Vision 2050

National Institute of Research on Jute and
Allied Fibre Technology
Indian Council of Agricultural Research

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National Institute of Research on Jute and
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(Indian Council of Agricultural Research)
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प्राक्कथन

भारतीय सभ्यता कृषि विकास की एक आधार रही है और आज भी हमारे देश में एक सुदृढ़ कृषि व्यवस्था मौजूद है जिसका राष्ट्रीय सकल घरेलू उत्पाद और रोजगार में प्रमुख योगदान है। ग्रामीण युवाओं का बड़े पैमाने पर, विशेष रूप से शहरी क्षेत्रों में प्रवास होने के बावजूद, देश की लगभग दो-तिहाई आबादी के लिए आजीविका के साधन के रूप में, प्रत्यक्ष या अप्रत्यक्ष, कृषि की भूमिका में कई बदवाल होने की उम्मीद नहीं की जाती है। अत: खाद्य, पोषण, पर्यावरण आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

पिछले 50 वर्षों के दौरान हमारे कृषि अनुसंधान द्वारा सृजित की गई प्रौद्योगिकियों से भारतीय कृषि में बदलाव आया है। तथापि, भौतिक रूप से (मृदा, जल, जलवायु), बायोलोजिकल रूप से (जैव विविधता, हॉस्ट-परजीवि संबंध), अनुसंधान एवं शिक्षा में बदलाव के चलते तथा सूचना, ज्ञान और नीति एवं निवेश (जो कृषि उत्पादन को प्रभावित करने वाले कारक हैं) आज भी एक चुनौती बने हुए हैं। उत्पादन के परिवेश में बदलाव हमेशा ही होते आए हैं, परन्तु जिस गति से यह हो रहे हैं, वह एक चिंता का विषय है जो उपयुक्त प्रौद्योगिकी विकल्पों के आधार पर कृषि प्रणाली को और अधिक मजबूत करने की मांग करते हैं।

पिछली प्रवृत्तियों से सबक लेते हुए हम निश्चित रूप से भावी बेहतर कृषि परिदृश्य की कल्पना कर सकते हैं, जिसके लिए हमें विभिन्न तकनीकों और आकलनों के मॉडलों का उपयोग करना होगा तथा भविष्य के लिए एक ब्लूप्रिंट तैयार करना होगा। इसमें कोई संदेह नहीं है कि विज्ञान, प्रौद्योगिकी, सूचना, ज्ञान-जानकारी, सक्षम मानव संसाधन और निवेशों का बढ़ता प्रयोग भावी वृद्धि और विकास के प्रमुख निर्धारक होंगे।

इस संदर्भ में, भारतीय कृषि अनुसंधान परिषद के संस्थानों के लिए विजन-2050 की रूपरेखा तैयार की गई है। यह आशा की जाती है कि वर्तमान और उभरते परिदृश्य का बेहतर रूप से किया गया मूल्यांकन, मौजूदा नए अवसर और कृषि क्षेत्र की स्थायी वृद्धि और विकास के लिए आगामी तीन दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

(राधा मोहन सिंह)

Foreword

Indian Council of Agricultural Research, since inception in the year 1929, is spearheading national programmes on agricultural research, higher education and frontline extension through a network of Research Institutes, Agricultural Universities, All India Coordinated Research Projects and Krishi Vigyan Kendras to develop and demonstrate new technologies, as also to develop competent human resource for strengthening agriculture in all its dimensions, in the country. The science and technology-led development in agriculture has resulted in manifold enhancement in productivity and production of different crops and commodities to match the pace of growth in food demand.

Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farms, rural-urban migration, coupled with new IPRs and trade regulations, are some of the new challenges.

These changes impacting agriculture call for a paradigm shift in our research approach. We have to harness the potential of modern science, encourage innovations in technology generation, and provide for an enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy, and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive. Our institutions of agricultural research and education must attain highest levels of excellence in development of technologies and competent human resource to effectively deal with the changing scenario.

Vision-2050 document of ICAR-National Institute of Research on Jute & Allied Fibre Technology (NIRJAFT), Kolkata has been prepared, based on a comprehensive assessment of past and present trends in factors that impact agriculture, to visualise scenario 35 years hence, towards science-led sustainable development of agriculture.

We are hopeful that in the years ahead, Vision-2050 would prove to be valuable in guiding our efforts in agricultural R&D and also for the young scientists who would shoulder the responsibility to generate farm technologies in future for food, nutrition, livelihood and environmental security of the billion plus population of the country, for all times to come.

(S. AYYAPPAN)
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Preface

Jute and allied fibres constitute a diverse group of plant fibres catering to the various requirements of the people in the country apart from creating large employment opportunities and contributing significantly to the national exchequer through export. This sector occupies an important place in the national economy especially in the eastern and north eastern region as it supports nearly four million farm families. Besides, industry provides direct employment to above two lakhs industrial workers and livelihood to another 1.5 lakh people in the tertiary and allied sector.

Besides jute, other natural fibres like banana, sisal, flax, ramie, sunnhemp, coconut, pineapple leaf fibre, etc. have separate characteristic properties and possess immense potentialities along with jute for creating a healthy, sustainable and environment-friendly choice of livelihood for the people. But the fibres are scarcely used as these are not available in plenty due to lack of awareness and non-availability of appropriate extraction technology. The potentialities for utilization of the residual biomass after extraction of these fibres for conversion to value added products may be exploited to make fibres extraction commercially viable and attractive. Production and processing of jute and allied natural fibres for value addition and utilization of fibre agro-residues will help in sustainable livelihood and empowerment of the poor in the rural sector.

The technological research and development in different areas of jute and allied fibres carried out at the National Institute of Research on Jute and Allied Fibre Technology through decades has created a vast knowledge base and developed technologies in processing and product development for the medium and small scale entrepreneurs in the decentralized sector. Opportunities have been created in employment generation and livelihood support and improvement for the people at large. Pioneering work on quality upgradation of fibre, design and development of instruments for quality management of fibres, processes for diversification and value addition to fibres, technologies for utilization of fibre agro-residues, geotechnical and agro- horticultural applications of fibres, biocomposites, fibre boards, paper, etc. have been carried out and technologies have been disseminated.

In continuance of the ICAR's continuous efforts for harnessing science through generation, refinement and assessment of appropriate

technologies, NIRJAFT has played a major role in promoting excellence in development of novel technologies in extraction of fibres from jute and other allied fibre plants. The ribboner developed by NIRJAFT is a model for fibre extraction units of various institutes. Envisioning the crisis of water availability in the near future, the Institute has developed retting technology which requires practically insignificant quantity of water. In the VISION document some priority areas have been identified which may fetch socio-economic benefits to the fibre producing farmers. The scientists of NIRJAFT have the commitment to fulfill the vision of our Prime Minister, Make in India concept to indigenize various lignocellulosic fibre processing machinery at the earliest.

VISION 2050 document provides a road map to support the vision direction, identify the major barriers to progress and focus attention on priority areas. This document consists of specific challenges to the institute ranging from short term to long term, production of quality fibres, enhancement of ecological importance of jute and allied fibres, opening of new business ventures, introspection into future growth areas, life cycle analysis, value chain approach for unexploited and under exploited fibres and their biomass, application of biotechnology and nano technology, management of agro residues, technology transfer systems and exploring emerging and cutting edge technologies.

Director appreciates the sincere and diligent efforts of Dr. Sambhu Nath Chattopadhyay, Principal Scientist and Dr. Utpal Sen, Chief Technical Officer for bringing out this vision document, VISION 2050 in time.

(D. Nag)

Director

Contents

Acronyms

CNTs	Carbon Nano Tubes
GIS	Geographic Information System
GM	Genetically Modified
GPS	Global Positioning System
GURT	Genetic Use Restriction Technology
ICT	Information & Communications Technology
IPR	Intellectual Property Rights
ISF	International Seed Federation
ISTA	International Seed Testing Association
MAS	Marker Assisted Selection
MIR	Molecular Impulse Resonance
NSAI	National Seed Association of India
OECD	Organization for Economic Co-operation and Development
PGPR	Plant Growth Promoting Rhizobacteria
PPP	Public Private Partnership
SPT	Seed Production Technology
SRR	Seed Replacement Rate
TOT	Transfer of Technology
UPOV	International Union for the Protection of New Varieties of Plants
USD	United States currency in Dollar
VRR	Varietal Replacement Rate

Context

National Institute of Research on Jute and Allied Fibre Technology established in 1938 is dedicated to the cause of jute and allied fibres in respect of agricultural development in one hand and industrial growth on the other. With passage of time this institute has undergone a thorough reorientation in its activities conforming to changed consumer demand and global scenario. Jute, lignocellulosic fibre has a pride of place in Indian fibre sector providing livelihood to millions of families. It is, however highly underutilised in comparison to the potential that exist for this natural and renewable fibre nationally as well as internationally. The technological research and development in different areas of jute and allied fibres carried out at NIRJAFT during its 75 years of glorious existence has made exceptional achievements for socio economic uplift and created a vast knowledge base for benefit of stake holders. Now there is a need to revisit these achievements in today's perspective of global warming, global population growth, global economy, global water crisis, energy crisis, technological advancement and many more to count. There are a lot of challenges that the society has to face to keep up with above mentioned requirement. Policies have to be made, decisions have to be taken and actions need to be carried out. And for such an endeavour to be successful we need a vision. A vision, which is focussed and achievable. The future approach will be knowledge intensive, based on alternatives to mechanical and chemical processing as well as built on the capacity of farmers / workers for higher productivity with limited natural resources and input efficiency. It will be based on principles of low input sustainable processing and increased biological, nano-technological and ICT (Information and Communication Technology) enabled technology. Presently jute sector is mostly based on large scale industry. There needs to be a shift of this position to small scale industry to flourish significantly. Initiatives have already been taken. These small scale industries will mostly be rural based and produce jute and other lignocellulosic fibre based products such as specialty yarns, decorative fabrics and handicrafts with miniature processing system.

It has been realised that for the advancement of jute and other lignocellulosic fibres, the commodity should not be restricted to making packaging goods only. The benefit of the sector should reach the farmers, traders and industrialists in totality. It has, however, been found that

farmers do not get remunerative price from their produce and they are, in general, being discouraged to grow jute because distressed sale has become a common practice in almost all the years. This is not a healthy situation at all and the jute and allied fibre sector can only flourish if benefit can be shared duly among the farming community, traders and industries at large. The uniqueness of jute and allied fibre crop is its annual renewability at a low cost and farming of these fibres is affected by adversities of nature to a lesser extent than other crops.

With the above scenario in the background NIRJAFT has transformed itself from a mere quality testing organization to a research institute with well distinct activities viz. (a) The Institute is working on jute as well as allied fibres (flax, ramie, banana, sunhemp, pineapple, sisal, dhaincha, etc) and their agro-and industrial residues. (b) The Institute deals with post harvest aspects and development of products out of jute as well as from allied fibres and their blends. (c) The Institute is devoted to R&D activities on both woven and non-woven products to be used as domestic goods, disposable bags, floor coverings, geo-textiles, agro-textiles, other technical textiles and composites. (d) The Institute deals with both large and small scale industries, organized and decentralized sectors and the farming community. (e) NIRJAFT functions in close collaboration with industries and entrepreneurs in one hand and academic institutions on the other. The challenges being faced have to be countered through extensive diversification of jute and allied fibre products beyond their packaging arena.. For this, chemical, biochemical and nano- technological modification and development of processes and products for utilization of jute and allied fibres in new and virgin areas, development of miniature processing system, blending of jute and allied fibres with natural/manmade fibres may be taken up as strategies. The trend shows that in the future days to come NIRJAFT will be a multi-disciplinary institute encompassing engineering, textile technology, chemical technology, electronics, bio-technology and nano technology as well.

Mandate

a) To carry out basic and technological research on jute and allied fibres.
b) To promote production of good quality fibres.
c) To upgrade the fibre and the product quality.
d) To find diversified uses of plant fibres, their by-products and industrial wastes in large scale and decentralized sectors.
e) To act as a repository of scientific and technological information on jute and allied fibres.

f) To act as a centre of human resource development in relation to jute & allied fibres and establish linkages among different scientific and industrial organizations through exchange of scientific and technological knowledge.

In the past research contributions of the institute comprised development of various technologies for improved retting, devising system for grading jute and popularization & creation of miniature jute spinning system in decentralized sector. The institute developed several technologies for processing of underutilised fibres such as pineapple leaf, banana, ramie, sisal, etc., on jute machineries. A number of products including jute apparel, furnishing textiles, shopping bag, and warn garments have been developed. Different types of non-woven products and its applications as geo-textiles, agro-textiles and technical-textiles have been identified. Improved bleaching, dyeing and finishing of jute yarn and fabrics using energy saving and eco-friendly techniques helped in development of value added and diversified products. Particle board, bio-composites and moulded products and pulp and paper have been produced from jute and jute residues which were found popular in industries. A number of modern instruments were devised for evaluation of jute fibre and product quality and studies have been done on fine structure and physical properties of bast and leaf fibres. Institute has the credit of having several patents which are already granted and few of the patents are in the final stage of approval. To revamp the industry and nurture the small and medium scale entrepreneurs, business planning and development (BPD) unit has identified several technologies to turn the innovative research ideas into sound commercial ventures in technology business incubation concept.

Indian Council of Agricultural Research is a prime organisation for agricultural and related activities in India. Their activities are linked to the technology development, its dissemination, value chains and many more in food and fibre sector. It has thus major role to play in dealing with current problems and equipping India for its future needs. The diversity in agricultural sector is tackled by various Institutes under ICAR. The National Institute of Research on Jute and Allied Fibre Technology is playing a path breaking role in the field of post harvest technology on jute and allied fibre and has overcome numerous challenges for more than seven decades and is now a leader in this field. The technologies developed by the institute are adopted by the farmer and industries, applauded by the policy makers and have made a contribution to the society. The institute is responsive, vibrant and sensitive to the needs of its stakeholders and it is expanding its reach for generating and

disseminating new knowledge pertaining to natural fibres.

Vision

To uphold the cause of jute and allied fibres in favour of farmers, trade and industry keeping in view the prevalent global scenario and bring back the glory of the golden fibre with socio-economic uplift.

Mission

The mission of NIRJAFT is to utilize jute and allied fibres in wide and diverse areas by exploiting the intrinsic and advantageous properties of the fibres and converting the demerits whatsoever into merits by application of scientific tools through development of technologies, products and process for the benefit of farmers and industries both the large and small scale.

Focus

To accomplish the VISION and MISSION for holistic development of natural ligno-cellulosic fibre sector starting from production, processing, marketing and entrepreneurship development, NIRJAFT is engaged for more than seven decades and will also march ahead with these objectives in future. It would concentrate on the following strategic areas involving modern cutting edge frontier research technologies.

- The emerging power of science and technology would be harnessed in the research activities of NIRJAFT for cost-effective production, processing and value addition to jute and allied fibre and better technologies for breakthrough in promising fields of geo-technical, agro-horticultural, bio- and green-composites etc., as well as in exploiting the utilization potential of their agro-residues.
- Stress would be given on developing low-cost and eco-friendly technologies for extraction of fibres with low or no-water requirement in view of water scarcity.
- Proper storage of fibres for longer duration without damage is an priority area.
- Industrial process for extraction of fibres from plant
- Use of nonconventional and renewable energy for mechanical and chemical processing of fibres
- Instrumentation for quality management of fibre, development of finer yarn from jute and jute blends, new process line for spinning and non-woven machineries
- Development of jute and allied fibre based bio- and green-composites, non-yellowing hand-made paper from jute whole plant,

green technologies utilizing eco-friendly processing and finishing chemicals for making value added and diversified jute and allied fibre products

- Innovative cutting edge technologies intervention with biotechnology and nanotechnology for development of value added products and nano-composites from jute and allied fibres would be a priority research area in the ensuing program of NIRJAFT
- Efficient utilization of under-exploited fibres like banana, coir, sisal, pineapple leaf fibre , ramie, etc., and their agro-residues through value chain system would be a priority
- Management of IPR issues and environmental concern in R&D activities are important in the present context and would address effectively in the coming years.
- Use of biomass, after extraction of fibre, for preparation of fine chemicals.
- Extraction and utilization of lignin and its derivatives for industrial use.
- NIRJAFT would take advantage of new tools, technologies and approaches evolved with the emerging science and technology for human resource development and accelerate dissemination of technologies, entrepreneurship development through business incubation, cluster development to promote livelihood through marketing of innovative natural fibre products.

A futuristic look in the field of jute and allied fibres in the domestic and global context and likely scenario in 2030 has been documented earlier. The outlook for starting afresh has emerged as the need of the time in view of the challenges of population increase, water crisis, climate change and growing environmental consciousness which has created new opportunities in the domestic and global market for development of natural fibres to meet the consumer demand in diverse fields. It has become necessary to revisit the Vision 2030 document and look at the priorities and programme afresh with an outlook of the likely scenario in 2050. This document provides a roadmap to support the vision direction, identify the major barriers to progress and focus attention on priority research areas. So, the specific reasons to prepare long term vision of NIRJAFT are as follows:

- Vast opportunities created or likely to be created in global market for sustainable and eco-friendly development with the advancement of science and technology, how to benefit the jute and allied fibres sector from them
- Time gap between researches and its output and adaption with

"business as usual" approach delaying delivery of output and outcome.

- To increase relevance of jute and allied fibres sector in the national economy, carbon foot print, eco-friendly society and food security.
- To promote new programme with innovative ideas and thinking to achieve breakthrough in the sector utilization of the most advanced technologies, and continuing discussions at the highest intellectual levels.
- Diversification of growth and products

Challenges

Overall production of textile fibers was roughly 82 million tonnes in 2011 of which 33 million tonnes are natural fibers, cotton being about 27 million tonnes and the rest other natural fibres viz. flax , Jute, Wool, Ramie, Kenaf, Silk, Hemp, Sisal, and Coir. By 2030 we will have an additional demand for food of 43%. On the other hand arable land is limited and the cropland area per person will shrink. Also the demand for textile fibers (natural as well as man-made) will increase by 84%.Both, the population growth and the growth of the per capita textile consumption resulted in a continuous, substantial increase of the overall fiber consumption. It has reached 82 million tons in 2011 and is projected to grow with an average growth rate of 3.1% p.a. to a level of 133.5 million tons in 2030 and 216.27 million tons in 2050. Cultivation of jute and mesta shares only about 0.15% of the cropped area of the country which may further decrease in the coming decades in view of competition for increased production of food crops to meet the growing need of expanding population. Development of high yielding varieties and genetic modifications by agricultural scientists may be the solution for increased productivity of the fibre crops. Study of water consumption pattern reveals that agriculture represents 66% of the total withdrawals, the other 34% being used by domestic household (10%), industry (20%) and evaporation (4%). Water withdrawals for agriculture will increase by about 11% in 2050. For India, water scarcity will negatively affect a large population demanding development of advanced technologies for water conservation in agriculture and industry. Technology has to develop for water conservation in the water intensive production and processing of natural fibres. It is also a great challenge to maintain and enhance human resource in jute and allied fibre sector.

India's population 1970 to 2050 and per capita income

Year	Total Population (Million)	Urban Population (%)	World Population (Billion)	Per Capita Income (`) 2011-12 Prices
1970	541	20	3.7	14824
2010	1186	31	6.9	53331
2050	1619	52	9.15	848727

An increase of 2.25 billion projected over the next 40 years, which is lower than the 3.2 billion increases between 1970 and 2010. The trend is similar for India with an increase of 433 million by 2050 compared to 645 million increases between 1970 and 2010. This deceleration will impact agriculture by lowering its growth and also a reduced growth rate in agricultural consumption compared to the past. Increase in food grain production will boost the demand in packaging sector in which jute and allied fibre can play a major role

Change: Past and Future Rate of Growth %/Year

Item	Past (1970-2010)	Future (2010 – 2050)
Population	1.98	0.78
GDP	5.43	8.00
Per Capita Income	3.25	7.16

Specific Challenges to the Institute

1. The production of jute industry has largely remained stagnant during the last decade growing only at the rate of 0.1% CAGR (Cumulative Average Growth Rate) during the period. This may be due to severe competition from cheaper alternatives which has been gradually eroding the traditional market of the jute products.
2. The provision of unconditional protected market over the years coupled with administered cost plus pricing system for such
   products the industry has been reluctant to put in much effort in diversification and new product development. Thus all along the product mix of the industry is heavily lopsided in favour of traditional product like sacking and hessian which constitutes more that 80% of the total production.
3. Jute industry in general suffers from technological obsolescence, as there have been only lukewarm responses in adoption of new technology developed by international machinery manufacturers and Govt. of India sponsored projects. Poor industrial practices in the field of material handling, training of labour, maintenance, quality management, energy management, IT application, etc caused the industry dearly in terms of profitability and cost management.
4. For good quality product the raw material should be of good quality. Most of the lignocellulosic fibres are coarser, less flexible and highly variable in all the properties. With such a quality, good products cannot be prepared. Therefore, attempts should be made

to produce good quality fibres. Hence, good quality fibre not only be used to manufacture different quality products but also enhance market demand and fetch a good return.

5. In addition to banana, pineapple, flax, sisal and ramie, there are a number of other natural fibres such as screw pine, water-hyacinth, palm leaf, different types of grasses, etc which are available in India. All these fibres are under exploited and there is a wide scope for varied usage across different product categories. So, extensive R&D studies are needed for development of appropriate technologies and to devise promotional mechanism for them.

General Challenges to the Institute

- Poor supply-chain management prohibiting growth of industry
- General peoples are not concerned about ecology and pollution of environment.
- Lack of/Less interaction among the scientists between institutes and with producers.
- Least attention on energy issues.
- Lack of innovative ideas
- Lack of awareness about the benefits of natural fibres.
- Lack of awareness and interest about the new technologies and diversified uses and products of lignocellulosic fibres.
- Backdated fibre and product marketing
- Ecological hazards from technologies which generate pollution.
- Day by day water crisis will increase. Therefore, water intensive technologies should be modified.
- Population and industries are increasing rapidly and hence, land area for cultivation of jute & allied fibres should expand.

R & D Interventions to Address the Challenges

Short Term (2013–18)

- Collaborative effort with relevant institutes to work out and perfect technologies for specific areas and conditions
- Extraction and processing of jute and allied fibres.
- Dry retting of lignocellulosic fibres.
- Process control protocols establishment for commodity and export oriented products.
- Standardization of product & process specification in industry
- Eco-friendly level of products to attract global attention
- Intervention in automation to achieve labour reduction and quality

product.
- Improved energy efficient technology.
- Innovative product development to replace synthetic fibers in diversified areas.
- Eco-friendly chemical processing techniques with less water consumption.
- Development of disposal protocol accepted at the global level and ensure eco-labeling for better standardisation of jute products.
- Use of non-conventional and renewable energy for mechanical and chemical processing of fibres.
- Strengthening research efforts in various technical textiles such as automotive, building & construction, geotextiles, agrotextiles and relevant areas.
- Creating CAD CAM, modeling and simulation center for specific machine development for allied fibers.
- Dissemination of tested technologies through training, awareness programme and business incubation
- Scientists exchange between institute in India and abroad.
- Life cycle analysis and eco-labeling of jute and allied fibre products

Mid-term (2019–2028)

- Implementation of online process control and monitoring.
- Application of laser technology for fibre separation in mechanical processing of jute & allied fibre to make finer yarns.
- Development of suitable ICT (Information and Communication Technology) tools in the entire value chain for transparency and monitoring the performance of major stakeholders in the value chain
- Effluent free processing and zero water techniques through biological interventions and nanotechnology.
- Renewable energy equipments.
- PPP model for object oriented research and quicker impact
- Industrial processing of jute and other lignocellulosic plant into fiber and alternate energy source with better efficiency.
- Technologies for technical textiles like medical, smart, built tech, aerospace, protective, etc..
- Flexible laminated jute and allied fibre based materials for uses such as fully biodegradable and ecofriendly products.
- Regenerated fibers from jute and allied fibre biomass.
- Molded products from jute & allied fiber and biomass using natural and synthetic binders.
- Opening centres of NIRJAFT in different parts of the country for

dissemination of appropriate technologies
- Scientists exchange between institute in India and abroad.
- Establishment of International Bast & Allied Fibre Science Society and making consortia of multidisciplinary institutes for high end research and development.
- Products from non woven like air filter, soil filter, padding material, napkins.
- Life cycle analysis and eco-labeling of jute and allied fibre products

Long term (2029–2050)

- Analysis and feedback for fibers from high growth rate, water stress tolerant plants for development of novel products.
- Modification of fiber using nano and bio- technology to achieve high value products
- Artificial limbs from jute and allied fibre based composites.
- Use of jute & allied fibre materials to make composites for interior decoration of aircrafts.
- Breakthrough research output to attract national and international attention
- Creation of data base and knowledge base on fibre crops and their related products and technologies, troubleshooting and on-line assistance
- Creating Centre of Excellence of Natural fibres
- Engineered products like super absorbent, bio sensors, plaster casting, medical textiles, from engineered fibres
- Finer and softer jute and allied fibred will be used to manufacture skin touch apparel grade fabric.
- Bio polymer from natural sources
- Conversion and preparation of carbon fibres from jute for reinforcement and filtration

Operating Environment

Jute and allied fibres constitute a diverse group of plant fibres catering to the various requirements of the people in the country apart from creating large employment opportunities and contributing significantly to the national exchequer through export of jute goods. The jute sector occupies an important place in the national economy especially in the eastern and north-eastern regions as it supports nearly four million farm families generating about ten million man-days of employment in the rural India in farming activities though it shares only about 0.15% of the cropped area in the country. Besides, jute industry provides direct employment to about 2 lakh industrial workers and livelihood to another 1.5 lakh people in the tertiary and allied sectors. The average export of jute goods per annum in last four years is 166,000 tonnes at a value of Rs.10, 756 million. Jute cultivation still remains traditional without any significant technological intervention and poorly remunerative to the cultivators who are marginal and small farmers with poor resource base. Changing global environment has made people aware all over the world to use more natural fibres and created new opportunities for development of jute and allied fibres which enjoy unique position as eco- friendly, bio-degradable and renewable natural fibres. Recognizing the significance of jute in India's economy, the Government of India announced the National Jute Policy, 2005 to focus on thrust areas for overall development in the jute sector to increase production as well as consumption and export.

Other natural fibres crops viz. ramie, sisal, sunnhemp, flax , banana fibre, pineapple leaf fibre, etc have vast fibre yield potential mostly from their agroresidues but scarcely extracted and utilized . Growing concern about the environment and dwindling petroleum reserves have made the future of these fibres visible due to remarkable qualities and diverse industrial potential.

Fibre Production Scenario

Jute is grown once a year between March/April and July/August (90-120 days). Cultivation of raw jute crop provides not only fibres but jute stick also which is used as fuel and building material by the farming community. The production of raw jute during 2009-10 is 98.2 lakh bales (1 bale = 180 Kg) in an area of 7.82 lakh hectares which remain

almost static or even shrink or may be pushed towards marginal trends.

Further increase in area is unlikely because of present day crisis in jute trade vis-à-vis fluctuating prices of jute fibres over the years and high cost of basic inputs for raw jute cultivation. More than 60% of the fibre obtained is of poor quality (TD4 and TD5) which distorts the product-mix towards low value products like hessian and gunny bags. The area, production and yield have been subjected to various fluctuations due to

- Varying climatic conditions causing insufficient water availability
- Lack of awareness and adequate availability of certified seeds,
- Low incidence of mechanized farming and poor farm realization,
- Increase in preference for alternate crops,
- Shortage of farm labour
- Limited demand for jute products and
- Lack of Price stabilization mechanism

Other bast and leaf fibres like sunnhemp, sisal, banana pineapple leaf fibre, etc. remain underexploited in spite of their vast availability and yield potential.

Jute Textile Industry

There are 80 composite jute mills in the country, of which 62 are located in West Bengal only. The total production of jute goods was 16.34 lakh tonnes in 2008-09, valued at approximately Rs. 6000 crores. The product mix of the jute industry is highly distorted in favour of low-valued jute sacks and Hessian (more than 80%) due to poor quality of fibre produced. Nineteen hundread Small and Medium Sector
Enterprises (SMEs) provide employment to around 1.35 lakh artisans/ workers who are engaged in production of diversified jute products. In addition, around 1.5 lakh people are engaged in tertiary sector and allied activities supporting the jute economy.

The jute industry has grown marginally at a CAGR of 0.1% in volume since 1999, but has grown in value terms largely because the costs have increased over the years. Domestic consumption of jute goods contributes to around 87% of the production and exports are in the range of around Rs. 1050 to Rs. 1190 crores. Sacking is the key product in the domestic as well as in export market, besides the jute diversified products which include yarn, soil saver, décor fabrics, etc. Indian share in the global export market was 285.8 thousand MT in the year 2005-06 which has gone down steadily to 83.8 MT in 2009-10 losing its ground to Bangladesh. Jute industry predominantly produces traditional products using age old technology. The Industry

is labor intensive and as such, its labor-output ratio is high compared to other industries. There has been little technological breakthrough in the production process in spite of steps taken by the Government of India for modernization since 1980s as the industry, mostly engaged in manufacturing conventional sacking and hessian show limited interest in adopting the new machinery and technology.

Growing Demand of Jute Diversified Products

Today, India is one of the largest producers of jute products in the world and commands a fortune out of it. Government of India is trying to rejuvenate the jute sector through various activities and policy decisions. The Government launched the Jute Technology Mission (JTM) spanning a period of 5 years during the 11th Five Year Plan period (2007-08 to 2011-12) for overall development of the jute industry with diversified products and growth of the Jute Sector. The traditional concept of jute as packaging has undergone substantial changes. A huge demand for various diversified jute products viz. carry/shopping bags, shoes, composite materials, geo-textiles, home textiles, handicrafts, floor coverings, gift items, etc. is continuously increasing in both local and foreign markets. There is about 16 per cent increase in JDP export value during 2007-08 as compared to 2006-07. The future prospect of this eco-friendly natural fibre- jute is expected to increase day by day with effective support from the national governments of the producing countries through adoption of appropriate policies like banning of synthetic packaging materials and enactment of regulations favourable towards its cultivation, diversification and marketing.

Ecological Importance of Jute & Allied Fibres

Natural fibres are a renewable resource and totally biodegradable at the end of their life cycle. They are also carbon neutral and generate mainly organic waste and leaf residues that can be used for generation bio- energy and make eco-friendly housing material. The Kyoto protocol on global climate change has accelerated change towards a sustainable and more environmental friendly economy. International environment laws promoting green economy favours Indian scenario of growing market of technical textiles which show new application areas for natural fibres and reduce dependence on depleting petroleum based synthetic products. A number of new markets are emerging, such as fibre reinforced composites in automotive industries, building and products construction materials, biodegradable geotextiles and jute diversified with the ecological image of cellulosic fibres becoming a driving force for

innovation and development. Evaluation of jute for its ecological and environmental compliance and quality has shown that jute has high capacity of fixing atmospheric carbon and biological efficiency.

Though jute products are 100% biodegradable and recyclable and they can also be disposed of without causing environmental hazards, but it was observed during process of conventional retting that the chemical and biological oxygen demand of the water increases due to addition of huge quantity of organic matter and accelerated microbial activities in the water. The prevailing process leads to eutrophication of water which causes environmental pollution to a large extent. Also, retting involves biological degradation of organic molecules which causes emission of CO_2 and methane that contribute to global warming. Processing of jute requires energy, the main source of which is fossil fuel which adds harmful green house gases like CO_2, SO_2 and methane into the environment and by-products like fly ashes affecting human health directly or indirectly. Adequate R&D initiatives need to be taken to study environmental implications of jute fibre in its entire life cycle starting from cultivation of fibre to disposal of end- products (cradle to grave) to increase its acceptance to the civil society against synthetic materials.

Another observation is that finished jute products, either conventional or diversified, sometimes contain some undesirable and objectionable non-fibrous components though jute fibres cultivated following Good Agricultural Practice (GAP) and processed under Good Manufacturing Practice (GMP) in Jute mills are usually free from any toxic residues. Hence, for better market acceptance and customer satisfaction, it is imperative for the jute sector to develop eco-friendly technologies for processing of jute and allied fibres in order to meet the stringent EPA guidelines and the sanitary and phytosanitary issues related to textiles.

Technology Landscape

Developments in biotechnology, nano-technology and plasma technology are expected to effect a paradigm shift in processing of jute and allied fibres to provide opportunities for development of new products and productivity enhancement. These are also posing new challenges of capacity building and human resource development. There is a need to develop organizational policy and guidelines aimed at enhancing inventions and accelerating innovations in technology to harness the opportunities in the field of natural fibres especially in jute and allied fibre sector by integrating both modern and conventional research approaches.

Emergence of New Business Ventures

Jute has a long history of use in the packaging industry. New opportunities have been created in the packaging segment for increase in food grains production due to Green Revolution. But, the major breakthrough would come when the automobile, pulp and paper, and the furniture and bedding industries use jute and its allied fibres in woven or non-woven form in geo-textiles, agro-textiles, technical textiles and composite production. Jute and allied fibres has entered into various diversified sectors, where natural fibres are gradually becoming better substitution. It plays an important role and has the potential to drive the economy.

Apart from having huge export potential, jute-based companies cater to the domestic and the international markets. However, the industry is facing big challenges in its growth because of high production cost and poor supply-chain management. With market going global, Indian jute industry is still following the traditional methods of manufacturing jute products. The products made are costlier and are exported at higher rates as compared to other Asian countries, especially Bangladesh which is the biggest competitor to Indian jute industry. Despite being a mother industry, it has emerged as a huge decentralised and unorganised sector in the current scenario. Jute and allied fibres has the ability to be blended with other fibres, both synthetic and natural, and accepts cellulosic dye classes such as natural, basic, vat, sulfur, reactive, and pigment dyes.

As the Indian jute industry is facing severe challenges in the international markets from synthetic fibre and from Bangladesh, the industry needs innovative processes and diversified products to overcome them. National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT) through sustained research over decades in this area has come out with a number of technologies and diversified products with jute and other natural fibres with an increase in consumer's preference for bio degradable products, the jute industry has an advantageous position. There is an increased demand for a ban on the use of plastics in different parts of the world. This has opened up new opportunities for the jute industry. The industry should not be confined to the domestic market only, but also venture into international market.

The rising popularity of jute and other lignocellulosic fibre items has prompted the need of small and mid-sized companies to revamp their processes, introduce better designs, bring more investment and adopt new marketing strategies. This will definitely put the industry in a dominant position. To revamp this industry and to nurture small ventures, Business Planning and Development (BPD) unit at NIRJAFT

has identified several technologies like retting technology, geotextiles, particle boards and composites, ramie degumming and processing , etc. to turn the innovative research ideas into sound commercial ventures in Technology Business Incubation (TBI) concept. Creation of training centre for entrepreneurship development is an urgent need.

To implement the incubation concept, NIRJAFT has come out with the idea of incubation facility for small and medium scale entrepreneurs. The main objectives of this programme are to translate the developed technologies into products at commercial level. It gives thrust to develop infrastructural facilities, laboratory facility, pilot plant facility, cost evaluation and other commercial facilities to satisfy the need and support the entrepreneurs.

The Institute is dedicated to develop technologies for product and process development and create a knowledge base in jute and allied fibres for the benefit of jute farmers and industry as well as the entrepreneurs in the decentralized sector. The immense socio-economic importance and eco-friendliness of natural fibres in general, jute and allied fibres in particular are evident for the following reasons:

Natural Fibers are a Healthy Choice

- Natural fiber textiles absorb perspiration and release it into the air" that creates natural ventilation. Because of their more compact molecular structure, synthetic fibers cannot capture air and "breathe" in the same way. The "breathability" of natural fiber textiles makes jute packaging eco-friendly especially for food grains. The high capacity of absorption of moisture and toxic gases makes natural fabrics suitable for household textiles

Natural Fibers are a Responsible Choice

- Natural fibers production, processing and export are vital to the economies of many developing countries and the livelihoods of millions of small-scale farmers and low-wage workers. Today, many of those economies and livelihoods are under threat: the global financial crisis has reduced demand for natural fibers as processors, manufacturers and consumers look to cheaper synthetic alternatives.
- Almost all natural fibers are produced by agriculture, and the major part is harvested in the developing world.
- In India, an estimated 4 million marginal farmers earn their living– and support 20 million dependents – from the cultivation of jute, used in sacks, carpets, rugs and curtains. Competition from synthetic fibers has eroded demand for jute over recent decades and, in the

wake of recession, reduced orders from Europe and the Middle East could cut jute exports by 20% in 2009.

- Coconut fiber is mainly for export to developed countries for use in rope, nets, brushes, doormats, mattresses and insulation panels. About 5 lakh people are employed in small-scale coir factories in southern India.
- Sisal fiber, extracted from the sisal agave and used in twine, paper, bricks and reinforced plastic panels in automobiles had a great demand. However, the global slowdown has cut demand for sisal, forced a 30% cut in prices, and led to mounting job losses.

Natural Fibers are a Sustainable Choice

- Natural fibers play a key role in the emerging "green" economy based on energy efficiency, the use of renewable feed stocks in bio-based polymer products, industrial processes that reduce carbon emissions and recyclable materials that minimize waste. . They are also carbon neutral: they absorb the same amount of carbon dioxide they produce. During processing, they generate mainly organic wastes and leave residues that can be used to generate electricity or make ecological housing material. And, at the end of their life cycle, they are 100% biodegradable.
- An FAO study estimated that production of one ton of jute fiber requires just 10% of the energy used for the production of one ton of synthetic fibers (since jute is cultivated mainly by small- scale farmers in traditional farming systems, the main energy input is human labor, not fossil fuels).
- Processing of some natural fibers can lead to high levels of water pollutants, but they consist mostly of biodegradable compounds, in contrast to the persistent chemicals, including heavy metals, released in the effluent from synthetic fiber processing. More recent studies have shown that producing one ton of polypropylene – widely used in packaging, containers and cordage – emits into the atmosphere more than 3 ton of carbon dioxide, the main greenhouse gas responsible for global warming. In contrast, jute absorbs as much as 2.4 tonnes of carbon per tonne of dry fiber.
- The environmental benefits of natural fiber products accrue well beyond the production phase. For example, fibers such as hemp, flax and sisal are being used increasingly as reinforcing in place of glass fibers in thermoplastic panels in automobiles. Since the fibers are lighter in weight, they reduce fuel consumption and with it carbon dioxide emissions and air pollution.

- But where natural fibers really excel is in the disposal stage of their life cycle. Since they absorb water, natural fibers decay through the action of fungi and bacteria. Natural fiber products can be composted to improve soil structure, or incinerated with no emission of pollutants and release of no more carbon than the fibers absorbed during their lifetimes.
- Synthetics present society with a range of disposal problems. In land fills they release heavy metals and other additives into soil and groundwater. Recycling requires costly separation, while incineration produces pollutants and, in the case of high-density polyethylene, 3 tonnes of carbon dioxide emissions for every tonne of material burnt.
  Left in the environment, synthetic fibers contribute, for example, to the estimated 640,000 tonnes of abandoned fishing nets and gear in the world's oceans.

Natural Fibers are a High-tech Choice

- Natural fibers have intrinsic properties – mechanical strength, low weight and low cost – that have made them particularly attractive to the automobile industry.
- In Europe, car makers are using mats made from abaca, flax and hemp in press- molded thermoplastic panels for door liners, parcel shelves, seat backs, engine shields and headrests.
- For consumers, natural fiber composites in automobiles provide better thermal and acoustic insulation than fiberglass, and reduce irritation of the skin and respiratory system. The low density of plant fibers also reduces vehicle weight, which cuts fuel consumption.
- For car manufacturers, the moulding process consumes less energy than that of fibre-glass and produces less wear and tear on machinery, cutting production costs by up to 30%. The use of natural fibres by Europe's car industry has reached 100,000 tonnes by 2010.
- Worldwide, the construction industry is moving to natural fibres for a range of products, including light structural walls, insulation materials, cement blocks reinforced with sisal fibre, composite boards, floor and wall coverings, roofing and geotextiles for earthworks.

Natural Fibers are a Fashionable Choice

Natural fibers are now at the heart of a fashion movement that goes by various names: sustainable, green, ethical, eco-, even eco-environmental. It focuses fashion on concern for the environment, the well-being of fiber producers and consumers, higher prices for natural fibres and promotes social and environmental standards in fibre

processing. Designers now offer “100% carbon neutral” collections that strive for sustainability at every stage of their garments’ life cycle – from production, processing and packaging to transportation, retailing and ultimate disposal.

Indian economy is set to expand at the world’s fastest rate over the next 50 years to emerge as a major force globally, but it would still rank as the second worst in terms of prosperity of its citizens. Over the 50-year period between 2011-2060, India will register an annual economic growth rate of 4.9 per cent, as per a latest report by Paris-based international grouping of the world’s leading economies, the
Organisation for Economic Cooperation and Development (OECD).
Such an economy will render a big market for fiber consumption. With the ecofriendly reforms slowly moving in with time, a lot of emphasis will be given to natural fiber as a whole and jute and allied fiber in particular.

New Opportunities

Jute and allied fibres, being natural, biogradable and eco-friendly, offer exciting research opportunities for accelerating R&D through cutting edge technologies and selling its products in the following ways:

- Enzymatic biotechnological processes for improved quality fiber and ecofriendly process
- Industrial process for extraction of fibres from plant
- Use of nonconventional and renewable energy for mechanical and chemical processing of fibres
- Nanotechnology application in fibre processing for value addition
- Carbon credit based product competition
- Support for new Business planning and execution
- R&D technologies for improved energy, water and manpower efficiency
- Standardized product eco-labeling for international market selling
- Development of instruments and machineries modification.
- Collaborative work on genomics for end use specific variety development.

Future Growth Areas that Need Attention

Technical textiles especially geotextiles, agrotextiles and auto textiles Global technical industry is estimated at $127 billion and its size in India is pegged at $11 billion, according to a joint study of the Ministry of Textiles and the FICCI.

- Bio and green composites, particle and fibre boards, bio plastics
- Carry bags, shopping bags, fancy bags, food grade jute and allied fibre bags
- Pulp and paper
- Traditional jute products – floor coverings, carpet backing cloth, etc.
- Fine chemicals from lignocellulosic plants after fibre realisation

Life Cycle Analysis

- Products from underexploited fibres and their biomass (Jute, Sisal, Linseed, Banana, Sunnhemp, Pineapple and Bamboo)
- Value added products from jute and allied fibres using nano-

and biotechnologies
- Technical textiles for geo- technical and agro-horticultural applications
- Bio and green composites from natural fibre resources

Pathways

- Innovation and efficiency will be key drivers of eco-friendly sustainable growth and other changes
- Green revolution 2.0 - From input intensive to knowledge intensive
- Improved technologies, new technology including nano-biotechnological applications
- Converting waste to wealth
- High value and secondary agriculture
- Competitiveness

Goals and Targets

Adequate availability of fibres and fabrics in jute and allied fibres sector to meet the demand in diversified areas for the growing population by 2050 (about 1600 million people and most of them are from urban areas with high income) is the main challenge. The cultivation and post-harvest processing of natural fibres being labour intensive provides a large number of livelihood and employment generation opportunities in the rural sector throughout the country. To maintain and enhance human resource in jute and allied fibre cultivation is also an important challenge. Considering annual production and utilization in textiles of different plant fibres, jute ranks second to cotton in the country with an average annual production of about two million tonnes. The other plant fibres which are available in the established crops system in the country and have vast yield and utilization potential do not have any significant presence in the trade and industry. The multifarious technological challenges for extraction and utilization of these fibres and their residues would be undertaken with the emerging new approaches and better technologies with the advancement of science and technology which promise breakthroughs to accomplish the goal and help in economic growth of the country by improving livelihood and employment generation in rural sector. Intervention of emerging power of science and technology would be made in the following areas for production, processing, and value addition to jute and allied fibres as well as in exploiting the utilization potential of their agro-residues.

Extraction of Quality Fibre

One of the major problems of jute industry for diversification of and value addition to jute is the inadequate supply of high quality fibre. The quality of jute is greatly affected by imperfect retting in the traditional process due to insufficient availability of water and washing of fibre besides high labour input, drudgery and environmental pollution involved in the process. The problem of creating adequate retting facilities and sustainable production and supply of high quality fibre in sufficient quantity has been a burning issue due to scarcity of water for retting caused by erratic monsoon and global climate change. The following alternative technologies would be explored to develop water-saving and user friendly processes for extraction of jute and jute like

fibres viz. kenaf and roselle.

Ribbon Retting

Development of a high capacity machine for peeling ribbons from green plants and retting of ribbons by chemical/microbial action in minimum volume of water is envisaged for production of high grade fibre.

Fungal Retting

Fungal retting of jute conducted directly on the harvested green plant by spraying with specific fungus without addition of water has been found effective for extraction of fibre. It is also known as 'dry retting'. Development and standardization of the technology for fungal retting of jute, a technology of immense possibility, can change the paradigm of jute cultivation.

Microwave and Ultrasound Technologies

These are potential technologies for retting jute with very little or no requirement of water. Microwaves of specific wavelength are capable of breaking the bonds between lignocellulosic material, pectin and gums that may perform miracle in retting of jute and degumming of ramie within a few minutes of exposure to specific microwave. Development of this technology can bring a real breakthrough for retting of jute and degumming of decorticated ramie fibre as pollution free and time saving method. The technology has also immense potential for extraction of other lignocellulosic fibres like banana, sisal, flax, etc.

Steam Explosion

Steam explosion usually involves the thermal treatment of biomass with water under pressure. Then the pressure is suddenly released, causing the biomass to break and explode, with the simultaneous fibrillation of the exploded biomass. The process has been experimented on flax and hemp extraction when short length fibre of high purity was obtained which may be processed to produce high quality yarn and fabric. The process may be explored for production of jute fibre suitable for production of biocomposites and paper pulp.

Value Chain Approach for Unexploited and Underexploited Fibres and their Biomass

A rich variety of other natural fibres like ramie, sunnhemp, sisal, pineapple, flax/linseed, banana, dhaincha, bamboo, coconut etc. are

available in India which have negligible presence in the trade and industry. Each of these fibres has some special properties. Sufficient data and information are lacking for these underexploited fibres which have huge potential in terms of demand and economic growth of the country. Blending of these fibres with jute and allied fibre produces a very special appeal and enhances the value of product. Management of this vast resource of natural fibres and their agro-residue biomass would be given priority for integration in the system by intervention of new methods, techniques and technologies.

Application of Biotechnology and Nanotechnology

Processing of natural fibres and their value addition offer a great promise with application of the frontier sciences like biotechnology and nanotechnology. Surface modification of fibres and fabrics by nanotechnology imparting targeted functional properties, developing nanocomposites and nanofinishing of textiles for technical applications are some of the areas of frontier research that would be integrated in the on-going and future research programme for better efficiency of research and higher achievements. Biotechnology has an eminent role and potential to address the on-going and future challenges in eco-friendly process and product developments from natural fibres and their agro-residues to meet the consumer preferences and sustainability of environment. Priority would be given to those areas like fibre extraction, eco-friendly chemical processing of fabrics, bio-pulping, utilization of biomass for production of ethanol and other important molecules, etc. which have shown considerable research success through conventional approaches in the past.

Management of Agro-residues

Efficient management of the huge amount of biomass generated in the extraction process of bast, fruit and leaf fibres would be given high priority for post-harvest processing, value addition and marketing. Potential applications of some fibre agro-residues for creating wealth from waste viz particle boards and fibre boards from jute retting agro-residue, energy from jute stick etc. through carbonization and pelletization, paper of different grades through pulping of agro-residues, bio-fuels like ethanol, hecogenin and pectin from sisal fibre extraction residues, bio-adhesive from agro-residue pulping and ramie degumming effluents, etc. have been explored. More focus would be given with the advancement of knowledge in science and technology and emergence of new tools and techniques to primary and secondary level value

addition and processing of these vast resources to promote the natural fibre value chain.

Processing and Product Development: Cutting-edge Technologies

Development of specialty yarns and fabrics from jute & allied fibres and its blends, processing of underutilized fibres like linseed, sisal, banana, pineapple, coconut etc. for value addition, jute & allied fibre based geo-technical and agro-horticultural textiles, bio-composites, fibre boards, etc are some of the areas in which considerable research has been carried out with limited success and development of some technologies through conventional approaches in the past. High speed, energy efficient, auto-control processes and nonconventional yarn and fabric engineering would be integrated in the on-going and future research programme to maximize the production and marketing potential in order to meet the consumers' choice and preferences.

Advanced Instrumentation and Process Control

Instruments for quality management and grading of jute and allied fibres, modification of existing handloom system for production of jute based specialty fabric, etc. had been developed through sustained research work in the past. Priority would be given on research in this area of instrumentation and machinery development especially for development of an integrated instrument system for quality evaluation and grading of fibres, upgradation of jute processing machinery including non-woven product line, process control system for efficient utilization of resources and quality improvement of products. Application of new ideas and innovations would promise technological breakthroughs to accomplish the goals.

Human Resource Development

Upgrading of the quality of human resource through sustained training and educational programme is essential in research organization for successful implementation of its research programme, developing technologies and dissemination of knowledge to the stake holders.

Effective and need based training programme to improve the human resource through development of state- of- the-art infrastructure and enhancing the faculty competence would be undertaken to adequately address the challenges in the emerging fields of research. This would facilitate close linkage between research and development and the end-users through dissemination of technologies, knowledge and information.

Technology Transfer Systems

Effective delivery of the new and better technologies to the stake holders through improved knowledge management system would greatly help in realizing the potential of the technology. Dissemination techniques for transfer of technology, knowledge and information related to jute and allied fibers to the stakeholders through training, pilot plant demonstrations, entrepreneurship development, business incubation in participatory model, etc. would be harnessed for effective transfer of research achievements to the end users.

National Institute of Research on Jute & Allied Fibre Technology would adopt a multi dimensional strategy to achieve the visions and goals set for the period.

- *Socio economic improvement of jute growers and improvement in quality of fibre*
  - Eco-sustainable and water saving system of retting of jute and other lignocellulosic fibre to eliminate polluting aspects of traditional retting process
  - Efficient and user-friendly extraction and grading systems for jute and allied fibres, a fast and mechanized fibre extraction process, with potential of being adopted by rural industries, is to be developed.
  - Utilization of agro-residues by value addition through product/ process development.
  - Pulp, paper and composites based on whole jute & allied fibre plant.
- *Market driven technology upgradation and product development for growth and long-term viability of the jute & allied fibre industry*
  - Engineering fine yarns and lighter fabrics from jute & allied fibres, to produce high value home and packaging textiles.
  - Eco-friendly and efficient jute & allied fibre processing system by ensuring replacement of batching oil, lowering of power consumption and increasing process productivity.
  - Modern process control system for jute industry to improve its efficiency, product quality and flexibility.
  - Indigenization of needle punch and adhesive bonded non-woven machines
  - Nonwoven technology and products based on jute & allied fibres and their blends to diversify the product range of jute industry.
- *Innovative and cutting edge technological intervention for developing value added products from jute & allied fibres and agro-residues*
  - Use of nano-, bio- & plasma- technologies for development of

value added diversified jute & allied fibre textiles for functional applications.

– Engineering of end use and eco-system specific technical (geo/ agro/packaging) textiles.

– Jute & allied fibre products with attribute of triggered bio-degradability for making textiles for geo technical applications and bio-composites.

– Bio-and green-composites based on jute & allied fibres and agro-residues – in a collaborative multi-institutional approach- use of steam explosion/ ultrasonic techniques.

– Nano composites based on cellulosic microfibrils from different sources.

– Superior grade paper based on jute, allied fibres and agro-residues, suitable for producing in small scale sector.

- *Intellectual property right compatible transfer of technology system for accelerated dissemination of technologies, knowledge and information*

– Capacity building and empowerment through training and technology demonstration.

– Establishment of Technology Park, techno-museum and jute & allied fibre cluster, to enhance awareness about the possibilities of natural fibres as a vehicle of wealth generation.

– Entrepreneurship development through BPD system.

– Collaboration with organizations / body of stake holders engaged in promotion of jute & allied fibre products for dissemination of information, transfer of technology and receiving feedback about technology/product requirement.

- *Efficient use of under-exploited allied fibres and agro-residues through value chain system*

– Machinery and equipment for extraction, processing and grading of allied fibres available in the region and setting up of pilot plants for demonstration at the production center.

– Development of value-added market driven products out of the extracted fibres.

– Improvement of indigenous processing technologies for the benefit of local entrepreneurs.

– Agro-residue utilization for creation of wealth and employment.

Way Forward

Future Road Map

- Demand driven and responsive research
- Impact assessment of research
- Social relevance & accountability in research
- Setting up of a International Centre of Excellence in Jute and Allied Fibres

Possible Scenarios

- Increased use of natural fibre-rich innovative green products
- Value chain on under exploited / unexploited natural fibres
- Eco-labeling of jute & allied fibre products
- Efficient knowledge management system and business incubation

Proposed Strategy

- Development of strategic partnership and alliances with other public, private & international institution
- Bridging scientific and technology gap between the developed world and India
- Looking beyond border

Cutting Edge Research Theme

- Super automation in machinery & process in jute & allied fibre processing technology to improve quality and production
- Industrial process of extraction of fibre from plant
- Process minimization during conversion from fibre to fabric
- Application of laser technology for fibre separation in mechanical processing of jute & allied fibre to make finer yarns
- Use of nano- and bio- technologies for development of value added diversified jute & allied fibre textiles for different functional application (rot proofing, water proofing, fire retardant, crease recovery, soil release, anti microbial, UV resistant, etc)
- Jute & allied fibre products with attributes of triggered bio-degradability to produce textiles for geo-technical applications
- Bio and green composites based on jute and other lignocellulosic fibres and agro residues

- Artificial limbs from jute & allied fibre composites
- Use of jute & allied fibre materials to make composites for interior decoration of aircrafts
- Nano composites based on cellulosic micro fibrils from different sources
- Extraction of nano fibres from jute and allied fibres for reinforcement and other application
- Flexible laminated jute based materials for uses such as fully biodegradable and ecofriendly products
- Waterless fibre surface modification technology like plasma, vaccum UV, etc.
- Replacement of structural materials (wood, metal, etc) by jute and other lignocellulosic fibre based composites
- Conversion and preparation of carbon fibres from jute for reinforcement and filtration
- Use of jute and other lignocellulosic fibre based technical textiles in aerospace
- Development of disposal protocol accepted at the global level and ensure eco-labeling for better standardisation of jute products
- Management of effluent and waste generation during processing
- Improved processing environment management system
- Use of ICT (Information and Communication Technology) for improvement of machinery, process optimization , product quality, value chain for transparency and monitoring the performance of major stakeholders in the value chain
- Life cycle analysis and eco-labeling of jute and other lignocellulosic fibre products

Place the Institute in Future

- Self reliance in technology development
- A national institute with international reputation

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