Vision 2030

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Foreword

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The diverse challenges and constraints as growing population, increasing food, feed and fodder needs, natural resource degradation, climate change, new parasites, slow growth in farm income and new global trade regulations demand a paradigm shift in formulating and implementing the agricultural research programmes. The emerging scenario necessitates the institutions of ICAR to have perspective vision which could be translated through proactive, novel and innovative research approach based on cutting edge science. In this endeavour, all the institutions of ICAR, have revised and prepared respective Vision-2030 documents highlighting the issues and strategies relevant for the next twenty years.

Engineering interventions have become essential for reducing cost, drudgery, improving overall resource use efficiency and profitability in production systems. Simultaneously technological innovations are essential for enhancing value addition, processing efficiency, employment and income generation in an environmentally benign manner. It is in this context that the role of the Central Institute for Research on Cotton Technology (CIRCOT), Mumbai becomes crucial and relevant. The institute needs to strive hard to generate viable and appropriate technologies in the realm of secondary agriculture not only on cotton fibre and the by-products of its processing but also on the biomass generated in production of cotton and similar fibre crops. The Institute, with its sound infrastructure, should closely liaise with the textile industry to undertake joint programmes of mutual interest with a view to ensure profitability to all the stakeholders in the cotton value chain including the farmers.

It is expected that the analytical approach and forward looking concepts presented in the *'Vision 2030'* document will prove useful for the researchers, policymakers, and stakeholders to address the future challenges for growth and development of the agricultural sector and ensure food and income security with a human touch.

Dated the 8th July, 2011
New Delhi

(S. AYYAPPAN)

Preface

As visualized by Mahatma Gandhi decades ago, agriculture continues to be the backbone of the Indian economy. In the past, Indian agriculture has been confronted with many challenges, and it continues to do so with every change in the scenario and passage of time. Post WTO, there is an urgent need to improve competitiveness of Indian agriculture to make import unattractive, which also calls for intervention by postharvest Technology with mechanization, newer and efficient processing techniques, and minimization of losses, technology transfer, and marketing.

As the country's apex body of the national agricultural research and education, the Indian Council of Agricultural Research (ICAR) is ever vigilant and resolved various challenges in the Indian agriculture by providing an effective agricultural invention-and-innovation continuum. The Central Institute for Research on Cotton Technology (CIRCOT) is one of the premier constituent institutes of the ICAR, and one of its kind in the world conducting R & D on utilization of every parts of the cotton plant. The institute is developing new technologies and machinery for better utilization of cotton and other textile fibres by carrying out basic, applied, strategic and anticipatory research in postharvest technology. The institute has carried out pioneering work on cotton crop residue, value addition to cotton processing waste, mechanical processing of cotton, development of industrial yarn and fabric by using natural and synthetic fibre blends and environment friendly chemical finishes for cotton. Calibration cotton is one of the hallmarks of these developments.

In this VISION-2030 document, CIRCOT has critically focused its perspective for the coming two decades and prepared the strategies to attain its vision. I am sure realizing the vision embodied in the document through the proposed strategies will reaffirm CIRCOT as a one-stop solution provider for issues on cotton technology.

I express my gratitude to Dr. S. Ayyappan, Secretary, DARE & Director General (ICAR) who is guiding force behind the preparation of Vision 2030 document. I am grateful to Dr. M.M. Pandey, Deputy Director General (Engineering) for their invaluable guidance and constructive suggestions. I am also thankful to Dr. K.K. Singh, Assistant Director General (PE) for his valuable contribution. I sincerely thank Dr. R. P. Kachru, Chairman, Research Advisory Committee for his critical evaluation and positive suggestions on research priorities and programmes.

I am thankful to scientists and technical staff of CIRCOT for providing necessary inputs in preparing the document. I also thank Dr. S.K. Chattopadhyay, Head, Mechanical Processing Division and his team for compilation of the document. I express my gratitude to Dr. S. Sreenivasan, Former Director of CIRCOT and Dr. R. H. Balasubramanya, Former Head, CBPD and Emeritus Scientist for their active support.

July, 2011
Mumbai

(A. J. SHAIKH)
Director, CIRCOT

Preamble

In India, cotton, the 'White Gold' enjoys the pride of place among the cash crops and contributes significantly to the national economy from the earliest times. Cotton traverses between the two largest sectors; agriculture, and textile manufacturing industry, thus providing employment to millions. Internationally, cotton has to face stiff competition from synthetic fibres like polyester and its share has declined to 38%. But in India, it enjoys pre-eminence as an industrial raw material for the spinning industry with a share of 62%. Since the expiry of Multi-Fibre Agreement (MFA) and opening of Quota-free global trade in 2004, the cotton textile sector has been receiving much impetus to growth. India's strong economic growth in recent past has helped in expanding the domestic market leading to increased spending on clothing with fashion accentuating preferences of the consumers. With recent technological advances in cotton processing and value addition, India has emerged as a major player in the World cotton production-processing-value addition-consumption-export scenario.

Given the current cotton situation, CIRCOT being a bridge between the Industry and the Agriculture will have a major role to play, so that India's resolute towards attaining supremacy in the world cotton and cotton textile, remains firm. There are several challenges and threats ahead, and critical R & D issues need to be resolved at every turn of the trajectory, necessitating major changes in research canvas and managerial priorities. Keeping this in mind, the present vision document of CIRCOT has been prepared.

Under the guidance of ICAR, CIRCOT drafted its first vision document, 'Vision 2020' in 2000, which was revisited with a fresh look at research priorities and programmes to prepare 'Perspective Plan 2025' in the year 2007. ICAR, being the apex body of the national agricultural research and education system has already prepared 'ICAR Vision 2030' document, and has directed its constituent institutes to do so as well.

'CIRCOT Vision 2030' is a documentation of the collective wisdom of all its scientists and technical staff, who had participated with remarkable zeal. It encompasses a brief of the present postharvest technology scenario of cotton, identifies the critical R & D issues and key challenges ahead and outlines a broad research agenda and strategy for CIRCOT for the next twenty years. The document emphasizes on the postharvest processing and value addition strategies to cotton and other natural fibres and utilization of their by-products to maximize economic, environmental and societal benefits to farmers and all other stakeholders in the value-chain.

Contents

Cotton Postharvest Technology Scenario

Cotton Production, Consumption, Export and Stock to use Ratio

COTTON as an important industrial crop has played a vital role in the history of mankind and civilization. After the onset of the industrial revolution in England, cotton cultivation spread fast under the influence of the British Empire. Now cotton is grown in nearly 90 countries of the world in about 35 million hectares with an annual production of about 25 million metric tonnes (MMT). It is projected to rise by 9% to 27.4 MMT in 2011/12 (Source: ICAC). The crop productivity on a global level is currently estimated at 750 kg/ha.

India, being the World's second-largest cotton producer, consumer and exporter commands a special attention. Cotton and the cotton textile industry have played a fundamental role in culture and trade throughout India's history. Spinning, weaving and dyeing of cotton dates back to 5,000 years. In the 20th century, cotton grew in domestic importance and emerged as a central symbol for India's independence movement.

Indian cottons belong to all the four cultivated species of gossypium, such as, *G. arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense* besides their intraspecies and interspecific hybrids. The old-World species, *G. arboreum* and *G. herbaceum*, are believed to have originated in the Indian subcontinent with history dating back to unrecorded antiquity. However, a notable change in the composition of species could be observed over the years, and now *G. hirsutum* is grown in almost 95% of the cotton area in the country (Fig.1).

According to The Directorate of Cotton Development (DOCD) estimate, about 85% of the area under cotton is now cultivated with Bt-Cotton hybrids. Since its introduction in 2002, Bt-

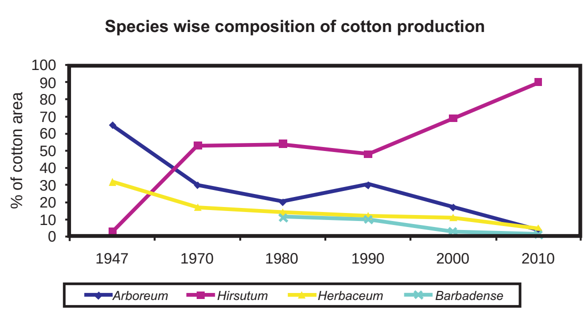


Fig. 1

Cotton that confers resistance to pink boll-worm has rapidly gained acceptability among the farmers (Fig. 2).

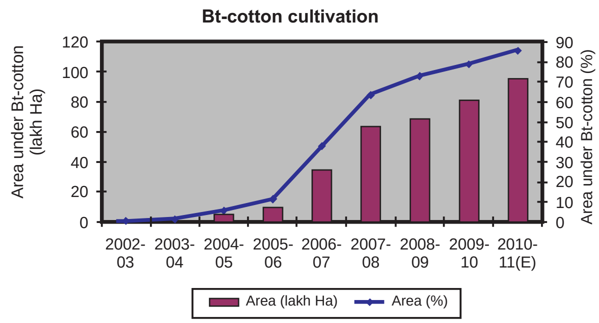


Fig. 2

In 2010-11, the area under the cotton was about 111 Lakh hectares (projected) with a production of 312 MMT. In the last five years, area under cotton has increased by 22% and production by 15%.

World cotton consumption is forecast to increase by 0.9% in 2010-11 to 26 MMT, with a stock-to-use ratio of about 33%, which is well below the long-term average of 47%. The world cotton area, production, consumption and stock to use ratio during 2000-2011 are shown in Fig. 3.

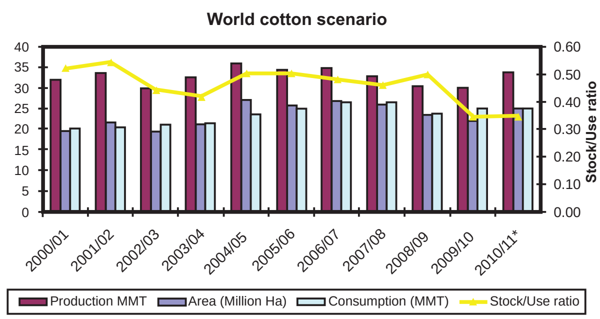


Fig. 3

The national scenario is marked by increased use of cotton in recent years. The cotton consumption by the textile industry which was about 4.25 MMT in 2009-10 is projected to be 4.68 MMT in 2010-11 with a stock-to-use ratio of about 10% against a long-term average of about 22%. The last eleven years data for Indian Scenario has been presented in Fig. 4.

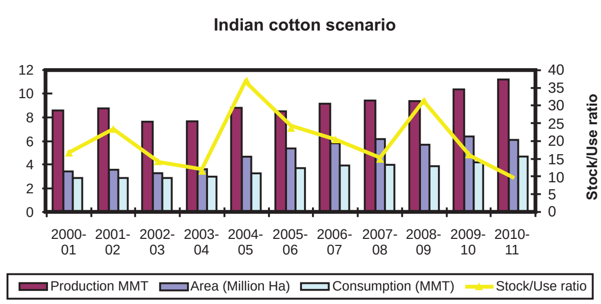


Fig. 4

Thanks to noticeable increase in cotton production during the past decade, India has now emerged the second largest exporter of cotton in the world, exporting about 55 lakh bales (935 million kg).

Cotton Postharvest Technology

Cotton accounts for about 60% of the total fibre consumed by the Indian textile sector against less than 40% share in global scenario. Out of the total cotton consumed, 94% is chiefly used for spinning of yarn and 6% is used in the production of surgical cotton and for other applications. It has been noted that there has been a huge expansion of spinning capacity in recent years. On an average, over 2 million spindles are being added every year, resulting in an increase in yarn production that spurs the demand for cotton. Fig. 5 shows the installed capacity of ring and rotor spinning production heads over the years.

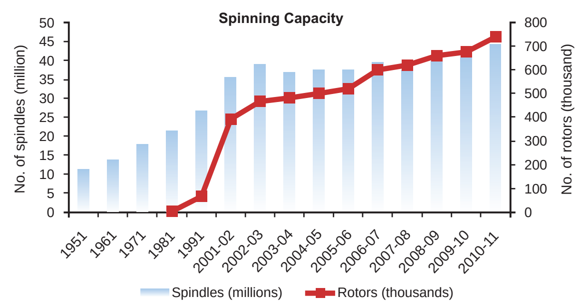


Fig. 5

The yarn production graph is shown in Fig. 6. In 2009-10, the total yarn production was 4.2 billion kgs. The Compound Annual Growth Rate (CAGR) for cotton yarn is about 4 % for the period 2004-10 (Table 1). Similarly, CAGR for cotton fabric is about 5.5% (Table 2), and the fabric production trend is shown in Fig. 7. Cotton is dominant in all sectors of fabric production namely, mill sector, hand-loom, power loom and hosiery sectors.

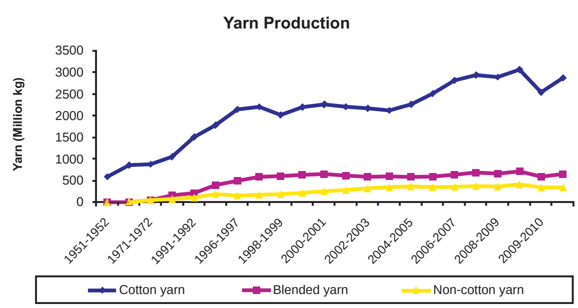


Fig. 6

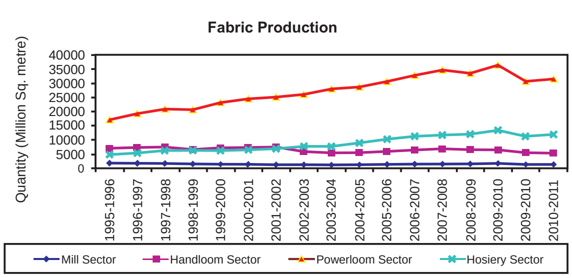


Fig. 7

Table 1 : Production of Spun Yarn (Billion kg.)

	2004-05	2009-10	% CAGR (2004-10)
Cotton	2.3	3.1	4.9
Blended	0.6	0.7	2.7
Non Cotton	0.4	0.4	0.3
Total	3.2	4.2	4.6

Table 2 : Fabric Production (Billion Sq.m.)

	2004-05	2009-10	% CAGR (2004-10)
Cotton	20.7	28.9	5.8
Blended	6.0	7.8	4.3
Non Cotton	18.0	22.8	4.1
Total	44.7	59.5	4.9

Indian textile and clothing sector is highly dependent on cotton that drives the growth both in yarn and fabric production as well. Cotton also dominates in apparel and non-apparel export market. In 2009-10, cotton has accounted for 72.5% share in textile apparel export. In recent years, the cotton consumption has shown a significant rate of growth commensurate to production.

From the field to fashion, cotton is subjected to a combination of processing steps such as mechanical, chemical or combination of both to convert fibres into yarn, and then to fabric and garment. In non-apparel sector, cotton is mainly used for medical applications. The current scenario in some of the important sectors and their issues requiring immediate attention are described below

Cleaning, Ginning and Baling

India has over 4000 ginneries that include both roller and saw ginning machines. Ginning is a primary processing industry whose major functions are to clean and gin kapas (seed cotton), clean the lint and form a bale. Till the beginning of 21st century, most of the gins were conventional, and the entire material handling was carried out manually. The globalization of markets and demand for quality textiles have led to advancement of new technologies in ginning and pressing machinery, and automation at every stage of cotton processing.

The mission of Indian government to achieve modernization of ginning industry through the Technology Mission on Cotton (TMC) has been a laudable effort. The last decade resulted in the indigenous development of a multitude of machinery and automation that lessens human intervention and contamination in cotton. These include improved versions of double roller (DR) gin with higher productivity, precleaner and post-cleaners to suit the Indian cottons, seed cotton distribution systems to DR gins, pneumatic and mechanical systems for conveying seed cotton, lint and seed. For baling, now the focus has shifted from the double stage up-packing presses to fully automatic down-packing and oil-hydraulic presses. These technological developments with improved infrastructure has had an impact on the ginneries significantly by increasing the production capacity, improved fibre quality, reduced contamination and welfare of the employees. Till date, over 1000 ginneries are upgraded with these technologies.

CIRCOT developed Axial-flow pre-cleaner

With availability of labour becoming a matter of great concern for agriculture related operations, it has become necessary to promote mechanical picking of cotton. It is known that the machine picked cotton contains around 20-25% trash, the nature of which varies compared to those found in handpicked cotton. The machine picked cotton contains a large quantity of sticks, burrs and green leaves. There is a need to design and develop appropriate precleaning and post-cleaning machines to process mechanically picked cotton with farm level pre-cleaning machine for seed cotton to increase the returns to the farmers. CIRCOT has already developed suitable precleaners for removal of sticks, burrs etc. They need to be adopted at the farm or close to farm level so that the farmer would be able to clean and market the seed cotton even after mechanical picking and obtain appropriate remuneration for his produce.

In India, about 80% of cotton produced is subjected to ginning by using the double roller (DR) gins. The present double roller gins are low productive, nonenergy efficient and generate high noise coupled with vibration. Efforts need to be made to standardize the process of moisture application to seed cotton before ginning. Also, modification and management in existing humidifiers is needed to suit Indian ginneries.

Majority of the presses in India are still the conventional double stage type, which are prone to produce cotton bales with nonuniform weight and density with increased contamination. Though steadily automatic single stage presses with auto-trampling, which reduces labour and avoids contamination are becoming popular; but their energy-consumption are on the higher side needing suitable engineering interventions.

The biggest challenge before the ginning industry is to develop quality standards for the machinery used in ginning and allied operations for enabling the ginner to choose the right machine for his cotton.

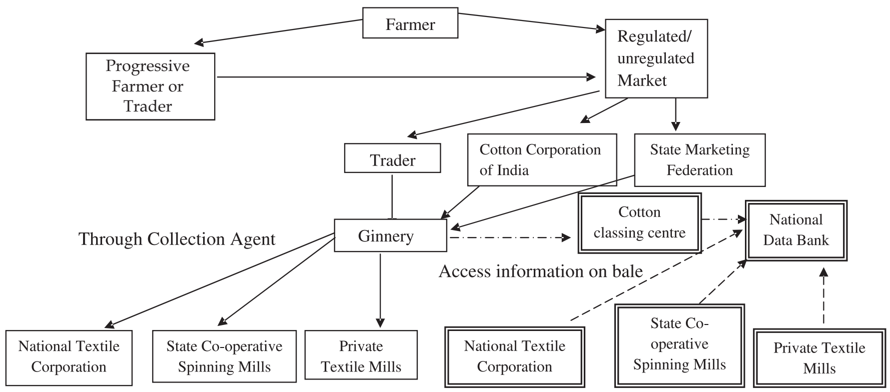
Fibre Quality Characterization

Being a supplier of raw material for the textile industry, cotton plays a vital role in the Indian economy. Now cotton fibre quality characterization is done by using the High Volume Instrument (HVI) and Advanced Fibre Information System (AFIS). While the former is used by the traders to meet the contract specifications and ginners to optimize the gin-settings, the latter is used by the spinners to improve the yarn quality and meet end product needs.

Cotton fibre quality improvement is being carried out through the All India Coordinated Cotton Improvement Project (AICCIP), a platform for breeders of State Agricultural Universities (SAUs) and seed producing companies to release new and improved varieties and hybrids. Many popular varieties and hybrids have been notified for commercial cultivation through this much lauded multidisciplinary coordinated project of ICAR, instituted in 1966. But this is not in vogue for Bt-hybrids. So far the fibre properties aimed for improvement are 2.5% span length, micronaire and strength which have been achieved to a large extent. But the variations in properties are high in Indian cottons compared to imported cottons. Further in the present project (AICCIP), there are no guidelines and procedures for drawing samples by the breeder. So breeders' samples from different location may vary leading to difficulty in comparison with the test results. Besides, the future research on cotton quality improvement should focus on reducing short fibre, immature fibre and nep content, and on improving fibre strength enabling high-speed spinning of cottons into yarns.

Marketing

In India, private traders, state level cooperatives and CCI (Cotton Corporation of India) are the three main players involved in marketing of cotton. Private traders handle 70% of cotton lint, followed by cooperatives and the CCI. The sale is carried out through cotton brokers and by mill representatives. Spinning Mills are struggling to maintain uniformity in fibre quality from



lot to lot due to non-classification of lint by the ginners. In US and China, all the bales produced are tagged with quality data by the classing centre, and the farmers are the owners of lint and seed. A national database is maintained by US classing centre that provides telecommunication borne informative data to traders and the industry enabling them to buy the needed quality by paying the right price to farmers. Similar to US and China, cotton classing centres may be set up in major cotton growing areas in our country. All cotton classing centers should be equipped with two or three most modern HVI for evaluation of major fibre properties and grading. The cotton samples should be drawn and collected by the collection agent from the ginnery with the help of CCI and sent to the nearest classing centre. The measured data obtained at each classing centre would then be transported to a common server maintained by CIRCOT. The data must be checked for validity before assigning a permanent identification number to each bale and a national database can be preserved. Authorized users can access the National database by using the permanent bale identification number attached to each bale of cotton by paying a fee. The flowchart below focuses on the present marketing chain in our country, and the dotted lines are the proposed additions to enable quality based bale tagging and marketing.

Spinning Technology

In the past two decades, the cotton spinning technology has gone through a drastic change. Though the production speed of machines has increased enormously, the yarns have become more even and nearly fault-free. Innovative technologies which ensure greater positive control on the fibres during their flight through the spinning machines have helped to achieve this. CIRCOT's continued investigation on yarn-faults has impacted on the yarn production scenario, and helped industry to produce yarns with fewer faults equalling world's best 5-25% standards. The demand on cotton fibre for performance at high spinning speeds with almost zero-breaks on the production head has been constantly highlighted. The prospects of blending cotton with other natural and synthetic fibres with newer shapes and microsizes are alluring given the changing fashion demand, and of course, high cotton prices at times.

The innovation of fibre spinning started right in the blowroom stage, where mixing and the method of cleaning cotton have undergone a conceptual upliftment. The modern bale openers have now been conferred with powers to pinch fibres at the same time from 200 different bales and layers enabling randomly intensive fibre mixing. This helps in producing long lengths of yarn with consistent properties. The production capacity of blowroom has also increased, with 2000 kg per hour now a reality. The trash removal efficiency of the machines has improved a lot and with the help of CCD camera enabled gadget, it is now possible to remove even the smallest foreign contaminant. In the carding machine, multiple licker-in to stationary flats, precision flat setting, programmable integrated grinding system, online monitoring of the neps and trash particles are the modern developments. These have helped to achieve high production (100 kg per hour) without damage to fibres, with concomitant elevation in product quality. Joining of drawframe module with cards has lessened the production cost. The use of both short and long-term auto levelers in card have helped to produce excellent yarn evenness.

The rotor spinning has established an enviable place in coarser yarn spinning since its commercial introduction in 1984 in India. Before that, CIRCOT had conducted a research program to ensure its aptness in Indian spinning sector. Robotic piecing has ensured clean and efficient yarn. Friction free aero-bearing or magnetic bearing has resulted in drop in energy consumption. With innovations of such type a rotor speed of 1,60,000 rpm is now achievable. The air-jet and friction spinning machines are also getting attention for application in spinning of both fine and coarse industrial yarns, including fibre blends.

The most important innovation in spinning in the last decade is the compact spinning, where the yarn is compacted pneumatically just before the delivery. It results in decrease in long hairs (2 mm and above) in the yarns produced. The tenacity, evenness and abrasion resistance of the yarns have improved a lot due to increased compactness of the yarns. There is a need for adoptive research on processing Indian cottons by using modern spinning technology to economize on the production cost without sacrificing yarn quality.

Nonwovens

Nonwovens are engineered fabrics that can form disposable products meant strictly for single use. The Unique Selling Points of cotton nonwoven are superior absorption, soft, disposable, portable, and with less risk of cross-contamination. International studies have shown that single-use nonwoven products reduced infection by 2.5 times compared with that of the traditional textiles. The main requirement for such disposable and hygienic textile is a fabric with low weight, as low as 20 gram per square meter (GSM). They cannot be produced by using the conventional weaving or knitting technology. Such fabrics are now made by newly introduced spunlace nonwoven technology. The advantages of nonwovens compared to woven and knitted textiles are their higher economic efficiency of production and performance competence as well as lower product weight. One disposable wipe contains only 3-4 grams of cotton and if priced at Rs. 3 a wipe, the minimum net realizable value (NRV) is above 100%. The current market size of wipe is about 2 million square metres of fabric valued at Rs. 12 million. Limited manufacturing of wipes exists in India to cater to this growing market. The Indian consumer is changing rapidly, because of urbanization, increased buying power, education, awareness, affordability, busy lifestyle and increasing concern for health and hygiene. Besides, product innovation and diverse applications will further stimulate the demand for faster adaptability of such products in India. Therefore, the growth rate of disposable wipes has been estimated at a CGAR of 15% for the coming 10 years. The market size comprising domestic, medical, cosmetic and baby wipes is of Rs. 450 crores. The consumer wipes market is negligible. Premoistened baby wipes have been recently introduced and have become popular in urban settings. Cotton as a raw material can play an important role in this sector, and promises better returns to all in the value chain including farmers. However, much research is needed to ensure its suitability from processing to end-application.

Technical Textiles

Conventional textiles are mainly used for clothing and furnishings. The value chain for production of apparel is well-set up in the industrial sector, with production centres located across the country. Cotton is the dominating natural fibre followed by wool in conventional textiles. In the last decade or so, many new non-apparel specific applications of textiles have come up and, all these are collectively incorporated in the term technical textiles. Technical textiles are primarily used for their technical and industrial performance, and functional properties rather than their aesthetic or decorative characteristics. The application areas are hi-tech that includes transport, filtration, protective clothing, military textiles, geotechnical engineering, building construction, medical and hygiene, agriculture, packaging, sports, machine parts and insulation.

Friction Spinning Machine for industrial yarn

Technical textiles account for over 25% of all fibre consumed and almost 50% of the total textile activity in certain industrialized countries. However, the potential of technical textiles in India is still untapped. The current overall market size of technical textiles in India is estimated as Rs. 42,000 crores. The projected annual growth rate without any fiscal support is about 11% against global growth rate of 3.8%. The expected market size of technical textiles at the end of the 12th plan period is about Rs. 70,000 crores. To cater to such a growth rate, continuous research efforts and product developments are needed. Green fibres like cotton are easy to recycle, needing rather low amount of energy for their conversion into textiles, and are climatically adaptable, eco-friendly and a viable alternative to be researched on for use in technical textile.

Natural Fibre Composites: Scientific Extraction of Hard Natural Fibres and Surface Modification

Plant-based fibres are low in density, have acceptable specific strength properties, are nonabrasive, biodegradable and have potential for energy recovery and carbon dioxide sequestration. While it is known that Natural Fibre Composites (NFCs) cannot replace glass and carbon fibres in many high-end applications, they have the potential for use as building materials like roofing, panels, fluid containers, bridge-parts, boats, structural parts of spacecrafts, and in the automotive industry. NFCs are produced using approximately energy of the order of 4 GJ per tonne, and priced between Rs. 7,000-40,000 a tonne as against traditional reinforcing fibres such as glass priced at Rs. 48,000-72,000/- per tonne and expending energy of 30 GJ per tonne. While carbon fibre costs Rs. 5,00,000/- per tonne and the energy needed for production is 130 GJ per tonne. Thus a natural fibre composite is both cost and energy efficient. Here, the important researchable issues are to impart hydrophobicity to the natural fibres and improve the interfacial bond strength, which are critical for getting better mechanical properties as composites. Besides, scientific extraction of hard natural fibres, like coconut fibre, sisal, pineapple, palm, etc., and making them amenable for textile use avoiding deterioration in fibre quality and environment is yet to be achieved. It calls for development of new line of energy-efficient machines and surface modification with techniques like plasma impingement on fibres.

India has a plenty of natural fibres, which have not been commercially exploited to its maximum potential. The extraction of natural fibres (coconut fibre, pineapple, palm, sisal) has to be made scientific, energy efficient and economically viable. Composite product development by use of natural fibres alone or in combination with synthetic fibres is the need of the hour for long-term sustainability.

Wet Processing and Dyeing

Textile wet processing is the most complex part in textile manufacturing, in which the value of the material is increased by many folds and therefore needs greater R & D intervention.

Textile wet processing is a water and energy intensive operation especially for processing of cotton and blended materials. Table 3 gives the comparison between the requirements of water for processing different textile fibers. Clearly, cotton textiles need more water than other synthetic materials. Also, whatever quantity of water is used for the processing is discharged as effluent.

Table 3: Water requirement for wet processing of different fibres

Material	Water requirement (litres per Kg)
Cotton	80-200
Polyester	40-100
Nylon	50-120
Acrylic	30-80

Table 4 : Water requirement for wet processes

Material	Water requirement (litres per Kg)
Scouring and bleaching	15-60
Jet dyeing and washing	60-120
Finishing	2-5

Besides, dyeing of textiles consumes maximum volume of water (~80-85%) among all the wet processing operations (see Table 4). It also causes maximum pollution by various chemicals and auxiliaries such as dispersants, leveling agents, salts, acids, alkalies and carriers. These make the effluent produced difficult to biodegrade, excessively coloured and high in total dissolved solids (TDS). Research should focus on development of natural-based dyes that produce effluents which can be treated easily.

The researchable issues in wet processing have been identified as (i) water and energy use efficiency, (ii) converting and replacing the harmful chemicals and dyes with eco-friendly alternatives and (iii) Zero discharge or minimum discharge of effluent. In short, burning environmental concerns of this sector need to be addressed by focusing pointed R & D on the above researchable issues.

Nanotechnology

Nanotechnology manipulates atoms, molecules or clusters into structures or devices with new properties for varied applications, such as in materials (coatings and composites), electronics (displays and batteries) and health care (like pharmaceuticals).

Keeping the ethical and ecological issues in focus, researchable issues in nanotechnology are:

1. Preparation of nanocomposites from biopolymers for use in food packaging and agricultural field mulching.
2. Functional finishing of cotton/blended textiles using nanomaterials.
3. Electrospinning of nanofibers for nanofilters and nano-adsorbents.
4. Smart and intelligent textiles with natural fibres by using nanomaterials.

In the long-term, there is a need to undertake a network project involving various ICAR institutes for conservation of resources in agriculture production, postharvest management and processing using nanotechnology as a new research tool.

Cotton seed and Linters

Cottonseed is a by-product of cotton and is a valuable source of edible oil, cake, linters and hulls, all of which have several industrial and other applications. The oil in the seed is about 22%. Cottonseed oil in its refined state is used for cooking, and in cosmetics. Less refined grades are used in the manufacture of commodities such as soap, candles and detergents. Cottonseed hulls contain about 35-47% alpha cellulose, 19-27% pentosons, 15-20% lignin, and about 5% of fat, protein and ash in equal proportions. Cottonseed hull is used as animal feed, soil conditioner, base filler for manufacture of hardboard of high strength and durability, and in preparing 65-70% active carbon. Cottonseed cake which is devoid of oil contains about 40-50% protein with all the essential amino acids and is extensively used as animal feed for poultry, pigs and fish.

About 97 lakh tonnes of cottonseed and about 11 lakh tonnes of refined oil were produced in India during 2009-2010. The demand and prices for cottonseed oil and linters in India are likely to remain high in coming years. Also introgressive breeding along with genetic engineering (RNAi) technology and inexpensive biochemical methods would aid in Gossypol elimination from the seed/meal which is one of the impediments in its current use. Research should aim for almost complete extraction of oil (upto 95%) by improved engineering and oil press technology.

Cotton linters are the short fuzzy mass left on the cottonseed after the fibres are removed during the ginning. In India, linters are removed by machines known as delinting machines in two succession, using toothed circular saws to give first cut and second cut linters. A single operation is commonly used in the industry to give mill-run linters. The first cut linters have long fibres of about 6 to 12 mm and find application in paper making, strawboard manufacture and felting. The second cut linters are about 2 to 6 mm and are used for preparing chemical derivatives such as cellulose acetate, cellulose nitrate and carboxy-methyl cellulose (CMC). Mill run linters include fibres of various lengths and may go into both uses. Industrial grade CMC is made from cotton linter pulp. The end use of the product is in the manufacture of lacquers and varnishes. Cotton linter pulp is used for producing bank note/ bond and speciality paper, viscose fibre and filter paper. The cellulose content of bleached cotton linter is around 98 %.

The energy consumption during saw delinting has been recognized as one of the impediments in promoting this technology. It is well realized that 50% of the operational cost in delinting is towards electricity consumption. Therefore, there is an urgent need to direct research attention to improve the energy efficiency in delinting operation. Besides, alternate energy efficient and productive methods of removing linters preserving the quality of the product need to be innovated.

Cotton stalks and textile processing waste

Intensive cotton cultivation has reduced the secondary micronutrients in the soil. The huge biomass available after picking of seed cotton and textile mill waste is a source to restore soil nutrients. Accelerated composting techniques and production of bioenergy by improved solid-state fermentation techniques can be researched. In the recent past, CIRCOT has developed technologies for production of particle boards, hard-boards, pulp and paper from cotton stalks. Pilot plant study and commercial trials were also conducted successfully to find out the technical feasibility

Pilot plant for particle board manufacturing and economic viability under the Common Fund for Commodity (CFC) projects. However, mechanism for uninterrupted supply of cotton stalk at the factory gate needs to be ensured for commercial sustainability. Many efforts need to be put to popularize these technologies and build entrepreneurship by extensive technology transfer activities.

Agribusiness and Commercialization of Technologies

CIRCOT is developing and transferring technologies in agriculture and textile related processes, product and services for the benefit of farming and textile community. Currently, this work is done by the Technology Transfer Division (TTD) of Institute and Business Planning Development Unit (BPDU).


CIRCOT calibration cotton

A market analysis showed that lack of general awareness among the potential entrepreneurs in both rural and urban areas has hindered business growth of cotton based by-products like cotton stalk, cottonseed, cotton protein and linters. Only the cotton fibre and cottonseed based technologies and products have shown significant business growth. CIRCOT has been active in developing technologies in the areas of mechanical processing, quality evaluation and improvement, chemical and bio-chemical processing and by-product usage of cotton. CIRCOT has implemented IPR guidelines of ICAR, and has various initiatives like ITMU, ITMC, ZITMC and ZTMC in place to promote intellectual property protection and technology commercialization. The objective of protecting intellectual property is to encourage in creating valuable ideas and to promote their commercialization. Understanding this, CIRCOT has filed 55 patents out of which so far 13 have already been granted rights.

There are three broad channels for the technology commercialization: (a) Selling or assigning ownership of the technology to an existing company, (b) Licensing the technology to an existing company, and (c) Starting a new company. The widely used commercialization strategy in CIRCOT is licensing of technology. However, starting a new company using CIRCOT technologies may be the future endeavour, as an increased interest is shown by budding entrepreneurs. Besides, setting up science and technology parks with governmental support preferably in a PPP mode to reduce the risk of such start-up companies by providing support like pilot plants and other resources would also be the cause of business development.

CIRCOT : A SWOT Analysis

Strengths

CIRCOT is the pioneer and the only institute in the country actively involved in all postharvest processing of cotton. It acts as a bridge between the cotton producer and consumer. The institute is well equipped with world-class facilities and in 2005, with funding from NATP under the Team of Excellence (TOE) mode became *a Referral Laboratory on Cotton Textiles*, the first one of its kind in the world. Newer facilities have been added under the six NAIP projects currently in operation at the institute. It has well qualified and trained scientific and technical staff and is accredited by NABL. It is also approved as Nodal Agency for developing certified reference materials on cotton and its allied products. Trade and industry look upon this Institute as the primary agency for promoting Indian cotton across the globe.

Weaknesses

Among the foremost weakness is inadequate scientific personnel and lack of space. As the institute is 87-year old, some of the equipment and facilities are old which need to be replaced with the state of the art equipment to keep pace with the changing scenario. Interaction with textile industry is not to the desired extent.

Opportunities

CIRCOT is internationally and nationally, a unique institution – can keep the Indian flag flying high in cotton technology area. Cotton is the preferred clothing material due to its inherent comfort properties. The opening of world markets and subsequent building up of capacity by the Indian textile industry increased domestic consumption and export of cotton, the country being the second largest producer, consumer and exporter of the raw material have all conferred to provide ample opportunities for research and development.

Technical textiles is an emerging field which offers good scope for value addition and cotton can be successfully used for many such applications. Cheaper natural fibres such as banana, coconut and others can also be used for these applications along with cotton by blending or using modern technologies such as DREF thereby reducing the production costs. Nanotechnology and smart textiles also offer good scope for value addition.

Environmental considerations are today at the forefront. Polluting dyeing industries are being ordered to close down. CIRCOT has already begun work on environment friendly processing and dyeing technologies. Research work on application and refinement of nascent water saving technologies such as plasma and supercritical carbon dioxide in textile processing will help in drastically reducing the water requirement and the pollution load.

By-products of cotton plant have not been fully exploited for farmers' benefit. This area offers many opportunities for the Institute to grow and excel. The institute can offer its expertise in ginning and other fields to act as consultant and train personnel from African countries where cotton cultivation is now getting more attention.

Threats

Rapid depletion of scientific personnel in the past 5 years because of superannuation, and fewer recruitment has created an alarming situation so far as the availability of trained scientific manpower is concerned. Further many useful disciplines concerning the institute have been kept out of purview of ARS examination. Hiring of scientific staff on contract basis and reemploying retired scientists may help tide over the situation. The ICAR should draw up a positive policy for recruitment of scientists, more specifically belonging to basic science disciplines.

CIRCOT 2030

ESTABLISHED in the year 1924, as the Technological Laboratory of the Indian Council of Cotton Committee (ICCC), the institute is 87 years old. ICAR took over in 1966 and renamed it as Cotton Technological Research Laboratory (CTRL). The name was changed to the Central Institute for Research on Cotton Technology (CIRCOT) on the 1st April of 1991.

CIRCOT has its research divisions and administrative sections housed in four separate buildings in its premises in Central Mumbai. There are four divisions in the Institute: Quality Evaluation and Improvement Division (QEID), Mechanical Processing Division (MPD), Chemical and Biochemical Processing Division (CBPD) and Technology Transfer Division (TTD). The institute has five regional units in various cotton growing states in the country and a Ginning Training Centre at Nagpur. An up-to-date library of books and journals on Cotton, Cotton Technology and Basic Sciences is maintained at the institute. Besides, ASTM, British and ISO-Standards are available in the library.

Vision

Cotton Technology for Prosperity, Environment and Security.

Mission

To provide scientific and managerial interventions to postharvest processing and value addition to cotton and other natural fibres and utilization of their by-products to maximize economic, environmental and social benefits to farmer and all other stakeholders.

Objectives

- To develop new technologies and machinery for better utilization of cotton and other textile fibres by carrying out basic, applied, strategic and anticipatory research in postharvest technology.
- To extend effective technological support for improvement of quality of Indian cottons and cotton products.
- To act as nodal centre for diversified utilisation of cotton plant by-products and processing waste and other crop residues.

- To provide services like training, education and consultancy to textile industry, Government and private agencies and to function as a referral laboratory for textile testing.

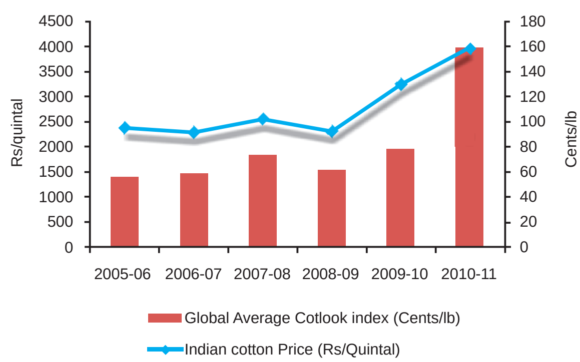
Function

To function as a centre of excellence in R & D and as a technology provider for processing and value addition of cotton and other related natural fibres, their blends and by-products; to act as an interface between cotton breeder and industry by providing technology support to both; to function as an accredited referral laboratory for textile testing, and to provide need based training and entrepreneurship development programmes to all the stakeholders in the cotton value chain.

Volatile trend in cotton price

FROM a long slumber, the cotton prices have jumped up significantly in recent years. International cotton price has increased by 131% during January 2010 to 2011 period, followed by a drop of 28% between March to June 2011. The trend in cotton price shown in the figure below brings out this fact clearly.

Last year, untimely rains and inclement weather lowered the cotton production and made the prices more volatile. Effect of high cotton price may be mitigated by research on blending cotton with other natural fibres including man-made fibres and using high-end spinning technology to use cotton optimally with other fibres. For the same, more natural fibres from other agricultural sources need to be scientifically extracted and made amenable for processing with cotton. There is a need for extensive research in this area. Besides, cotton needs to be processed with superior technology, with higher production speed for producing value added product through nonwovens. Newly emerging technologies like nano and plasma can be exploited to improve the functional finish of cotton textile for better value realization.



Increasing trend in organic cotton production

Globally, the organic cotton production has increased by 54% in the last five years. Currently, it is about 2,41,276 metric ton over a cultivated area of 1.14 million acres. It represents 1.1% of global cotton production and engages 23 nations in the cultivation. India is the largest organic cotton producing nation commanding 80% of total world production, with a growth rate of 37% year on year. The production cost for organic cotton cultivation is 20-30% lower compared to conventional cotton, but with more consistent yield that increases with time. In ecological benefits, organic cotton cultivation has shown to improve microflora, restore fertility and successfully manage insecticide resistance, while reducing health and environmental risks of contamination. Given the leading position India has internationally, it is important to promote and increase production of organic cotton on a large-scale. It needs to integrate production, certification and processing of organic cotton. There is a lack of coordination among farmers, processors, marketers and certifying bodies at present.

Despite the prominent position for organic cotton in the country; as 85% of the area is under Bt cultivation, organic cotton exports have been receiving setbacks due to alleged contamination. A serious research effort is needed to identify contaminant fibres in organic cotton to improve its quality and export performance.

Low awareness on farm level seed cotton cleaning and lack of suitable equipment

There is a lack of scientific management practices both on-and-off farm for seed cotton-picking, storage and transport to ginneries and market yards to reduce trash and avoid contamination. The cleaning at farm level is necessary for dual-purpose. First, large trash ingredients such as burrs, bracts and branches must be removed from the seed cotton before they are broken up and get embedded in the cotton. This will aid the gin stand to be worked at peak efficiency and without excessive downtime. Second, seed cotton cleaning is often necessary to obtain optimum grades and market values. At present in India, even though cotton picking is done manually, the seed cotton contains good amount of foreign matter. So, it is necessary to develop suitable equipment to aid farmers in cotton cleaning at the farm itself to increase the saleability of his product. Due to inadequate availability of labour in future, the mechanical harvesting of cotton may be a reality in India leading to increase in trash in the picked cotton. Therefore, there is a need for anticipatory research on development of suitable cleaning machines preferably to be operated on farm/near farm for mechanically harvested cotton.

Absence of Quality Based Cotton Marketing

The cotton crop in India is grown on a massive area that encompasses diverse agro-climatic zones; from arid to semi-arid to high rainfall areas. At present, cotton is sold based on the subjective assessment of quality by the collection agents. An effective quality based marketing using fibre data obtained from instrumental testing will provide the farmer a good price for his product. The goal of objective quality based cotton marketing is to provide cotton producers with remunerative prices for their cotton. It may need institution of a quality based marketing, which may include testing of cotton at the collection centre, storing and supply data of fibre from a central server, electronic trading, crop contracting, etc.

Non-availability of enough cotton sliver/yarn as raw material for village industries

In the villages, cotton yarns are used by small-scale cottage industries for making products like towel, lungi, children garments and so on. Such small-scale cottage industries are run by individual farmers and cooperative bodies. There is a great demand for cotton yarn by these industries within the village itself. However, these industries always face short supply of yarn. Thus, there is an urgent need to enhance and ensure availability of cotton yarn in the village itself on regular basis and at an affordable price. Traditional equipment for village level sliver/yarn production is cumbersome, less productive and often results in an uneven yarn. Therefore, an accelerated research thrust is needed for the development of improved mechanized low-cost spinning machines for village level operation which would yield good quality of sliver and yarn, ensuring regular supply for the village industries.

CIRCOT's sliver making machine

Non-standardized and Low Productive Ginning Machines

Earlier, the sole purpose of cotton ginning was only to separate fibres from seed. But today's modern cotton ginning is required to do pre and post cleaning; to convert the harvested cotton into a saleable package for commerce. The cotton gin produces two products, with cash value that is the fibre and the cotton seed. The latter is usually sold to oil mills for conversion into several important and valuable products. However, the design and operation of cotton gins are usually oriented towards fibre production. In essence, the modern cotton gin should be energy efficient, more productive and should increase the value of the cotton by separating the fibre from seed and by removing objectionable foreign matter. Therefore, ginning technologies have become important for producing good quality fibre for the textile industry, which will ensure better returns to farmers. At present, Indian gins are non-standardized, low productive and less energy efficient, requiring R & D interventions. Also, material handling, health and safety of worker during ginning machine operation are to be kept in mind while designing new machines.

Increasing Spinning Machine Speeds demand good quality fibre

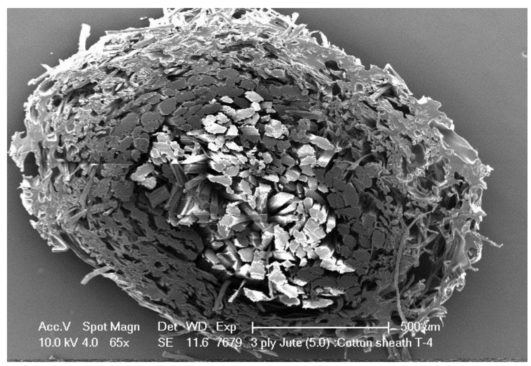
The state of the art spinning machines are equipped with automation, online quality control, inverter drive and so on, which all lead to higher speed and efficiency, lesser downtime and higher yarn productivity. Latest ring frames run at 20000 rpm with productivity of 120 gm of yarn per spindle. These spinning machines demand high quality of cotton fibre in terms of low short fibre content, good micronaire and high strength. The order of quality preference will depend on the spinning system to be used for production of a particular yarn and end use of the product. While the fibre length of Indian cotton is all right, improvement is needed in the other quality features, particularly in fibre strength, uniformity in attributes in the same lot of cotton. Improvement in Indian cotton fibre quality is also needed to produce niche fabric. Besides, there is an urgent need to concentrate on the improvement of fibre micronaire, strength and short fibre content in the cotton improvement programme run by the ICAR.

Adoption of New Spinning System

Adoption of high-speed rotor spinning and compact spinning in India is steadily increasing. While rotor spinning can handle significantly lower grade cotton for production of coarser yarn, compact system can spin a bit lower grade cotton into a medium to fine count yarn compared to those spun by the existing ring frame. The open-end rotor spinning system provides three-fold increase in yarn production with saving in power even when using a low-grade cotton fibre. The latest DREF spinning can make many kinds of multicomponent yarns. Adoption of new spinning system for better economy of the cotton spinning sector needs to be given priority.

Use of technical textile is increasing in India

The technical textiles industry has a vast potential to grow and excel in a developing economy. India has a clear chance to emerge as a key player in the technical textiles industry with its vast natural resources. India currently consumes the products under all 12 categories of technical textiles, though not all of them are produced domestically. India is a large producer of products in Packtech, Clothtech, Hometech and Sportech segments of technical textiles. The technical textile industry is an import intensive industry. Many products like baby diapers, adult diapers, spunbond fabric for disposables, wipes, protective clothing, hoses, and webbings for seat belts are imported to a large extent. The current market size of technical textile in India is estimated at Rs 41,756 crores. The overall technical textile industry in India is expected to grow at the rate of 11% year on year in the coming years. The current technical textile consumption in India is estimated at Rs 38,835 crores which is expected to increase to Rs 65,722 crores by the year 2012-13. Thus, there is a good opportunity to explore various natural fibres in technical textiles for different industrial and value added applications. At present, there is a low R & D investment, lack in innovation and skilled manpower in this sector.



SEM of cotton covered jute

Environmental Issues in Cotton Textiles

The major environmental issues in cotton textile sector are: high-energy consumption, use of toxic chemicals, chemical discharge in water creating water pollution and generation of solid waste. The textile sector is being constantly condemned as being one of the world's worst offenders of pollution. As many as 2,000 different chemicals are used in the textile industry, from dyes to transfer agent. Water, which is a finite and quickly depleting resource, is used at every step of the processing both to convey and fix chemicals on to the textile substrates and to wash the excess chemicals into the discharge. The water with full of chemical additives is then expelled as waste. So, it is the need of the hour to develop environmentally appealing technologies.

Occupational Hazards

The major occupational hazards in cotton sector are due to use of unsafe chemicals, generation of fibre dust, vibration and noise, and monotonous repetitious processes. The major problems associated with dust are respiratory problems that include byssinosis, bronchitis and bronchial asthma. The problems are highly prevalent in mills of developing countries like India. Noise induced deafness, liver failure, occupational skin diseases and respiratory disorders were found to be some of the common ailments in textile clusters. Increasing incidence of cardiac failure among workers owing to inhaling of gases/smoke containing carbondisulphide for prolonged period too is a major cause for concern. More effort could be directed at providing an environment more conducive to the general worker's health. Research efforts need to be directed to device efficient dust collection equipment, treatment of dust prior to release, etc. There is a need for design and development of new processes and equipment that are free from occupational hazards.

Lack of Reliable Study on Carbon Footprint of Textile Value Chain

Climate change is one of the main challenges facing our society today. Industries, scientists, politicians and society are called on to halt rising emissions of greenhouse gases and make more efficient use of existing resources. In terms of its output, export and employment, the cotton industry is one of the largest industries in the world, and its impact on greenhouse gas emissions and climate change is significant. However, measurement of carbon footprint of textile value chain is ambiguous because of its complex nature and requires a reliable study. The carbon footprint of a cotton textile should measure how much carbon dioxide and other greenhouse gases are produced during the entire life cycle of a textile starting from cotton cultivation to production of textile, its life cycle and dispensation. A rough estimate has showed that a T-shirt produced in Asia, has an average carbon footprint of six kilogram CO_2 from farming through manufacturing and transport to the shop - 20 times more than the net weight of a T-shirt. At the same time, the environment benefits of natural fibre *vis-à-vis* synthetic fibre used for the same end product are to be borne in mind. An exhaustive R & D study is needed to find out carbon footprints of both natural and synthetic fibres.

Collaborating with partners that are competent as well as committed to environmental protection is essential for performing such a programme. All parties can benefit from sharing ideas and experiences to identify suitable strategies for tackling carbon emissions.

Slow Entrepreneurial Development in Cotton Textiles

Cotton industry is capital-intensive; especially the machinery cost is very high. Shrinking profit margins owing to rising yarn and cotton prices in recent years are slowing down the entrepreneurial development in cotton textiles. Energy and power are also some of the major challenges for developing economies like India, which further increase the manufacturing cost. There is lack of coordination among fibre producers, spinners, weaving and processing industries in the value chain causing market speculations on demand-supply scenario, and thereby making it further difficult for the small and medium entrepreneurs to compete in the international market. This causes slow entrepreneurial development in this sector.

Low Skilled/Unskilled Migrant Labourers, Mainly Women with Low Wages

The industry sector mainly employs low skilled and unskilled migrant labours. Lack of education and qualification force them to work at low wage rate, especially for women from rural areas. There is need for skill development of such workers to improve their performance, and living standard.

IPR (Intellectual Property Rights) on research and development

Intellectual property rights (IPR) include the independent IP rights that can be collectively used for protecting an inventive work. It may be in the form of Patents, Copyrights, Trademarks, Registered (industrial) design, Protection of IC layout design, Geographical indications, and Protection of undisclosed information. IPR is widely recognized as one of the most important instruments for promoting the economic, social and cultural development of every nation in the world with sustainability. IPR has become important in the face of changing trade environment characterized by global competition, high innovation risks, short product cycle, rapid changes in technology, high investments in R&D, production and marketing, and need for skilled manpower. IPR awareness and management for innovations in cotton textiles need to be made as a continuous and regular activity particularly among researchers.

Strategic Framework

Goal	Approach	Performance Measure
Improve cleanliness and quality of seed cotton and cotton by-products	• Demonstration of clean cotton-picking, on-farm storage and transport practices • On-farm cleaning of trashy seed cotton • Strengthening cotton stalk supply chain for value addition and its demonstration	Availability of clean, high quality seed cotton and cotton by-products for industrial applications
An efficient ginning and improved quality of lint from Indian cotton	• Improved ginning machinery and material handling to increase productivity, energy efficiency and safety for the ginnery workers • Norms for ginning machinery for incorporation as BIS standard	Efficient, high productive ginning machines and improved cotton lint. BIS accredited ginning machines
Characterization of Cotton and other Natural Fibres, Yarns and Textiles	• Improved quality norm based technological support to AICCIP • Development of a model on-line objective cotton fibre quality information system for market adoption • Development of an objective hand and wear comfort grading system (Moisture, heat transfer, feel) for tropical climate	Development and sourcing of quality cotton and textiles Availability of objective measurement of comfort characteristics of cotton fabrics
Use of natural fibres in technical textiles and composites	• Development of suitable machinery for extraction, cleaning and segregation of hard natural fibres • Natural fibre-based technical textiles for agricultural and medical applications • Development of natural fibre reinforced composites • Design and development of smart textiles • Comprehensivew utilisation of natural fibres for value-added products	Technologies and products incorporating natural fibres for industrial and functional uses.

Eco-friendly textile finishing technologies incorporating efficient water and energy use	• Processing and functional finishing of cotton and blended textiles using eco-friendly agents including nanomaterials and effluent treatment • Use of plasma and supercritical carbon dioxide technologies for conservation of water and energy • Treatment of effluents • Study on carbon foot-print of cotton textiles	Availability of Eco-friendly and efficient processing methods for cotton and blended textiles
Value addition to Cotton Biomass and By-products	• Accelerated composting of cotton biomass • Bio-mechanical process for preparation of lignocellulose in nano-form for application as fillers in composites • Integration of different processes for production of gossypol-free cottonseed meal for feed and food • Development of energy efficient delinting machines • Development of packaging materials from crop residues and horticulture wastes	Value added and economical products from cotton by-products and biomass
Entrepreneurship in Cotton Technologies and Human Resource Development	• A six-month certificate course in ginning and quality assessment • Customized training programmes in Roller ginning, cotton quality evaluation and by-product utilization • On-site contact programs for popularization of CIRCOT services and technologies • Organizing Industry-Interface meets and awareness programmes • Consultancy and organisation of Training Programmes for African countries	Newer enterprises based on various newly developed technologies and creation of trained human resource

Epilogue

THE Central Institute for Research on Cotton Technology (CIRCOT) is one of the premier constituent institutes of the ICAR, and one of its kind in the world conducting R & D on utilization of every part of the cotton plant. It has been providing continuous technological support to the country's cotton breeding programme and also, testing service to the trade and industry. The institute is engaged in developing new technologies and machinery for better utilization of cotton and other textile fibres by carrying out basic, applied, strategic and anticipatory research in postharvest technology. The institute has carried out pioneering work on cotton crop residue, value addition to cotton process waste, mechanical processing of cotton, development of industrial yarn and fabric by using natural and synthetic fibre blends and environment friendly chemical finishes for cotton. Calibration cotton is one of the hallmarks of these developments.

In this VISION-2030 document, CIRCOT has critically focused its perspective for the coming two decades for providing machines for farm-level cotton cleaning anticipating mechanization of cotton picking, high productive standardized ginning system, minimizing handling and processing losses, augmenting quality of cotton as an engineered industrial raw material, strengthening cotton stalk supply chain for value addition and initiating new R & D on application of cotton in high value technical textiles and in reinforced composites. The institute will continue and strengthen its support to cotton breeding programme with thrust on development of high strength varieties to best suit the ever-increasing speeds of spinning and fabric forming. CIRCOT needs to carry out a multi-pronged research intervention to develop energy efficient fibre extraction and processing machines, techniques to conserve chemical energy and water in chemical and bio-chemical processes, minimize effluent and solid waste, in order to make cotton and other natural fibres as most sought after industrial raw material for varied applications. It needs to accelerate, transfer and commercialization of technologies with appropriate human resource development. It is hoped that CIRCOT Vision-2030 would provide science and engineering led direction to cotton postharvest sector leading to improved livelihood opportunities, profitability and sustainability for cotton farmers and all other stakeholders in the cotton value chain.