VISION 2025

CIRCOT
PERSPECTIVE PLAN

Central Institute for Research on Cotton Technology
(Indian Council of Agricultural Research)
Adenwala Road, Matunga, Mumbai-400 019

July 2007

FOREWORD

Indian agriculture must continuously evolve to remain ever responsive to manage the change and to meet the growing and diversified needs of different stakeholders in the entire production to consumption chain. In order to capitalize on the opportunities and to convert weaknesses into opportunities, we at the ICAR attempted to visualize an alternate agricultural scenario from present to twenty years hence. In this endeavour, an in-depth analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT) was undertaken to place our research arid technology development efforts in perspective so that we succeed in our pursuit of doing better than the best. Accordingly, the researchable issues are identified, strategies drawn and programmes indicated to have commensurate projects and relevant activities coinciding with the launch of the 11th Five Year Plan.

Central Institute for Research on Cotton Technology, Mumbai has focused its perspective to minimize handling and processing losses and improve quality pf cotton as raw material. It has taken into account the growing consumer preference towards eco-friendly natural raw materials, higr-I speed processing and green finishing, continuously changing garment fashion trends accentuated by developments in modern technologies and utilization of agro-residues aqd processing by-products in designing its R&D agenda. The challenges posed by the" man-made fibres and the need to provide clothing to a growing population of the country, that is expected to touch the 1.5 billion mark by 2025, have been the guiding factors for envisaging the programmes and activities. The institute attempts to begin by ensuring the picking of seed cotton, its handling and transport so as to minimize trash content. The next level of activities deal with the modernization of ginneries for higher performance combined with economy and quality. The institute will continue to support the cotton breeding programme through quality evaluation activities. Development and use of state-of-art technologies for production of yarn, fabrics, composites and technical textiles has been envisaged. Utilization of crop residues and processing byproducts form an integral part of the institute's activities. The mission of the institute is to provide the science and engineering support to tl1e ., cotton post harvest sector leading to the enhancement of livelihood opportunities and the profitability of cotton producers and processors.

It is expected that realization of the Vision embodied in the document would ensure that the 'CIRCOT, Mumbai continues to fulfill its mandate and make Indian agriculture locally, regionally and globally competitive. The efforts and valuable inputs provided by my colleagues at the ICAR Headquarters and by the Director and his team at the institute level for over an year to develop Vision 2025 deserve appreciation. it is hoped that the implementation of the programmes mentioned in the document will go a long way to strengthen agriculture sector in the country.

Secretary,
Department *of* Agricultural Research & Education and
Director General,
Indian Council of Agricultural Research,
Dr. Rajendra Prasad Road, Krishi Bhawan,

New Delhi 110001,
India

February 2007

PREFACE

The revolutionary changes in economic and trade laws that swept across the globe by the end of the last millennium and the liberalization of Indian economy have had their impact on the agricultural and industrial activity in the country. Coupled with this, the sudden explosion in information technology and development of agricultural biotechnology and nanotechnology in the recent past have strengthened the perception of agriculture as a means of entrepreneurship development and business promotion rather than as a source of subsistence. The World Bank assisted National Agricultural Technology programme successfully carried out in the recent past and the vision of ICAR have made a strong case in favour of public-private partnership in agricultural research and in commercialisation of technologies.

Under these changed circumstances it has become necessary to revisit Vision 2020 document prepared earlier by the Institutes and look at the priorities and programmes afresh with an outlook for 2025. The perspective plan documents are expected to give a broad outline of the research agenda for the coming 20 years taking into account the past performance, success and failures with a reoriented research agenda in tune with the future outlook both at the domestic and global level. The first draft of the perspective plan Vision 2025 was prepared almost two years ago. Subsequently it has been discussed at the Research Advisory Committee and Management Committee and modified accordingly with the inputs received from the hon'ble members. A peer review team both at the Institute level as well as at ICAR had after scrutiny made suggestions for improvement. Those suggestions have been duly incorporated in the final version of the perspective plan document of CIRCOT.

The Vision 2025 document has been prepared strictly in accordance with the format suggested by the Council. The Preamble in the first section discusses in brief the background for the preparation of the perspective plan and the scope of the document with a clear vision and mission statement. The Institute's mandates have been suitably modified taking into account the wider canvas under which CIRCOT operates in recent times. In the third section the infrastructure facilities available at CIRCOT are discussed. Under section 4 the highlights of the past achievements in research along with technologies developed have been presented.

An impact assessment of the technologies so far commercialized by the Institute has been carried out and this introspective assessment is discussed in the 5th section of the document. Efforts have been made to have a futuristic look at textiles both in the domestic and global context and the likely scenario at 2025 is presented in unit 6. Section 6 also contains a brief discussion on the SWOT analysis of the cotton sector as well as CIRCOT. Section 7 in the document brings out the perspective areas in which CIRCOT's research programmes would be conducted for the period upto 2025. The relevant issues bringing out the perspectives and the strategies to tackle them are delineated under section 8 entitled –Issues and Strategies‖. Section 9 is devoted to discussing the research

and related activities of CIRCOT and the projects that would be undertaken in the coming 20 years both in a short term mode as well as those for long term implementation.

Under section 10 the likely linkages and coordination arrangements for executing the proposed research and technology transfer programmes are illustrated. The highlights of the financial requirements as well as human resource needs are brought out under section 11 while an objective risk analysis is presented under section 12. The project review arrangements are spelt out in section 13.

The current emphasis by the Council on resource generation calls for special efforts. The resource generation of CIRCOT during the last seven years is presented along with future commitment by the Institute under section 14. A realistic picture of both output and outcome is presented in the sections 15 and 16. What follows in Section 17 is a summary of future course of action in a nutshell.

It is heartening to mention here that action on many of the proposals drafted in the document has already been initiated at the Institute level even as the Vision document was getting ready. Now that CIRCOT's perspective plan is ready, with the active participation of a dedicated team of researchers and with the coordination from all categories of staff, the envisaged progammes would be carried out in letter and spirit by the Institute. All out efforts at the Institute level would be taken to see that the total implementation of the perspective plan takes place as we move along.

S. Sreenivasan
Director

ACKNOWLEDGEMENTS

We sincerely thank Dr. Mangala Rai, Secretary, DARE and Director General, ICAR who has been a guiding force behind the preparation of the VISION – 2025 Document of CIRCOT. Constructive suggestions with regard to research priorities and programmes received from Dr. Nawab Ali, Deputy Director General (Engg.) and Dr. Pitam Chandra, Assistant Director General (PE) are gratefully acknowledged.

Suggestions received from the members of the Research Advisory Group chaired by Dr. P.R. Roy have been duly incorporated in the document. Our grateful thanks to the RAC team for their contribution in shaping this document.

The draft document was prepared by a Committee consisting of Dr. K.M. Paralikar, Head, Transfer of Technology Division, Dr. R.H. Balasubramanya, Head, Chemical & Biochemical Processing Division, Dr. R.P. Nachane, Head, Quality Evaluation and Improvement Division, Shri Muntazir Ahmed, Head, Mechanical Processing Division, Dr. G.F.S. Hussain, Principal scientist, Dr. P.V. Varadarajan, Principal Scientist, Dr. A.J. Shaikh, Principal Scientist, Dr. S.K. Chattopadhyay, Senior Scientist and Shri V.B. Suryanarayanan, Technical Officer T-7-8. I sincerely thank each one of them in particular and also the entire technical and scientific staff of CIRCOT for their hard work in preparing the document.

My heartfelt thanks to Shri M. Mohan, for the computer support, Smt. Viniya Nayak, Smt. U.N. Bhandari and Smt. R.R. Tawde for typing assistance and Shri V. Murugan for the help rendered in photocopying and binding.

THANKS !

S. Sreenivasan
Director
CIRCOT

ABBREVIATIONS USED

AICCIP	All India Coordinated Cotton Improvement Project
CCI	Cotton Corporation of India, Mumbai
CDOCT	Centre for Development of Coir Technology, Trivandrum
CFC	Common Fund for Commodities, Netherlands
CIAE	Central Institute for Agricultural Engineering, Bhopal
CICR	Central Institute for Cotton Research, Nagpur
CPCRI	Central Plantation Crops Research Institute, Kasaragod
CPPRI	Central Pulp & Paper Research Institute, Dehradun
CRIJAF	Central Research Institute for Jute and Allied Fibres, Barrackpore
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
CSTRI	Central Sericultural Research and Training Institute, Bangalore
CSWRI	Central Sheep and Wool Research Institute, Avikanagar
DBT	Department of Biotechnology, New Delhi
DST	Department of Science and Technology, New Delhi
EICA	East India Cotton Association Ltd., Mumbai
FAO	Food and Agriculture Organisation
GTC	Ginning Training Centre of CIRCOT, Nagpur
IIT	Indian Institute of Technology, New Delhi
IJT	Institute of Jute Technology, Kolkatta
NAARM	National Academy for Agriculture Research Management, Hyderabad
NATP	National Agricultural Technology Project, ICAR, New Delhi
NCDEX	National Commodity & Derivatives Exchange, Mumbai
NDDB	National Dairy Development Board, Anand
NIFT	National Institute of Fashion Technology, Mumbai
NIRJAFT	National Institute for Research on Jute and Allied Fibre Technology, Kolkatta
NRCB	National Research Centre for Banana, Trichy
SASMIRA	Silk and Art Silk Mills' Industries Research Association, Mumbai
SAUs	State Agricultural Universities
TMC	Technology Mission on Cotton
TRAs	Textile Research Associations
UICT	University Institute of Chemical Technology, Mumbai
UNDP	United Nations Development Project
USDA	United State Department of Agriculture
VJTI	Veermata Jeejabai Technical Institute, Mumbai

EXECUTIVE SUMMARY

The Revised Perspective Plan Document of CIRCOT envisions the programme of work for the Institute in various frontier areas of textile research during the coming twenty years. The activity plans are chalked out on the basis of past accomplishments, failures and lessons learnt during the IX and X Plan periods. The future thrusts for the years up to 2025 AD are discussed in detail in the document.

CIRCOT, which was established in the year 1924, has its research and administrative sections housed in four separate buildings in its premises in Central Mumbai. The Institute has six Regional Units in various cotton growing states in the country and a Ginning Training Centre at Nagpur.

Taking into consideration the changes that have been taking place in cotton research at the national and global levels, the emergence of new areas of research and the policy changes being planned at the Council level on research priorities, the Mandate of the Institute has been proposed to be suitably modified, by providing a wide canvas for research on other textile fibres and also utilisation of other crop residues apart from cotton.

Salient research achievements under different core areas during the IX and X Plan periods have been detailed. These include development of Laboratory Model Gins of various input capacities ranging from 1kg seed cotton to 50 kg seed cotton/hr, Variable Speed Double Roller Gin that is incapable of yielding 70%-100% more ginned lint per hour compared to conventional DR gins and development and evaluation of a heap making machine.

In the Core Area II *viz.* Improvement and Quality Evaluation of Fibres, Yarns and Fabrics, the achievements include fabrication of an instrument for measuring moisture vapour transport through fabrics, development of variety-wise relationship between Micronaire value and degree of thickening of the secondary cell wall in cotton Fibres to arrive at the true maturity, defining a maturity index for cotton Fibres based on their flexural rigidity, etc. A banana pseudo stem fiber extractor *cum* cleaner has been developed for obtaining cleaned good quality banana Fibres. An operator friendly, state-of-the-art miniature spinning system has been developed to assess the spinning potential of small samples. Several newer fabrics were prepared by blending in the cotton system cotton with other natural Fibres like ramie, jute, Angora rabbit hair, short and fine Indian wool, etc.

Under eco friendly wet processing and finishing, the institute has developed a process for bio scouring of cotton and blended fabrics that requires less energy and also less polluting. An eco-friendly method for extraction of natural dyes from safflower petals has been developed. During the year under report, utilizing a novel technique nanoparticles of silver and zinc have been produced and applied to textiles to impart anti microbial and UV protection properties.

A one tonne per day particle board demonstration plant based on cotton plant stalks has been installed and commissioned under the CFC funded project. To utilize the ginnery waste, a technology for producing compost from this waste has been developed. Several machines varying in capacity have been fabricated to compact cotton stalks for easy transportation from the field. Several patents were also filed on processes and instruments developed at CIRCOT.

The impact of CIRCOT's activities as well as that of the technologies developed has been summarized. Lessons learnt from the past activities have been taken into consideration while formulating the future programmes. The textile scenario – global vis-à-vis Indian context has been discussed in detail. A thorough SWOT Analysis of CIRCOT has been carried out leading to the future vision of the Institute.

Different issues that need to be addressed such as technological upgradation of Indian cottons, quality of ginning and of ginned cotton, gaps in post harvest technology, changes in chemical processing, utilization of cotton plant by-products and other crop residues, microbiological approach to eco-friendly processes, pilot plant projects for technologies developed, generation and dissemination of technical information, etc. and the strategies to tackle them have been outlined. Based upon this, different thrust areas have been identified and a list of basic, strategic and anticipatory research activities in the area of agricultural engineering that are relevant to CIRCOT have been delineated.

Taking into consideration the priorities in cotton research, CIRCOT in the coming years will address the following issues of national importance :

Quality assessment of new cotton varieties to facilitate the breeders and to provide quality material to the industry as per the requirement

Creation of data bank on the technological attributes of cotton germplasm

Objective grading of cotton for trade

Fibre attributes based marketing of lint instead of seed cotton

Development of ginning machinery and post-harvest handling of seed cotton

Production of composite and technical textiles for various end uses

Diversified use of natural and manmade fibres for blending with cotton

Standard test methods for knits

Development of cotton based non-wovens

Development of fabric handle values specific to tropical conditions

Ecofriendly and user friendly wet processing technologies for cotton and blended textiles

Utilisation of cotton by-products and crop residues for value added products

Research and skill oriented Human Resource Development

Technology marketing and revenue generation

Based on the above perspective a number of programmes have been planned during the coming years. Some of the critical areas needing human resource development have been identified and it is proposed provide the training at appropriate national and international organizations. Linkages with various public and private organizations have been enlisted.

Resource generation is proposed to be achieved through the following activities :

Commercial testing of textiles
Training programmes in cotton quality evaluation, gin maintenance and training on sophisticated testing instruments
Sale of technologies developed at CIRCOT
Contract research
Consultancy for setting up testing and ginning units
Research projects under revolving fund scheme of ICAR

CIRCOT would strive in coming years to generate about 20% of its total budget through the above activities.

The implementation of the above mentioned programmes would require additional resources as indicated below :

Personnel Available and Future needs

Category	**Sanctioned**	**Additional Requirement**
Scientific	50	5
Technical	114	11
Administrative	48	2
Supporting	68	-

Funds

Estimated Budget for Next two Five Year Plans

Rs. in Lakhs

Expenses	X Plan	XI Plan	XII Plan
Recurring	502.66	800	1200
Non Recurring	776.27	1600	2000
Total	1278.93	2400	3200

CONTENTS

1. Preamble

Established in the year 1924 as Technological Laboratory of Indian Central Cotton Committee (ICCC), the Institute is 83 years old. ICAR took over in 1966 and renamed as Cotton Technological Research Laboratory. The name was changed to Central Institute for Research on Cotton Technology on 1-4-1991.

Liberalisation of country's economy and GATT agreement has necessitated changes in research and managerial priorities. The modifications have been built up against the backdrop of India's current cotton scenario. Past failures, if any, have been critically examined to identify risks and pitfalls in the planning. The strengths of the Institute based upon the achievements of the last 10 years and the future challenges have been analysed and the research programmes have been planned for the period upto 2025.

The Perspective Plan document for CIRCOT is the product of a group effort in which most of the scientists and technical staff of the Institute had participated with remarkable zeal. Protracted discussions, both intra- and inter-divisional, held at CIRCOT on many occasions have served to make the document a true reflection of everyone's vision of what the Institute should strive to achieve in the years to come.

While preparing the Perspective Plan document, the activities and achievements of the Institute during the IX and X Plan periods have been used as the backdrop for building future programmes. The vision document of CIRCOT is presented as per the format received from the Council.

1.1. Vision

CIRCOT's Vision for the future is to retain through innovative strategies the pride of place for cotton and other natural fibres with their by-products as prime raw materials for clothing and other industrial needs to co-exist with man made fibres.

1.2. Mission

To provide a holistic scientific and managerial intervention to post harvest processing and value addition to cotton and other natural fibres and utilisation of their by-products to maximize economic, environmental and societal benefits.

2.
Mandate

Mandate – Current

To participate in cotton improvement research by evaluating the quality of new strains evolved by agricultural scientists in India and giving them the necessary technological inputs to produce cottons meeting the quality requirements of textile industry.

To undertake basic and applied research in post harvest technology for improving quality of cotton fibres and finished products.

To maintain an update of quality and performance of different varieties of cotton and by-products as well as of other ligno-cellulosic materials.

To undertake commercial testing of textile materials for the benefit of trade, industry and Government agencies and to provide consultancy services.

To develop new technologies for utilization of cotton, cotton plant, agricultural and industrial processing wastes and strive for commercial exploitation of such technologies.

To function as a national centre for education and training in cotton technology and related areas.

Mandate – Proposed

- 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 post harvest 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 & 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.

3.
Growth

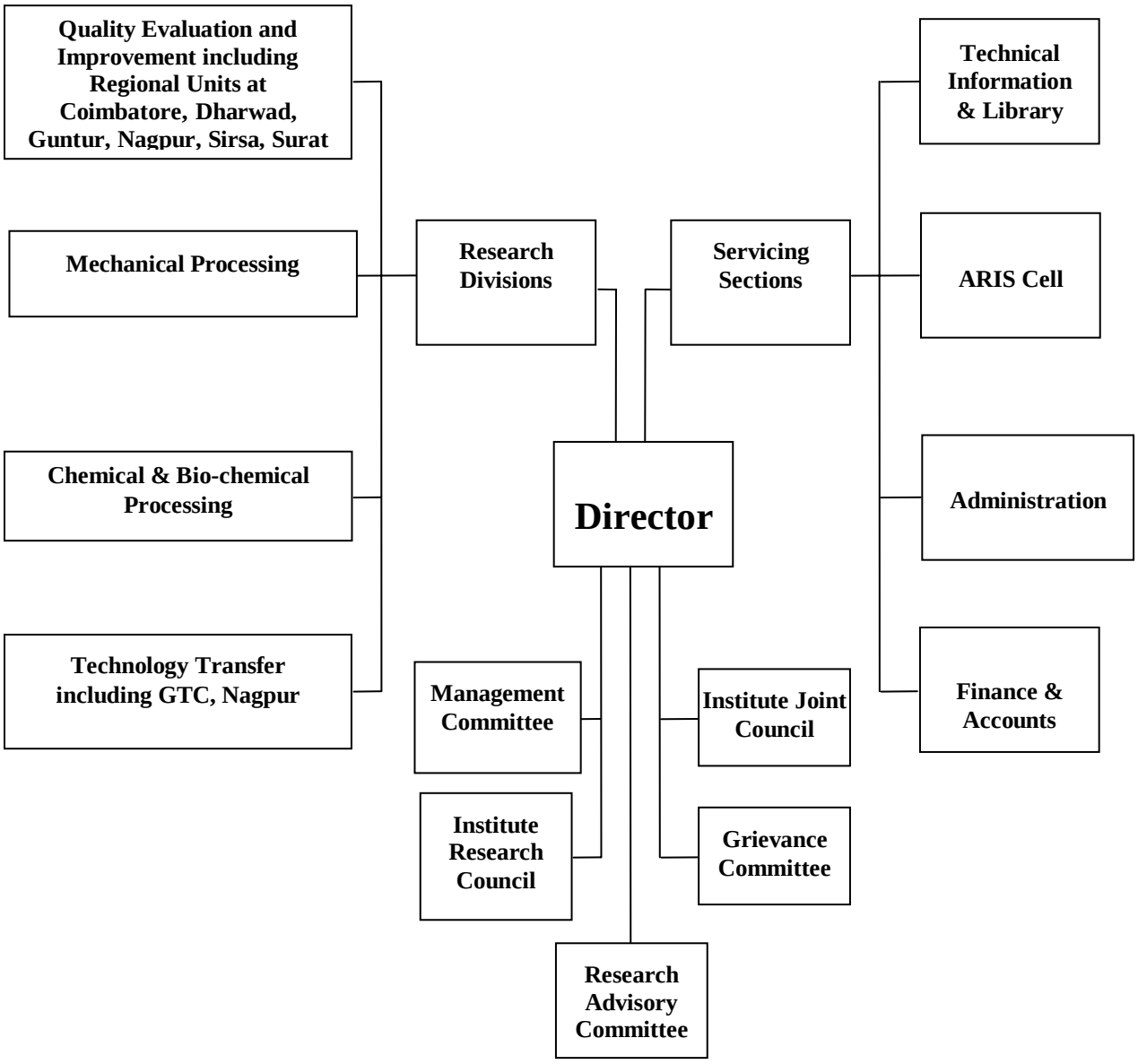
3.1. Infrastructure

There are four Divisions in the Institute; Quality Evaluation and Improvement Division, Mechanical Processing Division, Chemical & Biochemical Processing Division, Technology Transfer Division. Besides these there are four servicing sections – Technical Information & Library, ARIS Cell, Administration and Finance & Accounts. The Institute has six regional stations at Sirsa, Surat, Nagpur, Guntur, Dharwad and Coimbatore. An up-to-date Library of books on Cotton, Cotton Technology and allied subjects, Physics, Chemistry, Microbiology, Computers, Statistics, etc. is maintained at the Institute. Around 100 Indian & foreign Journals are subscribed. About 2000 Indian, ASTM Standards and British Standards are available in the Library.

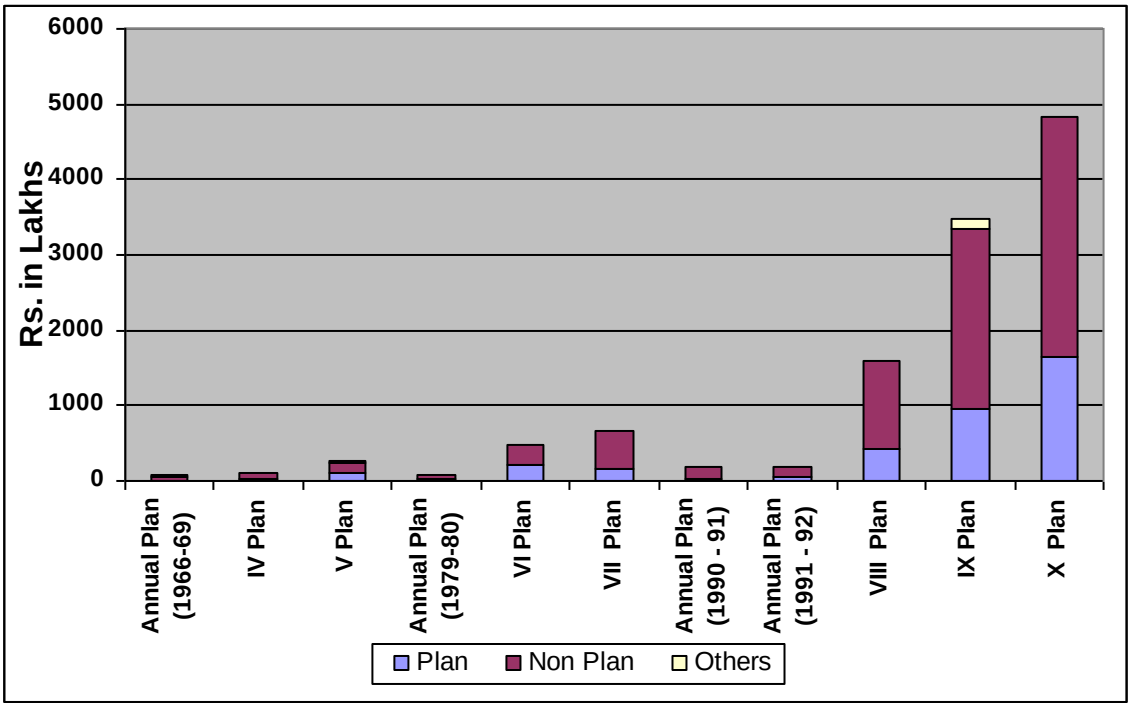
Specialised Instruments

- Rotobar Gin
- Laboratory Model Gins
- High Volume Instrument
- Advanced Fibre Information System
- Vibroscope
- Contact Angle Tensiometer
- Moisture Analyser
- Instron
- Ring Spinning
- Rotor Spinning
- Miniature Spinning System
- Uster Tensorapid
- Classimat/Yarn Fault Analyser
- Computerised Universal Testing System
- Knitting Machine
- Kawabata System
- Scanning Electron Microscope
- Automatic Washing Machine and Automatic Tumble Dryer
- Wrinkle Recovery Tester
- Colour Viewing Booth
- Flammability Tester
- Auto 45° Flame Chamber
- Horizontal Flame Tester
- Spectroflurometer
- Lyophiliser
- Thermal Analyser
- Multi Frequency UV Cabinet
- Automated Solid Phase Extractor
- Microwave Digestion System
- Centrifuge
- XRFS
- XRD
- FTIR
- Eco Testing Instruments
  - GCMS
  - AAS
  - HPLC
  - HPTLC
  - Weatherometer
  - GC
- Paper making and Testing Machines
- Composite Board making Machines

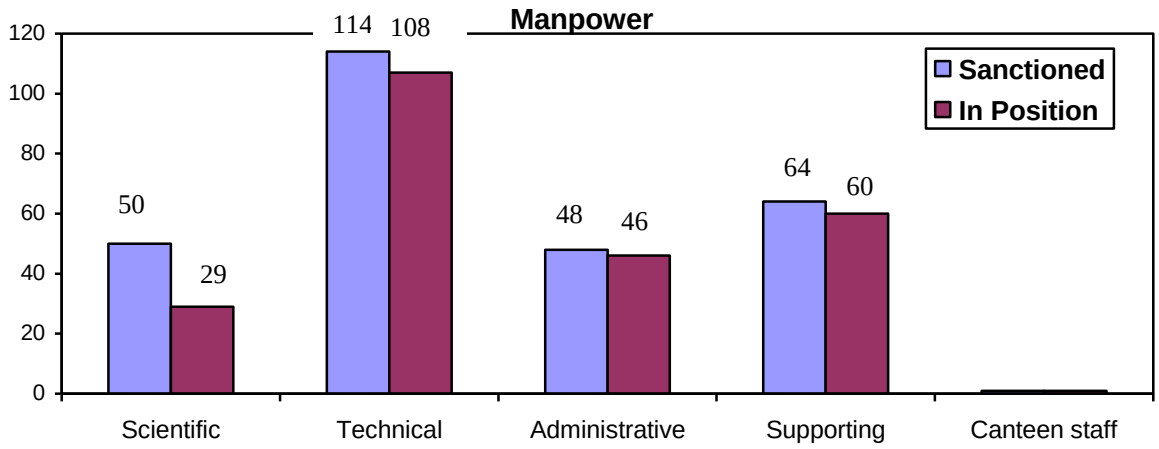
Organisation



3.2. Budget



3.3. Human Resource (as on 01-7-2007)



Human Resource over the Plan Periods :

Sl. No.	Plan Period	Scientific	Technical	Auxiliary	Admini-strative	Suppor-ting	Total
1	III Five Year Plan (upto 1968 - 69)	9	58	-	21	-	88
2	IV Five Year Plan (upto 1973 - 74)	17	77	-	27	-	121
3	V Five Year Plan (upto 1978 - 79)	50	82	-	34	-	166
4	Annual Plan (1979 - 80)	48	91	-	37	72	248
5	VI Five Year Plan (upto 1984 - 85)	49	48	27	45	69	238
6	VII Five Year Plan (up to 1989 - 90)	41	92	27	49	77	286
7	Annual Plan (1990 - 91)	40	92	30	51	78	291
8	Annual Plan (1991 - 92)	40	95	30	51	79	295
9	VIII Five Year Plan (upto 1996 - 97)	37	101	33	47	79	297
10	IX Five Year Plan (upto 2001-02)	30	113	-	48	71	262
11	X Five Year Plan (upto 01-7-2007)	29	108	-	46	61	244

4.
Salient Research Achievements

4.1. Research and Development

The research achievements of CIRCOT during the past 10 years in different core areas are as follows :

Core Area I : **Cost effective ginning for contaminant-free cotton**

IX Plan :

Indian Cottons grown in the central and southern regions are subjected to roller ginning in order to preserve their quality. Conventional double roller gins do not have the provision for independent variation in speeds for both roller and beater. As a result they have low productivity of the order of 40-45 kg/h. CIRCOT has developed a variable speed double roller gin which has provision for varying the speeds of the rollers and beaters. This gin yields 60 – 80 kg of lint per hour on an average by suitable selection of roller and beater speeds depending on cotton with no extra demand on power as compared to 40-45 kg of lint output by conventional DR Gin.

Laboratory model gins of various capacity viz., CLOY Gin, Lilliput Gin, etc. have been developed by CIRCOT to help farmers to gin their cotton and to get best quality of pure seed.

X Plan :

CIRCOT has developed precleaners to get trash-free seed cotton before ginning.

A laboratory model high productive double roller gin has been developed for the first time that could process about 50 kg seed cotton per hour.

A Modified double roller gin was developed that enhances the lint output with energy saving.It has a high efficiency and is a low cost gin as compared to the currently used Jumbo DR Gin.

To mechanise the heaping operation in ginneries, CIRCOT has developed a Cotton heap making machine that has capacity to transport 30 quintals of seed cotton per hour.

An array of precleaning systems has been developed for mechanically harvested cotton. These machines are capable of reducing the trash content in mechanically picked cotton to the level of 5% in ginned lint.

Core Area II : **Improvement and quality evaluation of fibres, yarns, fabrics, made-ups and garments**

IX Plan :

As the Technology partner in evolving cottons under AICCIP, CIRCOT has been providing fibre quality details of the varieties grown under the scheme. CIRCOT in consultation with the trade and industry has also specified norms to enable breeders develop varieties that are suitable for producing quality yarns.

To measure the stiffness i.e. resistance to penetration of cotton bolls, a Boll Rind Hardness Tester has been designed and developed. This would help in categorizing all the varieties showing promise. several pieces are currently in use in agricultural universities both in India and abroad

Recent studies conducted at the institute showed that structural weak links in cotton can be reduced substantially by a simple aqueous swelling treatment followed by stretching and drying of the fibres in taut condition. The irreversible changes brought about by the treatment include improvement in tenacity, increase in lustre, decrease in extension and convolution frequency. This treatment is found to be more beneficial to cottons which initially have poorer strength.

A non-destructive IR technique for determination of cellulose content has been standardized.

A database on fibre properties of natural fibres other than cotton has been generated that will enable researchers in developing diversified products using these fibres.

The phenomena of inverse relaxation and inverse creep were first observed in textile materials and some exploratory studies have been carried out at the Institute on cotton and other textile materials.

X Plan :

With the renewed emphasis on developing quality cottons, it has been possible to release varieties/hybrids that satisfy the quality requirements apart from improved productivity and pest resistant traits.

An Instrument for testing moisture transport through fabrics has been developed during the period. Using this indigenous set up, it has been possible to show that although cotton fabrics take longer time to remove moisture from the source, it is possible to keep the wearer dry and comfortable as the fabric absorbs large amounts of moisture and retains within its body rendering the wearer comfortable.

Recently, a variety-wise relationship has been developed between Micronaire value and degree of thickening which would help in arriving at the true maturity for a variety from its Micronaire value, which is an easily measurable parameter. Ideal Micronaire for a given variety has been established through this study and values lower than the ideal are bound to have negative impact on cotton processing.

A new maturity index based on flexural rigidity is developed. This can serve as reference standard for measuring maturity of cotton fibres.

A method has been developed and standardized to determine the frictional characteristics of fibres and fabrics while in relative motion with fibres/fabrics or any

other material. Convolution and fineness in cotton fibres together influence the frictional characteristics. Effect of chemical modifications on frictional behaviour has been studied.

A banana pseudo-stem fibre cleaner has been designed and fabricated for cleaning the fibres extracted by the modified Raspador. The productivity and quality of the fibres improve with this additional gadget. Data on physical characteristics of fibres extracted from 140 varieties of banana were generated.

Using X-ray fluorescence spectrometer, quantitative analysis was carried out on toxic elemental content and gram negative bacteria in soil, cotton plant parts, lint and processing dust. All the plant parts are densely populated with bacteria except the lint. Processing dust obtained during ginning and mechanical processing of lint was found to contain Ni, Ba, Cd, Br beyond toxicity level. Preventive measures for the workers in the processing units should be taken to save them from inhaling the toxic dust.

A Miniature spinning system has been developed by CIRCOT to find out the spinning potential of small samples. This system is operator friendly and can spin fibre samples and their blends weighing as low as 40 g to provide sufficient quantity of yarn for quality evaluation.

Newer textile fabrics were prepared by blending cotton with natural fibres like wool, Angora rabbit hair, ramie and jute

Core Area III : Improvement/innovation in wet processing of cotton and other blended fabrics with natural and environment friendly synthetic agents

IX Plan :

Developed techniques for dyeing of cotton with Lac Dye

A new process is developed to prepare absorbent cotton by combining scouring and bleaching into a single stage treatment as compared to multistage processing being done conventionally. This process gives absorbent cotton of the same or better quality as compared to conventional process in a quicker time and at lesser cost.

Under a sponsored programme, a technique was standardised for dyeing cotton with natural dye. Apart from this about 110 potential dye bearing plants were identified, technique standardised both for dye extraction and its application to cotton fabric.

X Plan :

Developed techniques for dyeing polyester blended cotton fabric with Natural Dyes

A process for bioscouring of cotton and blended fabrics that requires less energy and causes minimal pollution has been developed. This may result in the reduction of pollution load by about 25% and saving in energy to an extent of about 30%.

An eco-friendly method for extraction of Natural dyes from Safflower Petals was developed. Value added products such as Yellow Dye in powder form, particle board from safflower stalk, Herbal Tea from safflower petals, etc. were prepared.

Anti-inflammatory property of yellow dye extracted from safflower petals was demonstrated in animal studies

Developed new techniques for the production of Nano Particles of Silver & Zinc

Core Area IV : Value-addition to cotton plant by-products and other agro-residues and processing wastes

IX Plan :

An inexpensive assembly has been designed for growing anaerobic microorganisms

Stickiness in lint causes problems during spinning. CIRCOT has developed a method for reducing stickiness of cotton by employing a free-living nitrogen fixing bacterium.

To enable easy feeding of cotton plant stalks into the drum chipper employed in chipping wood both power and hydraulic system operated cotton stalk compacting machines have been designed that can compact bundles to desired dimensions.

An enzymatic method to prepare Peptone from cottonseed meal. This could be used for growing microorganisms, producing enzymes, production of antibiotics, preparation of bio-pesticides, etc.

Technology for generating biogas from willow dust by adopting dry fermentation technique employing mixed microbial consortia has been developed. Plants have been installed at textile mills, which use the generated biogas in their canteen.

An inexpensive anaerobic pre-treatment method to cellulosic substrates was developed for seeding oyster mushrooms on cotton stalks or rice straw.

Developed technologies for producing paper and composite boards from cotton stalks and other crop residues.

An anaerobic method for degumming of ramie fibres has been developed.

X Plan :

A technology for generating compost from ginnery waste has been developed. Large ginnery generating about 4-5 tonnes of trash daily can produce about 60-75 tonnes per annum of good quality compost and earn around Rs. 1.2 – 1.5 lakhs in a month.

A method has been developed for preparing cellulose powder from crop residues.

A one tonne per day particle board demonstration plant based on cotton stalks has been installed at GTC of CIRCOT, Nagpur under CFC funded project.

4.2. Technologies and Patents

Products

Lab Model Miniature Gins

Ginning Percentage Balance

BollRrind Hardness Tester

Variable Speed Double Roller Gin

Modified Double Roller Gin

HIPRO Laboratory Model Double Roller Gin

Improved Saw Gin

Modified Saw Gin

Miniature spinning system

CIRCOT's Calibration Cotton : Standard Reference Material

Banana Pseudostem Cleaner

Processes

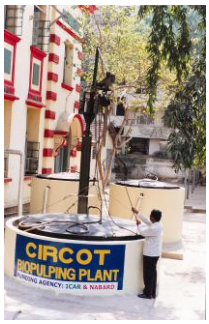
- Biogas Production from Textile Mill Waste

- 

Compost from Willow-dust and Ginnery Waste

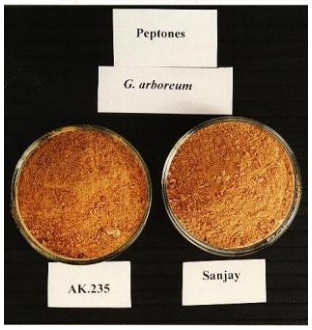
- Particle Board from Cotton Plant Stalks

- Binderless Boards from Cotton Plant Stalk
- Corrugated Boxes and Writing Grade Paper from Cotton Plant Stalks

- 

Biological Pulping of Cotton Stalks and other Crop Residues

- Peptone from Cottonseed Meal



- 

  Bioenrichment of Cottonseed Hulls with Microbial Proteins

- Bioscouring of Cotton and Blended Fabrics

- Blended textiles

Cotton + Angora rabbit hair blended textiles

- Cotton + Ramie Fibres Blended Products

Patents :

Patents were filed for the following technologies developed at CIRCOT :

A process for the preparation of paper grade pulp from cotton plant stalk by anaerobic digestion. Indian Patent No.176891, (1993)

Variable Speed Cotton Ginning Machine (V.S, Gin) Indian Patent No. 189878, (1998)

A Process for the Preparation of Peptone from Cotton Seed meal by Enzymatic Hydrolysis. Indian Patent No.192704, (1998)

A New Single Stage Process for the Preparation of Absorbent Cotton from Short Staple Fibre Waste (2001)

Banana Pseudostem Fibre Cleaner (2002)

A Novel Low Cost Technology for Improving the Digestability of Cattle Feed with Increased Microbial Protein (2002)

Production of Cellulose Powder from Crop Residues (2002)

Retting and Degumming of Decorticated Ramie Fibre (2002)

An Inexpensive Assembly for the Isolation of Anaerobic Microorganisms (2002)

Breed Farm Trade (BFT) Gin (2002)

Use of Nyle-Thane Polyurathene as a Material for Roller in Roller Gins (2002)

Modified Double Roller Gin (2003)

Biochemical Method of Deinking Newspaper Waste (2004)

Biochemical Scouring Technique for Cotton (2004)

Multilayered Particle Boards from Cotton Plant Stalks (2004)

Biological Method of Preparing Binderless Boards (2004)

Hand-cum-Power Operated Cotton Stalks Compacting Machine (2004)

Cotton Stalks Compacting Machine using Hydraulic System (2004)

Miniature spraying system for Cotton seeds (2004)

Biochemical Technique for Scouring Cotton (2004)

A Process for Production of Silver Nanoparticles using the Fungus *Pleurotus sajor caju (2005)*

Development and Use of Rubber Disk with soft Rubber Layer as Material for Self Grooving Roller (2005)

A Novel Sliver Making Machine for Cotton Processing (2007)

5.
Impact Assessment and Lessons Learnt

5.1. Impact Assessment

The impact of programmes as well as that of the technologies developed by CIRCOT is summarized in the following table :

CIRCOT's Activity	Impact/Benefit
The economic impact to farmers from the joint activity of CICR, SAUs& CIRCOT	Quality maintenance of varieties, arrests losses Early maturing varieties allow growing of supplementary crops Improved resistance to pests reduces crop damage High yielding and better quality varieties give extra income to farmers
CIRCOT's insistence on quality	Increased production of high strength medium staple cottons.
Research on pre-cleaning, and training programmes.	Monetary advantage to ginners
Awareness programmes	Significant reduction of trash in cotton
Fibre Quality Index and microspinning technique	Optimisation of mixing cost.
Cotton plant stalks as raw material	Monetary gain to farmers and board manufacturers. Renewable raw material for paper & board industry.
CIRCOT's Pre-cleaner	Commercialised through M/S Bajaj Steel Industries, Nagpur About 40-50 pieces sold annually Turn over around 1 crore annually 3000 ginning factories : potential beneficiaries

CIRCOT's Activity	Impact/Benefit
CIRCOT's Laboratory Model Gins	Fabricated and marketed by M/S Precision Tooling Engineers Ltd., Nagpur About 10 – 15 pieces sold annually : More than 100 pieces sold so far A few pieces exported : FAO, USA, etc. Potential users: 250 market yards being modernised under TMC
CIRCOT's Variable DRG in Technology	Produced and marketed by M/S UD Patel & CO, Mumbai 150 units so far sold Potential beneficiaries: 3000 factories Likely sale: 50,000 DR's Potential annual earnings: Rs. 80 crores
Objective Quality assessment, Micro-spinning, Spinnability prediction	Enables minimisation of mixing cost 5 to 6 % savings Rs. 5 lakhs for an average spinning mill Annual savings of Rs. 3 crores if 5 % mills use
CIRCOT's Calibration Cotton	Import substitute Customer list on the rise Repeat orders received Export made 800 Packets (100 g) sold annually Foreign exchange savings Rs. 20 lakhs per year
Pulp from Cotton Stalks	Benefit of Rs. 30 lakhs for medium scale paper manufacturers (10% raw material if replaced) One per each cotton growing state: likely gain Rs. 2.7 crore
Particle Boards from Cotton Stalks	Market size Rs. 310 crores Likely to grow to Rs. 510 crores in 2-3 years 10% market by cotton stalk particle boards Potential economic activity: Rs. 50 crores
Biogas from willow-dust	Full size plant set up in Century Textiles and Industries Ltd., Mumbai Abatement of pollution

CIRCOT's Activity	Impact/Benefit
Compost from Willow-dust	M/s Hanjer Fibres, Surat has been producing 100 tonnes compost per month and selling @ Rs. 2400/- per tonne as against raw material cost of Rs. 100/- per tonne Enriches soil micronutrient level Good organic amendment to soil Enhances moisture holding capacity of soil

5.2. Lessons Learnt

One of the most important functions of CIRCOT is to provide technological support to cotton improvement research. While the breeding programmes under AICCIP have produced several high yielding varieties of cotton, the following lacunae have remained.

i) Productivity is still about 450 kg/ha, which is much lower compared to the world average of 730 kg/ha and more so when compared to those of countries like USA (735 kg/ha), China (879 kg/ha), Australia (1270 kg/ha) and Israel (1700 kg/ha).
ii) New high-speed technologies in spinning and weaving demand cottons of high strength, high extensibility, high maturity and low variability. Very few among the new varieties possess these properties. Greater emphasis needs to be placed on fibre quality in breeding research.

Indian cotton is relatively trashy. Leafy matter, seed coat bits and motes tend to lower both technological quality and commercial value of cotton. Promotion of good ginning practices and corrections through breeding ought to have been made to reduce trash so that Indian cotton attracts premium in the export market of lint in which our country has to enter in a big way in coming years. Although CIRCOT has made several initiatives to improve ginning in the country and thus promote the production of trash-free cotton, there has been only partial success. CIRCOT should step up its interaction with connected agencies to bring tangible results in cotton ginning.

Environmental considerations in agricultural production have assumed great emphasis in recent years. Moderation in the use of fertilisers and pesticides has been suggested from time to time but there have been very little improvement. Environment conscious communities in Europe and America seem to prefer what has been euphemistically called "organic" cotton, grown without the use of objectionable inputs. The development of "colour cotton" or naturally tinted cotton has also assumed significance at a time when the use of harmful dyes is questioned by some countries of the West. Although India has made its mark in the production of organic cotton, vigorous efforts are needed to improve the country's rating in this area.

One of the mandatory functions of CIRCOT has been the testing of samples from various stages of trials under AICCIP, from Agricultural Universities. In recent years, there has been sporadic complaints from AICCIP quarters that all their samples are not evaluated in time and that many samples do not find a place in the reports presented by CIRCOT at the annual workshop meetings generally held in the month of April. The four month period prior to the workshop is the most busy time for the Institute's testing sections. Seasonal restructuring steps such as deploying personnel from other sections for testing work, staggering of working hours to accommodate two overlapping shifts, increasing the quota of work to each testing assistant, etc. are some steps being considered for increasing work output in this seasonal activity.

In Regional Quality Evaluation Units of CIRCOT, samples from preliminary trials of breeding are tested. However, the number of such samples has increased over the years. Here also, the rate of disposal of samples by testing is far from satisfactory. The reason is reduced manpower and also lack of microspinning units. Attention needs to be given to modernise the regional QE units.

Objective grading of lint quality on the basis of fibre attributes and fixing commercial price is slowly gaining ground internationally. CIRCOT with the active collaboration of NCDEX, the commodity exchange has developed objective grades for two most popular cottons J.34 and S.6. The trade seems to be reluctant to introduce this system for commercial transaction for reasons best known to them. A preliminary interaction with a few mills has not also drawn positive response. CIRCOT needs to bring the trade and industry around to convince them and introduce this system in commercial transactions for the benefit of both the end user and the grower (producer of the raw material).

CIRCOT has developed a process of blending cotton with other natural fibres like ramie or Angora rabbit hair and has come up with technology for production of niche fabrics and garments. Entrepreneurship development needs to be created.

CIRCOT has developed a technology for production of both particle boards and hardboards from cotton stalks. This technology has already been transferred and a factory set up at Dharwad, Karnataka. However, large scale adoption has been hampered by the lack of institutional mechanism for providing chipped, cleaned stalks at the factory gate. Cotton stalks, being light and bulky, cannot be transported economically to long distances. With the help of funding from CFC, Netherlands this Institute is working on this problem. Quick solutions need to be found to popularise this technology and build entrepreneurship.

The technology for producing pulp and paper from cotton stalk was developed by this Institute a few years ago. Commercial trials also were conducted successfully to ascertain the technical feasibility and economic viability. However, the response from potential users of the technology such as existing paper mills has been lukewarm, the reason being that they are not prepared to use an unconventional raw material largely because of the skepticism about assured raw material supply. They also seem to be reluctant to incur expenditure on purchasing additional equipment or spend time and labour for the

standardisation of a new process in their system and also to install effluent treatment plant that is generally considered expensive. It would seem that CIRCOT should make special efforts to dispel their doubts and develop cheap, small, efficient effluent treatment technology and see that the existing mills are able to adopt the same. Farm co-operatives can be motivated to ensure uninterrupted supply of cotton stalk.

The Bio-gas generation technology from willow-dust was standardised a decade ago. Improvements by way of dry fermentation process, increase in gas yield and enhancement in methane content, etc. were also accomplished. A techno-economic feasibility report was prepared after a large-scale trial. However, the technology has benefitted only a few mills. The reasons for mills' reluctance are the additional burden on their engineers by way of maintenance responsibility of the gas plant and their high expectation by way of government subsidy. CIRCOT has to adopt appropriate strategy to tackle this problem effectively and make a success out of the gas production technology developed at the Institute.

CIRCOT has undertaken all through the years several basic studies and has generated considerable data on structure-property relations in cotton fibres. Adequately clear picture has still not emerged. Even today it is not possible to predict fibre strength accurately from structural properties or yarn strength from fibre characteristics. Due emphasis will have to be given on these studies, as well.

CIRCOT has developed technologies for value addition to ginnery waste in the form of compost production. They need to be popularised among the new breed of enterprising professionals who have established modern ginneries under the Technology Mission on Cotton.

6.
Scenario and SWOT Analysis

6.1. Scenario : Current and Future

Textile Scenario 2025 : Global Vis-à-vis Indian Context

India, more than 5000 years ago pioneered globally the cultivation of Cotton. Today, Cotton is the most important natural fibre and India still holds the maximum land area under cotton cultivation. The world of Textiles, including Clothing has undergone interesting periodic changes in the post Second World War era. Although, global trade in 1947 started with a bang with the concept of a free trade (GATT), the subsequent onslaught of exports primarily by the Four Asian Tigers, namely Japan, Hong Kong, South Korea and Taiwan compelled the developed industrialized countries to impose restraints through Quota allocations and thus controlling / monitoring the free movement of Textiles. This led to a series of agreements between the countries starting with a Short Term Agreement (STA) followed by a Long Term Agreement (LTA) and Multifibre Arrangement (MFA). In 1995, GATT reappeared in the form of World Trade Organization (WTO) and promised a Quota-free global trade through a fresh multilateral Agreement on Textiles & Clothing (ATC) replacing MFA. The ATC was to remain valid for 10 years between Jan ' 95 to Dec ' 04. The free trade regime bereft of quotas thus began from January 2005. The current US $ 360 bn global Textile trade is free of any restraints and offers a tremendous opportunity to a large Textile manufacturing country like India.

A huge number of international reports/analyses have attempted to project the major gainers and losers in the context of post '04 Quota-free global trade. Interestingly, all such analyses indicate India to gain substantially at the cost of some of today's key players in the new emerging scenario. Though somewhat belated, Govt. of India and Textile industry have been making serious efforts to bring in radical Policy changes that may enable the industry to become competitive. In turn, the Textile industry is responding through significant investment decisions leading to Modernization, Expansion and Opening newer fronts / markets (by choosing relevant global Products).

In spite of a major global shift towards the use and consumption of Man-made fibres, particularly Polyesters, Cotton continues to dominate the Indian Textile scene. As Indian cottons are used for Coarsest to the Finest Textiles, it is expected that the global trade will continue to encourage the recent trend of enhanced export of Cotton products (Yarns, Fabrics & Made-ups and Garments) from India. However, in terms of Yield, Consistent quality, Contamination and the availability of Strains having matching properties like their imported counterparts, Indian Cottons do not enjoy the reputation others have. In this context, to maintain India's leadership position in Cotton products in the Quota-free regime CIRCOT will have a major role to play as a bridge between the Industry and the Agriculture.

Although the analysts forecast China to lead in the new world of Textiles, it is almost certain that India will continue and build up on its dominance in the Cotton Textiles. The foreign investments in the textile sector, particularly in weaving and processing technologies in developing countries, would be high in the coming 5-10 years. Cotton lead exports from India today has an overall share of 3% in the world market and is expected to go up by 10% in the coming decade and has a bright future. The demand for finished products is high in any country both for domestic consumption and export. There is going to be complete automation for the textile manufacture in the European countries and in developing countries, cotton being more labour intensive, will never be allowed to die and on the other hand continue to establish smaller units to create job opportunities. A great demand has been forecasted for home textiles and processed fabrics. Also significant shift is predicted towards production of manmade fibres in Indonesia, Taiwan, Korea and China. In developing countries, particularly blended fabrics would remain the most sought after clothing due to durability and affordable cost. This is going to increase and cotton will continue to enjoy its pride due to its inherent qualities and in the next 30-40 years Asian textile industries will play a significant role.

Internationally cotton has to confront stiff competition posed by synthetic fibres particularly polyester. Being a natural fibre endowed with high moisture absorption, cotton textiles provide the right amount of warmth and wear comfort allowing friendly contact between human skin and textile. However, polyester and more prominently polyester – blended textiles have tremendous customer support due to their enhanced durability and aesthetic appeal particularly for their elegant look and drape.

Despite being an eco-friendly biodegradable fibre, the cotton consumption in terms of its share in the fibre utilisation has been on the decline the world over. It has been noted that the share of cotton in the whole world had progressively decreased to reach 38% in 2000. A revival of sort has taken place thanks to untiring efforts by Cotton Incorporated, USA and also by the Committee for Demand Enhancement for Cotton of the ICAC. Currently the cotton share is about 42% and is likely to pick up and grow up to 45% by 2025. This demand enhancement would also be assisted by the fact that petroleum reserves deplete year after year. The Indian situation was also equally dismal with the cotton share declining from 73% in 1990 to 58% during 2000. During 2000-07 the share of cotton has gone up by 62% and is likely to sustain in the future. Another point of concern was that annual growth rate the world over for polyester was noted to be about 7% as against the cotton growth at the rate of only 1.3% during the 90s. The gradually increasing production capacity for man-made fibres and the comparatively low material cost for polyester had contributed in good measure to the down slide in the cotton share in fibre consumption. However, during 2000-07, the annual growth rate for cotton has picked up to 5% and a downslide in polyester. It is felt that by 2025, cotton growth would surpass that of polyester.

The population is on the increase globally and in India it is likely to touch the 1.5 billion mark by 2025. Considering the improved agronomic practices coupled with transgenic cottons and integrated pest management in place in 2005, the global production of cotton has crossed 25 million tonnes that is likely to grow up to 52 million tonnes by 2025, if a CARG of 5% is assumed. This would also mean that being a natural biodegradable

environment friendly fibre its share in the total fibre basket would grow from the current 42% to 45%. In India the picture is not quite different. Though the area is expected to decrease a little from the current 9 million hectares, the cotton production would touch around 275 lakh bales by 2007 and 600 lakh bales would be required by 2025. The cotton fibre with many desirable factors would always stand as the first choice over the manmade fibres. Even in non-woven sector cotton is already making its mark. However, manmade fibres would definitely continue to make a dent in technical textiles and non-wovens and cotton fabrics would continue to remain as materials for baby wear and apparels including undergarments. There will never be any threat to cotton mills, be it 100% cotton or blended with viscose and synthetic fibres. Blending of cotton with silk and wool is also on the increase. CIRCOT has a special interest in blending natural fibres from both plant and animal origin in cotton system to suit specific end uses.

Indian cotton is besieged with several intra-fibre and inter-fibre challenges. It is a matter of concern that despite a healthy buffer stock and a moderately strong production base, Indian mills had been resorting to heavy imports in recent years. Although low international price and credit facilities had been the contributory factors for the huge inflow, certain quality deficiencies and the highly contaminated nature of the Indian cottons were cited as causative factors. Indian cottons also face problems like high variability in fibre attributes within and between lots presumably due to inadvertent mixing of varieties. Technology Mission on Cotton, a Government of India enterprise has done its best to find solutions to some of the above pressing problems. Now, Indian mills have almost stopped imports but for extra long staple and quality has also shown tremendous improvement. By 2025 India would not only be self sufficient in cotton but also likely to export at least 10% of its production as raw cotton, although efforts would be in place to enhance export of value-added products.

Use of cotton and other natural fibres would find wide applications in Technical Textiles. Friction spinning technology will become important for the coarse count segment for production of technical textiles.

There is a strong trend for companies and brands with an ecological and ethical status for successful marketing of textile products. Ecobranding is an emerging area which is going to be in place by 2025. In the area of chemical finishing, encapsulation of reagents like fragrance chemicals, those that invigorate skin as well as slow release of pharmaceutical preparations, etc. would become a common practice. Smart textiles that would preserve/ create favourable ambience/micro climate in terms of humidity and temperature, etc. would also be commercially available. Textiles would not only be –comfortable‖ but also would contribute to –well being‖. The future trend in finishing of textile goods would be for easy care, flame retardancy, anti-static, non-slip, colourfastness, UV protection, enzyme finishing, anti odour and fragrance, nanofinishing, etc. Effluent treatment plants would be in place in all processing units by 2025.

Due to global warming, there is an increase in the temperature all over and cotton due to its inherent comfort properties continues to rule over synthetic fibres. Efforts are underway to produce textile grade fibres from soybean, corn (biopolymer), milk (casein), and even cottonseed. Banana, pineapple, bhindi and bamboo fibres are also gaining popularity. Natural fibres other than cotton will also make a significant dent in the

international market in blends with cotton for non-woven and other technical textiles. Increased awareness among rural masses in India and other developing countries with regard to the benefit of cotton garments would support this phenomenon. Naurally dyed fabrics are being preferred and would continue to grow and it is expected that at least 40% of synthetic dyes will be replaced by 2025 in handloom sector with assured generation of employment.

The world today is becoming more and more environment conscious. Textiles, due to its inherent nature, has been using more than 800 chemicals during its life cycle leading to increased pollution. Enhanced awareness has led to slow and steady replacement of chemicals with biochemical/enzymatic treatments. In the area of cotton ginning, replacement of existing leather roller material with chromium free rubber based materials will become popular. The preparatory process of purifying cotton goods that consumes not only good amount of chemicals but also energy intensive would slowly get replaced by biotreatments like scouring, bleaching, etc. Special finishes would also be made using appropriate cocktail of enzymes.

There is increased awareness in the production and consumption of organic cotton particularly in European countries. The contribution of organic cotton in the world today is less than 1% of the total production despite Indian contribution in significant quantity (around 30%). This activity is gaining popularity and it is expected that the contribution to the total world pool would be about 5-10% by 2025. A significant increase is there in cultivation of Bt cottons, which is supposed to be organic, but unfortunately due to resistance by western countries, particularly European Union, today it is out of green list. Whatever may be the reason, whether Bt cottons or organically grown cottons, the consumption of pesticides will drastically come down by 2025 with increased awareness for cleaner environment.

In general, biomass (crop residues) would serve as raw material for power generation and cotton stalk will have a major share in cotton belt. Depletion of petroleum reserves will definitely force the use of renewable energy sources. Production of pulp and paper via biological route and hydrogen from biomass by anaerobic fermentation would also become a reality. The wastes generated in the fields, be it cotton or any other crop, would serve as an excellent raw material for briquetting. Dependence on renewable raw materials (crop residues) as input for paper and board industries will save forest timber and prevent environmental degradation.

Cottonseed will yield a few by-products namely linters, seed hulls,, oil and meal on scientific crushing. Oil could serve as an excellent edible medium on refining and crude oil could go in for the production of bio-diesel, which is also becoming popular due to high cost of petrol and also its depletion. Edible grade protein from cottonseed meal would also be on the increase. Gossypol free cottonseeds are already available now and will definitely occupy more areas in the years to come. Gossypol would also get accepted as an active ingredient in birth control formulations.

Utilisation of lignocellulosic fibres is on the rise. Cottonisation of these fibres will open up new avenues in blending. During *in situ* treatment of microorganisms, these lignocellulosic fibres will become finer and could be easily blended with fibres namely cotton, flax, ramie, silk, etc. During this microbial treatment there is every chance of bringing closer the microfibrils and thereby achieving higher strength. By controlled manipulation, enzymes elaborated by microorganisms could do wonders at will and would become a tool in the years to come to produce/converrt fibres as per our requirement.

Immediate Future Indian Outlook

With the abolition of quotas and a distinct possibility of the manufacturing base of the textiles shifting to Asia, Indian textile and clothing industry is in a resurgent mood. Although China has been identified as the most potent winner of the liberalisation and quota-free access for markets, India has been regarded and recognized as the future beneficiary of free trade regime thanks to lower manufacturing cost, huge raw material base and expert manpower and entrepreneurial skills.

In order to address the problems confronted by the industry, Governmental efforts in the form of Technology Mission on Cotton, Technology Upgradation Fund, setting up of Technology and Apparel Parks are going on strongly. These programmes provide a synergistic effort to private initiatives in this sector to improve the competitiveness of the sector as a whole.

The Indian Cotton Mills' Federation now called Confederation of Indian Textile Industry (CITI) being the apex body of the textile industry in India enjoying the consultative status with the national government and international agencies has set out a vision for the industry.

By 2010, the Indian textile and apparel industry can achieve a potential size of US$ 85 bn.

With an increase in per capita consumption from 19 meters to 32 meters, the domestic market potential would be Us $ 45 bn.

With a 6% share in global textile trade, exports would comprise the remaining US$ 40 bn.

- Nearly 60% of the exports would comprise garments
- Exports would drive over 60% of the incremental growth in industry size

Over 35% of India's exports would be from textiles

Over 12 million jobs would be created – 5 million jobs through direct employment in the textile industry and another 7 million jobs in allied sectors.

With a strong focus on value addition in the coming years the above vision is to be achieved by generating additional output in different sectors.

Sector	Current output	Target for 2010
Cotton fibre (lakh bales)	171	350
Yarn (mn. Kg)	4181	10,362
Fabric (bn sq mtrs)	32	90
Garments (bn pieces)	4.4	15

Although India enjoys a strong multi-fibre raw material base, cotton forms the strong point in the textile scenario of the country. Even now the industry heavily relies on cotton goods as the primary exportable commodity. It is envisioned that with several innovative measures such as contract farming, corporate farming and quality boosting programmes this raw material base can be widened and strengthened to achieve the targets.

Coordinated participation and timely and strategic action by stakeholders that include government and private sector industry associations, have been identified as pathways to realize the vision set by the industry for the next five to ten years.

Industry's vision for 2012

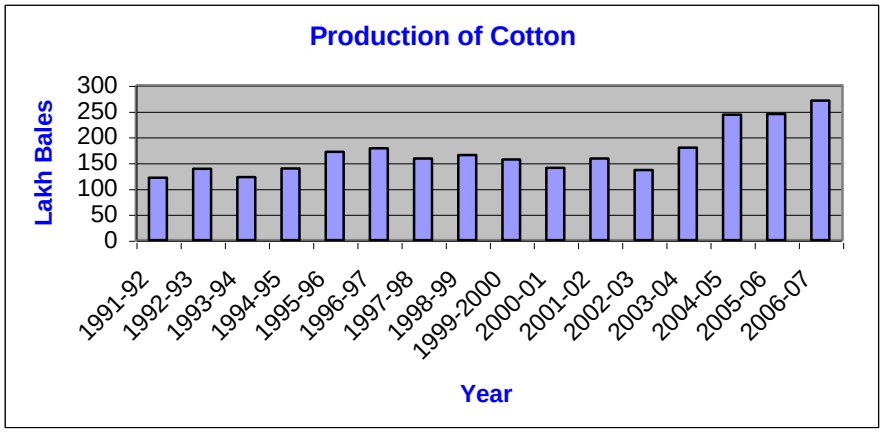
The salient features of the vision statement formulated by CRISIL for the Confederation of Indian Textile Industry (CITI) are enumerated below.

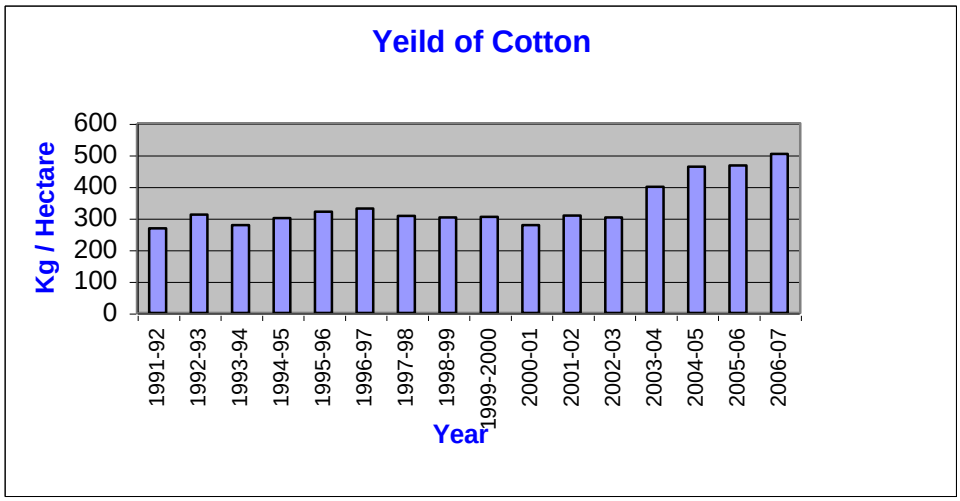
Indian textile industry hopes to capture a market worth USD 110 bn., by 2012 that includes both export sales worth 50 bn and domestic segments contributing 60 bn.
16% increase in production of goods expected
India's share in export market to rise from the current level of 4% to 7% by 2012.
Special emphasis to produce more value added products and also increase in manufacture of technical textiles.
Investment required for 2007-12 period would be USD 43 bn. (Rs.1,94,000 crores)
Increased investment would lead to generation of additional employment to 14 million people with 6 million direct employment opportunities
Cotton requirement would go upto 450 lakh bales by 2012

Sectoral Strength

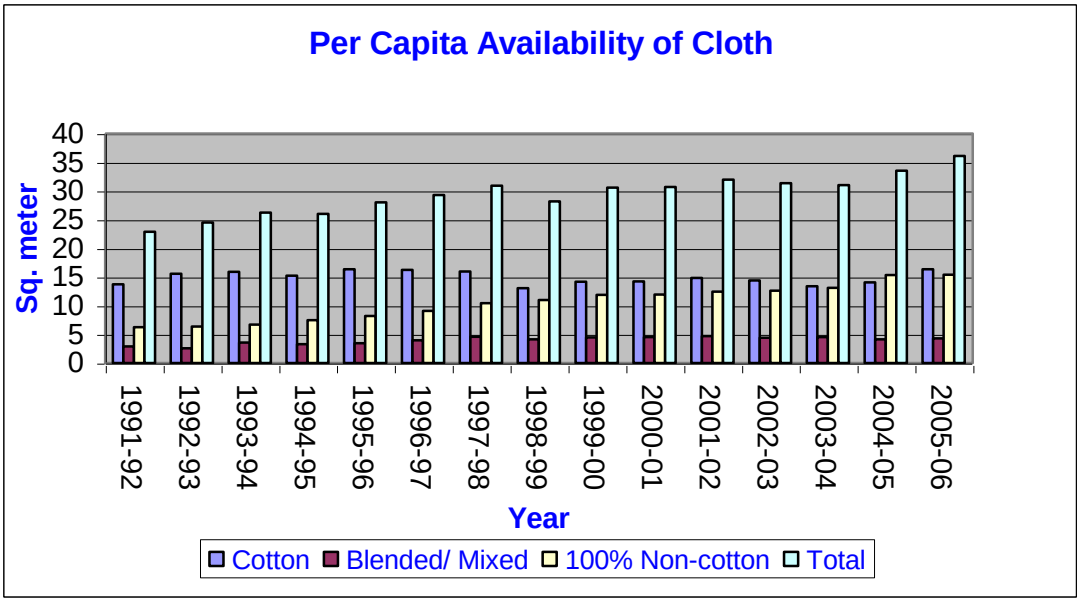
In the past two decades India has become fully self sufficient as regards the requirements of cotton, both in quality and quantity. Despite the fact that area under cotton cultivation has remained nearly unchanged, the production and productivity have shown substantial increase over the decades, thanks to the evolution of high yielding varieties and hybrids through co-ordinated research efforts. The total cotton production has been around 150-

170 lakh bales in recent years, which has grown to 240 lakh bales in 2004-05 (cotton season) and expected to rise upto 275 lakh bales during 2006-07. Besides meeting the domestic requirements of the textile industry, India has been also making export of raw cotton. Export of textiles comprising raw cotton, spun yarns, sewing threads, fabrics, garments, etc. has in the recent years surpassed expectations. The demand for cotton for apparel use is increasing all over the world and therefore, there is considerable potential for the export of both raw cotton and value added products from our country.

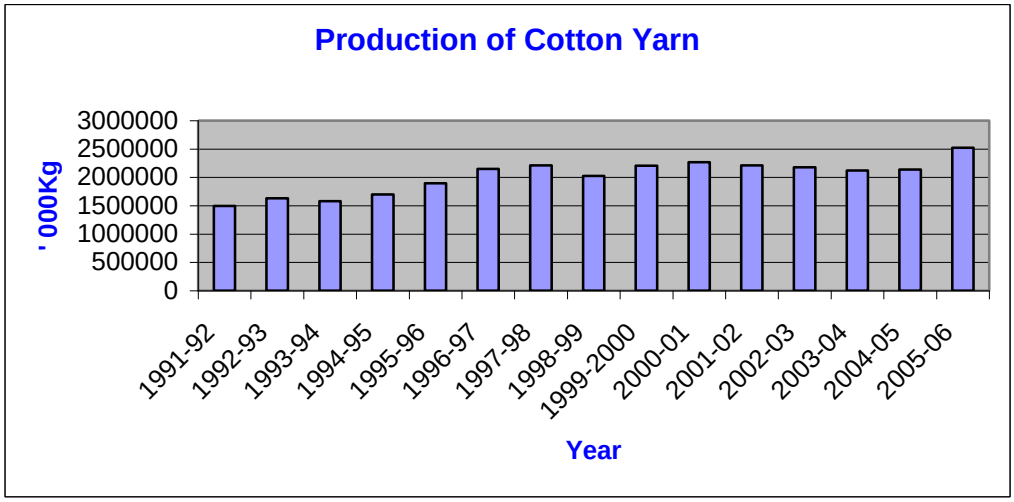


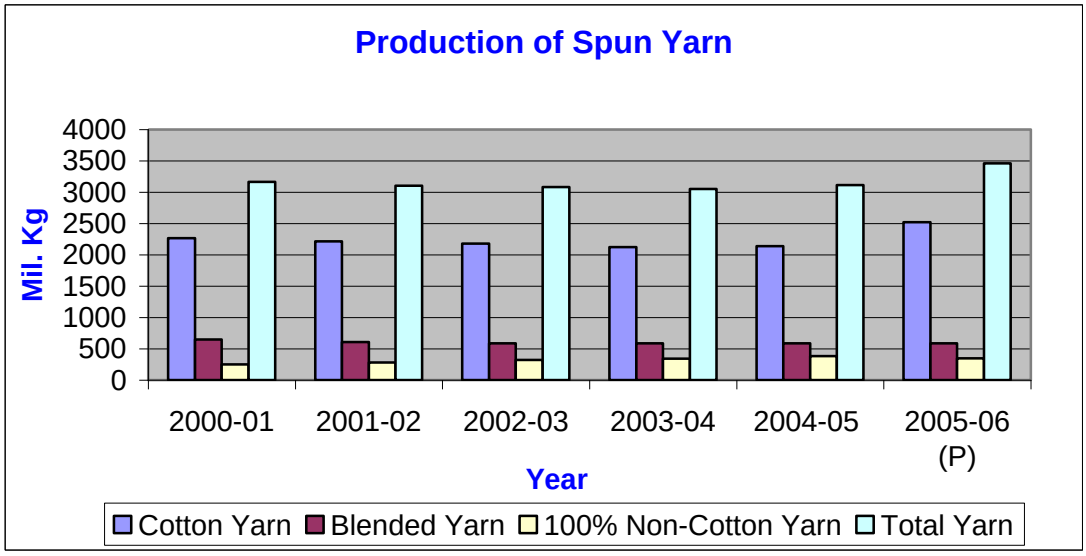


The per capita consumption of cloth in India is only about 20 square metres. In the developed countries like U.S.A., Germany, etc., the per capita consumption of cloth is 5 to 10 times this figure. This wide difference is due to the low standard of living and the poor purchasing power of a vast majority of the population in our country. It is being predicted that with the liberalisation of the trade and economy, the standard of living will improve and there will be increased demand for cloth.

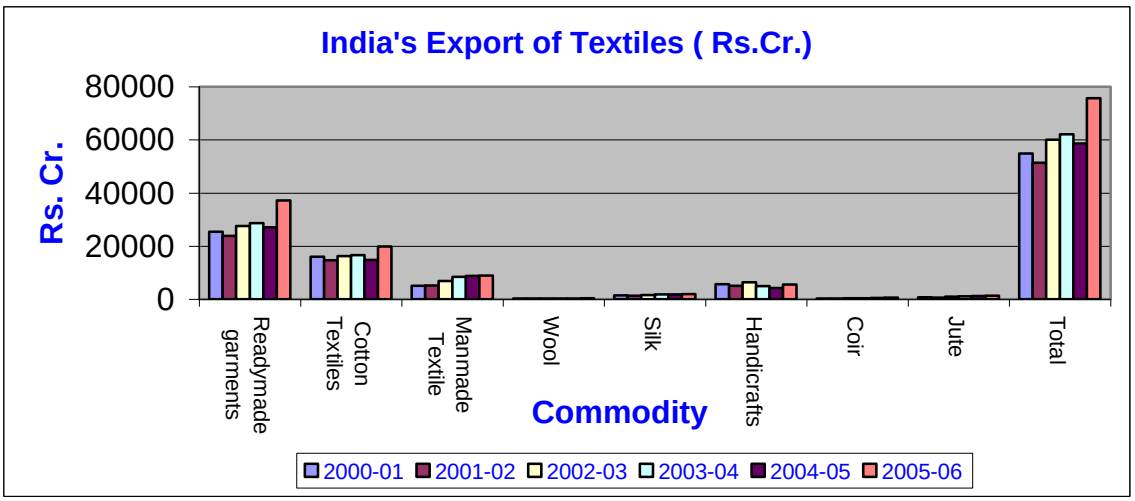


Cotton consumption by textile mills in India has increased considerably during the last 25 years, from 61 lakh bales in 1966-67 to 145 lakh bales in 2002-03 and 177 lakhs in 2003-04 including non-mill consumption and SSI Mills. Production of spun yarns both of pure cotton as well as of blends has recorded an impressive growth rate of about 4% per annum in the past ten years. It is interesting to note that cotton accounts for 60% of the fibre consumed by the mills in India. If this trend is maintained the mill consumption can be expected to increase at CARG 5%. It is worth citing here that cotton consumption both mill and SSI units put together have already reached 220 lakh bales during 2005-06.



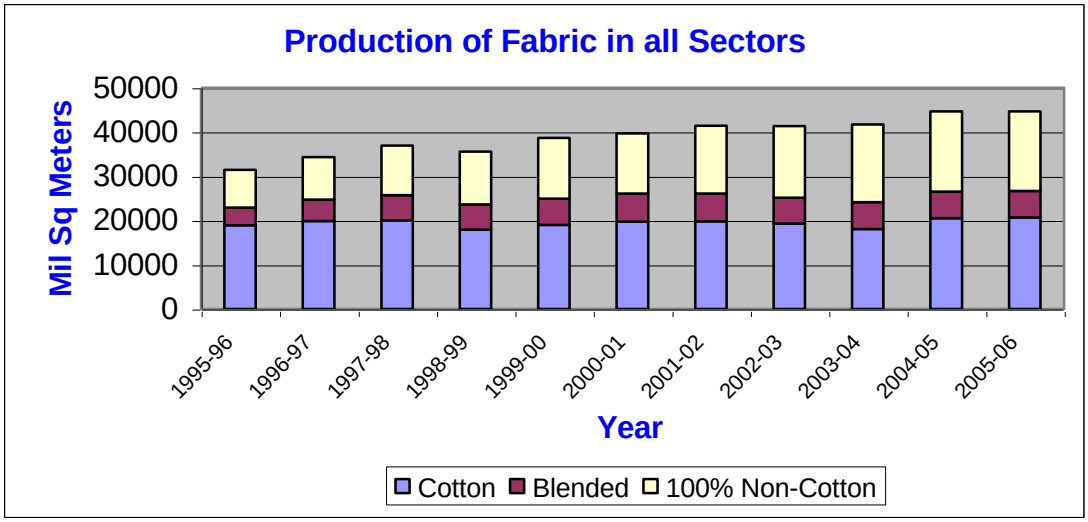


India has made a mark in world market of textiles. The post 1990 period has witnessed an upswing in the export of textiles comprising fibre, yarn, fabrics and garments. The earnings from export of textile materials have increased from Rs.9000 crores in 1990-91 to over Rs.25000 crores in 1995-96, accounting for nearly 30% of the country's total export earnings and currently stands at around Rs. 60,000 crores. It is also important to note that cotton alone makes up for about 70% of the gross earnings from textile exports. India exports its textile produce to over 180 countries spread over in five continents, of which nearly two-thirds are going to US and European Union.



Several varied technologies are in vogue in the Indian textile industry. Ring spun yarn to air-jet spun yarn, handloom fabric to shuttleless loom woven fabric, handmade goods to sophisticated plant processed goods, etc. co-exist in the Indian market. The production of cloth by all sectors being around 31,958 million square metres in 1995-96 has reached 42,383 million square metres. Cotton fabrics alone accounted for around 61% of the total

fabric production, of which 5% came from the mill sector, 38% from the powerloom sector 24% from hosiery and 33% from the handloom sector. Cotton products account for 60% to 70% of the textile materials exported. The export of textile materials, especially garments, has been increasing rapidly during the last few years.



There is a good demand for our cotton in other countries as may be inferred from the export of over 13 lakh bales each during the years 1986-87, 1989-90 and 1992. However, there has been a setback. A reversal of the trend has taken place again and India has exported about 13.25 lakh bales of raw cotton during 2003-04 and 50 lakh bales in 2005-06. If serious attempts are made, it will be possible to market at least 10% of bales of cotton annually to foreign countries particularly within Asia. In the years of short crop, the Government can permit import of additional cotton required to meet the mill demand.

In addition to the quantity of cotton for mill consumption and export, a substantial quantity of cotton (about 10 to 12 lakh bales) is used for non-mill purposes, including stuffing of mattresses and furniture, preparation of surgical, absorbent cotton, etc. This consumption is also likely to increase to over 15-20 lakh bales by 2010 A.D

India is bestowed with different agro-climatic conditions and hence different natural fibres of both plant and animal origin are grown. Cotton could be blended with other fibres for various end uses.

6.2. CIRCOT : A SWOT Analysis

Strengths

CIRCOT is the pioneer and the only institute in the country actively involved in all post harvest processing aspects of cotton. India is the only country growing all the four species of cotton including hybrids. Strong technological and scientific capability in well qualified and experienced staff with interest in basic research is the Institute's strength. The laboratory is accredited by NABL and 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.
Recently CIRCOT has implemented a project on –Establishment of a Referral laboratory for Cotton Textiles" in Team of Excellence Mode (TOE) under funding from NATP. *CIRCOT is the first Textile Institute in the World to become a Referral Laboratory on Cotton Textiles.*

Weaknesses

Among the foremost weakness is inadequate scientific personnel and lack of space. The Institute lacks international exposure. There are a lot of administrative bottlenecks in a governmental set up.

Opportunities

CIRCOT is internationally and nationally, an unique institution – can keep the Indian flag flying high in cotton technology area. There is relative vacuum in India: Textile Research Associations (TRAs) are no more in full vigour. More applied R&D and selling of technology should be taken as a challenge. Technology areas are not truly saturated for cotton. Creating database on imported cottons and using it to generate income, also, opening up services to overseas clients are some of the opportunities. By-products of cotton plants have not been sufficiently exploited for farmers' benefit. This area exposes innumerable opportunities for the Institute to grow and excel.

Threats

Private sector initiatives in cotton breeding and in cottonseed production/sale are eroding the domain of ICAR – indirectly, of CIRCOT. Private sector in India – Indian firms and also branches of foreign firms – are getting stronger in the testing services area, especially by providing total service expeditiously at reasonable costs. Globally, manmade fibres are displacing cotton: and this is happening in India also in spite of its weather conditions being more favourable for wearing cotton. Availability of cleaner and cheaper imported cottons from other countries is a threat looming large. Cheaper rates of good quality imported cotton, manmade fibres, ban on finished goods due to pesticide residues and high cost of cultivation are some of the threats faced by India that indirectly affect CIRCOT's prospects.

7.
Perspective

Taking in to consideration the above scenario CIRCOT perceives the following areas as its area of working :

Quality assessment of new varieties and elite materials to facilitate breeders and to provide quality cotton to the industry as per the requirement
Creation of databank on the technological attributes of cotton germplasm
Objective grading of cotton for trade
Fibre attributes based marketing of lint instead of seed cotton
Development of ginning machinery and post-harvest handling of seed cotton
Production of composite and technical textiles for various end uses
Diversified use of natural and manmade fibres for blending with cotton
Standard test methods for knits
Development of cotton based nonwovens
Development of fabric handle values specific to tropical conditions
Ecofriendly and user friendly wet processing technologies for cotton and blended textiles
Utilisation of cotton by-products and crop residues for value added products
Research and skill oriented human resource development
Technology marketing and revenue generation

8.
Issues & Strategies

Some of the issues that need to be addressed and the strategies to tackle them are given below.

Technological upgradation of Indian Cottons

Issue *: In order to successfully compete with the cottons of other producing countries; Indian cottons need to have high strength, high maturity and high extensibility, low strength of attachment and short fibre content and low incidence of seed coat fragments.*

Strategy : CIRCOT, being a partner in the All India Coordinated Cotton Improvement Programme would strive to impart above desirable attributes to Indian cottons.

Quality of ginning and of ginned cotton

Issue : *Indian ginneries need to be modernized with energy efficient machinery and human resource in this sector needs upgradation.*

Strategy : Designing of precleaning machines, standardisation of quality of cotton bale, training in gin setting and gin maintenance, preferably on site consultancy for installation of modern ginning and pressing units are some of the strategies needed for improving the quality of ginning and of ginned cotton.

Gaps in Post Harvest Technology

Issue : *Post harvest processing leading to quality products should not only bring about value addition but also should be a means to enhance the income of both grower and processor.*

Strategy : To reduce the gaps in post harvest technology it is necessary to employ objective grading using instrumental test methods, method for prediction of spinning potential of cotton and providing blending norms for each new variety released. Use of Quick Spin System for testing spinnability of samples, suitability of Indian cottons to newer and faster spinning systems and knitting need to be assessed. Conducting Training courses in relatively high tech areas to empower quality control personnel in industries, standardisation of norms for fibre, yarn and fabric quality and research on fabric aesthetics and comfort are a few most important thrust programmes to achieve the above objective.

Challenges in Chemical Processing

Issue *: Chemical processing and finishing meant to impart desirable attributes should keep in mind, minimisation of chemical inputs and energy apart from preserving the environment, workers health and safety.*

Strategy : Some of the strategies to face the challenges in chemical processing would be development of processing additives, source reduction, studies in dyeing using eco-friendly reactive dyes and natural dyes, development of functional finishes including biochemical scouring, eco-Monitoring of textile auxiliaries, etc.

Utilisation of cotton plant by-products & other crop residues

Issue *: By-products of cotton cultivation and processing wastes should be subjected to value addition to enhance growers income and to develop rural entrepreneurship*.

Strategy : With the current awareness on value addition to agro-wastes some of the technologies to be improved are utilisation of cotton plant stalk in preparation of chemi-mechanical pulp for manufacture of news print, blending chemical pulp of cotton stalk with semi-chemical pulps of other agro-residues like rice straw, wheat straw, bagasse, jute caddies, etc. for making paper and other items. Development of binderless hardboards from cotton stalk, preparation of rayon grade pulp and viscose filament from cotton plant stalk, etc are some other areas that need improvement. Apart from these, preparation of low cost edible cottonseed oil, production of bioenergy from cellulosic wastes by solid state fermentation, preparation of biogas from solid cellulosic wastes, preparation of compost from ginning waste, biopulping of various crop residues as well as utilisation of cottonseed meal for various end uses should also be taken up vigorously.

Microbiological Approach to Eco-friendly Processes

Issue *: To preserve environment and to reduce cost of chemicals and energy there is a need to turn to microbial treatments for imparting desirable attributes to cotton textiles.*

Strategy : The emergence of microbiological approach for eco-friendly processes needs research in production of enzymes for treatment of fabrics for smooth finish, microbial breakdown of pesticides and other toxic effluents, production of cellulose in vitro, production of extracellular microbial polysaccharides for sizing yarn and fabrics, bleaching and softening of fabrics using enzymes, etc. Other areas in this field would be studies on Honeydew or stickiness of cotton, study of pesticide residues in cottonseed oil and meal and production of microbial surfactants

Pilot Plant Projects for Technologies Developed

Issue *: Technologies developed at the laboratories need popularization and demonstration.*

Strategy : To demonstrate the viability of the technologies developed as well as popularising them it is necessary to set up pilot plants.

Generation and Dissemination of Technical Information

Issue *: Know how gathered and technologies developed need to be made known to the appropriate user group.*

Strategy : To disseminate information about the technologies that are being generated it is necessary to create a suitable communication network. The technologies can be popularised with the publication of periodical newsletters. Creation of database for all popular varieties of cotton would help breeders and others involved in developing new varieties. There is a need for creation of a Centre of Excellence in Fibre Science and Technology for the benefit of all those engaged in research on the subject. Education and training in the field of cotton technology is another area which will be useful to all those involved in cotton trade and industry.

9.
Programmes, Projects and Fund Requirement

Thrust Areas

With growing concern for food, nutritional and environmental security, there is greater emphasis on the management of input resources and output to bring about cost effectiveness and quality consciousness. It is in this context that engineering principles need to be interfaced with various agricultural science disciplines to meet the intended objectives. With the liberalization of economy and removal of quantitative restrictions for the import and export of commodities, the gestation period for achieving the targets has been reduced considerably.

Indian agriculture at present is characterized by heavy human energy input and very small landholdings leading to low farm income and the resultant low GDP contribution from agriculture. The situation needs to be changed considerably with a quantum shift in the agricultural energy mix on the farm. Human energy from production agriculture needs to be shifted to post harvest loss reduction and value addition activities. The production agriculture needs higher level of mechanization with greater mechanical energy input. The rural areas need to be provided with significant improvement in the infrastructure related to power, transport and communication to reverse the trend of rural to urban migration. It is essential that the post harvest processing and value-addition activities in the rural sector receive adequate attention for the maintenance of food safety and quality. Simultaneously, the by-products from the production and post harvest activities must be suitably treated to derive food, feed, fuel and fibre and to avoid any subsequent ecological degradation. It is in this context that the following list of basic, strategic and anticipatory research activities in the area of agricultural engineering that are relevant to CIRCOT have been identified.

Basic Research:

1. *Frictional behaviour of leather and metal parts in ginning machinery*
2. *Diversified use of cotton and other natural fibres in blends with synthetic fibres*
3. *Behaviour of cotton during mechanical processing*
4. *Morphological, structural and mechanical features of genetically modified cotton*
5. *Production and characterisation of nano particles for use in textiles*
6. *Production and characterisation of microbial pigments/natural dyes suitable for textile dyeing*
7. *Burning characteristics of cotton in different forms*

Strategic Research:

1. *Development of efficient cleaning system for mechanically harvested cotton*
2. *Development of machines suitable for village level processing of cotton*
3. *Application of chemicals/nano particles for functional finishes*
4. *Comfort characteristics of textile fabrics in the context of Indian condition*

5. *Development of microprocessor/microcontroller in post harvest processing of textile fibres*
6. *Utilisation of crop residues for various industrial applications*
7. *Utilisation of lignin for preparation of industrial chemicals*
8. *Development and application of eco-friendly binders for composite boards.*
9. *Monitoring of harmful chemicals in textile processes*

Anticipatory research

1. *Source reduction and treatment of industrial textile effluents*
2. *Production of industrial textiles from natural fibre base*
3. *Home based textiles from natural fibre blends*
4. *Behaviour of Indian cottons in the modern spinning systems*

Based on the identified thrust areas of research, the programmes identified by CIRCOT during the coming years are given below along with the current status, gaps and action points.

Sl. No.	Programs	Current status and Gaps	Action points	Time Frame	Expected Outcome
1.	Technological support to cotton breeders under AICCIP NATP, MMI of TMC, etc in releasing varieties/hybrids	Varieties are released depending upon yield. Quality characteristics are not given due consideration when varieties are released	Testing of samples and categorising them as per CIRCOT norms.	Continu ous	Varieties/ hybrids acceptable to industry
2.	Production and marketing of calibration cottons and preparation of calibration cottons for AFIS	Standard reference materials (calibration cottons) are costly and have to be imported from USDA requiring foreign exchange. Presently standard cottons for calibrating AFIS with special reference to neppiness are also not available.	Preparation of calibration cottons of different fibre characteristics	Continu -ous	Indigenous calibration cottons for Indian market
3.	Development of efficient cleaning systems for mechanically harvested cotton	Mechanical harvesters are not popular in India due to small holdings and non availability of suitable varieties. Mechanically harvested cottons contain high amounts of trash.	Development of appropriate precleaning systems for mechanically picked cotton to reduce trash.	2007-2012	Cleaning machinery for mechanically harvested cotton

4.	Small scale ginnery at rural level	Farmers have to take their produce to places where ginneries are situated. Suitable and affordable small scale ginneries are not in existence.	Establishment of small scale ginnery to help farmers gin at their place to supply raw material to village level processing units.	2007-2012	Additional income to farmers
5.	Quality norms for knitted fabrics	Presently stringent norms are not available for knitted fabrics	Development of norms for various knitted fabrics	2007-2012	Quality norms for knitted fabrics
6.	Fabric aesthetics and wear comfort	Subjective evaluation is still in vogue in India.	Standardisation of objective evaluation methods for fabric aesthetics and wear comfort	2007-2015	New standards for objective evaluation of fabric
7.	Creation of database for physical & chemical properties of all natural fibres and crop residues	Various natural fibres are grown in India and a large amount of crop residue is wasted. Data available on their properties is inadequate.	Creation of a database.	2007-2012	Better utilisation of natural fibres and crop residues
8.	Diversification of cotton and other natural fibres in blends with synthetic fibres	Natural fibres are under utilized. Intrinsic wear comfort properties are rarely tested with cotton. Dominance of synthetic fibres, lacking in wear comfort	Blending of cotton with other natural and synthetic fibres to combine aesthetic elegance with wear comfort and to produce quality apparels and functional textiles.	2007-2020	Novel blended products with cotton
9.	Logistics of cotton stalk and other crop residues, their collection, chipping and transportation of clean chips for use by composite board industry	Cotton plant stalks are presently used as fuel. Data on collection, chipping and transportation is not available	Optimisation of collection, chipping and transportation of cotton stalk to make available as raw material for particle board industries.	2007-2025	Logistics for supply of chipped cotton stalks to industry
10.	Eco-friendly methods for preparing and characterization of unspinnable cottons for medical use	Chemical methods are in vogue. The methods being used are expensive and cause pollution.	Biochemical methods will be standardized.	2007-2010	Environment-friendly process for making surgical cottons
11.	Anaerobic retting of bast fibres for blending with cotton and other fibres	Open retting is currently being practised. Bast fibres are not fully exploited.	Anaerobic retting technology would be perfected and commercialized.	2007-2010	Cost effective ecofriendly process for degumming of bast fibres

12.	Aqueous treatment of fabrics	Chemical treatments are widely used to enhance the recovery characteristics and nhanc of fabrics. CIRCOT studies reveal that these improvements can be brought about by simple aqueous swelling treatment. No data about this treatment on fabrics is available.	Treatment to be imparted to cotton/blended fabrics of various constructions at different stages of processing. Collection of data on tensile characteristics of these fabrics.	2007-2010	An ecofriendly process to remove/ reduce the use of chemicals in fabric finishing treatment.
13.	Development of energy efficient delinting machines	The currently available mechanical delinter consumes lot of energy. Energy efficient machinery is not available.	Development of energy efficient delinting machine to make available quality linters at low cost.	2007-2015	Quality linters at low cost
14.	Promotion of scientific extraction of cottonseed oil and enhanced extraction of oil using enzymes	Presently whole seed is being crushed which results in less oil recovery.	Creating awareness amongst cottonseed crushing industry	2007-2015	Scientifically extracted cottonseed oil and value addition to byproducts
15.	Development of microprocessor / microcontroller based machines for post harvest processing of textile fibres	Microprocessor / microcontroller based machines are not available in India. Imported machines are expensive.	Post harvest processing machines employing microprocessors/ micro-controllers will be developed to ensure high processing efficiency and quality output.	2007-2015	Achievement of high processing efficiency and quality output
16.	Development of energy efficient lab model saw ginning	Presently saw gins are being used to gin medium and short staple cottons. Energy efficient Lab model saw gins are not available	Design and fabrication of a lab model saw gin. Evaluation of efficiency and power consumption	2007-2012	Efficient laboratory model saw gin
17.	Development of machines suitable for village level processing of cotton	Available processing machines at village level are old and outdated. Machines suitable for village level processing of cotton of appropriate quantity is not available in India.	Development needs to be taken up in this area. Raw cotton in the form of processed slivers are to be supplied as raw material for village level spinning, weaving and handloom units.	2007-2012	Processing of cotton at village level
18.	Structure and property	Newer technological development has	Preparation of woven and knitted products by	2007-2020	Database on structure and

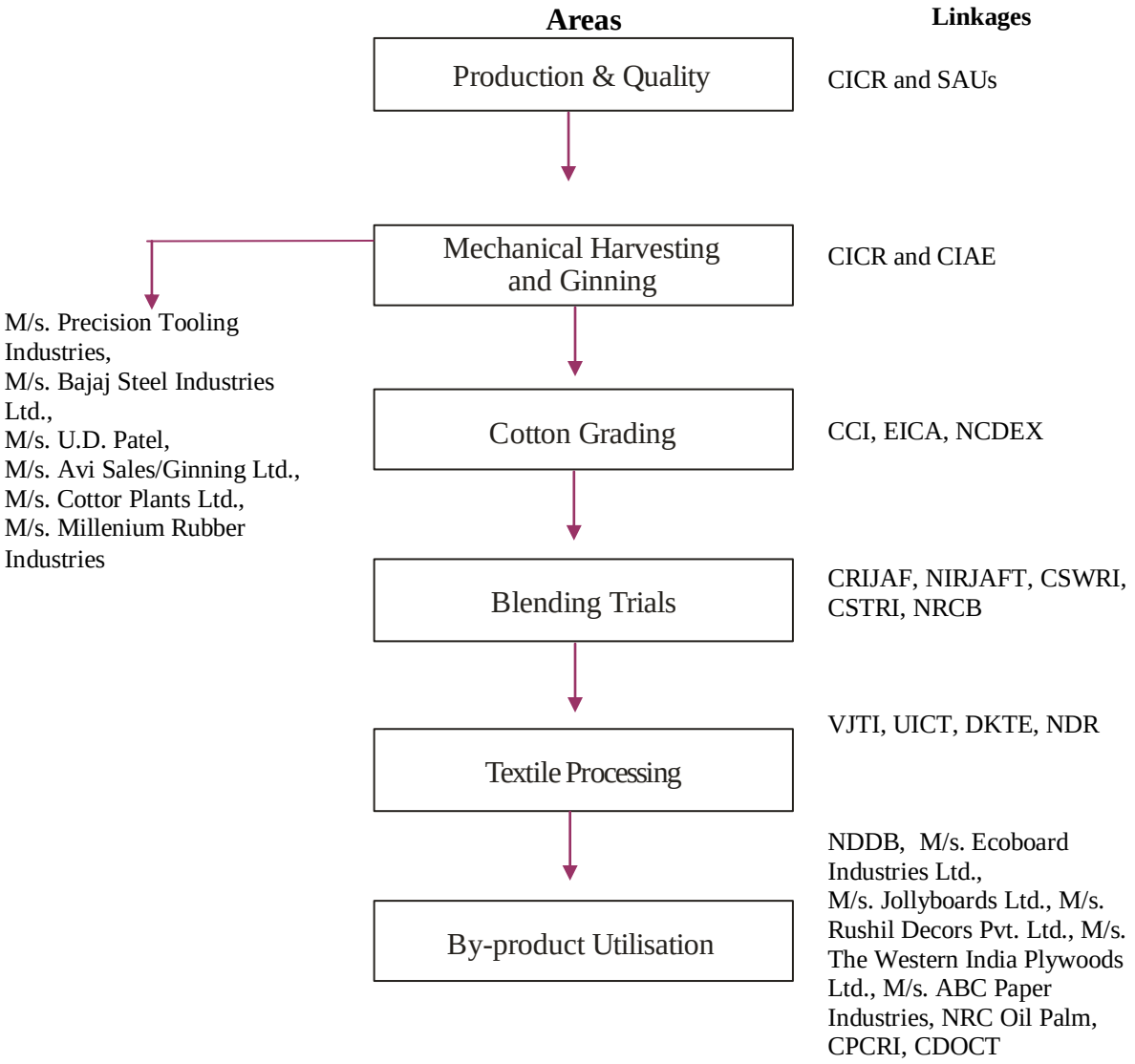
	relationships of fibre, yarn and fabric of knitted and woven materials from Bt./organic and others on different systems	resulted in faster and computer controlled machines. No data is available on the structure and property relationships of fibres, yarns and fabrics used in these machines	using the modern machines and study of the structure and property relationships of fibre, yarn and fabrics		properties of textiles produced by using different systems and their relationships
19.	Burning characteristics of cotton in different forms	During summer months cotton bales catch fire during storage. Data on burning characteristics not available.	Basic and applied studies on burning characteristics of raw cotton.	2007-2012	Better /safer storage methodology
20.	Production of composite and home based industrial textiles from natural fibre base	Composite textiles are generally produced using friction spinning. Sufficient data on production of these textiles in cotton spinning system is not available.	Systematic study will be taken up	2007-2015	Diversified uses of cotton and other natural fibres
21.	Production of garments and fashion designing	The value addition is too high for readymade garments and fashion designing is changing everyday	Woven fabrics will be made into garments in an identified manufacturing industry	2015-2020	Value addition to garments
22.	Eco-friendly wet processing, dyeing and finishing of cotton and blended textiles	Conventional chemical processing discharges toxic effluents. Effluent treatment is expensive.	Eco-friendly methods will be developed to reduce the load of effluents.	2007-2015	Greener processing methods
23.	Production, characterization and application of nano particles for use in imparting functional finishes to textiles	Research on nano particles is an emerging area. Sufficient data not available.	Nano particle production through ecofriendly route would be attempted. Nano-technology will be used to improve the application efficacy, functional finish efficiency and cost competitiveness.	2007-2020	Novel functional finishes
24.	Production and characterization of microbial pigments/natural dyes suitable for textile dyeing and development of	Research on microbial pigments is an emerging area. Data on microbial pigments/natural dyes are inadequate.	Application techniques employing microbial pigments would be standardized to impart therapeutic properties to textiles intended for	2007-2012	Speciality medical textiles

	antibacterial properties, etc.		medical use.		
25.	Development of Eco-friendly textile processing, using enzymes and treatment of textile / paper industry effluents	Ban on export of garments containing pesticide residues. Methods to analyse and quantify pesticide residues not yet standardized. Chemical methods, which discharge toxic effluents, are currently being used. Efficient and cheaper methods are not available. Currently costly chemical methods are predominantly used. Efficient and cheaper methods are not available. Small scale industrial effluent treatment plants absent.	Quantification of pesticide residues in cotton textiles and their monitoring. Biochemical methods will be standardized and up scaled. In addition to chemical treatment, biochemical methods will be tried for effluent processing. Small scale viable treatment plants to be developed.	2007-2018	Safer textile products, Cleaner textile processing, safer methods of effluent treatment
26.	Bio-chemical pulping technology	Currently chemical pulping is only available. Biopulping is not commercially adopted.	Attempt will be made to install a semi-continuous plant in a paper mill and popularize this technology.	2007-2012	Environment-friendly pulping process
27.	Development and application of eco-friendly binders for composite boards.	Currently chemical binders are being used. These binders are not eco-friendly.	Natural materials like cashew shell liquid, chitin, other organic binders, etc., which are eco-friendly will be tried.	2007-2012	Eco-friendly binders for composite boards
28.	Enrichment of lingo cellulosic crop residues with microbial proteins	Crop residues are currently being used as cattle feed. Lignocelluloses are poor in nitrogen, possess low digestibility.	Anaerobic treatment to enrich various crop residues for use as cattle feed would be taken up as an eco-friendly methodology.	2007-2012	Bio-enriched cattle feed

29.	Production of biodiesel from rancid/used cottonseed oil / hydrogen from industrial wastes / energy from cotton biomass	Presently fossil fuel is being used. There is depletion of fossil fuel.	Rancid cottonseed oil will be used as raw material for production of biodiesel. Technology and application methodology would be standardized.	2008-2015	Bio-diesel from rancid cottonseed oil
30.	Fabrication of cage gins	Presently double roller gins, saw gins and rotobar gins are being used. Seed coat fragments, cut seeds and fibre breakages are commonly observed.	Cage gins are expected to pull out fibres due to centrifugal force and lint is expected to be much more cleaner	2012-2020	Cage gin
31.	Production of knitted and woven cotton and silk blended fabrics	Silk is expensive and amenable to moth attack	Cotton : Silk blended fabrics are cheaper, lustrous and resistant to moth attack	2012-2020	Cotton and silk blended fabrics
32.	Development of biochemical methods to improve the inherent strength of cottons	Presently only breeding methods are possible which are time consuming	Biochemical methods are expected to increase the required strength of lint	2012-2020	Alternate route for enhancement of quality of cottons
33.	Production of microbial biosurfactants	Presently they are made from petroleum based products and not ecofriendly	Microorganisms capable of producing biosurfactants will be mass produced and used. They are ecofriendly and biodegradable	2012-2020	Safer biosurfactants
34.	Preparation of intelligent textiles (smart textiles) using natural fibres	Currently Smart textiles are being made using manmade fibres.	Development of natural fibre based smart textiles	2012-2025	Smart textiles

10.
Linkages, Coordination and Execution Arrangements

CIRCOT has been collaborating with other ICAR institutes, Govt. organizations and with appropriate private organizations in its research projects. The following table gives details of the linkages :



In the years to come the existing linkages would be strengthened to derive maximum benefits. CIRCOT would also strive to establish meaningful contacts with organizations like NIFT to prepare niche consumer-appealing textiles. Useful R & D programmes and application endeavours would also be taken up by liasioning with both national funding agencies like DST, DBT, etc. and international agencies like CFC, UNDP, World Bank, FAO, etc. The Institute also has liaisons with M/s. Morarji Bombana, M/s. Mafatlal, M/s. Century Textiles and Industries M/s. Reliance Industries, M/s. Bombay Dyeing, Gokak Mills, M/s. Grasim Industries for commercial testing activity.

11. Critical Inputs

11.1. Funds

Estimated Budget for Next two Five Year Plans

Rs. in Lakhs

Expenses	X Plan	XI Plan	XII Plan
Recurring	502.66	800	1200
Non Recurring	776.27	1600	2000
Total	1278.93	2400	3200

11.2. Personnel

Personnel Available and Future Needs

Category	Sanctioned	In Place	Additional Requirement
Scientific	50	29	5
Technical	114	108	11
Administrative	48	46	2
Supporting	68	61	-

Immediate requirement of staff

To carry out the envisaged projects there is an immediate requirement for scientists in the following disciplines. This is needed in addition to filling up the exixting vacancies for which requisitions have been made already.

Biotechnologist – 1
Chemical Engineer – 1
Textile Manufacture – 2
Home Science (Textiles) – 1

11.3. Human Resource Development

On identified critical areas needing human resource development the Institute would do its best to provide training to the existing staff and would also strive to get more staff with required background. Some of the areas identified for training are as follows :

Frontier area of training	Institute where the training will be given
Advanced Fibre Information System	Zellweger Uster, Switzerland
Ultra structural studies on fibres with special reference to XRD, FTIR & SEM	M.I.T., U.S.A.
Advances in Cotton Processing/Ginning	U.S.A.

Frontier area of training	Institute where the training will be given
Quick-spin Technique	Institute fur Textiltechnik, Reutlingen, Denkendorf, Germany
Air-jet Spinning	Kyoto Institute of Technology, Kyoto, Japan
Friction Spinning	CSIRO, Australia
Modelling and Computer Simulation of Reverse Engineering Process	Engineering Staff College, Hyderabad, India or Indian Statistical Institute Calcutta
Computer-aided Weaving Design	VJTI, Mumbai
Fabric Aesthetics and Comfort	Kyoto University, Kyoto, Japan/ University of Maryland, U.S.A.
Eco Testing of Textiles for Banned amines and Pesticides	Federal Bureau of Consumer Health Protection and Veterinary Medicine, Germany
Printing of Textiles	U.I.C.T., Mumbai/ V.J.T.I., Mumbai/ I.I.T., New Delhi
Designing and Development of Packaging Materials	Indian Institute of Packaging, Mumbai
Bio-Technology Applications in biopulping, nano particle production, etc.	CPPRI, Saharanpur
Solid-State Fermentation for Bioenergy, Enzymes and Mushrooms	Fruit Research Institute, Norwich, U.K./ Dept. of Biotechnology, Cornell University, U.S.A./ Institute für Biodenbiologie, FAL, Bunolesalle, 50, 3300, Braunschweig, Federal Republic of Germany/ Dept of Food Science and Technology, University of California, Davis, California-95616
Technology Marketing and Entrepreneurship Development	NAARM, MANAGE – Hyderabad

12.
Risk Analysis

The land use policy is very important. The area under cotton cultivation has been steady at about 8.5 lakh hectares in the past many years though in the last two years a significant increase has come about. The productivity requirements projected for the coming years are based on this area remaining unchanged. If the area is reduced due to any radical change in land use policy of the Govt. of India, our calculations are likely to be upset.

The inherent comfort properties of cotton are ruling over even with stiff competition from synthetic fibres. Many industries are devoted to processing 100% cotton. Availability of cotton world over is on the increase due to improved cultivation practices coupled with genetically engineered crops. Although plans are chalked out with the optimism that favourable climate would persist, it is necessary to be conscious of the risks and pitfalls in our endeavour. In view of the predominance of dry farming (rainfed cultivation) in Indian agriculture with regard to cotton cultivation, the production of cotton is always questionable.

A number of varieties/hybrids are being released both by public and private organizations. If the fibre attributes are not satisfying the requirements of high speed spinning and weaving systems they cannot sustain in the mainstream of varietal release.

High strength cottons will not be in place suiting high spinning mills.

Cotton will not find place as blends with other fibre due to inherent properties.

Non implementation of eco-friendly pre and post process will continue to discharge more toxic pollutants and environment will not be safe and clean.

Non utilisation of crop residues including cotton stalks will not generate rural employment and rural based industries and not prevent deforestation.

A shift in textile policy by the government wherein synthetic fibres particularly polyester if given prominence there is every likelihood of a threat for the survival of cotton.

If crop residues in general and cotton stalk in particular are not available to board industry at an affordable price it would affect the raw material procurement scheme.

Scientific resources in the designated disciplines if not restored, will drastically affect the implementation of scientific programmes. Above all, the progress of the project will depend on the availability of funds. Any major shift in policy with regard to allocation of funds for research will adversely affect the programme or may call for revision and reorientation.

13.
Project Review, Reporting and Evaluation Arrangements

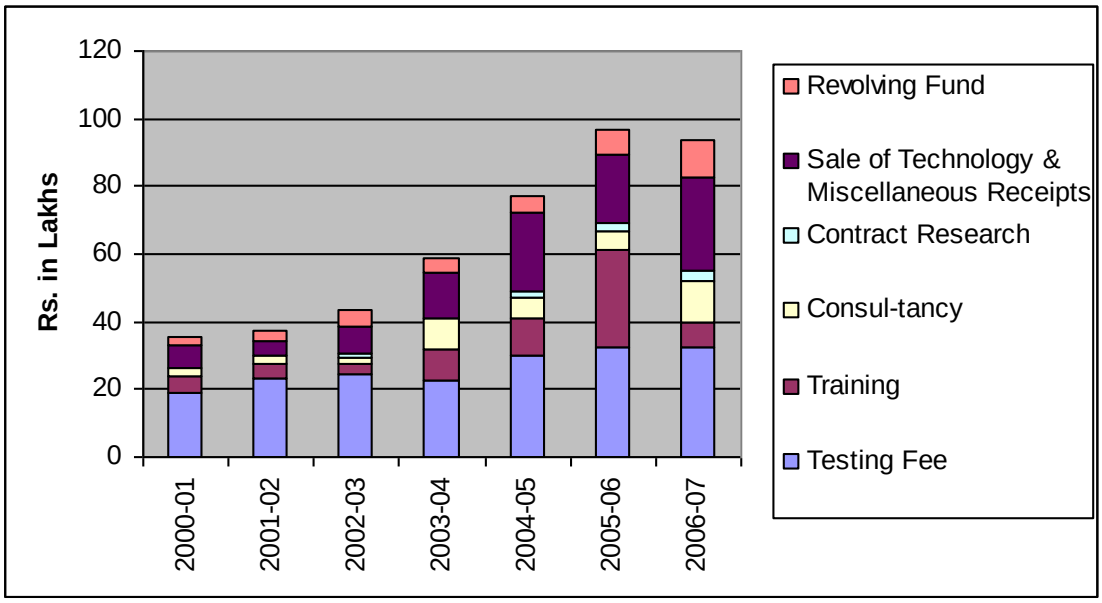
The Project Monitoring and Evaluation Committee (PME) reviews the project reports and submits its comments to the IRC and RAC. The Research Advisory Committee (RAC) gives its feedback on the progress of the various projects. After a thorough discussion the RAC recommends/suggests new areas for research. The Institute Research Council (IRC) of CIRCOT monitors the selection of project proposals by giving suitable feedback. It reviews the progress of work done on each project, approves changes in plan of work, etc. At the end of each project the IRC interacts with the project group to learn the positive and negative aspects of the project. The final project reports are regularly sent to the Subject Matter Division (SMD) at ICAR, which monitors the results. The Director General, ICAR also regularly monitors the research progress made by the Institute. Once in five years, a Quinquennial Review Team (QRT) constituted by ICAR reviews the research activities of the Institute and submits its report along with recommendations to the Council.

14.
Resource Generation

CIRCOT generates revenue through the following activities/programmes :

Commercial testing of textiles
Training programmes in cotton quality evaluation, gin maintenance and training in sophisticated testing instruments
Sale of technologies developed at CIRCOT
Contract research
Consultancy for setting up testing and ginning units
Research projects under revolving fund scheme of ICAR

Resource Generation over last seven years (Rs. In lakhs)



CIRCOT currently generates on an average about 8-10% of the total budget (Plan + Non Plan) annually as revenue. The Institute would strive to enhance this share to 20%.

15.
Output

The implementation of the programme envisaged upto 2025 would lead to the following situation:

- ✯ Imbalances in the production of different staple classes of cotton would have been completely removed and there would be adequate quantity of cotton produced in the country for spinning to all required count levels. Further, India would have established itself as a major exporter of cotton catering to the needs of countries in the East and West alike.
- ✯ Technological properties of Indian cottons would have received a boost in respect of fibre maturity, strength and extensibility. Many Indian cottons would be adapted to processing on high speed spinning and weaving systems.
- ✯ Cotton Ginning would be modernised and precleaning practice would become popular. Trashy Indian Cotton would be a thing of the past.
- ✯ Spinnability of cotton would be more accurately predictable by means of statistical formulae such that fibre quality indices would directly determine the commercial value of cotton.
- ✯ Means would have been found for designing cotton fabrics of predetermined levels of durability, aesthetic value and comfort.
- ✯ With the evolution of new finishing processes cotton fabrics would imbibe the desirable characteristics of synthetics thereby gaining superiority over the latter.
- ✯ With appropriate finishing using modern tools and reagents, textiles would not only be a protector from vagaries of weather or one to enhance aesthetic appeal and wear comfort but would have become a means of –well being‖.
- ✯ Cotton by-products and waste materials would emerge as commodities having extensive application such that cotton farming becomes more remunerative and rural economy attains strength.

16.
Outcome

By 2025 the following could be expected:

- ✯ Varieties/hybrids acceptable to the industry
- ✯ Indigenous calibration cottons for Indian market and therefore non dependence on imported USDA calibration cottons
- ✯ Cleaning machinery for mechanically harvested cotton – contaminant free clean cotton
- ✯ Efficient laboratory model saw gin
- ✯ Processing of cotton at village level – availability of quality yarn for village processing
- ✯ Diversified uses of cotton and other natural fibres
- ✯ Better utilization of natural fibres and crop residues
- ✯ Novel blended products from cotton and novel functional finishes
- ✯ Better utilisation of genetically modified / organic cottons
- ✯ Logistics for supply of chipped cotton stalks to industry – an alternate raw material for board industry and deceleration of afforestation
- ✯ Environment- friendly process for making quality surgical cottons
- ✯ Cost effective ecofriendly process for degumming of bast fibres – quality bast fibres for blending
- ✯ Cleaner textile processing, safer methods of effluent treatment
- ✯ Scientifically extracted cottonseed oil and value addition to byproducts
- ✯ Eco-friendly binders for composite boards
- ✯ Bio-diesel from rancid cottonseed oil and reduced dependence on petroleum based fuel
- ✯ Specialty medical textiles and smart textiles

17.
Concluding Remarks

The Institute intends to pursue research in areas like energy efficient ginning and cleaning to enable production of contaminant-free clean cotton, high speed spinning and fabric manufacture, non-conventional blending for preparation of novel products, eco-friendly chemical finishing and by-products utilisation by value addition in order to address the problems confronting cotton utilisation. Simultaneously, there is an urgent need to –diversify‖ use of cotton into –non-traditional‖ areas like industrial and functional textiles and also in the manufacture of –non-conventional‖ niche market products. This is all the more necessary for sustaining the additional productivity sought to be achieved by implementation of cotton improvement programmes like –Technology Mission on Cotton‖, –Commercial Cultivation of Bt/Transgenic Cotton‖ and –Integrated Cotton Farming‖, etc. It is hoped that all these efforts, would bring back glory to –king‖ cotton and make cotton farming a remunerative endeavour. Finally it is felt that a comprehensive value chain approach encompassing fibre, stalks and seed by-products would not only provide cost competitiveness and quality but also enable equitable sharing of benefits among all the stakeholders in the sector.

ANNEXURE I
Role of Regional Units

CIRCOT has six Regional Units located at Sirsa, Surat, Nagpur, Dharwad, Guntur and Coimbatore. These units cater to the agricultural universities and other research institutes carrying out research in cotton. They also undertake commercial testing of cotton samples that is a source of revenue generation. It is suggested that all the units need strengthening in terms of infrastructure and human resource. The commercial testing facilities at the units need to be strengthened. A scientist should be deputed to the units as in-charge so that research on cotton in collaboration with the agricultural universities could be taken up. The regional units must also be involved in transfer of technology activities of CIRCOT. They must be used as a window for popularising the technologies developed at CIRCOT.

ANNEXURE II
Hall Mark of the Institute

National Centre of Excellance in Cotton Fibre Science and Technology

Technological support to cotton breeding, ginning, spinning, quality evaluation of textiles, fibre structure analysis and agrowaste utilization through chemical and biological processes are areas in which CIRCOT has conducted extensive R&D work.

Over the years the Institute has standardized several techniques for the determination of physical, rheological, surface and structural features of cotton fibres, yarns and fabrics. The institute has laid a strong foundation needed for carrying out basic studies on structure and morphology of cotton fibres. Investigations carried out at CIRCOT has helped to unravel structure – property relations in developing fibres and understand the mechanism of cellulose biosynthesis. Research efforts in the Institute have led to significant breakthrough in the prediction of important fibre properties from structural studies. Comparative studies of various aspects of fibre structure and morphology both prior to and after chemical modifications of cotton fibres contributed immensely in understanding the structural differences that exist among varieties. Studies on the rheological characteristics of fibres and yarn have thrown significant light on the visco-elastic domain of cotton fibres. Institute has propounded indicies to grade fibres and yarns and prediction formulae relating fibre properties to the spinning potential of the variety. Extensive studies on cotton blended with other natural fibres and man-made fibres have shed light on the potential of cotton blends, which will enhance the utility of cotton.

Scientific publications on basic research emanating from the Institute have been widely acclaimed nationally and internationally. Being the only one premier Institute in the country devoted purely to the cause of cotton and functioning with a view to enhance its quality and utilization, the Institute is providing (also looked upon to provide) solutions to specific problems, pertinent to cotton, faced by the textile and allied industries.

On technology side too, the CIRCOT has several firsts in the area of post harvest technology especially on ginning and by-product utilization. At the time cotton, which forms vibrant part of Indian Economy, is threatened not by man-made fibres but also by on flow of quality cottons from abroad, CIRCOT with its man power, equipment and infrastructure has the capacity and potential to come out with solutions related to cotton in all its spheres from breeding to industry.

CIRCOT is recognized by Mumbai University for post graduate and doctoral studies by research in various disciplines viz. Physics, Textile, Technology, Chemistry and Microbiology. This is the only Institute in the country wherein studies are carried out in Textile Physics for the award of M.Sc. and Ph.D. In view of its inherent strength, the Institute could be considered as a –National Centre of Excellence in Cotton Fibre Science and Technology‖ and could be appropriately strengthened both in terms of human resources and infrastructural facilities in the near future to carry out the enlarged mandate and programmes proposed with vision document.