptions still showed a relative high percentage. Of other major cotton areas, West Africa was positioned in the middle range with 34%, almost unchanged to 2003 (36%). In the USA the level increased from 28% in 2003 to 36%.

Further down, cotton from Australia could reduce its level to 17% (2003: 21%). Paraguay, Zimbabwe and Togo recorded the lowest degree of seed-coat fragments with 10%, 7% and 0%, respectively.

The long-term development shows that only the US and Indian cottons have improved their records compared to 1989. In West African descriptions the presence of seed-coat fragments has almost fallen back to the level of the base year. Brazilian and Turkish cottons still have higher levels. In Central Asia the deterioration is the most obvious with +131%.

EXTRANEOUS CONTAMINATION IN RAW COTTON BALES - A NIGHTMARE TO SPINNERS

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This paper gives an overview of actual nature and quantum of contamination in cotton bales from different origins. The information presented is fully based on manual cleaning of over 200 million kilograms of various cottons in the last 7 years. An attempt is made to identify the most dreadful or obnoxious type of contaminants, which are difficult to remove in the spinning process and which result in down grading of yarns, fabrics and garments. Further, threshold level of these 'obnoxious type' contaminants in raw cotton, where the spinner will be comfortable with adequate support from electronic gadgets, is determined by controlled experiments. Some corrective measures are suggested to obviate/minimize these obnoxious contaminants at the origin - in growing, picking and ginning stages.

Extraneous contaminants in raw cotton have become a real nightmare to spinners worldwide. Spinners have been demanding low levels of contamination in raw cotton for the last 3 decades. On the contrary, contamination in raw cotton has been on the increase constantly. ITMF surveys show a **two-fold increase** in total contaminants worldwide in the last 15 years, while the end users of yarn and fabrics demand incredibly low level of contamination. Thus, spinners are hit on both sides.

Contaminants present in the yarn result in huge volumes of fabrics and clothing to be sold as seconds. Ultimately, the claims from the end users are passed on to the Spinners down the line. It is quite unfortunate that the spinner is the one who is blamed for the presence of contamination in yarn, fabric and garments. Spinners pay a sizeable % of the total sales of their cotton and blended yarns on the claims due to contamination, while they struggle and survive on very thin margins. Hence, they are forced to take steps at their end to minimize the problem, even though the origin of the problem is elsewhere.

Spinners are compelled to invest huge amounts of money on electronic gadgets fitted in the spinning process especially in Blow room and Winding. Now, new developments are taking place to enable further detection at Cards, Draw frames, etc. Spinners are, no doubt, running high risk as none of these gadgets can ensure 100% removal of all types of contaminants. The problem of contamination has to be dealt at the origin. For this, we need to have accurate information on the nature and quantum of contamination in different origins of cotton and their impact on yarn and fabric quality.

WHAT IS THE ACCEPTABLE CONTAMINATION LEVEL FOR THE END USER OF YARN AND CLOTH?

There are no established standards for the size and frequency of contaminants acceptable in knitted and woven fabrics worldwide. Contamination, even if it is a tiny single fibre, leads to downgrading of yarn, fabric and garments to second quality or even total rejection of an entire batch or shipment.

To day, most of the end users demand zero contamination in the yarn and fabric. Only, a few of them, who understand the reality, accept certain low levels. But then, these levels also are not within easy reach of spinners.

The size of contamination objectionable to the end users could be as small as **1 mm** and less, while electronic clearers cannot clear less than **1 cm**.

STEPS TO ELIMINATE / MINIMIZE THE CONTAMINATION AT THE ORIGIN:

Obviously, the problem has to be attacked in cotton growing, picking and ginning. For this, firstly, a clear understanding of actual nature and extent of contaminants present in different origins of cotton is necessary.

Secondly, it is necessary to identify what types of contaminants are 'obnoxious', that are difficult to remove even with electronic gadgets in the spinning process.

Thirdly, it is necessary to determine the threshold level of the 'obnoxious type' contaminants in raw cotton, with which the spinner will be comfortable.

Finally, to identify preventive measures in cotton growing, picking, ginning and baling processes to minimize these obnoxious types of contaminants in raw cotton bales and ensure that the contaminants do not exceed the stipulated threshold level.

NATURE AND EXTENT OF CONTAMINANTS IN DIFFERENT ORIGINS OF COTTON:

Manual cotton cleaning:

We are consuming large quantity of raw cotton, about 125 –130 tons per day, imported from different countries for the production of 100% cotton yarns and blends, greige fabrics, and Denim fabrics. We started manual cleaning of raw cotton about 7 years ago primarily to get rid of the contaminants and minimize complaints from our customers. About 90 tons of different cottons used for ring spinning are cleaned manually everyday and the contaminants thus collected are analyzed for their nature and quantity.

The whole gamut of data collected from more than 200 million kilograms of raw cotton is used to study the actual nature and extent of contamination in different origins of cotton. Also we tried to identify the most dreadful ones, which cannot be easily removed by electronic gadgets and arrive at a threshold level of contaminants in raw cotton bales. Today, we will be glad to share this information with all of you, with a hope to find a solution to this burning problem.

Cotton Contaminants Removal (CCR) lines:

Manual cleaning (Cotton Contamination Removal lines or more precisely Consummate Contamination Removal lines) lines are designed by us in such a way to easily detect even very tiny contaminants in raw cotton bales. The operators engaged in the manual cleaning are given a comfortable seat, good table and proper lighting. A part of the table has wire mesh to de-dust the cotton, and a part with white surface to detect colour contamination.

Operators pick up very small tufts from the bales, open the tufts by hand & search for contamination. The contaminants detected are duly discarded in to the waste bags and cleaned cotton is thrown to the conveyer. White polypropylene, oil, shiny spots, fungi, etc are detected at the end of the conveyer under UV light. The cotton thus cleaned are re-baled in cotton wrappers and stored with proper identification of shipment, type, etc. (Figures: 1 - 6)



Fig 1: General view of CCR line



Fig 2: CCR table with wire mesh & white top



Fig 3: Contamination collected in waste bags



Fig 4: Cleaned cotton on the conveyer



Fig 5: UV checking



Fig 6: Repacked bales

Primary advantage of this manual cleaning is effective removal of contaminants to the tune of 98-99%, before feeding the cotton to blow room and prevention of pulverization. Other advantages are: thorough blending, good opening, less fibre damage, effective removal of sand and dust, reduction in stickiness, reduction in load on electronic clearers and improved winding efficiency, accurate information on nature & extent of contaminants in cotton and finally authentic feed back to the cotton suppliers

The only disadvantage is the additional cost involved in CCR operation – for extra labour, power, material handling, packing material and inventory. As much as 1.5 to 2.0 cents per pound is added to the cost of raw material depending on the contamination level in the cotton. It is just impossible to practice this in developed countries where labour cost is high.

GENERAL INFERENCES FROM THE ANALYSIS OF MANUAL CLEANING DATA:

The actual data on contamination segregated manually from raw cotton bales are analyzed for (1) % of bales with extraneous contaminants –Table: I (2) Actual quantity (gram/ ton) of contaminants and (3) Classification of contaminants.

TABLE I: % BALES WITH EXTRANEIOUS CONTAMINATION

COUNTRY OF ORIGIN	1999 / 2000	2004-2005	
	Average	Average	Range
GROUP I			
AUSTRALIA	14%	20%	10-30%
CHINA	20%	23%	15-30%
BRAZIL	35%	27%	15-35%
AM. SJV	28%	28%	20-45%
AM.FIBER MAX	-	32%	20-50%
AM.MEMPHIS	23%	32%	30-60%
MEXICAN	31%	35%	22-50%
GROUP II			
W AFRICA	58%	66%	62-80%
ZAMBIA	-	75%	70-80%
UZBEKISTAN	84%	86%	80-95%
PARAGUAY	75%	80%	75-95%
MOZAMBIQUE	79%	82%	70-90%
GROUP III			
INDIA	94%	92%	87-100%
ZIMBABWE	-	93%	75-100%
UGANDA	-	96%	90-100%
PAKISTAN	100%	97%	95-100%
TANZANIA	-	97%	95-100%
SYRIA	100%	100%	99-100%

The following broad inferences could be drawn from our analysis:

1. The % of bales affected by contaminants in different shipments of raw cotton from different origins varies from 10% to 100%. (Ref: Table I). The presence of contamination in bales can be said to be an accident, if it is in small proportion of bales say 5-10% of bales. If a high % of bales is found with contaminants then it should not be classed as an accident, but as a tradition.
2. The % of contaminated bales is on the increase from most origins in the last 5-6 years. This is in line with the findings of yearly ITMF surveys.
3. Extraneous contaminants are found in all origins of cottons with out any exception. No any cotton shipment - in the last 7 years was found to be totally free from contamination
4. There is also wide fluctuation in the level of contamination between shipments of the same type of cotton from the same origin.
5. Cottons from different countries differ in degree of contamination, but the nature of contamination is similar. (Fig 7 to 35)
6. Developing countries have started using cotton bale covers, while developed countries are yet to do so. They still use polypropylene and jute cloth for wrapping the bales. If cost is the main concern for using cotton wrappers for bales, then the best alternative would be to use thick polyethylene transparent wrappers, which cannot fibrillate.

Photographs of some typical contaminations from different origins:



Fig 7: Green Polypropylene



Fig 8: Black polypropylene



Fig 9: Human hair



Fig 10: Yarn waste



Fig 11: Orange colour polypropylene



Fig 12: Contaminants in Aus Cotton



Fig13: Contamination Australian cotton



Fig 14: Contaminants in Brazilian



Fig 15: Contaminants in Chinese cotton



Fig 16: Hair in US cotton



Fig 17: Contaminants in US cotton



Fig 18: Contaminants in US cotton



Fig 19: Contaminants in US cotton



Fig 20: Contaminants in Mexican Cotton



Fig 21: Contaminants in West African Cotton



Fig 22: Contaminants in West African Cotton



Fig 23: Contaminants in Zambian cotton



Fig 23: Contamination in Uzbekistan Cotton



Fig 24: Contaminants in Paraguay Cotton



Fig 25: Contaminants in Mozambique Cotton



Fig 26: Contaminants in Indian Cotton



Fig 26: contaminants in Zimbabwe cotton



Fig 27: Contaminants in Uganda Cotton



Fig 28: Contaminants in Pakistan Cotton



Fig 29: Contaminants in Tanzanian Cotton



Fig 30: Contaminants in Syrian Cotton



Fig 31: Contaminants in Turkish cotton



Fig 32: Contaminants in Spanish cotton



Fig 33: Contaminants in Iran cotton



Fig 34: Contaminants in Argentina cotton



Fig 35: Special contaminants



Fig 36: Special contaminants



Fig 37: Special contaminants



Fig 38: Special contaminant



Fig 39: Special contaminants



Fig 40: Metallic Contamination in Cotton – Ginning and baling m/c parts

NATURE AND QUANTUM OF EXTRANEIOUS CONTAMINATION IN COTTON BALES:

Broadly, extraneous contaminants found in cotton bales can be classified in to 2 groups based on their nature and the ease of removal in the spinning process.

Fibrous contaminants constitute human hair, animal hair, bird feathers, yarn pieces and cloth pieces, polypropylene fibres, jute, etc. As these have almost the same buoyancy as the cotton, it is difficult to separate them from cotton. As they are fibrous, they are spun in to the yarn body. Thus, fibrous type contaminants are the most dreadful component of the extraneous contaminants and are **obnoxious**. No chemical process can remove these polypropylene and hair contaminants from the yarn and fabrics. It is rather expensive to extract the contaminants from the woven

cloth. These fibrous contaminants cannot be removed from knitted fabrics/ knitted garments as there is danger of causing holes.

Non-fibrous contaminants consist of paper, chocolate/mint wrappers, cables, stones, metallic wires, nuts and bolts, nails, parts from ginning machines, rubber, leather, tin, insects, etc. These are somewhat easier to remove in the spinning process. However, these can cause damage to machine parts.

The weight of extraneous contaminants (gram/ton of cotton) varies between cottons of different origins. Fibrous contaminants, which are the most difficult to remove in the spinning process, form about 60-85% of the total extraneous contaminants.

Actual data on fibrous and non-fibrous extraneous contamination in different origins of cottons are summarized in the following table II:

TABLE II: NATURE AND QUANTUM OF EXTRANEEOUS CONTAMINATION

COTTON	1999-2000		2004-2005		
	Total tons inspected	Contaminants Grams/ Ton	Total tons inspected	Contaminants Grams/ Ton	% Fibrous Contaminants
GROUP I					
AUSTRALIA	12707	1.4	6400	1.9	65
CHINA	6834	2.2	1450	3	63
BRAZIL	1089	3.2	9600	2.7	65
AM.SJV	2760	2.8	4800	2	62
AM.FIBERMAX	-	-	1950	2.6	63
AM.MEMPHIS	4136	3	6300	3.2	61
MEXICAN	2160	3.4	900	3.6	66
GROUP II					
W.AFRICA	6590	3.7	17900	7	80
ZAMBIA	-	-	300	6.5	79
UZBEKISTAN	-	-	500	9.1	82
PARAGUAY	472	5.5	1300	13.7	78
MOZAMBIQUE	-	-	500	13.3	75
GROUP III					
INDIA	382	40.1	4595	36	76
ZIMBABWE	-	-	2900	27.8	82
UGANDA	-	-	4600	19.8	83
TURKEY	200	22.1	-	-	-
PAKISTAN	475	23.3	800	27.4	80
TANZANIA	783	40.6	750	43.2	86
SYRIA	2205	98.7	835	99.2	75

The above figures on quantity of contamination per ton of raw cotton appear to be very small if we look in terms of weight. However, contamination is counted in cloth as frequency, not by the weight of the contaminants. 1 gram of fibrous contamination in a ton means 0.001% by weight, but this will be in several thousands when we calculate in numbers. If we assume an average length of 2 cm and denier of 10.0 for these fibrous contaminants, then 1 gram of fibrous contamination per ton of cotton works out to about 15,000 fibres! The lighter the fibrous contamination, the more they are in numbers and hence the harder it is to remove them.

ELECTRONIC GADGETS IN SPINNING PROCESS FOR REMOVAL OF CONTAMINATION

Spinners are forced to take action at their end to minimize the problem by providing electronic gadgets in blow room and in winding. High investments are needed for installing these electronic gadgets and highly skilled professionals needed to handle and monitor these them. When these gadgets fail or when their sensitivity changes, the results are disastrous. Further, there are limitations to electronic detection as it depends on the speed of the process & buoyancy, size and colour shade of contaminants.

Blow room:

It is true that the anti-contamination gadgets fitted to blow room line are helpful in early detection of large contaminants, thereby preventing them being pulverized in subsequent processes. However, contaminants below a certain size (1 sq.cm) cannot be detected, while majority of contaminants present in raw cotton are already below this size. Normally, about 60%-65% of the contaminants can be removed with these gadgets in blow-room. However, single fibre contaminants such as hair, fragmented feathers, tiny polypropylene fibres, etc, escape detection.

Winding:

Finer contaminants are removed to the tune (80-85%) in winding process, at the cost of significant drop in efficiency of winding & increased joints/weak points in the yarn. However, fibrous contaminants below 1 cm and with less than 5% darker shade cannot be removed. The majority of fine hair and fine polypropylene fibres still pass though and are present in the yarn.

EFFECT OF INITIAL LEVEL OF FIBROUS CONTAMINATION IN BALES ON RESIDUAL LEVEL IN YARN

Hair (animal / human hair) and fine polypropylene are the most difficult of the fibrous contaminants to deal with. Hair and polypropylene fibres are beyond the control of the spinning process, as they have the same buoyancy as that of cotton and as they can be twisted easily along with cotton fibres. Hence, it is very important to have low level of these two fibrous contaminants in the cotton

Three cotton shipments of the same origin, but with widely different level of fibrous contamination, were chosen for this study. 5 bales from each were analyzed for manually for contamination, but contaminants were not picked out. All the 3 samples were processed on the same spinning line equipped with Anti-contamination equipment in Blow room and anti-contamination yarn clearers in winding, with the closest setting possible. The comparative data on foreign fibre cuts in winding and residual contaminants in the yarn are given below for these 3 trials.

TABLEIII: FIBROUS CONTAMINANTS IN RAW COTTON VS. RESIDUAL LEVEL IN YARN (NE 30S CM)

Particulars	Sample A	Sample B	Sample C
Fibrous contaminants (gm /Ton)	7.5	4.2	1.2
% Waste at anti-contamination equipment in Blow-Room.	0.21	0.15	0.1
Foreign Fibre cuts winding /100 km	25	21	7
Residual Foreign Fibres/100 km	1.2	0.78	0.1
Nature of residual contaminant	Hair, PP	Hair, PP	Hair, PP

In our opinion, with all the electronic gadgets to arrest contamination, **a threshold level of < 1 gram of fibrous contaminants per ton** of raw cotton bales would be helpful to spinners to satisfy their customers and avoid complaints & claims, with due support from electronic gadgets in Blow room & Winding.

BEST SOLUTION - ATTACK THE CONTAMINATION PROBLEM AT THE ORIGIN:

We all know that the problem has to be tackled at the root as prevention is far superior to cure. Cotton growers, ginners and supporting organizations should take adequate measures at their end to control fibrous contamination such as hair, polypropylene, cloth pieces, yarn pieces and bird feathers, thereby reducing the burden on spinners. This problem can be handled more by commonsense than anything else. The following steps need to be taken by both growers and ginners. There is no high technology involved in obviating this problem in cotton growing, picking and ginning.

1. First of all, wipe out the opinion that presence of contamination in cotton is normal as cotton is a natural fibre. These contaminations are extraneous and not grown in the cotton plant.
2. Educate everyone down the line through visual media about the consequences of this problem.
3. Wherever manual picking is in practice, insist on 100% white cotton uniform and white picking bags for the pickers.

4. Growers should be made aware of the danger in using PP bags (of fertilizers & pesticides) for marking the fields as flags. Better to use flags of white cotton cloth.
5. After machine picking, the leftovers are collected manually by collectors. For this, invariably polypropylene bags are used. This practice should be stopped & cotton cloth to be used instead.
6. Workers in ginning factory also should use only white uniforms made out of 100% cotton fabrics.
7. Also insist on white cotton caps for the pickers and ginning workers in order to prevent hair contamination.
8. No hair cutting/ trimming should be allowed near the fields.
9. Strictly avoid animals and birds in the fields and in the storage areas near ginning.
10. Discourage cotton pickers and workers in ginning factories to bring eatables and plastic bags.
11. Use 100% cotton covers for the bales. Never use colour or white polypropylene. In case, cotton bale covers cannot be used, at least use transparent polyethylene wrappers.
12. Regularly check the actual contaminants in the cotton using manual cleaning of few random bales. It is better to know the problem at the ginning stage instead of hearing from the users.
13. Use of electronic equipment to detect and reject contamination in ginning before pulverizing the contaminants.
14. Introduce bonus for clean picking.
15. Consider contamination as one of the major quality parameters the same as effective length, micronaire and grade and further; introduce risk clauses in the contract. More risk is involved in using cotton with hair and polypropylene, than using cotton with a bit lower grade or length.

CONCLUSION:

Cotton is under constant threat from manmade fibres; presence of contamination is one of the main factors. If this not controlled at the origin, this will have serious impact on the whole cotton industry in long run, as Spinners might prefer to spin manmade fibre yarns and blends. It is high time cotton growers, ginners and supporting organizations should get together and act on this burning issue, especially to eliminate fibrous contaminants like polypropylene, coloured threads, coloured cloth pieces and hair.

ACKNOWLEDGEMENTS:

The author thanks the management of PTApac Inti Corpora for the constant encouragement given for implementation and execution of this project, and for the kind permission to present this paper. The author's sincere thanks are also due to the employees of the CCR section & QC lab of PT.Apac Inti Corpora, Indonesia for their meticulous work in collection and compilation of data.

REFERENCES:

- 1 ITMF contamination surveys 1999-2001-2003
- 2 J.T.Smith, Growers and ginnors can reduce cotton contamination, Abilene reporter news, Oct, 1997
- 3 Marinus H.J.VanderSluijs, Vijayshankar, Stuart G.Gordon, Contamination, its causes and cure, Textile Asia, Feb 2004
- 4 Philipp Schoeller, Fritz Blum, Contamination – The spinners' perspective, 27Th International Cotton Conference, Bremen, 2004.
- 5 Paul L.Hollis, Progress being made, South East farm press resources, Feb, 05

COTTON FIBRE PROPERTIES: THEIR IMPACT ON TEXTILE PROCESSING PERFORMANCE AND COSTS

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This paper briefly discusses the measurement of cotton fibre properties and the impact of changes in fibre properties on textile processing performance and quality.

Cotton, being a natural product, varies greatly in its fibre characteristics, both physical and chemical, mainly the former, due to genetic, environmental, harvesting and ginning factors. Such variability impacts on the textile processing performance (including machine stoppages and waste), costs, quality and utilisation throughout the entire cotton pipeline, from the farm to the end-product, the fibre representing between 50 and 70% of the yarn manufacturing costs. Ideally, therefore, the price of the cotton should be linked to the fibre characteristics. The relationship between cotton fibre price and properties has been investigated by Chakraborty *et al* (see Figure 1) with Deussen and Neuhaus having also advanced tables suggesting a link between cotton value/price and fibre properties.

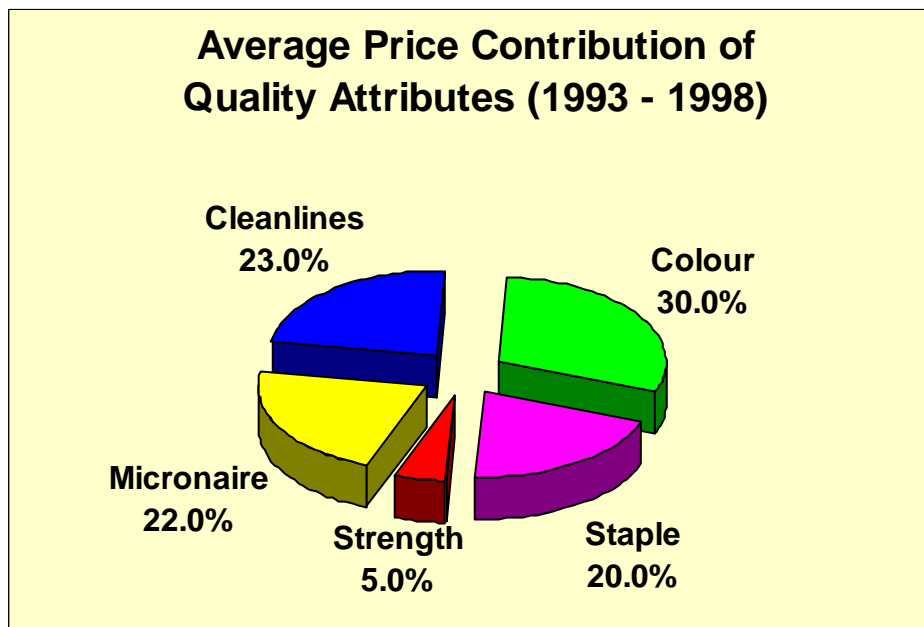


Fig. 1 (Chakraborty *et al*)

Increasing quality and performance demands are being placed on the entire textile pipeline, from raw material to end product. For example, some 20 years ago 15 non-reparable faults per 100 metres of cotton fabric were permitted, today it is five, and this may become three in future (Weissenberger and Legler), seconds also having come down from 3% to 0.5%, with 0.3% possible in future. Weaving machine stops have also decreased by 50% over the same period, some 20 to 30% of such stops being due to yarn defects, the repair of an end-break costing about \$0.70. It is known that yarn thin places with extension and strength below certain minimum limits caused weaving end-breaks, this being influenced by fibre properties and spinning mill conditions.

In view of the foregoing, it is hardly surprising that so much effort has, for over a century, gone into developing instrument methods for measuring the fibre properties (Table I), preferably on each bale of cotton, and relating the measured properties, quantitatively, to processing performance and yarn and fabric properties, so as to improve and optimise quality all-round. Tremendous progress has been made in this regard, in terms of fibre properties, a very good example being the development of the systems for the high volume testing of cotton, commonly referred to as HVI systems. There are now close on 2000 such systems in place in over 70 countries, in theory capable of annually testing the entire global cotton crop of close on 100 million bales.

In spite of the extensive research (experimental and theoretical) carried out to relate the measured characteristics of cotton to processing performance and yarn quality, no 'generic' relationships, empirical or theoretical or other means are as yet available to accurately relate cotton fibre properties to subsequent textile performance. The reasons for this include the tremendous variations in cotton fibre properties, and their interrelationships, as well as in processing conditions, and the interactions between processing conditions and fibre properties. The relative importance of the fibre properties also depends on the spinning system (Table II) and whether or not the cotton is combed and on the fineness of the yarn being spun.

This paper briefly discusses the measurement of fibre properties and the impact of changes in fibre properties on textile processing performance, quality and costs. Nevertheless, the cost implications of changes in fibre properties are complex, being not only highly mill and product dependent but also difficult to isolate and quantify, even within a mill. For example, how does one calculate the cost implications of a deterioration in yarn evenness due to a decrease in cotton fibre length and/or an increase in short fibre content? Another example is the cost implications of an increase in cotton waste due to an increase in short fibre content, taking into consideration the recycling and/or selling of waste. It has been estimated that an increase of 1% in carding waste and in blowroom waste increases yarn costs by about 1%, while an increase of 1% each in blowroom, carding, combing and spinning waste can increase yarn costs by over 3%. Hence, the cost implications of changes in fibre properties will only be touched upon.

TABLE I COTTON PHYSICAL CHARACTERISTICS OF IMPORTANCE IN TEXTILE PROCESSING PERFORMANCE, UTILISATION AND VALUE

1.	<p><u>Fibre Length</u> Length (eg UHML, 2,5% Span Length, ML, Staple Length) Length Variability (eg CV, Uniformity Index/Ratio) Short Fibre Content</p>
2.	<p><u>Fibre Fineness / Cross-Section</u> Mean (eg Mtex, micronaire) Variability (eg CV) Maturity (ratio between fibre wall cross-section and central canal) Immature / Dead Fibre Content</p>
3.	<p><u>Tensile (bundle and single fibre)</u> Mean Strength Strength Variability Mean Elongation Elongation Variability Elasticity Modulus Work-to-Rupture</p>
4.	<p><u>Fiber Colour and Dyeability</u> Yellowness (eg + b) Brightness (eg Rd) Variability in Colour (Spottedness, etc.) Dyeability (eg UV Reflectance / Fluorescence)</p>
5.	<p><u>Non-Fibrous Content / Contaminants</u> Plant Matter / Trash Mineral Matter (eg sand and dust) Organic Matter (eg Wax) Foreign Fibres (eg Polypropylene) Honeydew / Stickiness / Reducing Sugars</p>
6.	<p><u>Faults / Flaws</u> Fibrous Neps Seed Coat Neps</p>
7.	<p><u>Crimp / Undulations / Convolutions / Bulk</u></p>
8.	<p><u>Friction</u></p>

TABLE II ORDER OF IMPORTANCE OF FIBRE PROPERTIES FOR DIFFERENT SPINNING SYSTEMS

Order of Importance	Ring	Rotor (open-end)	Air-jet	Friction
1	Length and Length Uniformity	Strength	Fineness	Friction
2		Fineness	Cleanliness*	Strength
3		Length and Length Uniformity	Strength	Fineness
4		Cleanliness*	Length and Length Uniformity	Length and Length Uniformity
5			Friction	Cleanliness*

* Trash, dust, etc. (Deussen, H.)

THE MEASUREMENT AND EFFECT OF COTTON FIBRE PROPERTIES

General

The initial cotton fibre instrument measurement (laboratory) systems, developed during the first half of the 20th century (e.g. Pressley tester in the early 1940s and the Stelometer and Colorimeter in the early 1950s), tended to be time consuming and to be fairly operator dependent, and it was increasingly realised that what was ultimately required were systems, preferably automatic or even on-line, whereby all relevant fibre characteristics could be measured accurately, rapidly and cost effectively, with little operator involvement. Nevertheless, it took many decades before this goal was reached. A major step in this direction was the development of the High Volume Instrument (HVI). From its development in the late 1960s, commercial introduction in the late 1970s and first use for cotton classing in the early 1980s, the high volume testing of cotton has made enormous strides and has become widely accepted globally. Despite certain shortcomings it remains the only method for the wide scale and cost-effective testing and classing of the global cotton crop.

The latest generations of high volume testing systems can test for all the traditional HVI measured properties, plus short fibre content, neps, seed coat neps, stickiness, maturity and moisture content as well as additional colour parameters (separately from those of trash and other contaminants), although in some cases, this is accompanied by a loss in testing speed and further improvements are still required, particularly in terms of the measurement and characterisation of trash. It can safely be said that the lint characteristics routinely measured by high volume systems today account for the bulk, but not all, of the variations in the textile processing behaviour and yarn quality of cotton. Nevertheless, the accuracy and reproducibility of the test

results for some of the abovementioned properties have not as yet achieved the levels required by industry. A problem today is the different generations (hardware and software) and makes of high volume systems in place worldwide, and the reproducibility and agreement of the results they produce, although the use of universal calibration procedures and materials (cotton, tiles, etc) as well as participation in round trials (USDA and Bremen) provide some safeguards in this respect. Results of the various inter-laboratory round trials are reassuring but do not exclude the possibility that some systems may be testing consistently “out of tolerance”. One way to overcome this particular problem would be to introduce a “certification scheme” whereby only laboratories with test results falling within the pre-set tolerances are allowed to use the certification mark. Such certification schemes are already widely used and highly regarded for wool (Interwoollabs) and mohair (Mohairlabs) and highly commendable efforts are afoot by the ICAC in the form of its newly established CSITC in collaboration with the ITMF, USDA and Bremen Fibre Institute, to introduce something similar for cotton trading purposes

The ultimate aim is to eventually be able to measure once only, on an accurate, routine, rapid and cost-effective manner, all those cotton characteristics (Table I) which determine processing route and performance, product quality, utilisation and application and ultimately the commercial value, and then to be able to quantitatively relate these properties to the subsequent textile processing performance, utilisation and quality, on a mill specific basis. These results so generated should accompany the bale until it reaches its final destination.

Another important and popular development relates to the rapid individualised fibre measurement systems for cotton (e.g. electro-optical systems, such as the AFIS), enabling the laboratory measurement of properties, such as length (including short fibre content), neps (fibrous as well as seed coat), trash, dust, fineness and maturity (also immature fibre content, $\theta < 0.25$), and their respective distributions. For example, there are now some 760 AFIS systems in place worldwide. The advantage of such systems is that they supply more detailed information, even down to the individual fibre level, also covering properties presently not measured by high volume systems. The main drawback of these systems, in terms of the routine high volume testing of cotton for classing and trading purposes, is their relative slowness, although higher speed systems are now making their appearance.

The application of NIR, and other parts of the electromagnetic spectrum, for the measurement of certain cotton properties (e.g. maturity, stickiness and moisture content) also represents a potentially promising field of research. Such measurement systems, being non-contact and non-destructive, lend themselves to on-line applications, as well as to being extremely rapid and versatile.

Micronaire

Micronaire was one of the first cotton fibre properties the importance of which was recognised and it was also one of the first cotton fibre properties measured by instrument using the airflow principle. Micronaire is generally used as a measure of maturity, which is true for a specific cotton variety (cultivar) and region. Nevertheless,

more generically speaking, it is a function of both maturity and fineness, which affect textile processing and quality independently and differently. It is therefore important, particularly when different cotton varieties and growing regions are involved, to measure maturity and fineness separately, and these will be discussed separately below. Nevertheless, some research has indicated that, for Upland cottons, micronaire was as good as, if not better than, maturity in predicting yarn quality and dyeability. Chellamani *et al*, for example, found the following relationship between colour difference (ΔE) and difference in micronaire and immature fibre content:

$$\frac{I}{\Delta E} = 2.064 - 0.552 (\text{micronaire difference}) - 0.025 \times \text{immature fibre content}$$

Where micronaire alone is measured, its importance lies in the fact that it affects processing waste (lower micronaire fibres break more easily during mechanical action), neps (lower micronaire fibres are generally more flexible and entangle more easily to form neps), short fibre content, spinning performance, yarn and fabric quality, dyed fabric appearance and neppiness in particular. Lower micronaire cottons also tend to become more easily entangled around particles of trash and leaf, thereby increasing the amount of good fibre removed. These effects impact directly and indirectly, affect on processing performance and product quality and costs. Lower micronaire cottons also need to be carded slower. Neps can interfere with drafting, resulting in end-breakages during spinning. Micronaire levels within a lay-down or mix should also not vary unduly (by more than 0.2 units) or else it could lead to streakiness or barré due to differences in dye shade. It is generally considered that both too low and too high micronaire cottons should be avoided, the ideal range being between about 3.8 and 4.2 for American Upland type cotton. Nevertheless, micronaire values below 3.8 would be preferable provided the cotton is mature, particularly for rotor spinning.

Maturity

Maturity can be defined as the relative wall thickness, and it generally has a greater effect on fabric appearance and defects than any of the other fibre properties. It is commonly measured by the double compression airflow test, although single fibre measurement (e.g. AFIS) are used for more detailed information, including maturity distribution and the presence of immature and dead fibres. Different means of expressing maturity are in use, the two most popular being the percentage maturity (Pm) and maturity ratio (M), a level of at least 0.9 (preferably 0.95) for M and 80% for Pm being desirable. Cotton fibre maturity greatly affects nep formation, dye uptake and dyed appearance. Variations in maturity within a yarn batch or fabric can lead to streakiness and barré due to differences in dyed appearance. It is, however, not only the average maturity which is important but also the distribution of maturity. A small percentage of immature or "dead" fibres may not significantly affect the average maturity but could significantly affect the yarn and fabric appearance, notably in terms of neppiness and white flecks which can comprise only about 0.5% (by weight) of fibres. The lighter appearance of dyed immature fibres is mainly due to their flat and ribbon like non-uniform shape and the shorter path-length the light takes through the thinner dyed wall, rather than due to a lower dye uptake, with the difference in

light reflectance characteristics from the “flat” fibre surfaces also playing a role (e.g. “shining neps”). Nevertheless, the rapid desorption of dye from immature fibres may also play a role. Scouring and finishing losses are also greater for immature cottons, because their non-cellulosic contents are higher. Fibre maturity also affects lustre. Immaturity can also be associated with stickiness and roller lapping due to excessive plant (reducing) sugars, particularly under high humidity conditions. Combing is known to preferentially remove relatively immature and fine fibres.

Fineness

Cotton fibre fineness per sé has an affect on many aspects of processing performance, including spinning performance, and yarn and fabric quality. It is measured by double compression airflow tests as well as by single fibre ‘optical’ measurement systems such as the AFIS. Finer fibres, being more flexible and buckling more easily, entangle more easily to form neps, break more easily to create more short fibres and fibrous waste, but improve spinning performance and yarn evenness, and strength, mainly through the effect of the greater number of fibres in the yarn cross-section, this being particularly important for very fine yarns and for the rotor (open-end) and air-jet spinning systems. The spinning limits, in terms of the number of fibres in the yarn cross-section, are 100 or more for rotor, friction and air-jet spinning and about half that for ring spinning. Finer fibres also enable lower roving and yarn twists to be employed, as well as that required for maximum yarn strength. Finer fibres also lead to yarns and fabrics which are more flexible (less stiff) and which have a softer handle, with fabric air-permeability inversely related to fineness. The ideal, particularly for rotor spinning and fine yarns, is a very fine (< 150 mtex) but fully mature fibre.

Length and Length Uniformity

Length, length uniformity and distribution, including short fibre content, are probably the most important cotton fibre properties, although their importance does depend somewhat on the spinning system used (e.g. ring, rotor, air-jet, friction (Table II)). Cotton fibre length characteristics are probably the best criterion of ring spinning performance and spinning limits and often also of yarn strength. An increase of 1mm in fibre length increases yarn strength by some 0.4 cN/tex (Frey, M.) or more. The Staple Length, Upper Half Mean Length (UHML) and 2.5% Span Length all provide similar, but not identical, measures of the length of the bulk of the long fibres in a sample and approximate the length of the fibres when carefully detached from the seed by hand. They are measured by HVI and other similar systems, as well as by slower single fibre measurement systems, such as the AFIS. These measures are useful for setting drafting roller distances, with the UHML increasingly being measured by high volume systems and adopted for trading purposes, a length above 28mm being desirable in most cases, although this depends upon the spinning system and yarn count. The Mean Length (ML) or 50% Span Length is generally regarded as providing a better measure of spinning performance and yarn quality. Longer cottons, which are often also finer, are generally more prone to form neps during carding and are therefore often carded at lower speeds and also combed to

remove neps and to even better align the fibres. Longer fibres also enable lower roving and yarn twists and higher ring spinning speeds to be employed, also producing finer, stronger, more even and less hairy yarns, as well as stronger fabrics with better appearance.

Excessive fibre length variation (e.g. CV of Fibre Length, Uniformity Ratio or Uniformity Index) tends to increase manufacturing waste and to adversely affect processing performance, including spinning performance and yarn quality. The inverse of length uniformity also provides a measure of floating fibres within the drafting zone, although the Short Fibre Content (SFC) is a better indicator of the floating fibres. SFC is generally defined as the percentage, by weight, of fibres shorter than $\frac{1}{2}$ " (12.7mm). SFC by number is, however, considered a more sensitive measure of processing conditions and is used to optimise such. Although the Uniformity Index is typically, and accurately, measured on high volume systems, it, on its own, does not provide an accurate measure of Short Fibre Content. A Uniformity Index of above 83% and Uniformity Ratio above 48% are desirable, although it depends upon the spinning system and yarn count.

An increase in SFC increases spinning end breaks, processing waste (including comber noils), fly and optimum roving twist and causes deterioration in yarn and fabric properties, notably yarn strength and evenness. An increase of 1% (absolute) in SFC can decrease ring-spun yarn strength by 1% or more. Fabric strength and abrasion resistance also tend to deteriorate with an increase in SFC. Although there has been an improvement in the measurement of SFC by high volume instruments, it is not yet regarded as entirely satisfactory. Differences in SFC and other measures of fibre distribution can exist between different instruments. An SFC below 8% (by weight) is desirable although the SFC level is generally a function of the staple length (UHML).

Strength

Cotton fibre strength is generally measured on fibre bundles, as opposed to single fibres, at either zero-gauge or $\frac{1}{8}$ " (3.2mm) gauge, with the latter increasingly being measured and accepted worldwide as a better indicator of yarn and fabric strength than the former. High volume systems provide a reasonably accurate and reliable measure of cotton fibre strength. Although cottons with good strength usually give fewer problems and neps during processing than weaker cottons, cotton fibre tenacity per sé does not play such an important role in processing, except probably in rotor spinning where it can improve spinning performance, particularly when spinning fine yarns. It is important to note, however, that in absolute terms, (i.e. cN) finer and less mature cottons are weaker than coarser and more mature fibres, but when strength is expressed in terms of tenacity (cN/tex or gf/tex), i.e. corrected for fibre cross-section or fineness, then this affect largely disappears. Clearly, finer, and therefore weaker, fibres will be more inclined to break during processing, but when converted into yarn of a constant linear density, will produce a stronger yarn because of the greater number of fibres in the yarn cross section. It is therefore always important to make a distinction between absolute fibre strength (i.e. uncorrected for cross-section or fineness) and fibre tenacity (corrected for cross-section or fineness).

Even in terms of spinning performance, the effect of fibre tenacity is small, whereas fibre tenacity is virtually linearly related to yarn and fabric strength, all other factors being constant. Fibre tenacity is particularly important for rotor spinning. At optimum yarn twist, fibre tenacity has a greater effect on yarn tenacity than any other fibre property, strength utilisation being typically 50 to 60% for rotor yarns and 60 to 70% for ring yarns, an increase in fibre strength of 1 cN/tex increasing yarn strength by some 0.5 cN/tex or more. A bundle tenacity above 30 cN/tex (HVI level) is generally desirable.

Elongation

Generally fibre elongation is measured at the same time as fibre strength, although there is still some improvement required in the high volume testing of elongation. An increase in elongation is associated with an increase in yarn and greige fabric elongation and nep formation, the relationship between yarn elongation and fibre elongation being a function of fibre length and yarn twist and linear density. Yarn elongation significantly affects weaving efficiency. An increase in fibre elongation can sometimes reduce spinning end breakage and yarn strength, a level above 7% being desirable.

Colour

It is important not only to measure average colour, but also colour variability, including spottedness, since this can impact on processing and dyeing performance and fabric appearance. Cotton is generally white when the boll opens, but continued exposure to weathering and micro-organisms can cause the cotton to lose its brightness and to become darker. Cotton may also become discoloured or spotted by the action of insects, fungi, plant diseases and soil stains or when killed by frost or drought. Reducing sugars and storage under high humidity conditions can cause yellowing. Colour is generally measured by instrument, in terms of its greyness, reflectance or brightness (Rd) and yellowness (+b), although there is a move towards the CIE colour values with trash having some affect on the measured values. Colour per sé has little effect on processing but affects dyeing and finishing, with bleaching often able to reduce, or even eliminate, differences present in the raw cotton. Differences in colour after bleaching do not necessarily correlate with colour differences after dyeing. Typically +b is about 9.0 and Rd 75%.

Preparation

This property, which indicates the appearance of the cotton after ginning, as a consequence of the treatment which the cotton received during harvesting and growing, cannot, as yet, be measured by instrument. Preparation can have an affect on processing waste and yarn quality.

Neps

Neps consist of either an entanglement (cluster) of fibres (typically 16 fibres), with or without foreign matter (e.g. trash or seed coat fragments) as a core. Although neps are related to fibre properties, such as maturity, including maturity distribution and “dead” fibres, harvesting, ginning and mechanical treatment (processing) conditions in the spinning mill significantly affect nep levels. There is therefore a need for a separate test for neps, many instruments being available to do so, but few, if any, are rapid enough for high volume classing purposes. It is also important to be able to separately measure the different types of neps, e.g. seed coat neps and fibrous neps. Neps lead to yarn and fabric imperfections and unevenness and also to spinning end breakages, being responsible for up to 50% of yarn imperfections, seed coat fragments being particularly problematic.

Trash (Non-lint) Content

Both the nature (type) of trash as well as the quantity of trash is important in determining processing behaviour and performance and waste levels. Trash content can be measured by various instruments (e.g. Shirley Analyser, AFIS, MDTA) as well as by high volume systems, but the latter do not, as yet, provide a satisfactory means of doing so, and also does not measure dust, providing a measure of trash area and number (count) and Leaf Grade. Sophisticated systems, using image analysis and colour differentiation, have been developed to more accurately measure trash levels and type.

Trash content is directly and indirectly related to processing waste, the removal of trash being associated with both fibre breakage and the removal of fibres as waste as well as nep formation. These in turn can considerably affect spinning performance, particularly rotor spinning, and yarn quality, air-jet and friction spinning require even lower levels of non-lint content than rotor spinning. Fabric and yarn appearance can also be adversely affected by trash which is not removed during processing. Trash and dust content can have a particularly adverse effect on rotor spinning performance and yarn properties, since it causes a build up of deposit in the rotor groove which interferes with yarn formation, and therefore end breaks and yarn quality. Seed coat fragments, with tenaciously clinging fibres, are an important cause of yarn faults, also adversely affecting spinning and yarn performance.

Respirable dust, or agent(s) associated with the dust, also create health problems and lead to byssinosis. Fine particles of trash can also form the nucleus for neps. Microdust can also affect the wear of spinning components, particularly for the newer spinning systems, such as rotor, friction and air-jet, and also clog the rotor groove and air-jet nozzles.

Foreign matter and other contaminants, such as plastic materials, can have a very harmful factor on quality, not only adversely affecting processing performance, notably spinning, but also showing up as faults in the fabric, particularly after dyeing, ITMF studies indicate that claims due to contamination amount to between 1 and 3% of total sales of cotton and cotton blend yarns.

Wax Content

Cotton wax, usually measured by solvent extraction, which is mainly on the fibre surface and in the primary wall, has a beneficial effect on mechanical processing. The amount of wax per unit surface is fairly constant, and finer cottons therefore contain more wax per unit mass (weight) than do coarser cottons. Wax affects wetting behaviour and should be removed where good wetting is required, such as in towels. Such removal can beneficially affect yarn strength but adversely affect fabric crease recovery, flex abrasion and tear strength. Excessive wax can sometimes also cause problems with stickiness and roller lapping. In most cases the wax on the fibre makes it unnecessary to apply oils or lubricants to facilitate mechanical processing, but any wet treatment applied prior to processing can affect this deleteriously.

Friction

Fibre friction is important in determining mechanical processing behaviour and performance as well as yarn quality, strength in particular (fibre to fibre friction). Cotton fibre friction does not vary greatly, being determined by the cotton wax and any chemical (wet) treatments applied to the fibre. No suitable practical test for fibre friction is available, probably the measurement of cotton fibre surface wax levels, e.g. by NIR, represents the best approach to obtain a rapid, though indirect, measure of cotton fibre friction. Cotton wax enables cotton to be processed trouble free on most systems.

Ultra-Violet Fluorescence

Variations in the ultra-violet (UV) fluorescence, within and between bales of cotton, could signify potential dye variation and fabric streakiness, particularly when dyeing pastel shades. Such differences in UV fluorescence could be due to differences in ageing, weathering, contaminants, light exposure, mildew attack and heat treatment.

Dyeability

Dyeability is important, particularly in terms of streakiness and white specks, being related to micronaire, maturity, colour and fibre structure, some 70% of yarn-related dye problems being due to the fibre. The control of the first mentioned three properties will largely control dyeability, although there is still a need for a rapid test for dyeability (e.g. by means of UV or NIR).

Stickiness

Sticky cotton causes roller lapping and can have a very large adverse affect on processing performance, including both ring and rotor spinning. It may be caused by excessive quantities of plant sugars on immature cotton, but more often than not (80%) by honeydew (a sugar-containing sap secretion from insects, such as aphids

or whiteflies), by high wax levels or even by additives or contaminants (e.g. pesticides). Cotton-seed oil, from seed-coat fragments and seed motes, could also be related to stickiness problems. Storage and low levels of humidity during processing as well as certain additives (e.g. water, enzymes, surfactants and lubricants) can reduce certain stickiness related problems. Various tests are used for measuring stickiness, including:

- Mini-card
- Thermo-detector
- Crush-rollers and Image Analysis
- pH
- Chemical/reducing sugar content* (e.g. Clinitest, Perkins Method, Benedict Test and Fehling Tests)
- HPLC
- Discolouration upon heating

*Provides a measure of non-honeydew related stickiness

Nevertheless, there is a need for a rapid (high volume) means of measuring stickiness, (e.g. NIR) this being complicated by the “non-uniform” and “localised” (spotty) nature of stickiness and the low levels and different types of contaminants which can lead to stickiness problems.

Crimp and Bulk

Fibre crimp can be expressed in terms of crimp frequency and amplitude, as well as in terms of de-crimping force and crimp extension (crimp per cent). Cotton fibres vary in crimp (or undulations) and bulk but there is little evidence that the variations in crimp generally encountered in practice, have a significant effect on cotton processing performance and yarn quality. A high recovery from compression is regarded as a pre-requisite for good carding.

Stiffness, Elasticity, Modulus and Work-to-Break

Often the ratio of bundle tenacity to bundle elongation is taken as a measure of stiffness, stiffer fibres being less prone to buckle or entangle and form fewer neps during carding. A better measure of stiffness would be the ratio between the absolute fibre strength (cN) and elongation as this would allow for the substantial effect of fibre fineness on stiffness and nep formation.

Work-to-Break, Elasticity and Modulus can be estimated from high volume measured results, but the magnitude and importance of variations in these properties in practice still need to be established.

REFERENCES

Chakraborty, K., Ethridge, D. and Misra, S., Proc. Beltwide Cotton Research Conferences, 374 (2000).

Chellamani, K.P., Arulmozhi, M. and Kumarasamy, K., Indian J. Fibre Text. Res., 26, 296 (Sept., 2001).

Deussen, H., Schlafhorst Dokumentation No. 10 (1984).

Deussen, H. and Neuhaus, L., Schlafhorst Dokumentation No 21 (1988).

Frey, M., Mell., Textilber., 76, 787 and E 194 (1995).

Weissenberger, W. and Legler, F., Text. Month, 41 (July, 1995).

IMAGE ANALYTICAL FIBRE LENGTH MEASUREMENT

PART 1

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PART 2

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ABSTRACT

Within the framework of a research project carried out by the Institute of Textile Technology and Process Engineering (ITV) Denkendorf and Faserinstitut Bremen (Bremen Fibre Institute, -FIBRE-), methods based on image analysis were developed which allow to determine the length distributions and the short fibre content of cotton samples. The method developed by FIBRE is a semi-automatic reference method based on the automatic marking of the fibres with manual control during image analysis. The method developed at ITV aims at the automatic opening to single fibres, imaging and measuring of the fibres in dynamic state.

PART 1

INTRODUCTION

With instrumental cotton classification based on high-speed, integrated test instruments (Standardised Instruments for Testing of Cotton - SITC resp. High Volume Instruments HVI¹), key characteristic values such as micronaire, length, length uniformity, strength and colour can be obtained with reliable test results². Further characteristic values, e.g. short fibre and trash content or the degree of maturity are, despite their importance for the yarn production, only rarely used by trade or in spinning mills due to the fact that it is difficult to achieve reliable test results.

Short fibres do not contribute to yarn strength, tend to build neps during processing, reduce yarn evenness, and lead to fibre fly on the processing machines in the spinning mill and in downstream processing. They practically mean a loss for the spinning mill and a quality reduction to the yarn.

While fibre length measurement shows high reproducibility, the results of the Bremen Round Trial show dramatic deviations among the involved laboratories in determining the short fibre content with respect to all standard measuring methods such as AFIS, Almeter or high volume test devices (SITC).

¹ Registered trademark, USTER

² Choice of the ICAC Task Force on Commercial Standardization of Instrument Testing of Cotton, CSITC

Table 1.1: Interlaboratory variation of length test results, expressed in the interlaboratory coefficient of variation (average of 20 Bremen Round Trials, expressed in %).

Instrument	Result	Mean Interlab. CV
HVI	UHM	1,6
	UI	1,1
	SFI	31,6
Almeter	ML (N)	7,6
	CV (N)	13
	SFC (N)	36
AFIS	ML (N)	5,4
	CV (N)	8
	SFC (N)	18,2
	ML (W)	3,3
	CV (W)	6
	SFC (W)	21,8

Results based on Bremen Round Trials 1997 to 2001

In order to obtain more reliable length measurement especially in the range of short fibres, the project 'Short Fibre Length Measurement' was carried through within the framework of the AiF-project 13488N: "Development of a practice-oriented method for short fibre measurement using image analysis".

The aim of the project can be divided into two parts: the first one was the development of a technology for single fibre opening without fibre damage as a basis for an automated method for fibre length measurement based on image analysis – a method to be developed, too. This part of the project was carried out by ITV Denkendorf and will be described in Part 2 of this presentation.

With an automated length measurement on not perfectly drafted and aligned fibres, it is unavoidable to be exposed to significant systematic influences on the results. From this follows the second aim of the project: The development of a valid, reference method based on image analysis. This reference method can be used to verify/correct the results of the automatic image analysis method and to be a general basis for the other length measurements, too, as it is calibrated with basic physical length standards and does not need any natural fibre or artificial standard test samples. This part of the project was carried out by Bremen Fibre Institute (-FIBRE-) and will be described in this Part 1 of the presentation.

BACKGROUND: COTTON FIBRE LENGTH MEASUREMENT

Types of Length Measurements and Systematic Distinction

There are several different methods for fibre length measurements, and the results can only be compared to a limited extent. For analysing the length measurement methods, some distinctions have to be considered to form a systematic structure:

1. The degree of straightening of the fibres
2. Measurement of single fibres or fibre collectives („beards“)
3. Alignment of fibres in the collective/beard
4. Measurement of the total fibre lengths (= Staple Length) or partial fibre lengths (= Span Length)
5. The mathematical basis of the distribution diagram
6. The used presentation of the characteristic data
7. The way of calibration

As soon as test methods for length belong to different degrees of straightening of the fibres, different alignments or different mathematical bases of the distribution, the results will not match to each other, but will certainly show correlations, nevertheless.

1) Referring the degree of straightening of the fibres, the following degrees have to be distinguished:

- curved fibres
- aligned fibres (without stretching)
 - AFIS
 - Almeter
 - Fibrograph / SITC (Uster HVI, Premier ART, Lintronics)
- stretched fibres (without any crimp)
 - manual two-tweezers method
- elongated fibres (by stretching and additional force – this has to be avoided)

2) Fibres might be measured:

- individually
 - AFIS, two-tweezers method
- or in a fibre collective (fibre beard)
 - Fibrograph, SITC, Almeter, comb sorter, aQura

Measurements on fibre collectives will need less time for measurement, but will cause uncertainties in the results.

3) In fibre collectives / beards, the fibres can be:

- end aligned
 - (Almeter, comb sorter, aQura)
- without end alignment
 - Fibrograph, SITC

These different ways of fibre alignment cause differences in the time needed for the fibre preparation – and they result in different characteristic data.

4) The results for single fibres and end aligned fibre collectives are measurements of the total fibre lengths (typically “staple length” results). In contrast, the results for collectives without end alignment are partial fibre lengths (typically “span length” results). Whereas staple length results are based on the real fibre length, span length results are derived from the clamping of the fibres in the drafting process in the spinning mill. Theoretically it is possible to derive span length results from staple length results and vice versa, but practically it always has to be respected how the

fibres have been prepared and measured – with their total lengths or with their partial fibre lengths.

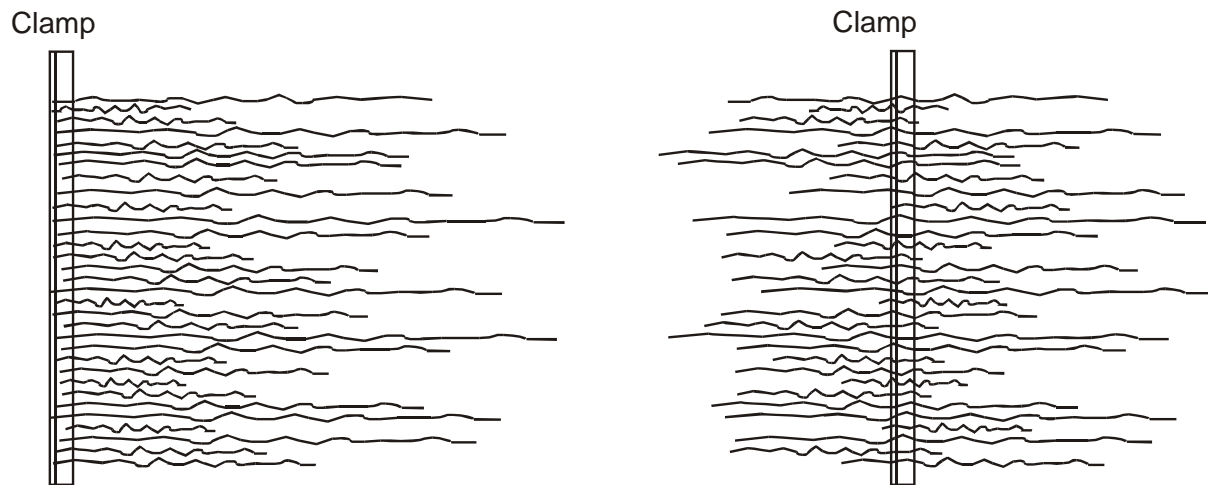


Figure 1.1: Fibre collectives for measurement: end aligned (left) and without end alignment (right)

5) A differentiation that is difficult to understand is the mathematical basis for the class frequencies in the fibre length distributions:

- Length distribution by number
 - Each fibres is counted/weighed the same
 - Example: AFIS, two-tweezers method
- Length distribution by cross section
 - More coarse fibres count more than fine fibres
 - Example: Almeter
- Length distribution by length
 - Each fibre counts with its length, so a fibre with double length (1.6'') counts double compared to a fibre with the shorter length (0.8'')
 - No typical example; can be derived from the length distribution by number
- Length distribution by weight
 - Each fibre counts with its weight, so longer and more coarse fibres will be weighed more than shorter resp. more fine fibres.
 - Example: comb sorter

One differentiation is well known for length and short fibre results measured with AFIS or Almeter. Both are typically named as Length by number / SFC by number resp. Length by weight / SFC by weight. In contrast to this, the correct wording based on the measurement is:

- for Almeter: SFC by cross section or SFC by weight
- for AFIS: SFC by number or SFC by Length

A conversion between these different presentations of the class frequencies is only possible with some simplifying assumptions and is therefore critical.

6) Based on the detected raw data of the length measurement, different characteristic results can be defined. A classical example is the measurement with the Fibrograph or SITCs (HVI, ART). In fig. 1.2 the typical evaluation of span length and so called staple length results from a fibrogram is shown.

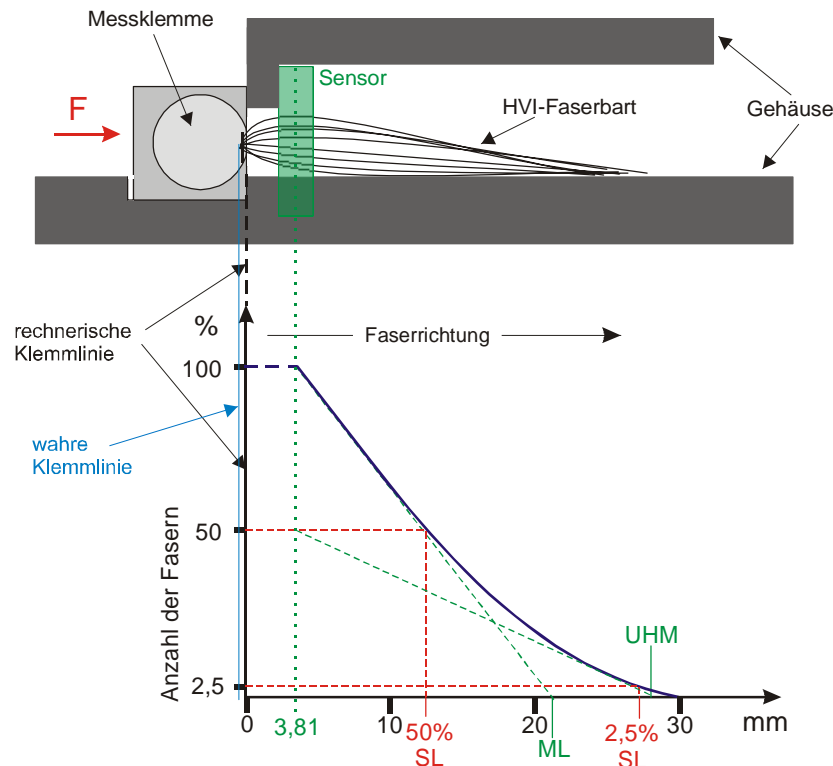


Figure 1.2: Evaluation of span length and so called staple length results from a fibrogram (based on fibre beards without end alignment)

7) Last but not least is the difference in calibration.

- Calibration with physically basic length standards
 - two tweezers, comb sorter
- Calibration with natural fibre standards or specific artificial test samples for the given fibre testing instrument
 - Fibrograph/SITC, Almeter

Only test methods with the first way of calibration can be used as reference methods for length measurements.

Besides this numeration of theoretical distinctions, it is possible to name and distinguish existing test instruments. A choice of instruments and their classification according to the above mentioned distinctions are:

- Two-tweezers method
 - Measurement of the stretched fibres
 - Measurement of single fibres
 - Measurement of the total lengths of the fibres
 - Length distribution by weight

- Calibration with basic length standards
- Uster AFIS
 - Aligned fibres / single fibres / total lengths / distribution by number / calibration with natural fibre standards
- Premier aQura
 - Aligned fibres / end aligned fibre collectives / total lengths / distribution by cross section
- SITC (Uster HVI, Premier ART, Lintronics) and Fibrograph
 - Aligned fibres / fibre collectives without end alignment / partial lengths / distribution by – not to be assigned – / calibration with natural fibre standards
- Comb Sorter
 - Aligned fibres / end aligned fibre collectives / total lengths / distribution by weight / calibration with basic length standards
- Almeter
 - Aligned fibres / end aligned fibre collectives / total lengths / distribution by cross section / calibration with specific artificial standards

The image analytical based fibre length measurements in this presentation can be described in the following way:

- Measurement of the stretched fibre lengths on curved fibres
- Measurement of single fibres
- Measurement of the total lengths of the fibres
- Length distribution by number
- Calibration with basic length standards

Recapitulating, it can be seen that there is an unmanageable number of different test results, each based on different ways of measurement. It can be seen that it is not possible to talk about any length test result without regarding the underlying test method / test instrument.

Typical characteristic results for the determination of the short fibre content are:

- AFIS
 - Short Fibre Content (SFC) by number
 - Short Fibre Content (SFC) by Length (erroneously “weight”)
- Almeter
 - Short Fibre Content (SFC) by cross section (erroneously “number”)
 - Short Fibre Content (SFC) by weight
- Fibrograph/ SITC/ Uster HVI / Premier ART/ Lintronics
 - Short Fibre Index SFI

Reasons for Measurement Uncertainties in the Fibre Length and Short Fibre Content (SFC) Measurement

As shown in table 1.1, the reproducibility of basic fibre length results is sufficient. But the variability for short fibre results is unacceptable.

Systematic differences between different types of instruments (like described in the last chapter) lead to different results. Figure 1.3 shows the systematic differences between different short fibre results based on the Bremen Round Trial.

High variability between different instruments of the same instrument type will be either unsystematic or systematic. Unsystematic differences result from

- inhomogeneous raw material
- insufficient precision of the test instruments
- non adequate work of the operators
- and from statistical reasons (see below)

Systematic differences between instruments of types of instruments are caused by:

- individual test procedures of different laboratories or operators
- machine based or maintenance based effects

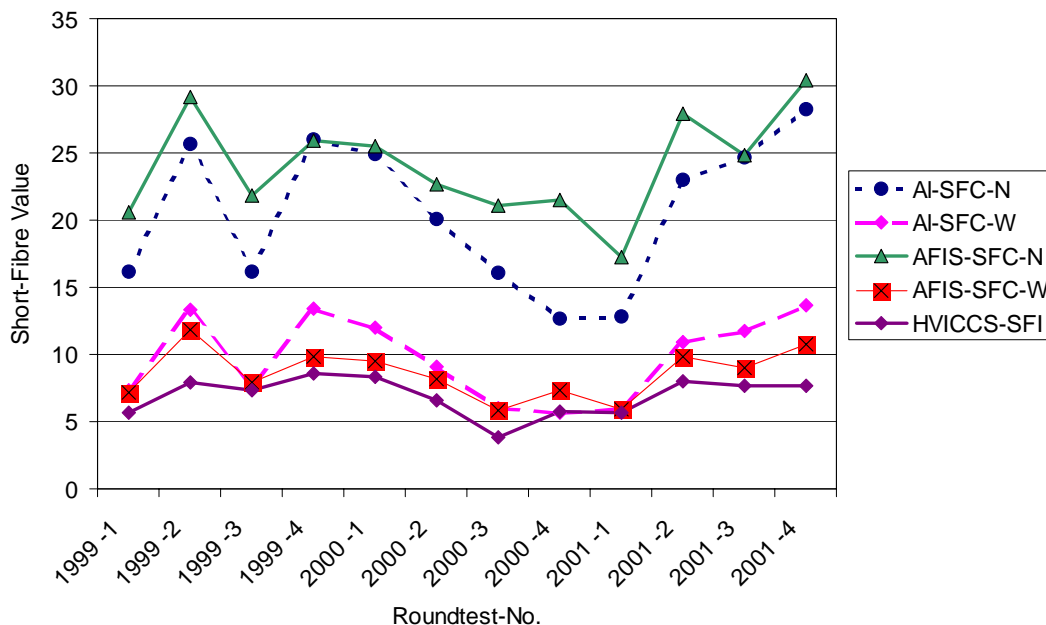


Figure 1.3: The comparison of the results of different test methods for the Short Fibre Content / Short FIBRE Index (based on the Bremen Round Trials) show constant differences in their results.

Allan Heap showed with simulation calculations that, solely based on statistical reasons, the variability of the SFC is 3 times higher than the variability of typical length results as the Upper Half Mean [Heap 2004].

An evaluation of the SFC results based on the Bremen Round Trial shows not only unacceptably high variation, but additionally a high degree of systematic deviations of the participating laboratories from the interlaboratory average. Figure 1.4 for the Almeter shows for nearly all laboratories either strictly too high or strictly too low

results (noticeable on the ratio between the deviation and the absolute deviation tending to 1). The same can be found for AFIS.

Concluding, it is premature and incorrect to either condemn only the given measurement instruments or on the other side to entitle the inhomogeneity as the only reason for the variation of the SFC results. A reduction of the variability based on inhomogeneous material can be achieved by a higher number of tests with the according effort. Systematic deviations between the laboratories will have to be reduced by more intense measures for the harmonisation of instrument testing.

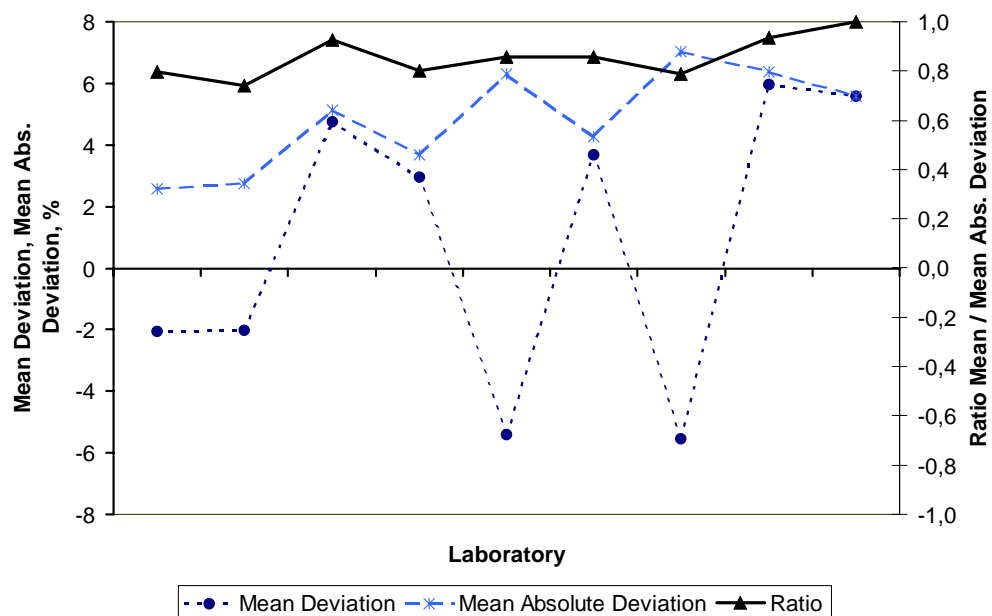


Figure 1.4: In the Bremen Round Trial, laboratories participating with Almeter instruments show lasting systematic deviations from the interlaboratory average (noticeable on the ratio between the deviation and the absolute deviation tending to 1). The same can be found for AFIS.

DEVELOPMENT OF AN IMAGE ANALYSIS BASED REFERENCE TEST METHOD

Requirements

For the development of the reference test method, the following requirements were regarded as boundary conditions:

- Calibration of length as basic parameter
- No further adjustment correction, e.g. by calibration with standards of natural fibres
- Reduction of fibre preparation to reduce/exclude bias caused by the operators
- Determination of complete and unbiased fibre length distribution > 4 mm

- Evaluation of true fibre length distribution covering the whole cotton fibre length range

Additionally, the reference method should be automated in such a manner that – while observing the complete and real measurement of all fibres – sample preparation and testing time are kept to a minimum. The requirements mentioned above do not allow an automated tracking because the automated detection leads to systematic falsifications. Therefore, the aim was to develop a semi-automated system where the fibres are pre-marked by the system and the course of the fibres is subsequently confirmed, completed, and corrected by the tester.

Sampling and Sample Preparation

At first it has to be mentioned that the sampling and the sample preparation affect the test results significantly. A very common falsification of the length test results is given by giving a systematic emphasis on the long fibres during sampling. Due to this reason, a defined way of sampling was developed and described in the project, as well for flock material as for sliver.

For measuring fibres with image analysis systems, the fibres have to be individualised. During this time consuming action, it is difficult and even more time consuming to avoid all overlappings of fibres or fibre loops. The developed image analysis method therefore allows for overlappings and loops. But in order to avoid misreadings, it is inevitable to check the automatic fibre tracking manually. Therefore the method is called semi-automatic method.

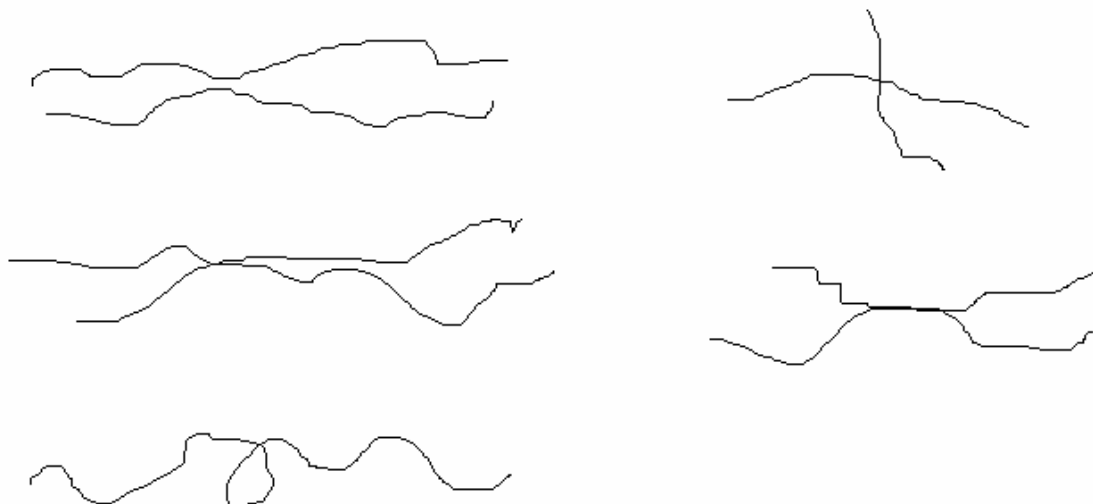


Figure 1.5: Position of fibres prepared for measurement

- left/above: quasi-parallel arranged fibres without overlappings
- left/central: simple overlapping
- left/down: loop
- right/above: automatically identifiable overlapping
- right/below: not automatically identifiable overlapping

For the individualisation a measuring field with maximum surface area is preferred. But since the area of the measuring field determines the image file size and the necessary time for the measuring process, a measuring field of min. 50 x 70 mm was specified to put the separated fibres on the surface. On this area, approx 30 to 60 fibres can be placed separately. An image of this area needs, based on 1200 dpi resolution, a memory of approx. 8 MB.

Image Acquisition

For the detection of single fibres, the necessary resolution is given as soon as the fibre is always completely covering one pixel; for this the resolution has to be higher than 5000 dpi. This resolution causes very large image files that result in a long duration for the evaluation of the results. It could be proven that – as in the case of average cotton fibre diameters of 12 μm and thin places down to 8 μm – a resolution of 1200 dpi is sufficient in order to track the fibres satisfactorily.

For the image acquisition, a high resolution scanner and a CCD camera were tested. The preliminary tests proved that a scanner combined with transmitted light technology is the appropriate image recording system.

Scanner technology was chosen because camera technology showed disadvantages due to length distortions. The length distortion of the camera was identified with a coefficient of variation of approx. 2%, whereas the scanner showed less than 1%. For the calibration of length measurement, it is necessary to horizontally and vertically measure the scanner, as they may differ.

Camera and scanner-based image acquisition both allow for reflected light and for transmitted light illumination techniques. The fixation of the fibres has to be adapted to the chosen method of illumination. For reflected light, fibres can be fixed on any material that is capable of fixing the fibres on a plate (2-dimensional) and of offering sufficient contrast to the fibres (as e.g. a velvet). For transmitted light, the fixing material has to be transparent. This was solved by a liquid material on a glass plate, which does, in comparison to any fixing material for reflecting light, show the least disturbing textures. Based on preliminary tests, transmitted light illumination was chosen with glycerine or iso-propanol as fixing liquid. Both liquids do not swell the fibres.

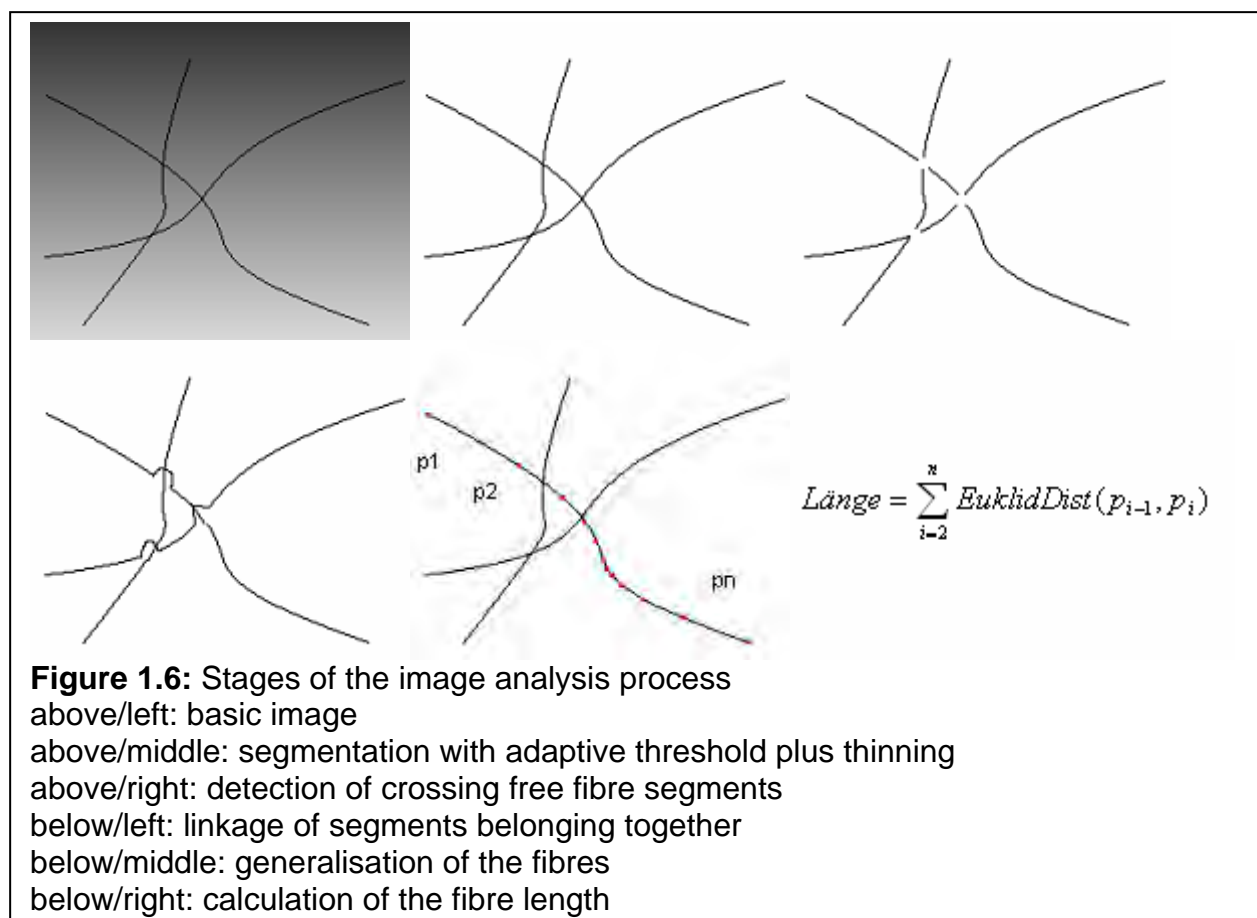
As for the calibration of length measurement, it is necessary to horizontally and vertically measure the scanner within the measuring range in order to be able to consider the different resolutions of both directions. The determined calibration factors must be applied to the differential share of the fibres in horizontal and vertical image direction.

Image Analysis

For the purpose of image analysis, the fibres are segmented by an adaptive threshold method, and wrongly segmented objects are eliminated automatically. This is followed by thinning of the fibre image.

The information details of the fibre image formations which are shown as raster graphics and which have been reduced, now must be transformed into vector graphics. The realized process stages here are as follows:

1. vectorisation free of crossovers
2. linkage and
3. generalisation of the vectors



Before generalisation and due to the considered 8-pixel neighbourhood and depending on the angle of the fibre section, a systematic error can make up by 8%. The problem is solved by the approximation of the fibre with a polygon line. A method of continued secant division (Douglas-Peucker algorithm) as well as a method of direct tracking in straight line was developed for generalisation technique. Additionally, the possibility for a selection between the consideration of maximum deviation or the sum of the deviations between fibre pixels and polygone segment representation was implemented.

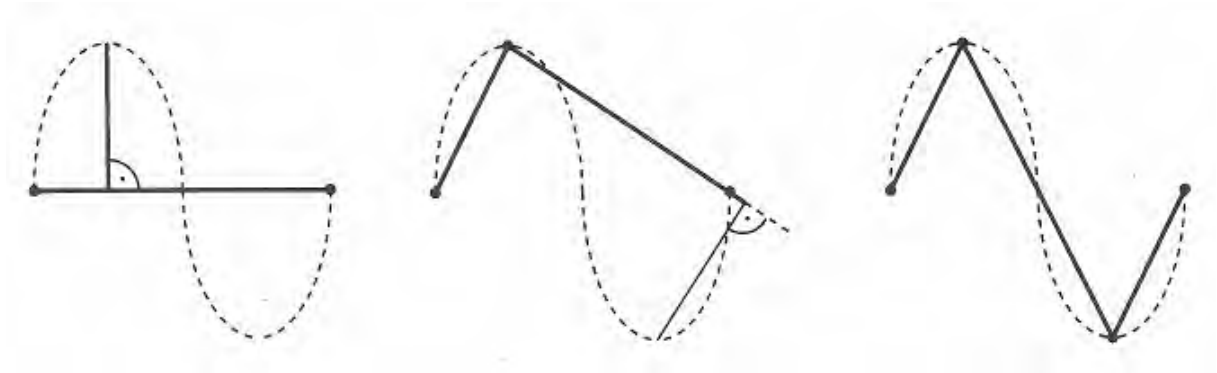


Figure 1.7: Method of generalisation of the curved fibre by continued secant division (Douglas-Peucker algorithm) [Bässmann 1998]

The selection of the method of generalisation, the consideration of the maximum or sum deviation, and the determination of the allowable tolerance of deviation – show a systematic influence on the results of fibre length measurements. Due to the consideration of synthetic fibre courses and measurements with fibres of defined lengths, the following could be stated as selection with optimum length match:

- Secant division with non-cumulative fault tolerance and a fault tolerance of 2 pixels

The project report includes a systematic analysis of the measurement uncertainty and the necessary calibration [ITV/FIBRE 2005].

- The only necessary calibration is according to the length scale of the scanner in x- and y-direction. This calibration is done at the areas of the scanner, where the fibres are measured.
- The described measuring method, in addition, was optimised in such a manner that there is no accentuation of the fibres - neither in the case of flock nor in the case of sliver samples. Sampling was designed to avoid any emphasis on longer fibres. Sample preparation was reduced to the least possible number of steps to avoid fibre loss, which would definitely result in systematic deviations.
- A systematic influence by the operator is reduced by the automatic selection of fibre segments
- A systematic influence of the segmentation algorithm is reduced by the operator check at fibre overlappings
- A zoom function for image details assists to find decisions for difficult places of the fibre segmentation.
- The impact of the length generalisation on the length measurement by the developed software was minimised by intense tests to find out the optimum parameters for the generalisation, based on synthetic fibre courses and measurements with fibres of defined lengths

As a result of this fibre length measurement method, the fibre length distribution by number is given in the same way as it is given e.g. by AFIS, but being valid for reference measurements.

RESULTS AND COMPARISON

The following cotton samples were used for all comparative measurements (results based on AFIS tests):

- B1 (sliver) Mean Length 25.5 mm, SFC(N) 16.9 %
- RM01 Simbabwe³ Mean Length 21.5 mm, SFC(N) 21.1 %
- RM13 Turkey⁴ Mean Length 20.1 mm, SFC(N) 26.4 %

As the results of all examined cotton samples showed the same effects, only the homogenous sample B1 (sliver) will be discussed more in detail in the following.

The following standard methods of length measurements – with raised number of trials – served as basis for the newly developed fibre length measurement by image analysis:

- Two-tweezers method (current method of reference, DIN 53808)
- Uster AFIS
- Premier aQura⁵
- Almeter

In addition, the results of the Bremen Round Trials for HVI, Almeter and AFIS for the flock samples were compared as they provide a significant statistical coverage.

Additionally to the mentioned test methods, the results of the following newly developed measurements are presented:

- Reference measurement by image analysis with semi-automatic fibre tracking (FIBRE)
- Image-based measurement with manual fibre tracking (FIBRE)
- Automated image-analytical measurement (ITV) with automatic fibre tracking
- Automated image-analytical measurement (ITV) with manual fibre tracking

Results of the Semi-Automatic Reference System, Based on Image Analysis

In figure 1.8 the length distribution of sliver sample B1, tested with the newly developed semi-automatic reference system can be seen. For each sample in this graph, approx. 1500 to 2000 fibres were tested. Remarkable is the second peak of the distribution at the range of the shorter fibres. This peak is reproducible and was found for every tested cotton. Additionally it has been proven by comparison of the results of different operators that this result does not depend on subjective influences of different operators.

³ Material from the Bremen Round Trial

⁴ Material from the Bremen Round Trial

⁵ Tests were carried out on site of manufacturer Premier Evolvics, India

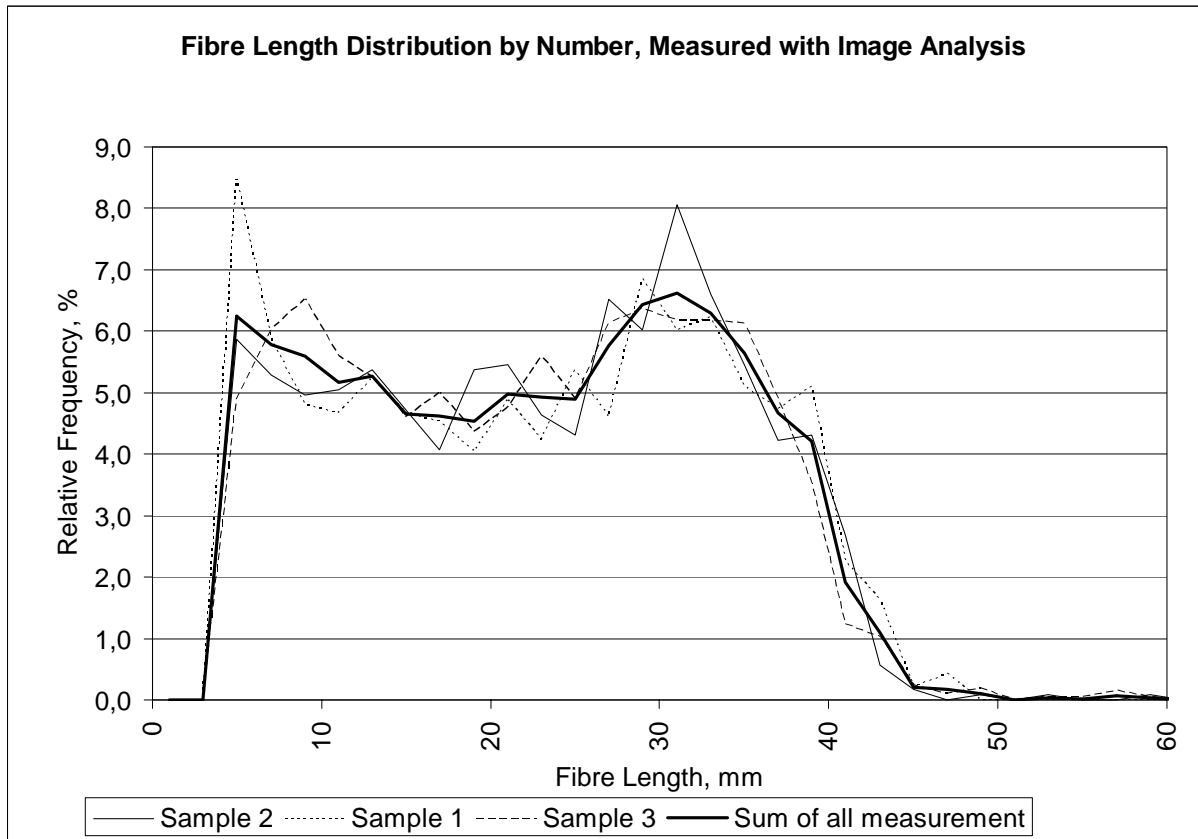


Figure 1.8: Length distribution results for sliver sample B1, measured with the newly developed reference test method, based on image analysis and semi-automatic fibre tracking

Comparison of the Results of the New System with Results from Other Test Methods

The comparison of the characteristic length values of all usual measuring methods shows significant differences (see table 1.2), which are caused in the different measurements and result parameters mentioned in the first part of this presentation. For these reasons it is difficult to compare these results. The short fibre content results (SFC) reveal even bigger differences. For this reason the usual measuring methods as AFIS or Almeter are not applied as a reference, but are considered with respect to relative changes between different samples.

The comparison between the two-tweezers method and the semi-automatic image analysis (Fig. 1.9), developed as reference method, shows good correlations regarding longer fibres for all examined samples. There is a difference mainly concerning the measured frequency of fibres shorter than 10-15 mm. In contrast to the two-tweezers method a significantly raised short fibre content (SFC), which shows a second maximum of distribution, is recognizable with respect to image analysis - despite of identical sample preparation by the same operator. A possible influence by the test persons can be excluded, as the results were repeated by different operators.

Table 1.2: Fibre length results for sample B1 with different test methods

<i>All distribution results are given by number or by cross section</i>					
Semi-Automatic Image Analysis (FIBRE)					
Sample	No. of fibres	ML mm	Median mm	SFC(N)<12,5 %	SFC(N)<10 %
B1	4681	22,7	23,36	24,3	17,6
Image Analysis Manual Method (FIBRE)					
Sample	No. of fibres	ML mm	Median mm	SFC(N)<12,5 %	SFC(N)<10 %
B1	1400	23,06	23,87	24,3	18,0
Two Tweezers					
Sample	No. of fibres	ML mm		SFC(N)<12,5 %	SFC(N)<10 %
B1	4173	24,25		16,7	10,7
AFIS					
Sample	No. of fibres	ML mm		SFC(N)<12,7 %	
B1	105000	25,5		16,9	
aQura					
Sample	No. of fibres		Median mm	SFC(N)<12,7 %	SFC(N)<10mm %
B1			22,79	23,2	17,5
Almeter					
Sample	No. of fibres	ML(N) mm		SFC(N)<12,5 %	
B1		25,1		9,1	

The raised short fibre content is also reflected at all other image-analytical methods

- Image analysis with manual fibre tracking (FIBRE);
- automated Image analysis with manual fibre tracking (ITV);
- results of a former AiF-project concerning image-related fibre length measurement [FIBRE 1997].

So it can be proven that this difference is not caused by deviations in the developed semi-automatic image-analytical reference method, but is typically for image-analysis based results. The AFIS measurements, too, show a slightly raised short fibre content for the flock samples.

At the two-tweezers method short fibre pieces possibly adhere to longer fibres which cannot be identified visually and thus get lost for the measurement while in the case of image analysis adhering fibre pieces can be identified. This result casts doubt on the two-tweezers method for the fibre length and short fibre content measurement – a method that has been considered as reference method thus far. Further research will be needed on this topic.

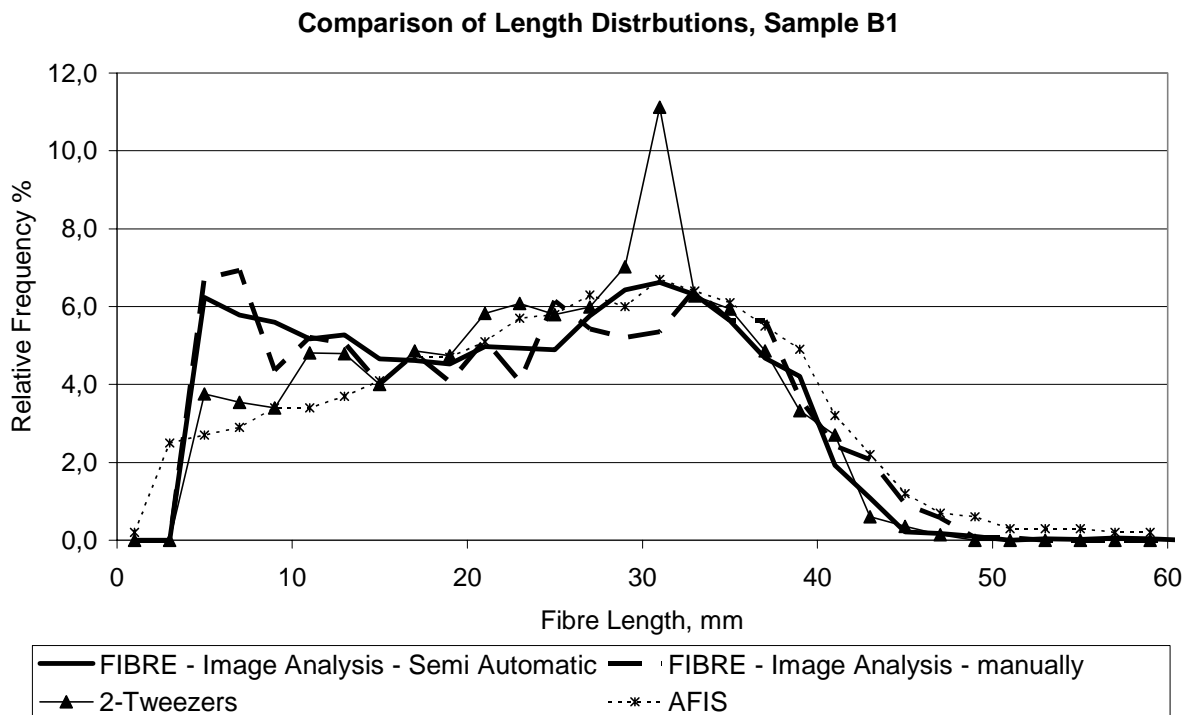


Figure 1.9: Length distribution results for sliver sample B1, measured with the image analysis based reference method, with a manual image based measurement, and the two-tweezers method. Additionally shown AFIS distribution

REFERENCES (Part 1)

- Bässmann-H, Kreyss-J 1998: Bildverarbeitung AdOculus, Springer-Verlag, Berlin, 1998
- Heap-A 2004. Proceedings of the Bremen Cotton Conference; Faserinstitut Bremen, Germany, March 2004
- ITV/FIBRE 2005: Research Report AiF 13488N: Entwicklung einer Methode zur Faserlängenmessung insbesondere des Kurzfaserteils mittels Bildanalyse. Institut für Textil- und Verfahrenstechnik Denkendorf and Faserinstitut Bremen, Germany
- FIBRE 1997: Research Report AiF 10196: Entwicklung eines Verfahrens zur Kurzfasermessung bei Baumwollen unter Berücksichtigung einer vereinheitlichten Faserlängenmesstechnik. Faserinstitut Bremen, Bremen, Germany.

PART 2

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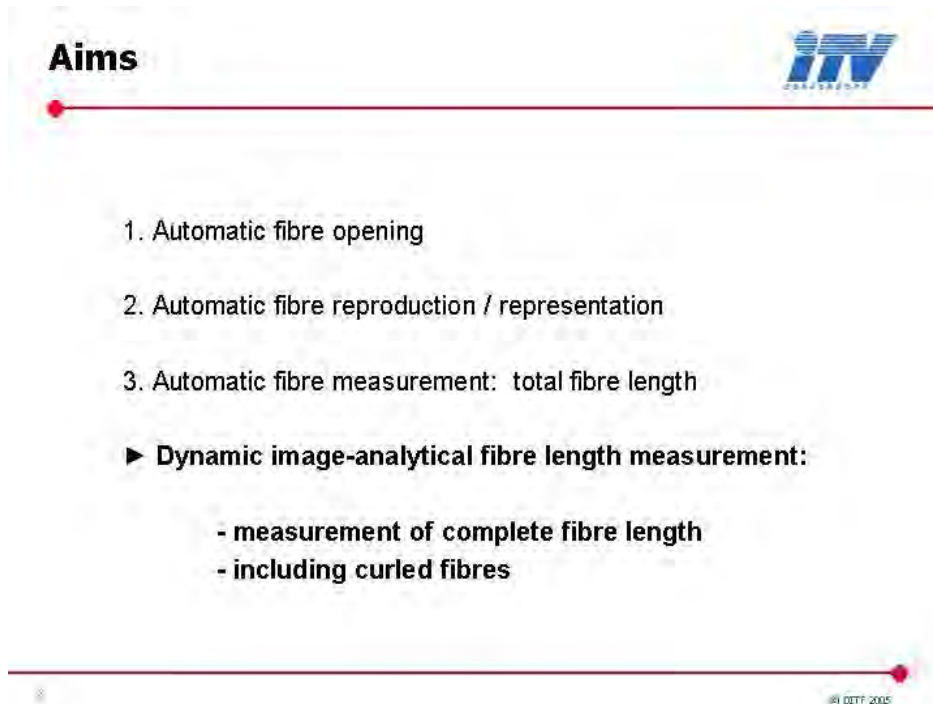


Figure 1 Aims

In the second part of this presentation we will introduce the dynamical fibre length measuring method developed by the ITV Denkendorf (Fig. 1). This method aims at an automatic single fibre opening, single fibre imaging and single fibre measurement in dynamical state. In our opinion, this method can only be realized by image analytical fibre length determination. This measuring technology makes it possible to pick up the whole fibre length with including the curled fibre ends. This requires fibre photographs, which represent the single fibres in flight without movement resolution and rich in contrast. The project at ITV consists of two parts: Optimization of single fibre opening and real fibre length measurement. In order to carry out the measurements, a device developed by ITV was assembled which is based on the principle of the Dust and Trash Analyzer (MDTA). The basic system components are shown in the following figure.

Principle ITV-fibre length measurement

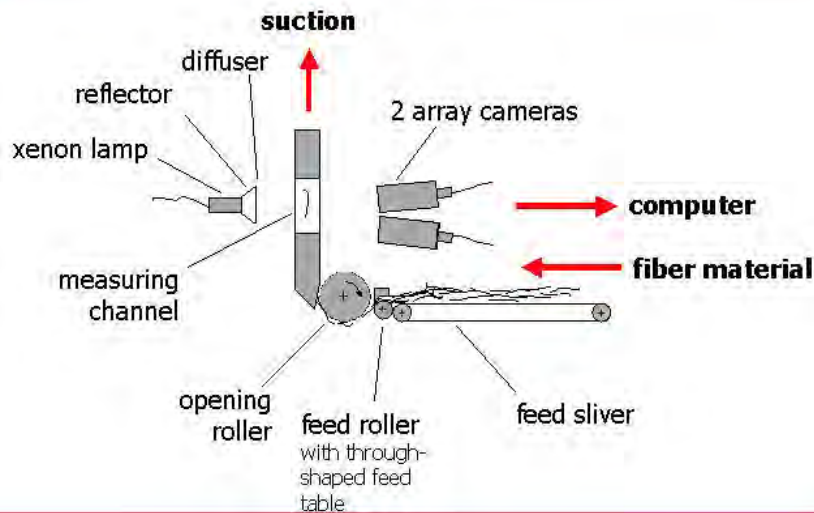


Figure 2 Fibre length measurement – ITV principle

The fibre material is fed to the opening roller via a feeding through, opened to single fibres and subsequently transported by vacuum through the measuring channel (Fig. 2). In order to be able to process the fibres by image analysis, the fibres must be prepared in such a way that these are damaged as little as possible during opening and pass the measuring channel as flat fibres. Though the focus has been on the measurement of short fibre lengths, of course the longest cotton fibres also had to be measured. In order to determine the optimal recording area of 80 x 30 mm, two array cameras instead of only one had to be used because of reduced costs.

Optimization of fibre separation



Aim:

Optimal separation at minimal fibre damage

- types of opening rollers
- opening roller speed
- sample feeding speed
- counter feed, countercurrent feed
- carding segments

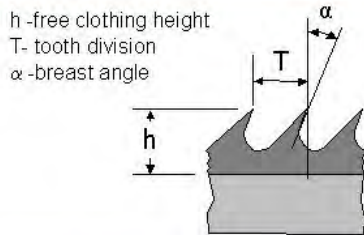
Figure 3 Optimization of fibre opening

To reach an optimal fibre opening the following trial parameters were investigated (Fig. 3):

- Clothing of opening roller - mainly determined by tooth geometry and number of tips per area
- opening roller speed
- sample feeding speed
- current feed / countercurrent feed
- influence of a carding segment.

Long staple cotton with low trash and short fibre content was consciously used as trial material because a possible fibre damage would be easily detectable. During the project work the type and speed of the opening roller proved to be as a significant influence parameter. So only the results thereof are dealt in more detail. The following types of opening rollers were investigated:

Types of opening rollers



OB 20



OS 21



opening roller	breast angle α [°]	number of tips [tips/inch ²]
OB 20	25	323
OS 21	15	211
OK 37	-9	146
needle roller	5	56

OK 37



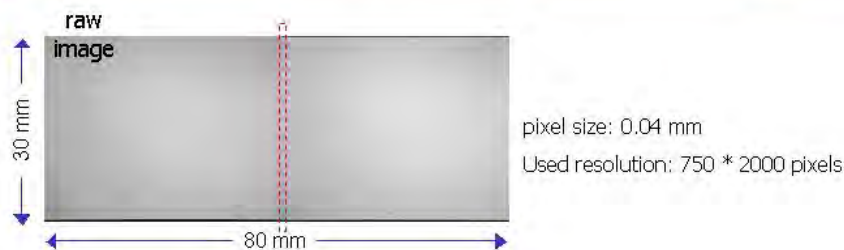
needle



Figure 4 Types of opening rollers

The fibres are subject to intensive mechanical stress when they are separated by the opening roller in a clamped state. Accordingly, there happens an excellent opening to single fibres at this process stage. On the other hand, however, there is the danger of fibre damage. This stage, therefore, was investigated in all details. The opening rollers, type OB 20 and OS 21, are serial products (Fig. 4). They are more aggressive than the opening roller, type OK 37 and needle opening roller due to higher tip density and breast angle which enable a more gentle fibre opening. The use of the needle roller and OK 37 roller always resulted in poor opening behaviour of the flocks while the trials with OB 20 and OS 21 showed good opening behaviour. Flocks are unsuitable for being used by the image processing system. They, therefore, shall not be dealt with in the following. The more aggressive geometry of the clothing of the opening roller OB 20 effects a raised degree of short fibres compared to OS 21 connected with a reduced mean fibre length. The mean fibre length of the feed material is only reduced by circa 0.7 mm by OS 21 and the short fibre content is raised by circa 2.5 % (absolutely). The opening roller OS 21 was considered to be the optimal solution for this application because flock opening had proved to be excellent. Optimum conditions for image analytical fibre length measurement were reached at opening roller speeds of 8000 min⁻¹ and a fibre feed speed of 0.1 m/min. The use of an additional card segment did not lead to improved flock opening. It caused fibre shortening independent of tip density.

From raw image to fibre detection



Aim:

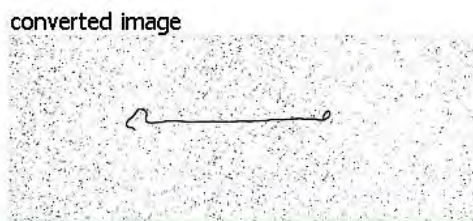
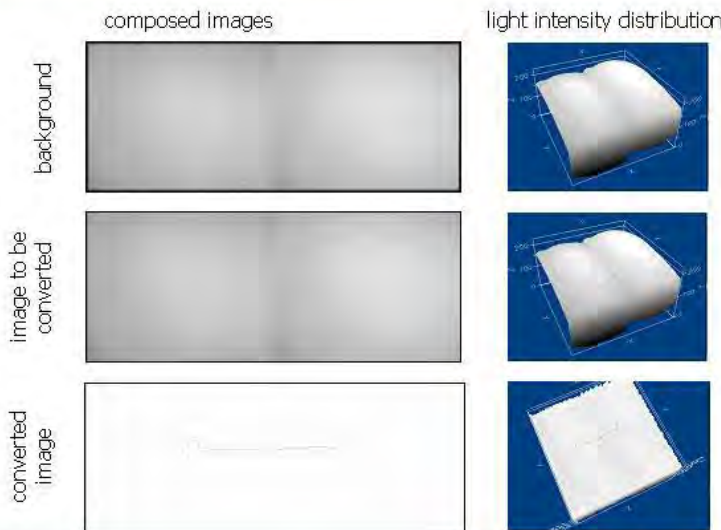


Figure 5 From raw image to fibre detection

Shutter speeds of less than 100 ns are required at fibre speeds up to 80 m/s in the measuring channel and a motion blur which shall be less than 10 % of the fibre diameter (Fig. 5). 'Optimas' a commercially available image processing system was used as suitable software for the evaluation of the images. The use of two cameras results in an overlapping area which may lead to double imaging of the fibres. A long fibre, therefore, is sometimes identified as two short fibres.

Image conversion



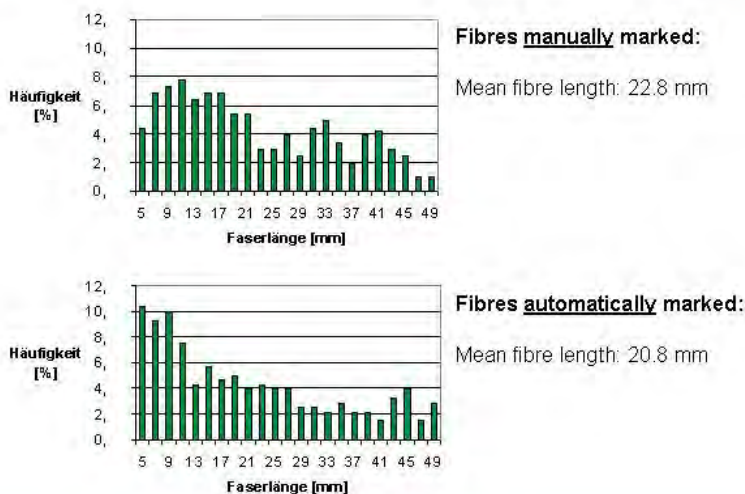
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Figure 6 Image conversion

For this and further reasons (contrast, illumination, interruptedly represented fibre courses), the images must be converted by mathematical operands and filters offline before the real fibre length measurement begins (Fig. 6). The converted image is the basis for the real measurement.

Fibre length distribution Image analysis - ITV



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Figure 7 FIBRE LENGTH MEASUREMENT

It could be shown that the result of the method of fibre length measurement is systematically influenced by different factors (Fig. 7).

Fibre crossovers, fibre knots as well as fibres which project from the edge of the image are rejected by using a macro. With respect to proportion more longer than shorter fibres are rejected.

In addition, there occurred undesirable side effects during image acquisition and graphical representation which influence the automatic marking.

So, in general the converted image sequences were analyzed by two different methods (ITV method). The fibre course, on the one hand, was marked automatically and on the other hand the course of each fibre was marked manually as a check. Automatic fibre marking consequently results in the stressing of short fibre lengths. The determination of the fibre length was made in both cases by automatic measurement. Only Fibre lengths over 4 mm were taken into account.

Fibre length distribution Image-analytical methods

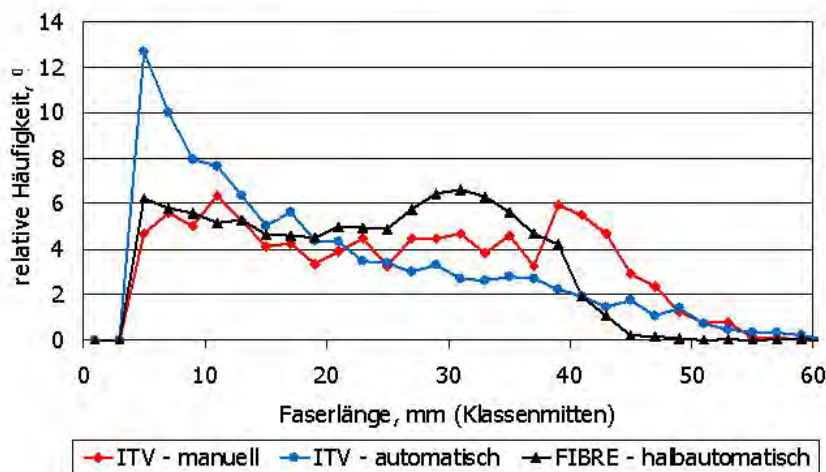
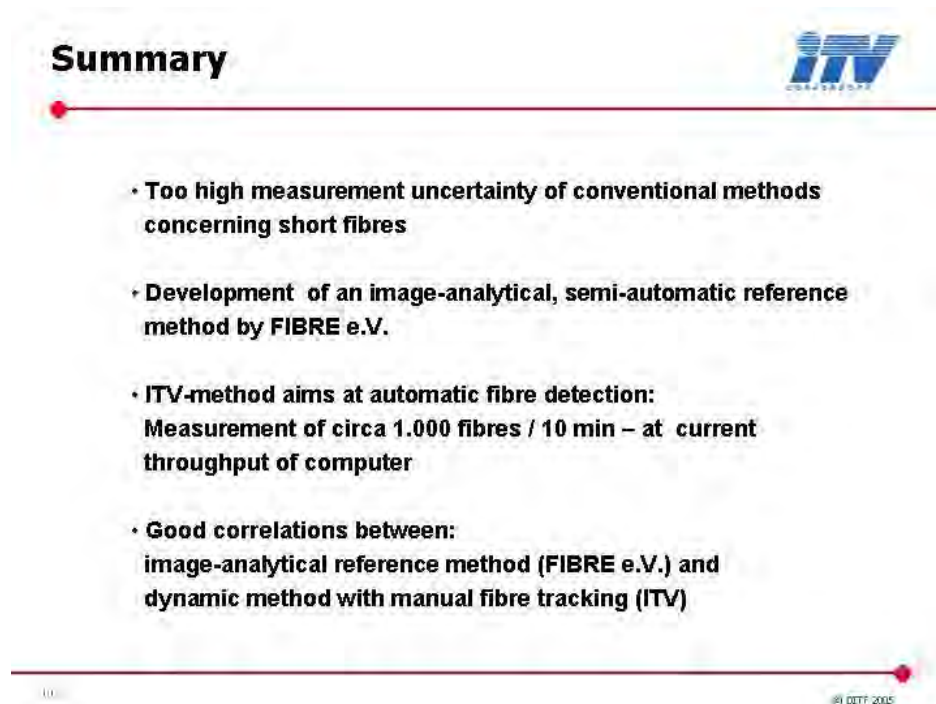


Figure 8 Fibre length distribution – Image-analytical methods

The results of the measurements by means of the automated fibre opening and manual fibre marking method show a principal correspondance with the results of the image analytical reference method of FIBRE e.V. (Fig. 9). Deviations of the results with automated fibre opening and manual tracking presumably are based on the small number of tested fibres. There is, however, a systematic difference at fibre lengths beyond the maximum of length distribution of the FIBRE curve. The possible detection of two fibres lying next to each other in the images, thus appearing to be one single fibre, may be the reason for that difference.

The results of the automated fibre opening and measuring (ITV), however, reveal a significantly changed form of distribution with a single maximum of length distribution concerning the shortest fibres detected. This cannot be ascribed to the testing material, but is rather caused by the systematic influences of the measurement equipment with two cameras mentioned above and the resulting overlapping area. These can be reduced by improved technical expenditure. The reduction of fibre length by automated opening proved to be inevitable, but justifiably minor.



Summary

- **Too high measurement uncertainty of conventional methods concerning short fibres**
- **Development of an image-analytical, semi-automatic reference method by FIBRE e.V.**
- **ITV-method aims at automatic fibre detection: Measurement of circa 1.000 fibres / 10 min – at current throughput of computer**
- **Good correlations between: image-analytical reference method (FIBRE e.V.) and dynamic method with manual fibre tracking (ITV)**

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Figure 9 SUMMARY

To summarize (Fig. 10), the following statements can be made: The short fibre content of cotton that is essential for processing can be determined only insufficiently because of the uncertainty of measurement. There is a considerable deviation of the measuring values both for the individual instruments and the comparable ones. Moreover, the correlation between the differently used instruments is rather low.

In the case of the two-tweezers' method the share of short fibres is not represented satisfactorily, as opposed to all image-based methods. This may be caused by non-recognized, adhering fibres or insufficient consideration of the short fibres by the tester.

Within the present research project the Institute of Textile Technology and Process Engineering (ITV) Denkendorf and the Fibre Institute Bremen (FIBRE e.V.) developed image analytical methods which enable to exactly determine the short fibre content of cotton samples. The method developed by FIBRE e.V. is an image-analytical, semi-automatic reference method which allows to verify or calibrate existing and newly developed test methods.

Based on current computer technology, about 1.000 fibres can be measured within 10 minutes by means of this method. Either flock material or slivers can be used. There is a good correlation between the image-analytical reference method (FIBRE) and the dynamic method with manual fibre detection (ITV). After the solution of the determined causes which still lead to systematically changed values at automatic fibre measurements the method in principle appears to be suitable for automatic, image-analytical fibre measurements concerning short fibres.

ACKNOWLEDGEMENTS

We would like to thank 'Forschungskuratorium Textil e.V.' for the financial support of this research project (AiF-No. 13488N) that resulted from funds of 'Bundesministerium für Wirtschaft und Technology (BMWA)' by means of a grant of 'Arbeitsgemeinschaft industrieller Forschungsvereinigungen 'Otto von Guericke' e.V. (AiF)' (Fig. 11).

NEW SEED GENERATIONS AND THEIR IMPACT ON YIELD AND FIBRE

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Cotton producers require high yield to be profitable while fibre quality is an important factor affecting mill use and value. Historically, high yielding varieties have seldom had the high quality in demand by mills. This manuscript evaluates the yield and fibre quality of 26 non-Acala picker varieties that were the most widely planted varieties in the United States from 1994 to the present. These varieties were evaluated in 864 different growing environments across the USA. Variety yield and fibre of each variety was weighted against the proportion of the USA crop planted to each variety by year to estimate the genetic component to USA cotton fibre by year. These studies support that genetic progress was slow in yield improvement during the early years of evaluation, and that varieties being grown resulted in shorter staple length and higher micronaire from 1998 through 2002. In the recent three years there has been a dramatic improvement in yield accompanied by substantial improvement in fibre length and a reduction in micronaire. It is especially significant that Delta and Pine Land Company breeders have broken the genetic linkage between high yield and high micronaire. New varieties have top yields and a micronaire near 4.0. The USA cotton producer has benefited from an increased level of plant breeders focused on germplasm improvement in yield and fibre quality. The increased value of seed due to the transgenic traits contained in the seed and elimination of grower saved seed with transgenic traits has stimulated this level of effort. These new high yield and high quality varieties are just recently making their way into the USA market with sufficient volume to begin to affect the overall average yield and quality of the USA cotton.

Cotton producers have to be profitable to sustain their farm operation. Yield has more impact on profit than any other consideration. For this reason, plant breeders place a very high priority on yield. Fibre quality characteristics are important as they affect the price per pound. Meredith (2002) has indicated there is generally a yield penalty associated with high fibre quality traits. Textile mills are concerned with fibre quality. Lewis (2003) aptly pointed out fibre quality needs of the mill is not reflected in sufficient price incentive to not select varieties on the basis of yield.

The concept of a USA yield plateau and negative changes in fibre quality was a significant point of discussion at the end of the century and during the early years of the 21st century. Data to support these concerns have been summarized by Meredith 2002 and 2003; and Lewis 2003. Transgenic technologies were introduced commercially in 1996. Detailed yield and fibre quality comparisons of seven D&PL variety sets (conventional parent, Bollgard[®], Roundup Ready[®], or stacked trait version), grown in multiple locations and years showed differences to be of minor magnitude and the result of plant selection in a backcross breeding program (Kerby et al. 2000). Lege et al. (2001) reported similar results. Stability of the conventional

parents and transgenic versions were shown to be identical (Kerby et al. 2001). Yield and fibre quality of the 58 varieties that were planted on the most USA acres during the period 1995 to 2001 showed an average yield increase of 5.9 lbs/A/yr, but a reduction of 0.05 staple/yr and an increase of 0.013 micronaire/yr during the period due to varieties selected by growers (Kerby et al. 2002).

Delta and Pine Land Company (D&PL) has reported variety releases in recent years that have shown substantial improvement in yield while at the same time improving fibre quality over popular varieties during the late 1990's (Lege et al., 2003; Lege and Leske, 2003; Lege and Williams 2004; Lege and McGowen, 2005; and Speed et al., 2005). D&PL has extensive on farm variety testing and tests these same varieties in public sector trials. D&PL has developed proprietary software that allow for data storage of all public official variety trials and its own research and on-farm testing.

To demonstrate the change in yield and quality, this manuscript will first, review data for 45 D&PL varieties released between 1981 and 2005 and make direct comparisons of yield and fibre changes over the past 25 years (Kerby and Hugie, 2006). Yield and fibre of the most popular varieties grown in the past 11 years will be evaluated and used to estimate the expected quality of the USA crop. Lastly, the most common varieties of the 1999 and 2000 testing years will be compared against the most common varieties in testing in 2004 and 2005 to observe the fibre quality of the highest, middle, and lowest yielding groups.

MATERIALS AND METHODS

See Kerby and Hugie (2006) for detailed methods for the 45 variety releases of D&PL between 1981 and 2005.

The 26 most popular non-Acala picker varieties planted in the USA as reported by the USDA AMS Cotton Division between 1994 and 2004 were selected. These represented varieties from D&PL (DP, NuCOTN, PM, and SG), Monsanto (BXN and ST), and Bayer (FM) (Table I). High-Plains stripper varieties and Acala varieties would have been tested only in their respective regions; therefore, they could not be used in over year and region analysis. D&PL conducts large plot on-farm variety trials as well as utilizes the small plot variety testing by Universities. This combined data is stored in a proprietary data base. A statistical tool (SAS General Linear Model) was used to calculate average values for yield, staple length, fibre strength, and micronaire of these 26 varieties over 864 test locations between 1994 and 2004. The average yield and fibre quality of these varieties over the 864 locations and 11 years eliminate environmental effects. The calculated values were then applied to the percentage of acres planted to each variety by year from 1994 to 2004 to show what the genetic gain (or loss) should be in yield and quality of the USA crop by year with environmental effects eliminated.

The most common entries in variety test plots in 1999 and 2000 (Table II) were compared to the most common varieties in testing during 2004 and 2005 (Table III). The earlier year comparison contained 29 varieties analyzed in the method described in the previous paragraph over 863 test locations. There were 24 varieties

represented in the 2004 and 2005 test with a combined total of 846 test locations. Varieties were divided into three groups (top, middle, and bottom), each representing one-third of the varieties in the trial. Fibre quality was compared to the yield of the three yield groups.

Table I - The 26 most widely planted non-Acala picker varieties planted in the USA between 1994 and 2004, listed in order of year of release or first volume sale in the USA.

Variety	Year of Release or 1 st US Sale	Variety	Year of Release or 1 st US Sale	Variety	Year of Release or 1 st US Sale
DP 90	1981	SG 125	1995	FM 832	1998
DP 20	1983	BXN 47	1996	DP 451 B/RR	1999
DP 50	1983	NUCOTN 33B	1996	PM 1218 BG/RR	1999
DP 51	1989	NUCOTN 35B	1996	ST 4892 BR	2000
DP 5415	1990	DP 5415 RR	1997	FM 958	2001
DP 5690	1990	DP 5690 RR	1997	DP 555 BG/RR	2002
ST 474	1991	DP 436 RR	1998	DP 444 BG/RR	2003
DP 5409	1994	DP 458 B/RR	1998	ST 5599 BR	2003
SG 501	1994	DP 655 B/RR	1998		

Table II - Varieties (29) with the most frequent occurrence in variety trials in 863 trials across the USA during 1999 and 2000 (group to left). Varieties (24) with the most frequent occurrence in variety trials in 846 trials across the USA during 2004 and 2005 (group to right).

BXN 47	DP 655 B/RR	SG 105
DP 20 B	DP 675	SG 125 BR
DP 388	FM 832	SG 501
DP 409 B/RR	FM 958	SG 501 BR
DP 436 RR	FM 989	SG 521 R
DP 451 B/RR	NUCOTN 33B	SG 747
DP 458 B/RR	PM 1218 BG/RR	ST 474
DP 5415 RR	PM 1560 BG	ST 4793 R
DP 565	PM 1560 BG/RR	ST 4892 BR
DP 5690 RR	PSC 355	

DP 424 BGII/RR	DP 488 BG/RR	FM 991 BR
DP 432 R	DP 494 R	FM 991 R
DP 434 R	DP 543 BGII/RR	PM 1218 BG/RR
DP 444 BG/RR	DP 555 BG/RR	PSC 410 R
DP 445 BG/RR	DP 515 BG/RR	ST 4575 BR
DP 449 BG/RR	FM 960 BR	ST 4892 BR
DP 454 BG/RR	FM 960 R	ST 5242 BR
DP 455 BG/RR	FM 989 BR	ST 5599 BR

Table III - Average fibre quality of the varieties falling into the top 1/3, middle 1/3, or bottom 1/3 for yield for the common varieties in trials in 1999 and 2000 compared to those in variety trials in 2004 and 2005.

	Top 1/3 Yield		Middle 1/3 Yield		Bottom 1/3 Yield	
	1999 and 2000	2004 and 2005	1999 and 2000	2004 and 2005	1999 and 2000	2004 and 2005
Lint Yield Lbs/A	1005	1216	957	1180	925	1127
Staple Length	35.0	35.9	35.1	35.7	35.1	35.9
Strength (g/tex)	28.7	29.7	28.7	30.4	28.8	30.3
Micronaire	4.58	4.20	4.46	4.25	4.35	4.30

RESULTS AND DISCUSSION

Kerby and Hugie (2006) evaluated 45 D&PL varieties released during the past 25 years for yield and fibre quality. Their results indicate modest yield improvement (3.1 lbs/A/yr) up until the turn of the century when improvements have averaged almost 15.0 lbs/A/yr the last five years. Staple length was nearly flat until the last five years where new releases have average about 0.5 staple longer than the earlier varieties. Fibre strength has been generally flat with time, with a modest increase of 0.3 g/text for varieties released in the past five years. Micronaire increased during the 1990s, but has declined sharply in the recent five years.

YIELD AND FIBRE QUALITY OF THE MOST WIDELY PLANTED NON-ACALA PICKER VARIETIES 1994 TO 2004

Non-Acala picker varieties planted on more than 1% of the of the USA acreage between 1994 and 2004, according to USDA-AMS Cotton Division were selected for comparison. Acala varieties or stripper type varieties are both grown in only restricted areas of the USA and an over year and region of the country would not be possible for these varieties. The 26 varieties used in this analysis are listed by year of release in Table I. Standardized means were calculated for all 26 varieties utilizing 864 test locations representing the entire USA cotton growing area. The variety average was then weighted according to the percent of the USA planted to that variety by year to get an estimate of USA trends (independent of environment). This is compared to the actual USA average according to UDSA-AMS figures. The USA average is an obvious combination of both genetic and environmental effects (both weather and management).

USA cotton producers generally plant the varieties that provide the greatest economic return, which are generally the varieties with the highest yield. Figure 1 demonstrates a sustained yield improvement due to varieties planted. Note that variety testing generally occurs in locations with higher average yield than the average USA field. Yield improvement averaged 10.7 lbs/A/yr lint during these years, but the trends are best described with a third order polynomial curve showing greater yield improvement in the most recent three years. The average USA yields have improved during this same period by an average of 21.6 lbs/A/yr, an amount that is double the genetic gain. The last two years show strong improvement and likely involve favorable environments. The years 1995 and 1999 were particularly adverse years from an environmental perspective. In 1995 there was severe and in many cases uncontrolled tobacco budworm injury due in part to pyrethroid resistance while 1999 reflected a hot and dry period during the critical boll development period.

Staple length trends are given in Figure 2. Differences between the genetic line and the USA average relates to the fact that some of the genetic data comes from Universities where they use small gins without lint cleaners. Genetic effects demonstrate that growers were selecting varieties that had lower staple lengths up until 2001. Varieties that were high yielding but with shorter fibre length began to be replaced by improved varieties in 2002 and that trend has continued. The USA cotton industry had the misfortune to combine this period of time when varieties were being

grown that had shorter staple with an environment that was also resulting in shorter staple.

Fibre strength trends are given in Figure 3. Genetic improvement in fibre strength of the varieties growers chose to plant remained fairly constant until the recent four years. Fibre strength of the USA crop dipped from 1998 through 2001, but has steadily increased beginning in 2002.

Micronaire trends are given in Figure 4. Genetic effects on micronaire showed growers chose varieties with slightly higher micronaire between 1995 and 1999. During the four-year period from 2000 to 2003, micronaire values were genetically higher than at any other time. New varieties with high yield and low micronaire are an increasing proportion of the crop beginning in 2004 and increased further in 2005. The environment was favorable for lower micronaire in 1996, 1997, 2000, and 2004. The environment was adverse and favored higher micronaire in 1998, 2001, and 2002. Micronaire of the USA crop in 2001 and 2002 was especially high because it combined an environment that favored high micronaire with the time when varieties with high micronaire were planted.

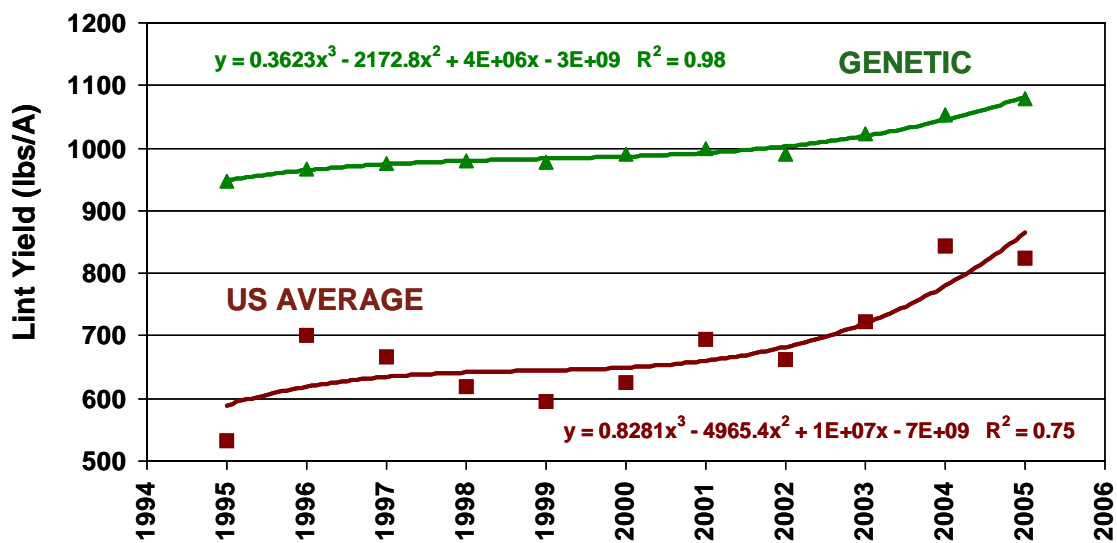


Figure 1 - Actual USA average yield according to USDA-AMS compared to the yield estimated according to varieties planted by year (as determined for the leading 26 varieties planted in the period based on performance in 839 different test environments).

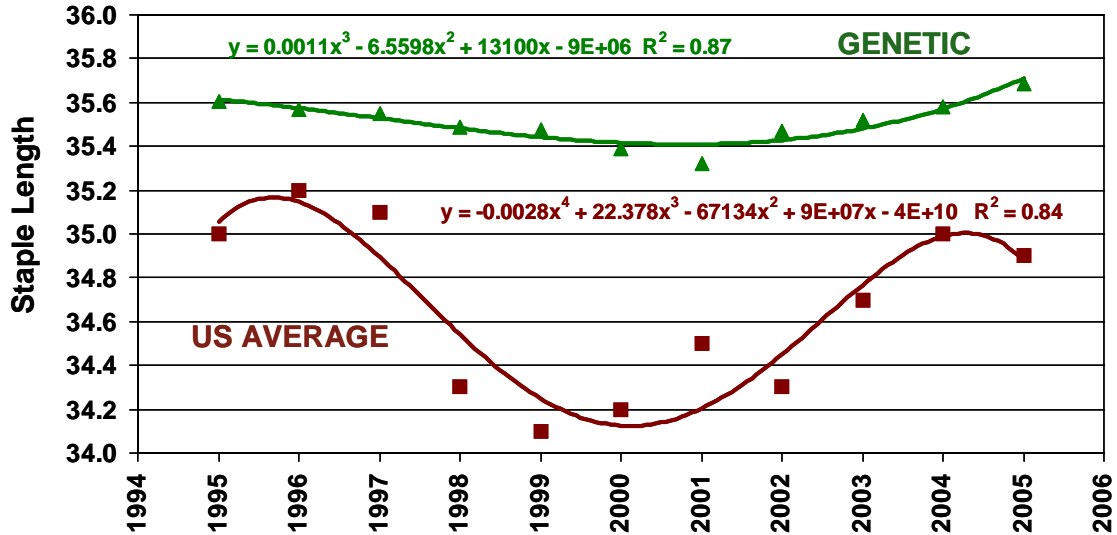


Figure 2 - Actual USA average staple length according to USDA-AMS compared to the staple length estimated according to varieties planted by year (as determined for the leading 26 varieties planted in the period based on performance in 839 different test environments).

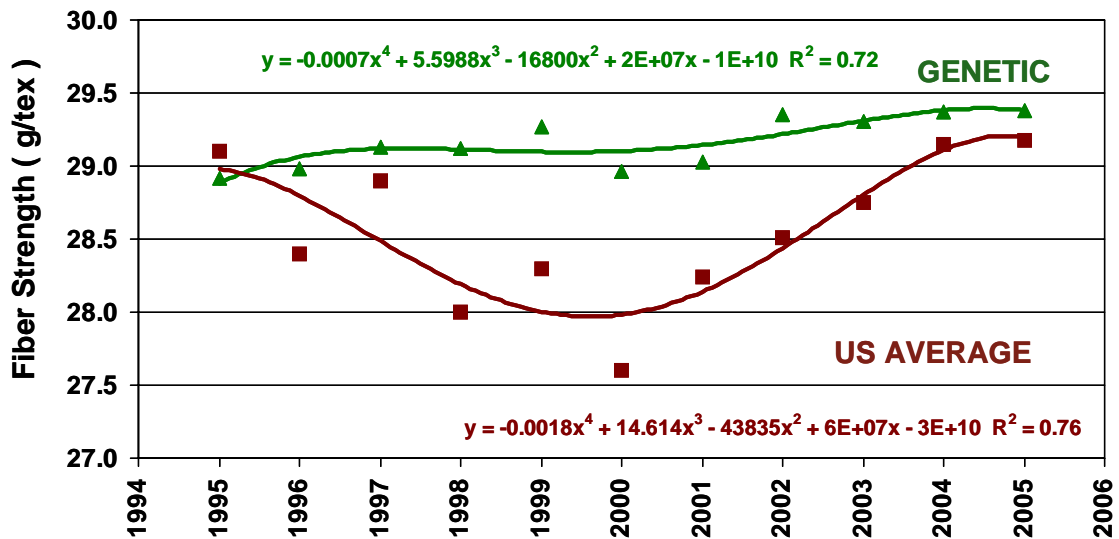


Figure 3 - Actual USA average fibre strength according to USDA-AMS compared to the fibre strength estimated according to varieties planted by year (as determined for the leading 26 varieties planted in the period based on performance in 839 different test environments).

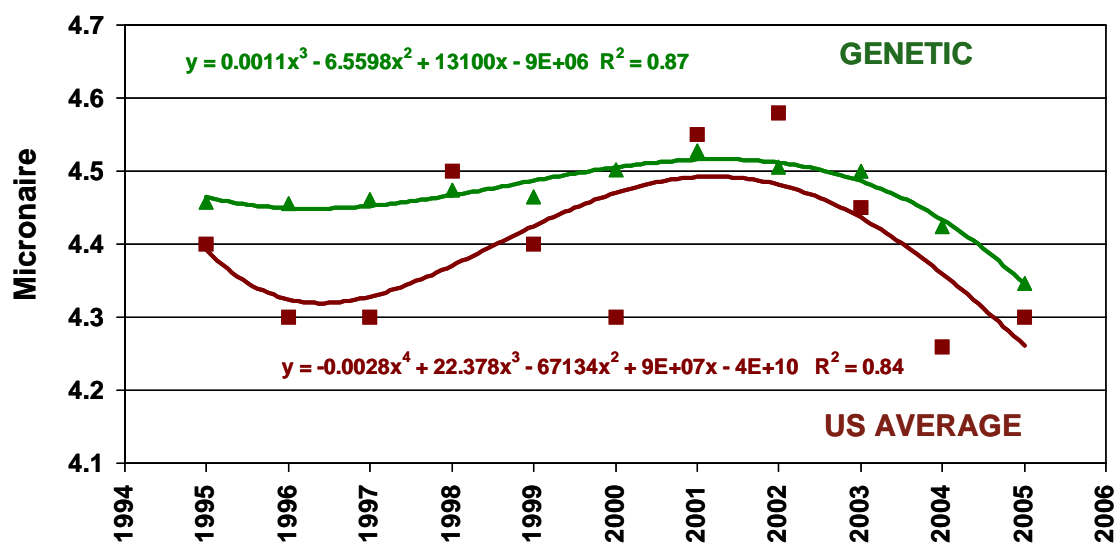


Figure 4 - Actual USA average micronaire according to USDA-AMS compared to the micronaire estimated according to varieties planted by year (as determined for the leading 26 varieties planted in the period based on performance in 839 different test environments).

YIELD AND FIBRE QUALITY OF VARIETIES IN TRIALS TODAY COMPARED TO FIVE-YEARS AGO

Twenty-nine varieties were common in trials conducted during 1999 and 2000 (Table II left side). These years were selected because they were the years when varieties being grown by cotton growers had the shortest staple length and the highest micronaire (Figures 2 and 4). Trends in yield have been much higher in the recent three to four years, but this has also been accompanied by improving fibre quality (Figures 1, 2, 3, and 4). For this reason the 24 most common varieties in variety trials in 2004 and 2005 (Table II right side) were compared to a different set of varieties five years earlier.

For both sets of years, varieties were divided into three groups according to yield (top 1/3, middle 1/3, and bottom 1/3) and average fibre quality of these yield groups reported in Table III. In 1999 and 2000 the top third was comprised of seven D&PL varieties, and one each from PhytoGen, FiberMax, and Stoneville. Staple length of the three yield groups were similar as was fibre strength, but micronaire was highest for the high yield group, intermediate for the middle yield group, and lowest for the low yield group. This is in agreement with the classic historical observation of cotton breeders, that high yield is associated with high micronaire (Meredith 2002).

Average yield of the 24 varieties is substantially higher in 2004 and 2005 compared to the 29 varieties in 1999 and 2000 (Table III). Since they were different environments and years, we are not able to estimate how much of this difference is due to variety or environment. However, data in Figure 1 demonstrates strong genetic improvement of varieties grown, and Kerby and Hugie (2006) demonstrated increases averaging 15 lbs/A/yr lint in the past five years due to genetics. D&PL had

six varieties in the high yield (top 1/3) with Stoneville having the other two. Fibre length of all varieties averaged 0.8 staple longer for the 2004 and 2005 group. Staple length improvement occurred in all yield levels (top, middle, and bottom). Fibre strength of the 2004 and 2005 varieties improved an average of 1.4 g/tex over the varieties tested in 1999 and 2000. The top-yielding group had a lesser improvement of 1.0 g/tex, but was still quite good averaging 29.7. There was a complete reversal in micronaire trends between the two sets of varieties tested. In 1999 and 2000 the high yielding varieties had the highest micronaire. In the 2004 and 2005 set, the highest yielding group had the lowest micronaire, and averaged 4.20 compared to 4.58 for the high yielding group in 1999 and 2000.

DISCUSSION AND CONCLUSIONS

The cotton seed industry has undergone dramatic changes during the past decade in the USA. Biotechnology has been widely adopted with the result that more revenue is derived from the seed, and a higher percentage of grower seed is purchased from seed companies. This has resulted in increased competition to develop varieties that carry the high value traits to cotton producers. Prior to biotechnology, D&PL supported five separate breeding programs in the USA. Today that has expanded to 13 global programs that focus on new germplasm development. Introgression of transgenic genes into advanced germplasm is accomplished by a different set of transgenic breeders. These programs are located throughout the USA, Brazil, Australia, Greece, and India. These additional programs have increased the genetic base of cotton germplasm, and they have led to improved genetics. These improvements are in yield as well as fibre quality. Breakage of the historical negative linkage between yield and micronaire is a great example of the advancements made by D&PL cotton breeders. These new and improved varieties for yield and fibre quality have been proven in the field in research and test plots, and are now being multiplied for sales in quantities that will continue to affect the fibre quality of the USA crop in a positive way better positioning the lint American growers offer the global textile market.

ACKNOWLEDGEMENTS

The authors would like to recognize the efforts and talents of the Delta and Pine Land research and technical services staff across the USA who collected the data and processed many samples from the numerous variety trials reported herein. Our thanks also go to the many grower cooperators who provided land and time to accommodate these studies.

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REFERENCES

Kerby, Tom, Dave Albers, Ken Lege, and Janet Burgess. 2002. Changes in yield and fiber quality due to variety grown. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Kerby, Tom, Marc Bates, Janet Burgess, Ken Lege, and Dave Albers. 2001. Fiber quality stability of significant Delta and Pine Land varieties over years and locations. pp. 410-414. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Kerby, Thomas A. and William V. Hugie. 2006. Yield and quality improvement of significant D&PL varieties during the last 25-years. (In Press). Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN

Kerby, Tom, Bill Hugie, Kevin Howard, Marc Bates, Janet Burgess, and Jay Mahaffey. Fiber quality comparisons among varieties for conventional, Bollgard, and Roundup Ready versions. 2000. pp. 484-488. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Lege', Ken E., Kevin D. Howard, Thomas A. Kerby, Don L. Keim, David W. Albers, and Tom R. Speed. 2003. Simultaneous improvement of yield and fiber quality. pp. 2557-2560. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Lege, K.E., T.A. Kerby, D.A. Albers, and T.R. Speed. 2001. Yield and fiber quality comparisons between transgenic and conventional varieties. pp. 405-408. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Lege', Ken E., and Richard Leske. 2003. DP 555 BG/RR, a new mid-full season picker variety with high yield potential. pp. 58-65. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Lege', Ken E., and Robert E. McGowen. 2005. DP 393, A new early-maturing, conventional picker variety with high yield and fiber quality potential. pp. 50-60. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Lege', Ken E., and Curtis Williams. 2004. DP 444 BG/RR, a new early-maturing transgenic variety with high yield potential and fiber quality potential. pp. 148-157. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Lewis, Hal. 2003. Cotton yield and quality. pp. 77-81. Proceedings 16th Engineered Fiber Selection Conference, Greenville, SC. Cotton Incorporated, Cary, NC.

Meredith, William R., Jr. 2002. Factors that contribute to lack of genetic progress. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Meredith, William R., Jr. 2003. Thirty-six years of regional high quality variety tests. pp. 2561-2566. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Speed, Tom, Tom Kerby, Ken Lege', Dave Albers, and Kevin Howard. 2005. DP 432 RR and DP 434 RR: new high quality, early maturing RR's from D&PL. pp. 77-83. Proceedings Beltwide Cotton Conferences, National Cotton Council, Memphis, TN.

Session IV: Future of Cotton in Africa

- ***“Cotton - made in Africa“ - Implementation of a Sustainable Cotton Production***
Gerd Billen
- ***Cotton in Zimbabwe***
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- ***Specialities of African Cotton***
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“COTTON - MADE IN AFRICA” - IMPLEMENTATION OF A SUSTAINABLE COTTON PRODUCTION

G. Billen

Otto (GmbH & Co KG), Hamburg, Germany

ABSTRACT

The project “Cotton – made in Africa”® (CmiA) seeks to foster the sustainable growing of cotton in relevant African regions and to increase market share in the international textile industry. By means of coordinated sourcing by retailers as well as brand names from Europe and the US the necessary economic scale will be reached. The project character is more operational and results oriented whereas conceptual aspects will be dealt with only to the extend necessary.

CmiA can be competitive in international markets despite of prevailing terms of trade. The project wants to prove this by practical example, based on a market driven approach and covering the entire supply chain, i.e. starting with cotton production in Africa - via the various production steps- to retail outlets in Europe and the US. Particular emphasis will be given to sustainability aspects.

INTRODUCTION

The goal of the project CmiA is to promote sustainable cotton cultivation in Africa and to sell the end products to customers worldwide. It seeks to establish links between distributors and cotton farmers, thereby improving the competitiveness of sustainable African cotton. Thus, the project will strengthen the socio-economic position of cotton farmers while protecting the environment

The label Cotton made in Africa is a market-based and open initiative to promote and encourage sustainability in the cotton chain. Participants in the initiative cooperate to achieve sustainability in the production, post-harvest processing and trading of mainstream cotton in the long term. It is only through commitment to continuous improvement by stakeholders along the chain, including corporate environmental and social responsibility, that this ambition can be achieved.

The label’s approach to sustainability builds on the Millennium Development Goals of the United Nations, which aim at sustainable livelihoods, and has a social, an environmental and an economic dimension:

- Cotton production can only be sustainable if it allows for decent working and living conditions for farmers and their families as well as employees. This includes respect for human rights and labour standards as well as achieving a decent standard of living.
- Protecting the environment such as primary forest and conserving natural resources such as water, soil, biodiversity and energy are core elements of sustainable cotton production and post-harvest processing.

- Economic viability is the basis for social and environmental sustainability. It includes reasonable earnings for all in the cotton chain, access to markets and sustainable livelihoods.

The objective of CmiA is to foster sustainability in the 'mainstream' cotton chain and to increase the quantities of cotton meeting basic sustainability criteria within all three dimensions. Encouraging sustainability for cotton is a productive, competitive and efficient way to enhance the economic conditions of the individuals employed and engaged in the growing, post-harvest processing and trading of cotton.

The mechanisms of the label provide conditions to re-arrange the transfer of added value toward the producers, to optimise cooperation and to raise awareness of responsibilities along the cotton chains. The mechanisms of the label aim to provide the business community, consumers and civil society and as well political decision makers in developing and developed countries with a credible system that informs them about sustainability performance in mainstream cotton.

The label is open to voluntary participation by all stakeholders in the cotton chain who comply with its principles. Each stakeholder, at their own level of operations and activities, promotes and supports the production, post-harvest processing and trading of cotton on its way to sustainability. This also applies to the promotion of cotton products using or containing such cotton, taking market conditions and practicability into account.

PURPOSE

Cotton is one of the world's largest traded commodities and is produced in many developing countries, which are often heavily dependent on cotton export earnings. It generates income for millions of people in the cotton growing areas worldwide. In the last decade, agro-technological methods, changes in production, volatile markets, structural imbalances in the world economy and political developments have put high pressure on cotton producers in developing countries.

The consequences of the current situation vary, but in many countries prices paid do not even cover the costs of production. Unsustainable production, processing and trading, therefore, sometimes form the basis for competition, resulting in social and environmental losses.

Motivated by this, OTTO one of Germany's largest retailers groups founded the Foundation of sustainable Agriculture and Forestry (FSAF). This Foundation agreed with DEG and GTZ on behalf of the German Ministry for Economic Co-operation and Development (BMZ), to start a Public Private Partnership Project to implement the initiative in a multi-stakeholder approach in several African Countries.

Essential in the approach of promoting and selling African cotton is the establishment of broad alliances that can and will channel large volumes of cotton through the cotton production chain.

The purpose of the sustainability index for “Cotton - Made in Africa” is complex because different stakeholders view from a variety of perspectives such concepts as the sustainable use of resources, poverty alleviation and the cotton trade chain. The index should encourage farmers and ginners to grow and process cotton in a sustainable manner through a demand-driven approach. It intends to provide access to a growing market and give farmers a fair share of the world market price.

The sustainability index gives a sound foundation to end-products labeled “Cotton - Made in Africa”. The label will be carried by the products of an international group of companies joining the initiative. The group was initiated by the Michael Otto foundation and joined by other major distributors of cotton products.

"Cotton - Made in Africa" aims at enabling social, environmental and economic sustainability in the production, post-harvest processing and trading of “mainstream” cotton for all actors along the cotton chain, and will support long-term development with continuous improvement.

"Cotton - Made in Africa" aims at increasing the supply of and demand for cotton on its way to sustainability based on market-mechanisms. The cotton offered in the major consumer channels under mainstream brands has to meet certain criteria under three dimensions of sustainability.

The label "Cotton - Made in Africa" will be developed in a multi-stakeholder approach in a transparent participatory process open to all operators active in the global cotton sector. The documents are developed in the spirit of cooperation and mutual understanding of core values.

Representatives of institutions in producing countries, trade and industry as well as civil society are involved in the formulation of the Label CmiA. Non-governmental organisations, multilateral and international organizations and institutions support this process and provide their knowledge and experience.

IMPROVING THE VALUE-CHAIN

The label is not a solution to the current cotton crisis, but offers a long-term development perspective to suppliers and establishes a new basis for competition with regard to the quality of the product and the quality of sustainable production methods. All actors in the chain cooperate in the label to constantly enhance the production and supply of cotton on its way to sustainability and to increase the demand for cotton produced and processed under sustainable methods by promoting this concept in mainstream markets.

Reasons for producers to join the label:

- Better market access and business relationships
- Enhanced returns from production
- Improvement of working and living conditions
- Improved social conditions for workers

- Empowerment and improved management capacity
- Preservation of the environment

Reasons for trade and industry to join the label:

- Ensured supply of quality cotton
- Ensured cotton market for the future
- Commitment to corporate social responsibility and sustainability
- More sustainability for the mainstream market
- Positive image
- Enhanced market transparency and traceability
- Preservation of the environment
- Chances for communication and marketing

Producers, processors and traders complying with the requirements of the label will improve their competitiveness and bargaining power as a result of improved management and enhanced returns from optimised production, thereby creating better market access and higher margins. Vertical diversification and the creation of added value, accompanied by the label system further support competitive producers and processors. A constantly growing demand for "Cotton - Made in Africa" supports sustainable development in the cotton sector and encourages stable trading practices between business partners.

Buyers of "Cotton - Made in Africa" along the chain strive to expand the proportion of mainstream cotton on its way to sustainability and publicize their performance in regular reports. They seek ways to transfer the added value of label cotton to the level of production and processing of cotton.

THE LABEL SYSTEM

The "Cotton - Made in Africa" system is an open system and all operators in the chain are eligible to implement and use the label in their operations and commercial relations if they join the initiative.

Participation in the label is open to all forms of production systems – including smallholders, organizations / associations, ginners and traders, provided they are organized and work towards sustainable production in the cotton chain.

Information about the system, its requirements and user's conditions, is provided by the FSAF.

Prerequisites for entering the system are a

- self-assessment,
- the exclusion of unacceptable practices and a
- commitment to continuous improvement.

The label then allows for a transition period wherein all stakeholders combine to improve practices in cotton production and processing. The stakeholders are committed to creating the economic and organizational conditions that will enable the establishment of a process of continuous improvement.

The label system provides the contact and the access to these interested partners, development agencies and programmes to support the improvement process on a national or regional level.

The experience of pilot projects, which bring together public and private partners in the sector, provides the basis for specification on a regional and / or production system level and helps to improve the development.

The project management, in cooperation with engaged partners, develops concepts to enable capacity building by channelling resources and providing training. These are based on feedback reports summarizing results from and experiences with the self-assessment and the implementation audits. The analysis of the current practices will take place on the regional and / or national level and will be compiled by the FSAF.

All actors along the chain will assume the responsibility to cooperate for further improvement in production, post-harvest processing and trading methods leading towards a sustainable cotton sector.

Users of the label agree to strive for the development of Public-Private Partnerships to implement the label and to support implementation. Coordinated by the label system, approaches by national and international initiatives, organizations, programmes and companies will guide the way to sustainable development and support continuous improvement. To achieve this, all actors in the label system commit themselves to cooperate in order to channel resources and activities for the benefit of a sustainable cotton sector.

THE INDICATORS

The basis for the label “Cotton - Made in Africa” is the sustainability of cotton production in Africa. But what kind of sustainability is meant? Is it ecological, economic or social sustainability? It is all three, and that is why scientific indicators for all three fields have been set up. The fields are called “People” for the social, “Planet” for the ecological and “Profit” for the economic aspect. In each field some relevant indicators have been formulated.

Table 1: Selected key indicators for sustainable cotton production.

Perspective	Indicator	Major aspects assessed by the indicator
People	Percentage of children in primary school	Ability of farmers to read documentation, manuals, etc. Level of child labor Potential for non-farm jobs for rural population

Perspective	Indicator	Major aspects assessed by the indicator
Planet	Water use and consumption	Water availability Crop yield (productivity) Drainage of water from cotton field to downstream environment
	Pesticide use	Environmental risk downstream from cotton area Potential pollution of groundwater in relation to drinking water safety Crop yield
	Fertilizer use	Potential pollution of groundwater and the downstream environment Depletion of soil fertility Crop yield
Profit	Farm gate to world market price ratio	Potential income of farmer (fair share to farmer) Position of farmer with respect to market (alternative modes of market access, monopolies)

Figure 1

The eligible criteria for the label are on three levels:

- Level one: no goes or exclusion criteria
- Level two: indicators and parameters
- Level three: sustainable criteria matrix

Unacceptable Practices – “no goes”

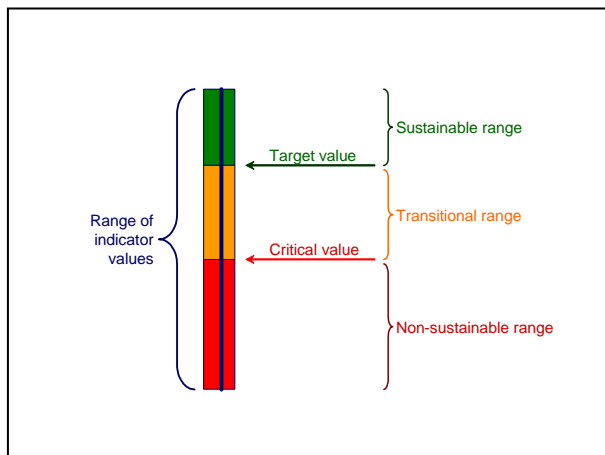
The label for the Cotton System excludes the worst forms of social, environmental and economic practices in the production, post-harvest processing and trading of green cotton. Those practices are called “unacceptable”. Definitions are primarily based on the UN Human Rights Declaration as well as existing UN conventions and standards and, usually, national legislation. The exclusion of unacceptable practices will be documented in the assessment report.

The indicator concept

The basis for the indicator system was developed effectively by the University of Wageningen. This system is based on the “traffic light system” concept. The extreme values are on either end of the range. Very positive values are in the green area; very negative ones in the red. The green range will be sustainable, the red one unsustainable. Between the two extremes is a yellow area defined as transitional.

- Red indicates that the current practice must be discontinued
- Yellow indicates a practice that needs to be further improved within a transitional period
- Green reflects a desirable practice.

The bottom border of the yellow area will be the critical value. Below this level sustainability will not be ensured. The upper level of the transitional range will be the target value. This value should be achieved to ensure sustainability.



Referring to a comprehensive concept of sustainability, the label consists of a social, an environmental and an economic dimension. The concept of sustainability is specified in the Label Matrix, which consists of categories, principles and criteria. Categories refer to the main aspects of the production, post-harvest processing and trading of cotton. Principles are positive statements that indicate the desired performance for each of the listed

Figure 2

practices. To assess the performance of a label unit, criteria specify the compliance with the requirements of these Principles.

Individual indicators for sustainability will be transferred as a set to a summary sheet. On this sheet all indicators will be displayed in concentric circles. The inner area is red, the middle yellow and the outer area green. The various indicators will be transferred with their values. The result looks like spider web; very high sustainable indicators will go to the outer circle, less sustainable will be near the center.

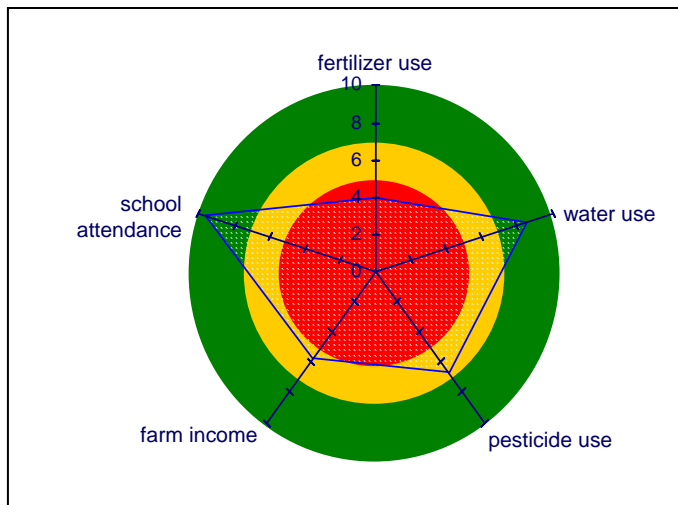


Figure 3

THE QUALIFICATION SYSTEM

Theoretically defined indicators

The Wageningen study proposes five indicators for quantifying the sustainability of cotton production from the three perspectives selected (People, Planet and Profit). The Wageningen study also defines an indicator for each criterion.

- Percentage of children in primary school
- Water use and consumption
- Pesticide use
- Fertilizer use
- Farm gate to world market price ratio

The criteria are part of an ingenious overall indicator system giving ready information about the achievement or underachievement of the indicators.

- Ability of farmers to read documentation, manuals, etc. Level of child labor. Potential for non-farm jobs for rural population.
- Water availability. Crop yield (productivity). Drainage of water from cotton field to downstream environment.
- Environmental risk downstream from cotton area. Potential pollution of groundwater in relation to drinking water safety. Crop yield
- Potential pollution of groundwater and the downstream environment. Depletion of soil fertility. Crop yield
- Potential income of farmer (fair share to farmer). Position of farmer with respect to market (alternative modes of market access, monopolies).

The criteria are scientifically defined and will be used for scientific research accompanying project implementation. The University of Wageningen will make a baseline study and monitor these indicators annually.

MONITORING AND EVALUATION

Monitoring will be done in two distinct ways. Monitoring in the narrow sense will be the collection of data. This will be done by the project staff in cooperation with extension workers and producers associations. In this area non-governmental organizations like WWF and DWHH could use their experience to build up capacities at the local level in order to enable the producer associations to monitor and evaluate the success of the project.

Information gathered in this way will be transferred to monitoring data sheets and non-scientific evaluation procedures will be done locally, scientific evaluation will be carried out at Wageningen. The monitoring sheets will be kept at the project management level and will also be available for the Wageningen team.

Monitoring will be carried out as follows:

1. Baseline data concerning the indicators will be collected at the beginning of the project.
2. Annual monitoring of data will be carried out for each indicator. The data collection will include data collected by other institutions as much as possible.

Scientific evaluation will be carried out by the University of Wageningen. This evaluation will give more detailed information about the effects of the project. Details of this scientific evaluation will be developed by the University of Wageningen in due time.

COMMUNICATION

The various stakeholders in the chain can use the results of the implementation of the label in their communications. Reporting and communication on the label contributes to a better image of cotton in world consumer markets and can counteract any negative product connotation related to developments in the cotton markets affecting the livelihoods of millions of individuals engaged in the growing of cotton.

All actors in the label system will cooperate to disseminate these positive effects and to transfer this image of cotton on its way to sustainability in order to stimulate consumer demand. Cotton made in Africa will not necessarily be communicated through labels attached to the final consumer products. In their communication to the public, buyers of Cotton made in Africa are free to report on the volumes of their labelled cotton purchased and on specific targets for increased market shares for Cotton made in Africa as agreed in the "Implementation Guidelines" .

The FSAF will support and guide communication practices in consumer markets and is the central institution for communication with the public and interested institutions.

In detail, this means:

- **FSAF** supported by implementation organizations (GTZ, DEG, NGOs)
- Screens existing structures in producing countries (organizations and institutions)
- Arranges CmiA label events with workshops in producing countries
- Attends dissemination workshops in CmiA label countries
- Develops PR-Material
- Developed an Internet platform for CmiA

Industry

- Develops promotional concepts
- Presents CmiA label concepts to other industry actors

Producer organisations

- Inform the Managing Body on organizational structures in producing countries
- Arranges dissemination workshops together with the Managing Body
- Organizes training on the CmiA label

PROJECT IMPLEMENTATION PLANNING

In the first half of 2006, verification of indicators will take place. From the second half of 2006 to the end of 2007, the introduction of the standards will be the main activity.

In order to create a common understanding among the project partners, all major partners will participate at the main missions. These are:

- the start-up mission with baseline data studies
- the mid-term review mission and
- the final evaluation mission at the end of the first project phase.

Indicators especially need specification, and will be modified according to the experience gained in these Pilot Projects. A time frame to comply with the specific requirements of the individual management plans is being defined, taking into account the results of Pilot Projects. This time path encourages a dynamic process of continuous improvement and allows credible monitoring. Furthermore, compliance with the requirements of the label helps to channel resources for the specific interests of label units, if requested.

COTTON IN ZIMBABWE

H. Mapara
Cottco, Harare, Zimbabwe

Cotton is one of Zimbabwe's major agricultural crops. It is a major employer, a catalyst for rural development and earns the country valuable foreign exchange.

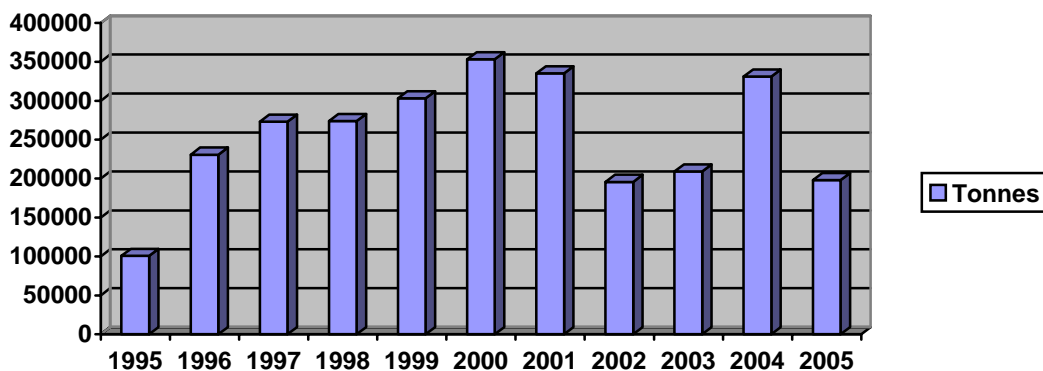
- 500 000 people are directly employed in the cotton sub-sector.
- At least 2 million other dependants derive their livelihood from cotton.
- 99% of Zimbabwe cotton is grown by the small scale farmer.

RECENT HISTORICAL HIGHLIGHTS

- From 1967 to 1994 the cotton industry was the preserve of the Cotton Marketing Board which was responsible for ensuring the production of the crop, the processing of same and marketing the products lint and ginned seed.
- In 1993 under the IMF Economic Structural Adjustment Programme certain sectors of agriculture were earmarked for deregulation, the cotton sector being one.
- In 1994 as part of the government's economic reform, the Cotton Marketing Board was commercialized and its successor the Cotton Company of Zimbabwe was privatized in October 1997 and listed on the Zimbabwe Stock Exchange in December that year.
- The Government of Zimbabwe retained a 25 percent shareholding in the company that was subsequently sold.
- The deregulation resulted in other entrants coming into the industry led by Cotpro and Cargill. The new millennium witnessed a second wave of smaller entrants into the market. Currently there are 14 other players involved in the cotton sector.

PRODUCTION: 1995 – 2005

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Tonnes	100600	230654	273000	274000	303000	353000	335000	195670	209130	331000	198000



PRODUCTION IN THE SMALL SCALE SECTOR

Prior to the attainment of independence in 1980 small holders accounted for 20 percent of national cotton production.

The period 1980 to 1985 witnessed strong growth in the small holder sector with hectarages expanding from 60 000 hectares to 130 000 hectares and production rising from levels of 45 000 to 130 000 tonnes of seed cotton.

This growth was facilitated by the expansion of intake facilities in the rural areas namely transit depots, the intention being that growers should have access to a buying facility within a 60 kilometer radius of their homestead. Transit depots were initially established in the Gokwe area in the west of the country and subsequently established in the Northern, Eastern and Southern cotton production areas of Zimbabwe. The Cotton Marketing Board was responsible for this infrastructural development.

1986 to 1995 was a period of consolidation in the smallholder sector which saw the area planted to cotton increase from 130 000 to 180 000 hectares and output rise by some 18 to 20 percent. It was also characterized by droughts in 1986/87, the worst drought in a century 1991/92 and a severe drought again in 1995.

A significant development during this period was the establishment of ginning facilities in the heart of two major smallholder production areas, Gokwe in the West and Muzarabani in the North in the Zambezi Valley. This had a twofold purpose in stimulating additional cotton production in these areas and creating employment for the local population.

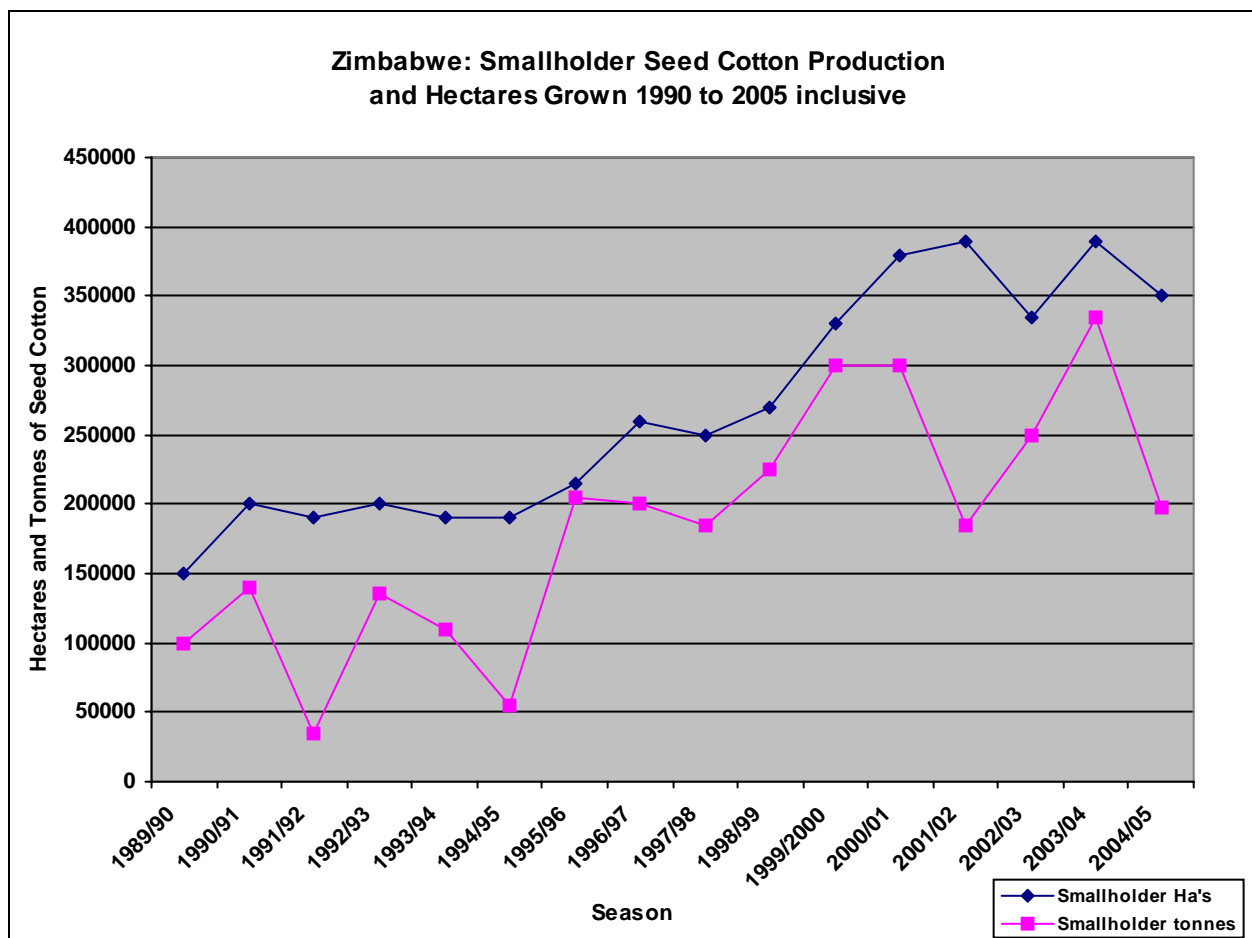
The drought of 1991/92 was the catalyst for the inception of the inputs scheme, following funding by the World Bank to ameliorate the impact of the drought on Zimbabwe's agricultural sector. Essentially funding was provided through the Cotton Marketing Board to growers, who in turn repaid the funding through their deliveries the following season. This was the beginning of a sustainable inputs scheme for cotton.

The Cotton Company of Zimbabwe came into being following the commercialization of the Cotton Marketing Board of Zimbabwe in 1994.

1996 – 2005

Strong growth was registered by the smallholder sector during these years with hectarages up from 180 000 hectares to 353 000 hectares and production from 138 000 tonnes to 330 000 tonnes up 139.00 percent and comprising 99 percent of national production.

Inputs were an integral part of the production process and contributed significantly to the growth of the smallholder sector and its placement on a sustainable growth curve. The industry was also deregulated fully during the period with competitors emerging, who unfortunately have not contributed significantly with their own inputs scheme to enhance national production.



INPUTS SCHEMES

The Cotton Company of Zimbabwe is a major player in the provision of inputs.

Since 1992/93 Cottco's inputs credit scheme has evolved and has three major aspects – the supply of inputs such as fertilizer, chemical and seed on a cash basis, the availability of the same inputs on credit and in some instances the offer of pre-season finance.

The inputs scheme has created convenience for smallholder farmers as they now travel shorter distances to buy inputs which are available at Cottco depots thus facilitating their production activities.

Inputs on a cash basis from Cottco means ready availability to the grower in his production area, and eliminates middlemen and gives assurance that the correct inputs are to hand.

Inputs on a credit basis has been a great success, enabling growers to procure inputs on credit during the cotton growing season, whilst allowing them to repay their loans through cotton deliveries to Cottco intake facilities in their locality. This has proved popular with smallholders who often face financial constraints at time of planting.

This aspect of the scheme is strictly monitored to ensure that only worthy farmers access the scheme.

Criteria Are:-

1. The grower must have a proven track record in cotton production.
2. The grower must have repaid in full previous inputs credit disbursements.
3. The grower must show tangible benefits from receiving inputs i.e. improved yield.
4. Be prepared to co-operate with Cottco's extension staff.
5. The grower must not have side marketed to competitors irrespective of whether he has settled his loan in full.

Prior to the grower accessing inputs on credit Cottco Loans and Extension staff assess his suitability for same.

Inputs are disbursed in 3 tranches to the grower, on the following basis:

1st Tranche: Mid October / November – Planting seed and compound fertilizer

2nd Tranche: December / January – Chemicals i.e. conventionals, larvin carbaryl and aphicides.

3rd Tranche: February / March – Additional chemicals, Pyrethroids to take the crop through to harvest and to selected farmers pre-season finance.

The tranches are disbursed after evaluating the growing season in relation to crop development and the grower's performance. This minimizes financial exposure for both Cottco and the grower if the season deteriorates.

The overall impact of the scheme has been sustained cotton production by smallholder farmers who have experienced substantial increases in cotton yield and quality. Farmers in the scheme generally attain yield increases up to 100% higher on average in some instances compared to growers who do not have access to the facility. Inputs scheme participants average 1650 kgs per ha compared to a national average of below 950 kgs.

The scheme has demonstrated its capacity to improve the living standards of smallholder farmers through enhanced financial returns.

However there are threats to the scheme as a result of the continuing deregulation of the industry which has seen plantation ginners establishing themselves, without investing in the crop production process and generally reaping where they did not sow.

Efforts to enact legislation to establish a regulatory framework under which the cotton industry would operate has met with no success.

If stakeholders in the industry contribute positively to the industry cotton hectares and production have the potential to double i.e. 600 000 to 700 000 hectares yielding upwards of 650 000 tonnes of seed cotton.

Current constraints facing the provision of inputs are high interest rates and foreign currency availability. Inputs have to be affordable to the provider and grower or the real possibility arises that neither party is viable.

CHARACTERISTICS OF ZIMBABWE COTTONS BUYING SECTOR

Scale of Operation and Service Differentiation		Cotton Company of Zimbabwe Limited (Cottco)	Cargill Zimbabwe (Pvt) Ltd	Others
1.	Input Credit Scheme	Group lending scheme for communal and resettled farmers with no lending to previous defaulters and group leader credit recovery bonus.	Limited credit scheme formalized.	Some operate small input schemes. Regulations being mooted to require all cotton buyers to provide inputs.
2.	Membership	Requires Producer Card to deliver cotton	No Producer Card requirement.	No Producer Card requirement.
3.	Market Share and Ginning Capacity	About 60%. Strong ginning base. Operates ginneries in Banket, Sanyati, Gokwe, Chinhoyi, Muzarabani, Kadoma, Glendale, Bindura and Mutare.	About 20%. Relatively small ginning base. Operates ginneries in three areas : Tafuna, Chegutu and Gweru.	About 10%. Very small but expanding ginning base in Sanyati, Harare, Rushinga / Checheche.
4.	Vertical Integration	Highly vertically integrated. Operates seed-certified firm, Quton (Pvt) Ltd. Also involved in cotton ginning and cotton exports. Has 75% stake in Scottco (Pvt) Ltd. A spinning mill.	Limited to cotton buying and ginning. No investments in value-adding activities yet.	Limited to cotton buying and ginning. No major investments in value-adding activities yet.
5.	Research and Development	Provides funding for cotton research through Quton (Pvt) Ltd.	No research support.	No research support.
6.	Extension Provision	Conducts field days and cotton grower-of-the-year competitions. Exhibits at the Harare Agricultural Show. Farmers also receive extension advice via the input credit scheme.	Some extension support.	Limited extension support.
7.	Transport	Offers transport to collect cotton harvest through its Farmgate Seed Cotton Purchase Scheme.	Offers transport / farmgate.	Transport offered / Farmgate to high output producers.
8.	Regional Coverage Zimbabwe	Operates country wide in all major cotton producing areas.	Country-wide.	Selected regions only.

GINNING

THE GINNING CAPACITY IN ZIMBABWE STANDS AT

COTTOCO	265 000 Tonnes
CARGILL	115 000 Tonnes
TARAFERN	35 000 Tonnes
OTHERS	<u>70 000</u> Tonnes
	485 000 Tonnes
	=====

During average years of production +/- 52% of installed ginning capacity is utilized. During the above average years utilization increases to +/- 70 percent.

To maximize on ginning capacity production has to reach a sustainable level of 485 000 tonnes. Taking the 2004 seasons production of 333 000 tonnes into account an increase of +/- 46 percent in production is required to satisfy the existing installed capacity.

This capacity can only be serviced by the adequate provision of inputs by the ginners in relation to their capacity.

The alternative is to set up a spv under the auspices of the Reserve Bank to provide inputs on a national basis, ginners contribute to same in Zimbabwe dollars and draw inputs in relation to their contribution.

Current constraints facing the provision of inputs are high interest rates and forex availability.

QUALITY

Zimbabwe since the inception of major commercial production has always had a grading system, whereby seed cotton at point of purchase would be graded into 4 basic seed cotton grades A, B, C and D. The grades reflect various fault factors in the cotton (i.e. leaf trash, insect stain and colour) and result in like cotton being grouped with like. This system ensured that lint quality after ginning would be homogenous, resulting in premiums for the lint product from clients and consequently better returns to the grower.

The grading standards were part and parcel of the old Cotton Marketing and Control Act which was repealed and superseded by the Agricultural Products Marketing Act. The seed cotton grading standards were not saved in force in the new act.

With the influx of new players into the industry the grading standards have been undermined to the point of being non existent. This has resulted in a marked deterioration in lint quality from new entrants. Established players such as the Cotton Company and Cargill have maintained these standards.

This issue needs to be addressed soonest.

LEGISLATION

The lack of a regulatory framework is impacting negatively on the industry. The National Cotton Council has put regulatory proposals to Government that would establish a framework for the industry to operate under but nothing has been forthcoming. Grading standards, the provision of inputs etc were covered in the proposals.

NATIONAL COTTON COUNCIL

The cotton industry is managed under the auspices of the National Cotton Council which encompasses the cotton sub-sector with representatives from ginner, spinners, oil expressors, grower organizations and government.

As a follow on the ginner have formed a ginner association to represent their interests, within the cotton sub-sector.

The council is also running with the legislative issues.

QUTON SEED COMPANY : THE SEEDS OF SUCCESS

Quton Seed Company which is a wholly owned subsidiary of the Cotton Company group has the responsibility of ensuring that there is sufficient seed to meet national requirements.

The Company has exclusive rights to commercialise the cotton varieties, researched by the Government Cotton Research Institute in Kadoma.

Varieties are bred specifically for hand-picking and the fibre quality is equal to the best in the world and compatible with modern spinning technology.

Quton is responsible for the multiplication of varieties following the release of a new variety into the market.

Quton produces treated planting seed, to enhance germination and reduce pest pressure for 6 weeks post emergence.

Annual production capacity is in excess of 10 000 tonnes planting seed.

The company has also initiated its own plant breeding programme and has 3 commercially viable varieties in the pipeline for release within the next 3 to 4 years.

Discussion are underway with BT providers to incorporate current technology into Zimbabwe cotton varieties.

VIABILITY

The biggest challenge going forward for the cotton industry in Zimbabwe concerns viability in relation to international prices.

The volatility and wide swings that have characterized the market in the 21st century to date make it difficult to plan ahead with certainty given that the cotton industry currently enjoys no subsidies and has not done so for over 15 years. The issue of subsidies in the developed world (i.e. USA/European Union) has to be addressed under the auspices of the WTO so as to eliminate the distortions that arise through them and thus minimize the negative influence they have on the cotton economies that are unsubsidized.

Countries in Africa also have to take cognizance of the importance of BT cottons, and the lower production costs associated with the technology and introduce same so as to compete with those countries utilizing the technology. The fact that BT cottons now comprise over 30 percent of international cotton trade hints at the influence this technology will have in relation to production costs and international cotton prices and overall viability. Countries that fail to adopt the technology run the risk of becoming the poor cousins of the international cotton community.

Zimbabwe has introduced biosafety regulations which were promulgated in 2000 and field evaluations of BT cottons are underway, with the ultimate aim of transferring the technology into Zimbabwean cultivars. Commercialization, however, is unlikely within the next 3 to 4 years.

Going forward notwithstanding the challenges to hand the future bodes well for cotton in Zimbabwe if all stake holders pull together for the common good of the industry.

SPECIALITIES OF AFRICAN COTTON

I. MALLOUM

Cotontchad, Mondou, Tchad

Editor's Note

A written paper was not provided by the author prior to the conference.

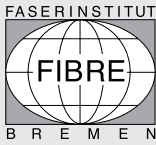
COTTON IN BURKINA FASO

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Editor's Note

A written paper was not provided by the author prior to the conference.



28th International Cotton Conference Bremen
March 22 – 25, 2006



Session V: New Products

- ***Cotton in Fibre-Reinforced Polymers***
Jörg Müssig
- ***Developing Standards to judge Flax Fibre Quality***
Danny Akin

COTTON IN FIBRE-REINFORCED POLYMERS

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ABSTRACT

The use of natural fibres in composites offers an interesting alternative to petrochemical products. In the German and Austrian automotive industry there is an increasing demand over the past years since 1997. Reclaimed cotton is mainly used as a low cost fibre to “fill” composites used as interior parts in the automotive industry. Mechanical requirements of such a composites are low and the potential of the cotton-fibre properties to reinforce plastics is not used adequately. This paper gives background information and discusses the use of the cotton fibres in composites compared to bast fibres like ramie. In this study the fibre strength was tested with a Dia-Stron testing device, fineness was tested with an image analysis system Fibreshape. A roller card with flexible card clothing is well suited to process fibres to a multi layer web. Cotton and ramie fibres were embedded in epoxy resin and a biobased resin PTP[®]. The composites were tested for impact and tensile properties. The results show that mechanical properties of the composites are strongly influenced by fibre properties. The data and results demonstrate the important role force-elongation characteristics of fibre play in optimising the properties of natural fibre composites. Cotton with its morphological and mechanical properties can play a more crucial role to optimise products with a view to improve the impact properties.

INTRODUCTION

The use of natural fibres for reinforcing plastic products is not a new approach but over the last decade it has seen the development of an entirely new market for natural fibres in this area, e.g. the use as plastic panel reinforcement for the interior trim of cars (Müssig, Karus and Franck, 2005).

According to Eisele (1994) the automotive industry has used vegetable fibres for the car interiors since the 1970s. Examples of the use of these fibres in these older models are:

- Jute (*Corchorus capsularis* / *Corchorus olitorius*) needle-felts for sound insulation, placed under the carpet.
- Wadding, based on wool and cotton (genus *Gossypium*) for seats and door trim panels
- Rubberised coir (*Cocos nucifera* L.) upholstery for seats
- Wood fibres for door trim panels.

During the 1970s and 1980s these fibres were partially replaced by petrochemical polymers because of their optimised properties and their faster manufacturing processes. In the mid 80s it was thought that the use of natural fibre reinforced composites could offer an interesting alternative to these plastics due to their technical, economic and ecological advantages and social benefits (Harig and Müssig 1999).

The use of natural fibres in the German and Austrian automotive industry shows an increased demand over the past years since 1997. While in the eighties and the beginning of the nineties mainly ecological arguments were the motive for the use of natural fibres composites, nowadays the favourable mechanical properties and the production costs play a major role. The currently used natural fibre composites are mainly press-moulded parts. They consist of textile semi-finished products from natural fibres and a polymer (thermoset or thermoplast), which are pressed into the desired form. Typical applications are door inserts, hat racks, pillar cover panels and boot linings (Karus and Kaup, 2002).

In 2003 ca. 45000 t of reclaimed cotton fibres were used in the German automotive industry for interior applications. Fibre content of these components was between 60 % and 70 % which results in 79000 t of composite parts and about 8 kg of cotton-fibre composites in a German car (Karus et al., 2005).

Reclaimed cotton is mainly used as low cost fibre to “fill” composites used as interior parts for automotive devices. Mechanical requirements of such composites are low and the potential of the cotton fibre properties to reinforce plastics is not used extensively. Since the late 1980s more publications can be found dealing with finding the limits and advantages of using cotton as an adequate reinforcement fibre.

According to Bollmann et al. (1986) the use of natural fibres like cotton in technical applications has a great potential. They used cotton, hemp (*Cannabis sativa L.*) and jute fibres to reinforce an Epoxy thermoset resin. Beside technical advantages they see economical benefits using natural fibres compared to glass fibre reinforced plastics.

Müller et al. (2001) reported that natural fibres like ramie (*Boehmeria nivea H. et A.*), hemp, flax (*Linum usitatissimum L.*), jute or cotton are well suited for reinforcing polymers. Beside advantages in processing and mechanical properties they focused their work on the evaluation of the acoustical properties of natural fibre reinforced thermoplastics. The behaviour with respect to acoustical parameters of this material is similar to sandwich parts which built up out of glass fibre composites and PU-foam.

To combine natural fibres like cotton with a biodegradable polymer is an innovative concept. Aim is to produce a composite which can be composted after use. Hanselka and Herrmann (1995) see possible applications for biodegradable composites based on renewable resources. In their work they investigated the production of natural fibre reinforced plastics (e.g. cotton). Among testing the mechanical properties they evaluated the biodegradation time of such a composites with different methods. According to their data it is possible to develop biodegradable

composites with good mechanical properties. Important is that biodegradation of technical products starts earliest after usage phase.

Jiang and Hinrichsen (1999 a und b) combined in their work a biodegradable polymer and a fibre based on renewable resources. Biodegradable composites consists of flax and cotton fibres in combination with polyester amide films which were hot pressed using the film stacking process. The aim of their work was to determine the degree and rate of biodegradability of PEA and its composites with natural fibres depending on the thickness of the samples.

Stanojlovic-Davidovic et al. (2005) developed composites based on a starch foam reinforced by natural fibres such as cellulose, hemp, cotton linters and wheat straw. Fibres were used to improve mechanical and water resistance properties of starch foam formulations. In addition, the increase of fibre content resulted in increased water resistance and improved mechanical properties of starch foams. The functional properties of the developed starch foams were comparable with those of polystyrene foams.

Expansion and establishment of products based on natural fibre reinforced plastics is only possible in the long term if databases and further theoretical investigations are developed in order to simulate the structural and processing properties of such materials. Therefore, it is necessary to measure fibre properties in physically exact way and define numerical models which are suitable for natural fibre reinforced plastics (Müssig et al., 2006).

Eichhorn and Young (2003) reported about new possible concepts of the deformation micromechanics of cotton and flax fibres in relation to their use in cellulose-based networks and composite materials. Very important in this context is to know the differences in mechanical and morphological properties of natural fibres like cotton or flax. Based on their function in the plant fibre characteristics like elongation or strength are very different and will influence the properties of the reinforced plastic in different directions. The influence of fibre properties, for instance on tensile properties of composites is, however, not uni-parametric they depend not only on fineness but also on stiffness and force-elongation characteristics of the fibre (Müssig, 2002).

In this paper results are presented which show the influence of force-elongation characteristics of cotton fibres on reinforced thermosets. Two different kinds of thermosets are used; one Epoxy resin based on petrochemical substances and PTP[®] resin based on renewable resources. Goal is to find out how composite properties like strength or impact can be influenced by choosing natural fibres and in which possible applications cotton fibres will play an important role to reinforce plastics.

MATERIALS AND METHODS

Fibres

Cotton fibres

In the experiments the following cotton fibre was used (FIBRE 1994):

- Cotton (*Gossypium hirsutum* L.) species: US Pima
- Mean Length by number (Almeter) Ø 25.13 mm
- Fineness (gravimetric) Ø 1.452 dtex

Ramie fibres

The fibres were made available for the experiments by the company Buckmann, Bremen, Germany. In this case chemically separated Ramie (*Boehmeria nivea* H. et A.) from China that was processed into card sliver and then was used (delivered 2000).

Resin

Epoxy L-135

A duromere 2-component-system was used for the production of the composites. The laminating resin system which hardens at room temperature from the company MGS, Germany which was used, consists of component A, the epoxy-resin L-135 and component B, the hardener 135. The mixing of the resin system took place in a mixing ratio of 100:35 (mass proportions). The gel time with the hardener application here is about 25-30 minutes.

PTP[®]-L

In the trials a thermoset resin PTP[®]-L produced by the company B.A.M., Ipsheim, Germany was used. PTP[®] is manufactured on the basis of renewable resources and has a profile of characteristics in the range of a usual thermoset resins. According to Schönfeld (1996, 2000 & 2005), PTP[®], may be completely produced on the basis of renewable resources.

Fibre testing

Fibre width – Fibreshape

The fibres were conditioned for 24 hours at 20°C and 65% relative humidity. The fibres were placed on a microscope slide with the aid of tweezers and were covered with a second microscope slide. The microscope slides were fixed together with adhesive tape applied to the short sides. 3 microscope slides were prepared per sample. Scanning took place with the instrument Canoscan FS 4000 US and with the scanning software FilmGet FS 1.0 for Windows, where a resolution of 4000 dpi (half-tone picture / positive) and a monitor Gamma-value of 1,57 were selected. The exposure and focus were set to automatic. The analysis of the images took place with the image analysis software DIASHAPE Version 4.2.2 / Software module FIBRESHAPE. The menu setting AFAS 4000.D00 was used. The use of this system to measure cotton fibre width was reported by Schmid et al. (2002)

Single element strength – Dia-Stron

Reproducible methods are required for the determination of the fibre properties providing data best suited to composite material development. A testing instrument from Dia-Stron Ltd., UK, was used to measure the force-elongation characteristics of the cotton and ramie fibres. The individual elements to be tested are glued in order to reduce the influence of clamping and tested at a gauge length of 3.2 mm. The cross-sectional surface area of each element is measured by means of a laser beam. The sample is then automatically transferred to the tensile testing system. After the tensile test, the sample containers are removed and the next samples are tested automatically. 45 individual elements are prepared in advance and are inserted into the system automatically by auto-sampler. The software allows both the determination of surfaces (N/mm^2) and of fineness-related values (cN/tex). The analysis program allows determination of the true zero point, elongation correction, Young's modulus determination and determination of breaking energy. Prior to the measurement the fibres were conditioned for 24 hours at 20°C and 65% relative humidity. 160 elements were tested per sample.

Composite production

Fibre processing

The fibres were oriented to a multi layer web using carding technology. For this experiment a lab roller card (manufactured by Anton Guillot, Aachen, Germany) with a working width of 30 cm was used. The rollers are clothed with flexible card clothing. The used roller card is shown schematically in Figure 1. The produced multi layer webs have a specific weight of about $800 \text{ g}/\text{m}^2$.

Composite production with Epoxy L-135

The required fibre masses for the desired fibre-mass-proportions (30%, 40%, 50% and 60%) were calculated for boards with the dimensions $323 \text{ mm} \times 223 \text{ mm} \times 2 \text{ mm}$. As a spacer an aluminium frame with internal dimensions of $343 \text{ mm} \times 243 \text{ mm} \times 2 \text{ mm}$ was available. For easier removal of the composite panel from the mould, the frame was treated with a parting compound from the company Marbocote. The multi layer web was dried for 2 hours at 105°C before compression moulding and was centred on the bottom pressure plate in the aluminium frame and the resin system was distributed evenly across the web surface. Compression moulding took place with a hydraulic press from the company Rucks Maschinenbau GmbH, Glauchau, Germany (nominal pressure force 1000 kN; pressure table $600 \times 600 \text{ mm}^2$). The pressure was set to 5 MPa and was maintained for at least 12 hours at room temperature. After mould removal the composites were hardened for another 16 hours at a temperature of 45°C in a forced-air-oven (company Memmert, Germany) in order to fully complete the network-reaction (Müssig et al. 2006).

Composite production with PTP[®]-L

The required fibre masses for the desired fibre-mass-proportions (20%, 30%, 40% and 50%) were calculated for boards with the dimensions $323 \text{ mm} \times 223 \text{ mm} \times 2 \text{ mm}$. The same pre-preparations were made and same press was used as for composite production with Epoxy L-135. The pressure was set to 100 bar and was maintained for at least 10 minutes at 160°C .

Composite testing

Tensile properties

The tensile strength and the Young's modulus were determined according to DIN EN 61. For this experiment the composites were cut into waisted specimens (type 1). The experiments with a gauge length of 115 mm were carried out in an Instron universal testing device (Instron 4502) with a power cell of 10 kN . The specimens were fitted in pneumatic strain gauges (Instron 2712) and were tested at a speed of 2 mm/min. Five specimens were tested at angles of 0° and 90° direction respectively.

Impact properties

For Charpy impact strength rectangular specimens (80 mm * 10 mm * thickness) were tested according to DIN EN ISO 179. Impact strength was measured on a Thwing-Albert FRANK testing machine (type 53302) operating with a pendulum length of 225 mm. For each testing procedure five specimens in 0° and 90° direction were examined.

In the presentation of tensile and impact results the values of the matted-fibre-composites are taken from the results of the values in longitudinal and transverse direction.

RESULTS AND DISCUSSION

Fibre testing

Fibre width – Fibreshape

The results of the measurements with the Fibreshape system are shown in Figure 2. In part a) of the graph the fibre-width distribution of the examined cotton fibres can be seen. The mean value of the normal distribution is shown 12.46 µm at a standard deviation of 3.56 µm. It is apparent that the fibre-widths show a relatively normal distribution. As opposed to the cotton fibres the examined ramie fibres (part b of the graph) show a much wider distribution of values. The mean value of normal distribution is 20.30 µm with a standard deviation of 7.62 µm.

Single element strength – Dia-Stron

In Table I the results of the strength tests of the cotton and ramie fibres are summarised. The ramie fibres achieved higher strengths and show less elongation in their median and mean values. As shown in Figure 3 the Ramie fibre is very stiff and the curve is comparable to a glass fibre curve. The cotton fibres achieved half the strength of the ramie fibres in their values, while elongation was more than twice as high. The strength-elongation curve of the cotton fibre is clearly distinguished from the curve progression of the ramie fibre.

Composite testing / Cotton/Ramie-Epoxy L-135

Tensile properties

The results of the Young's modulus determination of the composites with the thermoset resin Epoxy L-135 are shown in Figure 4. Here the mean values of fibre orientation show that there is, in principle, an increase of the tensile module with increasing fibre mass-fraction. The Young's modulus value of the non-reinforced epoxy-matrix (3109 N/mm²) is given for comparison.

The largest influence of fibre mass-fraction on Young's modulus is shown by the ramie fibre composites. At a fibre mass-fraction of 30% a modulus of about 7000 N/mm² is achieved. An increase of the fibre mass-fraction to 60% leads to tensile modulus values of over 10000 N/mm². On the other hand, the reinforcement fibre cotton has only a fairly low effect on the Young's modulus via the fibre mass-fraction. Beside the positive effect of the stronger increase of the modulus via the fibre mass-fraction, the ramie fibre-reinforced composites also achieve the highest absolute values, compared to cotton. The essential reason for this is the higher stiffness of the ramie fibre as compared to cotton (Müssig et al., 2006).

Impact properties

As shown in Figure 5 an increase in impact resistance values can be observed with increasing fibre mass-fraction for ramie and cotton fibres. In the fibre mass-fraction between 40% and 50% the cotton do not increase impact resistance. The introduction of cotton fibres into the composite achieves the highest impact resistance values in comparison to ramie. In this context the fibre characteristics of cotton are of particular importance. The high elongation at acceptable strength (cf. Table I and Figure 3) seems to have a considerable influence here (Müssig et al., 2006).

Composite testing / Cotton/Ramie-PTP[®]-L

Tensile properties – Young's modulus

The results of the Young's modulus determination of the cotton and ramie fibre reinforced PTP[®] resin are shown in Figure 6. The Young's modulus of the non-reinforced PTP[®] resin is given for comparison. Same as for ramie fibre-reinforced Epoxy resin L-135 there is an increase of the Young's modulus with increasing fibre mass-fraction. This trend is much more significant for ramie likewise for cotton in comparison to the reinforced Epoxy resin (compare Figure 4). Cotton/PTP[®]-composites show lower values than ramie/PTP[®]-composites due to the higher stiffness of the ramie fibre (compare Table I and Figure 3). The Young's modulus values of ramie fibre-reinforced PTP[®] resin are slightly lower than the Epoxy L-135 composites values but still on a high level compared to standard natural fibre-reinforced polymers used in the automotive industry (cf. Riedel et al., 2005).

Impact properties

As displayed in Figure 7, an increase in impact resistance values can be observed with increasing fibre mass-fraction for ramie and cotton fibres. The use of cotton fibres in the composite obtains the highest impact resistance values in comparison to ramie.

The strength-elongation characteristic with higher elongation values of cotton fibres in comparison to the stiff Ramie fibre yields in very good impact properties of the composite.

CONCLUSION

The use of natural fibres in the German automotive industry shows an increasing demand over the past years since 1997. In 2003 ca. 45000 t of reclaimed cotton fibres were used in the German automotive industry for interior application which means about 8 kg of cotton-fibre composites in one German car. Reclaimed cotton is mainly used as a low cost fibre to “fill” composites used as interior parts in the automotive industry. Mechanical requirements of such composites are low and the potential of the cotton-fibre properties to reinforce plastics is not used adequately.

Against the background of new passenger safety concept in the automotive industry the impact properties of composites gets more important. As reported by Riedel et al. (2005) in the automotive industry highest impact properties (25 – 35 kJ/m²) can only be achieved by using thermoplast (eg. Polypropylen) composites reinforced with Wood or Bast fibres. Improved impact by using thermoplast results in tensile strength, lower stiffness values and a reduced glass-transition temperature of the composite. Using cotton fibres in combination with a plant-oil based polymer like PTP[®] enables the combination of thermoset composites with high stiffness values and improved glass transition temperature as well as good impact properties.

The use of natural fibre reinforced polymers will grow in the future not only in the automotive industry but also in applications in the consumer market. Cotton fibre with its morphological and mechanical properties can play a more important role to optimise products with the view on improved impact properties.

ACKNOWLEDGEMENTS

The author thanks Mr. Sebastian Rau and Mrs. Birgit Pfeiffer for their support in the fibre quality measurements and the composite production and testing. We are much indebted to Mr. Uwe Schönfeld, Leader of R&D at the company Bio-Composites And More GmbH, Ipsheim, Germany for providing us with the biobased resin PTP[®]-L and his support.

FIGURES AND TABLES

Table I. Strength values of cotton and ramie measured with Dia-Stron

	<i>Break load in N</i>	<i>Corrected break strain in %</i>	<i>Strength in cN/tex</i>	<i>Strength in N/mm²</i>	<i>Young's modulus in N/mm²</i>	<i>Extension work in μJ</i>
<i>Cotton</i>						
<i>Median</i>	0.067	6.7	45.6	684.0	12000	10.1
<i>Mean</i>	0.071	7.3	47.2	709.1	12890	11.0
<i>Ramie</i>						
<i>Median</i>	0.512	3.7	82.0	1279.0	35300	31.2
<i>Mean</i>	0.552	3.8	80.8	1261.1	36078	37.9

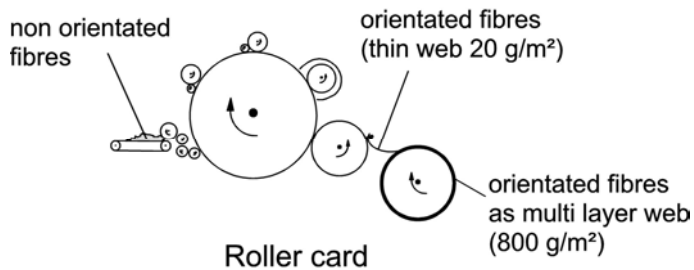


Figure 1. Fibre processing with a roller card (Müssig, 2002)

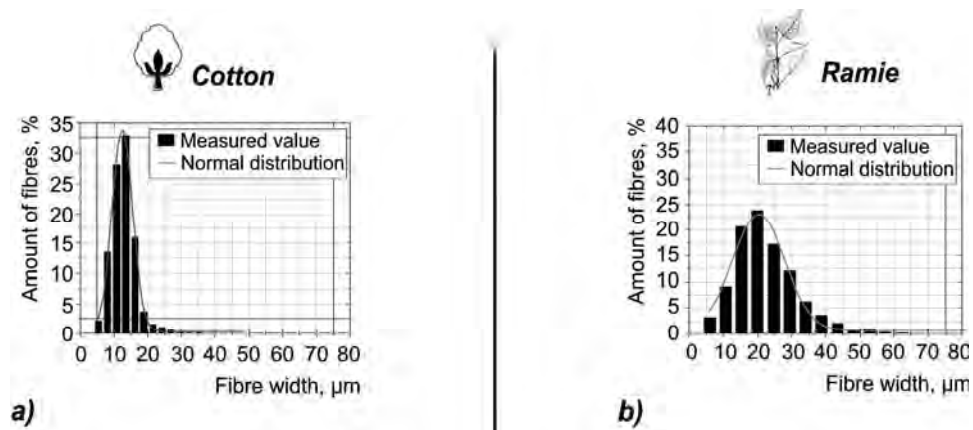


Figure 2. Fibre width distribution of cotton a) and ramie b) measured with Fibreshape (Müssig et al., 2006)

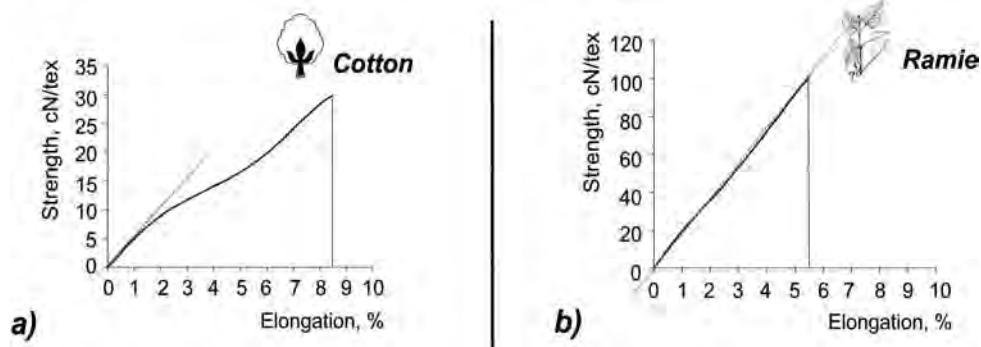


Figure 3. Strength-elongation curve of cotton a) and ramie b) (Müssig et al., 2006)

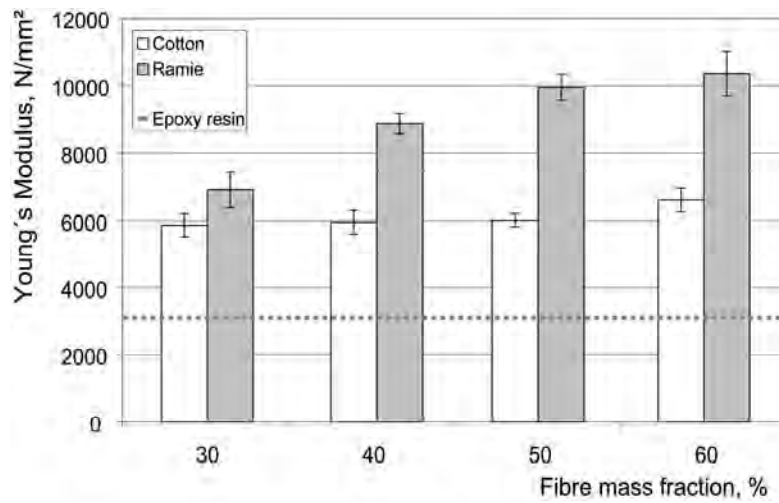


Figure 4. Young's modulus of cotton and ramie fibre reinforced Epoxy L135 resin

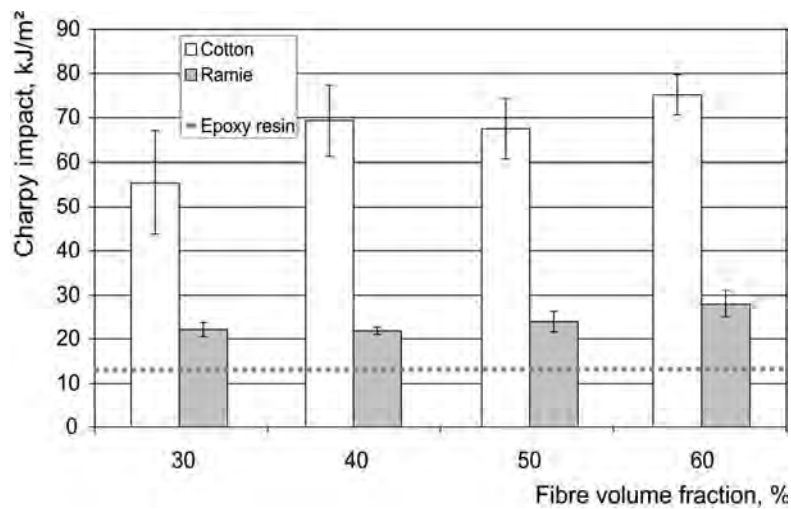


Figure 5. Charpy impact of cotton and ramie fibre reinforced Epoxy L135 resin

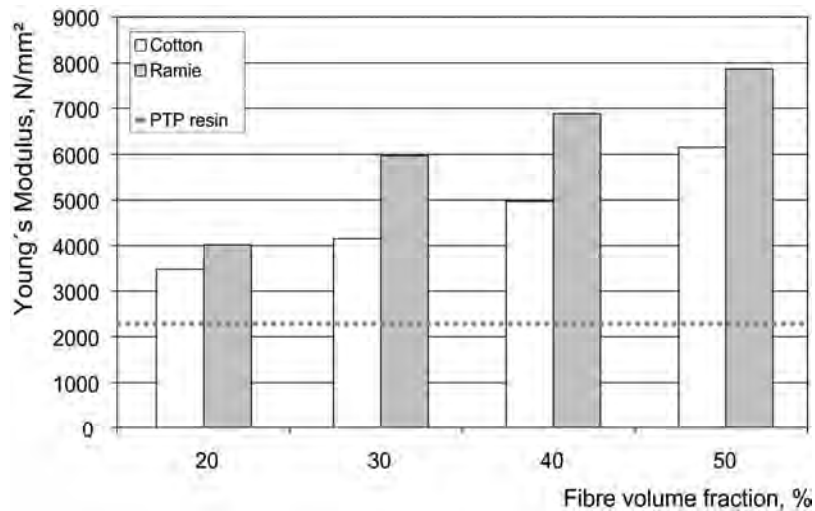


Figure 6. Young's modulus of cotton and ramie fibre reinforced PTP[®] resin

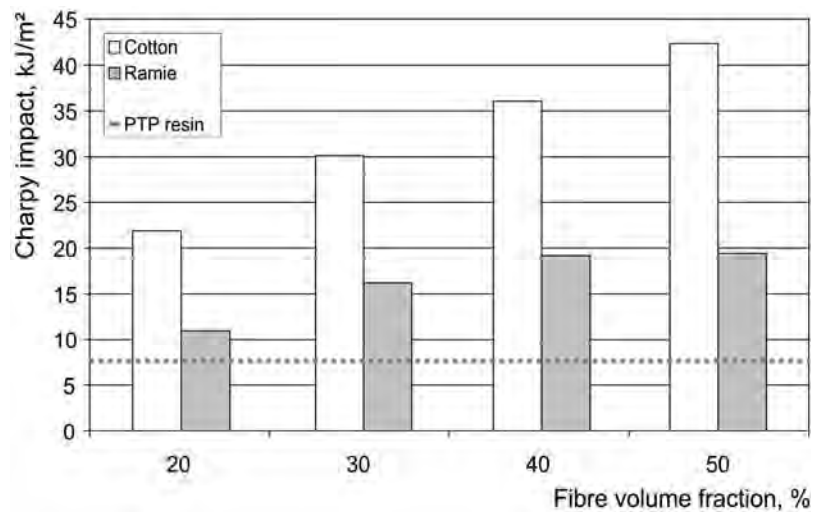


Figure 7. Charpy impact of cotton and ramie fibre reinforced PTP[®] resin

REFERENCES

Bollmann, G. / Hartmann, S. / Reiff, K. 1986: *Festigkeit von naturfaserverstärkten Kunststoffen*. Conference presentation: Verbundwerkstoffe, Kontaktstudiengang und werkstofftechnisches Kolloquium, Fachhochschule Osnabrück, Germany, 9.5. 1986 (1986), p. 156 – 170

Eichhorn, S.J. / Young, R. J. 2003: *Deformation micromechanics of natural cellulose fibre networks and composites*. In: *Compos. Sci. Technol.* , 63. Vol. (2003), No. 9, p. 1225 – 1230

Eisele, D. (1994): *Faserhaltige Bauteile für die Automobilausstattung - Zur Leistungsfähigkeit von Naturfasern* -. textil praxis international (Jan./Feb. 1994), (ISSN 0040-4853), p. 68 - 76

FIBRE 1994: *Bremer Baumwoll-Rundtest 1994/1 – Auswertung der Testergebnisse – Evaluation of the test results*. Faserinstitut Bremen e.V. – FIBRE –, Bremer Baumwollbörse (Editor): Bremen, Germany 1994, p. 1 – 18

Hanselka, H. / Herrmann, A.-S. 1995: *Kompostierbare Faserverbund-Bauteile aus nachwachsenden Rohstoffen. Compostable fibre composite components from renewable raw materials*. Presentation: 7th Int. Techtexil Symposium, Neue Verbundtextilien und Composites, Textilarmierte Werkstoffe Teil 2, (Messe Frankfurt GmbH, Frankfurt, Germany) , Proceedings p. 1 - 8.

Harig, H. / Müssig, J. 1999: *Heimische Pflanzenfasern für das Automobil*. In: Harig, H. / Langenbach, C.J. (Editor): *Neue Materialien für innovative Produkte - Entwicklungstrends und gesellschaftliche Relevanz*. Bd. 3. Berlin, Germany: Springer Verlag, 1999 (Wissenschaftsethik und Technikfolgenbeurteilung), (ISBN 3-540-66063-1), p. 235 - 251

Jiang, L. / Hinrichsen, G. 1999a: *Flax and cotton fiber reinforced biodegradable polyester amide composites, 1 - Manufacture of composites and characterization of their mechanical properties*. In: *Angew. Makromol. Chem.* Vol. 268. (1999), p. 13 – 17

Jiang, L. / Hinrichsen, G. 1999b: *Flax and cotton fiber reinforced biodegradable polyester amide composites, 2 - Characterization of biodegradation*. In: *Angew. Makromol. Chem.* Vol. 268. (1999), p. 18 - 21.

Karus, M. / Kaup, M. 2002: *Natural Fibres in the European Automotive Industry*. In: *Journal of Industrial Hemp* (ISSN 1537-7881), Vol. 7, Number 1 (2002), S. 119 – 131

Karus, M. / Ortmann, S. / Vogt, D. 2005: *All Natural on the Inside – Natural fibres in automotive interiors*. In: *Kunststoffe plast europe* (ISSN 0945-0084), 7 (2005), p. 1 - 3

Müller, D. H. / Krobjilowski, A. / Müssig, J. 2001: *Molded Fiber-Reinforced Parts - Special Properties and Influencing Parameters*. In: National Cotton Council of America (Editor & Organiser): **FOURTH INTERNATIONAL NONWOVENS SYMPOSIUM** during the Beltwide Cotton Conferences (Anaheim, CA, USA 2001-01-12 till 2001-01-13) Memphis, TN, USA: National Cotton Council of America, 2001, (2001 Fourth International Nonwovens Symposium)

Müssig, J. 2002a: *Influence of fibre fineness on the properties of natural fibre composites*. In: Universität Gh Kassel, Institut für Werkstofftechnik, Kunststoff- und Recyclingtechnik (Editor and Organiser): **4th International Wood and Natural Fibre Composites Symposium** (4. Internationale Tagung) (Kassel 2002-04-10 till 2002-04-11) Kassel, Germany: Institut für Werkstofftechnik, 2002, S. 5-1 - 5-12 .- Proceedings, Paper-No. 5

Müssig, J. / Karus, M. / Franck, R. R. 2005: *Bast and Leaf Fibre Composite Materials*. In: Franck, R. R. (Editor): *Bast and other plant fibres*. Cambridge, UK: Woodhead Publishing, 2005, (ISBN1-85573-684-5), p. 345 – 376

Müssig, J. / Rau, S. / Herrmann A. S. 2006: Influence of fineness, stiffness and load-displacement characteristic of natural fibres on the properties of natural fibre-reinforced polymers. In: *Journal of Natural Fibers* (ISSN: 1544-0478), Volume: 3 Issue: 1 (2006), p. 59 - 80 .- in press

Riedel, U. / Gassan, J. / Karus, M. / Müssig, J. / Prömper, E. / Schönberger, D. / Sperber, V. 2005: Technical and economical framework for parts based on natural fibre composites. In: Arbeitsgemeinschaft Verstärkte Kunststoffe - Technische Vereinigung e.V. (AVK-TV) (Editor & Organiser): Internationale AVK-TV Tagung für verstärkte Kunststoffe und duroplastische Formmassen (8. Internationale AVK-TV Tagung) (Baden-Baden, Germany 2005-09-27 till 2005-09-28) Frankfurt/Main, Germany: AVK-TV, 2005, p. A 3-1 - A 3-11 .- Manual

Schmid, H. / Müssig, J. / Gerardi, H. 2002: *Image scanning for measurement of cotton fibre width*. In: ITMF International Committee on Cotton Testing Methods (Editor): *Proceedings of the General Assembly Bremen, March 12 - 13, 2002*. Zürich, Switzerland: ITMF, 2002, (Committee Proceedings CD version), Working Group: Fineness & Maturity, Appendix: FM-10, p. 156 - 162

Schönfeld U. 1996: *Polymerwerkstoff, Verfahren zu seiner Herstellung und dessen Verwendung*, European Patent, EP0836 627, 1996

Schönfeld, U. 2000: *Epoxydharz aus nachwachsenden Rohstoffen*. 8. Symposium „Im Kreislauf der Natur - Naturstoff für die moderne Gesellschaft“ *Nachwachsende Rohstoffe auf dem Weg ins 21. Jahrhundert*, (3. till 4. July 2000 in Würzburg, Germany). C.A.R.M.E.N. (Organiser), Proceedings

Schönfeld, U. / von Buttlar H.B. / Dippon K. / Müssig J. / Schmehl M. 2005: *Halbzeugentwicklung auf der Basis Nachwachsender Rohstoffe für SMC-Anwendungen*. In: Arbeitsgemeinschaft Verstärkte Kunststoffe - Technische Vereinigung e.V. (AVK-TV) (Editor & Organiser): Internationale AVK-TV Tagung für verstärkte Kunststoffe und duroplastische Formmassen (8. Internationale AVK-TV Tagung) (Baden-Baden, Germany 2005-09-27 till 2005-09-28) Frankfurt/Main, Germany: AVK-TV, 2005, p. B 11-1 - B 11-9 .- Manual

Stanojlovic-Davidovic, A. / Bergeret, A. / Benezet, J. C. / Ferry, L. / Crespy, A. 2005: *Biodegradable composites based on starch foam reinforced by natural fibers: study of the properties in relationship with the microstructure*. In: Royal Institute of Technology (Organiser & Editor): *EcoComp 2005*. (Stockholm, Sweden, 2005-06-20 till 2005-06-21) Stockholm, Sweden: Universitetsservice US AB (www.us-ab.com), 2005 (3rd International Conference on Eco-Composites),.- Conference proceedings & CD-ROM Proceedings

DEVELOPING STANDARDS TO JUDGE FLAX FIBRE QUALITY

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ABSTRACT

Unlike cotton, flax and other bast fibres do not have objective standards for testing or classification. Flax fibres are evaluated and graded within countries or individual companies, but only one test method (ISO 2370 for flax fibre fineness) is recognized on an international level. Marketing of flax fiber is generally based on subjective methods of evaluation, but strong interest has existed for developing objective standards such as those that exist for cotton. Subcommittee D13.17 of ASTM International was established in 1999 as part of the Textile Committee with the goal of developing standards for flax fibre. Currently, four standards have been approved through the ASTM International and include standards for 1) terminology, 2) color, 3) fineness, and 4) shive content. These standards were developed through “within laboratory” data and are valid for 5 years. Round robin tests must be carried out in several laboratories to re-certify the methods. Research continues using near infrared and mechanical methods for standards related to other flax fibre properties.

INTRODUCTION

Webster’s Collegiate Dictionary defines a standard as: 1) “something that is established by authority, custom, or general consent as a model or example, and 2) something that is set up and established by authority as a rule for the measure of quantity, weight, extent, value, or quality”. Standards are necessary to assure uniform quality and performance and for commercial exchange. Natural fibers, such as cotton and flax/linen, by their nature are variable, and standards are needed for trade and by manufacturers of textiles and other fibre products. Without standards, manufacturers are without knowledge of how to set equipment for optimum production, which affects efficiency (e.g., downtime) and product quality, or of how best to use available resources. With a global economy, natural fibres can be produced in extremely different climates and under myriad production systems, further contributing to variations in fiber properties and quality.

Objective standards are generally lacking to facilitate marketing and utilization of flax fibres, despite the fact that flax is the source of linen and is one of the oldest textile fibres known (Sharma and Van Sumere, 1992). Long-line fibres are used for traditional linen, while the shorter tow fibres are used for textiles (blends), composites, and specialty paper/pulp. In addition to these industrially important fibres, flax is the source of linseed, from which is derived a highly prized industrial drying oil used in paints and varnishes and also a nutraceutical oil with high levels of 3-omega linolenic acid. It is appropriate that the scientific name (*Linum usitatissimum* L.) is translated as “linen most useful” because of the crop’s versatility and production in a variety of climates throughout the world.

US COTTON AS A MODEL FOR STANDARDS

The general business and trade practices related to cotton and its standards in the US provide an important example for flax fibers, particularly as designed for blending with cotton and other fibers on short staple spinning systems. As far back as the early 1900s, the US cotton industry recognized the need for standards to address problems related to marketing. A resolution was adopted in 1907 to establish uniform cotton standards “to eliminate price differences between markets, provide a means of settling disputes, and 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” (United States Department of Agriculture, 1995). Over the next several years, laws were enacted authorizing the United States Department of Agriculture (USDA) to develop cotton grade standards. Considerable evolution related to grading methods has occurred over the years and work continues to modify and improve standards for cotton (Schneider et al., 2002). The Agricultural Marketing Service, an agency of USDA, uses the term “cotton classification” to refer to application of standardized procedures for measuring physical and aesthetic attributes of raw cotton that affect quality of products or manufacturing efficiency. Currently, properties of almost every bale of cotton produced in the U.S. are analyzed and classified within just a few seconds by HVI (High Volume Instrumentation). Properties included in this analysis are: strength, length and length distribution, fineness, color, and trash.

FACTORS INFLUENCING QUALITY IN BAST FIBRES

The commercially useful fibres of flax, as well as other bast plants such as kenaf and hemp, are called bast fibres because they are produced in bundles in the cortical region between the outer epidermal cell layers and lignified inner core tissues of the stem (Figure 1).

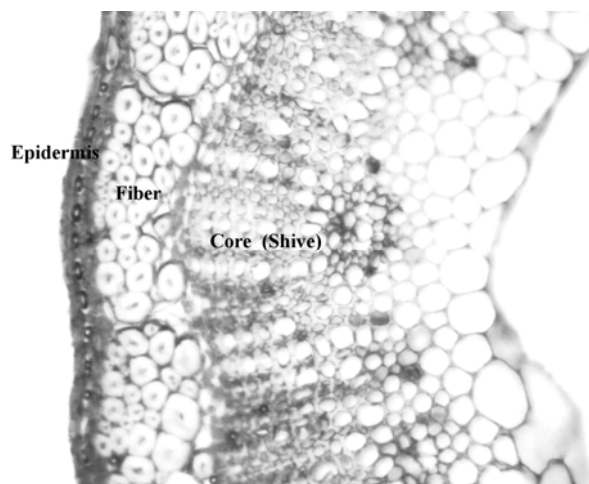


Figure 1. Light microscopy of cross section of flax stem showing the location of the bast fibre bundles (Fiber) between the lignified core cells and the epidermis. The shive originates from the core cells and are contaminants in fibre. The epidermis, which is covered with the waxy cuticle, is toward the outside protecting the stem tissues, and these fragments can also contaminate fibre.

Harvested bast plants are retted to obtain fibres (Van Sumere, 1992). Retting is usually a microbial process where plant pectin is degraded, and bast fibres consequently separate from non-fibre materials. The quality of retting exerts a large influence on the yield and quality of the resulting fibres. Dew-retting is the most widely used method today, and it is generally agreed that the best dew-retted fibre is produced in Normandy (northern France), Belgium, and The Netherlands. Because of the climate and the producers' skill and expertise, the quality is prized and rewarded, but even under these conditions fibre quality is variable and crop losses occur about one-third of the time. Most of the flax fibre is produced under less ideal conditions, and as a consequence commercial flax fibre can be extremely variable in quality. In China, 80% of the flax fiber production is reported to be by warm water retting, with low yields and moderate quality (Euroflax Newsletter, 2004). Because of problems in both water and dew retting, considerable research has been done and is continuing to find a chemical or enzymatic retting method (Akin et al., 1999b; Van Sumere, 1992), but no suitable alternative methods are yet commercially used. Fibres produced by these newer methods may have different properties than those from traditional methods.

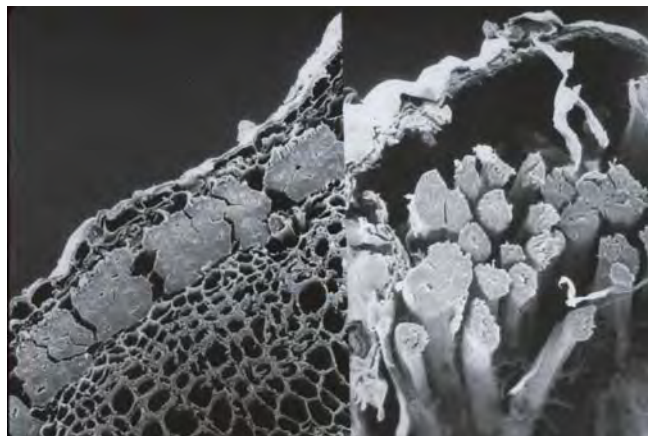


Figure 2. Scanning electron microscopy of unretted (left) and dew-retted (right) flax stems. Dew-retting separates the fibre bundles into ultimate fibres and smaller bundles of various sizes and also separates them from the core (not shown in this image) and the epidermis/cuticle.

Traditional linen in Europe is constructed with long-line fibres from scutching and hackling operations, but many industry analysts indicate greater amounts of short staple fibers will be used in textiles for blending with cotton or other fibres. Traditionally, short flax fibres, called tow, arise as by-products of scutching or hackling and are used in textile blends and applications other than textiles. Processing lines such as the Unified Line of Czech Flax Machinery or Lin Line of Temafa (Germany) produce a “total fibre” from flax stems, without traditional long line and tow products. Flax fibres may be “cottonized”, i.e., refined and shortened, for use in short staple spinning or for other applications (McAlister et al., 2002). With increasing interest in the use of natural fibres for composites in the automotive sector and other large industrial users, flax fibres could come from very diverse,

non-traditional sources. For example, linseed straw, which is a waste product of the linseed industry, is available in large amounts and currently has little value (a small percentage is used for specialty paper). While considered inferior in quality to fibre flax, fibres from linseed straw could be better processed and provide a higher value product for particular applications. Various cultivars and production practices also influence fibre yield and quality. Marketing and utilization of flax fibres from these diverse sources indicate the necessity for internationally recognized, uniform, and objective standards for judging fiber quality for trade and for optimal processing and applications.

HISTORICAL PERSPECTIVE AND INTEREST IN STANDARDS FOR FLAX FIBRES

Flax fibre is traditionally bought and sold by the subjective judgment of experienced graders who appraise by look and feel (Ross, 1992). Grading systems for traditional linen assess fineness, length and shape of fibers, strength, density, luster, color, handle, parallelism, cleanliness, and freedom from neps and knots. Various classification schemes that include the source (e.g., Belgium, France, Russia, or China), processing history (e.g., water- or dew-retted), or application (e.g., warp or weft yarn) have been used within an industry segment. The linen industry, which is small, sufficient, and self-contained, has not actively promoted the development of objective standards and continues to rely upon the subjective, organoleptic methods. Within particular countries (e.g., Czech Republic, Germany, Poland, Russia), measurement of flax fibres is done by more or less consistent means and, therefore, a limited classification system may exist. For example, in past years Russia used an elaborate judging and grading system for commerce and processing of flax (Pfefferkorn, 1944). Grades of flax fibres for various uses (e.g., cottonized fibres) are identified for marketing within a company.

Several instruments that objectively and rapidly analyze cotton were evaluated for application to testing flax fiber in trials with Zellweger Uster (Knoxville, TN) and the IAF (Reutlingen, Germany) (Anja Schleth, personal communication). While some success occurred with modifications in hardware and software of the cotton equipment, the performance required was not reached. In order to measure flax fibers successfully with cotton equipment, a major redesign in the mechanics and software of instruments, such as the AFIS (Automated Fiber Information System) and HVI (High Volume Instruments), was needed. The amount of development necessary, along with predicted small market size and lack of standards, caused Zellweger Uster to discontinue work. Other groups, e.g., IAF and Applied Science Division, Dept. Agric. Northern Ireland, continue to research rapid methods for flax fiber assessment.

While marketing of flax fibre is generally based on subjective methods, strong interest exists for developing objective standards and a classification system such as those that exist for cotton. While methods are available to characterize flax (van Langenhove and Bruggeman, 1992), only one international standard - ISO 2370 (1980) for flax fibre fineness – has been available over a long time period (Euroflax Newsletter, 2002). The variation in characteristics and potential for large and expanded uses in a variety of industries has resulted in considerable interest and

new calls for development of standards for flax fibres, and bast fibres generally (van Dam et al., 1994). For example, the Cost (European Cooperation in the field of Scientific and Technical Research) Action 8475 of the European Union (Textile Quality and Biotechnology), which operated until 2005, stated an objective of acquiring knowledge “to set up quality standards for assessing flax fibre” (Euroflax Newsletter, 2002). In the US, subcommittee D13.17 (Flax and Linen) was officially formed in 1999 and began biannual meetings as part of the Textile Committee of ASTM International. From research among various collaborators and this D 13.17’s actions, a series of standards has been approved as test methods for flax (Akin, 2005).

DEVELOPMENT OF SPECIFIC STANDARDS

Terminology

Under current rules, all committees in ASTM International must have a terminology standard related to their subject. Lengthy discussions over several meetings were required to reach agreement on precise terminology for flax. Research was undertaken to assure that terms were not counter to accepted language in Europe or other regions with a long history of flax. Patricia A. Annis, Department of Textiles, Merchandising & Interiors, University of Georgia, serves as technical advisor and led in writing and updating the document as discussions occurred. “Standard Terminology Relating to Flax and Linen” D 6798-02 was approved in 2002 as the first standard under D 13.17.

Color

The natural color of flax fibre is light amber. Retting methods, however, influence the color of processed fibres (Table I). Water-retting results in a light-colored fiber. Dew-retting, in contrast, imparts varying degrees of gray to black to the fibres, depending upon the extent of retting among other factors. Experimentally produced enzyme-retted or chemical-retted fibres are very light due to some bleaching action of the chemicals. In addition to lightness, color measurement systems can show other color scales, such as the red-green and yellow-blue, and thereby provide additional information. In one study, the water and dew retted fibres differed in yellow values (Table I). In practical usage, much of the flax fibre is blended among harvests to have consistent color in the final product. The use of a standard method for color values could help in blending for particular properties of a fiber sample arising from a variety of sources and processing methods. Helen H. Epps, Department of Textiles, Merchandising & Interiors, University of Georgia, served as technical advisor and led research, writing, and updating of a document for developing a test method for color. The use of CIELab measurements provided an established means for objective color determination using three factors: black to white (L^* value), green to red (a^* value), and blue to yellow (b^* value) (Epps et al., 2001). With this method, problems related to color matching can be more objectively addressed to provide better use of flax from a broad production system. “Standard Test Method for Color Measurement of Flax Fiber” D- 6961- 03 was approved in 2003.

Table I. CIELAB Color Values of Flax Fibers Retted by Various Means

Samples	L*	a*	b*
Dew retted (Natasja)	59.92	2.50	10.26
Dew retted (Viking)	57.88	2.27	9.99
Water retted # 1	66.80	2.67	14.20
Water retted # 2	68.28	2.53	14.89
Enzyme retted (Ariane)	76.20	2.31	14.03
Calibration cotton	90.00	1.38	12.66

Adapted from Akin et al., 2000

Fineness

Fineness is one of the most important properties for textile fibers. A European effort in the 1970's resulted in ISO 2370 (1980), which estimated fineness using air flow. An air flow test, based on a modified cotton micronaire system (ASTM D 1448-97) was developed (Akin et al., 1999a) using a series of flax fiber grades purchased from the Institut Textile de France, Lille (now the Institut Francais Textile – Habillement). This test provides a number as a comparative

Table II. Flax fibre fineness - image analysis and airflow

Fiber sample (ISO Fineness) ^a	Frequency of occurrence of fiber widths by image analysis:				Airflow fineness ^b
	10-30	40-100	110-200	210-300	
	Φ m	Φ m	Φ m	Φ m	
B (21.7)	76.3	19.6	4.1	0	3.7
C (23.5)	75.5	21.7	2.2	0.6	4.1
D (28.7)	65.2	28.9	5.2	0.7	4.6
E (32.0)	72.3	22.3	4.2	1.2	4.4
F (33.7)	65.4	27.4	6.4	0.8	5.2
G (39.1)	65.4	26.8	7.4	0.4	5.1
H (46.1)	58.1	29.7	10.3	1.9	6.0
I (50.5)	60.9	28.3	9.5	1.3	6.6
J (72.1)	46.1	36.3	13.7	3.9	7.4

^a IFS Standards (and airflow values for fineness) from Institut FrancaisTextile - Habillement.

^b Modified cotton micronaire method using 5.0g flax fibers cut to 2.5 cm, which resulted in a reading within the accepted range for the micronaire. Adapted from Akin et al., 1999b

score for ranking fibers, but does not permit the same units and use as cotton microaire. This ranking showed good agreement with fiber widths, particularly the finest categories, determined by image analysis (Table II). Jonn A. Foulk, ARS-USDA, Cotton Quality Research Station, Clemson, SC, is technical advisor for the Task Group and led the continuation of research and writing of a fineness document for subcommittee D 13.17. This proposed test method contains two options: 1) airflow resistance, and 2) estimated mass per unit length. For this document, Foulk obtained viscose rayon fibers of various deniers and used these as criteria for further development of the method. "Standard Test Method for Assessing Clean Flax Fiber Fineness" D-7025-04a was approved in 2004.

Shive content

The presence of non-fibre, trash particles contaminates fibres and is particularly troublesome in high-value products like textiles. The amount of non-fibre contaminants depends upon the quality of retting to a large extent. After retting and subsequent cleaning, shives (i.e., lignified core tissue) and cuticularized epidermis often still remain with the fiber. Production efficiency, e.g., spinning of yarn without interruption, and final product quality are both diminished with trash. A major problem with flax is the presence of shive in fibre products. Flax fibres are mostly cellulose, i.e., around 65-89%, with other non-cellulosic sugars present. The shives contain substantially more aromatics and lignin than fibers, and the different chemistries of these components provide a relatively easy way for differentiation. Table III shows variations in chemical components of bast fibers and shive.

A model was developed using near infrared spectroscopy for a series of mixtures with exact proportions (by weight) of ground fiber and shive. W. Herbert Morrison III, as the technical advisor for this Task Group of subcommittee D 13.17, led in developing the standard. Franklin E. Barton II and Miryeong Sohn provided expertise in NIR spectroscopy (Barton et al., 2002; Sohn et al., 2004). "Standard Test Method for the Measurement of Shives in Retted Flax" D-7076-05 was approved in 2005 and is the latest standard developed by subcommittee D 13.17.

Table III. Carbohydrate and aromatic constituents in flax fractions

Fraction	Non-cellulose carbohydrates	Glucose	Aromatics
	-----mg/g-----		
Shives	215	270	10
Bast Fiber	107	417	3

Data adapted from Akin et al., 1996.

Summary of Standards

The four standards approved to date by ASTM International through subcommittee D 13.17 are listed in Table IV. The standards for color, fineness, and shive content were based on intra-laboratory data; obviously, there is no bias for different laboratories with these standards. Their acceptance is valid for 5 years. After that

time, inter-laboratory data are required for validation. Round robin collaborators are being contacted to establish future round robin tests.

Table VI. Flax standards to date under subcommittee D 13.17 of ASTM International^a

Name of standard	Designation	Approved
Standard Terminology Relating to Flax and Linen	D-6798-02	2002
Standard Test Method for Color Measurement of Flax Fiber	D-6961-03	2003
Standard Test Method for Assessing Clean Flax Fiber Fineness	D-7025-04a	2004
Standard Test Method for the Measurement of Shives in Retted Flax	D-7076-05	2005

^aAnnual Book of ASTM Standards, Vol.7 (latest edition published in 2005).

FUTURE STANDARDS

The properties for which standards have already been developed are some of those commonly required for typical fibre applications. Standards for fiber strength and length are two others that require future action. The use of HVI (High Volume Instruments), which has been developed for the cotton industry, could provide an appropriate strategy for rapid testing if modifications could be made for flax fibre. The general idea of force to break a certain fiber mass could be considered for a variety of methods. Fibre length may be more problematic. While long line fibre for high-value textiles has a minimum length of about 50 cm, tow or “total fibre” where fibre is non-uniform and non-aligned from the whole plant could be extremely variable. Methods used for cotton or with newer image analysis systems will likely provide the starting point for fibre length standards in flax. Average values plus distribution of parameters are needed for bast fibers.

Recent attempts have been made to use rapid, spectroscopic methods to assess flax fiber quality in place of more time-consuming, physical methods. Models using near-infrared reflectance spectroscopy have been used for several parameters: fibre content in intact stems (Barton et al., 2002), degree of retting (Archibald and Akin, 2000), and flax content in linen/cotton blended fabrics (Sohn et al., 2005). Near infrared spectroscopy using particular wavelength ranges has been used to assess flax fiber fineness using calibration data from derivative thermogravimetric analysis and airflow methods (Faughey and Sharma, 2000). The spectroscopic methods require calibration sets from some other assessment method, e.g., wet chemical, strength, fineness. These methods offer a potential strategy, by rapid and non-destructive means, to develop standards for an objective classification system for flax fibres. While a near infrared model has been developed and a standard approved to predict shive content, the presence of cuticularized epidermis, having a high level of wax and cuticle along with aromatics, may call for another model, or modification, in further refinements of the near infrared method.

CONCLUSIONS

Unlike many fibres, flax does not have a uniform set of objective standards to judge quality. The broadening use of flax and the production from diverse sources call for objective standards for efficient processing, application, and marketing potential. The traditional linen industry depends primarily upon long-used organoleptic tests for quality. Interest is strong, however, for broadly recognized, uniform, and objective tests to measure properties of flax fiber that could be used in myriad applications. Subcommittee D 13.17 of the Textile Committee of ASTM International has been active since 1999 in developing standards for flax fibres, and to date four standards have been produced. Existing fiber methods have been adapted to flax where appropriate, but new technologies are being used for rapid, non-destructive testing. Subcommittee D 13.17 is currently active and meets regularly during ASTM's "Textile Committee Week". John A. Foulk currently serves as chair of this subcommittee.

ACKNOWLEDGMENTS

The author gratefully acknowledges the following as technical advisors and leaders in research and authoring documents resulting in standards: P. A. Annis and H. H. Epps, Department of Textiles, Merchandising & Interiors, University of Georgia, for terminology and a color test method, respectively; J. A. Foulk, Cotton Quality Research Station, ARS-USDA, Clemson, SC, for fineness test method; W. H. Morrison III, with assistance from F. E. Barton II and Miryeong Sohn, for shive content test method. The author also thanks the following for numerous contributions on research and evaluations related to standards: D.D. McAlister III, formerly of the Cotton Quality Res. Station, ARS-USDA, Clemson, South Carolina; R. B. Dodd, Clemson University; Brad Reed, Cotton Quality Research Station, ARS-USDA, Clemson; Luanne L. Rigsby, Quality Assessment Research Unit, ARS-USDA, Athens, Georgia; and Alvin Ulrich, Biolin Research Corp, Saskatchewan, Canada. The author is grateful to Adi Chehna, Textile Tech Services, Lowell, Massachusetts, and Vince Diaz, Atlantic Thread and Supply Company, Inc., Baltimore, Maryland for the many suggestions and contributions toward writing and approval of documents by ASTM International.

REFERENCES

- Akin, D.E. Standards for flax fiber. 2005. Standardization News September issue: 22-25.
- Akin, D. E., G. R. Gamble, W. H. Morrison III, L. L. Rigsby, and R. B.Dodd. 1996. Chemical and structural analysis of fiber and core tissues from flax. *J. Sci. Food Agric.* 72:155-165.
- Akin, D.E., L.L. Rigsby, and W. Perkins. 1999a. Quality properties of flax fibers retted with enzymes. *Textile Res. J.* 69:747-753.
- Akin, D. E., I. R. Hardin, L. L. Rigsby, and H. H. Epps. 1999b. Properties of enzymatically retted flax for linen fiber, pp. 486-492. *Book of Papers, American Association of Textile Chemists and Colorists, Research Triangle Park, NC.*

Akin, D. E., H. H Epps, D. D. Archibald, and H. S. S. Sharma. 2000. Color measurement of flax retted by various means. *Textile Res. J.* 70(10):852-858.

Annual Book of ASTM Standards. Vol . 7 Textiles. ASTM International, Westshohocken, PA.

Archibald, D.D., and D.E. Akin. 2000. Use of spectral window preprocessing for selecting near-infrared wavelengths for determination of the degree of enzymatic retting of intact flax stems. *Vibrational Spectrosc.* 23:169-180.

ASTM D 1448-97. Standard test method for micronaire reading of cotton fibers. *In Annual Book of ASTM Standards, Sec. 7, Textiles*, ASTM, West Conshohocken, PA.

Barton, F.E., II , D.E. Akin, W.H. Morrison, A. Ulrich, and D.D. Archibald. 2002. Analysis of fiber content in flax stems by near-infrared spectroscopy. *J. Agric. Food Chem.* 50:7576-7580.

Euroflax Newsletter, vol. 17 (1), Information Bulletin of the FAO European Cooperative Research Network on Flax and Other Bast Plants, Inst. of Natural Fibers, Poznan, Poland. pp 15-16.2002.

Euroflax Newsletter, vol. 21 (1), Information Bulletin of the FAO European Cooperative Research Network on Flax and Other Bast Plants, Inst. of Natural Fibers, Poznan, Poland. p. 7. 2004.

Epps, H.H., D.E. Akin, J.A. Foulk, and R.B. Dodd. 2001. Color of enzyme-retted flax fibers affected by processing, cleaning, and cottonizing. *Textile Res. J.* 71:916-921.

Faughey, G.J., and H.S.S. Sharma. 2000. A preliminary evaluation of near infrared spectroscopy for assessing physical and chemical characteristics of flax fibre. *J. Near Infrared Spectr.* 8:61-69.

International Standard (ISO) 2370. 1980. Textiles - determination of fineness of flax fibres-permeametric methods. International Organization for Standardization.

McAlister, D.D. III, J.A. Foulk, D.E. Akin, and P.A. Annis. 2002. Cotton fibres: properties and interaction with flax fibres in blends: focus on rotor spun yarn. pp. 207-211. 26th International Cotton Conference Bremen. Faserinstitut, Bremen, Germany.

Pfefferkorn, R. 1944. Oregon Fiber Flax for an American Linen Industry, O. S. C. Cooperative Association, Corvallis, Oregon, 46p.

Ross, T. 1992. Preparation and spinning of flax fibre. pp. 275-296. *In The Biology and Processing of Flax*, H.S.S. Sharma and C.F. Van Sumere (eds.), M Publications, Belfast, Northern Ireland.

Schneider, T., S.A. Heap, and J.C. Stevens. 2002. 26th International Cotton Conference Bremen. Faserinstitut, Bremen, Germany, 247 p.

Sharma, H.S.S., and C.F. Van Sumere (editors). 1992. *The Biology and Processing of Flax*, H.S.S. Sharma and C.F. Van Sumere (eds.), M Publications, Belfast, Northern Ireland.

Sohn, M., F.E. Barton II, W.H. Morrison III, and D.E. Akin. 2004. A new approach for estimating purity of processed flax fiber by NIR spectroscopy. *J. Near Infrared Spectros.* 12:259-262.

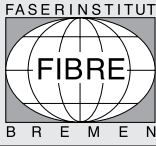
Sohn, M., D.S. Himmelsbach, D.E. Akin, and F.E. Barton II. 2005. Fourier transform near-infrared spectroscopy for determining linen content in linen/cotton blend products. *Textile. Res. J.* 75(8), 583-590. 2005.

United States Department of Agriculture. 1995 (revised). *The classification of cotton.* USDA, Washington, DC.

Van Dam, J.E.G., G.E.T van Vilsteren, F.H.A Zomers, W.B. Shannon, and I.T. Hamilton. 1994. *Industrial Fibre Crops, Increased Application of Domestically Produced Plant Fibres in Textiles, Pulp and Paper Production, and Composite Materials,* ATO_DLO, Wageningen, The Netherlands, 249 pp.

van Langenhove, L., and J.P. Bruggeman. 1992. Methods of fibre analysis. pp. 311-327. *In The Biology and Processing of Flax,* H.S.S. Sharma and C.F. Van Sumere (eds.), M Publications, Belfast, Northern Ireland.

Van Sumere, C.F. 1992. Retting of flax with special reference to enzyme-retting. pp.157-198. *In The Biology and Processing of Flax,* H.S.S. Sharma and C.F. Van Sumere (eds.), M Publications, Belfast, Northern Ireland.



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AUTOCORO PLANT OPERATION INGENIOUSLY NETWORKED PRODUCTIVITY AND QUALITY MANAGEMENT

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Mönchengladbach, Germany

ABSTRACT

With Autocoro Plant Operation, Schlafhorst offers Autocoro spinning mills a network of the production and quality data. Autocoro Plant Operation consists of the modules Corolab XQ, CoroPilot and CoroMobile. The consequent networking allows for the first time the remote adjustment of all yarn quality parameters from anywhere in the world.

INTRODUCTION

Successful spinning mill management is almost inconceivable without the support of electronic management systems. The systems network machines with administrative divisions of the company and are a lot more than just classic information platforms. The systems should support the planning, monitoring and control of production, actively assure yarn quality, promote time-saving deployment of personnel and should be able to be adapted flexibly to changing production conditions due to their modular structure. With 'Autocoro Plant Operation', Schlafhorst has generated a system that fulfils these requirements to an extremely high degree and is therefore tailored perfectly to Autocoro spinning mills.

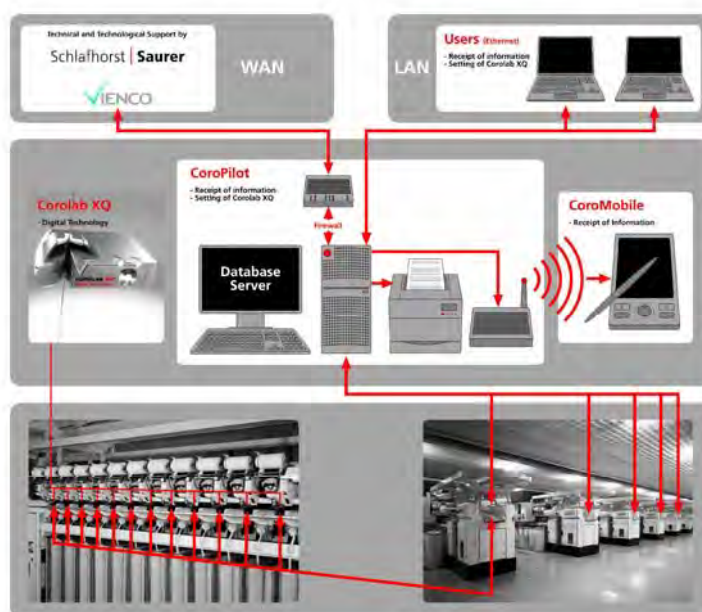


Fig. 1: Autocoro Plant Operation

Autocoro Plant Operation comprises:

- Corolab XQ, digital sensors at every spinning unit of the Autocoro for quality monitoring and control.
- CoroPilot, hardware and management software for networking productivity and quality parameters.
- CoroMobile, wireless handheld technology for the mobile call-up of quality and productivity information and fault messages.

COROLAB XQ

DIGITAL TECHNOLOGY FOR HIGHER QUALITY

In Corolab XQ Schlafhorst has realised an integrated yarn quality monitoring system, for the information that Corolab XQ generates is integrated perfectly into Autocoro Plant Operation.



Fig. 2: Corolab XQ

Each Corolab XQ sensor is self-sufficient. The measuring signals are processed directly in the sensor and evaluated without line losses. Optimum coordination of yarn quality to the requirements of weavers and knitters is thus guaranteed, for the new sensor technology achieves ten times higher measuring accuracy than conventional analogue measuring heads. Conventional systems cannot distinguish as well between faulty and correct yarn due to line losses and a lower resolution. The high precision of Corolab XQ prevents misinterpretation of the fault analysis and thus eliminates unnecessary clearer interventions and undesired productivity losses of the Autocoro.

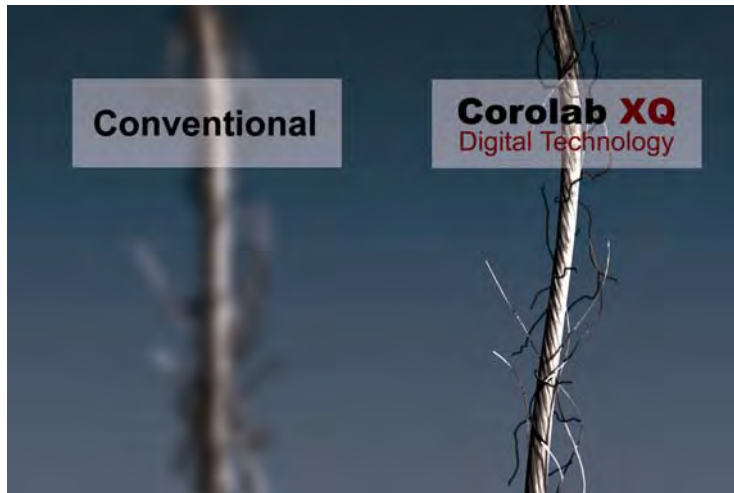


Fig. 3: Animation - resolution of the measuring result with Corolab XQ

Compromises between quality and productivity that were unavoidable in the past are, therefore, rendered unnecessary by Corolab XQ. The one-to-one assignment of sensor to spinning unit electronics allows the setting to be assigned to individual spinning units. Thus one machine can produce with several settings at the same time. This is not possible with conventional systems, where all spinning units of one machine must have the same setting. This function is especially interesting for spinning mills that sell their yarns and, with the same yarn count and twist, take different customer-specific clearer settings into account. Small lots become more economic since they no longer have to be spun on the complete machine, only on some sections of it.

Increased process reliability is another advantage of the Corolab XQ. For example, long-wave yarn count variations can also be detected and eliminated. This performance characteristic in particular should meet with great approval from knitting yarn manufacturers, as they are able to effectively prevent the classic knit fault of “ringlets due to yarn count variations”.

The logical linking of the clearing matrices also provides high process reliability. In the past data, entry mistakes could mean that a fault was detected but not classified because the clearing matrices were not coordinated to one another. The user had to generate the applicable logic himself, which required the corresponding know-how. This coordination is carried out automatically with Corolab XQ. Every yarn fault is correctly pinpointed, making it considerably easier for detection and elimination. The elimination of clusters was also optimised. Clusters are made up of several consecutive thick and thin places at irregular intervals in a yarn section up to 2,500 m. Considered individually, these deviations are inconspicuous and could remain in the yarn. As a cluster, however, they exceed the tolerances and are cleared. With conventional systems, the corresponding parameters are entered into a separate grading matrix that is not linked to the matrix for the other yarn faults. The user must know the exact correlation of the yarn faults to prevent illogical data being entered. The systems do not recognise the missing logic. Practice shows that the additional effort required to enter the cluster detection data is often spared or the data entry is

simply forgotten. With Corolab XQ, the cluster detection function is therefore integrated into the grading matrix for thick and thin places, which is particularly practical.

To activate the cluster clearing, the user clicks on the corresponding fields and defines his limits, e.g. 4 faults per 1,500 m.

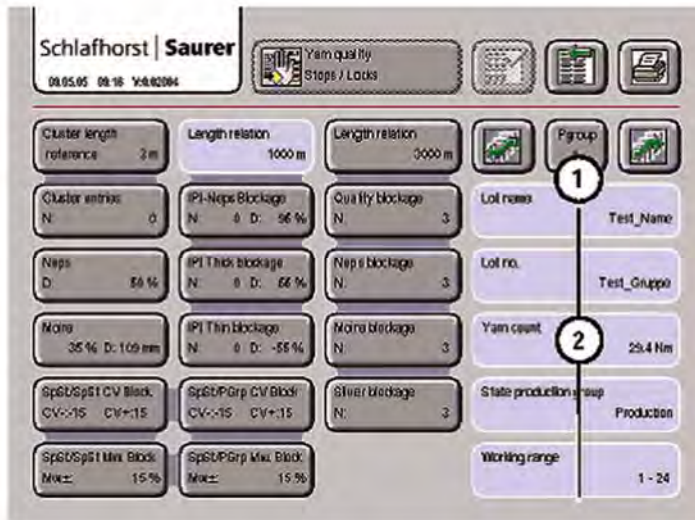


Fig. 4: Activating the cluster detection

The user specifies the limit values for cluster detection in the setting matrix for thick and thin places.

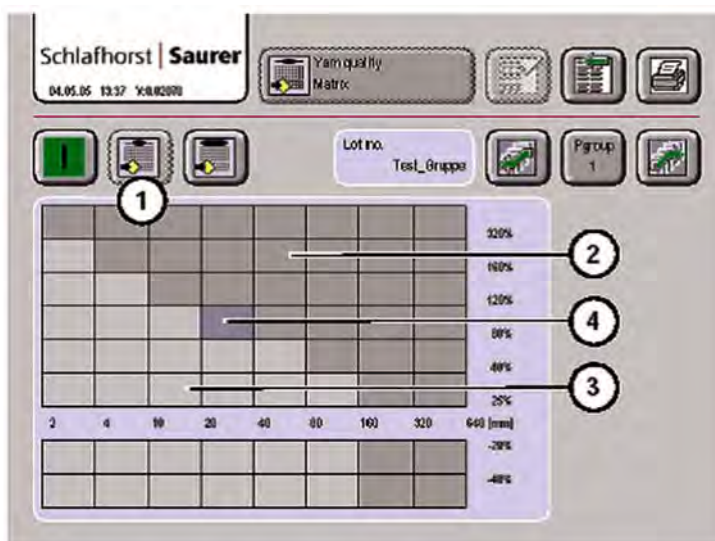


Fig. 5: Setting the cluster limit values

The faults that should be eliminated as a cluster are highlighted purple. They are generally to be found in the pale grey fields. If faults occur outside of a cluster, they lie below the fault tolerance curve and can remain in the yarn. Faults that definitely have to be cleared are highlighted dark grey. The user defines the limits. They are dependent on which faults the customer of the spinning mill tolerates and which yarn type is being spun. Schlafhorst principally recommends a differentiation between weaving and knitting yarns. For example, an increase in diameter is generally more critical for knitting yarns than weaving yarns. This should be taken into consideration in the setting matrix by activating the relevant fields.

Display of fault type and frequency in the form of a matrix is important for the fault statistics. The pale grey fields show, for the production group, how often deviations in diameter have occurred at which length. The dark grey fields contain the number of clearings in the respective fault category.



Fig. 6: Grading matrix of a weaving yarn for thick places, thin places and clusters

During production of a weaving yarn, the yarn monitoring system was, for example, activated 16 times to eliminate faults of 80 to 160 mm length with an increase of yarn diameter from 65 to 80 %. The yellow field shows in which field faults were last registered. If the user clicks on this field, another screen is opened that indicates at which spinning units the faults occurred. Even the fault characteristics are explained in detail. It can be seen in the pale grey fields whether the yarn monitoring system has eliminated a cluster as certain fields are highlighted purple. No clusters have occurred in the practical example as no field is highlighted purple.

The matrix, however, provides very little information about the character of the fault for the user. To find this out, with conventional systems the yarn sections containing faults are manually separated, the faults are then measured with a ruler and the fault data likewise manually entered in a database. A correct analysis is time-intensive and requires staff with extensive textile know-how. This process is fully automated

with Corolab XQ. At the push of a button, the yarn run profile is displayed, describing fault lengths and fault type in plain text and indicating deviation from the set mean value.

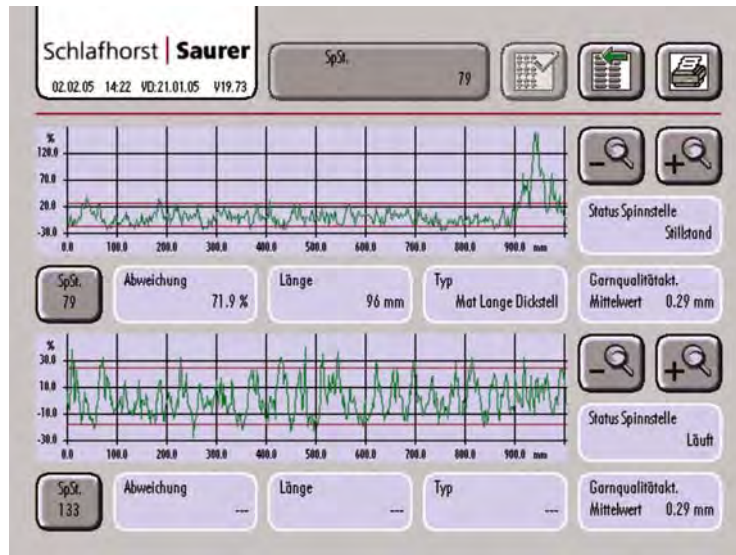


Fig. 7: Yarn profile

Spinning units that frequently generate faults can be directly compared to those that produce fault-free. This direct comparison provides helpful tips on the cause of the faults. With this function, quality problems are eliminated rapidly and in a targeted manner.

Easy, icon-assisted menu guidance simplifies the operation of Corolab XQ. It sets the user on the direct route to the required information, whether it be on a machine, lot or spinning unit level. All instructions are in plain text and the user can choose between ten languages.

Entry of machine quality parameters is carried out at the operating unit of the Autocoro. If the machines are networked with a CoroPilot, the data can be retrieved centrally and also entered centrally from every location around the world.

COROPILOT – THE NETWORK FOR MAKING SAVINGS

Autocoro spinning mills produce both large and small lots with defined quality parameters that either remain the same over a number of years or change in certain criteria. Spinning mills that are able to precisely fulfil a multitude of customer wishes 'just in time' are especially competitive. The administrative and planning effort required for this is, however, difficult to implement without an intelligent process management system. The CoroPilot from Schlafhorst provides the solution. More than 300 Autocoro 360 machines with a total of more than 100,000 spinning units are now connected worldwide.

What differentiates CoroPilot from other systems and what makes the system so successful? The CoroPilot is comparable to a central control station. It comprises a PC with server function and the CoroPilot software. The software networks the Autocoro machines with the server and the users in the companies.

Numerous manual and cost-intensive activities are eliminated with the application of CoroPilot. The collection of Informator logs, the time it takes to do this and manual evaluation of the information are rendered unnecessary. Considerable savings can be made through this alone, both for spinning mills in low-wage countries as well as in high-wage countries.

A spinning mill with ten machines and wage costs of 5 €/hr. saves approx. 20,000 euros per year. With wage costs of 15 €/hr., the annual saving amounts to over 50,000 euros.

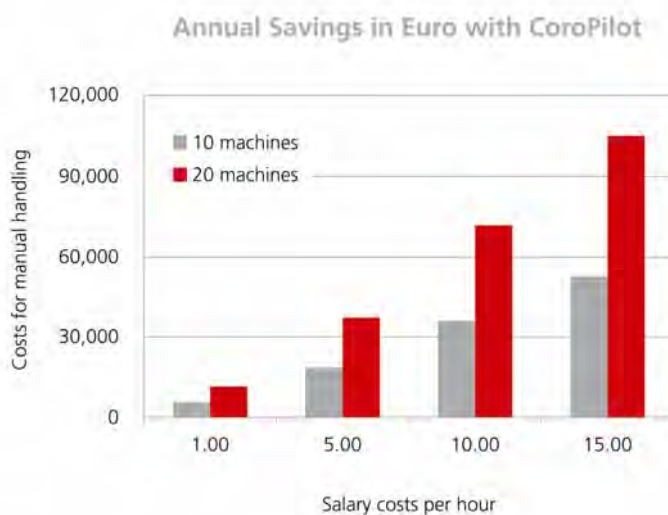


Fig. 8: Annual savings with CoroPilot

The CoroPilot is tailor-made to the changing production conditions of companies, to growing cost pressure and sinking qualification of employees. The management system is equally suitable for small spinning mills with just a few machines at one location as well as for large companies with many machines that could even be situated at different locations.

EVERYTHING UNDER CONTROL WITH INTELLIGENT DATA PREPARATION

With the development of CoroPilot software, Schlafhorst has awarded data quality maximum priority, for in practice it is the data that deviate from specification that are of prime interest, especially those that reduce productivity and yarn quality. In order to easily recognise these fault points, the information is, in addition to the classic table, also displayed as a user-friendly graphic. This means the user does not have to analyse long columns of numbers. Particularly important information is visually highlighted, for example with the traffic-light colours green, yellow and red. So that

the user always has access to current data, the data is updated every 15 minutes. With conventional systems, the data is only updated at the end of the shift, in other words, every 8 to 10 hours. Quick response in the event of productivity and quality problems is thus made difficult since the user can only react with several hours delay. Taking an Autocoro spinning mill with 22 machines as an example, particularly important functions will be explained in more detail below.

MADE-TO-MEASURE PROCESS ORIENTATION

The productivity analysis is carried out for the entire mill, for each machine and even for every spinning unit. This depth of information is one of the main prerequisites for the excellent suitability of the CoroPilot as a control instrument.



Fig. 9: Productivity display of an Autocoro plant

PRODUCTIVITY OF THE WHOLE PLANT

The plant survey illustrates the current productivity situation of every connected machine. Both the current efficiency as well as its range is shown. The coloured arrows mark the productivity tendency. This tendency analysis is especially important as the user sees at first glance which machines may possibly generate requirement for action, although they are still currently producing satisfactorily. The user can, using his own judgement and according to his needs, determine the limit value, i.e. from which efficiency level the machines are highlighted yellow or red.

In the practical example, machines 3, 4 and 12 are especially conspicuous. Machine 3 is standing still at the time of data call-up, it is being prepared for a new lot. Before being switched off, it had, however, produced satisfactorily, indicated by the green arrow. The machine efficiency ranged from 97 to 100 %. The lot on machine 4 had only just started-up at the time of data call-up, which explains the efficiency of just 87.2 %. Before lot completion, this machine also generated no need for action.

The productivity situation is, however, critical on machine 14. Although efficiency of slightly more than 95 % is still acceptable, the productivity tendency is pointing downwards. A comparable situation can be seen for machine 9. This development is not necessarily an indicator for fault functions on the Autocoro. It can also be caused by bottlenecks in capacity in the preparatory plant. Maintenance work on cards and drawframes can lead to several Autocoro machines not being sufficiently supplied with cans. An exact analysis of the causes of loss, if not already known, is advisable. The bar chart is helpful when the user only requires a short survey of the current productivity situation, but without tendencies.

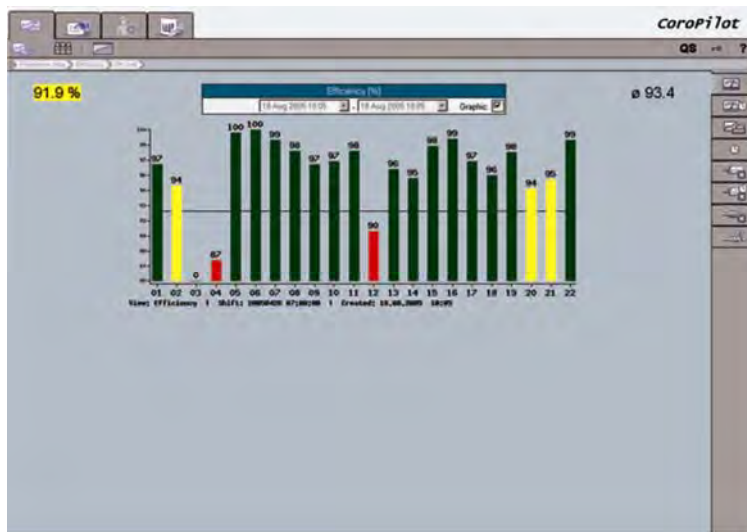


Fig. 10: Condensed productivity display of an Autocoro plant

PRODUCTIVITY OF THE MACHINE

If a machine lies outside the limits, productivity loss can have numerous causes. CoroPilot is the only management system that is logically networked with the machine control and that as a result can also display the causes of loss and their frequency. A typical cause of loss is too long a waiting time for automation. This could be reduced for example by an optimised piecing setting which would increase productivity of the whole machine. Through this detailed analysis, the user receives a valuable instrument to carry out optimisation actions directly related to the cause.

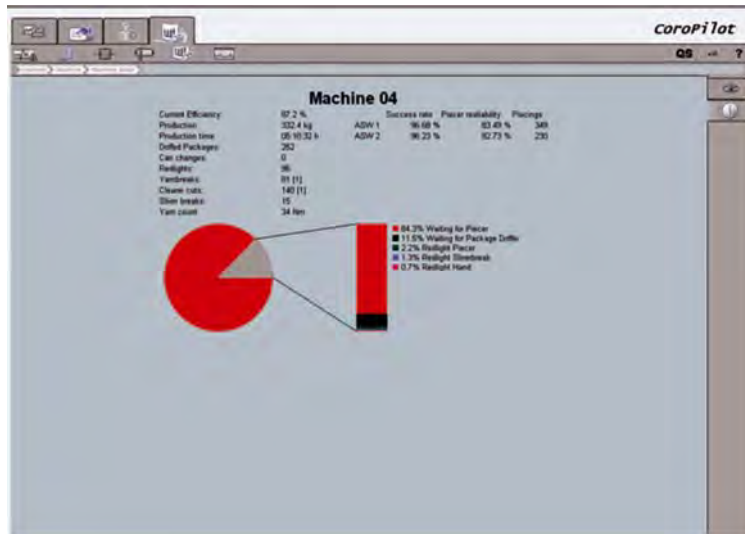


Fig. 11: Display of productivity of an Autocoro machine

Machine 4 had started with a new lot before data call-up. Machine efficiency was 87 % on data call-up. Automation is especially required during lot start-up, as the Coromat must first of all arrange the spinning process on all the spinning units. The graphic shows that approx. 96 % of standstills are attributable to the spinning units having to wait for the Coromat. The user can generally not prevent this waiting time. But he can reduce it by setting the automation units optimally to the yarn so that the piecing cycle is successful on the first attempt. An average of 25 to 27 seconds per piecing attempt costs every further piecing attempt valuable production time, both for the spinning unit with a delayed piecing cycle as well as for other spinning units that consequently have to wait longer for the Coromat. On machine 4, piecing reliability of the first piecing attempt is only just 85 %. Even if piecing reliability of 100 % is seldom in practice, the user should try to optimise the setting of the Coromat to speed up lot start-up on machine 4.

PRODUCTIVITY OF THE SPINNING UNIT

In practice, fault functions of just a few spinning units can considerably cut down productivity of the whole machine. Manual filtering and analysis of these poorly functioning spinning units is very time-consuming and requires highly qualified staff, since precise knowledge of both the machines and the technical and technological interrelations is required. The machine logs must be collected and the data transferred to a separate database and evaluated. To speed up this process and to be less dependent on staff know-how, spinning unit analysis is fully automated in the CoroPilot. The worst spinning units are automatically filtered out for the user. As a result, he can analyse the faults straight away and introduce suitable measures. This spinning unit analysis provides many tips about possible faults, e.g. incorrect or worn spinning components, soiling of the spinbox, sliver defects, just to mention a few of the causes.

Roller number	Efficiency (%)	Yarn coils (Steps)	VB (H)	Packing	Production time (h)	Red light	Prod (kg)	Sliver breaks	Deleted packages	Yarn length (km)
129	1.2	5	0	5	05:10:45	0	0.02	0	0	0.51
120	39.69	15	1	12	05:10:45	0	0.54	0	1	16.9
113	49.2	7	2	6	05:10:45	0	0.67	0	1	20.96
16	62.89	0	1	4	05:10:45	0	0.96	0	1	26.77
18	64.27	0	1	0	05:10:45	0	0.9	0	0	27.4
19	69.11	0	0	1	05:10:45	0	0.94	0	1	29.42
137	69.51	5	0	6	05:10:45	1	0.95	0	1	29.59
71	71.59	0	0	1	05:10:45	0	0.98	0	1	30.48
73	71.94	0	0	1	05:10:45	0	0.98	0	1	30.62
77	72.9	0	0	1	05:10:45	0	0.99	0	1	31.04
75	73.52	0	1	2	05:10:45	0	1	0	1	31.3
56	74.31	0	1	2	05:10:45	0	1.01	0	0	31.64
99	74.49	0	0	1	05:10:45	0	1.01	0	1	31.71
86	76.05	0	0	1	05:10:45	0	1.06	0	1	33.23
12	79.5	0	0	1	05:10:45	0	1.08	0	1	33.65
79	79.51	0	0	1	05:10:45	0	1.08	0	1	33.65
15	80.45	0	0	2	05:10:45	0	1.1	0	1	34.25
81	80.47	0	0	1	05:10:45	0	1.1	0	1	34.25

Fig. 12: Productivity display of the worst Autocoro spinning units

The worst spinning units of one machine are listed in the figure above. Spinning unit 129 has only just started-up. A realistic analysis of the efficiency of the spinning unit should be carried out at a later time once more yarn has been spun. Spinning units 113, 120 and 137 are in a critical state. The number of clearer interventions is extremely high. Inspection of the sliver is a suitable measure to rectify the poor state of the spinning unit. Irregularities of the draw frame sliver are transferred one-to-one into the yarn through the draft and lead to interventions of the yarn quality monitoring system.

Analysis of the Corolab XQ clearing matrix in CoroPilot provides detailed information on fault characteristics. Inspection of the spinning components is also advisable. Worn or soiled spinning components can adversely affect the quality of the yarn.

YARN QUALITY ASSURANCE WITH THE COROPILOT

A very sensitively-set yarn quality monitoring system can reduce machine productivity. The aim of every spinning mill is, however, a balance between productivity and yarn quality. Optimum safeguarding of this interaction acts as guarantee for the common platform CoroPilot, for CoroPilot not only allows call-up of the yarn cleaner setting but also its modification. If the user changes the setting, he can, due to the regular data update every 15 minutes, follow how the modification influences yarn quality and machine productivity and if necessary further optimise it.

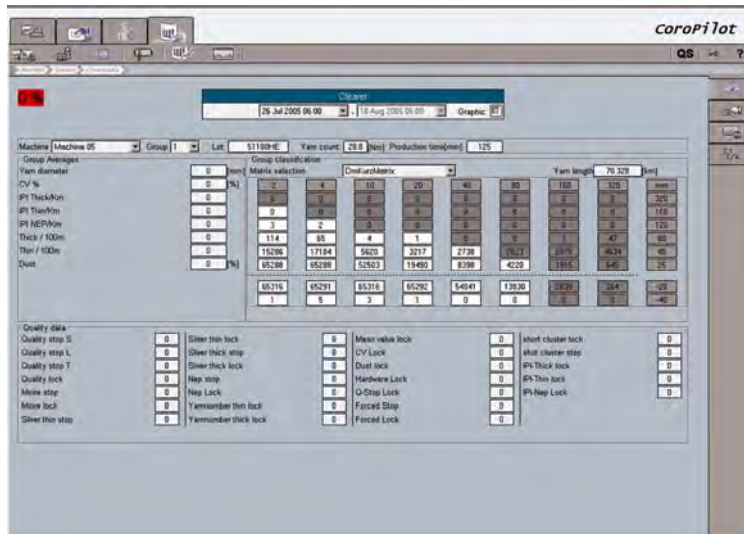


Fig. 13: Cleaning matrix of Corolab XQ in CoroPilot

Like the productivity data, the quality data of the yarn monitoring system up to the spinning unit level can be called-up. The following graphic demonstrates the network of machine and clearer activities of a plant.

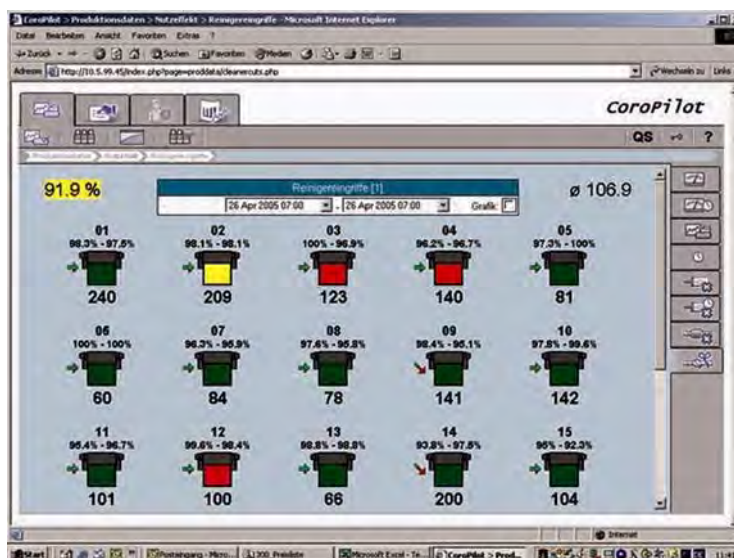


Fig. 14: Display of actions of the yarn quality monitoring system in combination with the productivity at an Autocoro plant

The graphic shows for every machine the number of clearer interventions and state of machine productivity. It shows that with the same basic setting the number of interventions by the yarn quality monitoring system varies from machine to machine. Determination of the cause of the deviations is realised by more precise observation of the conspicuous machines. Machines 3, 4 and 12 receive a critical productivity evaluation in spite of a relatively low number of interventions. The production state of

the machine, i.e. whether a lot change has just taken place, the basic machine functions, the available piecing and package doffing capacities and the spinning and Coromat settings, have a far greater influence on the productivity than a sensitively - set yarn quality monitoring system. This means, compromises in quality should only be made if the increase in productivity does not effect other measures. One reason for deviations with the same setting could be the slivers fed. If they are irregular, they inevitably lead to a higher number of thick and thin places in the yarn and thus to intervention by the yarn quality monitoring system. In this respect, the CoroPilot also proves itself in practice as an analysis tool for raw material. The CoroPilot also indirectly determines the efficiency of the raw material being used.

The user should also observe machine 14 with a relatively high number of clearer interventions. Productivity is not yet at risk. The tendency arrow, however, reveals a negative tendency.

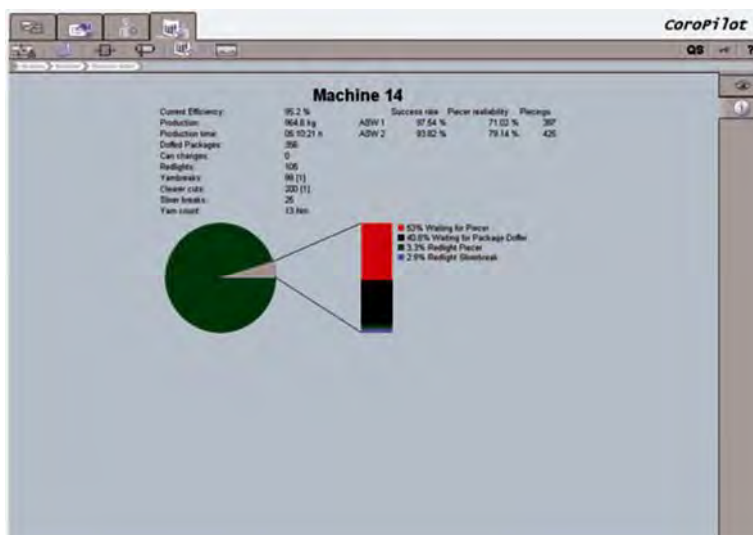


Fig. 15: Efficiency analysis

To prevent the machine falling below the productivity tolerance curve of the yarn quality monitoring system at a later time, the user analyses this machine in detail. Examination reveals that this machine which is spinning a relatively coarse yarn, is facing an automation capacity problem that could be supported by the activities of the yarn quality monitoring system. The loss of production mainly arises from waiting times for the Coromat. In addition, the piecing reliability is relatively low at under 80 %. A suitable measure to reverse the negative trend of this machine is to increase piecing reliability. Spinning of this lot on another machine with more Coromat units could likewise be a suitable measure.

LONG-TERM STATISTICS AS TREND ANALYSES

All settings and spinning results flow into one database integrated into CoroPilot. As a result, they can be called-up and viewed on a long-term basis. Thus the user can

generate shift reports and long-term statistics for a period of 6 months using the standard equipment of the CoroPilot. If he wants a longer-term database, he can generate this by integrating additional memory modules.

Shift reports can be generated for machines, machine groups, lots and the whole plant. They allow a direct comparison of shifts and provide tips on efficiency of the shift team, on bottlenecks in capacity and also on possible training needs of staff.

The convenient long-term statistics are possible and advisable for many parameters. All information on productivity, such as machine efficiency, number of stoppages and causes thereof, can also be displayed like the quality information. In particular, stoppage frequency is often displayed as a quality monitor caused by thick and thin places and neps.

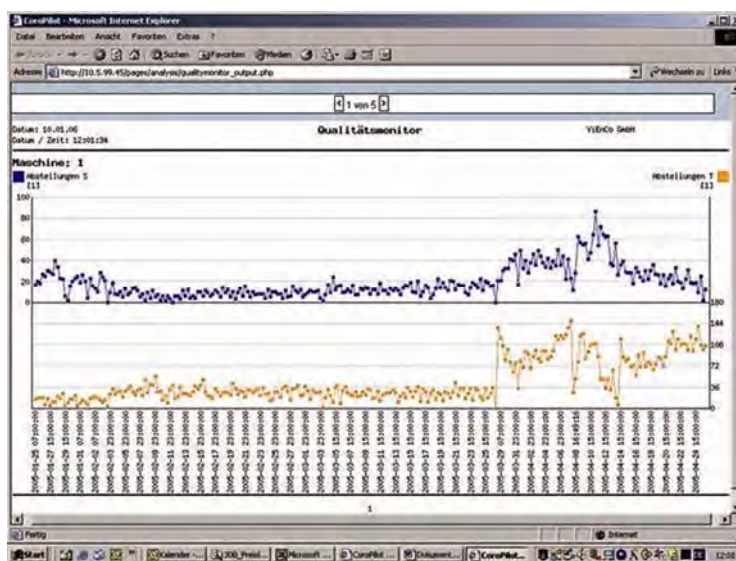


Fig. 16: Quality monitor as long-term statistic

The graphic shows a quality monitor for the number of short thick places and thin places on a machine. This is based over a period of 3 months. The long-term statistics demonstrate that the higher number of clearer interventions both for thick places and thin places occurred simultaneously. This quality monitor must, however, not necessarily be due to a quality problem. The increase can also be due to a lot change together with a more sensitive setting.

TRANSPARENT COMMUNICATION FOR OPTIMISED PROCESSES

Integration of CoroPilot into the Autocoro spinning mill means that process responsibility is regulated clearly and reliably. Communication errors, associated overlapping of competences and misinterpretations are ruled out since the system allocates clear authorisation to staff. An unlimited number of users can be connected for high information transparency. The authorisation of these users, however, can be individually restricted in terms of data entry or call-up. In this way the manager can,

for example, obtain all rights that he requires to call-up production data and to enter quality parameters at the machines. The sales agent, for example, can simply receive authorisation for data call-up so that he can see when the lot for his customers has been spun and is ready for dispatch. A valuable aid in this respect is the Lot Completion function integrated into CoroPilot.

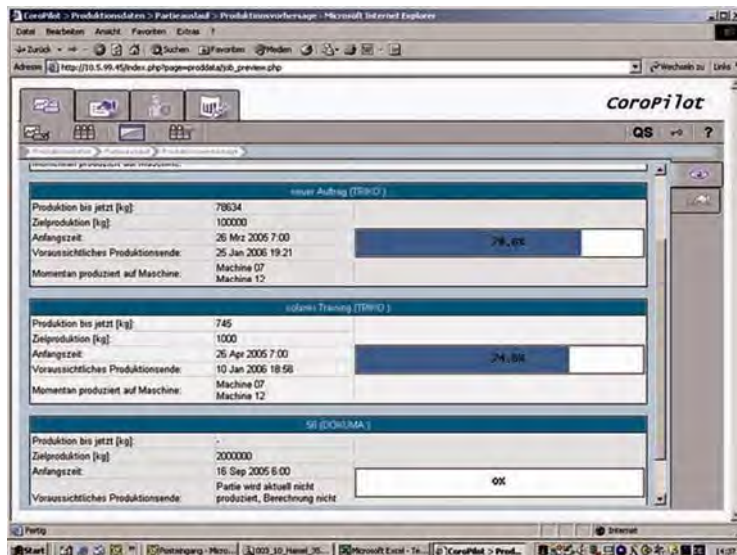


Fig. 17: Display of Lot Completion on CoroPilot

Based on this information, the sales agent can regulate dispatch of the yarn to the customers 'just in time'. Consistent regulation of business on this basis offers considerable savings potential, as the intermediate storage of yarn pallets and the need for space as well as deployment of staff is largely avoided. The automatic lot completion monitoring also supports personnel planning in the spinning mill. The user is always informed when the lots are completed. He schedules the work plans of spinning mill personnel accordingly. As a result, the work steps occurring during lot change are efficiently coordinated to each other and the preparation and standstill times minimised.

The high transparency of information with CoroPilot is supported by a web-based data transfer on a WAN (Wide Area Network) and LAN (Local Area Network) basis using a simple telephone line. Information can be retrieved via any computer from any global location with the relevant authorised access. Thus the yarn salesman can directly access data from his Asian spinning mill during his business trip in Europe, for example.

Some companies use different management systems simultaneously. Due to programming of the CoroPilot in the common SQL database language, Schlafhorst sets the course for maximum networking of information with external systems. All CoroPilot data can be exported. External database information that was programmed using SQL can be integrated into CoroPilot at the push of a button. On this basis, Autocoro spinning mills can use existing data sets in companies to the full.

COROMOBILE - THE MOBILE INFORMATION MEDIUM FOR THE USER

Use of the information that the CoroPilot offers is relatively simple for employees that have immediate access to the server PC or a connected computer. A lot of information is, however, also useful for employees who work almost exclusively on the machines, for example, the mechanics. These employees are judged on their ability to achieve the technical prerequisites for the maximum productivity of all machines. These employees perform their duties in conventional ways by continually walking through the spinning mill and checking the non-producing spinning units according to their level of knowledge which may vary considerably within the team. The time required for the standstill analysis is considerable, in addition, the mechanics face long waiting times of the spinning units. The production loss, that in particular occurs in shifts with few personnel, accumulates.

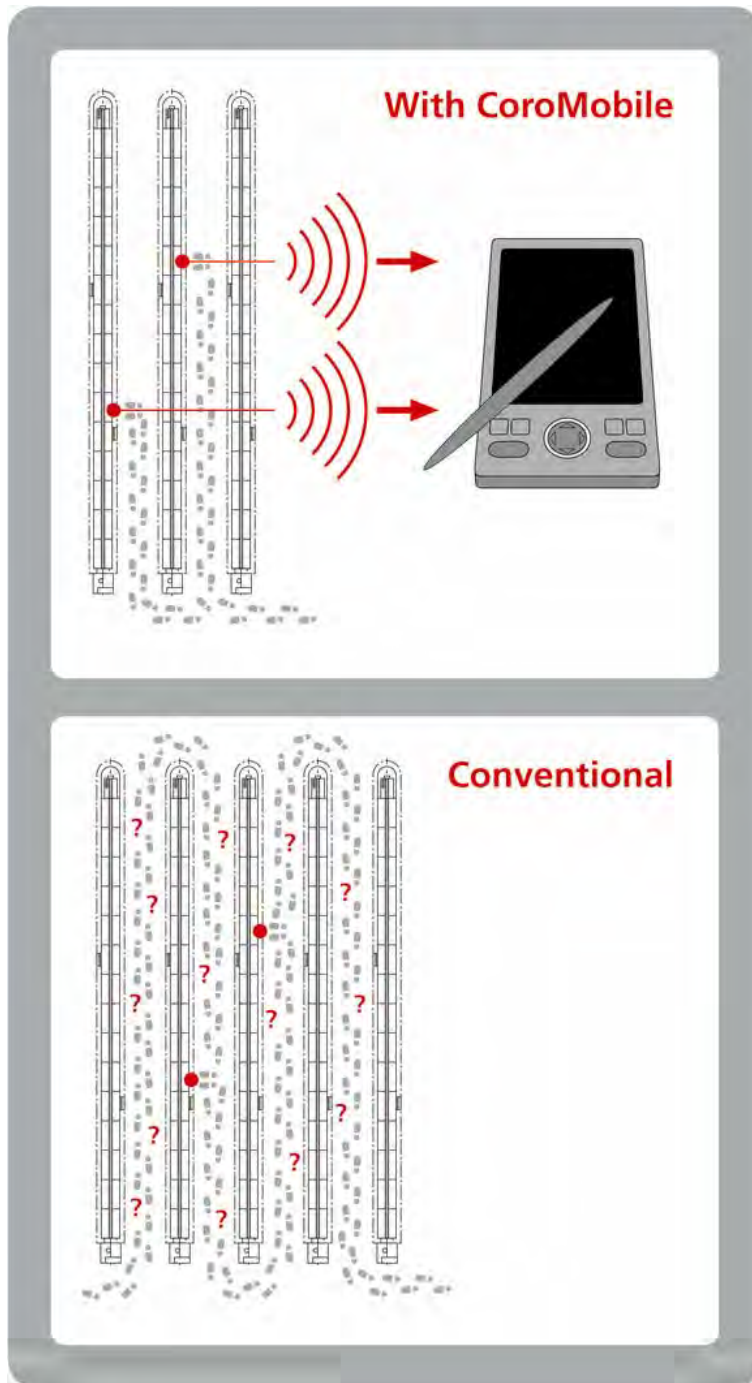


Fig. 18: Less time needed to get information with CoroMobile

With the introduction of Autocoro Plant Operation, Schlafhorst has also developed a suitable medium for these employees, namely the CoroMobile. CoroMobile in pocket format based on wireless handheld technology is coupled to the CoroPilot and provides the spinning mill employee with all the information that he needs accurate to the second.

This includes:

- Quality information, e.g. CV and IPI information specific to the spinning unit.
- Productivity information, e.g. limit value infringements of the machine efficiency rating, efficiency of the automation units.
- Fault messages, e.g. spinning component faults, causes of standstill, missing spinning cans.

On the one hand, this new type of technology achieves more efficiency in the spinning mill and on the other, employees with lower qualification can also take over maintenance tasks since cause analysis is largely unnecessary. Maintenance staff simply need to orientate themselves according to the fault-specific operating instructions.

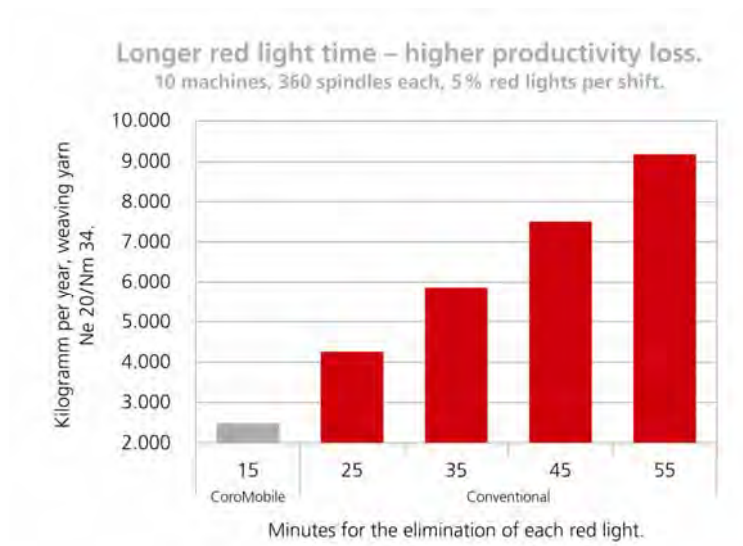


Fig. 19: Productivity increase through CoroMobile

With Autocoro Plant Operation, Autocoro spinning mills receive an efficient and transparent planning and control network. The net product of the machines increases just as the productivity of the employees. Globalisation – the nightmare of many spinning mills is transformed with Autocoro Plant Operation into a real chance.

THE RIETER CLEAN-LINE WITH NEW BLOWROOM TECHNOLOGY: QUALITY AND ECONOMICS

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INTRODUCTION

Developments in the blowroom in recent years have generally focused on improving raw material yield and increasing line output. Spinning mills have benefited from an improved price/performance ratio when making new investments. Genuine technological innovations in the blowroom have been rare. The new CLEAN-line blowroom concept incorporates genuine innovations that significantly improve yarn quality and enable spinning mills to operate the blowroom economically.

1. THE RIETER BLOWROOM – RELIABLE, FIBER-PRESERVING AND EFFICIENT

The Rieter blowroom is regarded among specialists in the cotton spinning industry worldwide as the most reliable with the best fiber-preserving performance. This is based primarily on Rieter's blowroom philosophy, the main features of which are as follows (Figure 1):

1. At the start of the process, on the UNIfloc, the cotton compressed in bales is opened to form "micro-tufts", resulting in a large tuft surface area and thus facilitating the cleaning action in the subsequent processes.
2. Cleaning of the cotton in 2 phases with pre-cleaning and fine cleaning. As much trash as possible is already removed at the start of the process. There is only one nip point in the entire process for opening the material. This ensures gentle handling of the valuable cotton fibres.
3. The optimum balance between cleaning intensity and the required cleaning efficiency is defined with the unique VarioSet control system at the push of a button. This enables flexible adjustments to be made to the specific cleaning conditions of the different types of cotton and levels of trash content without cleaning devices having to be installed or removed.
4. The proven 3-point blending principle is the basis for homogeneous blending of cotton and other staple fibres and thus for the quality of the end product.

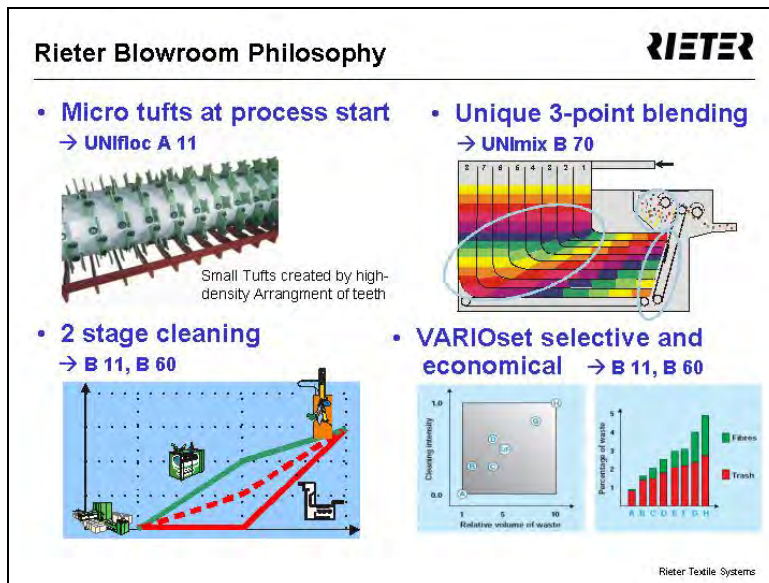


Figure 1

The sales success of the UNiclean B 11 pre-cleaner most clearly demonstrates the effectiveness of Rieter's philosophy: this machine is often used subsequently as a stand-alone unit in our competitors' blowroom installations. However, its use is not confined to cotton spinning; its technological advantages are also evident when it is used in ginning installations. In modern ginning installations lint cleaners are usually used for fine cleaning after the ginning process.

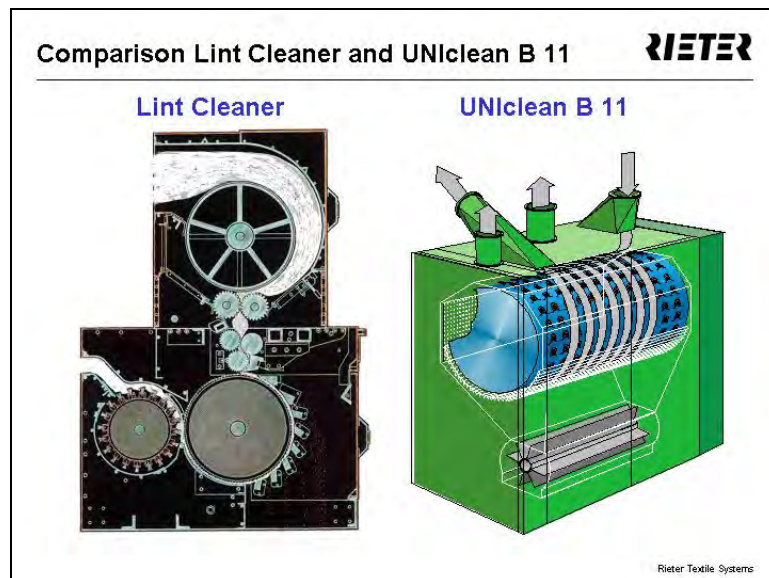


Figure 2

Figure 2 illustrates the mode of operation of a lint cleaner compared to the UNclean B 11. The fibres are opened vigorously in the lint cleaner, i.e. at the risk of shortening the fibres. The result of this process is a reduction in cotton quality of 1 to 2 classing grades (0.8 -1.6 mm). By contrast, the UNclean B 11 is a purely continuous-feed machine. The material is not clamped. The fibres are fed gently over grids in 7 passes by means of a stripper roller. The fibres are not damaged, i.e. shortened, yet the UNclean achieves the same degree of cleaning as the lint cleaner. Mill trials using the two cleaners in a ginning installation revealed considerable technological advantages of the UNclean B 11. Figure 3 shows the yarn values for imperfections when using the UNclean B 11 compared with the lint cleaner. The yarn values for imperfections (thin / thick places and neps) are better with the B 11 in all cases. This can be attributed to the longer fiber length.

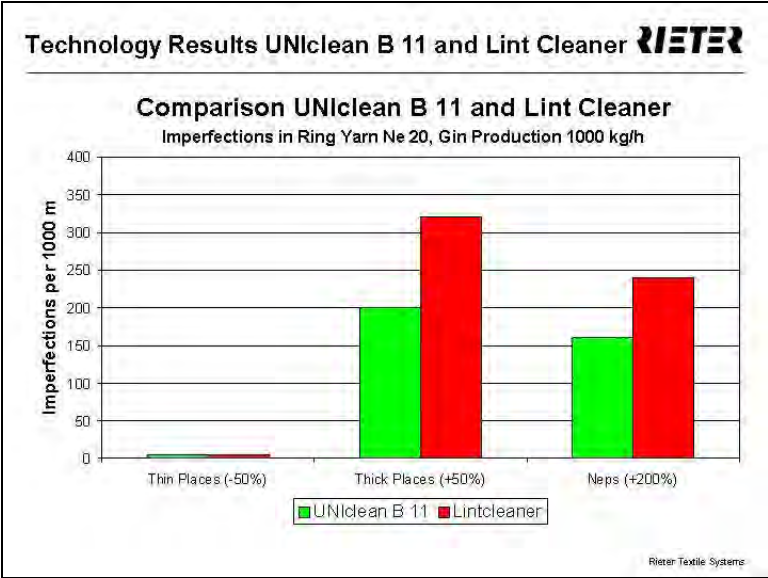


Figure 3

The findings from this study illustrate once again how important it also is in spinning mill blowrooms to pay more attention to preserving fiber length without having to risk less effective trash removal at the same time. This is the starting point for the new Rieter CLEAN-line blowroom, which demonstrates that this provides the basis for optimum raw material utilization and good yarn.

2. THE NEW RIETER CLEAN-LINE BLOWROOM CONCEPT

Two essential features characterize the new CLEAN-line blowroom concept:

- **Compact nature of the blowroom with output of up to 1200 kg/h.** This is immediately apparent in Figure 4 and Figure 5. Only one machine per process stage is used for output of up to 1200 kg/h. It consists essentially of the UNIfloc A 11 automatic bale opener, the UNIClean B 12 pre-cleaner (Figure 6), the UNImix B 75 blender (Figure 7), the UNIstore A 78 feeder (Figure 8) and the CLEANfeed card feed chute with integrated fine cleaning unit. Machines such as the UNImix and the UNIstore have also been completely redesigned. The result of this is not only reliable production, but consistently high quality at all output levels.
- **Integration of the fine cleaning unit in the card feed chute.** This design feature eliminates the intensive feed trough/feed roller nip point on the UNIflex B 60. The blowroom therefore produces quality that is unmatched to date.

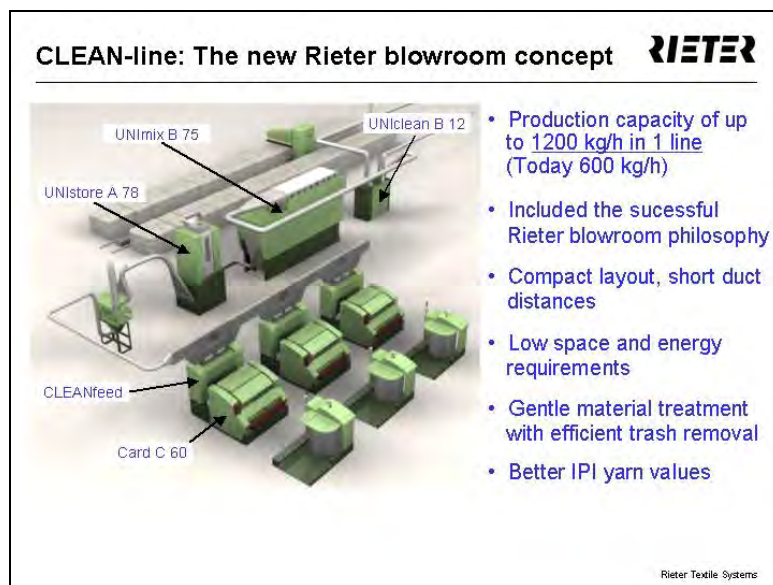


Figure 4

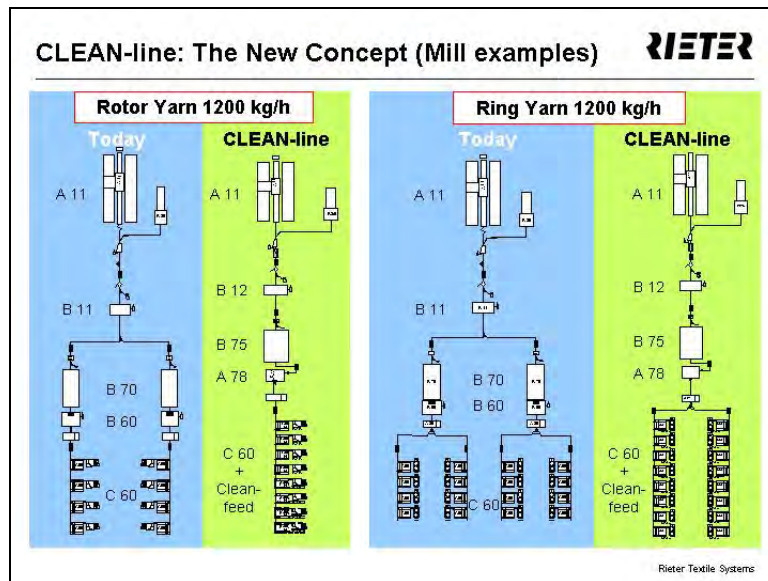


Figure 5

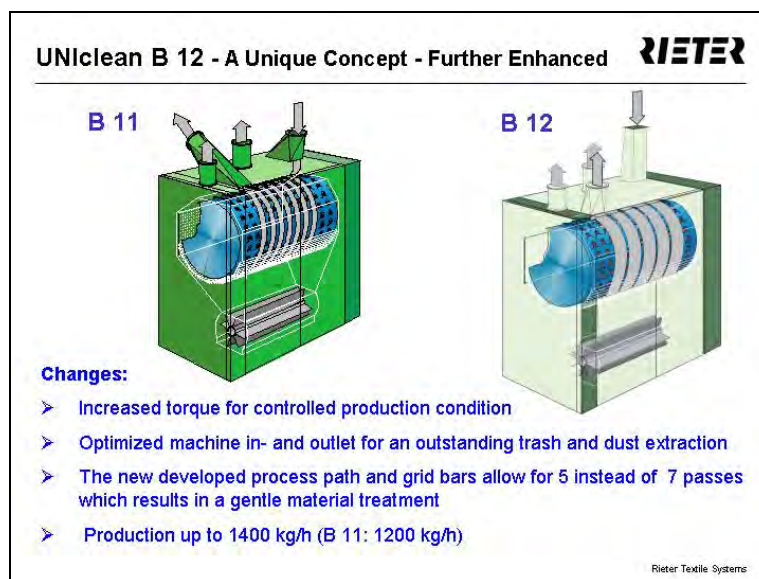


Figure 6

UNImix B 75 – the blending machine **RIETER**




Tasks

- Maximum production 1200 kg/h
- Working width 1,8 m (B70: 1,2 m)
- 3 point blending principle
- Adjustable degree of opening
- 8 chamber blending of the fibre tufts
- Dedusting of fibre tufts
- Raw materials: Cotton, MMF, comber noil

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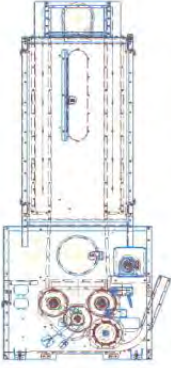
Figure 7

UNIstore A 78 – The Feeding Machine for C 60 **RIETER**



Features:

- 1200 kg/h
- storage capacity 30 kg cotton
- very gentle material opening
- constant feeding, constant tuft size
- cotton, MMF, regenerated fibres



Rieter Textile Systems

Figure 8

The obvious advantages of the CLEAN-line are:

- economy due to lower capital costs, fewer machines, smaller space requirements, reduced energy and filtering expenditure
- quality improvement due to fewer machines, fans and conveying lines; in particular, however, fine cleaning now takes place in CLEANfeed, in the card feed chute, i.e. at relatively moderate output, predetermined by the card, of up to 220 kg/h
- process control due to the reduction in sources of malfunction and the provision for emergency operation of all inverter-powered motors.

In addition to the process stages described above, the blowroom has also been improved in detail, such as the fans or the blowroom control system. All modifications had the same objective of improving quality and economy through to the end product.

3. CLEANFEED – CORE COMPONENT OF THE NEW BLOWROOM

Innovations are a tradition at Rieter and are the result of many years of intensive research effort. The changes in carding operations as a result of the trend-setting design and productivity of the C 60 card open up a completely new approach for the fine cleaning stage in the blowroom. The revolution caused by the C 60 makes the evolution in the card feed chute through CLEANfeed possible. The complex fine cleaning process is distributed as a logical option among several machines, i.e. integrated in the card feed chute (Figure 9, Figure 10). It is the card that controls the output level of CLEANfeed. It is a well-known fact that carding performance depends directly on the raw material and the requirements imposed on the end product. The huge increase in this performance has made this approach economically justifiable and therefore possible. The integration of fine cleaning in the card feed chute is not only a neat and economical solution, it also ensures maximum fiber preservation and end products of the highest quality.

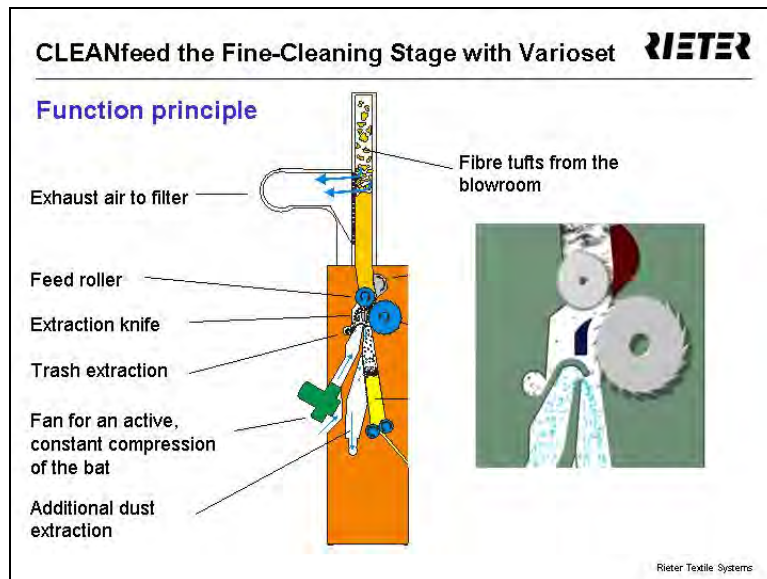


Figure 9



Figure 10

However, the innovation in CLEANfeed is not only a matter of distributing the fine cleaning stage among several card chutes, but rather of utilizing much more efficiently an opening unit which has long been an element of the card feed chute. The trash exposed on the freshly opened surfaces is removed immediately. The existing opening roller in the card chute is utilized and an additional extraction knife has also been integrated. The advantage of this is that no additional fiber loading occurs. The VARIOset unit in CLEANfeed enables knife and roller rotating speed to be changed at the push of a button. This enables the quantity and composition of waste to be defined selectively, as on other Rieter blowroom machines.

Maximum fiber preservation and very efficient extraction of finer trash particles have a particularly positive influence on the cotton raw material.

New options are also opened up in mill planning. Fine cleaning is no longer coupled to blowroom output. It now takes place independently of line output, at a lower production rate.

4. THE TECHNOLOGY CONCEPT

Total output of up to 1200 kg/h is distributed among a maximum of 2 x 7 CLEANfeed units in the carding line. Consequently, the fibrous mass per cleaning position in the fine cleaning process is up to 14 times smaller, depending on the application. Fine cleaning is performed at the most logical place, i.e. at the cards.

Figure 11 shows that the production at each CLEANfeed is 7-times lower compared to the fine cleaner B 60. However, the available cleaning width for the same production is increased 9-fold, leading to gentle and efficient cleaning.

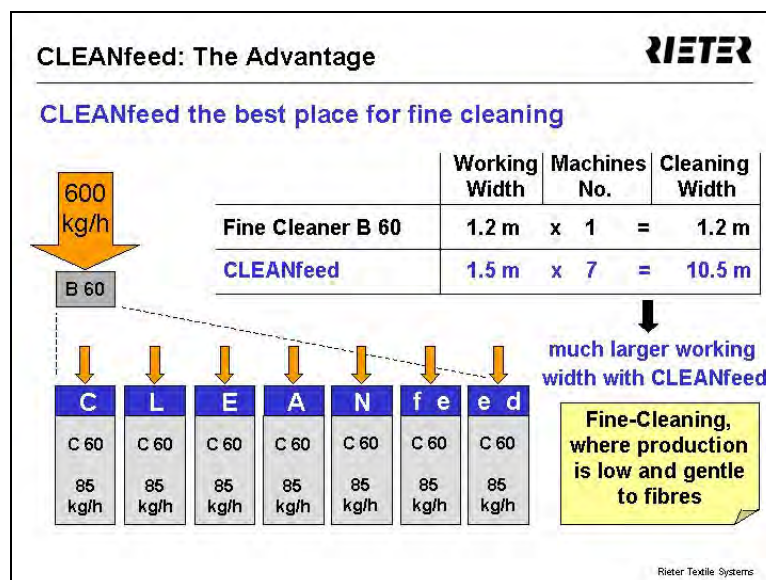


Figure 11

The technological advantages of using CLEANfeed and of the compact nature of the CLEAN-line are shown in figure 12. Shorter pipelines and fewer fans also contribute to improved results, even if this may in itself play a minor role. Practical results from our test installations enable us to make an initial assessment. Figure 13 shows an improvement in technology data in fine combed, ring-spun yarn in every respect. Figure 14 again underscores this statement with yarn values from a spinning mill.

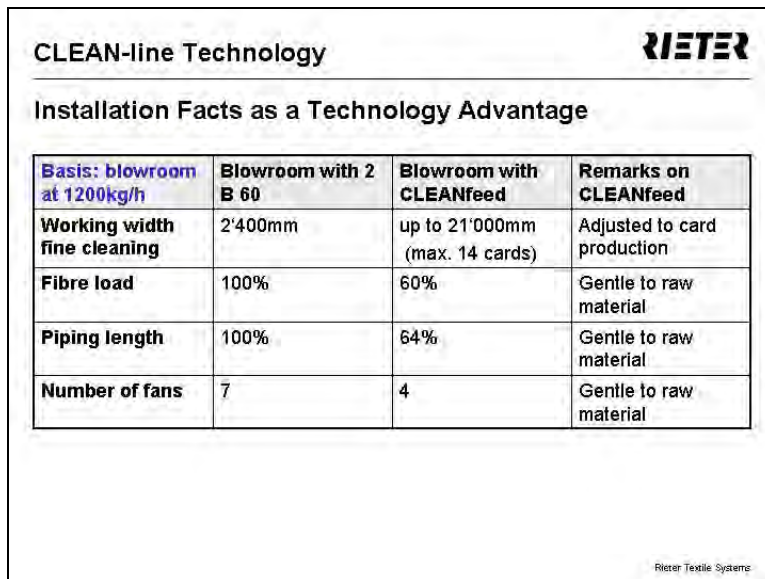


Figure 12

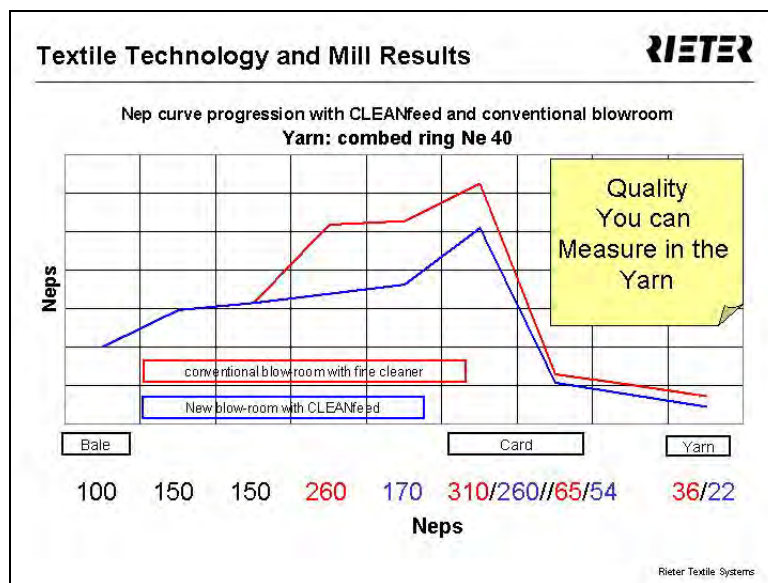


Figure 13

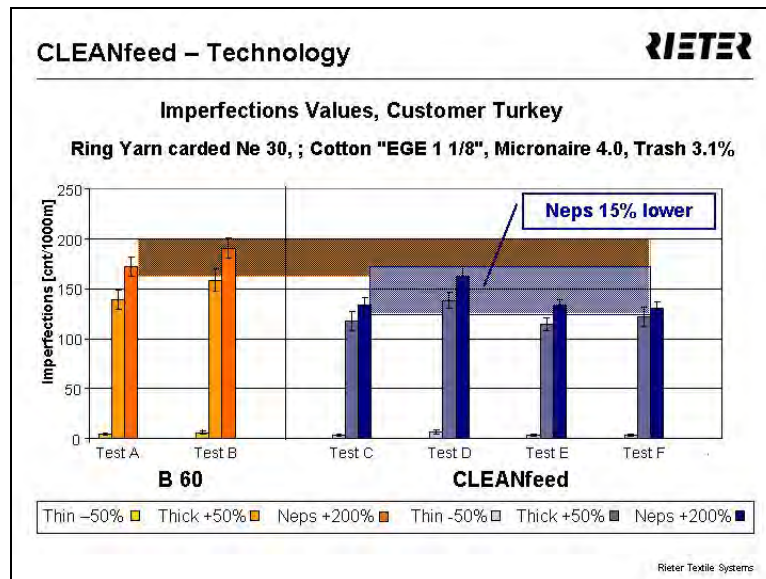


Figure 14

Discussions of the usefulness of a new concept are easier when based on facts, although this can differ, of course, depending on the application. For example, low capital and energy costs are especially important for a high-output rotor spinning mill, whereas the focus for a ring spinning mill is on quality improvement and raw material costs.

The new spinning mill concept enables carding operations to be expanded as required, without influencing the production volumes of the demanding fine cleaning process. Material throughput remains coupled to that of the card and is thus in the optimum range.

5. ECONOMY THROUGH TECHNOLOGY

Technological leadership is the crucial factor in the blowroom. As systems suppliers we not only have the technological and economic know-how from the raw material through to the end product, we also have a clear idea of how successful spinning machines have to perform. In summary, we interpret success as the sustained financial prosperity of a textile company. The following table therefore sets out the economic advantages (Figure 15).

CLEAN-line		RIETER	
Technical and economical facts			
Basis: blowroom at 1200kg/h	Blowroom with 2 B 60	Blowroom with CLEANfeed	Remarks on CLEANfeed
Space required m ²	100%	70%	Lower building costs
Transport air, Filter air	100%	87%	Lower filter costs
Energy consumption	100%	92%	Lower energy costs

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Figure 15

6. THIS CONCEPT IS PREDESTINED FOR SUCCESS

The new Rieter blowroom concept distributes the demanding fine cleaning process among several card feed chutes. The blowroom thus enables quality standards unequalled to date to be achieved at output of up to 1200 kg/h of carded sliver, in conjunction with a compactness that will set new standards. The new blowroom, with its evolutionary step to a revolutionary concept, is a genuine innovation.

DETERMINATION OF THE OPTIMUM MACHINE SETTINGS WITH INTELLIGENT SYSTEMS

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This paper addresses the spinning industry's growing need to complement production machinery with intelligent systems to automate or greatly facilitate the process of determining the optimum machine settings to meet demanding quality and productivity benchmarks. Several examples of such intelligent systems have already been commercialized but these will only be briefly touched upon. The focal point of this paper, however, is the measurement of cotton fibre length distribution with the newly developed Lengthcontrol LCT instrument. Examples are presented as to how its fibre length information, which has been tailored to the specific needs of cotton spinners, can be utilised in various ways to establish and maintain optimum settings in spinning preparation, i.e. of cards, drawframes and combers.

INTRODUCTION

More than any other business, the successful conversion of cotton fibres into yarns heavily depends on the frequent and periodic optimisation of all pertinent manufacturing stages within the mill processing sequence. The inherent variability and the inconsistencies of cotton as a natural raw material require continuous process and quality monitoring, permanent attention and numerous interventions to the machines to ensure that both quality and productivity are always on target. Apart from the need to apply optimisation routines in terms of machine performance, the competitive environment in global textiles forces many yarn producers to respond more flexibly to the present-day market conditions. With smaller lots and more frequent lot changes, it has already become rather challenging to establish and verify the optimum machine settings for a given application. When considering the time constraints that apply in a typical cotton mill production environment, then many such attempts never even approach the optimum. On top of these difficulties, the recent years have clearly highlighted the growing lack of technical expertise at different management levels plus the lack of a reasonably skilled production workforce in many cotton spinning mills around the globe. Therefore, it is safe to say that many machines in spinning preparation, the spinning itself and winding nowadays operate under sub-optimal conditions with a lot of leeway towards exploiting the full potential of those high-tech machines. The engineers in the textile machinery industry must eventually respond to these challenges and develop intelligent systems to automate or at least facilitate the process of determining the optimum machine settings. This paper introduces several examples of such highly advanced, intelligent technology as it is already applied in typical spinning preparation machinery. The focus, however, is on measuring cotton fibre length distribution with the novel Lengthcontrol LCT instrument and how its very specific fibre length information can be utilised in various ways to establish the optimum settings of cards, drawframes and combers.

MEASURING FIBRE LENGTH DISTRIBUTION WITH LENGTHCONTROL LCT

Lengthcontrol LCT has been developed as a workhorse fibre testing instrument to be utilised by machine operators on the floor, right at the machines. All cotton and man-made fibres in sliver form from cards, drawframes and combers in all common linear densities can be tested in a fully automatic mode. The best way to explain the unique advantages of the instrument is to list what it does not do: It does not require a laboratory, laboratory conditions or laboratory technicians. There is no sample conditioning, no sample preparation, no calibration. It is probably the first fibre testing instrument that has been developed strictly from the perspective of the user. The measuring system itself is based on the well-known Fibrograph principle which has been refined with two special features: The first is that the specimen – a short piece of sliver – is clamped in the middle so that the fibres protruding from both sides of the clamp are prepared and scanned. The directional differences in fibre length distribution of a cotton sliver represent highly valuable pieces of information. The second feature, which makes this instrument unique, is the application of a monochrome digital CCD line scan camera to scan the tapered fibre beard.

Unfortunately, it is not possible to describe the instrument's mechanical and electronic components and the functional principles within the scope of this paper. What can be accomplished through the measurements in terms of optimising machine settings, however, is probably much more interesting than exactly how these measurements are done. Nevertheless, **Figures 1 and 2** represent a view of the instrument in operation as well as a cross-section diagram illustrating the major elements of the system.



Figure 1 Lengthcontrol LCT

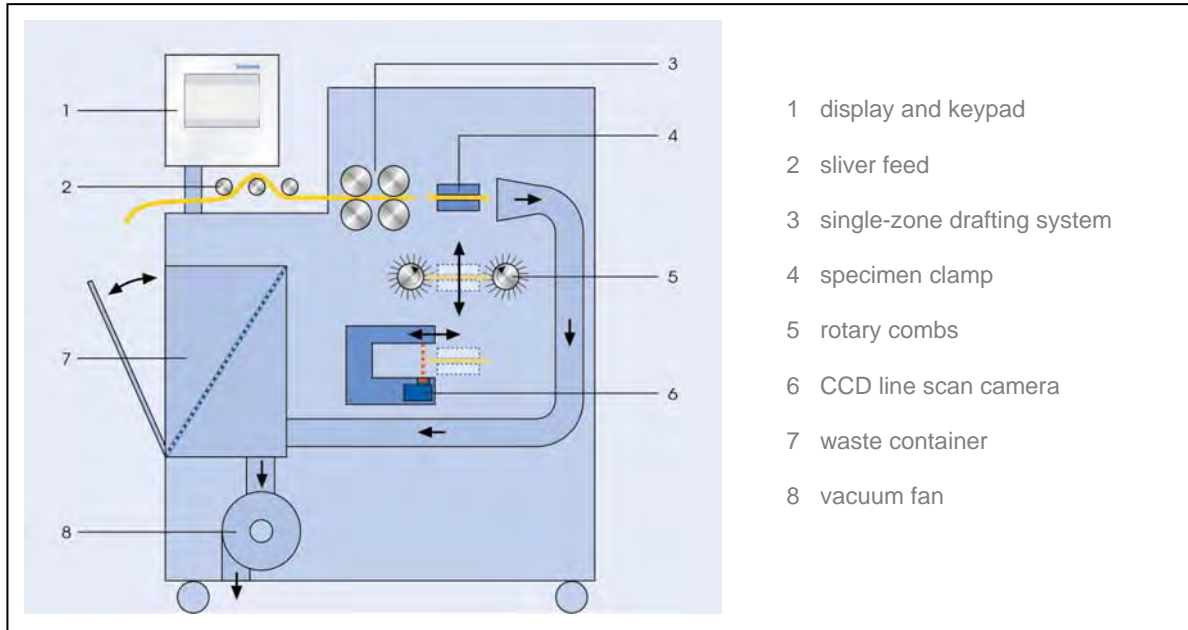


Figure 2 Cross-sectional view of the instrument

When monitoring the performance of cards, drawframes and combers or when optimising these machines with the Lengthcontrol instrument, only three measurements derived from the original fibre length distribution are required to successfully complete the vast majority of all applications. These measurements are

- Upper length
- LCT-Length
- Fibre hooks

Although few measurements are required, they are nevertheless 100% meaningful in the context of practical mill processing. The upper length measurement is the equivalent of the classic 2.5% span length derived directly from the fibrogram curve. It is reported in mm (inch) and for most practical purposes, it represents the staple length of a given cotton mix. The measurement is instrumental in setting up drafting systems, i.e. roll spacing in particular. LCT-Length, on the other hand, is based on the array function or staple diagram, which is mathematically developed from the fibrogram curve. LCT-Length is a measurement of mean fibre length by weight in mm (inch). The measurement has been carefully engineered to reflect subtle evidence of fibre damage as a result of the mechanical stress exerted on the fibres during processing. LCT-Length is particularly useful in assessing carding intensity. The fibre hooks measurement results from the bidirectional scanning of the fibre beard. It relates to the percentage loss of fibre length due to the formation of either leading or trailing hooks. As more and more fibre hooks are removed in drawing and combing, the percentage figure decreases, i.e. the fibres become more aligned and parallel and the effective length increases. With the help of this measurement, the number of drawframe passes, drafts and doublings can be optimised very effectively.

If the user desires to conduct a more profound analysis of fibre length distribution, the Lengthcontrol system offers additional, more detailed measurements. These are

- LCT-Length × fibre hooks
- Short fibre length
- Short fibre amount
- Short fibre content
- Staple gradient

LCT-Length × fibre hooks describes the LCT-Length in mm (inch) that fibres would possess once the fibre hooks are mostly removed and the fibres are fully aligned/extended. The measurement considers both the length of the fibres and the frequency of fibre hooks. It is particularly useful in optimising drawframes. Short fibre length is the length by weight in mm (inch) of 10% of the shortest fibres as per the array computed from the fibrogram curve. The short fibre amount percentage value represents the ratio of short fibres and long fibres. The measurement is weight-biased and it is an expression of short fibre content which is normalized to an upper length statistic and thus independent of the discrepancies observed between cottons of different staple lengths. Short fibre content is the classic percentage by weight of fibres shorter than $\frac{1}{2}$ inch. All three measurements of short fibres are applied in assessing the degree of fibre damage or the removal of short fibres. They are utilised almost exclusively in carding and combing applications. Last but not least, the staple gradient measurement is the ratio between the 50% and 2.5% span lengths quoted in percent, i.e. the classic uniformity ratio known from Fibrograph and HVI instruments.

DETERMINING OPTIMUM MACHINE SETTINGS IN CARDING

Optimising a cotton card is particularly challenging since the card's ability to remove objectionable particles (neps, trash and seed-coat fragments) and the degree of fibre damage are diametrically opposed. Whatever is done to improve carding intensity with a cleaner web in mind, is guaranteed to affect the fibre length distribution. In the effort to minimise yarn imperfections, fewer neps, trash particles and seed-coat fragments in the card sliver will certainly help, but the carding action needs to be carefully balanced against the occurrence of short fibres, which are another primary reason for yarn imperfections. This is particularly critical with carded ring-spun yarns.

Several years ago Truetzschler introduced the Nepcontrol NCT (**Figure 3**). The device is used for online monitoring of the card web for neps, trash particles and seed-coat fragments via digital image analysis.

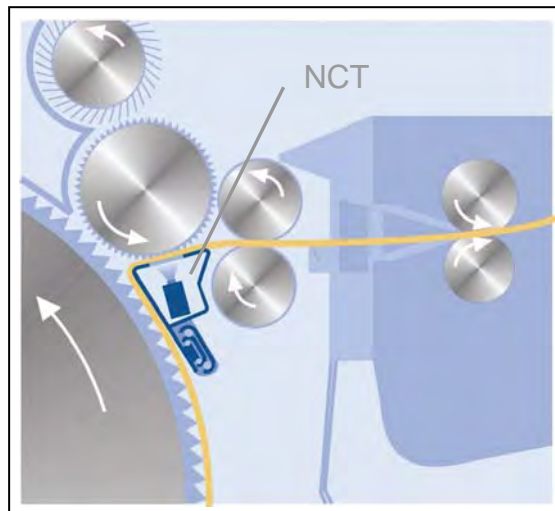


Figure 3 Nepcontrol NCT

This is an excellent example of a highly sophisticated system complementing the card and greatly facilitating the optimisation process. However, the overall optimum cannot be found when a card is optimised in terms of nep or trash removal efficiency alone. Information on the fibre length distribution is required to locate the optimum operating point.

In general terms, main cylinder speed of the card is frequently one of the first parameters to be adjusted when optimising card performance. Taken from a series of practical mill trials, **Figure 4** illustrates the effect of changes of main cylinder speed on NCT total particle count, i.e. neps plus trash particles plus seed-coat fragments. Evidently, there is a linear response of objectionable particles in the card web to changes in main cylinder speed.

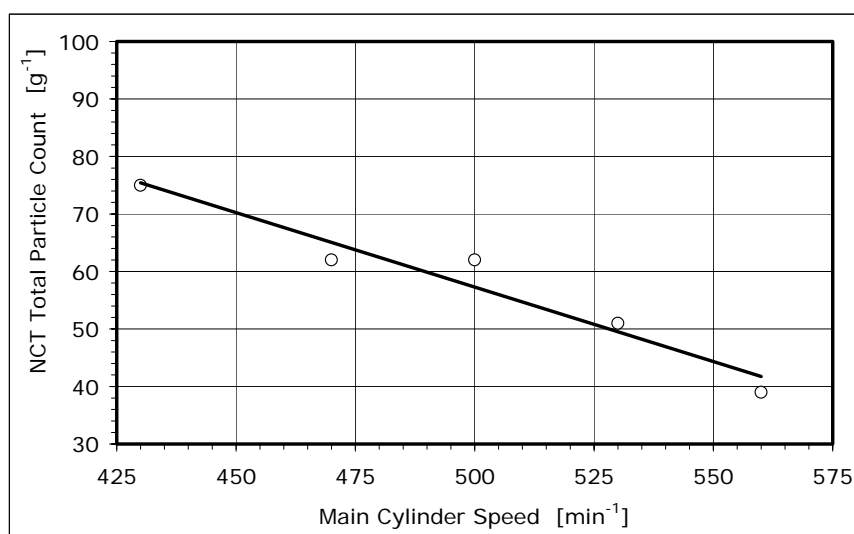


Figure 4 Effect of main cylinder speed on NCT total particle count

At moderate main cylinder speeds, the card may not remove an adequate amount of impurities to ensure low yarn imperfections. In contrast, excessive circumferential velocity of the main cylinder may generate more short fibres. Extensive spinning trials and studying the imperfection levels would certainly reveal the optimum operating point but Lengthcontrol LCT will provide that answer much more rapidly and cost-effectively. In **Figure 5**, LCT-Length is plotted over main cylinder speed.

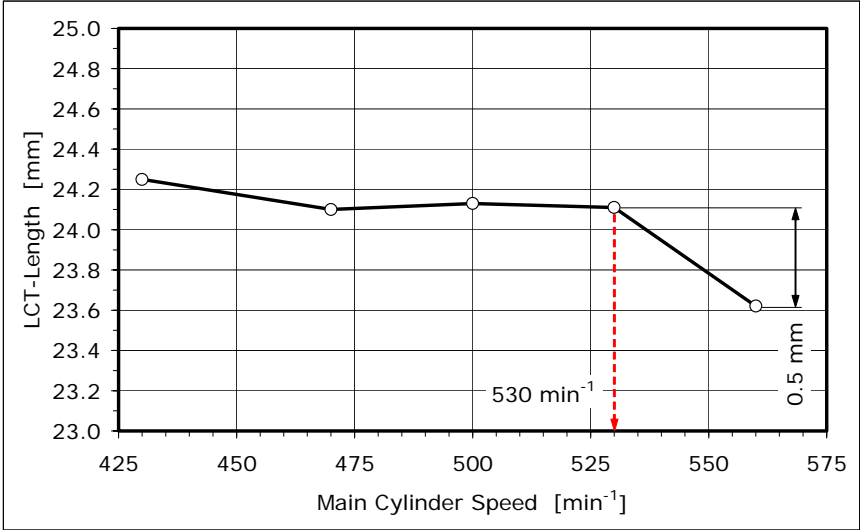


Figure 5 Effect of main cylinder speed on LCT-Length

Beyond 530 min⁻¹, the graph displays a pronounced decrease of LCT-Length of approximately 0.5 mm. It can therefore be concluded that the optimum main cylinder speed is 530 min⁻¹ but spending a little time on rearranging the data may help to further enhance the analysis:

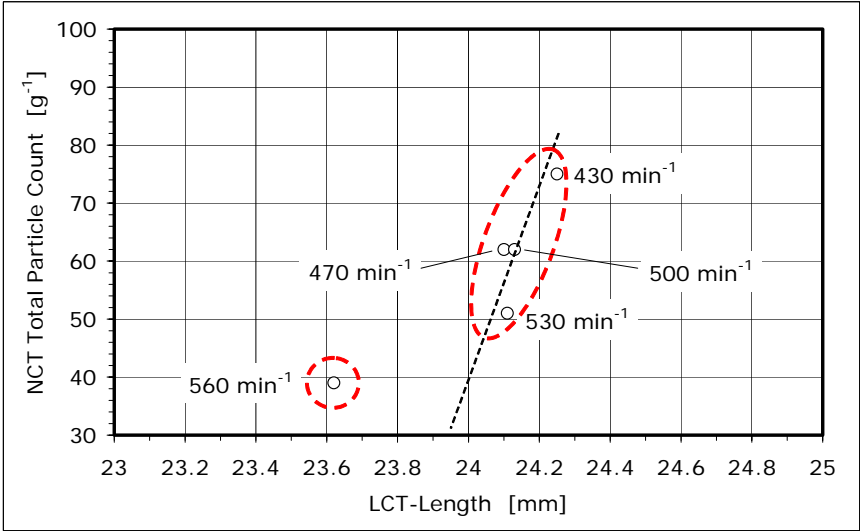


Figure 6 Cluster chart

In **Figure 6**, all three variables, i.e. main cylinder speed, LCT-Length and NCT total particle count, are displayed in one graph. The illustration reveals the fact that there are two distinct data clusters. The data points for main cylinder speeds between 430 min^{-1} and 530 min^{-1} display a low degree of scatter and appear to closely track a linear trend. However, the data point for 560 min^{-1} is displaced by a fair amount, it forms a separate cluster and does not follow the general trend. This indicates an abrupt, pronounced departure from the regular process. For the specific cotton mix processed and under the given processing conditions, the threshold carding intensity has been exceeded. Upon closer inspection of the data, the loss of LCT-Length has suddenly become over-proportional considering the observed reduction of total objectionable particles at a main cylinder speed of 560 min^{-1} . Again, this analysis suggests that a main cylinder speed of 530 min^{-1} reflects the optimum machine setting.

In this case study, the findings could be verified by spinning Ne 32/1 open-end yarns from the slivers produced at different main cylinder speeds. The relationships for yarn thin places, thick places and neps illustrated in **Figure 7** suggest that the most adequate main cylinder speed for minimum yarn imperfections is either 500 min^{-1} or 530 min^{-1} or somewhere in between.

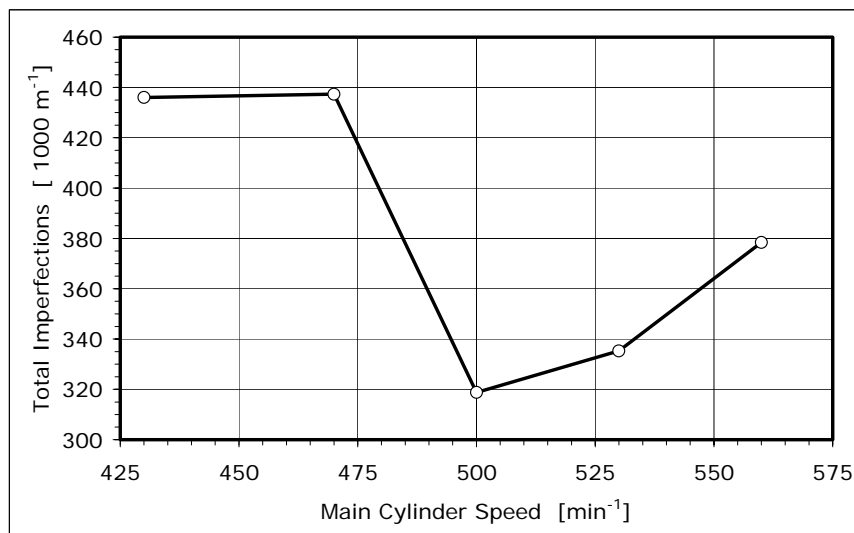


Figure 7 Total imperfections as a function of main cylinder speed

In any case, Lengthcontrol LCT has helped tremendously to determine the optimum machine settings with reasonable accuracy. Spinning trials would certainly have been prohibitive in a real-world mill environment for a variety of reasons and real-world optimisation therefore confined to merely intuitive adjustments.

DETERMINING OPTIMUM MACHINE SETTINGS IN DRAWING

The Lengthcontrol instrument is now taken from the card room to the drawframes.

Truetzschler TD 03 autoleveller drawframes are already equipped with two features that fall into the category of intelligent optimisation tools. The Autodraft system consists of a separate variable speed servo drive for the middle bottom roll of the drafting system and apart from enabling the operator to change break draft via the touch screen machine terminal, it permits the fully automatic determination of the optimum break draft for any given raw material processed (**Figure 8**).

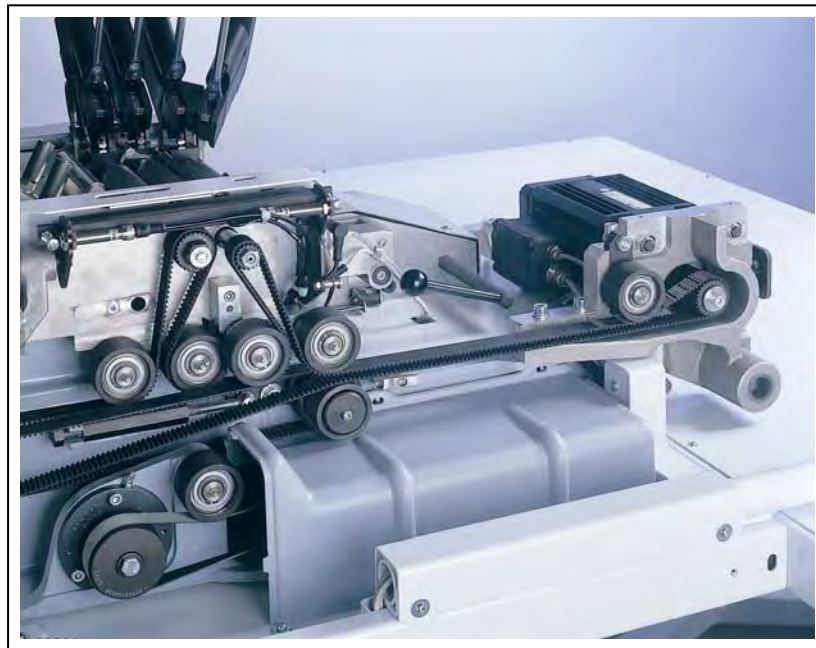


Figure 8 Autodraft servo drive for the middle bottom roll

The Optiset feature has just recently been introduced. Special algorithms implemented in the machine software determine fully automatically the optimum main drafting point while the machine is processing the corresponding sliver material. The main drafting point is another key setting of autoleveller drawframes, which largely determines the success of the autolevelling interventions and thus has a substantial effect on sliver evenness. **Figure 9** represents a screen shot of the machine display immediately after the automatic optimisation routine has been completed. The operator is now asked to confirm the proposed main drafting point.

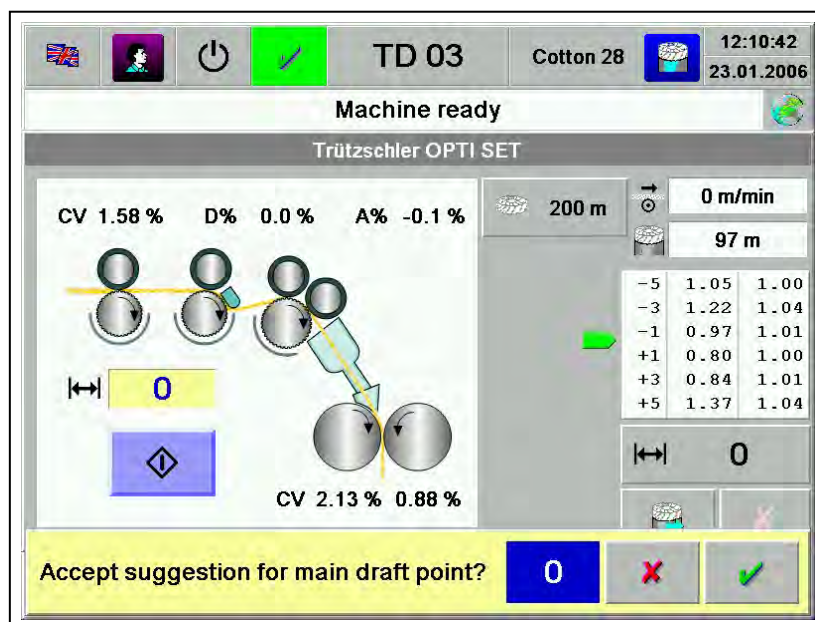


Figure 9 Optiset – determining the optimum main drafting point

However, there are several other crucial settings at the drawframe where fibre length information is required and where the Lengthcontrol instrument can make a very effective contribution. Adapting the roll spacing in the break draft and main draft zone to the length of the cotton fibres processed, for instance, is an archetypical optimisation problem. **Figure 10** should shed some light on the issue. The data presented in graphical form originates from an air-jet spinning mill. Air-jet spinning requires three-process drawing, and sliver quality is crucial to both yarn quality and processing performance, i.e. yarn breakage rate. The upper portion of the graph displays the response of LCT upper length to changes in the nip distance applied in the main drafting zone of the autoleveller drawframe (third pass). As nip distance increases, upper length also improves to a considerable extent. However, we can define three typical areas, a loss area, a critical area and a gain area. Needless to say that the gain area is targeted by selecting somewhat wider settings, whereas the loss and the critical transition area should be avoided. The increasing LCT upper length is strictly a result of better fibre alignment and fibre extension. Despite the tighter settings, the loss area is not indicative of fibre damage; rather, it suggests an obvious lack of fibre alignment. The middle section of **Figure 10** suggests that some of the improvement in LCT upper length is also caused by the removal of fibre hooks. The wider the nip setting in the main drafting zone, the lower the percentage of fibre hooks. The bottom part of **Figure 10**, however, explains why the overwhelming majority of drawframes in the global spinning industry are not operating in the gain zone. The best results in terms of sliver evenness are obtained at very tight nip settings and many people tend to overemphasize sliver evenness at the expense of yarn quality. A drafting system should never be optimised on the basis of sliver uniformity alone.

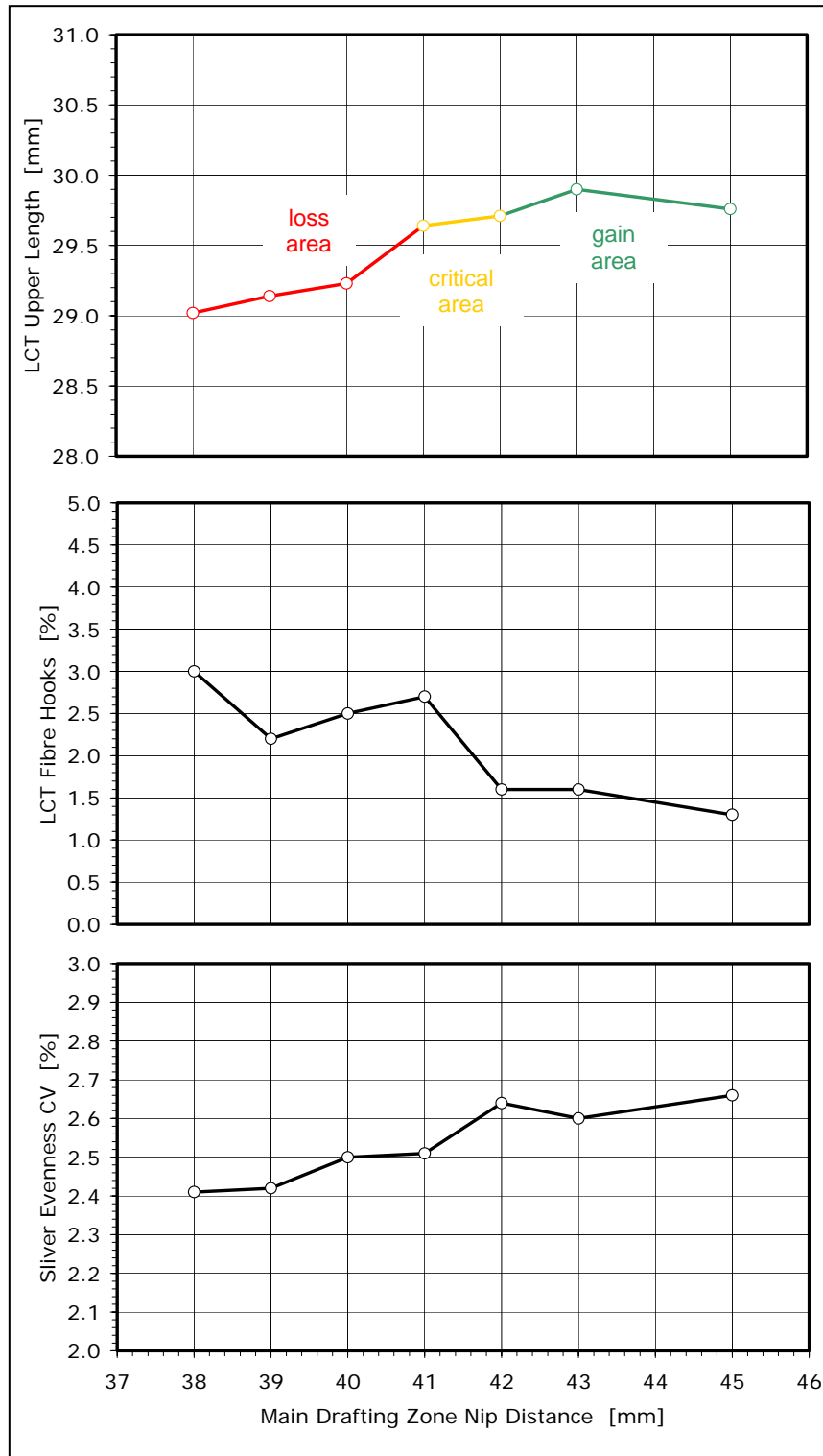


Figure 10 LCT upper length, fibre hooks and sliver evenness as a function of the nip setting in the main drafting zone

To counteract the common misconception of how to properly set up a drawframe, the Lengthcontrol instrument offers some very unique features. Testing the sliver to be processed on a drawframe with the Lengthcontrol instrument will provide the user with a proposal related to back and front roll settings for Truetzschler drawframes.

The proposed setting is mathematically derived from fibre length distribution parameters of the actual feed sliver. In addition to roll spacings, Lengthcontrol will also make a recommendation towards the positioning of the pressure bar and, last but not least, indicate the optimum break draft for drawframes without the Autodraft feature. Thus, three of the most important drawframe settings are automatically determined and displayed by simply testing the sliver to be processed. An example is given in **Figure 11**.

Date/Time	:	23.01.2006 11:51
Lot	:	IS2G2V2G-G2 PN68000
Comments	:	
Operator	:	
Machine No.	:	M5
Recommended setting for next draft passage		
Distance nip line / drafting system		
Main draft distance	[mm]	39,90
Break draft distance	[mm]	45,41
Break draft level		1,26
Pressure bar: Cam number		2
Back		

Figure 11 Optimum settings established by Lengthcontrol

The Lengthcontrol instrument is capable of translating data relating to the fibre length distribution into a language that is easily understood by machine operators. There is no obscure fibre quality data report that only few experts can analyse in a proper fashion but clear instructions as to what to do in order to optimise the performance of the drawframe.

Just recently, the Lengthcontrol instrument was evaluated by a very experienced individual in a cotton spinning mill. The drawframes operated in this mill are set based on the vast amount of experience and technical expertise this individual has accumulated and developed over years of successfully running these machines. It was extremely interesting for us to see how Lengthcontrol would perform in comparison with a true human expert. **Table 1** therefore provides a comparison between the optimum settings for both the breaker and the finisher drawframe as per the human expert and Lengthcontrol.

Table I Comparison between LCT proposal and actual mill settings

	Breaker Drawing		Finisher Drawing	
	Mill	LCT	Mill	LCT
Break draft distance [mm]	46.0	47.0	46.0	48.0
Main draft distance [mm]	40.5	41.0	41.0	42.0
Break draft level	1.23	1.35	1.23	1.23
Pressure bar position	2	2	2	2

The above table indicates that the differences between the settings are not very pronounced. However, the mill has literally spent years perfecting the drawframe settings while Lengthcontrol derived the proposed setting from a simple measurement of the sliver entering into the drawframe, which took less than ten minutes.

Figure 12 represents a comparative analysis of the yarn quality parameters obtained with the drawframe slivers after the empirical mill optimisation and after the analytical Lengthcontrol optimisation. The data relates to an Ne 24/1 open-end yarn spun from 100% cotton.

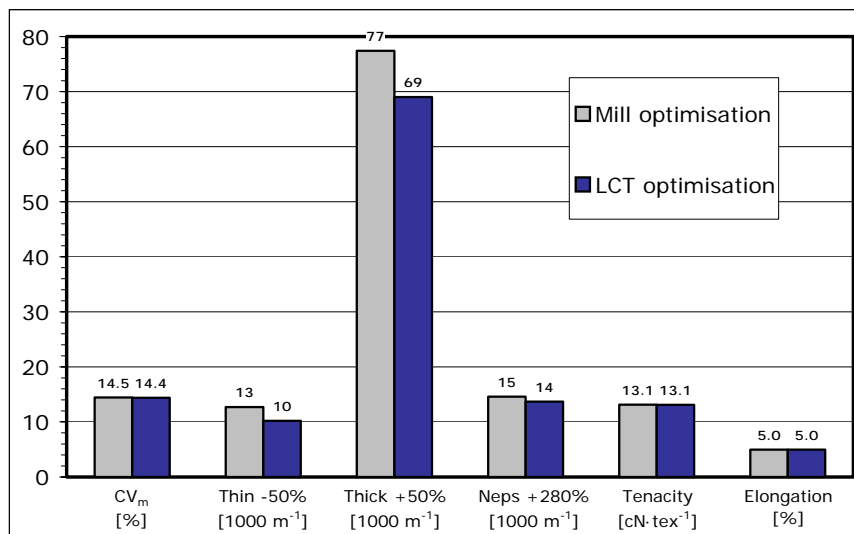


Figure 12 Yarn quality comparison

The graph illustrates the fact that determining the optimum machine settings with the Lengthcontrol system even slightly improved the yarn imperfections, i.e. thin places, thick places and neps. This case study was particularly gratifying in that the Lengthcontrol instrument proved to belong to the major league together with the best experts the industry has to offer.

DETERMINING OPTIMUM MACHINE SETTINGS IN COMBING

The Lengthcontrol instrument is now taken from the drawframes to the combers.

In a combed ring spinning mill, minimising comber noil extraction while maintaining the highest possible yarn quality is very often a standard optimisation problem. Needless to say that each half percent of comber noil saved amounts to an impressive reduction of annual raw material cost. In **Figure 13**, LCT short fibre content (the percentage by weight of fibres shorter than $\frac{1}{2}$ inch) of the combed sliver is plotted over comber noil extraction. As could be expected, short fibre content decreases in a non-linear, degressive fashion, suggesting that higher noil extraction will not be equally effective in removing short fibres as lower noil percentages. This is due to the fact that higher comber noil extraction generally results in a less favourable ratio of long fibres and short fibres in the noil.

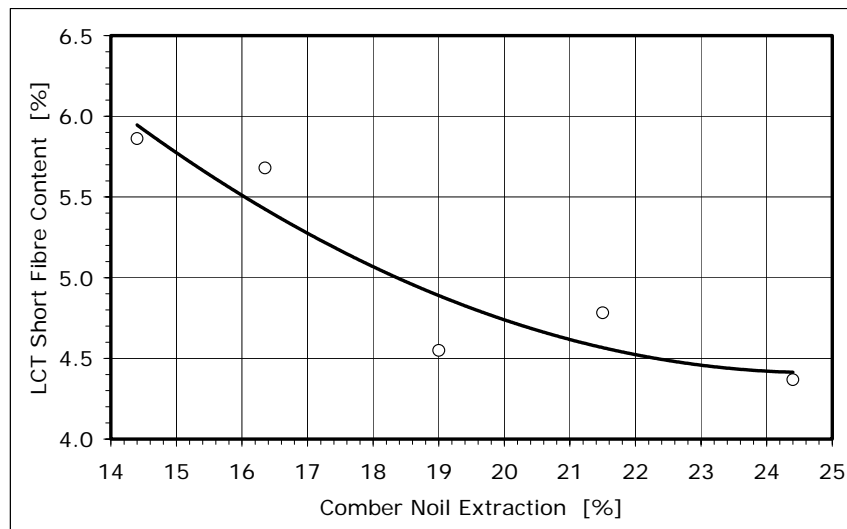


Figure 13 Effect of comber noil extraction on LCT short fibre content of the combed sliver

Figure 14 proves that the same non-linear, degressive characteristic of the LCT short fibre content can also be observed for the total imperfection count, i.e. thick places plus thin places plus neps, of an Ne 24/1 combed ring-spun yarn for knitting end-uses.

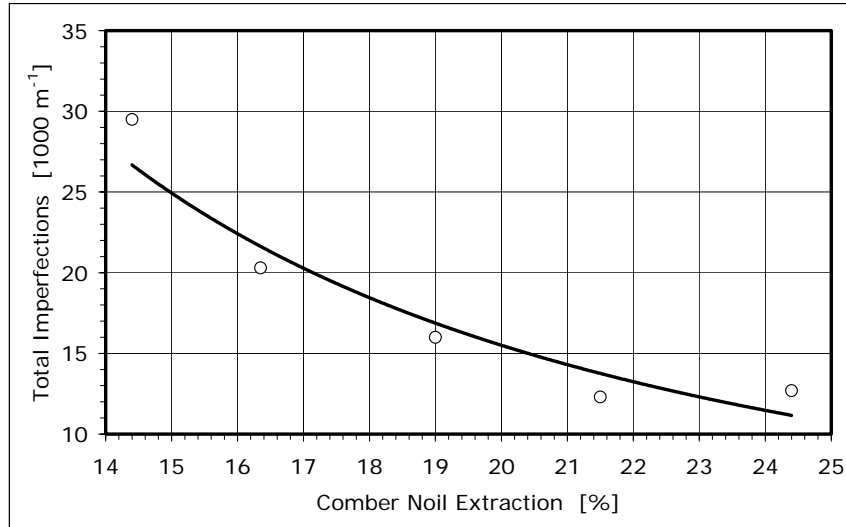


Figure 14 Total imperfections as a function of comber noil extraction

Figure 15 illustrates the correlation between total yarn imperfections and LCT short fibre content. The relationship between both parameters is of linear nature. There is some scatter in the experimental data, which results from the fact that spinning trials with different degrees of comber noil extraction are extremely time-consuming and in this case, they extended over three days. Considering these circumstances and the overall variability entering into a several-day experiment, a correlation coefficient of $r = 0.88$ appears to be acceptable.

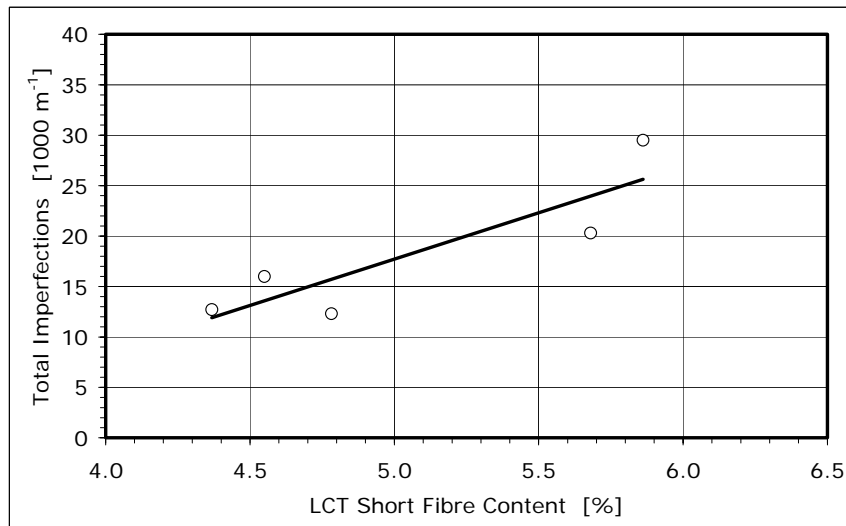


Figure 15 Correlation between LCT short fibre content and total yarn imperfections

In essence, measurements of LCT short fibre content of the combed sliver provide a fairly reliable estimate of total imperfections in the ring-spun yarn. Again, taking the combed sliver to the autoleveller drawframe, and progressing through roving and ring spinning for three days would have been totally prohibitive in a real-world production

environment. Therefore, using the Lengthcontrol instrument is the only justifiable way to achieve an optimisation of comber noil extraction. Once the machine has been optimised and once the relationship between LCT short fibre content and yarn imperfections has been established, the effect of changes in the cotton mix, for instance, or the effect of any other process variable can be monitored from now on by simply testing the combed sliver and determining the short fibre content.

CONCLUSIONS

These were just a few practical examples that illustrate the benefits of the Lengthcontrol LCT instrument when used for determining optimum machine settings in carding, drawing and combing. It could be demonstrated that such instrumentation undoubtedly has the potential to become an invaluable asset to many worldwide spinning mills.

From our perspective, it is also interesting to witness how new measurements and new measuring technologies open up horizons and uncover several territories that might be worthwhile exploring. We are rapidly gaining a much more profound understanding of the complex technological interrelationships and we are still learning new things every day. It is important to understand that fibres in the physical form of tufts, sliver or even roving contain all available information on how that specific fibrous material will behave under given processing conditions and what the final quality results will be. I like to compare it to a DNA code. The information is all in there and it is just a matter of extracting and decoding that information through analytical measurements. With our Lengthcontrol instrument, we definitely have a solid but also flexible platform to accompany our further research into fibre and processing technology.

REFERENCES

Schlichter, S. 2002. Strategies for optimising spinning preparation using on-line measuring technology. Proceedings of the 26th International Cotton Conference, Bremen, Germany. 146-163

Schlichter, S. 2004. Self-optimisation of spinning machinery – status and perspectives. Proceedings of the 27th International Cotton Conference, Bremen, Germany. 177-196

NEW DEVELOPMENTS IN MURATA VORTEX SPINNING

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Editor's Note

A written paper was not provided by the author prior to the conference.

PRAKTISCHE ERFAHRUNGEN MIT DER VORTEX-SPINNTECHNIK

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Bericht über unsere Erfahrungen in der Vortex-Spinnerei bei der Herstellung von Baumwoll- und Polyester/Baumwoll-Garnen und deren Verhalten in Weberei und Ausrüstung sowie deren Auswirkungen auf das fertige Gewebe und dessen Gebrauchseigenschaften.

Wir sprechen bei der Vortex-Spinnentechnik und den damit hergestellten Garnen bzw. Flächengebilden über ein noch neues, wenig bekanntes Thema - zumindest in Deutschland.

Ich bin überzeugt, dass sich Vortex als 3. Spinnverfahren für Stapelfasergarne neben Ring- inkl. Kompakt- und OE durchsetzen wird.

Zu dieser Überzeugung trägt auch bei, dass wir seit langem mit einem führenden schweizer Spinnereimaschinen-Produzenten zusammenarbeiten und dabei Resultate erzielt haben, die uns zuversichtlich machen. Dieser 2. Hersteller hat entschieden mit aller Kraft daran zu arbeiten, ebenfalls eine Luftdüsen-Spinnmaschine in den Markt zu bringen. Dies wird, wie die Erfahrung lehrt, deutlich zur Akzeptanz dieser Technologie beitragen.

Gleich zu Beginn die Ihnen allen bekannte Feststellung: "Nahezu nichts auf der Welt hat nur Vorteile" - auch nicht die Vortex-Spinnentechnologie. Demzufolge werde ich die noch vorhandenen Nachteile im Verlauf meiner Ausführungen, sofern sie von Bedeutung sind, nicht unterschlagen.

Worüber ich Ihnen berichten kann - und auch will - ist die nunmehr etwas mehr als dreijährige Erfahrung beim Einsatz von zunächst einer, dann zwei und nunmehr 7 Vortex- Spinnmaschinen im Bereich der Stapelfasergarnerzeugung, Nummernbereich Nm 24 - 85 sowohl in 100% Baumwolle als auch in diversen Mischungen mit Polyester und 100% Polyester. Wir gehen davon aus, dass wir in absehbarer Zeit die Versuche in Bereiche bis Nm 100 durchführen. Die Garne werden in unserem Unternehmen in verschiedenen Artikelbereichen in Kette und/oder Schuss eingesetzt, je nach Verwendungszweck.

Wir haben in diesen ersten Vortex-Jahren - wie beim Einsatz von neuen Systemen üblich - enorm viel gelernt und in Zusammenarbeit mit dem Maschinenhersteller bzw. den beiden Herstellern das System doch erheblich weiterentwickelt. Dennoch sind wir davon überzeugt, dass es noch Optimierungspotential gibt. Wir werden dieses, wie in der Vergangenheit auch, gemeinsam mit diesen umsetzen.

Den Einsatz für Vortex-Garne sehen wir in allen Bereichen, die wir heute bearbeiten, also

- technische Stapelfasergewebe
- Jeans- und Sportswear
- Berufs- und Schutzbekleidung
- Garne für Wirkerei und Strickerei.

Auch beim Einsatz von Vortex-Garnen gilt nach meiner Überzeugung der Grundsatz:

Luftdüsengesponnene Garne nur da einsetzen, wo sie gegenüber Ringgarnen - inklusive Kompakt - und auch gegenüber OE-Garnen Vorteile bieten, zumindest aber sich auf das Endprodukt und dessen Gebrauchstüchtigkeit nicht nachteilig auswirken.

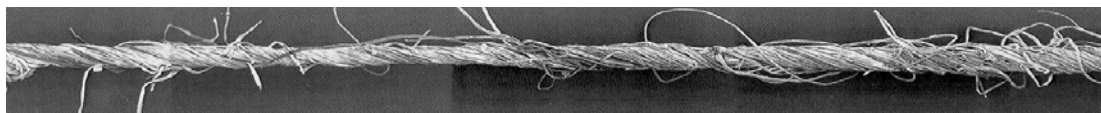
Die Vorteile von Vortex gesponnenem Garn können in einem oder mehreren der folgenden Punkte liegen:

- in Bezug auf die Garnkosten, Euro/kg
- in Bezug auf die Weiterverarbeitung der Garne
- in Bezug auf die Einhaltung vorgegebener Spezifikationen
- in Bezug auf die Qualität des Flächengebildes
- bzw. des fertig konfektionierten Teils und dessen erforderliche Pflege inklusive Tragekomfort
- in Bezug auf die Erzielung spezieller Effekte.

Ein generelles Thema liegt mir sehr am Herzen. Es darf bei der Vortex-Spinntechnologie nicht wie bei der Einführung von OE-Garnen vor 30 Jahren von Anfang an aus Unkenntnis und kurzsichtigen Marketing-Argumenten heraus zu einem falschen Image kommen.

Vortex-Garne können, wie ehemals OE-Garne, nicht einfach 1:1 gegen Ringgarne ausgetauscht werden. In der Artikelkonstruktion und Verarbeitung in allen Stufen muss auf die Besonderheiten gezielt eingegangen werden.

Wir müssen vor der pauschalen Beurteilung "gutes oder schlechtes Garn" wegkommen hin dazu, dass ein Garn für den jeweiligen Verwendungszweck geeignet ist oder nicht und das über die gesamte textile Kette.



Vortex



Ringgarn



Rotorgarn

Wie sehen die wesentlichen Unterschiede aus?

Zunächst zum Garnnummern-Bereich. Er liegt derzeit, nach unserer Erfahrung, im Bereich zwischen Nm 24 - 85, wobei Nm 24 nicht die ideale Nummer ist. Ein Vergleich von Vortex zu Ring bzw. Rotor fällt beim heutigen Entwicklungsstand wie folgt aus:

***Effektive Produktionswerte am Beispiel eines Nm 34
65/35% Polyester/Baumwolle, gleicher Rohstoffeinsatz, Spinnerei Lauffenmühle.**

- Ringgarn mit Baumwollanteil gekämmt
- Vortex, OE mit Baumwollanteil kardiert

Parameter	Vortex	Ring	OE
Nm-Bereich (Lauffenmühle)	24-85	18 - 100	6-64
Bauchbinden	nein	nein	ja

Produktion:*

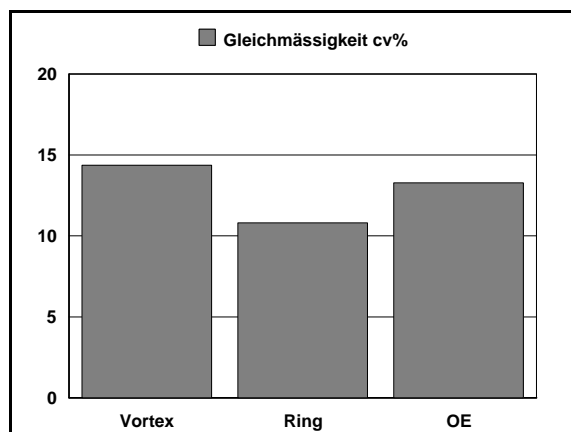
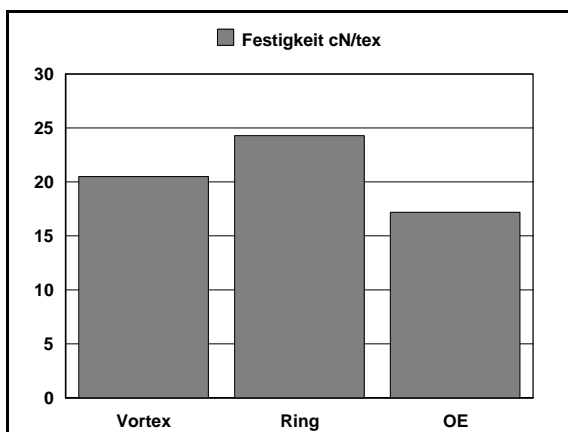
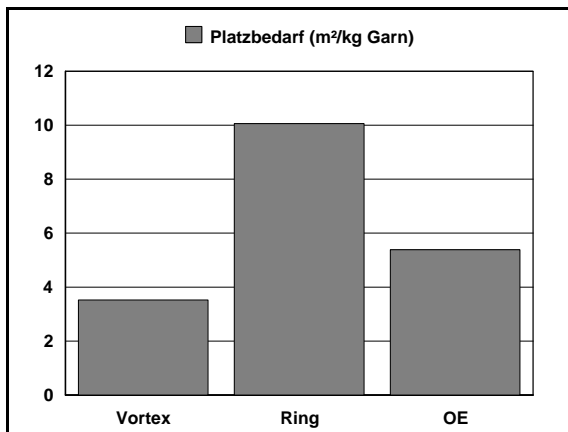
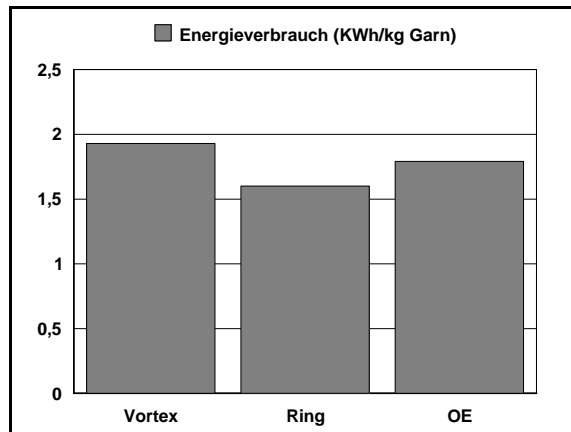
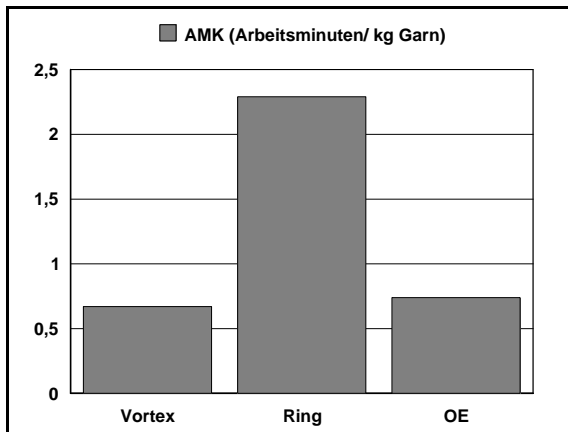
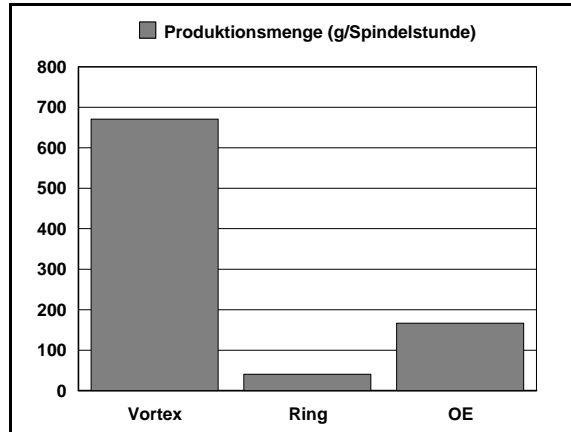
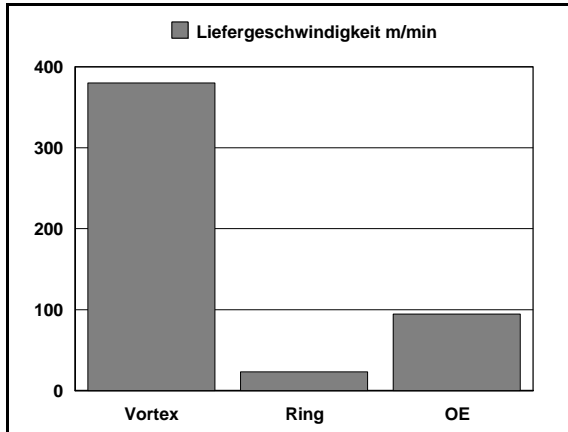
Liefargeschwindigkeit (m/min)	380	23,2	94,6
Produktionsmenge (g/Spindelstunde)	670,6	40,9	166,9
AMK (Arbeitsminuten/ kg Garn)	0,67*	2,29	0,74
Energieverbrauch (KWh/kg Garn)	1,93*	1,6	1,79
Platzbedarf (m ² /kg Garn)	3,53*	10,06	5,39

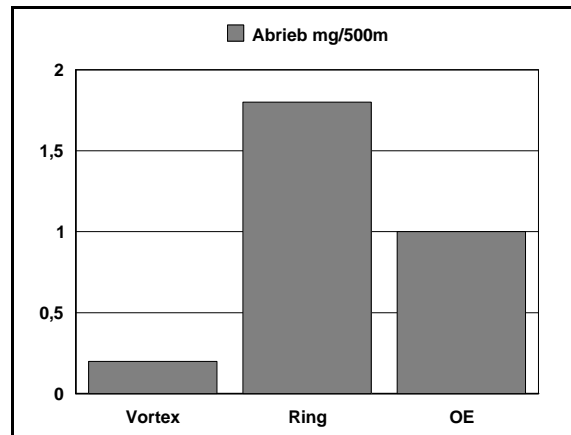
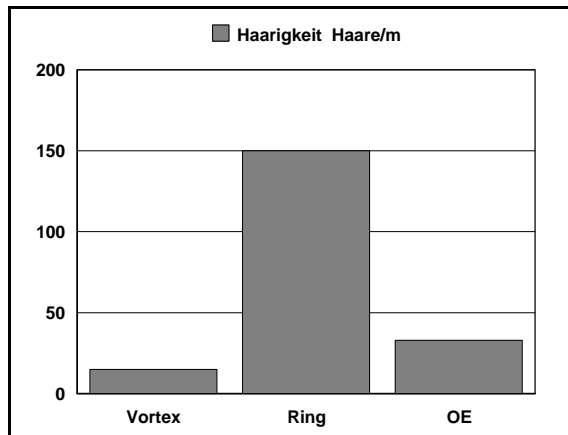
* Wir gehen davon aus, dass diese Werte noch deutlich zu optimieren sind. So wird z.B. der Platzbedarf bei der Rieter-Maschine erheblich sinken.

Garnwerte:*

Festigkeit (cN/tex)	20,5	24,3	17,2
Gleichmässigkeit (CV%)	14,37	10,81	13,28
Nissen (200%/280%)	12	15	12
Haarigkeit (Haare/m)	15	150	33
Haarigkeit (Haare >3mm/m)	0*	4	1,3
Abrieb (mg/500m)	0,2	1,8	1

* Für so wichtige Themen wie Pillingverhalten oder Staubanfall in der Produktion ist dies der entscheidende Wert





Bei Mischgarnen ist die Festigkeitsdifferenz zu Ringgarnen weitaus geringer als bei 100% Bw.-Garnen oder, anders gesagt, der Vorteil gegenüber OE ist deutlich höher.

Wenn man sich diese generellen Unterschiede klar macht, wird schnell deutlich, dass Vortex-Garne - zumindest derzeit - in allererster Linie gegen Ringgarne eingesetzt werden und dies sowohl gegen kardierte als auch gekämmte. In Feinheitsbereichen Nm 34 und feiner stellt die Vortex-Spinntechnologie allerdings auch eine vorteilhafte Alternative zum Rotorspinnen dar, natürlich immer - wie gesagt - unter Beachtung des Endartikels und dessen Einsatzzweck.

Generell wird mit dem Einsatz der Vortex-Spinntechnologie der Fertigungslohnkostenanteil reduziert. Es wird aber eine komplexe Infrastruktur hinsichtlich Luftversorgung und Abgangsentsorgung erforderlich. Ein enormer Vorteil gegenüber der Ringspinnerei ist - wie beim Rotorspinnen - der Wegfall des Flyers. Diese Prozessverkürzung bringt erhebliche Dispositions Vorteile und mehr Flexibilität. Zudem ist der Spulprozess wie in der Rotorspinnerei integriert. Das Endprodukt der Spinnmaschine ist die fertige Spule.

Im Vergleich zum Rotorspinnen entfällt die bei einem breiten Spinnprogramm notwendige Typen-Vielfalt an Rotoren, Auflösewalzen, Abzugsdüsen, Stützscheiben etc.

Im Bezug auf den Rohstoffeinsatz haben wir Stand heute sicher noch nicht das Optimum ausgereizt. Tatsache ist aber, dass wir mit den gleichen Baumwoll-Mischungen bzw. den gleichen Polyester-Typen fahren wie z.B. in der Ringspinnerei.

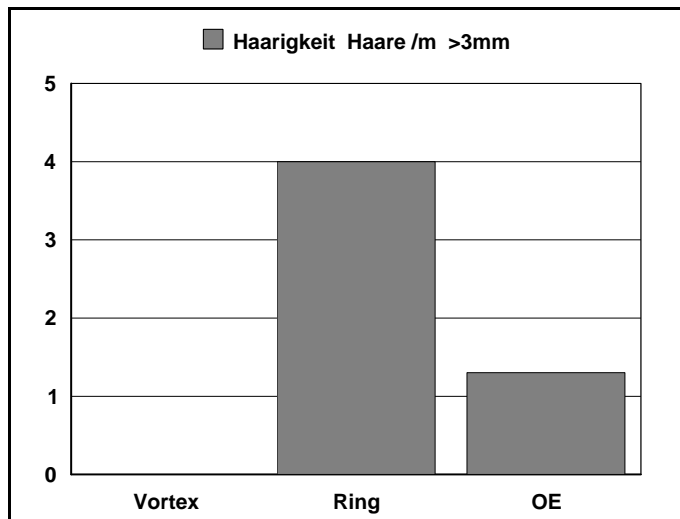
Im Spinnerei-Vorwerk hat sich nach unseren Erfahrungen der Einsatz integrierter Streckwerke an der Karde in Verbindung mit normalen Strecken bewährt, wobei wir von Streckenband zu Garn mit ca. 150-200-fachem Verzug arbeiten. Vergleichend mit dem Kämmprozess in der Ringspinnerei liegt der Abgangsprozentsatz bei 100% Bw. ca. bei 6-8 und bei Mischgarn etwa 3,5%. Diese Werte gelten für unseren Rohstoffeinsatz und Garnqualität, bei derzeit 380 min/m. Leistung. Wir sind der Auffassung, dass das System aber noch lange nicht am Ende der Möglichkeiten angelangt ist (500 m/min sollten bald möglich sein).

Im Spinnerei-Vorwerk, dem Weg von der Karde über die Strecken bis hin zur Spinnmaschine gibt es unseres Erachtens noch erheblichen Forschungsbedarf genereller Art.

Kommen wir zu der Fertigungsstufe in der Weberei:

In der Kettvorbereitung, speziell in der Zettlerei/Schärerei, wirkt sich beim Einsatz von Vortex-Garn besonders vorteilhaft aus, dass

- Vortexgarne signifikant weniger stauben als andere bisherige Garne, Ring inkl. Kompakt und OE. Das ist das Resultat davon, dass es keine Haare über 3 mm gibt.
- die Stopps pro Einheit (z.B. 10.000 Fadenkilometer) liegen auf vergleichbarem Niveau.



Damit sind für die Schlichterei gute Voraussetzungen geschaffen.

Für die Schlichterei gilt nach unseren bisherigen Erfahrungen, dass grundsätzlich - gleichgültig ob vogenetzt oder konventionell - mit den gleichen Grundrezepten gefahren werden kann. (Wobei wir von ca. 20% geringerer Konzentration ausgehen).

Auch im Hinblick auf die Maschinen-Parameter wie Abquetschdruck, Wickelspannung, Anpressdruck, Restfeuchte etc. gelten die Vorgaben von Ring- bzw. OE-Garn. Die Details müssen empirisch ermittelt werden.

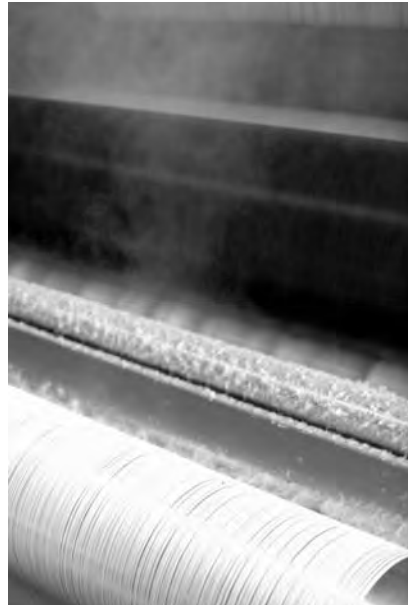
Kettbaum:

Das Fassungsvermögen muss der Garnstruktur entsprechend angepasst werden. Es ist etwas höher als bei Ring- bzw. OE-Garnen.

Im Trockenteilfeld der Schlichtmaschine ist, wie in der Zettlerei/Schärerei, der sehr geringe Staubanfall ein nicht zu unterschätzender Vorteil. Bedingt durch die geringe Haarigkeit wird das Teilen vor den Teilstäben begünstigt. Dies trägt dazu bei, dass die Fadenbruchzahlen absolut akzeptabel sind.



PLEVA Kontrollsystem



Schlichtetrog

Es ist darauf zu achten, dass die Fadenbelegung im Schlichtetrog einen gewissen Prozentsatz nicht unterschreitet, da sonst die Gefahr der Verkordelung besteht.

In der Einzieherei konnten wir bislang im Vergleich zu Ring- und Rotorgarnen keinen nennenswerten Unterschied ermitteln. Die Wahl von Lamellen, Litzen, Schäften ist weit mehr von der Webmaschine abhängig. Vorstellbar ist, dass wir mit leichteren Lamellen auskommen.

Zur Weberei:

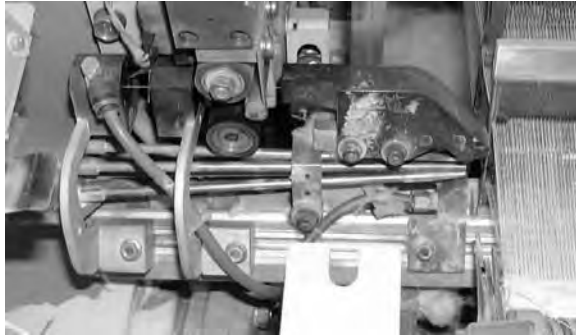
Die Verhältnisse bzw. Garnanforderungen für Kette und Schuss sind auf den heute gängigen_Websystemen Greifer, Projektil, Luftdüsen und Mehrphasen einfach zu unterschiedlich, um eine einheitliche, generelle Aussage zum Verhalten der Vortex-Garne zu machen.



Greifer



Projektil



Luftdüse



Webrotor

Wir haben festgestellt, dass die Vortex-Garne auf allen genannten Systemen, sowohl im Kett- als auch im Schuss-System, ohne Einschränkungen verarbeitbar sind. Auch in der Weberei ist der augenfälligste Vorteil der extrem geringe Staubanfall.

Der Spulenaufbau der Vortex-Maschine genügt auch den höchsten Schusseintragsleistungen.

Die Fadenverbindungen erlauben Fadenbruchwerte, die denen von Ring- und Rotor nicht nachstehen - wenn das Vorwerk gut gearbeitet hat.

Da wir selbst noch in der "Erfahrungssammelungsphase" sind, kann ich Ihnen heute noch nicht mit Bestimmtheit sagen, welches Websystem am optimalsten auf Vortex-Garne reagiert - wir wissen aber, alle sind gut möglich. Ich verzichte ausdrücklich darauf, Ihnen vergleichende Grafiken mit Fadenbruchzahlen Ring/OE/Vortex Kette und Schuss zu präsentieren und den Versuch zu unternehmen, Ihnen beweisen zu wollen, dass der Nutzeffekt um x % mit Vortex-Garn steigerbar ist. Was wir für uns sicher wissen ist, dass es am sinnvoll eingesetzten Vortex-Garn nicht liegt, wenn der Nutzeffekt in der Weberei sinkt.

In der Rohwarenschau sind Artikel mit Vortex-Garnen etwas weniger aufwändig, weil sauberer, aber das ist marginal und sicher auch von der jeweiligen Reinigungsanlage in der Weberei abhängig.

Folgerichtig geht's jetzt in die Veredlung:

In diesem Bereich der Gewebeherstellung - sicher auch bei Gewirken und Gestricken - sind die einschneidendsten Verfahrens- bzw. Rezeptänderungen erforderlich, um Ausfälle zu erzielen, die vergleichbaren Ring-, Ring-/OE- oder auch OE-Artikeln entsprechen.

An dieser Stelle ist es sicher angebracht, nochmals auf die Bewertungsmatrix vom Anfang zurückzukommen

Parameter	Vortex	Ring	OE
Nm-Bereich (Lauffenmühle)	24 - 100	18 - 100	6 - 64
Festigkeit	+	++	o
Haarigkeit	++	-	o
Bauchbinden	nein	nein	ja
Staubanfall in der Weiterverarbeitung	+	-	-

Stand heute ist es sicher so, dass der Einsatz von Vortex-Garnen für einen vollstufigen Textiler einfacher und besser kalkulierbar ist als z.B. für einen reinen Verkaufsspinner.

Der vollstufige Betrieb kann die beiden generellen Möglichkeiten

- Einsatz im bestehenden Artikel, Vortex- gegen Ring-/Rotorgarn
- Einsatz in neue, auf die besonderen Eigenschaften von Vortex-Garn abgestimmte Artikel

voll ausschöpfen.

In beiden Fällen sind in der Veredlung die generellen Arbeitsgänge natürlich die gleichen. Wir fahren sogar Stand heute, trotz geringerer Haarigkeit, über die Senge. Da wir lediglich Stückfärber produzieren, kann ich Ihnen über unterschiedliche Deckkraft bzw. Klarheit beim Druck nichts sagen.

Die Unterschiede zu Ring-/Rotor-Artikeln liegen in der Appretur. Dort muss von Fall zu Fall die dem Einsatzzweck entsprechende Griffgebung erfolgen (So wie es bei Rotor auch schon immer war und ist).

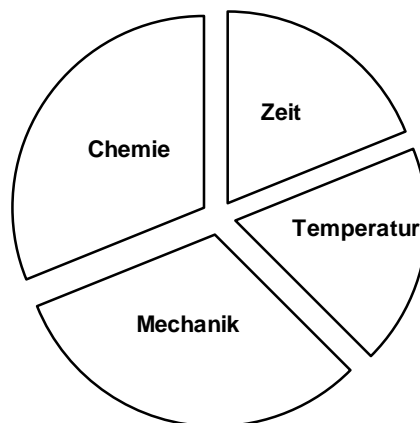
Noch zu einem vielbesprochenen - aus meiner Sicht völlig überbewerteten - Thema, der Garn- und schlussendlich Gewebefestigkeit:

Die Artikelvorschriften z.B. im Bereich der öffentlichen Auftraggeber, die Sie in Form von Technischen Lieferbedingungen/TL's, Technischen Beschreibungen/TB's etc. kennen, entstammen oft auch heute noch den Zeiten, in denen es ausschließlich

Ringgarne gab und die Festigkeitsstandards eben nach den gängigen Werten von card. bzw. gek. Ringgarnen erstellt wurden, völlig unabhängig davon, ob diese Werte in Praxis überhaupt erforderlich waren.

Leider hat sich die Erkenntnis noch nicht flächendeckend durchgesetzt, dass hohe Gewebefestigkeiten kein Garant für eine lange Lebensdauer des Artikels sind. Das Pillingverhalten, um nur einen wichtigen Parameter zu nennen, hat da einen wesentlich höheren Stellenwert und da haben Vortex-Garne größte Vorteile. Unsere Vergleichswerte belegen, dass der Pillingwert um ca 1 ½ bis zu 2 Noten bei Vortex gegenüber Ringgarn besser ist. Dies stellt eine enorme Verbesserung dar, die sich direkt auf die Lebensdauer positiv auswirkt und so die Kalkulation speziell im Leasingbereich verbessert.

Wir liefern z.B. seit 35 Jahren Artikel in dem Bereich Berufs- und Schutzbekleidung. Noch keines dieser Millionen Teile ist wegen der Reißfestigkeit frühzeitig ausgetauscht worden. Bei einer kalkulierten "Lebenserwartung" von 100 und mehr Pflegezyklen im Leasingbereich (sprich industrieller Wäsche), in dem der Sinnersche Kreis,



Sinnersche Kreis

der besagt, dass Chemie, Mechanik, Zeit und Temperatur immer 100% ergeben müssen, aus Kostengründen immer stärker in Richtung Chemie und Mechanik verschoben wird, gehen wir davon aus, dass sich Kombinationen aus den Spinnsystemen, die optimale Pilling- bzw. Scheuerverlustwerte bieten, durchsetzen werden. So gesehen ist Vortex allerbestens geeignet.

Ganz nebenbei, im Bereich Krankenhaus ist die extrem geringe Flusenabgabe ein Garant für weniger postoperative Vorfälle.

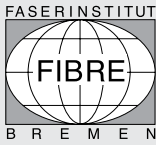
Auf Grund der Philosophie unseres Hauses haben wir die Möglichkeit, das jeweils angebrachte Garn-System - Ring card., gek., Kompakt, OE - oder eben Vortex zum Einsatz zu bringen. Entscheidend ist, dass die Mindestanforderungen an das fertige Gewebe in jedem Fall erreicht werden.

Selbstverständlich müssen die Gewebe neben all diesen meßbaren Parametern auch den Wünschen der Kunden und Verbraucher nach Anforderungen wie fließend, geschmeidig, feminin, klar, clean, soft, mit Stand, aktueller Optik etc. entsprechen.

Denken Sie daran, über 99% der Verbraucher wissen nichts von Ring, Rotor oder Vortex, die wollen nur den richtigen Ausfall.

Meines Erachtens müssen wir Spinner uns endlich zur Aufgabe machen, das unheilvolle Denken in gutes Garn und schlechtes, billiges Garn zu überwinden. Es kann nur den jeweiligen Anforderungen des Artikels entsprechendes Garn geben. Das kann Ring, Rotor und Vortex sein.

Vortex sinnvoll eingesetzt, ist etwas Gutes - und Sie wissen ja, es gibt nichts Gutes, außer man tut es.



28th International Cotton Conference Bremen
March 22 – 25, 2006



Session VIII: Measurement Technology

- ***Process Optimisation using Length and Short Fibre Information from aQura***
Mariappan Anbarasan
- ***Worldwide Implementation of Cotton Classing***
Hossein Ghorashi
- ***Legal and Technical Aspects of Harmonization***
Jan Wellmann, Thomas Schneider

PROCESS OPTIMISATION USING LENGTH AND SHORT FIBRE INFORMATION FROM aQura

V. Srinivasan and M. Anbarasan
Premier Evolvics Pvt Ltd, Coimbatore, INDIA

ABSTRACT

The Premier aQura – Raw material and Process Management system provides several parameters on Neps and fibre length which can be used by the spinners for optimising the yarn quality. This paper provides informative guidelines for utilisation of the length and Short Fibre Content (SFC) information from the length module of aQura.

The first part of the paper deals with the optimisation of the roller settings in draw frames using the aQura length distribution. The 3% aQura length is found to be the optimum setting for setting the draw frame rollers. The conclusion is based on the draw frame sliver quality as well as the corresponding yarn quality. The quality parameters studied at the draw frame stage included sliver evenness and hooks difference. At the yarn stage, the parameters studied included CV% at normal and longer cut lengths, imperfections at normal and higher sensitivity levels, hairiness characteristics, strength, strength CV, elongation, elongation CV% and seldom occurring yarn faults. At the optimum setting, most of the quality parameters showed an improvement compared to the other settings.

The second part of the paper deals with the appropriate reference length for determining SFC. For several reasons, the fibre length distribution of a cotton variety changes through the season from lot to lot. While spinners manage this variation to a certain extent by bale management and other methods, there is still considerable variation in the SFC levels of the mixing issued over a period. Since the process is generally optimized only at the start of a season when there is a major change in raw material quality, the fluctuation in SFC ,results in a corresponding change in the yarn quality. It has been shown earlier that a relative measure of the Short Fibre Content is more appropriate and useful for raw material selection than an absolute measure such as the 12.7 mm (½ inch) conventionally used. The present study compares the influences in process optimization. It was observed that the sliver quality and the yarn quality is best correlated when the SFC is estimated at about 30% of the 5% aQura Length. Therefore, optimizing the various process stages to minimise short fibres at this level is recommended for optimum yarn quality.

INTRODUCTION

This variability in fibre length leads to several problems in the spinning process while the raw cotton mass is converted into the yarn through several processing stages. Most important processes affected due to the length variability are the drafting process and the combing process.

Part 1 - Draw Frame Roller Settings

At the draw frames, the drafting or stretching of the slivers takes place through pairs of rollers set apart at a pre-defined distance and rotating at different speeds. The distance between the nips of the pairs of rollers is commonly referred as the 'roller setting'. The roller setting should neither be too close nor wide. If the setting is closer than the length of the fibres, due to the differential speed of the rollers, these fibres tend to break resulting in poor quality of the delivered sliver. If the setting is wide, during the drafting process, the shorter fibres tend to move without control once they cross the back roller, which again would result in inferior quality of the delivered sliver. It is therefore obvious that a compromise between the two effects has to be reached by arriving at an optimum roller setting so that the yarn quality obtained could be optimum. The fibre distribution plays an important role in deciding this optimum setting.

Over the years, several recommendations have been provided to arrive at the optimum setting from the fibre length distribution. It is generally agreed that the optimum roller setting is just higher than the long fibres in the drafting zone. Available recommendations are based on the 2.5% span length fibrogram and the 5% length of from staple diagram of currently available methods. The aQura measures length on an end aligned gripped beard and provides an accurate reproduction of the length distribution of the sample. Differences in the length distribution provided by aQura and the current instrumental evaluations necessitate separate guidelines for deciding the optimum roller setting. This paper provides recommendations on draw frame roller settings based on the length measures provided by aQura.

Part – 2 Reference Length for the Relative Short Fibre Content

The current practice of determining SFC at a definite length of 12.7 mm (½ inch) is inadequate in view of the fact that this is strongly influenced by the cotton type. Thus, the SFC does not distinguish between a short staple cotton which inherently has more short fibres and a long staple cotton which has higher short fibres due to more breakages during harvesting and ginning. A Relative measure on the lines of the classical Baersorter methodology provides more meaningful results.

Several relative measures of determining short fibre content have been proposed in the last few years, including the one by Mr. Allan Heap at the last Bremen Conference (2004). Using a theoretical statistical model, he illustrated that a relative measure could serve as a better measure for cotton classification. The relative SFC parameter he used, was the percentage of fibres shorter than one half of the Upper Half Mean Length.

By definition, such a relative measure is better than the absolute measure of the short fibre content for taking care of the variabilities between different cotton varieties. The utility of such a measure in taking care of variances within a variety over a period is yet to be studied.

The present study attempts to find possible relationships between the relative short fibre content and the corresponding yarn quality. Further, the study also attempts to arrive at a specific reference point or definition for the Relative Short Fibre Content.

LENGTH MEASUREMENT WITH THE aQura

The aQura comes with an integrated module for determination of the short fibre content precisely based on the classical comb sorter methodology. The length module of the Premier aQura uses the concept of measuring with end aligned samples (Figure 1) to accurately determine the short fibre content and other length parameters. The end aligned sample is prepared from material in sliver form placed on a needle array. For cotton samples and material stages prior to the sliver, the sliver is automatically formed in the nep module of aQura using a patented device eliminating laborious manual preparation.

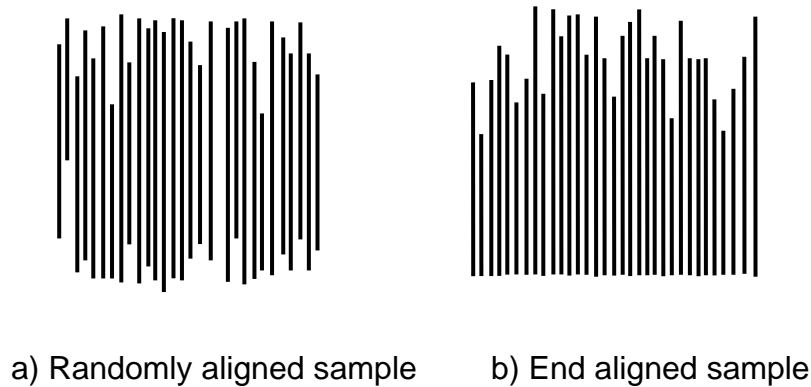


Figure 1 Samples for length measurement

The end aligned sample preparation is carried out by a repetitive process of clamping and removal of protruding fibre ends. Till the end aligned situation is reached, the clamped fibres are removed by end aligning device. After the end aligned status is achieved, the sample is collected and then transported to feed the length measuring device.

The length measuring device is using the optical technology to measure the length distribution. From the fibre length distribution, several length parameters are reported. They are

- Fibre Length exceeded by user defined percentage of fibres (2.5% length, 5% length, 50% length etc.)
- SFC by weight and number with a reference length of
 - 12.7 mm
 - Any user defined length

I. OPTIMISATION OF THE DRAW FRAME ROLLER SETTINGS

Comparison of Fibre length Distributions

The introduction of a new method of measurement always draws comparison with available existing methods. The length distribution as measured by the aQura was compared with the AFIS* for different types of cottons. To understand the distributions in proper perspective, a manual evaluation by extraction of individual fibres and measuring their length was done and the comparison included. Figure 2 gives the comparative distributions of a typical medium staple cotton.

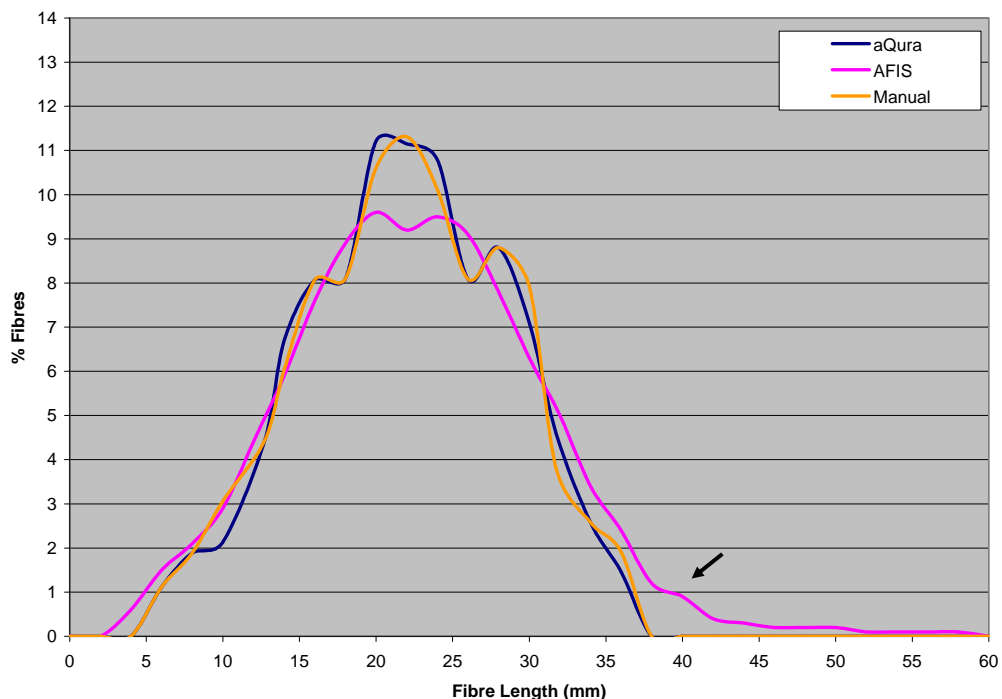


Figure2 Typical Fibre Distributions

It is seen from the distributions that the measurements in the longer length region is different for the three methods. The AFIS* provides a higher estimate of the 5% Length in comparison to the aQura and the manual methods.

Materials and Experiments

Combed cotton slivers of different Raw material mixings were used for the experimental studies. The mixings ranged from 4.5 to 15 tex (40s to 132s Ne) and the 5% aQura length range covered was from 31 to 42 mm. The fibre properties of the slivers used are given in Table 1.

* AFIS is the registered trademark of M/s Uster Technologies

Table 1. Fibre Characteristics of Slivers

Cotton	aQura				Count Spun
	5% L (mm)	50% L (mm)	SFCn (%)	SFCw (%)	
Medium Staple (M1)	31.35	20.62	13.4	5.9	14.76 tex (40s Ne) Combed Hosiery
Medium Staple (M2)	33.40	18.19	11.5	4.7	10.54 tex (56s Ne) Combed Hosiery
Long Staple (L1)	38.45	29.98	4.9	1.20	4.47 tex (132s Ne) Combed Hosiery
Long Staple (L2)	40.90	30.10	5.30	1.30	8.43tex (70s Ne) Compact

Draw Frame Roller Settings

The roller settings used for the study were selected taking into consideration the following:

1. Existing recommendations based on the 5% Length from staple diagram and 2.5% Span length from fibrogram.
2. Present optimised setting in the spinning unit.
3. Minimum mechanically possible draw frame setting.

A total of four settings for the mixings M1 and M2 and five settings for the mixings L1 and L2 were studied.

Based on initial trials and extensive spinning experience, for each of the settings, the back zone setting was maintained 4mm in excess of the front roller setting.

The various settings experimented for the different materials are given in Table 2.

Table 2: Details of Roller Settings at Draw Frame

Process	DF Roller Settings (mm)				
	A	B	C	D	E
M1	36/40*	38/42	40/44	42/45	-
M2	36/40*	38/42	40/44	42/46	-
L1	40/44	41/45	42/46	43/47	44/48
L2	40/44	41/45	42/46	43/47	44/48

Note :

Example 36/40 setting means 36 mm in front zone and 40mm in back zone.

* Minimum mechanically possible setting for the draw frame.

RESULTS

Sliver Irregularity

The draw frame sliver irregularity is directly influenced by the roller settings since it is a function of the control of fibres in the drafting zone. Figure 3 gives the CV%, CV1m% and CV3m% of sliver obtained at the different settings.

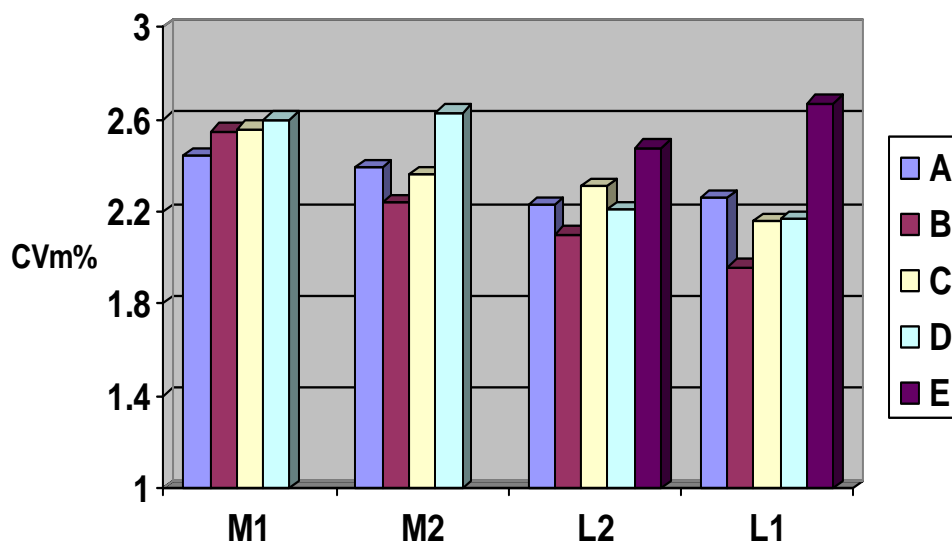


Figure 3a

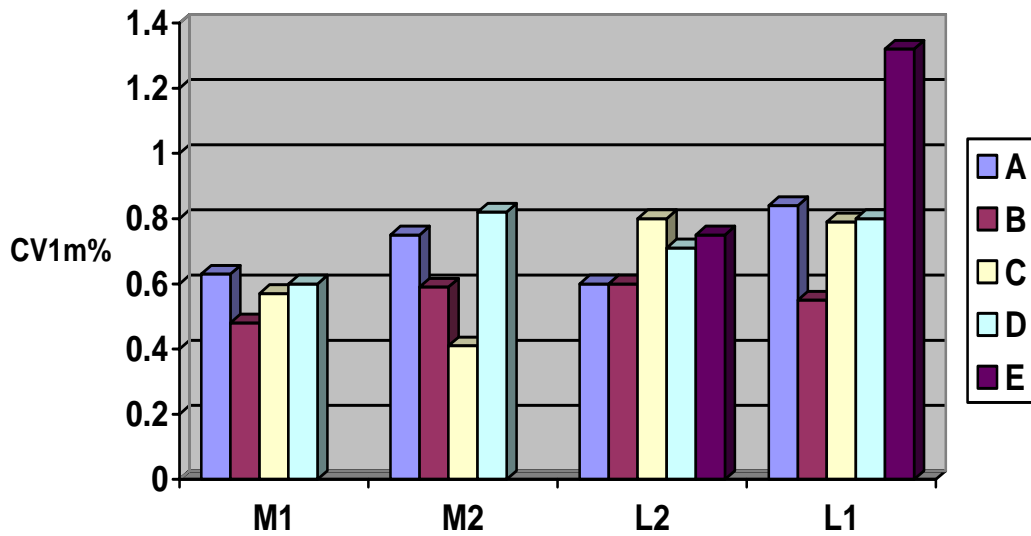


Figure 3b

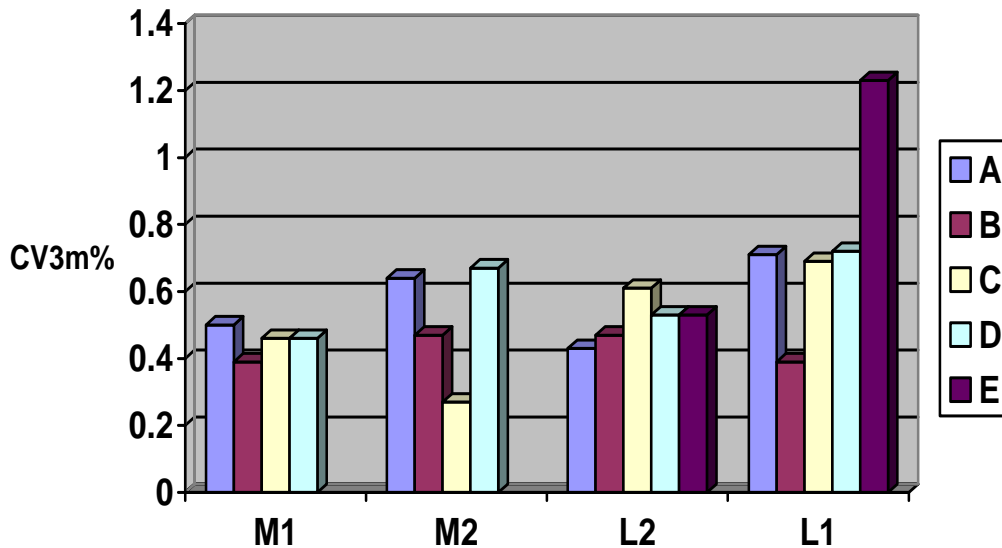


Figure 3c

It is seen that the sliver CV% is lower for the **setting B** in most of the counts.

Hooks

Hooks present in the sliver affects the yarn quality since they interfere with the drafting process and also reduce the contribution to yarn strength. The presence of hooks can be detected by assessing the difference in the fibre length distributions in the forward and reverse directions. The roller setting is optimum if the difference in the length in the forward and reverse direction is minimum. For assessing the difference in hooks, the draw frame sliver samples were tested in the Premier High Volume Fibre Tester with the help of special sliver clamps arrangement.

Figure 4 gives the Hooks difference for the different counts at the various settings.

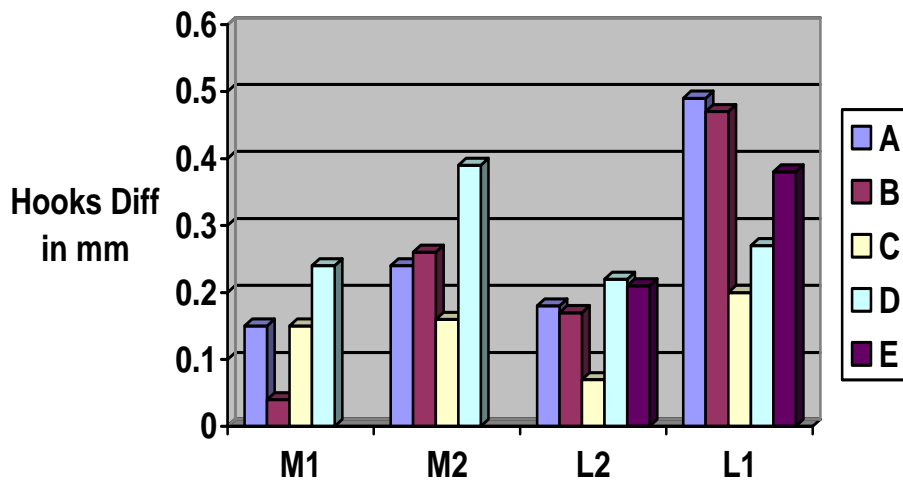


Figure 4

Yarn Quality

The draw frame roller settings has a significant impact on the yarn quality. In this study, the most important yarn quality characteristics – evenness, imperfections at normal and higher sensitivity levels, single yarn strength and elongation and yarn faults were compared. Tables 3 to 5 give the yarn quality results obtained from the different settings employed.

Table 3 : Effect of DF Roller Settings on Evenness and Hairiness Characteristics of Yarn

Raw Material Mixing	DF Roller Setting	CVm%	CV% 1m	Thin Places/km (-50%)	Thick Places/km (+50%)	Neps/km (+200%)	Total Imp/km	Extra Sensitivity Imp/km	Hairs/100m (>3mm)
M1	A	12.35	3.72	1	15	18	34	349	313
	B	12.29	3.78	1	14	21	36	347	317
	C	12.43	3.92	0	18	21	39	358	325
	D	12.78	4.01	1	19	19	39	425	429
M2	A	13.86	3.91	10	37	36	83	850	386
	B	13.63	3.72	7	31	27	65	752	408
	C	13.76	3.98	6	33	40	79	832	402
	D	13.89	4.02	10	34	38	82	664	410
L2	A	13.61	4.07	14	28	44	86	708	58
	B	13.67	4.32	12	37	45	94	676	59
	C	13.34	4.11	8	25	40	73	582	51
	D	13.44	4.10	10	26	38	74	621	55
	E	13.55	4.30	13	26	42	81	649	156
L1	A	16.21	4.31	114	113	163	390	2285	191
	B	16.25	4.34	116	120	171	407	2359	110
	C	16.45	4.51	136	129	171	436	2529	116
	D	16.32	4.39	122	130	187	439	2446	96
	E	16.15	4.40	110	111	144	365	2208	255

It is seen from the above results that yarns obtained with the roller **setting B** is better in terms of the evenness characteristics for 14.76 tex (40s Ne – M1) and 10.56 tex (56s Ne – M2) Combed Hosiery while the settings C and D are optimum for 8.43 tex

(70s Ne – L2) Compact and 4.47 tex (132s Ne – L1) Combed warp respectively. The quality in terms of hairiness does not show significant impact due to the roller settings.

Table 4: Effect of DF Roller Settings on Yarn Tensile Characteristics

Raw Material Mixing	Code	Tenacity (gf/Tex)	Tenacity CV% (gf/Tex)	Elongation (%)	Elongation CV%
M1	A	15.69	9.39	3.67	18.72
	B	16.60	7.82	3.74	14.75
	C	16.57	7.29	3.91	10.28
	D	14.69	11.25	3.44	14.33
M2	A	16.09	22.78	3.15	15.35
	B	15.80	9.73	2.88	14.09
	C	16.04	9.36	3.21	12.52
	D	15.98	9.23	3.06	14.38
L2	A	26.50	11.53	4.45	11.74
	B	27.91	9.34	4.89	10.19
	C	27.02	10.98	4.47	11.00
	D	26.73	10.85	4.39	10.81
	E	26.27	11.33	4.36	11.47
L1	A	21.21	17.09	3.46	16.19
	B	22.30	14.71	3.68	13.30
	C	21.56	15.55	3.33	16.87
	D	21.82	16.60	3.64	15.09

The tensile characteristics are optimum at the **settings B** for 14.76 tex (40s Ne-M1) Combed Hosiery , 8.43 tex (70s Ne – L2) Compact and 4.47 tex (132s Ne-L1) Combed warp and **setting C** for 10.56 tex (56s Ne – M2) Combed Hosiery.

Table 5 : Effect of DF Roller Settings on Yarn Faults

Raw Material Mixing	Setting	Yarn Faults per 100 km			
		Short Thick Faults	Objectionable Faults	Long Thick Faults	Long Thin Faults
M1	A	212	27	8	23
	B	230	27	8	23
	C	222	29	8	23
	D	243	30	12	57
M2	A	272	17	15	161
	B	271	18	13	142
	C	297	19	15	169
	D	320	22	18	180
L2	A	64	12	3	47
	B	95	17	5	66
	C	63	11	2	40
	D	83	21	8	65
	E	89	16	3	56
L1	A	2177	71	33	1959
	B	1998	67	77	1971
	C	2045	78	81	2192
	D	2105	68	69	1926
	E	2076	72	64	1817

The yarn faults are minimum at the **settings B** for 10.56 tex (56s Ne – M2) Combed Hosiery and 4.47 tex (132s Ne – L1) Combed warp, **setting A** for 14.76 tex (40s Ne – M1) and **setting C** for 8.43 tex (70s Ne – L2) Compact.

The following table provides an overall summary of the optimum settings with respect to the various parameters studied in the different counts.

Table 6: Summary of optimum Settings for various characteristics

Material	Draw Frame Sliver				
	SFCn	CVm	CV1m	CV3m	Hooks Diff
14.76 tex (40s Ne – M1) Combed Hosiery	B/C	A	B	B	B
10.56 tex (56s Ne – M2) Combed Hosiery	A	B	B/C	B/C	C
8.43 tex (70s Ne – L2) Compact	B/C	B	A/B	A/B	C
4.47 tex (132s Ne – L1) Combed warp	A	B	B	B	C

Material	Yarn Quality											
	CVm	CV1m	Thin	Thick	Neps	Extra Sens Imp.	H3	Tenacity	Strength CV%	Elong.	Elong CV%	Yarn Faults
14.76 tex (40s Ne – M1)	B	A/B	A/B/C	A/B	A	A/B	A/B	B/C	B/C	B/C	C	A
10.56 tex (56s Ne – M2)	B	B	B/C	B/C/D	B	B/D	A/B/C	A/C	B/C/D	A/C	C	B
8.43 tex (70s Ne – L2) Compact	C	A/C/D	C	C/D/E	C/D	C	A/B/C/D	B/C	B	B/C	B	C
4.47 tex (132s Ne – L1) Combed warp	A/B/E	A/B	A/B	A/B	A	A	B/C/D	B	B	A/B/D	B	B

Based on the above, and referring to Table 2, the optimum settings for the different counts were concluded. The optimum settings arrived were related to the fibre length distribution provided by aQura. **The optimum settings were found to correspond to the 3% aQura length.** Table 7 gives a summary of the optimum settings and the corresponding 3% aQura length.

Table 7: Optimum Roller Settings for Draw Frame based on aQura results

Count	Setting Code	Optimum DF roller setting		3% aQura length	Remarks
		Front Zone	Back Zone		
40s CH	A/B	36-38	40-42	32.8	Limited by the min possible machine setting
56s CH	A/B	36-38	40-42	33.6	
70s Compact	B/C	41-42	45-46	42.0	
132s C	A/B	40-41	44-45	39.5	

For coarser counts where short staple cotton is used, the machinery setting provides a limitation and therefore, in such cases, the minimum possible setting is to be considered as the optimum setting.

II. RELATIVE SHORT FIBRE CONTENT AND YARN QUALITY

The conventional method of determining SFC is by measuring the amount of fibres by weight or number shorter than 12.7 mm ($\frac{1}{2}$ inch). Such an absolute measure of the SFC is not adequate for either raw material purchase or for process control. Inherently, short staple cotton tends to have more fibres below 12.7 mm ($\frac{1}{2}$ inch) than a longer staple cotton assuming a given level of fibre damage at the ginning processes. Decisions based on the short fibre content without regard to the specific variety would prove to be improper since it is not possible to distinguish between a short staple cotton which inherently has more short fibres and a long staple cotton which has higher short fibres due to more breakages during harvesting and ginning. A relative measure based on the staple length of the cotton provides more meaningful results.

Several relative measures of determining short fibre content have been proposed over the years.

The concept had been used in very early years when SFC was assessed by using geometrical constructions on the staple diagram from Baersorter. A measure close to this classical method was used by Mr. Heap in his paper at the last conference (2004). The relative SFC parameter he used, was the percentage of fibres shorter than one half of the Upper Half Mean Length.

There have also been other relative measures experimented like the Lower Half Mean Length and others.

Relative Short Fibre Estimates from Premier aQura

The 5% aQura Length from the fibre length distribution provided by aQura is taken as the base length for arriving at several relative levels of Short Fibre Content. The different levels are shown in Figure 5

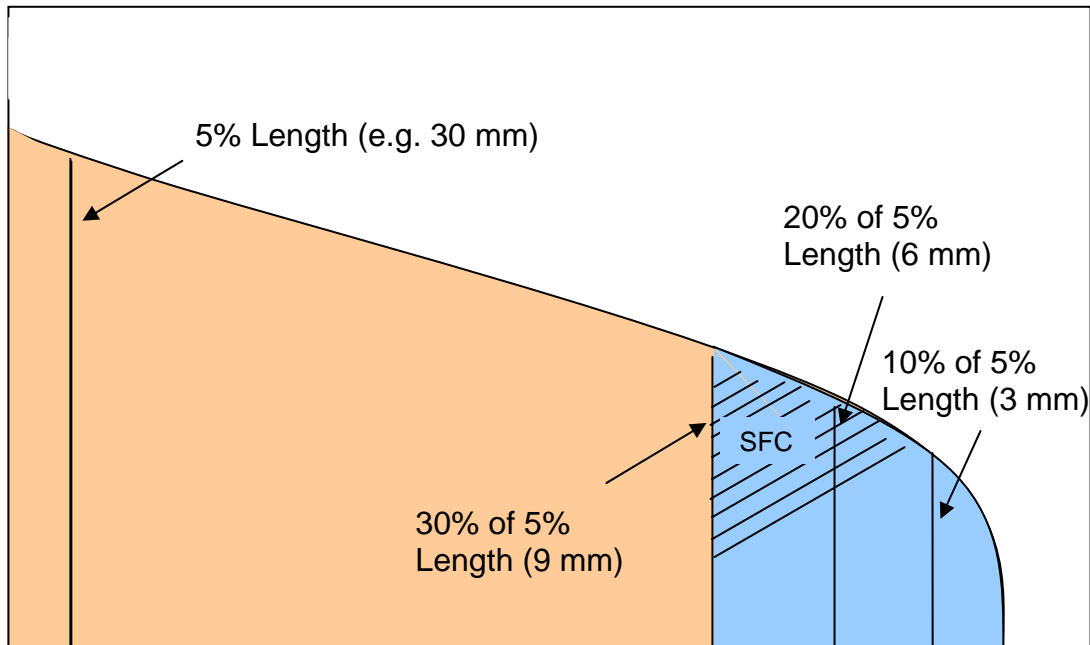


Figure 5 : Relative Short Fibre Content Levels

Thus, the SFC can be determined at several percentages of the 5% Length such as 10%, 20%, 30% etc.

The current paper aims at determining the most appropriate relative short fibre content influencing the yarn quality results.

Materials and Experiments

The studies were conducted by analysing the Cotton and yarn quality data from a spinning mill running medium to fine hosiery yarn. The quality data were analysed for a medium staple cotton processed and spun to 14.76 tex (40s Ne) Combed hosiery yarn. The cotton mix issued at the blow room, the comber lap and the combed sliver quality in terms of the length distribution was measured using the aQura.

The range in short fibre content over the entire period was assessed. For comparisons of the yarn quality with the fibre quality, several discrete mix issues with differing levels of short fibre content was considered. Corresponding to each test result, from the length distribution diagram, the SFC at different reference points was determined (Different percentages of 5% length). The reference points covered ranged from 5% of the 5% staple length to 50% of the 5% staple length.

The yarn quality characteristics were evenness and imperfections (thick and thin places).

To verify the observations made in the experiments, the optimized quality results arrived from the roller settings study for four different yarn counts were correlated with the corresponding sliver quality.

Results

Figure 6 gives the plot of the correlation (Y-axis) achieved between the yarn quality characteristics and the Relative SFC and the reference level (X-axis).

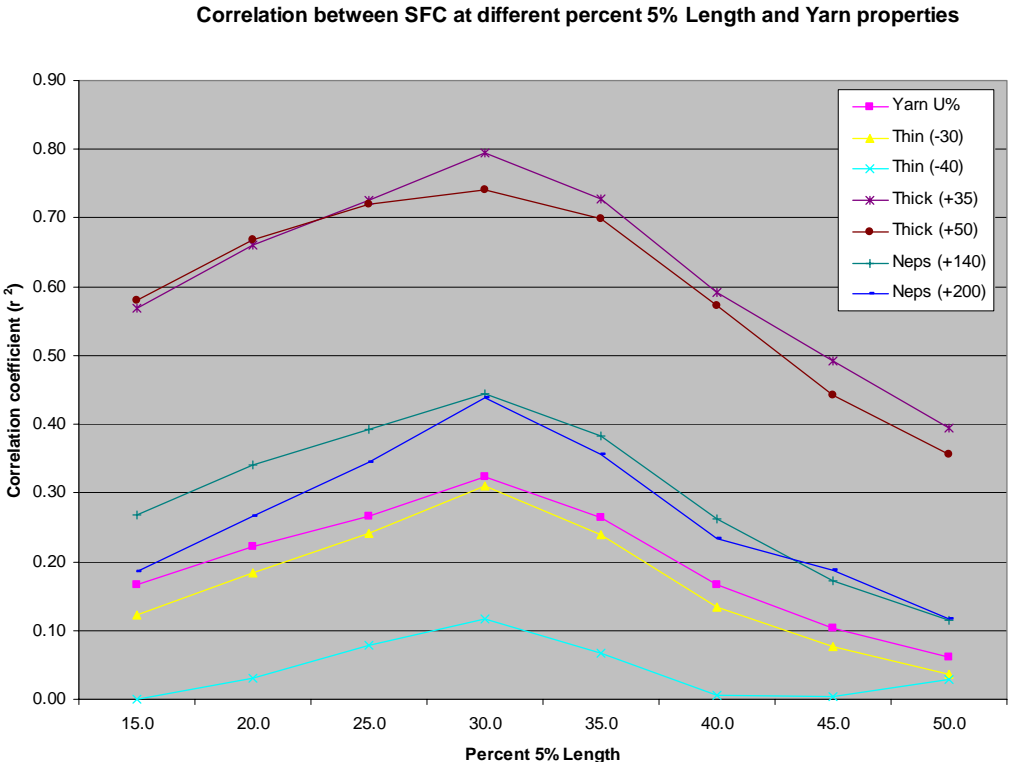


Figure 6

It could be seen that at the 30% level, the correlation is maximum between the SFC and the yarn quality characteristics. It should be noted here that the figures represented are 'r-squared'. This indicates that when the SFC at the 30% level increases, the yarn quality shows a deterioration and when the SFC reduces, the quality improves.

The Relative SFC at this level varied from 4.9% to 8.7%.

These observations were verified with the quality levels optimized by varying the draw frame roller settings in the earlier part of the this paper. The length distributions obtained from the draw frame slivers for different counts were obtained from aQura and the short fibre content at different relative levels were correlated with the corresponding yarn quality.

Figure 7 gives the correlations.

**Correlation Between Reference % and SFC(n)% on Yarn Total Imperfections/km for Mills
Optimum Draw Frame Setting for Different Counts**

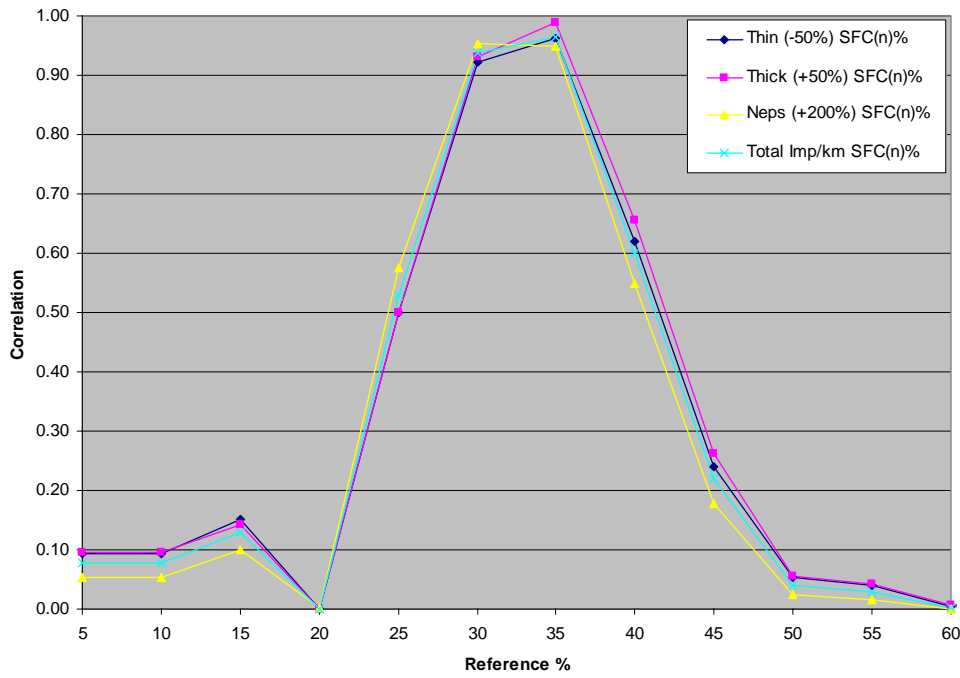


Figure 7

Figure 8 provides comparative correlations of various yarn characteristics with the absolute and relative short fibre content at sliver stage.

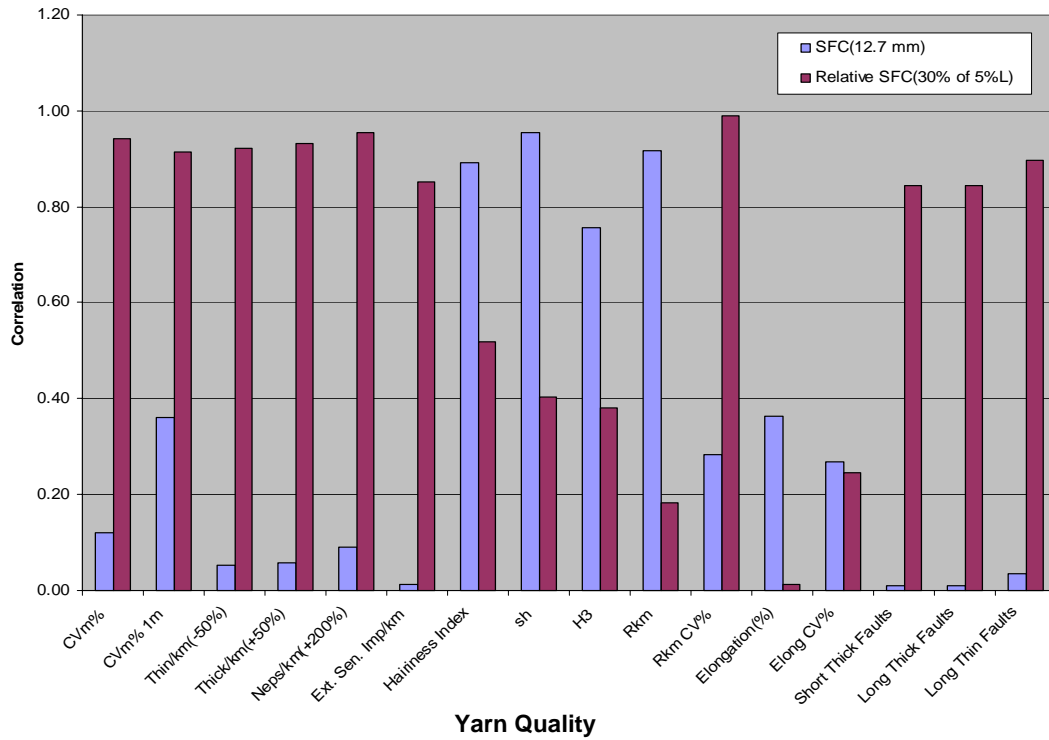


Figure 8

Representation of the Relative Short Fibre Content in aQura

For further research on this parameter, and to provide the possibility of additional experience being gained, the aQura is now incorporated with a new parameter called the '**Critical Short Fibre Content**' which provides an estimate of the Short Fibre Content below 30% of the 5% staple length. The user also has the option to set this reference point at a different level for his experiments.

CONCLUSIONS

The studies on Relative Short Fibre Content indicate that, while the Relative Short Fibre Content is a better parameter than the absolute short fibre content, the specific reference level at which the relative short fibre content is measured also has an influence on the yarn quality results. The study reported here indicates this would be at about 30% of the 5% Length. This observation is worth exploring further.

WORLDWIDE IMPLEMENTATION OF COTTON CLASSING

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It is currently an accepted fact that the cotton growing countries can get higher prices for their product if it is classed on internationally accepted instruments and standards. The successful classing projects in the United States, Uzbekistan, Brazil and other countries are testimonials to this fact.

This paper discusses the steps required for the successful implementation of instrument classing systems. Technical advances in Uster HVI will be reviewed and a status report on the progress on the Chinese cotton classing project will be given.

BACKGROUND

The benefits of changing cotton classification from manual techniques to instrument classing have become more apparent and are indicated through an increase in the interest of these programs by cotton growing countries.

There are two main reasons for this higher awareness. First, the advances and new developments in instrument technology are frequently presented in international forums and technical conferences. Second, organizations such as ICAC and Cotton Incorporated have communicated the benefits of utilizing internationally accepted instruments and universal standards for both growers and users of cotton. The US classing system is a good example of such benefits. In the 2005 cotton season, 23.7 million bales of cotton were classed. The bale fiber quality data was reported to the growers within 72 hours of the receipt of samples. This data, which is the basis of the crop value and the trade of this commodity, allowed them to make timely financial planning and decisions. The data also allows the traceability of the cotton and its fiber quality for the buyers worldwide. It is a reason that US cotton enjoys a competitive advantage in the international market.

In addition, this data base allows for the long-term analysis of cotton fiber quality grown in this country. Performance of different cotton varieties for quantity and quality are analyzed for research of new varieties and selection of suitable varieties for different growth areas. Accurate instrument classing is the very foundation of this system without which these accomplishments would not be possible. All involved in the US cotton chain have come to believe in the values and contributions of instrument cotton classing in this marketing system.

IMPLEMENTATION

The requirements for successful implementation of a cotton classing system fall into two basic categories.

The first category is the initiatives that must be implemented by the responsible organization. It is strongly recommended that the experiences gained from existing classing programs be used and the following initiatives are recommended:

- Establish government approval in the form of legislation or support in and promotion of this program
- Arrange for funding through government, private or international sources
- Establish infrastructure and procedures for logistics involved in sample handling, testing and data communication
- Establish education programs for growers on the benefits resulting in higher value for their cotton through a) more accurate and repeatable data and b) higher resolution for cotton grades.
- Establish education for more accurate and timely bale information. The additional fiber quality data over manual grades is an added benefit for marketing and use of cotton.
- Assure both segments of the integrity of the overall system's operation and performance of classing instruments. The historical data can be used to educate on the relationships between manual classing and instrument data, where applicable. Explain the basis of universally accepted calibration cotton and standards used in application of the instrument data.

The second category is to identify the following expectations from the instrument manufacturer:

- Experience and history in providing accurate and reliable instruments for such programs
- Comprehensive technical and service support
- Innovations to reduce operator influence on test results through automation
- Methods to reduce laboratory climatic requirements resulting in higher data integrity as well as reduction of overall operational costs
- Effective training for use of instrument and logistics
- Development of applications and data utilization across the cotton supply chain
- Development of international standards, statistics and certification programs

NEW DEVELOPMENTS IN HVI TECHNOLOGY

Uster Technologies established practices and acquired experience in providing and fulfilling the above requirements. This has been discussed in past papers at ICAC Conferences.

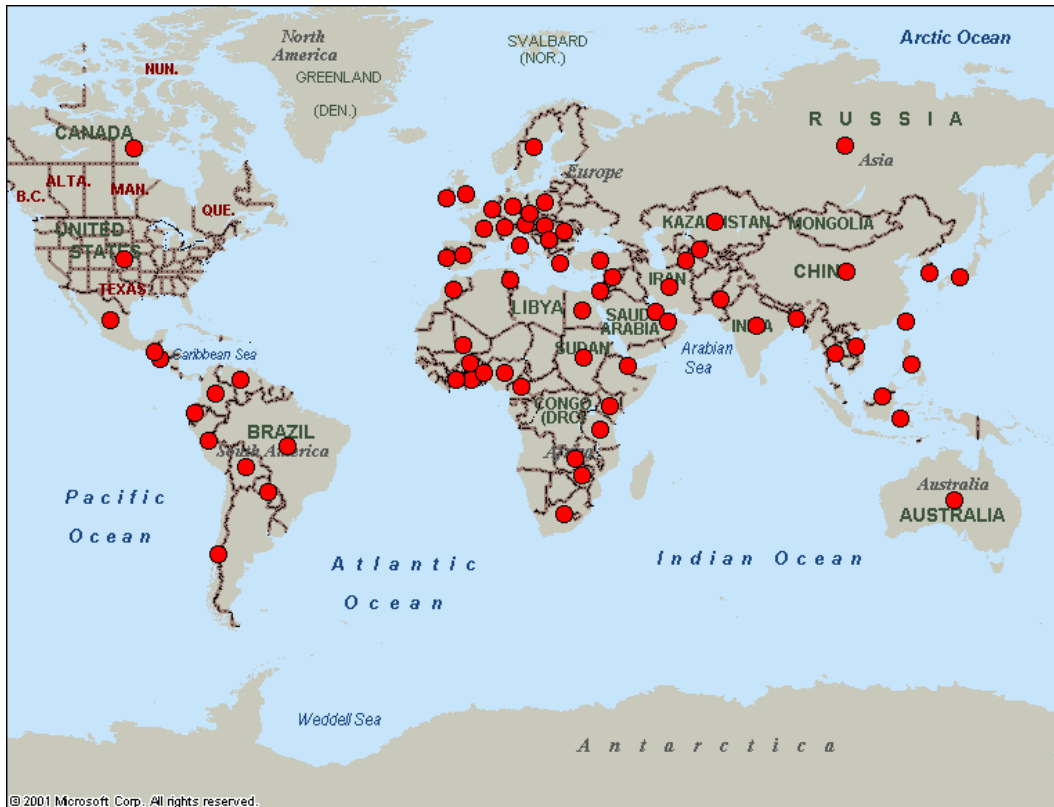
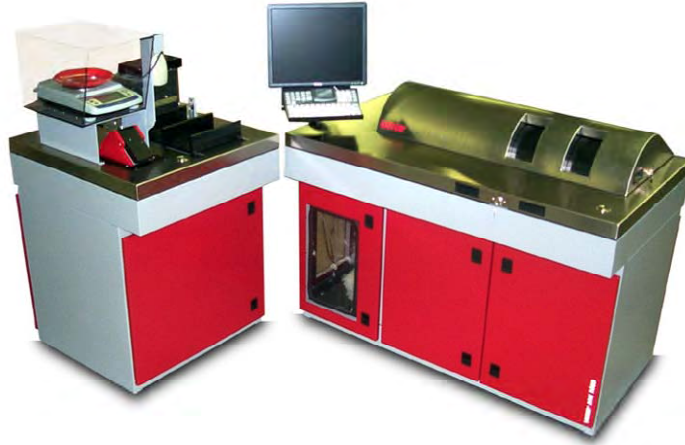


Figure 1. Installations – 2006 (Projected)
 Current Total: >1950 HVIs in 71 countries
 Overall Total: >2430 HVIs in 25 years

The Uster® HVI 1000 is the 5th generation of HVI introduced in 2004 and used by USDA for the 2004 and 2005 cotton season. The reports indicate that the performance of this HVI has surpassed its predecessors in both higher throughput and fiber quality accuracy.

USTER HVI 1000 “L” Configuration



USTER
Think quality

6

Figure 2.

USTER HVI 1000 “straight line” Configuration



USTER
Think quality

7

Figure 3.

One of the major challenges in implementation of instrument cotton classing in remote parts of the world is how to detect, compensate and alarm the occurrences of measurement errors. Cotton fiber data from the HVI can be negatively influenced due to two reasons. The first source of error is due to improper conditioning of samples in laboratories. Adhering to the ASTM Standards and proper conditioning of samples at all times is not a trivial task, and cotton fiber length and especially strength are affected by moisture content of the sample. Figures 4 and 5 show the influence of fiber moisture on these parameters for a short and long cotton. The second source of error is due to some failures in components that do not halt the operation of instrument but impact the measured data which could go undetected by the operator. The new developments in the HVI 1000 focus on these areas. The objective is to provide the highest level of data integrity and repeatability possible.

Moisture%	Length (mm)	Strength (grams per tex)
6.5%	24.02	22.53
7.5%	24.49	24.50
8.5%	24.95	26.87
9.5%	25.42	28.44

Figure 4. Moisture Content's Impact on Fiber Length and Strength
Example of a short and weak cotton

Moisture%	Length (mm)	Strength (grams per tex)
6.5%	32.42	34.76
7.5%	33.05	37.80
8.5%	33.67	40.84
9.5%	34.30	43.88

Figure 5. Moisture Content's Impact on Fiber Length and Strength
Example of a long and strong cotton

One of these new developments targets the reduction in the requirements for accurate control of laboratory ambient conditions. The application of an accurate moisture sensor on HVI has been previously reported. This sensor measures the cotton sample's moisture content and the HVI software, using a proprietary algorithm,

corrects the fiber length and strength measurements. In the HVI 1000, this concept has been taken to the highest level of implementation. A new moisture sensor has been developed which is located within the test zone of HVI 1000. It measures moisture content of the fibers that are under test for length and strength measurements. This architecture should provide the highest level of performance for this concept. Its application should relieve and eventually eliminate the expensive requirements for the strict control of laboratory ambient conditions.

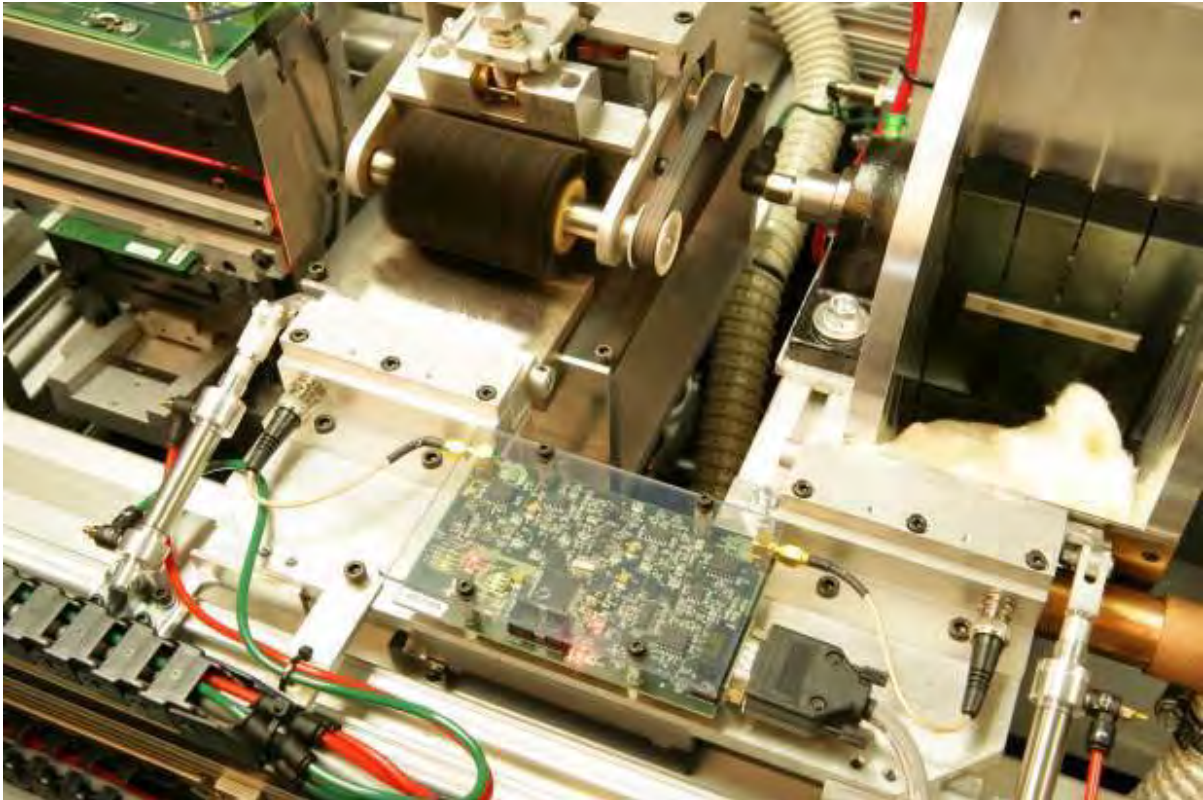


Figure 6. HVI 1000 Moisture Sensor



Figure 7. HVI 1000 Moisture Sensor

Another development is a new approach in insuring reliable operation of the HVI. To explain this concept an analogy can be made to a portable medical device that a human can carry to measure his vital signs periodically and alarms for action at the first sign of irregularities. To better understand the application of this concept, the 2 types of failure modes with HVI should be explained. The first one is when the HVI is not operational at all due to hardware problems. The second mode of failure occurs due to problems that do not stop the operation of HVI, but can have negative impact on data products. In the case of the first type of problem the need for action is obvious, whereas the problem in the second category can go unnoticed for some time during which the instrument produces erroneous data. The reasons for this type of failures can be multiple. A drift in power supply voltages, changes in sensitive mechanical settings, partially performing sensors, the use of wrong calibration cottons, or a mix up in calibration cottons or mediums can cause inaccuracies in data products.

This technique automatically and periodically measures these important parameters and will alarm the user of the detected anomalies. The HVI can also communicate this information to a remote repair center. (Figure 8) In the next version, the focus will be on analysis of HVI calibration parameters and history. We believe that these new developments will enhance HVI performance and reduce operational costs.

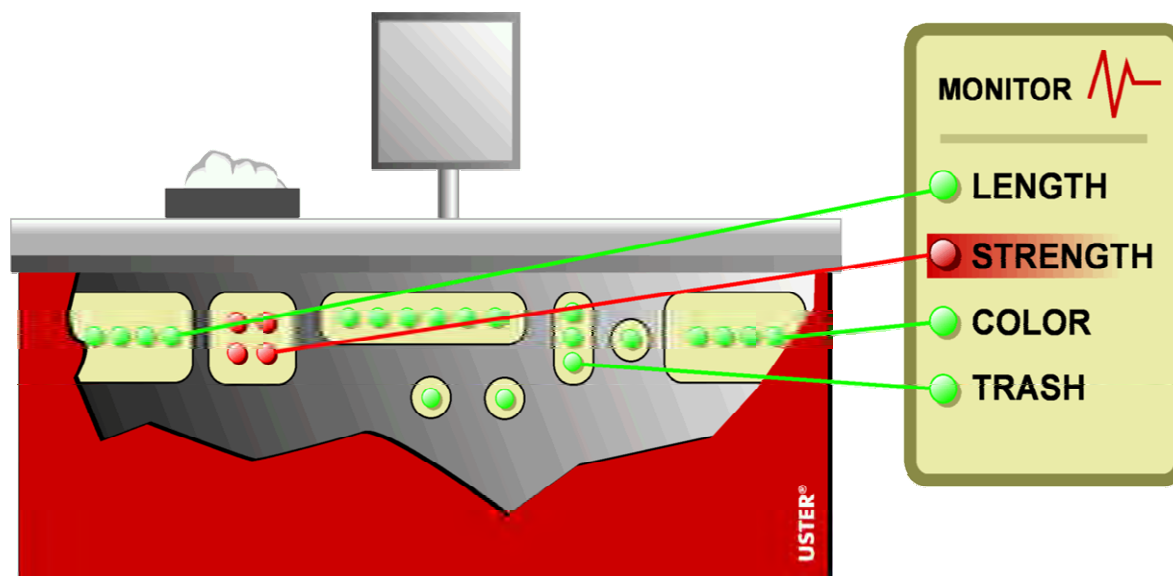


Figure 8. HVI's critical parameters such as voltages, sensors, calibration, sensitive dimensions are periodically measured, analyzed and problems reported

PROGRESS REPORT ON AN INTERNATIONAL INSTRUMENT CLASSING PROGRAM

The China classing project is a good example of all the above key points. As the background, in the span of two decades, Chinese mills have utilized over 90 HVIs to insure product quality in this country. However, the marketing system still uses measurement of fiber qualities based on manual and mechanical methods. Two years ago, the China Fiber Inspection Bureau (CFIB) started the evaluation of 22 HVIs in an effort to convert from manual to instrument classing using a similar system used in the United States.

The successful completion of this evaluation phase led to the official initiation of a large scale program by acquisition of 62 HVI 1000 Classing in 2005. These instruments have been installed in 53 Classing laboratories in the cotton growing areas in China, and have classed part of 2005 crop. In the past 2 years, a total of 45 textile technologists and 101 service technicians have been trained. When the project is completed in 2010, 378 HVIs will be in operation in over 100 classing laboratories. This will make the Chinese classing program the largest in the world. This is a major accomplishment not only for China, but for the international cotton market as well. As the largest producer and user of cotton in the world, the conversion to instrument classing using the HVI will further encourage the application of instruments. This will ensure a common language in cotton quality testing is spoken in the trade worldwide. However, this task is not yet completed. While the process of HVI installation is on going, the trade is interested in understanding the HVI measurements and their relationships with current manual and mechanical methods. For this reason, Uster continues research projects for neps, short fiber, trash and color measurements.

CONCLUDING REMARKS

It is clear that instrument cotton testing is the way of the future. It is estimated that by 2010, about 80% of the world cotton will be measured by instruments. The inquiries from several countries support this fact.

The Uster HVI has been the key to success in the implementation of every instrument classing project. Uster Technologies, Inc. remains committed to providing both the technology and technical support required for these important initiatives.

LEGAL AND TECHNICAL ASPECTS OF HARMONISATION

PART 1

J. B. Wellmann

Director, Bremen Cotton Exchange

PART 2

T. Schneider

Vice Director, Faserinstitut Bremen e.V.

PART 1

A) BACKGROUND

Chart 1

Chart 2

There are 15 International Cotton Associations worldwide in all five continents, in Africa, North and South America, Asia, Australia and in Europe.

Chart 3

Seven cotton associations offer their services in Europe: the Association Française Cotonnière in Le Havre/France, the Belgium Cotton Association in Gent/Belgium, the Bremen Cotton Exchange in Bremen/Germany, the Centro Algodonero Nacional in Barcelona/Spain, the Gdynia Cotton Association in Gdynia/Poland, the International Cotton Association in Liverpool/England and the Associazione Tessile Italiana in Milano/Italy. The Netherlands Cotton Association in Rotterdam was dissolved several years ago.

Chart 4

All the above mentioned associations maintain their own individual trading rules with quality arbitration and arbitral jurisdiction. These regulations deal with codified usages of cotton trading with respective national distinctions, which are embedded in the national law. French law applies to the AFCOT Rules, for the Bremen Rules it is German law, ICA English etc. All the associations are facing the fact that the textile industry in their country has been in decline for more than 30 years, or that production is being relocated to other countries.

Chart 5

The European cotton associations reacted differently to these developments. Starting with the consideration that international trade was traditionally covered by the rules of the Liverpool Cotton Association, now the International Cotton Association (ICA), they tried to take care of the delivery trade, i.e. the contract from the dealer to the spinner, with harmonised European rules and therefore to replace the dwindling domestic market with a European market. Following many years of negotiations, the

cotton associations of Belgium, France, Spain and Poland, which had previously joined together as a “European Cotton Confederation“, agreed on a draft set of “European Cotton Rules“. The Bremen Cotton Exchange, the ICA and the Associazione Tessile Italiana, which had also taken part in the talks, rejected the proposals for different reasons. Up to now, the European Cotton Rules have only been incorporated by the Belgium and the Gdynia Cotton Association. AFCOT announced the ratification for 2006.

B) CONCEPT OF THE BREMEN COTTON EXCHANGE

Given the speed of the decline in the European textile industry, which was unforeseeable at the beginning of the negotiations, the Bremen Cotton Exchange has decided to no longer pursue the adoption of the “European Cotton Rules“, but to go a different way: Since it is not possible to limit the “European Cotton Rules“ to one direction, i.e. to the delivery contract, there would still be two sets of rules in existence for international cotton trade if they came into effect: The European Cotton Rules and the Rules and By-Laws of the International Cotton Association.

Chart 6

The CICCAs default list shows clearly to what extent the problem of non-honoured contracts has developed. From 1995 until now the list increased from 20 to 297 firms.

The Board of the Bremen Cotton Exchange has come to the conclusion that there is no time left for two parallel existing sets of rules and that the consequence is that the international cotton trade must develop a standardised contract with, wherever possible, analogue, standardised rules to which, where necessary, an annex can be attached taking into account national distinctions. The primary difficulty in harmonisation, which has already been shown up in the discussions within the European Cotton Confederation, is the fact that the rules of the individual associations are embedded in the respective national laws. There is no European trading law and the so called UN purchase law (UNCITRAL) has so far been considered too broad and not suited to the specialised cotton trade, so that it has been excluded from all the regulations.

Since the rules of the International Cotton Association cover the majority of international contracts, it seems appropriate to incorporate these with as little change as possible. The members of the Bremen Cotton Exchange will therefore soon be presented with a proposal which contains the following suggestions for implementing the above mentioned concept:

Chart 7

1. Adoption of the ICA-Rules.
2. Retention of the arbitration and arbitral jurisdiction under German law.
3. Adoption of the ICA definitions (General trading terms).

The acceptance of this proposal would guarantee that standardised trading conditions and definitions would exist for both organisations, while at the same time the proceedings section would be maintained and the members would still have the option of arbitration or arbitral jurisdiction.

C) CONSEQUENCES OF THE WORK OF THE TASK FORCE ON COMMERCIAL STANDARDIZATION OF INSTRUMENT TESTING OF COTTON (CSITC)

The Task Force (previously called Expert Panel) on Commercial Standardization of Instrument Testing of Cotton recommended the following characteristics for inclusion in an instrument testing system:

Chart 8

- Micronaire
- Strength (grams/tex)
- Length (upper half mean length expressed in inches and decimals or in mm)
- Length Uniformity (Index)
- Colour (rd + b)

There was consensus to recommend that 100% of bales should be sampled in a standardized testing system with the understanding that commercial agreements between buyer and seller may stipulate different sample percentages. It was noted that module averaging and online gin sampling techniques are being evaluated. It was also noted that in many countries fewer than 100% of bales are samples. The Task Force agreed that alternative sampling systems may prove to be effective, but there was agreement that 100% sampling is ideal and should be recommended.

Chart 9

In the Rules of the International Cotton Association so far rules exist for Micronaire and Strength Arbitration only. The respective regulations are included in Bylaws 339 and 341 of the International Cotton Association (ICA) and in §§ 59 and 60 of the Rules of the Bremer Baumwollbörse.

Chart 10

§ 59 of the Bremen Rules reads as follows

1. Where, due consideration being given to the control limit, the cotton delivered deviates from the Micronaire value agreed upon, an allowance may only be claimed for the difference in market value of the deviation.
2. The control limit and the differences shall be fixed by the Committee for Fixing the Value Difference for the various growths and published in the Cotton Report of the Bremer Baumwollbörse.

Chart 11

§ 60 of the Bremen Rules refers to Pressley, Stelometer and HVI Strength and reads as follows:

If, due consideration being given to a control limit to be fixed in each individual case by the Committee for Fixing the Value Difference the cotton delivered is inferior to the Pressley/Stelometer/HVI Strength Value agreed upon, the party shall come to an agreement between themselves as to an allowance, and so far and so long as official value differences have not yet been fixed.

Chart 12

Bylaw 339 of the International Cotton Association refers to Arbitration based on the measurement of Micronaire and makes a differences between American and non-American cotton. The Bylaw comprises more than two DIN-A4 pages.

The basic regulation is as follows: In sentence 1 the Bylaw refers to the Bylaw 340 where the formalities are regulated.

In sentence 2 the Bylaw refers to contracts with a minimum Micronaire value and sets the percentage allowance below the control limit for each 0.1 Micronaire.

Chart 13

There are further details for contracts which set out a minimum of 3.5 Micronaire or higher.

Chart 14

In addition there are allowances for contracts which set out a maximum Micronaire value for bales which go over the maximum.

Chart 15

Finally there are regulations for contracts specifying a maximum Micronaire reading of 4.9 or lower.

Chart 16

Bylaw 340 of the International Cotton Association applies to all disputes about Micronaire and makes a differentiation between American and non-American cotton.

As far as American cotton is concerned the terms are intended to be consistent with a Micronaire agreement between ICA and the American Cotton Shippers Association. If there is a dispute about Micronaire, the cotton will be tested again and the following will be done:

- a) The buyer will choose which bales are to be tested. The time limits for commencing arbitration and sending samples for testing are the same as those for quality arbitration.
- b) The first set of test will be done in a laboratory agreed between buyer and seller or their arbitrators. If there is no agreement or no other laboratory available, the test will be done in the ICA laboratory.
- c) Either firm can appeal against the first test results within 21 days of the results being despatched. The appeal must apply to the total number of bales in the first test.
- d) A second set of test, done as a result of the appeal against the test results, can be done in any laboratory agreed between the buyer and seller or their arbitrators. If there is no agreement or no other laboratory available the tests will be done in the ICA laboratory.
- e) If another laboratory is to do a second set of tests, the first test results must not be given to that laboratory.
- f) Unless both firms agree otherwise, the ICA laboratory can do the second set of tests, even if it also did the first set.
- g) Unless the firms agree otherwise, the usual control limit of 0.3 will apply.

There is an almost identical subsection for non-American cotton in Bylaw 340.

Chart 17

For the arbitration based on the measurement of strength ICA Bylaw 341 applies. This Bylaw refers to all cottons and sets out percentage allowances for HVI (grams/tex).

Chart 18

Pressley still is widely used in international contracts but not recommended by the CSITC anymore.

Calibration cotton is not available anymore.

Bylaw 341 ICA also sets out percentage allowances for psi below the control limit.

Chart 19

Bylaw 342 ICA provides the formalities if there is a dispute about strength.

- a) Only samples from the bales in dispute will be tested. The time limits for commencing arbitration and sending samples for testing are the same as those laid down for quality arbitration.
- b) The first set of tests will be done in a laboratory agreed between the buyer and the seller or their arbitrators. If there is no agreement, the tests will be done in the ICA laboratory.

- c) Either firm can object to the first test results within 21 days of the results being despatched. The objection must apply to the total number of bales in the first test.
- d) If an objection is made, a second set of tests must be done in a laboratory agreed between the buyer and the seller. If one firm demands it, the second tests must be done in a different laboratory and if the firms cannot agree which laboratory should be used, the ICA will decide. ICA will not do both sets of test in their laboratory unless both firms agree.
- e) If another laboratory is to do a second set of test, the first test results must not be given to that laboratory.
- f) Unless the firms agree otherwise, the usual control limit of 2.0 grams/tex or 3000 psi will apply.

Chart 20

CONCLUSIONS

The consequences of the work of the Task Force on Commercial Standardization of Instrument Testing of Cotton for the International Cotton Associations at this stage are:

1. Elimination of Pressley in their rule books.
Pressley is considered scientifically outdated.
Calibration cotton is no longer available.
2. In line with the already existing Rules and Bylaws for Strength similar and even better simpler rules for the other 4 test procedures
 - UMH Length
 - Uniformity (Index)
 - Colour (rd)
 - Colour (+b)

must be developed according to the needs of the industry and the technical experience collected through the results of interlaboratory round trials.

Legal and Technical Aspects of Harmonization



by Jan B. Wellmann
Dr. Thomas Schneider

28th International Cotton Conference

Bremen, March 24, 2006



Chart 1

CICCA ASSOCIATIONS

Committee for International Cooperation between Cotton Associations

■ AFRICA	Association Cotoniere Africaine
■ BELGIUM	Belgian Cotton Association
■ EGYPT	Alexandria Cotton Exporters Association
■ GERMANY	Bremer Baumwollbörse
■ ITALY	Associazione Tessile Italiana
■ POLAND	Gdynia Cotton Association
■ TURKEY	Izmir Mercantile Exchange
■ UNITED KINGDOM	International Cotton Association
■ AUSTRALIA	Australian Cotton Shippers Association
■ BRAZIL	Bolsa de Mercadorias & Futuros
■ FRANCE	Association Francaise Cotoniere
■ INDIA	East India Cotton Association
■ JAPAN	Japan Cotton Traders Association
■ SPAIN	Centro Algodonero Nacional
■ USA	American Cotton Shippers Association

Chart 2

European Cotton Organisations with Rule Books

Association Francaise Cotonniere, France		AFCOT
Association Cotonniere de Belgique, Belgium		ACB
Bremen Cotton Exchange, Germany		BBB
Centro Algodonero Nacional, Spain		CAN
Gdynia Cotton Association, Poland		GCA
International Cotton Association, U. K.		ICA
Associazione Tessile Italiana, Italy		ATI

Chart 3



Chart 4



Chart 5

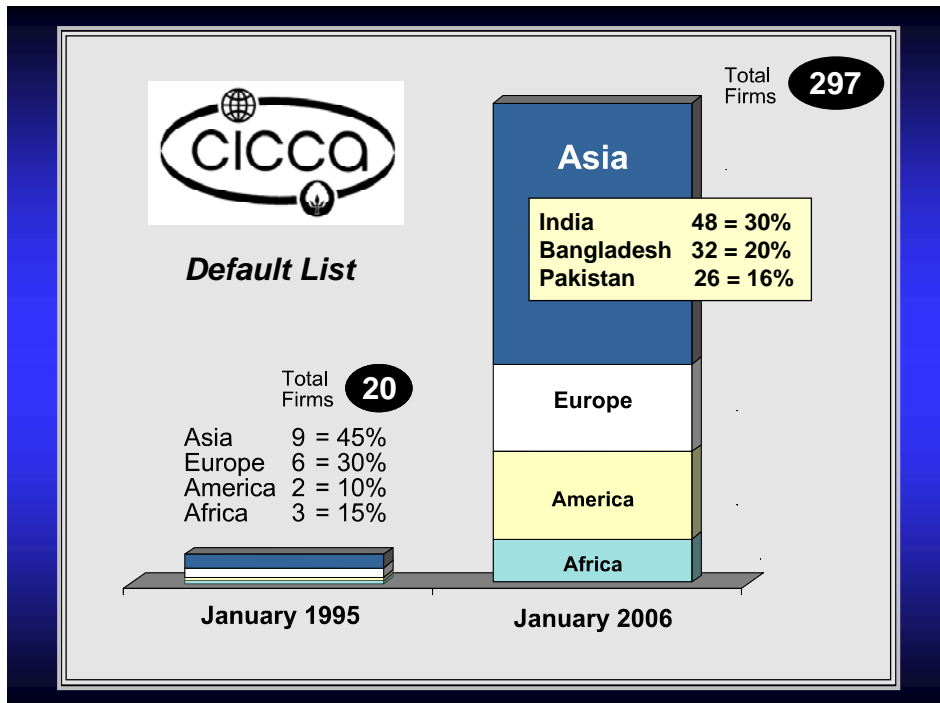


Chart 6

Bremen Rules 2006

- Incorporation of the ICA – Rules (§§ 5 – 40 Bremen Rules)
- Retention of the Arbitration and arbitral Jurisdiction under German Law
- Adoption of the ICA - Definitions (General Trading Rules) as Annex I

Chart 7

Instrument Measurements proposed by the CSITC

- Micronaire
 - Strength
 - UHM Length
 - Uniformity Index
 - Color Rd
 - Color +b
-

Chart 8

Instrument Arbitration

- **Micronaire** (Bylaw 339 ICA, § 59 BBB)

 - **Strength**
 - HVI (Bylaw 341 ICA, § 60 BBB)
 - Pressley (Bylaw 341 ICA, § 60 BBB)
-

Chart 9

§ 59 BBB Micronaire

- (1) Where, due consideration being given to the control limit, the cotton delivered deviates from the Micronaire value agreed upon, an allowance may only be claimed for the difference in market value of the deviation.

- (2) The control limit and the differences shall be fixed by the Committees for Fixing the Value Differences of the various growths and published in the Cotton Report of the Bremer Baumwollbörse.

Chart 10

§ 60 BBB Pressley/Stelometer/HVI-Strength

If, due consideration being given to a control-limit to be fixed in each individual case by the competent Committee for Fixing the Value Differences, the cotton delivered is inferior to the Pressley/Stelometer/HVI-Strength values agreed upon, the parties shall come to an agreement between themselves as to an allowance, in so far and so long as official value differences have not yet been fixed.

Chart 11

Bylaw 339 ICA

- 1 In any dispute about micronaire the procedure in Bylaw 340 will apply
- 2 Unless the buyer and seller agree otherwise:

For contracts which set out a minimum micronaire value, the allowances for bales which do not reach this minimum will be as follows:

Micronaire value below the control limit by	Percentage allowance
0.1	0.5
0.2	1.0
0.3	2.0
0.4	3.0
0.5	4.0
0.6	5.0

and so on for each 0.1 micronaire.

Chart 12

Bylaw 339 ICA

But if the contract sets out a minimum of 3.5 (3.5 NCL or 3.8 UCL) or higher:

- * on cotton reading 2.9 to 2.6 inclusive, the percentage allowance will be increased to 3% for each 0.1 micronaire below 3.0;
- * on cotton reading 2.5 or below, the percentage allowance will be increased to 4% for each 0.1 micronaire below 2.6.

Chart 13

Bylaw 339 ICA

For contracts which set out a maximum micronaire value, The allowances for bales which go over this maximum will be as follows:

Micronaire value above the control limit by	Percentage allowance
0.1	0.5
0.2	1.0
0.3	2.0
0.4	3.0
0.5	4.0
0.6	5.0

and so on by 1% for each 0.1 micronaire.

Chart 14

Bylaw 339 ICA

But if the contract specifies a maximum micronaire reading of 4.9 or lower:

- * on cotton reading 5.6 or higher, the percentage allowance will be increased to 3% for each 0.1 micronaire above 5.6.

Chart 15

Bylaw 340 ICA

- Buyer choose bales to be tested
- Tests in a lab agreed by the parties or their arbitrators
- Appeal within 21 days
- Second test in any lab agreed between the parties.
If no agreement ICA laboratory
- First test results must not be given to second lab
- ICA lab can also do the second test
- Usual control limit 0.3

Chart 16

Bylaw 341 ICA

- 2 Unless the buyer and seller agree otherwise, for contracts which set out a minimum strength value, the allowances for bales which do not reach this minimum will be as follows:

HVI grams/tex below the Control limit by: between and		Percentage allowance
1.1	2.0	1.0
2.1	3.0	1.5
3.1	4.0	3.0
4.1	5.0	5.0
5.1	6.0	8.0

Plus 4% for each gram/tex below 6

Chart 17

Bylaw 341 ICA

Pressley Psi below the Control limit by between and		Percentage allowance
1050	3000	1.5
3050	5000	3.0
5050	7000	5.0
7050	9000	8.0

Plus 4% for each 2000 psi below 9000

Chart 18

Bylaw 342 ICA

- Only samples in dispute
- Test in a lab agreed by the parties or their arbitrators
- If no agreement ICA lab
- Objection within 21 days in a lab agreed between the parties
- If one firm demands it, second test in a different lab
- If no agreement in which lab ICA will decide, but will not do both test in ICA lab unless both parties agree
- First test's results must not be given to the second laboratory
- Usual control limit 2.0 grams/tex or 3000 psi

Chart 19

CSITC Conclusions:

- Elimination of Pressley
- Development of Arbitration Rules for
UMH Length
Uniformity Index
Color rd
Color +b

Chart 20

PART 2

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ABSTRACT

The international harmonization of instrumental cotton inspection has become an economic necessity to ensure the smooth transaction of the cotton trade. The prerequisites for harmonization are based on the acceptance of legal and technical issues relating to all those involved in the cotton business. Variables for the implementation of this essentially comprise the technical feasibility (testing technology), strategic implementation and the combined effort of all interest groups involved in the value chain of cotton.

INTRODUCTION

The technical variables which influence harmonized cotton inspection have been examined for many years in various working groups and especially at the Bremen International Cotton Conferences. Leaving aside political interests and legal trade standards, the central prerequisite for an objective, instrumental testing system which would be accepted worldwide is the availability of an appropriately efficient testing technology. We do not have to go into detail at this point about the fact that the technical implementation of testing technology is extremely complex with regard to the measurement of type-specific quality characteristics of raw materials. The producers of fibre test instrument systems have been working for years on the adjustment of testing systems to the natural material of cotton. One of the key results of this adjustment process is the provision of physical (cotton) calibration standards and standardized calibration procedures, which are designed to allow different laboratories to obtain the same test values on samples of the same cotton, within the limits of known variances. Thus, it is important to realize that an instrumental evaluation is a relative measurement, based on the calibration standards.

The standard for assessment remains the classer. In other words, so long as a given lot of cotton may be evaluated either by manual classing or by test instruments, the test instruments should be constrained to return the same values as those provided by the professional Cotton Classer. The professional Cotton Classers are trained, and their skills are maintained, by reference to physical (cotton) standards that are provided, and maintained by official regional bodies, that are responsible for the commercial evaluation of a particular cotton crop.

Thus, the technical requirement to provide physical calibration standards for test instruments, together with the commercial need to base the system upon the historic Cotton Classer system results in the fact that the new, instrumental calibration standards have to be directly related to the old Cotton Classer standards.

However, there is an important difference between the physical standards that are used by Cotton Classers and those used by test instrument systems. A Cotton Classer uses his reference standards by making visual comparisons, leaving the standards untouched and unaffected. In principle, the Classer standards can be used for so long as they are unaffected by the passage of time. On the other hand, a test instrument needs to make measurements on the standards at rather frequent (e.g. daily) intervals. These necessary, but non-productive calibration tests take time and some of them are destructive, so the stock of expensive calibration material is rather rapidly depleted.

This difference imposes an additional economic burden upon an instrumental test line, so there is a clear pressure in favour of maintaining as few instrumental calibration standards as possible. The consequence is that cottons of all types and origins have to be assessed relative to measurements made on the basis of just a few calibration standards.

Therefore, there is sometimes a tendency to over- or under-value the material, which does not help in gaining general acceptance for instrumental testing procedures.

The following comments are therefore concentrated on ideas for testing technology, and of achieving the set target of an instrumental testing system which is accepted worldwide.

1. Feasibility (measuring instruments and standards)

Obviously, the development of a world-wide instrumental cotton classification system requires that all significant cotton growing regions have to be equipped with adequate instrumental testing capacity and the supporting infrastructure. A semi-automatic testing system is capable of classing about 1000 bales per day. If the crop has to be classed within, say, 150 working days, then each test line can deal with 150,000 bales or about 30,000 tonnes in a season. On this scale, a small country like Tanzania would need only three test lines whilst Mali would need at least eight and Turkey would need about thirty. The instruments have to be housed in conditioned laboratories and have to be operated by well-trained technicians. The classification operation has to be managed and maintained by a corps of experts in the appropriate fields. A central and highly competent quality assurance operation is also required, together with an efficient sample collection and transportation facility. Not all cotton-growing countries are prepared to dedicate scarce resources to such a demanding enterprise.

It is well known that there is a strong influence of the atmospheric conditions in a testing laboratory (especially the relative humidity) upon certain fibre properties - particularly the length and strength. The need for sample conditioning, and for maintaining strict control over the atmosphere of the testing laboratory is often cited as a severe problem for some cotton-growing regions. Conditioning units, especially when situated in areas with difficult climates, can be expensive to install, to run continuously, and to maintain in perfect working order.

Therefore, research is being carried out to discover the underlying relationships between the temperature and relative humidity of the ambient atmosphere, the moisture content of the fibre, and the values returned by test instruments. If (and only if) it should be discovered that there are unique relationships, valid for all types of cotton, and all levels of fibre maturity, over the whole range of temperature and relative humidity likely to be encountered in the cotton-growing regions, then it will be a simple matter to develop correction equations. Inclusion of such correction equations in the testing software, and installation of temperature and humidity measurement sensors at appropriate points, will mean that the test samples do not need to be pre-conditioned and the laboratory atmosphere does not need to be maintained at a fixed temperature and humidity.

This basic research is very important and should be encouraged and supported. However, the most likely outcome is that there are, in fact, no such unique relationships valid over the necessary range of cotton types, temperature and humidity. Nevertheless, it should be possible, eventually, to define a range of temperature and humidity within which the deviations shown by the different cottons are small enough to allow correction with a single equation to an acceptable degree of accuracy. Hopefully, this range will be wide enough to allow the use of conditioning plant which is of a much lower level of cost and sophistication compared to that required to meet the current standard of 65 ± 2 %RH and 20 ± 2 °C.

High-speed instrument testing systems, suitable for cotton classification, are delivered by several different manufacturers and each manufacturer may have several different versions on the market. Obviously, it is in the interests of the potential users of such equipment that all manufacturers are able to participate in the market. To this end, the end-users have to agree, and to promulgate, certain minimum performance standards which have to be achieved by all types and models. In addition the users need to have confidence in the "inner workings" of the different brands of instruments. A modern, high-speed test instrument is dependent not only on precision engineering but also on appropriate software algorithms. Of course, the detailed implementation of the algorithms is proprietary information and should remain so. But the general principles of how the values of fibre properties are deduced from electronic signals should be transparent to the market - so that potential purchasers can have confidence in the underlying principles.

The primary performance standards will be stated in terms of accuracy, precision, and repeatability. Accuracy means that the result obtained corresponds to the "true" value. Precision is the variation shown by repeated measurements on specimens from the same sample. Repeatability is the variation shown by different instruments in different laboratories, or the same instrument over an extended time period.

The required performance levels have to be specified by the users, delivered by the instrument manufacturers, and continuously monitored and validated by international Round Tests. In addition, the users and the manufacturers together will need to ensure that service and training centres are available to ensure that the instruments are used to their maximum potential.

A world-wide instrumental cotton classification system will need to establish a means for certifying laboratories that can demonstrate the required level of proficiency and consistency, so that test certificates attached to a bale or a lot of cotton can carry an appropriate level of authority and confidence

A very difficult challenge for the test instrument manufacturers may be that of over- or under-valuation of particular cotton lots, which can arise out of the need to have relatively few instrumental calibration standards.

Experience based on the Bremen Cotton Round Trials and internal examinations shows that, in the case of cottons which have significantly deviating characteristics in comparison to calibration standards, there is a risk of a tendency for over- or under-valuation. In cooperation with research facilities, the test unit producers have to make improvements in this field in order to cushion the relativity of measurement in relation to the calibration cotton used. We would like to stress at this point that the implementation of the vision of establishing a worldwide accepted test system for cotton is significantly linked to confidence in the measuring technology involved.

2. Necessity (acceptance and reliability)

The value chain in the international cotton business begins at the production and marketing of seed, moves on through cultivation and harvest and ends with the raw material trade in the spinning mill. If packaging and transport, plus clothing manufacture and retailing are also included, then it is clear that the value chain comprises many branches of business which benefit via profit in varying amount. The economic interests are oriented towards the global market, which is normal in the case of international economic goods such as cotton.

Cotton remains the most important natural textile fibre. Each year approx. 20 to 25 million tonnes of cottons from approx. 80 countries are produced. The central economic criteria for trade with cotton are of course the purchase price and the resulting sales potential; but also fibre characteristics are important for the further processing of the material in the spinning mills. From this we derive that the yarn manufacturer (spinning mill) would like to purchase the material at a low price and exploit this material optimally by means of modern spinning technology in order to achieve a competitive advantage compared to other yarn manufacturers. In light of this it is important that the material type and quality can be tested and reproduced irrespective of the location of the testing house, and that the certificate issued represents a reliable description of the quality of the material involved. The trader gains the benefit of providing his spinning mills with the best possible material of this type, even if qualities no longer available have to be replaced by similar cottons. In addition there is no reason for further testing of the material by order of the trader, which has positive cost benefits.

If the above-mentioned value chain is considered in a realistic way, on including all those involved in the cotton business, it can be said that every company can draw benefits from a harmonized testing system. In the wool industry there has been a similar quality recording system in use for many years. Therefore it can be expected

that the introduction of an internationally harmonized testing procedure can also achieve appropriate acceptance within the cotton industry.

One prerequisite for the success of this enterprise is, of course, that, within a given industry sector, each company is willing to deal and to work with the sectors before and after its own sector in the value chain, and is willing to deal with the new measuring technology. It is only from such willingness to identify with the material of cotton along the whole value chain that there is a real chance of implementing a worldwide accepted harmonization. As a result, this issue is a central point to be discussed by the Panel Discussion at the Conference (CSITC)

3. Implementation (certification and training)

The implementation of the concept requires the distribution of tasks among various contact partners:

The test instrument manufacturers have to give intensive thought to conceptual considerations of various fibre characteristics. It is necessary to take care of the specific character of the different varieties or to accept in total the measurement technology as a relative method.

They also have to expand the measuring technology with appropriate sensors to determine the moisture content of the fibre at a point immediately before the test measurement is made, in order to take advantage of correction equations which can make allowance for the dependence of the reported measurements on the temperature and humidity of the testing atmosphere. In addition, a swift supply on the part of operators with service, including spare parts, has to be ensured. Training of staff should also become a routine operation.

In order to maintain the vigour and integrity of an international network of harmonized cotton testing houses, participating laboratories will need the support of independently organized Round Tests, to manage and monitor their ability to perform reproducible measurements over an extended period. A proposal for an appropriate service is at present being prepared by the CSITC via a support application to the Common Fund for Commodities (CFC) in terms of a certification system. In addition, the certifying organization will provide aid in all issues of operation and service so that the operator of the lab will always have an immediate contact partner available for any issues which arise.

Remark:

One critical issue relates to the producers of seeds. The security, sustainability of seed quality, and the evaluation of special cases - such as "organic" cotton cultivation and transgenic cotton - are key issues.

A special issue, not mentioned so far, is the extra long staple cotton (ELS) which has as yet not been included in the certification system. The reasons for this are linked to the fact that ELS cottons seem to behave somewhat differently to short and medium

staple cottons when evaluated by the current high-speed instrumental testing systems. This difference in behaviour may be at least partly attributed to the roller ginning operation, most often used with ELS cottons, which does not provide such intensive fibre mixing as does the saw ginning set-up.

4. Cooperation (value chain)

The expansion of test centres in all relevant cotton sectors is required. The proper training of lab staff has to be ensured via workshops which should be provided regularly in the cotton-growing regions.

Internationally recognized committees such as the ICAC and the ITMF support the implementation of an internationally harmonized system of instrumental cotton classification.

In my personal opinion, the objective set here can be achieved only with the combined will of all interested parties involved.

In so far as each economic branch included in the cotton business can identify a benefit for itself from the establishing of an appropriate worldwide network, which should be indisputable, there should be a base for optimism for the realization of the vision of a 'Community of Cotton Economy' within the next 5 years, despite the different interests involved.