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Vision 2050

Central Research Institute for Jute and Allied Fibres
Indian Council of Agricultural Research

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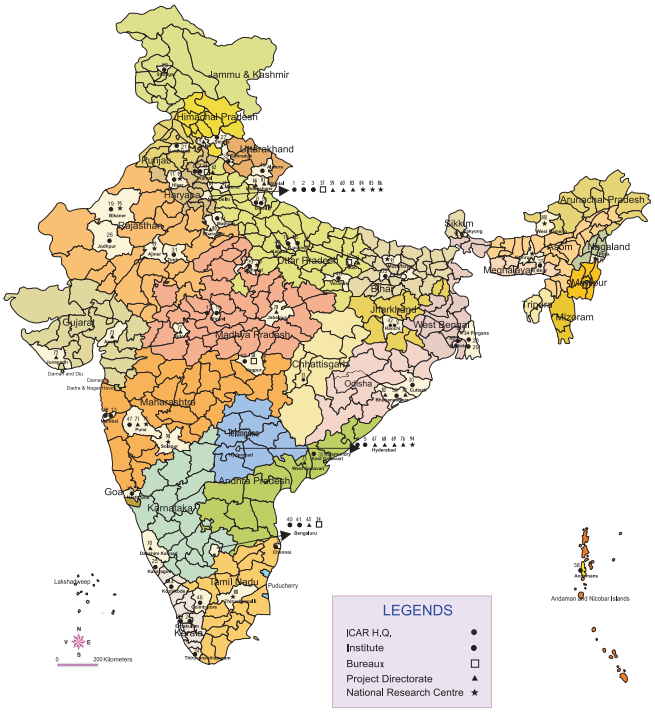

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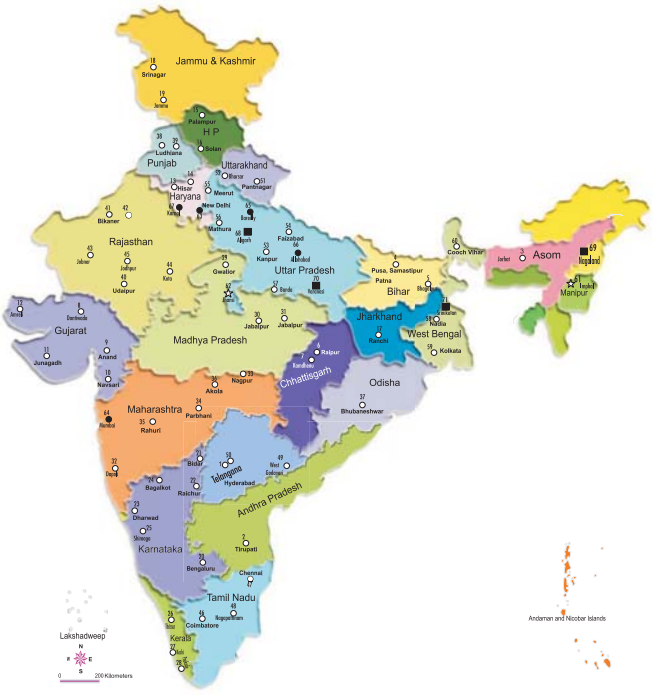

Vision 2050

Central Research Institute for Jute and Allied Fibres
(Indian Council of Agricultural Research)
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संदेश

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 कोई बदलाव होने की उम्मीद नहीं की जाती है। अतः 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-परजीवी 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 दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

(राधा मोहन सिंह)

केन्द्रीय कृषि मंत्री, भारत सरकार

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 rn 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-Central Research Institute for Jute and Allied Fibres (ICAR-CRIJAF), Barrackpore, ~~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)
Secretary, Department of Agricultural Research & Education (DARE)
and Director-General, Indian Council of Agricultural Research (ICAR)
Krishi Bhavan, Dr Rajendra Prasad Road,
New Delhi 110 001

Preface

Jute occupies unique position in the national economy in terms of its contribution to employment in agriculture and industry. Jute and allied fibre crops are versatile natural bast fibre yielding crops with considerable commercial, environmental and socio-economic importance having multifarious end users, mostly grown in the tropical and South-East Asian countries. Raw jute farming, industry and trade provide livelihood support to about 5 million people. Although it is grown in many other countries, sizable production and area come from the lower Gangetic delta comprising India and Bangladesh. India is the single largest producer of jute goods in the world, contributing about 60% of the global production which has made impressive strides on the front of jute productivity. Compared to the Fifties, productivity has been enhanced by almost 3 times which is at present 23.8 q/ha. The trend of area under jute in the country has been either declining or remained constant (≈ 8.0 lakh ha) since nineties but, the trend of production of jute fibre has been increasing over decades owing to the remarkable improvement in the productivity of jute in India. Besides the traditional uses of jute and allied fibres, as hessian and sacking, various value added diversified products boosted the export market which gained to earn more than Rs. 2095 crores per annum. The demand of natural geo-textiles manufactured from jute and sisal fibres is going to have a steady and sustainable growth in coming decades.

Concerted efforts are to be made to arrest the situation of progressive replacement of natural raw materials with synthetic fibres and promote comparative advantage of this group of fibres. Raw jute sector needs radical changes in terms of focus on many other aspects beyond the traditional use of fibre, rather emphasizing the pharmaceutical, nutriceutical, diversified commercial uses and exploiting the environmental benefit of jute crop as an effective carbon sequester in the back drop of climate change and environmental stresses created by the industrialization and urbanization. High biomass of mesta and elevated alpha-cellulose content in sunnhemp are advantageous for quality pulp as raw material in paper industry. Similarly, ramie, flax and finer jute fibres are ideal for high quality fabrics and apparel sector. Sisal and jute fibre with greater strength and durability are the potential raw materials

for the manufacturing of cordage, geo-textiles and industrial fabrics.

Owing to the continued population pressure there will be 11% increase in average per capita calorie consumption between 2003 and 2050 as estimated by FAO which will require 175-220 million hectares of additional crop land. Limited availability of additional arable land and water resources, nutrient mining by exhaustive cropping systems will certainly throw a challenge to sustain the availability of natural fibres. With a modest assumption of 50% increase in demand of bast fibre by 2050 (analogous to 50% increase in demand for food production), India has to increase jute productivity to 4.7 t/ha from present 2.35 t/ha if land under jute cultivation remains same. With a projected decrease in available area by 10-20%, average productivity should be increased to 5.5 t/ha by 2050.

The challenges in the scientific development are very complex and diverse for jute and allied fibre crops. Narrow genetic base of cultivated jute and allied fibre crops, less harvest index, mitigating high cost of cultivation, unavailability of low cost mechanization, simple and economical retting technology, changing vulnerability to biotic and abiotic stresses, development of varieties and plant types for multiple stresses and diversified use are the challenges which are to be addressed. No doubt there are opportunities also which may be exploited through advance scientific concepts, trained manpower with adequate infrastructural back up.

Identification of need-based productive programmes are very critical which can be explored through appropriate characterization of production environments. Increasing yield and improving quality to meet market and industrial requirement, enhancing the efficiency of production inputs, exploiting jute for environmental benefits, sustaining the potential yield under adverse edaphic and climatic condition are the important objectives to be achieved.

In the backdrop of changing consumer preference for jute goods, stiff competition from synthetics, changing climatic pattern, enhancing cost of cultivation, narrow product base, fragile market, this sector is in the lookout to overcome these bottlenecks through an envisioned research and development agenda considering every aspect in totality. VISION 2050 of ICAR-CRIJAF is a precise policy document which reflects the current and forthcoming issues and challenges in the jute and allied fibre agriculture, the opportunities, strategies and the possible roadmap to mitigate the challenges through advance scientific research

with long term perspectives.

I have the confidence that this vision document will serve as a valuable guide and give necessary roadmap to the researchers and policy makers to achieve the targeted fibre production (raw jute) of 250 lakh bales by 2050. All the scientists of CRIJAF have contributed their intellectual inputs to prepare the document in the present form. The contribution of Dr. S Satpathy, Dr D K Kundu, Dr Jiban Mitra, Dr. Surja Sarkar in preparation of this document is appreciated. Constant encouragement and guidance received from the Hon'ble DG, DDG (Crop Science) and ADG (Commercial Crops), ICAR, New Delhi is gratefully acknowledged. It is hoped that the document would be subjected to periodic reviews to accommodate imminent changes in future so that the perspective plan continues to be close to our target.

P. G. Karmakar

(P.G. Karmakar)
Director
ICAR-CRIJAF, Barrakpore, Kolkata

Contents

Context

As we progress through the twenty first century, challenges will confront us with wide range of changes in diversified areas. Major changes are expected in terms of climatic conditions, atmospheric O_2/ CO_2 and H_2O levels, depletion of ozone layer, chemical load in agri-ecosystem, and population dynamics. On the other hand, demand for food and feed likely to soar which has to be met with from minimal resources. Hence, existence of mankind in the future world will largely depend on how best we modify our agriculture to achieve futuristic goals. Apart from food and feed crops, demand for natural fibres is ought to increase with the changing lifestyle of the consumers.

Jute and allied fibres (mesta, sunnhemp, ramie, sisal and flax) play an important role in Indian economy. Raw jute (jute and mesta) supports about 4 million farm families and provides employment to the tune of 10.0 million man days in the rural sector. Moreover, about 0.25 million industrial workers and 0.50 million traders get employment in jute sector. Thus, raw jute farming, industry and trade provide livelihood support to about 5 million people though it occupies only 0.47% of the gross cropped area of the country. India is the single largest producer of jute goods in the world, contributing about 60% of the global production. The domestic market continues to be the mainstay of industry consuming about 87% of the total production. At the same time, our export market share is estimated at around 30% of the global market and it is showing an increasing trend. India today earns about Rs 2095 crores per annum through jute goods export as against Rs 233 crores in early sixties. This clearly shows that despite stiff competition from cheaper synthetic fibres, jute and allied fibres have made significant progress and have a very bright future.

Raw jute supports about 4 million farm families and provides employment of 10.0 million man days in the rural sector. Moreover, about 0.25 million industrial workers and 0.50 million traders get employment in jute sector. Thus, raw jute farming, industry and trade provide livelihood support to about 5 million people though it occupies only 0.47% of the gross cropped area of the country.

In the changing climatic scenario, the crop is more likely to be exposed to increased biotic and abiotic stresses. The uneven distribution of rainfall may pose jute to early season drought, while the shrinkage in

the natural water resources may affect fibre quality as large volume of clean and slow moving water is required for quality retting. Moreover, the crops may face a wider range of pest and diseases with the elevated temperature, some of which is already making their presence visible. Jute and allied fibre production under the present system of cultivation is labour intensive and costly, which need to be reduced significantly to make it competitive with the cheaper synthetic fibres.

Jute and sisal fibres are important raw materials for natural geotextiles. The key factor responsible to growth in geotextiles demand is the growing infrastructure activities in emerging economies of India, China, Brazil and South Africa. The governments of these countries have been extensively promoting the development and use of geotextiles which is further expected to augment the demand over the coming decades.

The global market for geotextiles is expected to reach at least USD 8.24 billion by 2020, increased focus on geotextiles and its applications in roadways and erosion prevention is expected to be a key driver for

the growth of the market. In addition, growing regulatory support in emerging countries including India, China, UAE and Brazil is also expected to augment the demand for geotextiles over the forecast period. Road construction and erosion control were the largest applications of geotextiles together accounting for over 60% of global demand in 2013. Road construction is also expected to be the fastest growing segment. The global geotextiles demand is expected to reach 4,323 million square meters and USD 17.81 billion by 2020. Beyond this period there will be an estimated growth rate of over 9%.

The ICAR-Central Research Institute for Jute and Allied Fibres (ICAR-CRIJAF), a premier crop research institute of the Indian Council of Agricultural Research (ICAR), is mandated to develop technologies to improve yield and quality of jute and allied fibres. It remains vigilant and responsive to changing scenario through development of novel technologies and by promoting problem-solving knowledge products. Jute varieties and production technologies developed by ICAR-CRIJAF have contributed a lot to achieve the landmark production of raw jute over 110 lakh bales/annum. Efforts for exploiting potentials of allied fibre crops such as sunnhemp, sisal, ramie and flax have been relatively little. Though ramie and sisal are much costlier and qualitatively superior to jute fibre, there is stagnation in the area, production and productivity of these crops in India. Similarly, fibre production potential of sunnhemp and flax have largely remained unexploited in India.

The productivity of jute and mesta has increased by two folds since independence which may be treated as a significant achievement. This was made possible through introduction of high yielding varieties supported by location-specific production and protection technologies. Besides, the *tossa* jute varieties having pre-mature flowering resistance enabled crop to be fitted in the intensive rice based cropping sequence of the eastern and north-eastern part of the country.

At present, jute is cultivated over an area of 8.5 lakh ha in the country with an average productivity of 25.3 q/ha, while mesta (kenaf and roselle) is cultivated in an area of about 1.5 lakh ha and the average national productivity of the crop is around 11 q/ha. Moreover, couple of varieties of finer fibre quality (fineness less than 2.5 tex) have been developed in *tossa* jute, which can cater to the need of industry for producing value added diversified products.

Productivity of jute and mesta has increased by two folds since independence through introduction of high yielding varieties, pre-mature flowering resistance enabled crop to be fitted in the intensive rice based cropping sequence.

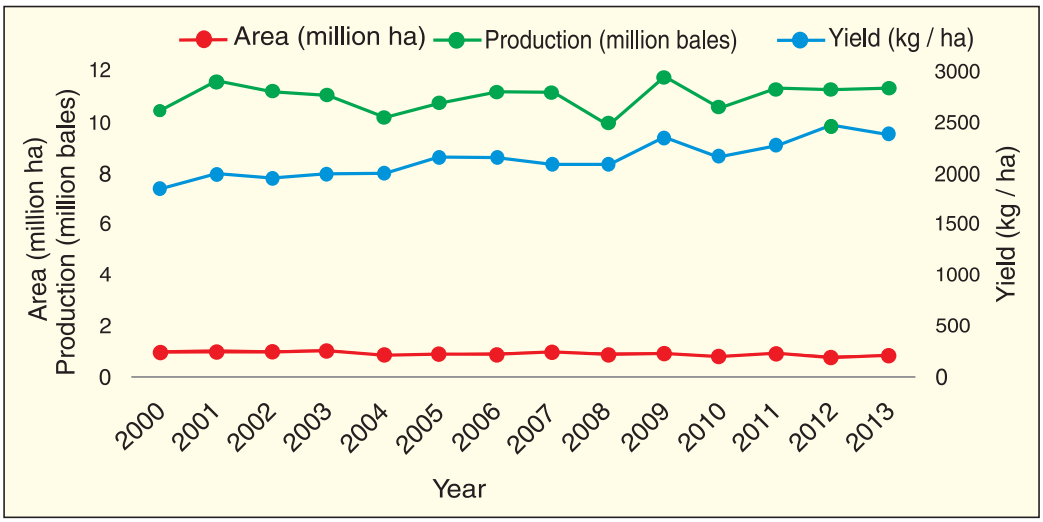

Fig. 1 Trend in area and production of raw jute in India

ICAR-CRIJAF envisions challenges that jute and allied fibre sector is facing, especially the competition from synthetics, changing climatic conditions, shortage of farm labour, non-availability of quality seeds/ planting materials and other inputs to the farmers, and is in the lookout for emerging domestic and global opportunities. Jute and allied fibre crops and their by-products can be highly economical, renewable, natural sources of bio-energy and important crops for environmental cleaning. The carbon sequestration potential of jute and allied fibre crops are estimated to be much higher than many tree species. Diversified uses of jute and allied fibres crops are proving more remunerative, but they require different kinds of production and processing technologies. It is now realized that jute and allied fibre sector would have to face several

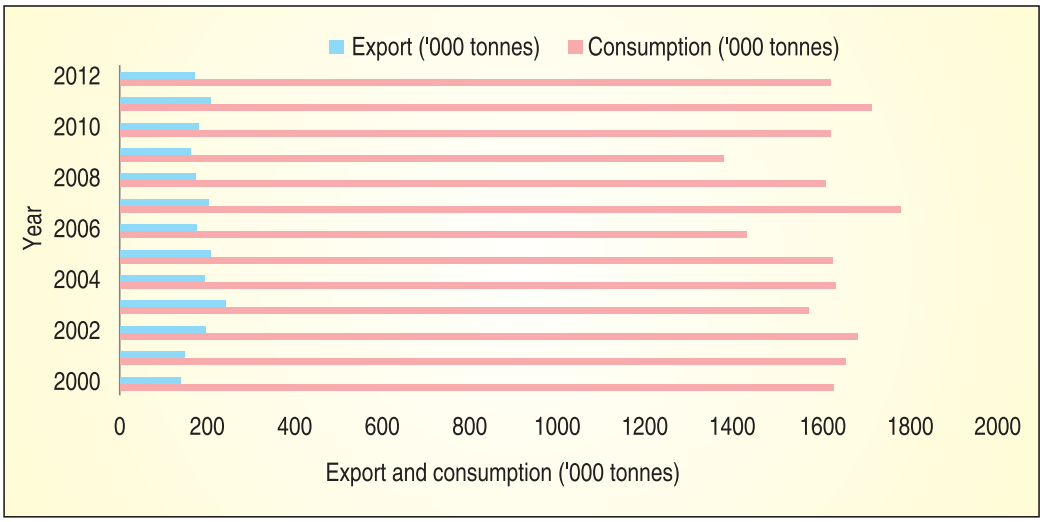

Fig. 2 Trend in export and consumption of raw jute in India

challenges and threats, along with the opportunities that are emanating from both supply and demand perspectives. An effective natural fibres invention and innovation continuum would play a crucial role in addressing a number of supply-side obstructions and in harnessing numerous demand-side opportunities. The pre-conditions for making jute and allied fibre sector more remunerative and sustainable would be to evolve effective mechanisms for technology delivery and to enhance capacity of all stakeholders in the invention-innovation continuum.

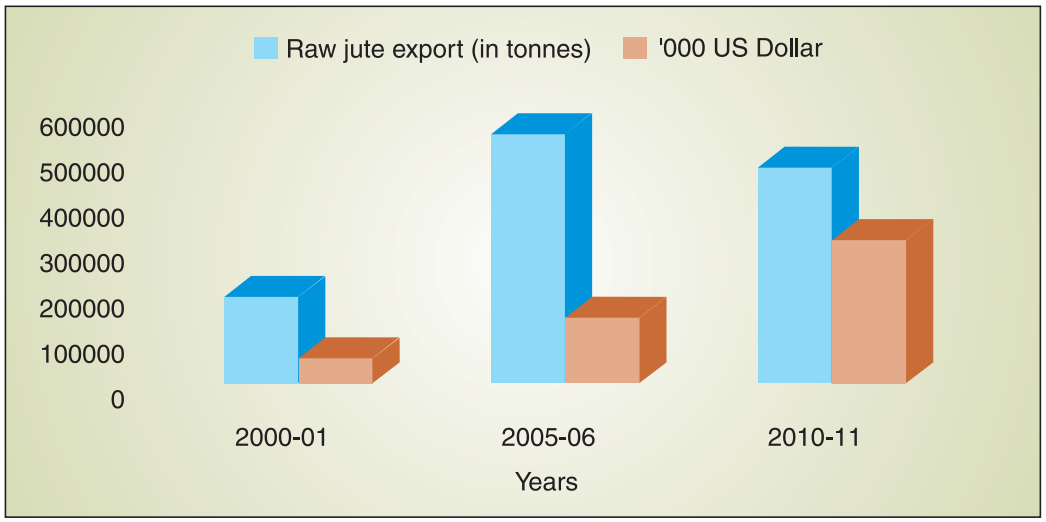

Fig. 3 Global trends of export quantity and values of raw jute and allied fibres

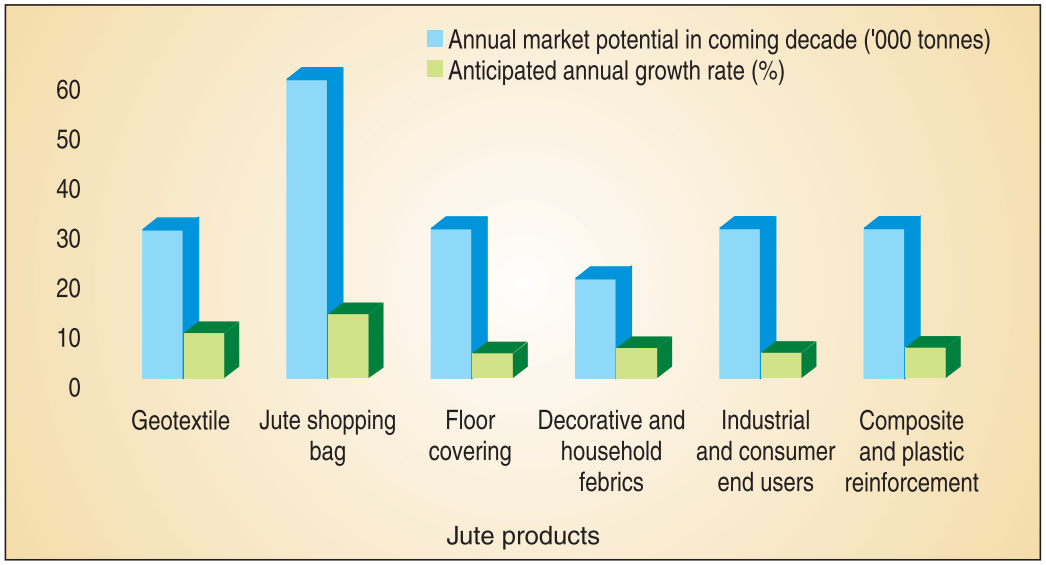

Fig. 4 Forecast for world market potential for non-traditional jute products

ICAR-CRIJAF Vision 2050' document narrates key challenges and opportunities in the jute and allied fibre sector in the next four decades for developing an appropriate strategy and gives a roadmap to

articulate role of the ICAR-Central Research Institute for Jute and Allied Fibres in shaping the future of the jute and allied fibre crops research for growth, development and equity.

Vision

Provide leadership in research and technology development to make jute and allied fibre farming profitable and sustainable

Mission

To explore traditional and new frontier areas of science for technology development, promotion and policy guidance for a vibrant, effectively productive and resilient jute and allied fibre agriculture.

Mandate

- Improvement of jute (*Corchorus olitorius* and *C. capsularies*), mesta (*Hibiscus cannabinus* and *H. sabdariffa*), sunnhemp (*Crotalaria juncea*), ramie (*Boehmeria nivea*), sisal (*Agave sisalana*) and flax (*Linum usitatissimum*) for higher yield and better quality.
- Improvement of jute and allied fibre crops for biotic and abiotic stresses.
- Development of economically viable and sustainable production technology and jute and allied fibres-based cropping systems.
- Development of post-harvest technology for improving the quality of fibre.
- Transfer of technology and human resource development in relation to jute and allied fibre crops.

Chronology in Research and Development of Jute and Allied Fibres

1904	Mr. R. S. Finlow, first fibre expert appointed in pre-independent India to improve quality of raw jute
1915	Chinsurah Green was developed as first jute variety by Mr. Finlow
1919	Dhaka 154 was also developed by Mr. Finlow
1928	Royal Commission on Agriculture suggested formation of Regulatory Body for agriculture, technological research and marketing of jute
1936	Indian Central Jute Committee (ICJC)was formed
1939	Jute Agricultural Research Laboratory (JARL) at Dhaka under the leadership of Dr. B.C. Kundu
1953	JARL was renamed as Jute Agricultural Research Institute (JARI) and shifted to Nilgunj, Barrackpore
1954	Jute varieties JRC 212, JRC 321 and JRO 632 were developed through pedigree selection
1956	Central Seed Research Station for Jute and Allied Fibres, Budbud was established
1959	Ramie Research Station, Sorbhog, Assam was established
1962	Sisal Research Station, Bamra, Odisha was established

1963	Sunnhemp Research Station, Pratapgarh, Uttar Pradesh was established
1966	JARI came under the administrative control of ICAR, most popular short duration and pre-mature flowering resistant *tossa* jute variety JRO 524 was developed using Sudan Green as a donar through trait specific hybridization programme
1967	First roselle variety, HS 4228 was released
1972	K 12 Yellow first variety of yellow seeded sunnhemp developed by CRIJAF
1977	Significant replacement of *white* jute belt into HYVs of *tossa* jute specifically suited to multiple cropping system
1983	TJ 40 was released as first commercial tossa jute variety developed through mutation breeding in collaboration with BARC, Trombay.
1990	JARI renamed as Central Research Institute for Jute and Allied Fibres (CRIJAF)
1998	JRO 66, a high yielding variety of tossa jute with quality fibre (TD2 grade) was released
1999	A high yielding variety of tossa jute, JRO 8432 was released
2004	MT 150 the first kenaf variety with high biomass suitable for paper pulp was developed
2005	S 19, a tossa jute variety resistant to premature flowering and stem rot disease was released
2007	JRO 204, high yielding tossa jute variety with quality fibre having premature flowering resistance genes from two different sources i.e., Sudan Green and Tangainika-1 was developed
2010	A trade mark for seeds of released varieties from Institute “CRIJAF SEED” was obtained
2011	Large scale seed production of improved varieties of CRIJAF was initiated in West Bengal
2012	First report of jute genome size
2013	Development of talc-based microbial retting formulation

Challenges

- Population pressure will shrink arable land and primary emphasis will be given to the food/feed crops. The population pressure is expected to cause 11% increase in average per capita calorie consumption between 2003 and 2050 as estimated by Food and Agriculture Organization of the United Nations. Meeting those demands would require 175-220 million hectares of additional cropland. Limited availability of additional arable land and water resources, nutrient mining by exhaustive cropping systems and the declining trend in crop yields globally make fibre availability a major challenge. In the coming decades, bast and leaf fibre crops will face a very stiff competition for land with food crops, and may also face new competitors in the area of product consumption (environment friendly polymers, alternate packaging materials). With a modest assumption of 50% increase in demand of bast fibre by 2050 (analogous to 50% increase in demand for food production), India has to increase jute productivity to 4.7 t/ha from present 2.35 t/ha if land under jute cultivation remains same. With a projected decrease in available area by 10-20%, average productivity should be increased to 5.5 t/ha by 2050.
- As we progress through the twenty first century, major changes are expected in terms of climatic conditions, atmospheric O_2/CO_2 and H_2O levels, depletion of ozone layer, chemical load in agri-ecosystem, population dynamics and associated demand for food, fibres and fuels. For Indian subcontinent, the IPCC has projected 0.88-3.16°C increase in temperature by 2050 depending on the pace in future development scenario. On the other hand, the concentration of atmospheric CO_2 may increase upto 445-640 ppm by 2050. These changes may deplete the SOC pool and structural stability, disrupt the cycle of C, N, S and other cycles and cause adverse impacts on biomass productivity and environment. Climate change with changing water regimes, ground and air temperatures will have potential devastative effect in production of jute and allied fibres.

India has to increase jute productivity to 5.5 t/ha from present 2.35 t/ha by 2050.

- Under changing climate, abiotic stresses are expected to be major limiting factors for crop improvement and new pests and diseases are

expected to break up in the changing climate scenario. A study has proposed that land degradation, climate change, water scarcity and pest problems could reduce up to 25% of world food production in this century.

- Keeping in view the importance of wild relatives of jute and allied fibre crops for traits for low lignin, fibre fineness, resistance to stem rot disease, drought and waterlogging condition, interspecific crosses for introgression of these important traits and also exploitation of heterosis through development of hybrid using stable male sterility remains challenge.
- Lack of retting water, in some years, due to rainfall deficit during jute harvesting period has also led to a severe problem of quality retting which dictates its market price. Jute is a rain-fed crop and the important post-harvest operation that is affected seriously by the deficit rainfall or shortage of freshwater is the retting. Thus, development of new retting technology without optimum availability of fresh free flowing water resulting in quality fibre in shorter period is required.
- Under the present mode of fibre extraction from ramie, fibre recovery is only 3-4% of the aboveground biomass (fresh weight basis) which is quite low. Challenges before the scientists are to fabricate a fibre extraction machine which will give 10% fibre recovery as that will significantly increase the productivity and profitability of ramie farming.

Development of new retting technology without optimum availability of fresh free flowing water resulting in quality fibre in shorter period is required.

- The fibre of Indian ramie genotypes have 28-30% gum (weight basis) which need to be lowered for production of apparel quality textile fabric. Breeding/development of low gum varieties of ramie is a challenge before the researchers. Improved microbial degumming technology facilitating repetitive use of the same consortium will overcome the disadvantage of present costly technology which is not capable of repetitive use.
- Import of sisal fibre in India increased at least seven times within twelve years period and the same will rise to 23,000 tonnes in 2050 at the present rate of population and industrial growth. The import value will be as high as 44 million US Dollar in 2050. Day by day, the price of imported sisal fibre is increasing, so a hefty amount of valuable foreign exchange may be drained from India. Therefore, India has to be self-sufficient for sisal fibre by increasing

the production through horizontal and vertical expansion. Lack of economic and simple propagation technology is the major bottleneck in early establishment of sisal plantation.

- Weed infestation is the important bottleneck of jute and allied fibre production as the magnitude of loss due to weed infestation varies between 52 and 70% and weeding alone contributes to about 35% of the total cost of cultivation as it is labour intensive activity. Again shifting cropping pattern due to climate change will also aggravate the weed problem with occurrence of new and invasive weed flora in jute. Development of integrated weed management practices with particular references to i) new safer herbicide molecules ii) improved mechanical weeding tools iii) screening suitable smother crops and iv) herbicide resistant transgenic jute to increase net return from jute husbandry.Moreover, moist soil in early seedling growth and inadequate seeding vigour reduce the efficiency of weed control practices and the capacity of crop to compete with faster growing weeds.
- In the context of probable changing spectrum and increasing loss from biotic stresses due to gradual shift in climatic conditions, edaphic factors and cropping sequence, there will be urgent need to develop ecological modelling for accurate pest and disease forecast for enhancing the efficiency of pest management tactics through precise scheduling of low-volume, persistent pesticides with improved application technologies.

Ecological modelling for accurate pest and disease forecast for enhancing the efficiency of pest management tactics is the need of the hour.

- Diversified and multiple uses of jute and allied fibre crops hold the key to make their production profitable. But at present there is lack of available technology for effective extraction and utilisation of the by-product for these crops. Besides, the pharmaceutical, nutraceutical, antioxidant properties of jute and allied fibre have remained unexploited. It is challenging to integrate the benefits of these diversified uses from the crop grown exclusively for fibre purpose as there is no such genotypes/cultivars which can deliver multiple/dual benefits.

The pharmaceutical, nutraceutical, antioxidant properties of jute and allied fibre have remained unexploited.

- Whatever amount of research for development and refinement of technologies are attained may be futile if not reached to the end users (say jute and allied fibre growers) in time. By middle of this

century, the quality and quantity of natural resources will further decline. In this scenario, agricultural extension section of the institute will come forward to inculcate the coping strategy among the jute and allied fibre growers.

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Operating Environment

The institute addresses an important non-food commodity sector, which provides livelihood support to the small and marginal farmers. Currently constraints of human labor, energy deficit and climate change are posing serious challenges to very sustenance of these crops.

Being a commercial crop the ultimate consumer requirement is fulfilled through a chain involving fibre production, processing, value addition and marketing which includes the stakeholders involving farmers, traders, industrialists and exporters. During last more than three decades, many technologies have been developed and demonstrated by the institute but the benefit in totality has not been realized in farmers' field for want of awareness, inadequate infrastructure and lack of policy support. India and Bangladesh are the major jute growing countries. Although very limited area is in other Asian countries, the research activities are mainly concentrated within these countries. Very regional presence make these crop least attentive for funding by other international Institute/agencies/countries.

India and Bangladesh are the major jute growing countries. Although very limited area is in other Asian countries, the research activities are mainly concentrated within these countries. Very regional presence make these crop least attentive for funding by other international Institute/agencies/countries.

The effect of change in climate in causing different abiotic stresses and shift in pattern of biotic stress needs to mitigate. At the same time the problem of deficit in rainfall along with shortage of fresh water retting has to be overcome with ecofriendly economic innovative approach for retting to result in quality fibres. Climate change with its impact on production and productivity of jute and allied fibre crops is looming large over the horizon. The challenges to enhancing yield and quality, preventing or combating pests, diseases and weeds, and generating crops adapted for future environments are issues that require urgent attention. There is more risk in terms of vagaries of weather in general and rainfall in particular, which becomes erratic in certain years, thereby making jute cultivation more risky and unstable. Problems related to soil health (nutrient and humus depletion), uncertainty about monsoon and unpredictable environmental conditions, floods, and pest and disease outbreaks have in the past made the jute production highly

unstable. Although many new technologies and few small machineries have been developed to reduce the labour requirement in jute cultivation, still the field operations and processing are labour intensive which enhances the cost of cultivation.

Jute being high potential crop for soil carbon sequestration and soil fertility, offers opportunity for exploitation of benefit of carbon credit to restore our environment. The diversified use of jute and allied fibre especially in geotextile, composite, textile, paper and pulp, biofuel and pharmaceutical will be the basis for the future growth in jute agriculture. Though meagre information is available on potential uses of jute and mesta as medicinal, neutraceutical value, proper scope for bio-prospecting for valuable biomolecule remains and this will result in profitability in this sector.

As in case of other crops, the pillar of crop improvement programme is the germplasm repository with huge diversity. Africa being the primary centre of origin it is inevitable to identify and incorporate some novel traits without the global exploration for wild relatives of jute in these countries.

With the increasing competition from other in-season cash and food cash crops to make the crops in this sector more remunerative the institutes involved in research, processing, marketing, value addition and export are to work in a cohesive manner.

To cope with the fast advancement in science the Institute is to create the required infrastructure and skilled human resources to harness the benefits offered by new science. With globalization of agriculture, the jute trade scenario is also undergoing sea change. Keeping these dynamic features in view, the institute needs to modernize, modify and improve upon its research strategies, infrastructure facilities and human resources. For its existence and visibility it has to be competitive inside the country as well as at the international level.

Linkage

ICAR-CRIJAF is responsible for carrying out and coordinating systematic research on jute and allied fibres in India. At present, ICAR-CRIJAF has four regional stations mandated with research on allied fibre crops and seed production. Three crop research station *viz.* Ramie Research Station, Sisal Research Station, and Sunnhemp Research Station were established at Sarbhog (Assam), Bamra (Odisha) and Pratapgarh (UP), for conducting research work on ramie, sisal and sunnhemp, respectively. Central Seed Research Station for Jute and Allied Fibres (CSRSJAF) was established at Budbud in Burdwan district of West

Bengal to conduct research on seed of jute and allied fibre crops. The institute has nine collaborative centres for multi-locational testing and revalidation of the technologies under All India Coordinated Research Project on Jute and Allied Fibres (AICRPJAF), started in 1967 and presently functioning as All India Network Project on Jute and Allied Fibres (AINPJAF).

Apart from ICAR-CRIJAF, there are other national and international organizations and bodies which are working in the area of jute and allied fibres with diversified mandates.

Organization	Areas of activities
NIRJAFT, Kolkata	Development of technologies for processing of fibres for industrial use
Department of Agriculture &Cooperation, Govt. of India	Facilitating the production of breeder seed of HYVs
Directorate of Jute Development, Govt. of India	Quick dissemination of improved technologies among the farmers and capacity building of farmers and extension officials
SAUs and Institutes	Research and development on jute and allied fibres
Office of the Jute Commissioner, Government of India	Deals with policy decision about jute and allied fibre crops
Jute Corporation of India, Kolkata	Policy determination for fixation of minimum support price (MSP) and facilitate the procurement of jute &mesta fibres from growers and funds support for research and promotion
Indian Jute Industries Research Association (IJIRA), Kolkata	Research on industrial processing of jute and allied fibres
Jute Industries	Product development
National Jute Board	Policy for marketing jute product and funding for research and development
State Agriculture Department	Development and dissemination of improved technologies among the farmers and capacity building of farmers.
KVKs	Training and demonstration of different improved technologies for dissemination among the farmers
PPV&FRA, Ministry of Agri., Govt. of India	Registration of varieties under PPV & FR act and facilitate DUS testing of jute varieties.
IIT, Kharagpur & IISER, Kolkata	Prototype for mechanization, genomics research in jute and allied fibre

Apart from these, a number of institutes in different countries (Bangladesh Jute Research Institute, Institute of Bast Fibre Crops, China, Beizing Genomic Institute, China and Institute for Natural Fibres, Poznan, Poland) along with international bodies like International Jute Study Group (IJSG), Dhaka are also involved in research and development in jute and allied fibres sector..

New Opportunities

- Since genes controlling some vital characters of jute and allied fibres are scattered among various species/varieties of same species and could not be combined into a one stock through conventional breeding, it was a serious setback to harness the benefit of available variation in respect of various characters.New frontier areas of science offer opportunities to deploy cutting-edge technologies like biotechnology, nanotechnology and convergence of conventional breeding with modern cell technological approaches for improvement of jute and allied fibre crops.
- To restore our environment, sequestration of half a billion tonnes of carbon in the tropics per year (equivalent to 1.8 billion tonnes of carbon dioxide) would require between 50 - 150 million hectares land. Jute, during its growth adds about 15 tonnes green leaves to the soil and the root of both the species that can penetrate upto 60cm soil depth or more with lateral roots may act as potential carbon sequesters and restorer of soil fertility. As potential for C sequestration in deeper soil layers is large, jute having deeper roots and quick and heavy biomass production characteristics will present greater opportunities for C sequestration. Through jute cultivation in 0.80 million hectare area, India reduces about 12 million tonnes of carbon-dioxide from atmosphere every year which has been valued at Rs. 1080 crores. Estimated CER (certified emission reduction) revenue per hectare of jute cultivation is about Rs. 16,000/-. Benefits of carbon credit of jute cultivation has not yet been explored and need to be realised in the coming decades.

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- Diversified and alternative uses would be the key to survival of jute and allied fibre crops. In future, bast fibre composites are expected to be good supplement of wood due to high strength and durability in paper pulp industry. Increase in textile demand also opens up opportunity for jute blended textiles and increased use of ramie-cotton blends. Besides, other alternative uses including identification of key botanical compounds from jute and mesta are expected to

be developed. Mesta fibre usually gives poor remuneration to the farmers but it can be augmented by producing fibre-cum-seed crops which will produce mesta fibre along with mesta seed containing 22-24% oil. Additional return from mesta seed oil/bio diesel and oil cakes (feed or costly concentrated manures) will add to the net return of mesta husbandry by adding its return to that of fibre. The International Energy Agency has set targets and roadmaps to replace 27% of the transport fuel by biofuel within 2050, which would also reduce carbon di-oxide emission by 2.1 gigatonnes. Today, about one third of the USA's maize harvest is channelled for biofuel production. Kenaf, roselle, jute and other lignocellulosic fibre crops thus have high opportunity in this area.

- The cropping system may play vital role in enhancing the profitability of jute and allied fibre crops through effective residual nutrient utilization enhancing the economic return from sisal and ramie plantations. Mixed and/or intercropping of jute with other short-duration vegetable, pulse, oilseed crops offer opportunities of insurance against drought, control of weed pressure, conservation of soil moisture and additional income to the farmers.

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- Sisal-based composites offer the highest flexural stiffness which have great scope for building and construction industries. Most of the industries are re-orienting their product range from high cost and high performance composites towards more environment friendly, less energy-intensive and lower cost plant fibre reinforced specifically sisal based composites. The marine ropes made from sisal fibres are mostly imported from Latin America and Africa.India has to be self-sufficient for sisal fibre by increasing the production through horizontal and vertical expansion and must have a goal to gain at least part of the export market also.
- Although technologies for weed management in jute and allied fibre crops have been recommended, development of resistant and invasive species necessiates continuous search for better alternative with integrated approach for weed management in jute and mesta as this can enhance the productivity by 40%. Projected shortage of labour in agriculture sector offers opportunity to the researchers to develop energy-efficient farm machines and identify environment-safe

chemicals for weed control.

- Present energy/input (water, nutrient, etc.) use efficiency in jute and allied fibre production in India is so low that their improvement alone can make this sector economically attractive. Advancement in irrigation technology, development of high-analysis, controlled-release fertilizer formulations and their applicators, invention of improved seed drill, herbicide/pesticide applicator offer new opportunities for improving energy use efficiency in jute and allied fibre production.
- Growing shortage of fresh water for retting has proved to be a serious constraint for cultivation of jute and mesta. This offers new opportunities for development of moist and/or dry retting technologieswith introduction of efficient retting microbes and identification of some safe chemicals for spray to achieve quick retting..

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Goals and Targets

1. **Increasing yield/meeting market demand for adequate supply of fibre**
   - Characterization of germplasm of jute& allied fibre crops both at morphological and molecular level, genetic divergence analysis, evaluation for economically important characters, bar-code documentation and registration of identified germplasm and their enhanced utilization through pre-breeding.
   - Development of improved varieties and plant ideotype of jute& allied fibres through conventional method integrating marker assisted selection and other biotechnological tools.
   - Exploitation of hybrid vigour through development/identification of stable male sterility of jute for productivity improvement.
   - Development of transgenic in jute and allied fibre cropsfor herbicide resistance, *in-planta* retting as well as resistance to biotic and abiotic stresses.

   Enhanced utilizationespecially of wild relatives through pre-breeding, hybrid development, transgenic for herbicide resistance and *in planta*retting will bring in increase in fibre yield.

2. **Improving quality to meet industrial requirement**
   - Genetic manipulation of lignin biosynthesis for achieving improved fibre fineness in jute, and of pectin biosynthesis for reducing gum content in ramie.
   - Determination of anatomical parameters responsible for fibre development in jute and mesta and use of nano-technology for improvement of lingo-cellulosic biopolymers.

3. **Reducing dependency on human labour and enhancing water and input use efficiency**
   - Development of cost-effective and user friendly crop–specific combiner for all farm and post-harvest activities.
   - Automatic sensor-based precise application techniques for enhanced input and water use efficiency and productivity.
   - Standardization of suitable activator and the delivery system during pre-retting stage and up-scaling of jute retting microbial

consortia to accelerate the retting process.

- Management of soil fertility with special emphasis on use of locally available organics and biofertilizers, recycling of crop residues under different agro-climatic conditions.

4. Jute for protection/conservation/cleaning of environment

- Development of photo- and thermo-insensitive varieties for longer growing season.
- Exploring the potentials of jute (with high carbon sequestration capacity) in mitigating global warming and harnessing the benefits of CER (certified emission reduction) revenue from jute cultivation.
- Simulation studies on weather-growth relationship of jute and allied fibre crops for yield assessment, enhanced CO_2 in soil, crop-pest interaction.

5. Stabilizing the potential yield under adverse edaphic and climatic condition

- Breeding specific varieties with resistance to salinity and pre-maturing flowering
- Mitigating the adverse impact of biotic stresses under changing environmental condition on yield with specific technologies.

6. Exploitation of alternate/diversified/multiple uses of jute and allied fibres

- Exploring potentials of the jute & allied fibre biomass as vegetable, fodder, bio-fuel, geotextiles and paper pulps.
- Harnessing the potential of edible healthy oil with high linoleic acid from seeds of jute & allied fibres.
- Ameliorating problem soils/waste lands exploring the adaptability of sisal and ramie.
- Development of dual purpose (seed and fibre) genotype of flax for better economic return

7. Promotion of public private partnership for development of jute and allied fibre

- Public-private partnership in production of quality seeds, planting materials for enhancing industrial use and marketing.
- Establishment of accelerated research-extension-farmer-market linkages.

Public-private partnership in production of quality seeds, planting materials will enhance industrial use and marketing.

- Facilitation of mechanization in jute and allied fibres cultivation through Farmers' co-operatives and public private partnership (PPP).

8. Capacity building for advance research and extension

- Creation of research facility and trained manpower on frontier research areas.
- Utilization of innovative and progressive farmers as para-professionals for extension.
- Dissemination of technologies through electronic media/e-extension, training of trainers and farmers in improved fibre production technologies; farmer to farmer approach through farm schools and utilization of innovative and progressive farmers as para-professionals for extension.

Strategy

In the coming decades, bast and leaf fibre crops will face a very stiff competition for land with food and horticultural crops, the same may reflected in the area of product consumption like environment friendly polymers, alternate packaging materials, etc. With a modest assumption of 50% increase in demand of bastfibre by 2050 (analogous to 50% increase in demand for food production), India is to increase jute productivity to 4.7 t/ha from the present 2.35 t/ha if land under jute cultivation remains same. With a projected decrease in available area by 10 – 20%, average productivity should be increased to 5.5 t/ha by 2050. To meet the challenges ahead, we may have to achieve following targets.

Improvement of Jute and Allied Fibre Crops to Suit the Changing Environment/ Requirement

- Development of short duration varieties of jute and mesta (preferably 80-90 days) maintaining high productivity by modifying fibre biosynthesis pathway to obtain higher fibre accumulation per day between 20 – 90 days.
- Evolving improved ideotypes with higher bark:core and stem: leaf biomass ratio (jute) , improved plant type suitable for intercropping system (jute and mesta) and higher fibre bundle number and minimal gum content (ramie).
- Exploiting male sterility and/or apomixis based technique for development of hybrid jute.
- Genetic intervention in sisal for increasing growth rate and number of harvestable leaves per year.
- Searching for improved genotypes having more capacity of carbon sequestration, premature flowering resistance

Exploiting male sterility and/or apomixis based technique for development of hybrid jute will enhance fibre productivity.

Value Addition of Jute and Allied Fibres for Diversified Use and Increasing Profitability

- Modification of fibre biosynthesis pathway to minimize meshiness for better spinnability of jute and mesta fibres.
- Development of plant types with smooth periphery and regular shape fibre bundles with higher fibre bundle density per fibre wedge in

jute and mesta.

- Pharmacogenetics of valuable chemical compounds from jute and allied fibres and development of technologies and varieties for large scale bioprospecting of valuable chemicals.

Development of photo-thermo insensitive varieties of jute and mesta for continuous biomass supply willmeet the prospective demand from paper pulp and biofuel industries.

- Development of photo-thermo insensitive varieties of jute and mesta for continuous biomass supply to meet the prospective demand from paper pulp and biofuel industries.
- Evaluation of jute species and varieties for vegetables with higher edible antioxidants like β-carotene, vitamin-C, and various minerals.
- Assessment of oil content and properties of jute and mesta seeds and sisal wax foruse in food, fuel, pharmaceutical and food preservation.

Application of Biotechnology/Genetic Engineering Tools for Improvement of Jute and Allied Fibre Crops

- **Genomics of cellulose-hemicelluloses network(s) in jute and kenaf**: targeted manipulation of the hemicelluloses and their interactions with cellulose in bast fibre using comparative genomics and/or reverse genetics:
  a) Identifying genes that encode hemicellulose synthase to modulate fibre hemicelluloses content, with a special reference to Golgi-resident hemicelluloses biosynthesis genes including *cellulose synthase* (*Ces*)*-like* (*Csl*) genes that belong to the *CesA*super-family.
  b) Modifying the interactions of cellulose with non-cellulosic polysaccharides using non-catalytic carbohydrate binding modules (CBMs), polysaccharide-binding proteins.
  c) Development of low-hemicellulose jute and kenaf with increased fibre strength and improved bast fibre characteristics, especially fibre fineness.

- **Genomics of lignin metabolic grid in jute and kenaf**: targeted manipulation of the phenylpropanoid pathway in bast fibre by metabolic engineering and/or reverse genetics:
  a) Development of lignin-free bast fibre in jute and kenaf, without affecting the wood (secondary xylem) lignin content that provides mechanical support to the plant stand.
- **Nanobiotechnology**:
  a) Identification and development of jute-derived biopolymers

for industrial and biomedical applications.
Design and development of nanocatalysts for conversion of jute wastes to biodegradable industrial solvents and bio-based fuels.

Application of genomics and nanotechnology for enhanced fibre productivityand quality.

b) Development of jute and kenaf fibre thermoplastic alloys.

- **Genomics of photoperiodic regulation of flowering and bast fibre biogenesis in jute based on comparative genomics and/or reverse genetics**:
  a) Identification and characterization of candidate genes controlling flowering time and bast fibre biogenesis in jute.
  b) Development of day-neutral (photoperiod insensitive), short-duration jute for diverse cropping systems and seed production across spatio-temporal environmental conditions without compromising fibre quality and yield.
- **Genomics of biological retting of bast fibre in jute and kenaf based on transgenics**:
  a) Development of auto-retting jute and kenaf *in planta* by developing transgenics expressing microbial genes that are involved in biological retting process and their pyramiding.
- **Designer jute and kenaf**:
  a) Tailor-made crop canopy to maximize nutrient use efficiency and marketable bast fibre yield so as to enable the farmers to custom-design their own optimum crop canopy for their specific growing conditions and needs.

Tailor-made crop canopy to maximize nutrient use efficiency and marketable bast fibre yield so as to enable the farmers to custom-design their own optimum crop canopy for their specific growing conditions.

  b) Development of jute and kenaf varieties with fibres of lower 'linear density' that would allow yarns of lower count to be spun resulting in the production of light-weight fabrics.

Controlling Increased Incidence of Diseases and Pests in Jute and Allied Fibre Crops

- Improved ecological modelling for pest and disease forecast: Development of degree-day models, coupling this with crop

modellingwill serve to predict insect and pathogen incidence better than empirical relations. This will help to assess impact of climate change on pest dynamics as well as crop-pest interactions which would act as a guide for adaptation measures. ETL-based sensor mechanism for initiating pest and disease management practices.

- Nano-formulation for pheromone, biocontrol agents and pesticides: Designing ofnano-fibre based composite formulations of semiochemical/pheromone for enhancing the photo- and thremo-stability, development of nano-sensor for controlled release of pheromones, nano-encapsulation of pesticides and biocontrol agentsfor precise and effective management of insect pests and diseases of jute and allied fibre crops with least residues.

Designing nano-fibre based composite formulations of semiochemical/pheromone,nano-sensor for controlled release, nano-encapsulation of pesticides will effectively manage insect pests and diseases of jute and allied fibre crops with least residues.

- Nanodipstick technology: Development of quick and accurate test kit for identification of plant viral, bacterial and phytoplasmal diseases in jute and allied fibre crops to provide the farmers low cost pathogen detection technology.
- Biotechnological interventions: Development of transgenic jute with Bt gene against Bihar hairy caterpillar, stem weevil and semilooper will certainly reduce the pest pressure and pesticides use in jute. Using RNAi silencing specific gene which is responsible for host plant-insect interactions may be used for management of sucking pests in jute and allied fibres.
- Application of genomics: Better understanding of pathogen and insect pest at the genomic level will open new door for development of disease resistant varieties which will be core component for integrated disease management of jute and allied fibre crops. Management of pests and diseases will be easier as we understand host-pest/pathogen interactions at the molecular level. Such strategies would be more eco-friendly, effective and durable.
- Bio-intensive disease management: In the backdrop of increased population build-up of pests and augmented inoculums load of pathogens, no single approach will be effective enough to manage the future pest and diseases. Rather, a combination of approaches spanning from bio-agents (PGPR, endophyte, bio-control agent) to new generation chemicals (including phyto-chemicals), broad horizontal resistance based host genotypes would be appropriate to

tackle the pest scenario.

- **Plant defence activation/plant immunization/cross protection:** Understanding of practical aspect and mechanism of induced systemic resistance (ISR) and systemic acquired resistance (SAR) mediated through biotic and abiotic plant defence activator which will play important role for eco-friendly disease management of jute and allied fibre crops.

Integrated Weed Control Measures in Jute and Allied Fibres

- Shifting of weed species and their life cycles in changed atmosphere/ ecosystem will require close monitoring.
- Screening of new low volume, safe herbicides for the control of changing weed dynamics in jute and allied fibre crops.
- Mechanical and cultural methods (plant residue management, growing intercrops, cover crops and green manure crops) of weed control will gain importance for generating additional income from the inter/smother crops and simultaneous maintenance of soil fertility.

Mechanization of Jute and Allied Fibre Crops Cultivation in View of Shortage of Labour and Cost-Effectiveness

- Crop-specific, energy efficient, low cost, light weight combiner for mechanization of farm and post-harvest operation.

Retting of Jute and Allied Fibres with Low Volume of Water and/or with Waste Water

- Development of moist retting (5-10% moisture) technology with the introduction of highly efficient retting microbe(s) without degradation in fibre quality.

Moist retting (5-10% moisture) technology with the introduction of highly efficient retting microbe(s) will enhance fibre quality.

- Development of dry retting technology with the introduction of highly efficient aerobic retting microbe(s) preferably bacteria may be cloned/genetically engineered without degradation in fibre quality.
- Development of varieties with pectin and xylan degrading gene screened out from the pectin and xylan degrading microbes, in such a way that at 100-120 days of crop growth these genes will show their expression and auto degradation of pectin and xylan will start and the dependency of retting on water will be very less.
- Standardization of suitable activator and the delivery system during pre-retting stage to accelerate the retting process.

- Integration of desirable traits of different microbes in single bacteria.
- Besides these, community retting facilities may be created, where repeated retting can be carried out in stagnant water by maintaining the BOD.

Development of Improved Production Technologies for Perennial Fibre Crops of Ramie and Sisal

- Improved crop husbandry and alternative planting materials for sisal and ramie with cost effective cropping system, micro-propagation for quick plantation establishment
- Development of ramie transgenics with diverse genes, singly or in combination, governing tolerance to various biotic and abiotic stresses, which may be tailored into existing germplasm to make them tolerant with enhanced productivity.
- Development of fibre extraction machine for ramie that can give fibre recovery of at least 10%.
- Development of efficient, cost-effective and easy-to-handle delivery system for microbial degumming consortia in ramie with better shelf-life suitable for repetitive use.

Effective Dissemination of Jute and Allied Fibre Production Technologies

- Maintenance of information data bank in local linguistics for transfer of customised technology cluster to individual jute and allied fibre grower through village resource centres.
- Market led extension and organization of commodity interest groups, information kiosks at village level for improving agri-technology information sharing with farmers and other stakeholders.
- Launching of expert centres for jute and allied fibre growers at research centre so that jute and allied fibre growers can have direct interaction with the experts.

Effective dissemination of technology through launching of expert centres for jute and allied fibre growers will bring overall developed in jute sector.

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Way Forward

For accomplishing the vision and the goals of the ICAR-Central Research Institute for Jute and Allied Fibres and for enhancing efficiency and effectiveness of the research resources, the following 6-point strategy would be adopted.

1. Balancing Futuristic and Problem Solving Research

- Strengthening of multi-disciplinary basic and strategic research to meet the challenges of climate change on jute and allied fibre crops
- Orientation of research to harness the benefits of alternate/diversified/ multi uses of jute and allied fibre crops for making them competitive with synthetics

2. Modernization of Infrastructure/Facilities for Conducting Upstream Research

- Establishment of well-equipped and centralised laboratories pertaining to genomics,phenomics, biotechnology, biochemistry, fibre quality, physiology, soil science, plant protection and agricultural chemicals
- Development of new and renovation of old equipment/buildings/ workshop, farm office, fibre extraction unit and storage facilities
- Establishment of greenhouse/polyhouse/glasshouse and creation of phytotron facilities for initiating simulation studies on impact of climate change on jute and allied fibre production
- Modernization of library facilities through digitization, e-resources and utilization of relevant electronic journals through network (national and international level) in secured manner
- Creation of crop- and/or region- specific research stations/centres to concentrate on focused research activity

3. Strengthening and Development of Human and Financial Resources

- Increasing cadre strength for focused in-depth research and allocating human resources in different crops in tune with relative importance
- Mobilizing fund from various sources through motivating scientific staffs for submission of winning proposals in vital scientific fields relevant to jute and allied fibre crops
- Training and visit of scientists in state-of-the-art laboratories for exposure to the advanced research methodologies

- Promotion of e-governance (paperless administration) in office

4. Thrust on R&D through Collaborative/Partnership/Network Mode

- Organization of network research projects to meet location specific requirements and refinement/validation of technologies
- Implementation of externally funded and inter-institutional/ collaborative research projects
- Strengthening of Public Private Partnership mode of R&D in jute and allied fibre sector

5. Faster Dissemination of Technologies by Adopting Innovative Methods of Extension and Impact Assessment

- Novel methods of technology dissemination of jute and allied fibres
- Modernization of KVKs with adoption of more villages and accommodation of more stakeholders
- Establishment of seed village for boosting quality seed production and farm income
- Development of ATIC with creation of e-extension channel to benefit large number of clientele

6. Commercialisation of Technologies and Research Outputs in IPR Regime

- Protection of plant varieties in allied fibre crops and motivating researchers through incentives and recognition
- Patenting of inventions/novel output of research
- Marketing/commercialization of research innovations (seeds, machines, etc.) through private firms

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