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CRIJAF *Perspective Plan*

VISION-2025

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

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PREFACE

Jute is the major commercial crop of eastern and part of the north eastern states, in general, and of West Bengal in particular, which provides raw material (fibre) for producing packaging materials by the industries and contributes significantly to country's economy. When viewed from the national context it is revealed that about 4 millions farmers, 0.25 million industrial workers and 0.5 million traders find gainful employment in jute sector. Over and above, jute farming generates 10 million man-days of employment in rural India during the growing and harvesting season of the crop (middle of March to middle of September). Thus, raw jute (jute and mesta together) farming, industry and trade supports livelihood to 5 million people though it shares only 0.15% of the cropped area of the country. These apart, the jute industry also contributes to the export earning to the tune of nearly 1200 crores of rupees yearly. Jute and mesta are cultivated in 9.04 lakh ha of land (average of last five years) whereas production is 95.39 lakh bales annually. Productivity is 9.55 bales or 19.12 q/ha when jute and mesta are taken together (mesta is inherently a low fibre yielder compared to jute). The productivity in jute, in particular, has more than doubled over the last 50 years with contribution of CRIJAF, extension agencies, both in private & public sectors, and of course, the farmers.

The Central Research Institute for Jute and Allied Fibres, Barrackpore is the premier body responsible for conducting research and dissemination of the knowledge to the farmers on the production of jute and allied fibre crops. This Institute has a long history of its contribution to the nation and for the benefit of the farmers by way of developing new varieties and also evolving new crop husbandry. It is heartening to note that productivity in jute has more than doubled (22 gha^{-1}) since independence (11 q ha^{-1}) with major contributions of CRIJAF. However, confronted with the challenge posed by cheaper synthetics and with other various socio-economic changes, there is an urgent need to frame strategies to meet the future needs.

Keeping all these in view, CRIJAF Vision-2025 addresses major issues particularly on:plant genetic resource enhancement, productivity and fibre quality improvement, integrated management of biotic and abiotic stresses, integrated management of soil-water-nutrient, post harvest technology, paper making from jute and mesta, and technology assessment & transfer. Cutting-edge technologies would be given support little more than earlier, and as a policy, R & D on allied fibre crops will be intensified. All these are welcome changes to ensure future demands of jute and allied fibres, in general, and especially the demands for quality fibres for increasing product diversification to further boost export earnings.

In the perspective plan formulation, there was an overwhelming response to the Council's initiative, which deserves all appreciation for undertaking this onerous task right from designing of the necessary format and taking the plan formulation process to its logical conclusion. The scientists of the Institute have put in their collective wisdom in bringing out the document to its present form. It is hoped that the framework prepared would continue to be reviewed to accommodate changes in future so that the perceived vision continues to be close to the expected target.

(H. S. Sen)
Director

EXPLANATION TO THE ABBREVIATIONS

AAU	Assam Agricultural University, Jorhat
ANGRAU	Acharya N G Ranga Agricultural University, Hyderabad
AINP	All India Network Project on Jute and Allied Fibres
BCKV	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur
CICR	Central Institute of Cotton Research, Nagpur
CIRCOT	Central Institute for Research on Cotton Technology, Mumbai
CRIJAF	Central Research Institute for Jute and Allied Fibres, Barrackpore
CU	Calcutta University, Kolkata
DBT	Department of Biotechnology, New Delhi
DJD	Directorate of Jute Development, Kolkata
DSR	Directorate of Seed Research, Mau
ICAR	Indian Council of Agricultural Research, New Delhi
IJIRA	Indian Jute Industries Research Association, Kolkata
IJSG	International Jute Study Group, Dhaka
IJT	Institute of Jute Technology, Kolkata
JDP	Jute Diversified Product
KU	University of Kalyani, Kalyani
KVK	Krishi Vigyan Kendra, Bud Bud, Burdwan
MPKV	Mahatma Phule Krishi Vidyapeeth, Rahuri
NBPGR	National Bureau of Plant Genetic Resources, New Delhi
NIRJAFT	National Institute for Research on Jute and Allied Fibre Technology, Kolkata
NRCPB	National Research Centre for Plant Biotechnology, Kolkata
OUAT	Orissa University of Agriculture and Technolgy, Bhubneswar
TMJ	Technology Mission on Jute
TNAU	Tamil Nadu Agricultural University, Coimbatore
UBKV	Utttar Banga Krishi Viswavidyalaya, Coochbehar

EXECUTIVE SUMMARY

Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore along with its research stations and All India Network Project (AINP), is the nodal research institute in the country for development of varieties and production technology needed to increase the productivity and improve the quality of fibre of jute and allied fibre crops so as to meet the demand of raw materials for the industries. Since its inception, the institute has made significant contributions in the development of high yielding varieties and improved production technologies, which have helped in doubling the national productivity and also enabled the jute crop to fit into the multiple cropping sequence.

The jute and allied fibre production is predominantly shifting from the earlier concept of ‘increase in yield’ to the ‘utilizable production of the whole chain that links the producer to the consumer’. In this trade chain, a new force has emerged that believes not on primary product alone, but on the development of secondary products as demanded by the consumers, both domestic and international. This is bringing about better utilization of primary products, value-addition and income generation at each stage of the production – consumption continuum. This links the agro-industries to the production system, unlike the past, where agro-industry was considered a separate entity.

Therefore, in the development of technologies, focus should be on several crucial issues. Research should be targeted to small and medium jute farmers over short-term as well as for long-term development. Technologies should have increased certainty with much less risks, minimum or reduced resource requirements in the fields of poor farmers. Another important issue is the quality of products, which has a direct bearing on the production – consumption chain. The market demand for products has changed, and product development has to take account of the market demand.

Technology is the *mantra* for the new millennium. The achievements of the past has given us enough confidence that there is the potential for change and reforms; but that again needs the change in the existing mindset, ideology and research policies. We need to do that forthwith.

The primary mission of the Institute is to explore traditional and new frontiers of science and knowledge for technology development and policy guidance resulting in a vibrant, responsive and resilient jute and allied fibre agriculture which must be effectively productive, eco-friendly, sustainable, economically profitable and socially equitable. The bottom line is ‘Increase in national productivity and sustained production of quality fibre in jute and allied fibre crops’.

The present perspective plan has been drafted in keeping with the changing social needs of the society, government policies vis-à-vis domestic and international market scenario, and most importantly, research and technological innovations having potentiality for application to the family of commercial bast fibre crops. Over the last decade, there has been a growing trend for assessment of research outcome and technology in terms of eco-friendliness, sustainability, and cost-competitiveness and value addition. In order to meet the emerging challenges and felt needs, new initiatives in specific research areas are suggested to meet the mandates; and the research efforts already initiated in the thrust areas have also been refined to meet the requirement of both packaging and diversified products sectors.

In light of above, future thrust of research has been projected to center around improvement of yield and quality of fibre, exploitation of their potentiality with specific attention on value addition of the fibres produced for which several diversified areas have emerged, and ultimately extending the socio-economic benefit to the farmers.

A time targeted action plan on thrust areas utilizing interdisciplinary mode of research on cutting edge technologies vis-à-vis goals has been systematically presented in the perspective plan. The goals were formulated with emphasis on several broad areas like thrust on allied fibre crops (mesta, ramie, sisal, sunnhemp and flax) in research as well as exploring new areas for their cultivation; broaden the genetic base of jute and allied fibre crops through collection of indigenous germplasm and exotic exploration, cataloguing and documentation of all collections; ascertain DUS to facilitate registration of new varieties; adopt systems approach to promote jute and allied fibre crops; reduction in cost of cultivation; emphasis on ecofriendly and cost-effective post-harvest technologies; introduction of mechanization in farming; identify quality parameters of jute and allied fibres for user friendly assessment in respect of target end products for commercial use; sensitize small entrepreneurs especially women folk for production of jute and allied fibre based diversified products for long term economic sustenance.

For addressing the new challenges, the research efforts shall be directed towards strengthening of basic and strategic research on the following areas :

- Genetic resources management including characterization both at morphological and molecular level and documentation leading to germplasm registration for protection; prebreeding and enhanced utilization of PGR leading to broadening of genetic base at farm level.
- Development of improved high yielding varieties with improved fibre quality and suitability for diversified uses.
- Higher productivity potentials, resistance to biotic and abiotic stress.
- Enhancing system efficiency through development of cost effective location specific sustainable production technology (especially in the field of weed management) to enhance production and productivity along with providing sustainability to the production system and also to meet the emerging needs for maintaining and enhancing the competitiveness in the post WTO era.
- Improved (user friendly as well as eco-friendly) retting technology.
- Integrated pest management.
- Integrated nutrient management.
- Promoting diversified uses.
- Strengthened efforts to facilitate transfer of technology and establishment of linkages with industry and related R&D agencies.

1. PREAMBLE

Jute is the major commercial crop of eastern and north eastern states, in general, and of West Bengal in particular, which provides raw material to a major industry and contributes significantly to country's economy. When viewed from the national context it is revealed that about 4 millions farmers, 0.25 million industrial workers and 0.5 million traders find gainful employment in jute sector. Over and above, jute farming generates 10 million man-days of employment in rural India during the growing and harvesting season of the crop (middle of March to middle of September).

Out of 8 lakh hectares of land covered with jute in the country 73% belongs to the state of West Bengal with 81% of country's total raw jute production. In the industrial segment 59 out of 76 jute mills in the country are located in West Bengal.

Raw jute consisting of jute and mesta has been traditionally in use as a source of raw material for packaging industry only so far. In the recent times, it importance as a versatile source for diversified application, in the textiles industry, in the paper industry, in building & automotive industry, as soil saver, as decorative & furnishing material, etc. have been recognized and its demand in a number of countries is on the rise at an increasing rate. Nearly about 12-15% of the jute products are commercially being exported from this country to about 120 countries in the world. It earns foreign exchange of about Rs.1,000/- crores per annum and the trend is on the increase.

Although jute acreage have stabilized around 8 lakh hectares in the country, jute productivity has doubled (22 q/ha) since partition of the country from 11 q/ha, total production of raw jute is although enough at present to saturate the demand of all the mills in the country but the quality of marketed fibre needs to be improved significantly. In view of the growing demand for quality fibres needed for manufacturing more and more diversified products, production of allied fibres is to be augmented. As such demand for natural fibre is on the increase for environmental concerns, therefore increase in productivity of jute and allied fibre crops assumes much greater importance in the coming decades.

In its journey for about 160 years, jute market has faced many ups and downs because of fluctuating prices. Various government policies and assistances have always been launched at different stages to stabilize the market, so much so that, jute industry, except a handful few, never came out of conservative managerial mind-set, because profit remained almost assured even without going for industrial modernization. Naturally into this gap, came the synthetic fibre in the packaging trade initially slowly during seventies, and then made its presence felt from eighties onwards, and invaded the market forcefully so much that jute fibre has already lost the cement segment. Lackadaisicalness of jute industry has been ill paid, market situation becoming more and more tentative and without vision. Fresh initiatives are must for the turn around of jute market since the raw jute (jute and kenaf) sector should not indefinitely depend upon a protected marketing condition provided by a special legislation called the Jute Packaging Materials (compulsory uses in packaging commodities) Act, 1987. It has to develop itself to withstand the competition being thrown by man-made (synthetic) fibre in the packaging trade.

In efforts to revitalize the jute market, most important is the fact that the products (both fibre and goods) are to be cost and quality competitive to those of synthetic fibre in domestic and international markets based on its inherent strength. Fibres basically being eco-friendly in production, annually renewable, biodegradable having low extensibility, high frictional resistance and flexibility, offer various inherent advantages over synthetic fibre, which is however cheaper and possibly more design friendly. For increasing global export market share and domestic consumption, the future marketing policies for this family of natural fibres be so framed that it gets an edge while countering the inroads already made by synthetics in the trade.

1.1 Mission

The primary mission of the Institute is to explore traditional and new frontiers of science and knowledge for technology development and policy guidance resulting in a vibrant, responsive and resilient jute and allied fibre agriculture which must be effectively productive, eco-friendly, sustainable, economically profitable and socially equitable.

In order to accomplish the above mission, the Institute will pursue the following prioritized researchable issues to meet the future demands.

- Higher productivity of jute and allied fibre crops resulting in increased returns
- Reduced cost of cultivation through cost effective and user friendly production practices and alleviation of constraints in low yielding areas
- Development of varieties having better fibre quality to meet specific end use requirement.
- Integrated pest management using bio-resources developed for minimal pesticides usage.
- Introduction of mechanization and energy saving technologies, which are cost effective and user-friendly
- Quality seed production in jute, mesta and sunnhemp

1.2 Vision

The jute and allied fibre production is predominantly shifting from the earlier concept of 'increase in yield' to the 'utilizable production of the whole chain that links the producer to the consumer'. In this trade chain, a new force has emerged that believes not on primary product alone, but on the development of secondary products as demanded by the consumers, both domestic and international. This is bringing about better utilization of primary products, value-addition and income generation at each stage of the production – consumption continuum. This links the agro-industries to the production system, unlike in the past where agro-industry was considered a separate entity.

Therefore, in the development of technologies, focus should be on several crucial issues. Research should be targeted to small and medium jute farmers over short-term as well as for long-term development. Technologies should have increased certainty with much less risks, minimum or reduced resource requirements in the fields of poor farmers. Another important issue is the quality of products, which has a direct bearing on the production – consumption chain. The market demand for products has changed, and product development has to take account of the market demand. Since these considerations were not in place earlier, there has been a skewed distribution of gains of the technologies developed in the past – technology generation and technology adoption has not always been all that satisfactory.

Technology is the *mantra* for the new millennium. The achievements of the past has given us enough confidence that there is the potential for change and reforms; but that again need the change in the existing mindset, ideology and research policies. We need to do that forthwith.

2. MANDATE

a) Improvement of jute (*Crochorus olitorius* and *C. capsularis*), mesta (*Hibiscus cannabinus* and *H. sabdariffa*), sunnhemp (*Crotalaria juncea*), ramie (*Boehmeria nivea*), sisal (*Agave sisalana*) and flax (*Linum usitatissimum*) for yield and quality.

b) Improvement of jute and allied fibre crops for biotic and abiotic stresses.

c) Development of economically viable and sustainable production technology and cropping systems with jute and allied fibre crops.

d) Development of proper post-harvest technology for improving the quality of fibre.

e) Transfer of technology and human resource development in relation to jute and allied fibre crops.

The mandates of the All India Network Project for Jute and allied fibre crops (AINP) are (i) to provide scope and opportunity for wider evaluation of the proven results/ technology of applied value with the help of interdisciplinary, multi-locational research approach, (ii) to cover a wide range of agro-ecological conditions in a wider socio-economic background and speed up spread and application of results of research.

3. GROWTH

3.1. Infrastructure

The Indian Central Jute Committee (ICJC) was formed in 1936 in view of the importance of jute in the economy of the country in general, and eastern India in particular. Subsequently Jute Agricultural Research Laboratory (JARL) was established in 1938 at Dhaka, now in Bangladesh. After partition of the country, jute research sifted to Chinsura in West Bengal, and then to Barrackpore, and finally established at the present place (Nilganj, Barrackpore) in 1953 as Jute Agricultural Research Institute (JARI). ICJC was taken over by Indian Council of Agricultural Research (ICAR) in 1966. The Institute has been rechristened to its present name Central Research Institute for Jute and allied Fibres (CRIJAF) in January, 1990. To carry out research work on allied fibres and seed, the Institute established the following four research stations at different parts of the country.

1. Ramie Research Station, Sorbhog, Assam (in 1959)
2. Sisal Research Station, Bamrah, Orissa (in 1962)
3. Sunnhemp Research Station, Pratapgarh, Uttar Pradesh (in 1963)
4. Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal (in 1956)

Besides, the Institute has nine (9) SAU based and six (6) ICAR institute based collaborating centers for multi-locational testing and revalidation of the technologies under All India Coordinated Research Projects on Jute and Allied Fibres (AICRP on JAF) now functioning as All India Network Projects on Jute and Allied Fibres (AINP on JAF).

CRIJAF is organized into 3 Divisions, viz., Crop Improvement, Crop Production and Crop Protection, and 5 sections namely, Soil Science & Microbiology, Agricultural Statistics, Agricultural Engineering, Agricultural Extension and Agricultural Meteorology supported by Farm, Workshop, Library, Research Management Unit (RMU), Agricultural Research Information System (ARIS) Cell, Administration and Finance & Accounts Units. The Institute has well equipped laboratories and field facilities for basic, applied and field oriented research in various disciplines of agriculture. For conducting field experiments the Institute has lands measuring 61.04 ha at CRIJAF (HQ), Barrackpore, 56.00 ha at Ramie Research Station, Sorbhog, Assam, 103.60 ha at Sisal Research Station, Bamra, Orissa, 9.18 ha at Sunnhemp Research Station, Pratapgarh, U.P and 65.00 ha at Central Seed Research Station for Jute and Allied Fibres, Budbud, Burdwan, W.B., respectively.

3.2 Budget

(Rs. in Lakhs)

Sl. No.	Name of Plan	YEARS					TOTAL
		1997-98	1998-99	1999-00	2000-01	2001-02	
1	IXth Plan actual	163.81	128.05	95.89	207.65	199.35	**794.75**

Sl. No.	Name of Plan	YEARS					TOTAL
		2002-03	2003-04	2004-05	2005-06	2006-07	
2	Xth Plan actual	141.74	99.70	379.74	266.32	62.51	**950.01**

Sl. No.	Name of Plan	YEARS					TOTAL
		2007-08	2008-09	2009-10	2010-11	2011-12	
3	XIth Plan Projection	240.00	250.00	330.00	340.00	340.00	**1500.00**

3.3 Manpower

CRIJAF Headquarter, Barrackpore, West Bengal

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	6	2	1	9
2.	Genetic & Cytogenetics	2	1	0	3
3.	Agronomy	4	1	1	6
4.	Agril. Extension	2	1	0	3
5.	Plant Pathology	4	1	1	6
6.	Agril. Ento.	4	1	1	6
7.	Plant Physiology	2	1	0	3
8.	Soil Sc. / Chem./ Fer.	4	1	1	6

9.	Microbiology	1	1	0	2
10.	Farm M / Power	1	1	0	2
11.	Physics	1	0	0	1
12.	Ag. Statistics	1	0	0	1
13.	Computer Appl.	0	0	0	0
14.	Ag. Meteorology	0	0	0	0
15.	Nematology	2	0	0	2
16.	Eco-Botany	1	0	0	1
17.	Biotechnology	1	0	1	2
18.	Biochemistry	1	1	0	2
19.	Ag. Chemistry	0	0	0	0
SUB TOTAL		37	12	6	55

S.R.S., Bamra, Orissa

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	0	0	1
2.	Agronomy	1	0	0	1
3.	Pl. Pathology	1	0	0	1
4.	Soil Sc. & Chem.	0	0	0	0
SUB TOTAL		3	0	0	3

A.I.N.P. & J. A.F., Barrackpore

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	0	1	0	1
2.	Agronomy	1	0	0	1
3.	Ag. Statistics	1	0	0	1
4.	Eco-Botany	1	0	0	1
5.	Project Coordinator	0	0	0	0
6.	Pl. Pathology	0	0	0	0
7.	Soil Sc. / Chem	0	0	0	0
SUB TOTAL		3	1	0	4

R.R.S., Sorbhog, Assam

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	1	0	2
2.	Agronomy	1	0	0	1
3.	Pl. Pathology	1	0	0	1
4.	Soil Sc. / Chem	0	0	0	0
SUB TOTAL		3	1	0	4

Sh.R.S., Pratapgarh, U.P.

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	1	0	2
2.	Agronomy	1	0	0	1
3.	Agril. Ento.	1	0	0	1
4.	Microbiology	1	0	0	1
5.	Pl. Pathology	1	0	0	1
SUB TOTAL		5	1	0	6

CSRSJAF, Bud Bud, Burdwan

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	0	0	1
2.	Seed Tech.	1	0	0	1
SUB TOTAL		2	0	0	2
GRAND TOTAL		**53**	**15**	**6**	**74**

NOTES :

1. By the year 2008 nearly ninety percent of the existing scientists particularly those in the Principal Scientist cadre will reach superannuation. This will necessitate a thorough alteration of the present composition of the existing cadre among the different disciplines. In this category total strength has been proposed to remain same, while the distribution among the disciplines along with inclusion of some new disciplines have been proposed with due weightage to new areas of work being proposed in the Perspective Plan.

2. For technical, administrative and supporting activities, the cadre strength would remain same as of now. Early action would be taken for filling up the posts of scientific manpower as has been proposed.

4. RESEARCH ACHIEVEMENTS

I. CROP IMPROVEMENT

In the the first phase of research on crop improvement, emphasis was laid on breeding high yielding, disease free, cosmopolitan varieties of jute and allied fibre crops. The impact of these high yielding varieties (Table 1) can be best judged by the fact that productivity in jute is around 22 q/ha at present which was around 11 q/ha few decades back even though the area remained static or even shrank. The productivity in mesta is around 11 q/ha at present which was around 7 q/ha few decades back. Table 1 provides basic information on all released varieties of jute and allied fibre crops.

Table 1. Jute and allied fibre crop varieties developed and released by CRIJAF

Name of the variety	Common name	Yield potential Q/ha	Year of release	Suitable land	Sowing time	Areas for which recommended
Tossa jute *(Corchorus olitorius)*						
JRO-632	Baisakhi Tossa	25-32	1954	Mid & high	Mid & End April	All India
JRO-878	Chaitali Tossa	25-32	1967	-do-	Mid March to Mid April	All India
JRO-7835	Basudeb	25-35	1971	-do-	-do-	All India
JRO-524	Navin	25-40	1977	-do-	-do-	All India
TJ-40	Mahadev	30-35	1983	-do-	Mid to End April	Orissa
JRO-3690	Savitri	30-35	1985	-do-	-do-	All India
KOM-62	Rabati	25-30	1992	-do-	-do-	Orissa
JRO-66	Golden Jubilee Tossa	35-40	1998	-do-	Suitable for Mid-April sowing	Tossa jute growing belt
JRO-8432	Sakti	35-40	1999	-do-	Suitable for Mid-March to End-April	Tossa jute growing belt
JRO-128	Surya	32-38	2002	-do-	Suitable for Mid-March to End-April	Tossa jute growing belt
S – 19	Subala	36	2005	-do-	Last week of March to end April	West Bengal, Assam, Bihar & Orissa
White jute *(Corchorus capsularis)*						
JRC-321	Sonali	20-25	1954	Low	End Fub. To End March	All India
JRC-212	Sabuj Sona	25-30	1954	Mid & High	Mid March to Mid April	All India
JRC-7447	Shyamali	25-30	1971	Mid & High	Mid March to Mid April	All India
JRC-4444	Baldev	30-32	1983	-do-	-do-	Orissa
UPC-94	Reshma	27-30	1983	Mid & Low	End Feb. to End March	U.P.
Hybrid ‘C’	Padma	30-32	1983	-do-	-do-	Assam & W.B.

KTC-1	Jayadev		1992			Orissa
Name of the variety	**Common name**	**Yield potential Q/ha**	**Year of release**	**Suitable land**	**Sowing time**	**Areas for which recommended**
JRC-698	Shrabanti	30-32	1999	-do-	Mid-March to Mid-April	West Bengal and Bihar
JRC – 80	Mitali	30-35	2005	-do-	-do-	North Bengal, Assam & U.P.
Mesta (*Hibiscus cannabinus*)						
H.C. 583		25-30		Mid	Mid April	All India
AMC 108	Bhimli 1	30-32	1982	Mid	Early sowing in southern region of country	Andhra Pradesh
MT 150	Nirmal	Green weight 256 q/ha	2005	Mid	Mid April to Mid May	Mesta growing belt
Roselle *(H. sabdariffa)*						
H.S. 4288		25-30		Mid & High	May to June	All India
H.S. 7910	Ujjal	25-30	1977	-do-	-do-	All India
AMV 1		25-30	1966	-do-	-do-	Andhra Pradesh
AMV 2		25-30	1982	-do-	-do-	-do-
AMV 3	Surya	30	1989	-do-	-do-	-do-
AMV 4	Kalinga	32	1991	-do-	-do-	-do-
GR 27	Madhury	27	2007	-do-	-do-	All India
Ramie (*Bohemeria nevia*)						
R-67-34	Kanai	13-15	1983		Mid June to July	Assam
Sisal (*Agave sisalana*)						
Sisal	Leela	15	1983	Mid & High	-do-	All India
Sunnhemp (*Crotalaria juncea*)						
K-12-Yellow		9-13	Early sixties	Mid & High	April to May	U.P., M.P., & Bihar
SH – 4	Sailesh	12	2005	-do-	-do-	-do-

1. Plant genetic resources

(i) Germplasm collection status

Till mid-1970's, only 300 accessions of jute and 200 accessions of mesta were available. Concerted efforts by this Institute in association with NBPGR, New Delhi and also in collaboration with International Jute Organization in the last two decades resulted in increase in gene pool of jute and allied fibre crops to the tune of 4723, which included wild species and important breeding stocks. Two wild species of jute namely, *C. pseudo-olitorius* and *C. depressus* were for first time collected, which were absent in the earlier gene pool (Table 2).

ii) Germplasm characterization and evaluation

Characterization and evaluation data on 928 accessions of *C. olitorius*, 1579 accessions of *C. capsularis*, 64 accessions of flax, have been documented. In general, *tossa* jute accessions of African origin have higher yield potential and also early flowering resistance trait and indigenous ones have finer fibre. *C. pseudo-olitorius* and *C. pseudo-capsularis*, two wild species, were found to produce finest fibre i.e. 0.95 tex and 0.20 tex respectively. Six jute wild species were found to have stress tolerant potential.

(iii) Genetic diversity in jute germplasm

With the recent global acquisition of a good number of jute germplasm, analysis of genetic diversity of physiological traits in the gene pool was necessary to identify rare alleles for utilizing them in crop improvement programme. From the detailed analysis of four morpho-physiological traits in the entire collection, the presence of distinct patterns of diversity between the two jute species has been noted. It was apparent that the accessions of both the species contained fairly low genetic diversity at the intra-specific level. However, differences in geographical location of sources did not affect genetic diversity.

Improvement of jute for both yield and quality of the fibre by redesigning the breeding programme involving newer germplasm remains a challenge to the jute breeders. The germplasm presently preserved in the gene bank of CRIJAF remain to be characterized at the molecular level. Widespread application of DNA markers to determine genetic relatedness of individuals is reported in many crop species. Neither any work has been carried out in Jute on STMS markers nor was any comparative analysis using different markers done to evaluate genetic diversity among Indian varieties of both the species and exotic germplasm along with wild relatives. Recently a set of STMS markers has been developed and found useful in species identification. The ISSR and RAPD markers detected both intra and interspecific polymorphism that established meaningful relationship among the accessions used. The study clearly revealed separation of the two cultivated species from each other. The germplasm of both the cultivated species showed greater genetic diversity than the commercial varieties. Therefore, this study revealed more molecular diversity at the intra-specific level which was, otherwise not observed when morpho-physiological trait diversity was assessed. However, the commercial varieties of *C. capsularis* were genetically more similar than that of *C. olitorius* varieties. Further, genetic improvement of jute requires the use of the divergent germplasm accessions, which are available in both the cultivated species *C. olitorius* and *C. capsularis*.

Table 2. Germplasm status in the gene bank of CRIJAF

Sl. No.	Crop species	No. of Accessions		
		CRIJAF/IJO Collection	Under the agies of NATP Collection	Total
1.	***Jute***			
	C. capsularis	889	50	939
	C. olitorius	1548	99	1647

	C. species	162 (covering six wild species)	151 (covering six wild species)	313
2.	***Mesta***			
	H. cannabinus	631	74	705
	H. sabdariffa	528	77	605
	H. species	74 (covering 12 wild species)	51 (covering 12 wild speies)	125
3.	***Flax***			
	L. usitatissimum	63	1	64
4.	**Sunnhemp**			
	C. juncea	108	41	149
	Crotalaria species	-	75 (covering 10 wild species)	75
5.	***Sisal***			
	Agave species	9 (covering 9 wild species)	36 (covering 4 wild species)	45
	Agave hybrid	1	-	1
6.	***Ramie***			
	Boehmeria species	2	-	2
	B. nivea	52	-	52
	B. utilis	1	-	1
Total		**4068**	**655**	**4723**

2. Basic and strategic studies

(i) Centre of origin

Since searching diversity basically requires information on the distribution pattern of a genus world over, this institute's first priority was to study the center of origin of jute and allied fibre crops. Centre of origin and diversity of the genus *Corchorus* and *Hibiscus* were extensively studied. *C. olitorius* originated in Africa, the primary centre, along with other wild species, and India or Indo-Myanmar region is the secondary centre of origin – being more frequent in Western and North-Western India. *C. capsularis* is believed to be originated in Indo-Myanmar region including South China, and frequently distributed in North-eastern India. *H. sabdariffa* has a major centre of diversity in tropical Africa (not in East Africa) whereas, *H. cannabinus* is widely distributed in East Africa and therefore, considered to be a native of Africa. Sunnhemp (*C. juncea*) is a native to Indian sub-continent although distributed throughout tropical and sub-tropical regions. Ramie (*B. nivea* Gaud) is indigenous to eastern Asia, from Japan to eastern China and Malaysia. Sisal (*A. sisalana*) is native to tropical and sub-tropical America and Caribben islands with maximum concentration in Mexico. Flax (*L. usitatissimum*) is native to Central Asia, Near East and Mediterranean region.

(ii) Fibre formation in stem/leaf

The detail account of origin, distribution and deposition, internal organization and minute details of fibre in the stem/leaf is essential to pinpoint the desirable characters to be considered for crop improvement *per se.* Keeping these facts in view, detail anatomical studies on origin, organization and structure of fibre in jute and allied fibre crops down to the level of ultimate fibre cells were made.

(iii) Inheritance of fibre yield and quality

Basically genetics of fibre yield and quality, and its component characters serve as guidelines for selecting the appropriate breeding methods to be adopted for further improvement. Therefore, inheritance of fibre yield and its components including physiological ones and fibre strength was worked out in detail. Genotype-environment interaction of quantative traits in jute was also studied. Based on this knowledge, subsequent breeding programmes were executed resulting in a good number of varieties, enclosed in Table 1.

(iv) Mutation breeding

In self-pollinating crops particularly when genetic base remains narrow, application of experimental mutagenesis was a powerful tool for creating variability, upon which choice of breeding programmes entirely depends. Extensive studies on mutagenesis employing both physical and chemical mutagens and mutants of jute, mesta and roselle were made over the years. Of applied significance, four high yielding jute varieties and several important genetic stocks were developed. Additionally, genetics of the mutant characters and anatomical details were also studied especially the genetic control of fibre bundle formation in jute, collectively paving the ways for future breeding programmes.

(v) Exploitation of heterosis

Exploitation of hybrid vigour or heterosis has always remained a prime concern for harnessing higher yield in field crops whenever there is more or less pronounced heterotic effect in the heterozygous condition of best heterotic combiners. Accordingly, attempts to exploit heterosis by manual methods were done in *C. olitorius* and *H. cannabinus* following the example of hybrid cotton. Range of heterosis was only 18-25% in jute and 30-40% in mesta. Cost of hybrid seed production through manual operation was also found prohibitive for commercialization of the technology. To exploit heterosis in jute, it will be necessary to identify cross combinations showing higher level of heterosis by involving divergent parental germplasm lines and identification of appropriate male sterility system.

(vi) Interspecific hybridization

In order to combine desirable characters of two species in a single hybrid, attempts were made on interspecific hybridization by different methods. Keeping this objective in consideration, interspecific hybridization in jute, mesta, roselle and sisal was undertaken by conventional methods. Factors of cross-imcompatibility in jute and kenaf were determined. In sisal, an interspecific hybrid between *A. amaniensis* and *A. augustifolia* was developed and released for general cultivation. An interspecific hybrid between *Corchorus pseudo-olitorius* and *C. capsularis* has been obtained by conventional hybridization techniques.

(vii) Radio response studies by embryo culture

Never before, radio-response was studied when there is difference in : embryo size and maturity, single gene difference, hybridity and cytoplasmic factors. Attainment of maximum mutation induction while sustaining minimum physiological effect is always a cherished goal. For these twin objectives, radio-response in mesta and roselle by employing cultured embryos was thoroughly studied. Response of excised mature embryo to X-ray revealed that early and small sized embryo varieties of both the species of kenaf were more susceptible than late and large sized embryo varieties and LD_{50} value was genotype dependent. Germination inhibition factors were absent in both the species of kenaf. In *H. cannabinus*, radio-resistance is governed by simple dominance and radio-response is influenced by the interaction of fertility restorer gene. Incited effectiveness of ethyl methane sulfonate in mesta was observed.

(viii) Out-crossing and isolation distance for seed production

Maintenance of genetic purity of released varieties and breeding stocks requires the most basic information on the extent of out-crossing in otherwise predominantly self pollinated crops like jute, roselle and mesta. This helps in determining isolation distance to be followed for seed multiplication. Out-crossing percentage and minimum isolation distance to be maintained in jute, mesta and roselle were determined for seed multiplication. In addition, jute and mesta seed production technologies were also standardized. Problems in storage and viability of seeds were studied to standardize seed production modules. Technologies for maximizing quality jute seed production in the Bangal basin in terms of sowing time, seed size, spacing, nutrition, mode of clipping, etc. were evolved.

(ix) Off-season nursery

This facility, whenever available, has helped plant breeders in particular for reducing the time lag for developing a variety by conventional methods. Off-season nursery facilities created by ICAR at SBI, Coimbatore, was utilized by this Institute for : 1) advancement of generation of breeding lines, 2) raising hybrids, 3) regeneration of germplasm accessions, 4) seed multiplication of ruling varieties. Productivity and seed quality particularly of tossa jute in the off-season nursery were much better than those of jute growing areas.

(x) Tissue culture protocols

In vitro techniques have helped to overcome the limitations of conventional methods in many ways in different crops.

(a) Tissue culture protocol, hardening process and transfer to field condition have been standardized in jute (*C. capsularis* L).

(b) For obtaining planting materials in sisal in shorter duration, i*n vitro* protocol for multiple shoot culture was standardized. In addition, plant regeneration via organogenesis and somatic embryogenesis in sisal (*A. sisalana*) were also standardized. The *in vitro* plantlets are growing satisfactorily in the field.

(xi) Donor parents for quality improvement

Fibre quality improvement *per se* is a basic necessity for sustaining the gathering momentum of jute product diversification at the moment. Concomitantly, germplasm stocks of jute and allied fibre crops have been enriched in the recent past. It was, therefore, considered logical to screen the existing genepool to identify donor parents to be involved in quality improvement programmes. Amongst the genepool, accessions of both tossa and white jute having stronger and finner fibre yielding potentials were identified and being exploited to develop improved fibre quality varieties. It was also ascertained that harvest of jute crop at 110 days to be the best compromise between fibre yield and quality.

(xii) Antibody mediated kit development

There are no detail studies on the stress responsive enzymes like peroxidases in jute. In order to find out a quick detection technique for screening germplasm for high/low peroxidase level, it was shown that polyclonal antibodies against two common plant peroxidases may be used for future research.

(xiii) Flax high yielding strains

High yielding strains of flax have been developed through the selection from the germplasm collected from Holland and Belgium. Package of practices for flax have been standardized. Areas of the cultivation of flax in the country have been identified.

(xiv) Varieties for diversified use

In pursuit of identifying newer outlets of jute and allied fibre crops product diversification, certain commercially unexploited areas were identified. These areas need further research so that commercially viable technologies are developed for the future. Different end uses of jute, mesta and roselle (paper, seed oil and horticultural products) were found to be feasible and documented. Cultivar, MT-150 of mesta was identified for release for pulp and paper making. HC-583 was significantly superior to other kenaf varieties except HC-269 relating to production of total biomass and dry fibre. Differences in variety and stage of harvest had no appreciable impact on pulp characteristics. Jute genotypes with higher paper pulp production potentials were identified.

Compared with other bast fibre crops, sunnhemp (cv. K12 yellow) yielded maximum green biomass (excluding leaves) closely followed by kenaf (cv. MT 150).

(xv) Photoperiodism

To improve the vegetative growth and to develop jute varieties to fit in multiple cropping sequences the basic requirement was to know its photoperiodic requirements for reproductive and vegetative growth.

While short day photoperiod is essential for the reproductive growth, vegetative growth is favoured by long-day conditions. The critical day length for flowering was found to be 12 hours 30 minutes beyond which flowering is retarded. *Corchorus olitorius* is more responsive to short-day lengths than *C. capsularis*.

(xvi) Growth and fibre formation

Since jute yield is directly related to its vegetative growth and vascular development, a detailed study was necessary to understand its growth pattern and phloem fibre differentiation.

a) This was extensively studied using both growth analysis techniques as well as radioactive tracers. The two cultivated species differed in their growth behaviour, which eventually influenced their fibre yield and quality. While *C. capsularis* varieties showed better longitudinal growth at early stage, *C. olitorius* ones grew more rapidly at later stages. However, the rate of transverse growth of *C. capsularis* varieties was always higher than those of *C. olitorius*. In both the species the growth of phloem pyramids and the layers of fibre bundles per pyramid was found to be developmentally controlled, which showed profound effect on their harvest index.

b) Studies on the growth and development of root system *in situ* indicated the differential adaptability of the two species in different types of soil and soil moisture conditions. Roots of both the species, however, could penetrate up to 60 cm into the soil though most of the lateral roots remained confined to a radius of 10 cm.

(xvii) Physiology of fibre yield

Since yield (ligno-cellulose fibre) of jute is the product of photosynthesis and assimilate partitioning, these two vital physiological parameters were studied in detail.

a) For the first time, characterization of photosynthetic CO_2 metabolism has shown jute to be a C3 plant.

b) Studies with an isogenic chlorophyll mutant showed that even one-third reduction in leaf chlorophyll does not reduce significantly the average photosynthetic rate (1.5 µmol mg^{-1}chlorophyll min^{-1}).

c) Taking the clue a genotype (PPO 4) has recently been identified from exotic germplasm accession with higher leaf photosynthesis per unit chlorophyll, comparable yield but with high harvest index and finer quality jute fibre than the ruling cultivar.

d) The Radiation Use Efficiency (RUE) of jute was found to be very high (2.89-3.50 g MJ^{-1}) primarily because of its woody nature.

e) However, its carbon use efficiency for fibre yield was found to be limited due to inappropriate canopy architecture restricting light interception down the canopy and assimilate translocation towards economic sink (phloem tissue) to a great extent.

f) A jute ideotype model for better utilization of solar energy and production of finer fibre was proposed.

g) An empirical model has also been developed for calculating jute phytomass and fibre yield at harvest from the height of 48 day-old seedlings.

(xviii) Radiation and carbon use efficiency

Prediction of potential limit of jute production from the radiation and carbon use efficiency under typical jute growing conditions was considered important. Considering the average photon flux density (39.87 mol $m^{-2}day^{-1}$) during April-August at 22°50'N, 88°22'E and photosynthetic efficiency of 1.25 g mol^{-1} and 53% respiratory loss, a daily potential biomass production of 49.77 g $m^{-2}day^{-1}$ has been predicted. Using the value of the fraction of light intercepted at various stages of growth the total potential primary productivity (biomass) of jute has been calculated to be 40.81 t ha^{-1}.

(xix) Jute lignin biosynthesis

Fibre quality improvement needs the study on the control of lignin biosynthesis on the wall of jute fibre cells. An induced phloem fibre lignin deficient mutant (*dlpf)* of JRC 212, an elite *C. capsularis* cultivar, was identified and thoroughly characterized for lignin synthesis. The true breeding mutant should be utilized to engineer low-lignin jute fibre strains. From the biochemical analysis an upstream control via PAL enzyme for lignin biosynthesis has been envisaged.

(xx) Bioelectrical potential

The study on biophysical behaviour of jute plant showed the following results :

a) The bioelectric potential of an intact jute plant was monitored throughout the 24-hour cycle with the help of an invented computer assisted electronic device. Of the various environmental factors, soil temperature seemed to affect the potential difference within the plant most.

b) External application of electromotive force has been shown to influence greatly the jute seed germination, growth and development.

II. CROP PRODUCTION

1. Cropping system

(i) Delineation of jute growing soil

Based on productivity under different soil and climatic conditions, jute-growing tracts in India were classified into nine zones for better soil and fertilizer management.

(ii) Cultural practices

Cultural aspects of jute and allied fibre crops were optimized, particularly in terms of mode of sowing, sowing date, seed rate and spacing.

(iii) Cropping sequence

a) Jute based cropping sequences for irrigated and rainfed conditions were identified in terms of wet rice, pulses and oilseeds in on-station trial.

b) Viability of intercropping in roselle with oilseeds and pulses was examined and groundnut was found to be the most suitable intercrop.

c) Hybrid sisal in association with *Tectona grandis* and *Gmelina arborea* produced 16.46% and 33.71% more fibre respectively, compared to *Agave sisalana*.

2. Interculture operations

(i) Weed management

Weeds pose a serious problem in jute accounting for around 40% of its cost of cultivation. Therefore, the problem was addressed from different angles and the salient findings are as hereunder :

a) Two post-emergence herbicides (Fluazifop butyl and fluazifop ethyl) suitable to jute were identified, particularly for the control of grasses.

b) One pre-planting herbicide (Dinitroaniline) selective to jute was identified for the management of both grasses and broadleaved weeds until harvest.

c) Use of organic mulches proved beneficial in suppressing weed growth in jute effectively and improved the fibre productivity.

d) Companion cropping with red amaranth plus radish and legume like greengram was found effective in suppressing weed growth effectively.

e) Soil solarisation by transparent polythene (200-400 gauge) raised the soil temperature up to 15^0C in 0-10 cm soil profile at 2 P.M. It killed all weeds including nutgrass when solarised for 30 days during April. The high cost (up to Rs. 75,000 per ha), hailstorms and menace of wild animals, however, remain prohibitive for its adoption.

f) Integrated approach for controlling weeds in jute revealed that the cultural + chemical + rotational method provided higher yield of jute as compared to cultural or chemical treatment alone.

g) Energy requirement (operation-wise and source-wise) for fibre production in jute, mesta, sunnhemp, ramie and sisal were analyzed to find out the high energy consuming operation and to develop energy efficient production technologies.

h) Sowing and weeding are the important operations in cultivation of jute crop which help in achieving desired plant population to maximize fibre yield and reducing cost of cultivation. Conventional method of broadcasting of seeds followed by manual hand weeding consumed very high cost to the tune of 35% of total cost of jute cultivation. To obtain jute crop in line, a low cost manually drawn single row jute seeder having capacity of 0.025 ha/hour was developed for line sowing operation. Single row seeder performed well but cost was more due to its low capacity. In order to increase the sowing capacity, four-row jute seeder was developed with capacity of 0.1 ha/hour. To increase the annual use, four-row jute seeder was improved for sowing mesta, paddy, wheat and pulses by changing the required size of seed discs. Low cost manually drawn mechanical wheel-hoe with the effective width to go in between two rows of jute was developed for intercultural operation and the same was useful for other line sown crops also.

3. Soil fertility management

(i) Nutrient requirement

Plant nutrients are the vital component of any system of sustainable agriculture.

a) *Olitorius* jute has less requirement of NPK than *capsularis* jute.

b) For one quintal of fibre production, *olitorius* required 2.06 kg N, 1.63 kg P, 5.18 kg K, 2.90 kg Ca, 0.62 kg Mg and 0.31 kg S.

c) For one quintal of fibre production, *capsularis* required 3.14 kg N, 1.54 kg P, 7.96 kg K, 3.56 kg Ca, 1.29 kg Mg and 0.46 kg S.

d) For one quintal of fibre production, Fe, Cu, Mn, Zn requirements were 36.8 g, 11.2 g, 1.8 g and 13.9 g for *olitorius* and 78.42 g, 25.08 g, 2.66 g and 21.43 g for *capsularis*, respectively.

(ii) Soil fertility in relation to crop productivity

Role of macronutrients

Nitrogen: Agronomic efficiency of N under irrigated and rainfed conditions evaluated were 15-25 kg and 10-15 kg fibre, respectively. Integrated use of inorganic and organic nitrogen resulted in higher fibre yield (an increment of 21% was achieved through application of 100% NPK + FYM over 150% NPK under Long Term Fertiliser Experiment).

Phosphorus: Since phosphorus accumulated in soil, regular application caused a heavy build up of the nutrient (nearly 200% increase in case of application of super-optimal over sub-optimal dose) recorded and therefore, it's application could be avoided till P level was above critical level, i.e., 25 kg ha-1.

Potassium: Although removal of potassium (upto 110 kg ha^{-1}) by jute was higher than that of it's application, the dynamic equilibrium of the available form was maintained through mining of this element from slow and potential sources as has been proved through long term intensive cropping.

Sulphur

a) Of late sulfur was recognized as a major nutrient and investigation showed nearly 14% increase with regard to yield and quality (strength) of jute, which could be achieved through application of sulphur at a rate of 45 kg ha-1.

b) Integration of NPK, FYM and S enhanced fibre production (approximately 20%) of roselle.

Role of micronutrients

Boron: Application of boron @ 0.25 and 0.50 kg ha^{-1} and iron @ 1.0 and 2.0 kg ha^{-1} in sunnhemp increased fibre yield by 8% and 6-9% over respective check.

(iii) Organic matter and organic farming

Imbalanced application of nutrients resulted in decline of soil organic carbon (SOC). Application of NPK + FYM maintained SOC and reached the equilibrium after 29 years of cropping. Green leaf / gliricidial leaf compost (including twigs) were found to be an effective and alternative organic matter source in jute cropping.

Organic farming is gaining a speedy ground in modern eco-friendly sustainable crop husbandry, particularly due to rapid decline of soil organic matter in Indian soils. The salinet achievements are as follows :

a) *In situ* residue recycling of bast fibre crops (jute, mesta and sunnhemp) improved the soil health and enhanced the fibre production of both jute and mesta. The production of succeeding crops (rice and mustard) was also boosted up due to a residual effect.

b) Growth and yield of jute was enhanced due to green manuring of bast fibre crops. Amongst bast fibre crops, sunnhemp proved to be the most potential in respect of both residue recycling and green manuring. S-11 has been identified as most suitable strain for green manure purpose. Early sowing of sunnhemp for green manuring produced more biomass with harder sticks which does not decompose in shorter span. Delayed sowing produced less green matter, while succulent sticks when decomposed early proved to be more beneficial to the succeeding crops.

c) Inclusion of sunnhemp, dhaincha, sorghum + sunnhemp and maize + cowpea as preceding crops improved the fibre production of the main crop *olitorius* jute.

d) Higher rice production was noted when legume grain (green gram) or legume fibre (sunnhemp) was strip cropped in 20% area of jute and this practice netted higher jute equivalent yield (up to 17%) of jute-rice ecosystem.

e) Dependence on inorganic fertilizers could be reduced up to 75% with the application of organic nutrient like neem cake.

f) Seed treatment with the fungal culture of *Trichoderma viridae* (local strain) exhibited a beneficial trend in jute fibre production.

(iv) Sustainability

Sustainability Yield Index (SYI), principal indicator for sustainable production, was evaluated for jute-rice-wheat which showed sustainable production of jute under combined application of inorganic and organic forms of nutrients (SYI = 0.72) even after 32 years of cultivation under jute based cropping.

(v) Soil quality

The mean weight diameter, available P, dehydrogenase activity and total N were key indicators of soil indexing identified. The organic system along with chemicals showed the highest SQI value. The two treatments i.e., 100 NPK + FYM (1.48) and 100% NPK (1.26) showed aggradations of soil quality but other three treatments 100% N (0.62%), 100% NP (1.01) and control (0.52) where no fertilizer and manures were applied showed negative change of soil quality in reference to undisturbed fallow (1.02) which indicated degradation of the system. In another study to work out the biological indicators of soil quality, microbial biomass carbon, available-N, nitrogen fixing bacteria and plant pathogenic nematodes were identified.

(vi) Soil test and yield targeting

Basic data on nutrient requirement and nutrients contribution from both soil and fertiliser for jute, rice and wheat were generated through soil test crop response correlation studies which acted as a guide for the efficient plant nutrient management by monitoring soil fertility. The yield targets of 25-30 q ha^{-1} for jute fibre, 40-50 q ha^{-1} for medium and coarse rice, and 25-30 q ha^{-1} for wheat grain were achieved (with 10% yield deviation) both in on-station and multilocational on-farm trials.

(vii) Biofertilizer and jute yield

The most beneficial effect due to *Azotobacter chrococcum* inoculation of jute seed was obtained when applied with 75% recommended N. Maximum increase in fibre production (about 20-24%) was obtained apart from saving of 25% fertiliser N over full recommended N through urea alone.

(viii) Fertility improvement

Leaf fall during growth period and at harvest is a characteristic feature of jute. About 10-15 MT ha^{-1} of green leaves were added during growth period of jute that added on an average 52 kg N, 8.5 kg P, 58 kg K, 22 kg Ca, 15 kg Mg, 600 g Fe, 78 g Zn, 154 g Mn and 4 g Cu per hectare to soil and thereby enhance the soil nutrient status for the following crop.

(ix) Ramie production technology

In ramie, lower spacing (20 cm x 40 cm) with N_{30} P_{15} K_{15} produced optimum fibre yield per unit area (16-20 q/ha in second and third year) under acidic soil condition. NPK coupled with manure was more effective than NPK alone for production of ramie fibre. Attempts were made to spread its cultivation in non-traditional areas having favourable agro-climatic conditions outside North Eastern states viz. Goa, Tamilnadu and Konkan (Maharashtra).

4. RNMV technology – A new line of approach to boost fibre production

A rice virus named "Rice Necrosis Mosaic Virus" (RNMV) was utilized directly to increase fibre production in jute and allied fibre crops like mesta. The whole study resulted into the development of "virus utilization concept", a new concept in the literature.

These RNMV-energized plants thrived well with minimum amount of fertilizer and the fertilizer responsiveness was also very high. Furthermore, such energized plants have shown slight response to major insect pests of these crops and thereby necessitated no application of pesticides and thus the technology appeared to be eco-friendly. Triggered action of growth hormone especially cytokinin-like (tentative termed as viralin) compounds appeared to play critical role in such higher growth and yield. In addition to this the passage of the RNMV-induced growth promotion to next generation through seeds has made the technology more viable and acceptable.

On-farm trials revealed that the requirement of such energized seeds was 50% less where the production was 30% more than normal standard seed (JRO-524) and this paved the way for commercialization. Furthermore, the technology has following advantages :

(a) No alteration in genetic constituents as revealed by molecular markers assisted polymorphism study.

(b) Sustainability with regards to fertility status of soil.

(c) No chance of spreading of the virus, as its vector, *Polymyxa graminis* is restricted to monocot only. Since the vector cannot infect jute root (dicot), therefore virus is not transmitted in the soil microflora. Succeeding paddy crop is not infected by the virus because of above mentioned host-specificity, which was confirmed by repeated field trials under NATP and other studies.

(d) Successful use of this technology to Arhar : seed yield increased, protein content increased.

5. Stress management

Water has been recognized as a precious commodity and needs judicious management for optimum utilization in agriculture. The salient findings are as follows :

a) The impact of excess water was analysed in depth, and for optimum growth, development and quality fibre production, drainage was found essential in jute crop. Twenty to 60% yield increase could be obtained through surface and internal drainage (up to 30 cm) in waterlogged (upto 30cm) soil.

b) Under deficit soil moisture conditions prevailing during pre-monsoon months, biomass accumulation is more in *capsularis* genotypes as compared to *olitorius* ones and *capsularis* varieties, in general, yielded higher quantum of fibre.

c) The critical water potential (Ψw) beyond which jute seeds did not germinate is -0.3 M Pa for *C. olitorius* and -0.5 M Pa for *C. capsularis*. The delayed germination of *C. olitorius* seeds under similar soil moisture tension was due to their higher internal Ψw compared to that of *C. capsularis* that inhibits the seeds to reach their minimal hydration level (150-170% of the seed dry weight). Detail biochemical studies of jute seed germination under moisture stress indicated that unless for more than the critical limit and for a very prolonged period, jute seeds are capable of maintaining active metabolism and embryonic growth is triggered faster as soon as the stress is relived.

III. CROP PROTECTION

A. Disease

1. Aetiology

For an effective management strategy, it is very essential to identify the cause and nature of damage by different diseases because it sharpens our target for minimizing the damage. The pathogens of major diseases of jute and allied fibres have been identified and the nature of their damage was studied in most cases.

Variation in morphology and virulence of *Macrophomina phaseolina* from different jute growing areas of the country has been studied. Details work on the pathogen complex of Hooghly wilt has been done which indicated that *Ralstonia* (*Pseudomonas*) *solanacearum* is the primary pathogen for the disease where as *Rhizoctonia bataticola* and *Maloidotyne incognita* facilitates entry of the bacterium.

Studies are underway on Yellow Vein Mosaic (YVM) disease of mesta, which revealed association of geminate particle with the disease. Typical symptom produced through white fly transmission and cleft grafting but no mechanical or seed transmission was observed. Characterization study showed an expected ~1.3 kb amplicon with beta-DNA specific primer of cotton leaf curl Rajasthan virus (Ganganagar isolate), which indicated the relation of this disease with ClCuV (cotton leaf curl Rajasthan virus). A ~ 500 bp amplicon with DNA specific Deng primer (coat protein specific primer) from infected leaves indicated association of both DNA A and beta-DNA with this disease, which proved similar to ClCuV in Southern hybridization and NASH test with cotton leaf curl DNA and beta-DNA. Cloning and sequencing of ~1.3 kb beta-DNA amplicon showed high sequence identity with ClCuV Ganganagar isolate, which finally confirmed that satellite beta-DNA was associated with this disease.

2. Epidemiology and Forecasting

Epidemiology is primarily concerned with plant diseases in population under the influence of climate and human interference. Forecasting of outbreak and dynamics of disease development are the immediate fall out of epidemiology. Collection of data on disease occurrence in jute and allied fibre growing areas of the country has been started quite a few years back under AICRP/AINP on jute and allied fibres and the works are in progress. This will help in formulating effective forecasting models. Effect of different weather parameters and soil condition on stem rot in jute has been studied. The same for mesta (HS & HC) has been initiated.

3. Chemical control

Large numbers of fungicides have been tested against major diseases and quite a good number viz. copper oxychloride, carbendazim and mancozeb, etc. have been identified to be effective and are in practice at present. Seed treatment for jute, mesta and sunnhemp with carbendazim and macnozeb have been established. Spraying of the same fungicides and copper oxychloride has been found effective for controlling major diseases of jute and allied fibres. Newer fungicides with lesser residual toxicity may be tried for the purpose.

4. Biological control

Though found effective in many cases, the chemicals have their own limitations. Environmental pollution, killing of beneficial insects and microbes and residual toxicity are a few to name. Therefore, biological control measures are very important in present day agriculture. Extensive work on biological control of diseases using antagonists, bio-fertilizers and botanical pesticides have been done. Seed treatment with *Trichoderma viride* formulation and its soil application have been successful for controlling root diseases of jute. Disease management of the allied fibre crops using the different bio-agents would be promising in the future.

5. Cultural practices

Effects of cultural practices like application of potash, nitrogen, oil cakes, lime, FYM and cow dung, thinning, clean cultivation, irrigation, time of sowing, crop rotation, mulching etc have been studied for control of insect pests and diseases in jute and allied fibres. Inclusion of graminacious crop like paddy and wheat in the rotation has remarkably reduced Hooghly wilt disease in jute.

6. Host resistance

Use of host resistance is probably the safest way for pest and disease management. To evolve a resistant/tolerant variety, it is very important to identify the source of resistance. The existing germpool of jute and allied fibres have initially been evaluated under field condition at different places against major diseases and quite a good number of promising accessions have been identified. Rigorous screening of *capsularis* germplasm has been done against *M. phaseolina* at the hot spot and nine accessions have been identified to be tolerant.

7. Seed Pathology

Seed plays a very vital role in disease spread. Most of the jute diseases are seed borne, soil borne as well as air borne. Once introduced through seed, they can remain in soil for very long time and affect not only jute but also other succeeding crops. Therefore, use of disease free seed is important. Jute seed infection by *M. phaseolina* has been studied in detail and the effective control measure evolved to produce disease free/healthy seed. Study on jute seed infection by black band pathogen (*Botryodiplodia theobromae)* is in progress. Study has been initiated on jute seed infection by *B. theobromae* and its control. Attempts are to be made for detail study on seed borne nature of *Colletotrichum* spp., the anthracnose pathogen on jute as well as sunnhemp.

B. Insect pests

1. Nature of damage and biology

Major insect pests of jute and mesta were identified and their biology was studied. The nature of damage and economic threshold level of major jute pests have been worked out.

2. Insect pests outbreak and forecasting

Occurrence of major and minor pests of jute and allied fibre crops and factors influencing their incidence were studied. Forecasting model for some insect pests has been framed in limited scale. Effects of soil and air temperature, sunshine, drizzling, relative humidity, rainfall pattern have been studied for the outbreak of *Apion corchori*, *Polyphagotarsonemus latus*, and *Anomis sabulifera,* three very important insect pests of jute.

3. Chemical control

Chemical control has so far been given prime importance in insect pest management because of quick and visible effects. Large numbers of insecticides were tested in large scale against major pests and quite a good number insecticides, viz., endosulfan, imidaclorprid, neem oil, etc., and acaricides, namely, dicofol and Omite were identified to be effective and are in practice at present. Relative toxicity of major insecticides has been evaluated under laboratory condition. Presence of sulphur component in endosulfan broadened its target and made it effective against yellow mite too. For future studies on pest management due care will be given to highlight that only those chemicals will be studied which are registered / approved by the Insecticide Registration Committee as provided under Insecticides Act - 1968. All the chemicals evaluated against pests of jute and allied fibre crops were approved by Insecticide Registration Committee. Banned chemicals / formulations will not be included in the field trials.

4. Biological control

Work on biological control of insect pests using parasite and predators, entomopathogenic fungi and botanical pesticides have been done. Neem oil, spores of *Beauveria bassiana, Bacillus thuringiensis, Metarhizum anisopliae* and *Gliocladium* sp. were found to be effective against jute pests. *Trichoderma viride* and *Gliocladium* sp. have been found to be effective in reducing jute pests and increasing fibre yield.

5. Cultural management practices

Thinning, clean cultivation, time of irrigation, crop rotation, mulching, etc. had detrimental effect on the incidence of insect pests in jute and allied fibres. The plant protection schedule for sunnhemp cultivation was developed.

C. Nematodes

Components of integrated nematode management have been identified. Crop rotation and use of biocide viz., *Paecilomyces lilacinus* will be incorporated in the integrated schedule for management of *Meloidogyne* spp. in jute and allied fibres. Ecology of root knot nematode on *tossa* jute has been studied.

Severity of nematode problem increased when root knot nematode (*Meloidogyne* spp.) was associated with *Macrophomina phaseolina* in jute and mesta. *Ralstonia* (*Pseudomonas*) *solanacearum* was the primary pathogen for the Hooghly wilt disease where as, *Rhizoctonia bataticola* and *Meloidogyne incognita* facilitated entry of the bacterium.

Management practices should be evolved keeping in view the complex situation in jute and allied fibre crops manily, *H. cannabinus.*

D. Weeds

Inter/ mixed cropping with red amaranth and /or summer radish, mulching with paddy straw proved to be a viable alternative to use chemical herbicide in jute. Quizalofop ethyl (Targa super) showed good grassy weed control effect with less or no residual toxicity.

E. Integrated Pest Management (IPM)

Integrated Pest Management is the effective combination of different management practices in an eco-friendly and environmentally safe manner for management of different biotic stresses. The IPM modules for jute involving primarily biological and cultural components and with minimum use of chemicals have been formulated and are under test in the farmers' field condition. This has created interest among the small and the marginal farmers for its cost effectiveness and early solvency due to inclusion of inter/mixed cropping with red amaranth and/or summer radish. Chemical herbicide (Targa super) having good grassy weed control effect which in turn would also reduce incidence of insect pest, created interest among the jute growers.

IV. FARM MECHANISATION AND POST HARVEST TECHNOLOGY

1. Fibre extraction

Fibre extraction from the bast fibre crops is the major energy and cost consuming operation and greatly influences quality of fibre. Mechanical approach was adopted in the fibre extraction and different machines were developed. 'Raspador' Decorticator powered by 5 H.P. motor/engine was developed for the extraction of ramie (6 kg hour $^{-1}$) and sisal (10 kg hour $^{-1}$) fibre, which are being used in almost all the plantations in India. To improve the jute extraction process Jute Decorticator machine run by 5 H.P. motor/engine with the capacity of extracting fibre from one ton of green jute plants per hour was developed. Considering the high cost of machine and operational difficulties of Jute Decorticator machine, a simple manually operated cycle-hub ribboning device which had the capacity to extract 30 kg green jute ribbon per hour was developed to perform the operation in field itself. Cycle-hub ribboning device performs well but involved high cost in the fibre extraction. To overcome high cost involvement in fibre extraction, a portable, low cost machine "CRIJAF Bast Fibre Extractor" powered by 1 H.P. motor / 1.5 H.P kerosene engine was developed for fibre extraction of jute, meta, sunnhemp and ramie. Uniform and improved good quality fibre was obtained by this method. A small manually operated Flax Scutching machine was developed, which extracted 2 kg flax fibre per hour.

2. Ramie degumming technology

Machine decorticated ramie fibre contained 20-25% gum. A low cost eco-friendly protocol for ramie degumming using *Bacillus sp.*, papaya pectinase has been developed which would reduce 17-20 % of gum. The degummed fibre would contain 4-5% gum.

3. Retting, the procedure for loosening fibres

A prime aspect of cultivation of natural fibres after harvest is the "Retting", which is the procedure for loosening the fibres from the stem of plant by the removal of pectin and other cementing materials binding the fibre to adhering tissues. In conventional method, jute, mesta and Sunnhemp plants are usually harvested at around 120 days, 140 days and 80 days after sowing, respectively and left in the field under sun for 3-4 days for shedding of leaves loosing approximately 25% by weight. By about 12-20 days retting is completed in cases of jute and mesta, and 3-5 days in case of Sunnhemp depending on temperature of water, pH, volume of water, height of water level above the immerged bundle, maturity of plants, water soluble constituents of plants etc. Retting is best done in clear, slow flowing water to get good quality fibre.

a) Fourteen bacteria (viz. B*acillus, Pseudomonas, Clostridium, Azotobacter* spp.) and 16 fungi (viz., *Cladosporium, Aspergillus, Penicillium, Colletotrichum,Fusarium and Tricoderma* spp.) were identified and tested for retting in jute.

b) Factors of retting were standardized, viz, temperature, pH of retting water, volume of water and placement of stacks for quality retting of jute.

c) Application of both inorganics (NH_4, K., Ca, Mg, SO_3, PO_4) and organics (green gliricidia, sunnhemp and dhaincha) were identified as activators for acceleration of jute retting.

d) Spraying of urea (5% conc.) at the basal portion of stem (60 cm) of the standing crop *in situ* at 10 or 5 days before harvest improved the quality of fibre and also reduced retting period.

e) To overcome water scarcity constraints, vertical steeping method of machine extracted ribbon in water for retting was developed which reduced water requirement to minimal and completed retting in 5-7 days, whereas, 15-20 days are normally required in conventional retting method.

V. AGRICULTURAL EXTENSION & HUMAN RESOURCE DEVELOPMENT

The section has been entrusted with the task of carrying the research results of practical value to the farmers with three major objectives

i) To popularize and intensify the use of sound agricultural practices and improved methods of jute cultivation in farmers' fields.

ii) To train and educate jute farmers for the adoption of improved cultural practices and to conduct training for human resource development of different jute growing areas.

1. Transfer of technology

It is very essential to transfer the improve jute production technology and stimulate the adoption rate to boost up the production and productivity. Keeping this mandate in view, several extension programmes and activities had been carried till date.

i) Lab to Land Programme

The CRIJAF carried out this programme in 18 adopted villages out of 4 blocks consisting of 900 farm-families in six phases during 1979 to 1992. Altogether 2960 demonstrations were conducted on following 5 jute-based crop rotations: Jute-Paddy-Wheat, Jute-Paddy-Mustard, Jute-Paddy-Potato, Jute-Paddy-Lentil, Jute-Paddy-Pea. Besides, 517 single crop demonstrations were also conducted. The results revealed that where irrigation could be provided, total production per ha rose up to 23 tones ha^{-1} with jute-paddy-potato cropping system, fetching a net income of Rs. 17,000 in 284 days.

ii) Operational Research Project

This was an integrated project (1990-1992), under which several demonstrations were conducted on different farm technologies comprising of improved jute production technologies and allied farming like, horticultural, fish farming, poultry farming, pisci-culture, agro-forestry, etc. in order to generate scientific awareness among the farmers community.

iii) Demonstration projects

Several trials were conducted since 1962 on improved performance of *olitorius* jute viz., JRO 632, JRO 524, JRO 66, JRO 8432, JRO 128, JRO 878, JRO 7835, JRO 808, JRO 4362 under irrigated and rainfed conditions, and *capsularis* jute viz. JRC 212, JRC 321 under irrigated condition over local checks.

2. Insect pests management in Jute

The cultivators generally used Endrex 20 EC in controlling jute pests. To control pest 32 trials were conducted on JRO 632 in farmers fields during the year 1976-80 using Endosulfan 35 EC, Fenitrothion 50 EC and Phosalone 30 EC. Except *Myllocerus* all other pests were controlled by these insecticides resulting higher fibre yield. Recently, IPM module developed by CRIJAF comprising of chemicals and biocides coupled with intercropping with red amaranth and summer radish is being tested in farmers fields.

3. Trials on the use of weedicide in *C. olitorius* jute

To demonstrate the efficiency of three weedicides in controlling weeds in the jute fields,18 trials were conducted on JRO 632 in cultivator's fields during 1977-1979. Three chemicals introduced in the field were: Frenock AC-60, Quizalofop Ethyl and Ansar-529. Weeds were found in patches in the plots treated with Frenock AC-60. A light hand weeding was required. In the plots sprayed with Ansar-529 weeds were temporarily suppressed but not totally killed. Fluchloralin affected the germination and the plant population was less than the other plots. The plots with two hand weedings were free of weeds. Recently Quizalofop Ethyl as a post-emergent herbicide was found effective in controlling weeds in jute field.

4. Frontline demonstration on jute

This programme has been conducted and continued in collaboration with DJD, Govt. of India. The several demonstrations on jute were conducted in each year on the farmers' field of different villages of jute growing districts of West Bengal. Out of many components of the demonstrated technologies, major emphasis was given on the improved jute varieties with all recommended package of practices like, crop management practices, line sowing, plant protection measures, nutritional management, retting technology, etc.

A total of 763 demonstrations were conducted from 1997-2004 on the farmers' field of Nort-24 Parganas and Hoogly districts of West Bengal on different high yielding jute varieties. Out of them, the jute variety 36E ranked first (29.08 q ha^{-1}) in terms of fibre yield during 1997, PBO-6 (28.22 q ha^{-1}) during 1998, JRO-524 (25.63 q ha^{-1}) during 1999, S-18 (29.99 q ha^{-1}) during 2000, JRO-524 during 2001 to 2004, as compared to others. However, JRO-524E ranked first in terms of benefit cost ratio (1:99) due to less application of fertilizer dose.

5. National demonstration programme

CRIJAF, Barrackpore, West-Bengal carried out National Demonstration Programme in the districts of North 24 Parganas and Hooghly in West Bengal from 1967 to 1975 with the following objectives:

i) to exploit these demonstrations for purpose of training farmers and for quick dissemination of latest research results to the farmers in the aforesaid areas.

ii) to minimize the time lag between research and its application in the fields and also to identify factors limiting crop yields and those contributing to higher yield.

The main emphasis was to maximize the production per unit area per unit time for the whole year by using high yielding varieties of jute, paddy, wheat and potato in combination with the package of practices. During the period from 1967 to 1975; 297 demonstrations were conducted on jute, paddy wheat and potato under irrigated and rainfed conditions. The results of national demonstrations showed that the increase in yield was more than double in jute, nearly 2.5 to 3.5 times in paddy, 1.5 to 2.5 times in wheat and 1.5 to 2.5 times in potato against the average yield in West-Bengal during 1967 – 1975.

6. Demonstrations on jute based multiple cropping sequences

In order to maximize the benefit from a unit area of land, the crop rotations (400% cropping intensity) trials were conducted on moong + jute-paddy-potato and jute-paddy-patato + wheat under irrigated conditions in farmers' fields in the district of North24-Parganas in West-Bengal during the year 1976-80. During the years 1997 to 2004, 695 demonstration trials on jute based cropping sequences were conducted on the farmers' field. Out of them, in terms of benefit cost ratio, jute-paddy-mustard (1.40) and jute-bengal gram (1.77) were found more profitable during 1997 and 1998, respectively, jute-paddy-pea (1.66) during 1999, jute-paddy-tomato (1.70 – 1.72) continuously found profitable during 2000 to 2002. However, jute-paddy-pea was found more profitable (1.44) during 2003 due to introduction of a new tomato variety (Munmun), which, however, yielded inferior quality and size of fruits.

7. Adoption process of jute technologies

An investigation conducted in Barrackpore and Barasat sub-divisions of West Bengal during 1976 revealed that there was significant difference in the knowledge scores among marginal, small and semi-medium farmers. The difference in the extent of adoption was highly significant among the farmers of three groups. The adoption intensity score of semi-medium farmers was 54.04, followed by small farmers (47.52) and marginal farmers (42.02).

8. Communication aspects of jute technologies

The field investigation was carried out with 225 farmers whom were selected and stratified into marginal, small and medium farmers on the basis of their size of land holdings in 18 villages. All the 29 independent variables fitted together in multiple regression analysis which jointly explained 81,91,94 and 80 per cent variations, respectively in the productivity of crops of the marginal, small, medium and pooled sample of farmers. However, only 3 variables namely status of land ownership, supervision of crop production and irrigation index contributed positively and significantly to the prediction of productivity of crops of marginal farmers. Regarding factors influencing jute productivity, it was observed that two variables i.e. economic status and knowledge of jute technologies contributed positively and significantly to the prediction on jute productivity and accounts for 45 per cent of the variation in jute productivity.

9. Human resource development in jute sector

In order to develop skill and train the farmers and extension workers in improved jute and allied fibre crop cultivation, several trainings / workshops were conducted. Among them, a training programme on “Entrepreneurship development on Diversification of Jute Products” was organized for 26 rural women in collaboration with National Centre for Jute Diversification (NCJD), Kolkata during 23 July to 10 August 2004. Moreover, a training for the farmers of Jharkhand state was also co-ordinated on improved jute and mesta cultivation during 2-6 August, 2004 at Hazaribagh, Jharkhand.

10. Extension programmes and activities

In order to create awareness, wide publicity about jute and allied fibres in different states of the country and educate the farmers for their social upliftment, different communication methods and extension approaches pertaining to jute production technologies and allied farming, were used on regular basis. A large number of Kisan Melas, off-campus farmers meet, exhibitions etc., which have been widely covered by print and electronic media, have been organized on regular basis both at the Headquarter at Barrackpore on jute as well as at its sub-stations on allied fibre crops.

VI. ALL INDIA NETWORK PROJECT ON JUTE & ALLIED FIBRES (AINP on JAF)

Since its inception in 1967 AINPJAF (previously AICRP on JAF) is coordinating research activities, testing technologies on multi-disciplinary mode in different agro-climatic conditions of the country for the evaluation of high yielding, early maturing and fertilizer responsive varieties of jute and allied fibres viz., mesta, sunnhemp, sisal and ramie and testing low cost and user-friendly production technologies both under rainfed as well as irrigated conditions. The entire research activities under AINP are broadly divided under four groups viz., crop improvement, crop production, crop protection and fibre quality, each having their own objectives.

1. Crop Improvement

Earlier major emphasis was on the evolution of high yielding varieties only. Recently, along with fibre yield better fibre quality is also a major concern, while testing the cultures through extensive multi-locational trials. Seventeen (17) high yielding varieties of jute, four (4) of mesta, one (1) each of ramie and sisal variety were released through AINP.

Table 3. Special characters of the varieties of jute and allied fibre crops

Crop species	**Varieties**	**Special characters**
Corchorus olitorius	JRO 632, JRO 3690 and JRO 66	Suitable for late sowing
	JRO 878, JRO 524, JRO 7835, JRO 8432 and JRO 128	Suitable for early sowing and multiple cropping sequences for pre-mature flowering resistant trait.
	JRO 878	Fine fibre quality
	KOM 62	Suitable for early sowing in Orissa.
	TJ 40	Suitable for late sowing in Orissa.
Corchorus capsularis	JRC 321	Suitable for early sowing in low lying areas and fine fibre quality.
	Padma	Suitable for early sowing in low lying areas.
	JRC 7447	Responsive to high nitrogenous fertilizers.
	JRC 212 and JRC 698	Suitable for mid-land situation.
	UPC 94	Fine fibre quality
	JRC 4444 and KC 1	Suitable for Orissa
	KTC 1	Suitable for Bihar
	Bidhan Pat 1, 2 and 3	Photo-insensitive, short duration.
Hibiscus sabdariffa	HS 4288	Suitable for eastern states
	HS 7910	Suitable for eastern states, non-bristle stem.
	AMV 1, 2, 3 and 4	Suitable for Andhra Pradesh, Tamil Nadu and Karnataka.
Hibiscus cannabinu s	HC 583	Suitable for eastern states.
	AMC 108	Suitable for Central, Western and southern states.
Bohemeria Nivea	R-67-34	Suitable for Assam, high yielder with medium gum content in fibre.
Agave sisalana	Lila (hybrid sisal)	High yielder with wide adoption potential.
Crotalaria juncea	K-12 yellow	Suitable for Uttar Pradesh Madhya Pradesh and Bihar, High yielder.

2. Crop Production

The activities under crop production are aimed at developing low cost and user friendly production technologies, which will increase the fibre yield and enhance the return to the farmers.

(i) Cropping system research

Under jute based cropping systems, remunerative crop sequences like jute – paddy / blackgram under rainfed condition and rotations like jute – paddy – winter vegetables, jute – paddy – potato, jute - paddy - mustard under irrigated condition were identified. For alluvial and sandy loam tracts, best crop rotations were identified. The suitable mesta based cropping system under rainfed conditions were identified for different states like Andhra Pradesh, Tripura and Bihar. Sunnhemp-wheat rotation was found to increase wheat yield by 10-15% while, sunnhemp-bajra effectively reduced incidence of wilt disease. Intercropping of pea, wheat and mustard with ramie was found to be economical for first two years. Double row planting in sisal accommodated highest number of plants with maximum fibre productivity.

(ii) Soil fertility

Optimum requirement of NPK for *olitorius* and *capsularis* jute was found to be 40:20:20 and 60:30:30 kg ha^{-1}, respectively almost in all agro-climatic zones. However, experimental findings on site-specific nutrient studies revealed that application of phosphate and potash can be skipped without hampering fibre yield. For mesta, recommended dose of NPK was 40:20:20 kg ha^{-1} under medium fertile soil condition. However, for rainfed areas of the principal mesta growing states of A.P., 25 kg. N ha^{-1} had been found suitable. Application of N as top dressing in two split doses was more useful. Where soil moisture was less, foliar spray of 1% urea by low volume power sprayer was advantageous in mesta. Supplementation of 50% inorganic N by poultry manure @ 1 t ha^{-1} was found to be at par with the application of 100% inorganic N. Application of 60-100 kg N, 30-35 kg P and 60-100 kg K per year per ha was found optimum for sisal provided the calcium status in soil was satisfactory.

Substitution of inorganic fertilizers through organics (FYM / compost / green manures) to the tune of 25% increased economic yield of jute and mesta based cropping systems and restored the soil fertility as well. Application of lime @ 2 t ha^{-1} was found to increase the production in mesta based production systems.

Application of *Rhizobium* alone and in combination with phosphate solubilising bacteria could substitute 25% chemical fertilization in sunnhemp without affecting the yield.

Application of boron @ 15 kg borax along with recommended fertilizer dose in acid corrected soils of North Bengal and Assam was found to increase fibre yield of *capsularis* jute where yield remains much below the national average. Application of 10-20 kg P ha^{-1} alongwith traces of boron and molybdenum improved nodulation and growth in sunnhemp.

In Sorbhog (Assam) application of NPK @ 30:15:25 kg ha^{-1} after each cutting (total four cut) was found optimum in ramie.

(iii) Weed management

Mulching with locally available biomasses like *Saccharum sp*. (a weed) @ 10 t ha^{-1} was found to be equally effective as two hand weedings in controlling weed growth in jute. Intercropping jute with red amaranth or cowpea also gave promising weed control and fetched additional income which was encouraging from farmer's point of view. Use of pre- / post-emergence herbicides like clomazone, fluchloralin or quizalofop-ethyl, however, were not found effective in controlling the jute weeds. Similarly, application of fluchloralin (1.0 kg a.i. ha^{-1}) coupled with one hand weeding in mesta produced comparable fibre yield with manual weeding twice. Atrazine @ 2 kg ha^{-1} per cutting or paraquat @ 2.0 kg ha^{-1} per cutting was found to give effective better weed control and higher fibre yield in ramie.

(iv) Seed production

Multi-locational trials on jute seed production indicated that besides Maharashtra and A.P., jute seed can also be produced in the drier tracts of West Bengal particularly in the district of Purulia.

3. Crop Protection

In crop protection, the objective was to develop cheaper and eco-friendly plant protection schedules for the fibre crops.

(i) Survey and surveillance

The major jute pests identified were hairy caterpillar, apion, semilooper and yellow mite with a variation in the intensity of infestation depending on climate as well as location, the peak incidence was found to occur around June, which generally increased with time. In mesta, aphids, jassids, weevils, semilooper and white fly were found to be the major pests in Amadalavalasa and adjoining areas, and the peak period of incidence was mid-August to early September. In rosselle, flea beetle and mealy bug were most common pests in W.B., Bihar and Assam while red cotton bug and jassids were common in A.P.

Incidence of stem rot and root rot in jute was highest in all the jute growing areas followed by anthracnose, leaf mosaic (in *capsularis*) and leaf blight (both in *capsularis* and *olitorius*). In mesta, leaf rot, in general, was found to be the major disease with its peak incidence during early June. Survey of mesta diseases also showed prevalence of foot and stem rot in A.P., U.P. and W.B. while tip-rot, anthracnose, root-rot and mosaic diseases were also common in U.P.

Application of carbofuran 3G @ 1 kg a.i. ha^{-1} controlled spiral borer of mesta effectively. Seed treatment with dithane M-45 @ 3 g kg^{-1} or pre-treatment of field with 2.5 kg ha^{-1} of copper oxychloride during land preparation and followed by 3 sprays of the same fungicide (0.5%) directed towards soil surface in late June, mid-July and early August were found to check foot and stem rot disease of *sabdariffa* mesta.

(ii) Biological control

Biological control of *M. phaseolina* diseases of jute by use of antagonists like *Trichoderma harzianum*, *T. viridae* and *Gliocladium virens* were found to be promising. Application of *Trichoderma viridae* twice in soil was found to be most effective against the disease. 'Hooghly wilt' disease earlier prevalent in jute-potato area of W.B. had been significantly reduced through adoption of intensive cropping systems with inclusion of cereals. Eight new spider predators of jute pests were identified at CRIJAF (W.B.). At Nagaon (Assam), 2 new braconid parasites on semilooper and 1 coccinellid beetle on yellow mite had also been found. Biological control of jute & mesta pests with biocide (*Beauveria basisana*) was found effective. Spray of neem seed oil or ethyl acetate extract of *Swertia chirata* as anti-feedant was found to control jute semilooper effectively.

(iii) IPM of jute

Combined application of manual weeding, *T. viridae* (soil treatment) and spray of neem oil recorded lowest stem and root rot infestation in *olitorius* jute at almost all the centers. *Fusarium* wilt in sunnhemp, which caused 30-40% crop loss, can be remedied by crop rotation and proper drainage.

4. Fibre Quality

The main objective was to assess as well as monitor the fibre quality of the jute and mesta varieties. The said varieties under advanced varietal trials were regularly tested for their quality characters and varieties like JRO 524 (*olitorius*), JRO 128 (*olitorius*), JRC 321 (*capsularis*) and AMC 108 (mesta) had been identified to be of superior fibre quality.

VII. Krishi Vigyan Kendra, Burdwan

The KVK was sanctioned by Indian Council of Agricultural Research (ICAR) on April 01, 2005 to be functional under Central Research Institute for Jute and Allied Fibres (CRIJAF). The KVK bas been made operational since March 15, 2006 at Central Seed Research Station for Jute and Allied Fibres (CSRSJAF), Bud Bud under this Institute.

(i) The KVK has initiated its activities on its farm at CSRSJAF, Bud Bud and at Keten village in Burdwan district about 18 km away from Bud Bud which has been adopted by the KVK.
(ii) Agro-ecosystem analysis of Keten village has been done, report prepared and interventions on the mandated activities of the KVK have been identified. The action plan was thoroughly discussed in the meeting of Scientific Advisory Committee (SAC) in which farmers (both men and women) are also members. The thrust areas of activities for Burdwan district was also identified in a meeting of SAC.
(iii) Demonstration units on production of jute with improved practices and horticultural and fodder crops have been established on the KVK farm at Bud Bud. Seedlings of cauliflower for cultivation in early season have been raised under protective agricultural system and the same have been provided to the farmers of Keten village. Work on seed production of paddy has also been initiated.
(iv) The activities which have been taken up in Keten village include demonstration of improved cultivation of jute, cultivation of early season cauliflower, demonstration of improved cultivation of rice, demonstration on composite fish culture, introduction of Khaki Campbell duck and Divyayan Red poultry in backyards. Necessary training on

crop production with improved technologies, management of composite fish culture and rearing of improved breeds of duck and poultry were provided to the target group of farmers as technology back-up measure. One programme on Animal Health Camp has been organized with State Department of Animal Resource Management.

5. IMPACT

5.1 Growth of sector

Jute was introduced in the country for large scale cultivation about 200 years back. Considering its agro-climatic requirements, its cultivation at that time was mainly concentrated in the present Bangladesh and the adjoining states of India. At the time of partition of the country, in 1947-48, the area under jute was only 2.6 lakh ha and the production was only 16.7 lakh bale. Our requirement of raw jute at that time was about 60 lakh bale. Thereafter, through various efforts, the area and production under jute have increased and now, we are self-sufficient in the supply of raw jute. Trend in area, production and yield of jute in India has been given in Table 3. It has been observed that from a level of about 2.6 lakh ha in 1947-48, the area under jute during the 9th Plan period rose to about 8.6 lakh ha. Simultaneously, the production of jute from a level of 16.7 lakh bale in 1947-48 rose to about 96.2 lakh bales during the 9th Plan period. Year to year, however, there was some fluctuation in area and production under the crop. It is, however, observed that there was an increasing trend of the productivity of the crop, which rose to about 20 quintal per ha during the 9th Plan period from a level of little more than 11 quintal per ha. The productivity and production during 2003-04 were estimated to be 22.50 quintals per hectare and 98.81 lakh bales, respectively.

Record of mesta area was available from the 1st Plan period. Trend in area, production and yield of mesta in India has been given in Table 4. From a level of about 1.6 lakh ha area during the 1st Plan period, it has now reached to a level of about 1.9 lakh ha during the 9th Plan period. However, through the development programmes, the coverage under mesta even rose to a level of about 3.8 lakh ha during the period of 1978-80. The production under mesta rose from a level of about 6.8 lakh bale during the 1st Plan period to about 11 lakh bale during the 9th Plan period. In the intermediate period of 1978 – 1980, the production even reached to a level of about 18.8 lakh bales. The productivity of mesta, however, did not increase much up to 7th Plan period. The main increase in productivity of mesta was noticed after the 7th Plan period. The productivity and production during 2003-04 were estimated to be 11.52 quintals per hectare and 11.04 lakh bales, respectively.

Jute is mainly grown in eastern and north eastern states while mesta is grown almost throughout the country. The jute growing states are West Bengal, Bihar, Assam, Orissa, Meghalaya, Tripura and Uttar Pradesh. Presently, the area under jute in the country is around 8.6 lakh ha. West Bengal contributes the maximum area to the tune of 73 percent of the country's total jute area and about 81 percent of the country's jute production. The major mesta growing states are Andhra Pradesh, Orissa, Bihar, Tripura, Meghalaya, etc. Mesta is grown in the country in about 12 states, but the major mesta growing states are Andhra Pradesh, Orissa, Bihar, West Bengal, etc. Andhra Pradesh is the main mesta growing state sharing about 41 percent of the country's total area of about 1.9 lakh ha and nearly 56 percent of the country's total production of 11 lakh bales.

Table 4. Trend in Area, Production and Yield of Jute and Mesta in India

Year/Plan	Area ('000 ha)		Production ('000 bale*)			Yield (kg/ha)	
	Jute	Mesta	Jute	Mesta	Total	Jute	Mesta
1947-48	263.9	-	1671.6	-	1671.6	1140	-
Pre-Plan 1947-51	411.3	-	2545.0	-	2545.0	1114	-
First Plan 1951-56	645.4	158.3	3928.8	682.6	4611.4	1096	776
Second Plan 1956-61	704.2	308.2	4441.0	1409.4	5850.4	1135	823
Third Plan 1961-66	847.2	380.9	5683.6	1648.0	7332.5	1208	779
Plan Holiday 1966-69	734.5	307.4	4869.8	1133.0	6002.8	1193	663
Fourth Plan 1969-74	765.0	322.1	5495.1	1220.0	6715.8	1293	682
Fifth Plan 1974-78	695.9	341.4	4906.2	1593.7	6499.9	1269	840
Annual Plan 1978-80	859.4	381.5	6270.9	1876.4	8147.3	1313	885
Sixth Plan 1980-85	818.5	311.7	6419.5	1422.9	7842.4	1412	822
Seventh Plan 19/85-90	802.8	266.1	7562.6	1277.0	8839.7	1696	864
Annual Plan 1990-92	826.5	238.6	8426.5	1330.1	9756.6	1835	1003
Eighth Plan 1992-97	766.6	196.9	8169.4	1116.7	9286.1	1918	1021
Ninth Plan 1997-2002	860.6	186.6	9618.6	1098.4	10717.0	2012	1060
Tenth plan 2002-03	864.0	176.0	10299.0	1037.0	11336.0	2142	1062
2003-04 (Estimated)	787.0	171.0	9881.0	1104.0	10985.0	2250	1152

*1 bale ≈ 180 kg

5.2. Input – output of sector

Jute

In India concerted efforts on increasing jute production were intensified after the partition of the country with the objective of becoming self sufficient in raw jute production. The systematic information based on statistics of production details became available from 1951 onwards. Till date, jute production and productivity witnessed several fluctuations at different intervals, and the production trend over the years can be grouped as four distinct phases like : Post partition phase, Self-sufficiency phase, Declining phase, Recovery phase.

Post partition phase : Only 16% of jute growing area of undivided country remained in India as a result of partition with a meager production of 7 lakhs bale to feed 108 jute mills, which remained in present India, whereas around 50 lakhs bales of jute was required. So, there was a great shortfall. To mitigate such an alarming situation, research and extension activities were intensified to increase the jute area as well as the productivity.

Area as well as production started increasing since 1951 and continued for about a decade. However, the rising trend was not always steady. There were fluctuations both in area and production and as a result, productivity varied from 10-13 q/ha. Average cumulative growth rate was 1.94% in respect to area whereas, it was little lowered for productivity. This phase continued till 1960-61.

Self-sufficiency phase: This phase began from 1961-62, which continued till 1968. At this phase, India surpassed the production of 50 lakhs bale mark (0.9 million tones), which was more than sufficient for the requirement of the mills. Higher production trend vis-a-vis self-sufficiency was maintained during this phase with the production level varying from 0.8 m tones in 1966 to 1.2 m tones in 1962. Area also fluctuated between 0.7 and 0.9 million hectares. Although there was considerable fluctuations in the productivity during this period, but at the later part (i.e. 1968) it touched nearly 14 q/ha. Growth rate slightly improved in respect to area, which was highest in respect to production but with regard to productivity, growth rate was, however, low.

Declining phase : In the year 1969, declining phase was initiated with the lowest production of only 29 lakh bales in independent India. As a result of stiff competition from cheaper synthetic fibre, export markets of jute goods started shrinking during late sixties and early seventies. This resulted in the fall of raw jute price and subsequent shrinkage of jute area and production. This was, however, an unusual situation when many adverse factors worked together at a time, ultimately reducing the area to 0.5 million hectares, and also the productivity down to 10 q/ha. In subsequent years, though the situation improved substantially but declining trend in area as well as production continued for about a decade till 1978. Productivity, however, maintained the upward trend reaching up to 14 q/ha during 1974. Growth rate in all respects was very low during the period being 1.14%, 2.31% and 1.06% for area, production and yield, respectively.

Recovery phase: During early eighties rejuvenation process started in jute industry. Jute production also shot up to 1.2 million tones during 1979, which could be considered as beginning of recovery phase. Special Jute Development Programme launched by Govt. of India and financial assistance from UNDP, FAO and other agencies helped in steady increase for manufacturing traditional items along with diversified and value added products. This phase is still continuing. The characteristics of this phase were that while there was a negative trend of growth rate in case of area during eighties and nineties, there was a positive trend of growth in production. These were very high positive growth rates of 5.25% and

1.01% during eighties and nineties, respectively. Productivity level of 19 q/ha was achieved during 1990 and 20 q/ha during 2000.

Mesta

Systematic data on mesta became available from 1955 onwards. West Bengal used to be the most important mesta growing state during fifties contributing about 36% and 50% of total area and production, respectively. Mesta production is not only restricted to Eastern region of the country but also grown all over the country. So the effect of post partition phase cannot be recognized directly in case of mesta. However, for the sake of understanding of jute and mesta situation together, the trend is being shown here in the same fashion as that of jute.

Trend of mesta production in India in last fifty years can be divided roughly into three phases viz., Post-partition phase, Self-sufficient phase and declining phase. There is no recovery phase visible in case of mesta.

Post partition phase : This phase started immediately after partition of the country and continued till early sixties when both area and production started rising. Average cumulative growth rate during the period was 10.93% and 4.48 for area and production, respectively. Production could maintain a positive growth rate in spite of negative growth rate in productivity. Reason for negative trend in productivity may be due to expansion of area under the circumstances without little considerations for agro-ecological factors.

Self-sufficient phase : This phase started from early sixties and sustained till eighties showing positive-growth rate in all the three parameters like area (1.65%), production (5.21%) and productivity (3.05%).

Declining phase : Beginning from eighties this phase is still continuing with a declining trend in both area and production having negative growth rate.

Table 5. Area (`00,000 ha) , production (`00,000 tonnnes) and yield (tonnes / ha) of jute in India

Year	Area	Production	Yield	Year	Area	Production	Yield
1951	5.71	5.95	1.0420	1978	7.97	9.65	1.2108
1952	7.90	8.49	1.0747	1979	8.84	11.65	1.3179
1953	7.34	8.34	1.1362	1980	8.34	10.93	1.3106
1954	4.97	5.61	1.1288	1981	9.41	11.71	1.2444
1955	5.03	5.31	1.0557	1982	8.26	12.22	1.4794
1956	7.04	7.61	1.0810	1983	7.37	10.71	1.4532
1957	7.72	7.78	1.0078	1984	7.47	11.30	1.5127
1958	7.05	7.23	1.0255	1985	8.34	11.76	1.4101
1959	7.33	9.36	1.2769	1986	11.46	19.59	1.7094
1960	6.82	8.16	1.1965	1987	8.07	13.24	1.6406
1961	6.12	7.22	1.1797	1988	7.16	10.41	1.4539
1962	9.23	11.51	1.2470	1989	6.67	10.64	1.5952
1963	8.51	9.81	1.1528	1990	6.71	12.73	1.8972

1964	8.68	11.13	1.2823	1991	7.78	14.03	1.8033
1965	8.38	10.84	1.2936	1992	8.65	15.93	1.8416
1966	7.53	8.04	1.0677	1993	7.70	11.99	1.5571
1967	7.97	9.64	1.2095	1994	6.97	13.29	1.9067
1968	8.30	11.38	1.3711	1995	7.43	13.84	1.8627
1969	5.27	5.28	1.0019	1996	7.23	13.36	1.8481
1970	7.67	10.18	1.3272	1997	8.74	17.56	2.0087
1971	7.49	8.88	1.18.56	1998	9.20	18.03	1.9598
1972	8.15	10.23	1.2552	1999	8.22	16.68	2.0288
1973	7.00	8.96	1.2800	2000	8.27	16.67	2.016
1974	7.92	11.20	1.4141	2001	8.57	19.28	2.250
1975	6.64	8.05	1.2123	2002	8.45	18.56	2.196
1976	5.85	7.99	1.3658	2003*	8.15	18.42	2.250
1977	7.37	9.64	1.3080	2004*	6.95	15.62	2.250

* Estimated

Table 6. Area (`00,000 ha) , production (`00,000 tonnnes) and yield (tonnes / ha) of mesta in India

Year	Area	Production	Yield	Year	Area	Production	Yield
1955	1.772	1.634	0.9223	1980	3.849	3.435	0.8924
1956	2.310	2.092	0.9055	1981	3.592	2.973	0.8277
1957	2.970	2.668	0.8982	1982	3.236	2.849	0.8803
1958	3.100	2.372	0.7653	1983	2.872	2.206	0.7682
1959	3.675	3.092	0.8415	1984	2.872	2.444	0.8509
1960	2.934	2.074	0.7067	1985	2.759	2.280	0.8263
1961	2.785	2.052	0.7368	1986	3.482	3.170	0.9103
1962	1.885	3.074	1.6310	1987	2.649	2.292	0.8653
1963	3.792	3.415	0.9005	1988	2.608	1.773	0.6799
1964	3.934	3.373	0.8574	1989	2.276	2.068	0.9088
1965	3.600	2.849	0.7915	1990	2.292	2.190	0.9556
1966	3.390	2.313	0.6823	1991	2.387	2.359	0.9882
1967	3.220	2.198	0.6825	1992	2.384	2.429	1.0191
1968	3.205	2.290	0.71.44	1993	2.409	2.042	8475
1969	2.768	1.632	0.5896	1994	1.945	1.977	1.0162
1970	3.215	2.035	0.2328	1995	2.140	2.190	1.0233
1971	3.304	2.259	0.6837	1996	2.130	2.294	1.0770
1972	2.957	2.071	0.7003	1997	1.950	1.987	1.0190
1973	2.926	2.001	0.6838	1998	1.779	1.815	1.0200
1974	3.704	2.622	0.7078	1999	1.885	1.996	1.0590
1975	3.190	2.453	0.7688	2000	1.91	2.200	1.152
1976	3.296	2.653	0.8048	2001	1.84	2.017	1.096
1977	3.515	3.142	0.8939	2002	1.80	2.008	1.116
1978	3.653	3.227	0.8823	2003*	1.61	1.624	1.008
1979	3.802	3.354	0.88.22	2004*	1.51	1.573	1.044

*Estimated

Growth pattern in production, consumption, export and marketing of jute goods

The total jute goods production continued to increase in the last five decades. Being the single largest producer of jute goods in the world, India produced on an average 1.6 mln. MT jute goods in 2000s, which was around 54.37% of the global production during the same period. Sacking continued to be the largest segment of production, accounting for almost 62% of the total production. Hessian constituted about 20%, which was, however, almost double during 1950s. Carpet backing cloth (CBC) had its peak in 1970s (12.1%) but reduced drastically in the last three decades. One significant change in the product mix had been the steady increase in the production of diversified value added products. The production of these items, taken together, has increased to 18.31% of total jute goods production during 2000s as against 1.96% in 1985-86 (Table 7) . This share, at the end of the current plan period, would continue to increase.

The domestic market continued to be the mainstay of the industry consuming around 87.4% of the total production as against only 17.6% during 1950s. Around 96% of sacking and 81% of hessian were consumed domestically, which were around four-fold and 16-fold increase, respectively, compared to those in 1950s. Thus, there had been profound changes in the consumption patterns of jute goods in India (Table 7). However, food grain packaging is the single largest segment followed by sugar packaging, fertilizer packaging and miscellaneous others. Cement packaging market is completely lost.

India's export market share is estimated at around 30% of the global market valued at Rs.12,000 million. Incidentally, India earned around Rs. 1000 crores by exporting jute goods in the year 2003-04 as against only Rs. 233 crores in 1962-63. Despite that, the export of traditional jute goods drastically reduced: sacking and hessian undergone around 8-fold and 3-fold reduction in 2003-2004 compared to those in 1962-63, and that the trend had been gradual. CBC too followed gradual reduction since its peak in 1972-73. Although not spectacular but 4-fold increase in the export of diversified value added products in 2003-04 compared to that in 1982-83 is an encouraging phenomenon (Tables 8 & 9). Similarly, export of fine (various grades and counts) and blended yarn from India had shown remarkable growth (Rs. 266 crores in 2003-04). Amongst jute-diversified products, floor covering is the most dominant (Rs. 95.44 crores in 2003-04), followed by hand and shopping bags (Rs. 95 crores in 2003-04) and home textile made-ups. Quantity-wise importing countries are in the order: U.S.A., Belgium, U. K., Turkey, Egypt, Japan, Saudi Arab, Spain, Germany, Italy, Europe, Africa, Australia, Latin America and Middle East. The disintegration of the erstwhile USSR had been a big blow to the export efforts; the impact is yet to be fully recovered.

Table 7. Production and domestic consumption of jute goods in India

Period (10 years average)	Hessian (%)		Sacking (%)		C.B.C. (%)		Others (%)		Total (Qty: '000MT)	
	P	C	P	C	P	C	P	C	P	C
1950 - 59	39.6	5.4	54.8	24.2	-	-	5.3	41.4	1000.4	17.6
1960 - 69	37.4	13.2	42.7	58.5	9.8	-	10.1	33.5	1243.5	33.3
1970 - 79	28.6	25.4	47.2	85.7	12.1	-	12.1	70.9	1196.6	56.3
1980 - 89	25.6	40.0	57.8	94.8	3.7	6.7	14.8	85.8	1294.2	77.9
1990 - 99	24.3	69.9	52.3	97.9	1.6	9.83	21.8	76.4	1454.4	84.9

2000-04	19.6	80.9	61.8	96.3	0.3	14.9	18.3	65.6	1604.8	87.4

N.B. : P = Production; C = Consumption

Source : Report on Base line data on jute industry, Natl. Jute Dev. Programme. UNDP, May 1993; Jute in India – a status paper, Dir. Jute Dev., 2003; Indian jute Vol. XV No. 2, Dec. 2004 and Das and Goswami (2001).

Table 8. Item-wise export of Indian jute goods (Qty : '000MT, Value : Rs. in crores)

Period	Hessian	C.B.C.	Sacking	Others*	Total	Value
1962 – 63	518.0	-	269.0	56.5	843.5	233.8
1972 – 73	256.4	162.4	91.0	68.4	578.4	249.1
1982 – 83	214.1	51.4	36.0	28.1	329.6	201.8
1992 – 93	102.9	20.1	27.7	45.1	195.8	351.7
1997 – 98	103.5	13.5	17.9	105.1	240.0	694.7
2002 – 03	100.8	2.8	6.1	116.3	226.0	913.3
2003 - 04	157.1	5.2	23.4	114.7	310.4	1051.9

*Others include quality yarn (various grades, count and blends) and diversified products since late eighties.

Source : Report on Base line data on jute industry, Natl. Jute Dev. Programme. UNDP, May 1993; Jute in India – a status paper, Dir. Jute Dev., 2003; Indian jute Vol. XV No. 2, Dec. 2004.

Table 9. Export of jute diversified products (canvas, tarp., twine, webbing, soil saver, felt, decorative fabrics, carpet, floor covering, blanket, wall hanging, shopping bags and others)

Period	Value (Rs. in crores)	% share of total export
1992 – 93	13.95	4.00
1997 – 98	87.21	12.55
2002 – 03	307.03	33.62
2003 - 04	290.07	27.57

Source : Indian jute, Vol. XV No. 2, Dec., 2004.

Application areas of jute and allied fibres

Raw jute (jute and kenaf) : Being the largest producer of jute goods, India produced on an average 1.6 mln. MT jute goods in 2000s, which was around 54.37% of the global production during the same period. Sacking constituted 62%, Hessian 20% and Carpet Backing Cloth (CBC) 12% of the total production. Diversified value added products were comprised of decorative fabric (6.9'000MTons), webbing (0.1'000MT), soil saver (3.9'000MT), matting (0.9'000MT), yarn and twine (136'000MT) and others (11.5'000MT) in 2004-05 (April to November) and exported to USA, Belgium, U.K., Turkey, Egypt, Japan, Saudi Arab, Spain, Germany, Italy, Europe, Africa, Australia, Latin America and Middle East.

Sunnhemp : Sunnhemp occupies nearly 55 ,000 ha area producing about 31,000 tons of fibre per annum with the productivity of 5.08 q/ha. Traditionally, sunnhemp fibre is used to produce ropes, twines, nets and tat patties. Hand made paper from sunnhemp fibre has good export potential.

Sisal : Sisal occupies nearly 7 ,000 ha area producing about 10,000 quintals of fibre per annum with the productivity of 1.45 q/ha. Sisal fibre is chiefly used for manufacturing marine and industrial ropes, agricultural and commercial twines and other forms of ropes and cables. The fibres are also used for padding, upholstery, matting, bags, sacks, fishing nets and various types of brushes and brooms.

Ramie : Ramie fibre is the strongest vegetable fibre and possess comparatively many better quality parameters than other vegetable fibres (except cotton). Ramie occupies nearly 150 ha area producing about 75 tons of fibre per annum with the productivity of 5 q/ha Ramie fibre has versatile uses as like shirting and suiting materials, table cloths, bedsheets, pully belts, ropes and curtain cloths, twines, threads, cordages, fishing nets, carry bags, impermeable fabrics, ammunition belts, camouflage nets, caartige cloths, parachute chords, gas mantles, roving for electric batteries.

Flax : India imports flax fibre from major flax producing countries. Flax fibre is used to manufacture apparel fabrics, linens such as damasks, sheetings, laces and threads. The fibres are also used for twines, canvas and bags such as mail sacks, towels and meat wraps. In the developed countries, flax fibre is used for making composites, non woven automotive products, particle boards etc.

6. SCENARIO

6.1 Scenario

Jute is the major commercial crop of eastern and north eastern states, in general, and of West Bengal in particular, which provides raw material to a major industry and contributes significantly to country's economy. When viewed from the national context it is revealed that about 4 millions farmers, 0.25 million industrial workers and 0.5 million traders find gainful employment in jute sector. Over and above, jute farming generates 10 million man-days of employment in rural India during the growing and harvesting season of the crop (middle of March to middle of September).

Out of 8 lakh hectares of land covered with jute in the country 73% belongs to the state of West Bengal with 81% of country's total raw jute production. In the industrial segment 59 out of 76 jute mills in the country are located in West Bengal.

Jute has been under cultivation in this country for nearly two centuries now. Raw jute consisting of jute and mesta has been traditionally in use as a source of raw material for packaging industry only so far. In the recent times, it importance as a versatile source for diversified application, in the textiles industry, in the paper industry, in building & automotive industry, as soil saver, as decorative & furnishing material, etc. have been recognized and its demand in a number of countries is on the rise at an increasing rate. Nearly about 12-15% of the jute products are commercially being exported from this country to about 120 countries in the world. It earns foreign exchange of about Rs.1,000/- crores per annum and the trend is on the increase.

Although jute acreage have stabilized around 8 lakh hectares in the country, jute productivity has doubles (22 q/ha) since partition of the country from 11 q/ha, total production of raw jute is enough to saturate the demand of all the mills in the country and quality of marketed fibre has improved significantly.

The production of raw jute, jute goods, internal consumption and export are given below.

Production of raw jute

Period	Jute			Mesta			Jute & Mesta	
July - June	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.
1999 - 2000	847	9428	11.1	189	1130	6.0	1036	10558
2000 – 2001	828	9317	11.3	190	1239	6.5	1018	10556
2001 – 2002	873	10549	12.1	176	1092	6.2	1049	11641
2002 – 2003	864	10299	11.9	176	1037	5.9	1040	11336
2003 – 2004 (Estimated)	787	9881	12.5	171	1104	6.4	958	10985

Unit : Area – '000 Hectares; Qty : '000 Bales; Yield : Bale / Hectare

Production, Internal Consumption, Export of jute goods during last 5 years (Qty : '000 M. Tons)

Production

Period April-March	Hessian	Carpet Backing Cloth	Sacking	Others	Total
1999 – 2000	345.0	8.0	909.5	328.6	1591.1
2000 – 2001	338.0	6.6	952.8	327.8	1625.2
2001 – 2002	275.3	5.0	1034.0	286.5	1600.8
2002 – 2003	338.3	4.7	1000.0	278.8	1621.8
2003 - 2004	305.2	4.7	979.3	282.1	1571.3

International consumption

Period April-March	Hessian	Carpet Backing Cloth	Sacking	Others	Total
1999 – 2000	287.0	2.0	906.8	231.5	1427.3
2000 – 2001	269.2	0.8	934.8	229.6	1434.4
2001 – 2002	243.0	0.9	1021.4	195.5	1460.8
2002 – 2003	251.3	0.5	954.8	167.1	1373.7
2003 - 2004	253.3	0.9	909.3	179.4	1342.9

Export

Period April-March	**Hessian**	**Carpet Backing Cloth**	**Sacking**	**Others**	**Total**
1998 - 1999	65.4	14.4	8.1	84.4	172.0
1999 – 2000	52.5	6.1	2.5	85.9	147.0
2000 – 2001	86.0	8.1	3.1	157.9	255.1

2001 – 2002	51.6	2.9	2.1	91.6	148.2
2002 – 2003	100.8	2.8	6.1	116.3	226.0
2003 - 2004	142.1	4.8	28.9	101.8	277.6

Source : Indian Jute , VOL.XV NO.I, June, 2004

6.2. SWOT Analysis

6.2.1. JUTE

Strength

The strength of jute lies in its being a natural fibre resource which is renewable and therefore a cheap commodity for diversified use

Biodegradability of the jute fibre contributes positively towards eco-friendliness

Around 60% of raw jute in the world is produced in India

A good number of HYVs suitable for multiple cropping available under different agro-climatic conditions developed which found acceptance in neighbouring jute growing countries as well

A good collection of germplasm of cultivated and wild types of jute collected from varied geographical conditions

Well developed breeding programmes known for development of improved varieties. Improved varieties may be developed using advanced lines of biotechnology research, not only for higher productivity but also for improved product targeted quality requirements. Similarly improved varieties resistant to biotic and abiotic stress can also be developed

A network for testing of varieties and production technology available under different locations. There are distinct possibilities to reduce cost of cultivation on one hand and improve quality and marketing infrastructure on the other, in order to make the cultivation more remunerative. There is also a distinct scope to bridge the gap between the potential yield and actual yield in farmers field

High seed multiplication ratio (1: 80) and low seed rate are inherent advantages. Additionally, the system for production of required quantity of breeder seed of improved varieties is well organized

Inherent strength of the fibre: jute fibre has advantages of high strength, abrasion resistance, sound and heat insulation

Increasing demand for quality fibre for increase in manufacture of a number of value added products in both developed and developing countries

Weakness

The crop is rainfed and grown commonly by resource poor i. e., small and marginal farmers. Productivity improvement is not always feasible because of economic constraints to adopt improved technology and inaccessibility to improved and quality seeds in time, since certified seeds is only 18-20 thousand quintals against the requirement of 45-50 thousand quintals per annum

Cultivation of the crop is labour intensive consuming about 65% cost of cultivation for weeding and post harvest operation including bundling, transport, steeping, retting, storage etc.

- Lack of adequate rettting facility and lack of cost effective and user friendly retting method
- Seasonal nature of the availability of jute plant is a limitation for its potential use for paper pulp industry and other large scale industries requiring jute as the resource material
- Inadequate availability of superior grade fibre for value added uses
- Lack of remunerative price to farmers and inadequate marketing infrastructure makes cultivation less profitable
- Some of the inherent defects of the jute fibre puts limitations for its value addition. These are: harsh feel, moisture sensitivity, brittleness and low extensibility. Due to high variability in its properties, jute fibre becomes unsuitable for technical applications that require precise conformity to the standards
- Inadequate research–extension linkage, and therefore lack of sufficient efforts for transfer of technologies in all the jute growing belts of the country
- Lack of adequate information on germplasm stock showing wider variability and high level of hybrid vigour which are necessary to develop improved varieties with higher yield and desired traits

Opportunity

- Increasing awareness for environment concerns in India and abroad
- Increasing trend in the price of natural fibre based products especially in the developed countries
- Increasing demand for packaging materials commensurate with increased agricultural production in India and abroad
- Whole jute plant as a source of paper pulp
- Growing demand for technical textiles, with special emphasis on low cost product in the country and world over
- Suitability for development of jute based composite at low cost
- Properties appropriate for soil saving applications in geo-textile fields
- Possibility of diverse business opportunities in jute
- Possibility for blending between different natural fibres and even with synthetics for better quality under each category of product
- Use of biotechnology to have a proper knowledge on genome and develop improved varieties of desired market related quality requirements and other needs

Threats

- Competition from synthetic fibres has hampered the growth of jute in its traditional application, i.e., packaging. The growth in any other field under such circumstances depends on the extent to which the jute products prove their worth in terms of effectiveness in use and cost of manufacture
- Availability of low cost imported synthetic products
- Tendency of the jute cultivators to opt for cultivation of other crop which is more profitable and involves less drudgery
- Further closure of jute mills and consequent unemployment
- Competition from Bangladesh in view of its capability to produce better quality fibre by virtue of its having better natural retting facility i.e., availability of slow flowing water resource

6.2.2. ALLIED FIBRE CROPS

6.2.2.1. MESTA

Strength

Being a hardy crop with wider adaptability, it can be grown in many parts of the country under low input and stress situation

High fibre yielding varieties like HS 4288, HS 7910, AMV 4, HC 583 and AMC 108 have been developed

Whole green plant of mesta can be used as raw material for paper pulp. A variety MT 150 suitable for paper pulp has been identified for release

Potential product diversification is feasible

Weakness

The crop is grown by poor resource based marginal and small farmers, thus the productivity often remains low

The crop is grown in drier areas where sufficient water is not available for retting

Non-availability of good quality seeds

Crop duration is relatively longer than other seasonal crops

Mesta cultivation being seasonal in nature, non-availability of mesta plants throughout the year can be a limiting factor for paper pulp industry. There is a need for carry over stock to ensure continuity of supply to the mill throughout the year

The need for storage of whole plants by paper industry increases cost and risk

The cultivation of mesta is not increasing due to lack of transfer of technology in mesta growing belts of the country

Lack of sufficient genetic base for improvement in productivity and quality

Opportunity

Mesta varieties now can be notified thus paving the way for certified seed production

Whole plant of mesta has been found technically suitable for production of paper pulp; development of varieties suitable for specialty paper pulp is needed

Low cost fibre extractor now available will provide opportunity to ret the fibre in low volume of water and improve fibre quality, and thereby extend cultivation to new areas

Threat

Availability of low cost imported synthetic products

6.2.2.2. SISAL

Strength

Being rainfed crop it may be cultivated in the rainfed regions of the country

It may be grown on undulated lands, lands having multidirectional and steep slopes, thus providing a scope of bringing the unutilized land to cultivation

It may be grown profitably in almost all types of soils including clay, forest and even marginal soils

Yields good returns to the farmers even on poor and waste lands with less inputs and management where other crops can not be grown; there is no insect attack on this crop

Being xerophytic in nature with wide spread root system, sisal checks soil erosion specially in the barren lands and can withstand natural calamities
Sisal Research Station at Bamra (Orissa) is engaged for maintaining germplasm collections of different *Agave* species and supply planting materials for extension of sisal cultivation in new areas
A number of value added uses has been identified and documented

Weakness

A large area is needed for commercial cultivation
Poor and marginal farmers with inadequate resource base cannot provide minimum inputs required for its cultivation
Initial longer time required for economic harvest
Insufficient sisal based small and large scale industries
Unorganized marketing facilities and non existent extension networks
Lack of sufficient genetic base for improvement in productivity and quality

Opportunity

The marginal and dry land giving less than Rs 500 profit per acre annually can safely be brought under sisal cultivation
Sisal crop can help to raise the socio-economic status of the tribals where large areas of land are lying unutilized and unproductive. It provides working opportunities in off-season in remote tribal areas
Sisal based product diversification (handicrafts, floor covers, carpets and low cost composite building materials) is a distinct possibility
Harnessing important secondary metabolites like 'Hecoginine', etc from sisal has bright prospect
Sisal is a good raw material for paper pulp
The country is importing sisal as well as manila fibre of about 4000 to 5000 q to meet the requirement of country's rope industry involving foreign exchange expenditure of about Rs 50 lakhs

Threat

Global competition from African countries
Competition from synthetic based composites

6.2.2.3. RAMIE

Strength

Ramie produces strongest and finest bast fibre of plant origin, well known for lusture, durability, damp and bacterial resistance, amenability to dyeing, colour longevity with repeated washings, and less friction among fibre

Ramie fibre can be easily blended with all types of fibre including other natural fibres like cotton, wool and also with synthetic fibres. Blending ramie with cotton, wool and synthetics provide extra strength to the blend

High fibre yielding variety like R 67-34 (Kanai) released for cultivation

Complete package of practices for cultivation available

Ramie Research Station at Sorbhog (Assam)is engaged for maintaining germplasm collections and supply planting materials for extension of ramie cultivation in new areas

Weakness

Semi-perennial nature of the crop, inadequate germplasm stock has contributed to slow progress in varietal development

Non-availability of fibre extractor (decorticator) machine amongst the farmers

Freshly extracted ramie fibre contains 20 to 30% gummy matters which makes the fibre stiff and creates problem during processing of fibre. The gum content should be reduced to 5-8%

Non availability of eco-friendly, user-friendly and cost-effective degumming method to farmers

Weeding operations are not cost effective

Area under ramie cultivation has been very low and restricted to only certain pockets in North East India

Lack of sufficient genetic base for improvement in productivity and quality

Opportunity

Ramie plantation has been established in Maharastra, Tamil Nadu and Goa outside its traditional growing areas, and may be spread to many other non-traditional areas

The ramie fibre based product diversification range makes an impressive list

Ramie is a good raw material for specialty paper pulp

Low cost fibre extractor machine is now available

Eco-friendly, user-friendly and cost effective degumming technique is now available

Threat

Competition from cotton and synthetics

Lack of enthusiasm among industrial units

No organized marketing system and extension activities

Competition from China

6.2.2.4. SUNNHEMP

Strength

Being a quick growing legume crop, sunnhemp is used both for fibre and green manuring purpose

Sunnhemp Research Station at Pratapgarh (Uttar Pradesh) is engaged for research on all aspects of sunnhemp cultivation

Being cross pollinated in nature, there is scope for utilization of hybrid vigour through development of composite, synthetic and hybrid varieties

A number of value added uses is well known and documented

Weakness

The crop is having strong self-incomapatibility which hinders work on development of pure lines
Low seed setting due to dwindling population of pollinator (bumble bee)
The crop is prone to insect pests and diseases
Lack of sufficient germplasm or genetic base for improvement in productivity and quality, as well as for its performance as a green manure crop

Opportunity

Sunnhemp is a good raw material for hand made and specialty paper pulp
Sunnhemp/cotton blend yarn may be used for producing various value added fabrics

Threat

No organized market and extension facilities resulting in lack of enthusiasm among the farmers and traders
Insufficient sunnhemp based small and large scale industries
Lack of remunerative price for the fibre

6.2.2.5. FLAX

Strength

Flax fibre based product diversification has bright prospect for its inherent good quality which includes softness, luster, flexibility, fineness, durability and strength
Crop duration is only 105-110 days for fibre purpose

Weakness

Flax being a crop of temperate region, in India it can be grown in a very limited area in Himachal Pradesh, hills of western Uttar Pradesh and under hills of North Bengal
Dual purpose varieties could not become popular since neither they produced good quality of fibre nor they give good seed yield
Non existence of scutching facilities in areas where flax cultivation may be taken up
Inadequate germplasm stock for breeding programme

Opportunity

Flax fibre has great demand in the country. India requires around 1200 tons of flax fibre annually and its requirement is mostly by import of raw fibre from Belgium and Holland costing around Rs 300-400 millions per annum
Good quality flax fibre may be produced in the favourable agro-climatic regions of the country

Flax is a good raw material for speciality paper pulp and a number of value added use especially apparel

Motorized and user friendly scutching machine will help extract fibre easily

Threat

No organized market and extension facilities resulting in lack of enthusiasm among the farmers and traders

Global competition from Netherland, Belgium, Russia, Ireland and France

7. PERSPECTIVE

In the context of global awareness for environmental concerns, jute and allied fibres, as eco-friendly packaging materials, are again in the center stage as against synthetic fibres, which are pollutants by nature as claimed by the environmentalists. Commensurate with increasing demand for natural packaging materials (hessian and sackings) for increasing agricultural production and steadily increasing export earnings from jute diversified products (JDPs), we may need to produce around 200 lakh bales (1 bale 180 kg) of jute and allied fibres by 2025 A.D., provided that the ratio of domestic to export markets of jute goods rise from the present 82%: 18% to 65%: 35% and 50%: 50% by 2015 A.D. and 2025 A.D., respectively. During 2005, sacking constituted 62%, hessian 20% and carpet backing cloth 12% of the total jute goods production. Diversified value added products were comprised of decorative fabric (6.9'000 MT), webbing (0.1'000 MT), soil saver (3.9'000 MT), matting (0.9'000 MT), yarn and twine (136'000 MT), and others (11.5'000 MT) in 2004-05, and exported to USA, Belgium, U.K., Turkey, Egypt, Japan, Saudi Arab, Spain, Germany, Italy, Europe, Africa, Australia, Latin America and Middle East. New and new products are expected to be added to this list in the near future. High value new generation products may also be expected to emerge from the application of new frontiers of science, i.e. nanotechnology, biocomposite and by harnessing fine chemicals. Coming to the present, jute geo-textiles are already expected to share a large market shortly. Likewise, there may be huge market for raw jute for pulp and paper if the developed technologies are found commercially viable.

In order to sustain the increasing trend of export earnings from JDPs (Rs. 1200 crores per annum, 2004-05), it is essential to further boost production and marketing of other JDPs as well. Except soil saver, almost all JDPs require better quality fibre (strength, fineness, lusture, colour, etc.), in general, which is already in short supply and the deficit is around 4 lakh bales per annum at present. While R & D efforts will be made, in the first instance, to increase national productivity of jute (22 q/ha to 33 q/ha), mesta (12 q/ha to 20 q/ha), ramie (12 q/ha to 20 q/ha), sunnhemp (6 q/ha to 12 q/ha) and sisal (10 q/ha to 20 q/ha) by 2025, appropriate thrust should also be given for producing better quality fibre (10 lakh bales to 50 lakh bales) by this period. Except sisal, all allied fibre crops are better quality fibre producers. The quality parameters, and the range of target products, however, differ from one to another. Accordingly, more concerted R & D efforts on allied fibre crops assume much greater significance. The bottom line is 'Increase in national productivity and sustained production of quality fibre in jute and allied fibre crops'. In this background, the major imperatives are as follows :

7. 1. Area of cultivation

Jute and allied fibre crops cover around 9.66 lakh ha, which is only 0.15% of the cropped area of the country. There is little chance to increase the area for raw jute (jute and mesta), although there remains a wide scope to increase productivity level and bridge the gap between the potential level and that obtained in farmers' fields. However, there is wide scope for increasing the areas for ramie, sisal, sunnhemp and flax. Therefore, exploring non-traditional areas for this group of crops assumes much greater significance than ever before in the present context of quality fibre production.

7. 2. Exploring areas for flax cultivation

There is great demand for flax fibre in India for value-added (linen based) products. India needs as of now about 1000 tonnes of flax fibre annually, presently imported entirely from Belgium and Holland costing around 400 million rupees in foreign exchange.

The agro-climatic conditions of Kangra valley in Himachal Pradesh are much similar to the requirements of this crop. Different elevations on the Himalayas, mountainous ranges of South India, some districts of North-West of Simla and the Punjab, and a vast suitable tract in indo-gangetic alluvium down upto Bihar should be found suitable for flax cultivation, if other cultivation requirements are available and appropriate, and the expenses of transit are not too high for marketing. Along with sensitization of the farmers timely supply of good quality seeds is to be ensured. Retting facilities and mechanized scutching machines are to be made available. Markets may be established near the growing areas. Policy measures be framed to encourage flax cultivation in India.

7. 3. Germplasm enhancement

Germplasm or genepool is the mother source for all the crop improvement programmes. CRIJAF has a moderate genepool of around 5000 accessions of jute and allied fibre crops, which is neither sufficient in number, nor satisfactory in terms of their genetic variability, for demand-driven research programmes of the future. The same is true for allied fibre crops also. Therefore, germplasm collection from thus far unexplored regions of the country, and particularly the exotic types especially from the centres of origin must be given top priority. Priority-wise direct exploration for exotic types may be launched in countries like Republic of South Africa for jute; Mexico and Brazil for sisal; Mediterranean region, central Asia and near east and other European countries for flax; Eastern Asian countries for ramie, and Zaire and Mozambique for roselle.

7.4. Productivity improvement

Productivity improvement, as envisaged above, may be within the realm of reality in near future. In jute, there is non-uniform productivity in about 87 jute-growing districts under varying agro-climatic regions; only 9 districts have above national productivity (22 q ha^{-1}), and the rest are well below that level. State-wise major jute growing states have productivity level of 24 q ha^{-1}, 17.8 q ha^{-1}, 16.2 q ha^{-1} and 15.4 q ha^{-1} in West Bengal, Orissa, Assam and Bihar, respectively. Similarly, for mesta, it is 13 q ha^{-1}, 13 q ha^{-1}, 12 q/ha, 12 q ha^{-1}, and 8 q ha^{-1}, in Andhra Pradesh, West Bengal, Orissa, Bihar and Assam, respectively. Growth in national productivity for each of the allied fibres is considerably slow, which need to be addressed seriously, and in this context, there is scope to give thrust for alleviation of constraints and thereby increase the yield level in each low productivity zone especially for jute and mesta, in time-targeted manner.

Different genotypes suited to different growing conditions of jute and allied fibre crops are essential to bring in an all round increase in productivity. Apart from genetic enhancement by conventional breeding, molecular breeding would contribute greatly to productivity and lessen cost of production through higher adaptability against major biotic and abiotic stresses. In the same domain of research, harnessing heterosis by exploiting male sterile system and also directed gene transfer from non-conventional source might lead to demand-driven continuous incremental *per se* increase in the current level of productivity.

7.5. Fibre quality improvement

The demand prospect for exportable jute yarn is the brightest spot in export chain. Export of JDPs constituted around 27% of total jute goods export in 2003-04. Amongst JDPs, floor covering was the most dominant (Rs. 95.44 crores in 2003-04), followed by hand and shopping bags (Rs. 95 crores in 2003-04) and home textile made-ups. The export prospect of six major JDPs, as demonstrated through their Compounded Average Growth Rate (CAGR) during the period 1999-04 are : shopping / carry bag, 44%; floor coverings, 24%; geo-textiles, 27%; decorative fabrics, (-)12%, and wall hangings, 7.7%. The CAGR for the total of above exportable 6 JDPs, all exportable JDPs, exportable jute goods, and % share of JDPs to jute goods export are 24%, 25%, 20% and 4%, respectively. Except jute geo-textiles, all the items mentioned above basically require higher quality fibre, which is inadequately available in India.

Two major parameters of fibre quality, i.e. strength and fineness are genetically controlled. For the development of value added product specific varieties, conventional breeding by greater utilization of existing germplasm is one route, while the other would be molecular breeding using short listed germplasm and identification of QTLs (using RILs and NILs) that would enable to tailor quality trait specific varieties more efficiently in the future. The market driven end products need always be of prime concern.

7.6. Degumming in ramie fibre

Quality-wise ramie fibre is best, when degummed, for various value-added textile uses. Standard chemical degumming process is cumbersome, costly, and pollutes the environment. It is most desirable to standardize a microbial method of degumming, which would reduce gum content in ramie fibre to the level of 4-5% from 20-25% present in the raw fibre, which should be economical, eco-friendly and farmer-friendly to use.

7.7. Compulsory jute packaging act

As a measure of support to jute industry, Government of India enacted a special legislation called the Jute Packaging Materials (compulsory use in packing commodities) Act, 1987 under which Government from time to time issues notified order specifying the commodities to be packed compulsorily in jute bags. Currently, the use of jute bags has been made compulsory for packing food grains to the extent of 100% and sugar to the extent of 90%. However, the jute sector can not indefinitely depend upon such a protected marketing condition – dilution of this act is a certainty in future. The industry has to develop itself to withstand the competition being thrown up by synthetics particularly in the WTO regime. Product diversification is one of the major options for their sustenance.

7.8. Remunerative price for better fibre quality

Since the economics of jute and allied fibre crops are entirely market oriented, and the crops are grown mostly by small and marginal farmers, it is essential that the Govt. of India continue to fix Minimum Support Price (MSP) for jute to safeguard the interest of growers. The prices for different grades of fibre be so fixed that would ensure higher price for improved quality, which would encourage the growers to grow higher grade fibres. As such the MSP at present is on the lower side which needs to be enhanced, and the criteria need to be re-looked with careful consideration of cost of cultivation and incentives for higher grade fibre.

7.9. Fibre grades and application areas

In order to simplify the existing fibre grading system for the benefit of farmers and as per recommendation made by CACP (accepted by GOI), specific recommendation for reduction in the number of grades based on scientific logics were made by the expert group to the government for necessary action more than a year back. The following table provides list of end products against each (revised) grade proposed, suggesting the importance of fibre quality.

Proposed grades	Existing grades	End products
TD1/W1	1+2	Fine yarn, specialities, carpet backing cloth, items where fibre quality is important.
TD2/W2	3	Fine yarn, carpet backing cloth, fine Hessian, blended products, items where fibre quality is important.
TD3/W3	4	Hessian warp, fine Hessian, blended products, items where fibre quality is important.
TD4/W4	5	Hessian weft, sacking warp, light sacking wept, blended products.
TD5/W5	6	Ordinary sacking wept, cotton sacking, items where fineness has no impact.
TD6/W6	7+8	Poor sacking, non-wovens, paper and pulp, Geo-textiles, composites etc.

7.10. Quality seed availability

Jute seeds are produced in states (Andhra Pradesh, Maharashtra) far off from major jute growing states (West Bengal, Assam, Tripura, Orissa, Bihar), causing violent price fluctuations at times and also non-availability of seeds in right time. Feasibility of producing quality seed production in jute fibre growing states may be explored to stabilize jute seed market, whenever the situation demands. Hence, policy measures should be so framed that certified seeds cover at least 55% area of cultivation. It is also necessary to take up organized seed production in sunnhemp and ensure availability of sufficient planting materials of sisal and ramie. Proactive policy measures are needed to advocate newly released varieties amongst seed agencies for their acceptance and adoption by the farmers. DUS testing is to be given priority to safeguard the interest of all stakeholders of jute and allied fibre crops.

7.11. Fine tuning of production technologies

Synthetic fibres, the competitors to natural packaging materials, have price advantage. For sustained growth of jute and allied fibre crops, reduction in cost of cultivation is important to ensure higher benefit to farmers, and/or cheaper raw materials (fibre) sought after by the industries made available to them. Jute and allied fibre production is labour intensive. Around 65% of total cost of cultivation of raw jute (jute and mesta) is due to weed management and extraction of fibre by retting. Almost similar are the cases of allied fibre crops, except sisal where retting is not essential. Retting is a natural microbial process carried out conventionally in generally stagnant water bodies containing poor quality water in insufficient quantity. This justifies that these two crucial areas receive top priority for research in crop husbandry. In order to reduce at least 30% of total cost of cultivation; integrated nutrient management (INM) coupled with cost-effective weed management, and improved irrigation management, as well as cost-effective, farmers' friendly, less time consuming, less water dependent module for fibre extraction-cum-retting are of paramount importance and a practical feasibility. So as to make INM more profitable, locally available organic sources, bio-fertilizers, prescription based fertilizer use for targeted yield be given emphasis in right perspective. While ascertaining profitable location specific cropping sequences, gradual changes in climate over the years due to green house effect or otherwise may be considered to safeguard the interest of farmers in exigency situations.

Use of new school of thought to increase productivity of jute and allied fibre crops through Rice Necrosis Mosaic Virus (RNMV) inoculation and development of RNMV – energized commercial seed production are to be given emphasis, more because this technology is less input demanding.

Improved technology package in the lines suggested above, using the appropriate genotypes, though available especially for jute and mesta, needs to be fine tuned for each agro-ecological situation to address for higher productivity and improved quality.

7.12. Crop diversification

In order to make production technology more economically viable, it is essential to introduce additional crops along with the sole crop in the schedule (red amaranth in the early growth phase of jute and mesta to check weeds, legumes between rows of sisal plantation, and medicinal plants between rows of ramie plantation), which would fetch extra income to the growers. The production technologies may accordingly be modified and further developed in farming system mode.

7.12. Stress management

Jute is mostly a rainfed crop because only 20% jute area is irrigated, grown mostly by small and marginal farmers (90%), and almost similar are the situations for allied fibre crops. Jute sowing is done with the onset of Norwest shower, and it is very common that the crop encounters drought at the early growth phase or other critical growth stages, and also during retting following harvest of the crop. It even faces water stagnation in northern and north-eastern belts at critical crop growing phases. Both these situations effect fibre yield and quality.

Amongst all biotic factors, semilooper, yellow mite, root knot nematode, stem rot in jute; spiral borer, mealy bug, foot and stem rot in mesta; top shoot borer, wilt in sunnhemp; mealy bug in ramie are the major ones. Integrated pest management by chemical and biological pesticides need to be location specific. While exploring antagonistic principles, microbes would be better than chemical means, but the best option is to harness genetic potentials for tolerance / resistance to biotic stresses.

In this perspective, needless to mention that, on the one hand, it is necessary that introgression breeding by involving genotypes having tolerance to abiotic stress (drought and waterlogging) and biotic stresses (as mentioned above) by conventional breeding be continued in uninterrupted manner while on the other, molecular breeding (QTLs using RILs & NILs), a potential supplement, may be undertaken for stress management.

The inherent tolerance / resistance to stress will be the most economic component of both INM and IPM (Integrated Pest Management) modules for jute and allied fibre crops.

7.13. Farm mechanization

Since jute and allied fibre crops are labour intensive, it is essential to go for mechanization for major cost involving farming operations. Major areas for interventions are: weed management, sowing and fibre extraction. The machines are to be user friendly, cost-effective, time saving and commercially available at affordable cost.

7.14. Plant ideotype based improvement

Unlike grain crops, economic yield in jute and allied fibre crops is a part of the vegetative biomass. Nevertheless, tailoring of more productive (both yield and quality) plant type, genetic engineering of biosynthesis of fibre mass and up-regulation of cellular and metabolic events leading to finer quality fibre may broadly be short and long-term strategies for yield improvement.

7.15. Functional genomics

Molecular characterization of genes governing economically important traits like tolerance / resistance to biotic and abiotic stress, fibre quality (strength, fineness, cellulose and lignin content), fibre development, and efficiency of retting microbes would ultimately lead to precision molecular breeding. As of now, identification of conserved domains, targeted disruption, complementation, cloning followed by constitutive, tissue specific enhanced expression are all reality in certain important crops, and should be applied for jute and allied fibres.

7.16. Bioinformatics

Being a strong adjunct to molecular techniques, bioinformatics would be helpful to construct database for germplasm accessions of jute and allied fibre crops, based on morphological and molecular characterization done by different DNA markers and EST sequences. With concerted efforts to pyramid genes for productivity, fibre quality and resistance to stress along with location specific crop husbandry, the targeted national level of jute and allied fibre crops may be achieved, for which bioinformatics should be of significant help.

7.17. Paper making from jute and mesta

Raw material crisis is a perpetual problem in paper making. The rampant use of forest, the main source, has a telling effect on ecology. The requirement is ever increasing over the decades. Interestingly, percent share of forest based materials is not increasing (around 53%) but that of agro-based materials increased in the last decade (around 11%). As renewable sources, jute and mesta whole plant or fibre have long been technologically found ideal for making various grades of papers. Economic viability has also been shown as promising in laboratory/small scale. Complete technology is available since decades back. Retting (consuming 30-35% cost of cultivation) can be avoided if whole plants are used. However, two important constraints that need to be addressed are: i) round the year non-availability of jute and mesta, and ii) storage problem of huge volume of biomass. It is, therefore, essential to develop photo-insensitive varieties for round the year raw jute cultivation. A combination of microbial and mechanical method may help overcoming for long term storage in the form of small briquettes to address the latter issue. Apart from jute and mesta, sunnhemp and ramie have also been found extremely promising for high grade papers of specific use.

7.18. By-product utilization

It is well known that huge plant biomass is produced while growing these crops for fibre purpose. Fibre constitutes only 4-6% of the total biomass, while sticks (generally used as fuel source) contribute the most, and the rest (except seed) is never utilized. The available information strongly suggest that these plant parts have got great potentials for product diversification, which are given below apart from those mentioned in the preceding sections:

Crop	Plant parts	Application areas / chemicals
Jute	Seed	Seed oil (8.2 to 11.9%) for industrial uses.
	Leaf, stem, seed, root and whole plant	Direct medicinal uses; contain 18 phamaco- dynamic compounds suitable for drug development.
Mesta	Seed	Seed oil (21.44%) for industrial uses.
	Leaf, stem, seed, root and whole plant	Direct medicinal uses; contain 14 phamaco- dynamic compounds suitable for drug development.
	Calyx	Jam, jelly, sauce, chutneys and natural colours
Jute and mesta	Sticks	Paper pulp, oxalic acid, furfural, charcoal, viscose rayon, Carboxymethyl Cellulose (CMC) & microcrystalline cellulose (MC)
Sunnhemp	Seed	Seed protein as adhesive.
	Leaf, flower, seed, root and whole plant	Direct medicinal uses; contain 5 phamaco- dynamic compounds suitable for drug development.
Sisal	Leaf, juice, root	Direct medicinal uses; contain 17 phamaco- dynamic compounds of great demand.
	Wax	Due to high melting point it has great demand in industries.
	Sap	Pulque beer, brandy, beverage and wine, sugar and medicinal uses.

7.19. Linkage with jute industry

Since jute for fibre and other related industries are the first hand consumers, it is desirable that close linkage between research and industry be made for mutual benefit. Product specific requirements can be judged better by the inputs from the industries, which would help in formulating market driven research through appropriate means. Even the ongoing programmes can be modified according to market needs.

7.20. Linkage between agricultural research and technological research

In the production-consumption chain, there has to be perfect synergy between research units involved in productions of raw fibre as such and those involved in technological processing to manufacture end products, which ultimately go to the market. Since technological processing, by and large, is expected to be dependent on inherent fibre quality attributes, a close system may be developed for complete blending of ideas between the agricultural and technological research units. Incidentally, CRIJAF and NIRJAFT are involved in these two domains of research. Appropriate policy be framed by ICAR to develop a common think tank which should function effectively.

8. ISSUES

Issues	Strategies
Crop improvement for productivity enhancement with special reference to biotic & abiotic stress and quality improvement for targeted quality traits for each jute & allied fibre crops.	Characterization of germplasm both at morphological and molecular level and genetic divergence analysis, evaluation for economically important characters and cataloguing / documentation leading to registration of identified germplasm; genetic resource management with GIS and RS technology.
	Enhanced utilization of germplasm resources through introgression of desirable traits from genotypes of cultivated and wild species; development of pre-breeding materials to broaden the genetic base of cultivars.
	Development of improved varieties through utilization of pre-breeding materials. Integrating marker assisted selection in the conventional breeding programme involving hybridization and mutagenesis to improve its efficacy.
	Exploitation of hybrid vigour for productivity improvement.
	Development of transgenic for resistance to abiotic stress and better quality parameters for diversified uses.
	Genetic manipulation of lignin biosynthesis for achieving improved fibre fineness.
Crop production technologies in farming system mode with special reference to moisture use & nutrient stress in each agro-climatic condition prevailing in jute and allied fibre crop grown areas.	Developing appropriate farming system module, which should be socially acceptable and cost-effective.
	Package of interculture operations with special emphasis on weed management for crops which should be cost-effective and eco-friendly suiting to each agro-climatic condition.
	Soil fertility management with special attention to use locally available organics and biofertilizers in each agro-climatic condition. Attention also to be paid to residual recycling and nutrient balance.
	Water management scheduling under moisture stress for each agro-climatic condition.

	Contingency plan to mitigate yield loss under drought and excess rain conditions.
	Quality disease free and higher seed production technology.
	Use of the new school of thought to increase productivity of jute & allied fibres through RNMV inoculation and develop commercial seed production protocol.
	Crop weather interaction study for forecasting of growth behaviour and yield pattern.
Evolving appropriate plant protection measures for each agro-climatic region prevailing in jute and allied fibre crop grown areas.	Weather based model with refinement for forecasting of important pest & disease outbreak and their impact on crop yield and fibre quality in each agro-climatic condition.
	Systematic characterization and improvement of beneficial microbes through biotechnological interventions for productivity enhancement and quality improvement in fibres for each agro-climatic condition.
	Identification of efficient local strains of antagonistic microbes for disease control, mass scale production of bioagents for productivity enhancement and quality improvement in fibres in each agro-climatic condition.
	Develop a cost-effective, eco-friendly and socially compatible protocol in IPM for productivity enhancement and quality improvement in fibres for each agro-climatic condition.
	Production of healthy jute seed to get quality jute seed to minimize reduction in production and quality besides spread of the disease.
Post harvest operations for improved quality of fibres with special attention to meet industrial demands.	Develop appropriate microbial/ biotechnological intervention for faster and improved retting of jute, mesta, ramie and sunnhemp for quality fibre.
	Biochemical intervention for cost-effective, eco and user-friendly technology for degumming of ramie fibre.
	Develop module for medium and long term quality storage of whole jute & mesta plants to ensure continuous supply of raw material to paper pulp industry.
Mechanization of farm activities for higher productivity and economic return suited to different economic class of farmers.	Design portable machine for fibre extraction, which will be cost effective, eco and user-friendly for each fibre crop.
	Develop wheel-hoe which will be cost-effective and user-friendly, as well as low energy requiring.

	Develop multiple row seeder which will be cost-effective and user-friendly, as well as low energy requiring.
Transfer of technology and human resource development in jute / allied fibre crop grown areas in different agro-climatic conditions.	Technology assessment and refinement in farming system mode.
	Develop protocol for fast and efficient communication linkage on improved technologies among jute/allied fibre grown areas.
	Act as facilitator for entrepreneurship development particularly among women and unemployed youth and economic benefit.
	Determination of contribution of production factors, identification of constrains and impact.
	Identification of farming situations, constrain and development of technology modules for increasing productivity of jute in inefficient zones.
	Documentation of indigenous technologies and its blending with scientific information for development of appropriate technology.
	Human resource development under different agro-climatic condition.

8.1 Strengthening of ongoing research areas

i) Basic and strategic research in frontier areas like genomics, transgenics, inter-specific gene transfer from wild species and marker assisted selection for the desired improvement in fibre quality, resistance/tolerance to biotic and abiotic stress and exploitation of hybrid vigour.

ii) Pre-breeding and enhanced utilization of germplasm leading to broadening of genetic base. Morphological and molecular characterization of germplasm (wild and cultivated species) for IPR protection. Ascertaining DUS to facilitate registration and eventually quality seed production of new jute varieties in the new PVP&FR regime.

iii) Development of location specific and socially acceptable technology package compatible with farming system modules for different agro-ecological situations with special focus on low yielding areas. Package of inter-culture operations with special emphasis on weed management for crops which should be cost-effective and eco-friendly suiting to each agro-climatic condition.

iv) Development of cost-effective and eco-friendly technologies on INM with special emphasis on locally available sources of organic and bio-fertilizers as well as potential of crop / farm residue recycling for jute / allied fibre crop based production system.

v) Water management scheduling under moisture stress for each agro-climatic condition. Contingency plan to mitigate yield loss under drought and excess rain condition.

vi) Developing a mechano-microbial retting technology, which should not only be cost-effective but also less time consuming and eco-friendly, particularly where appropriate retting water is scarce. Development of cost effective and user friendly consortium of retting microbes for the farmers to obtain improved quality fibre. Development of user friendly, cost effective and environment friendly degumming schedule in ramie.

vii) Identification of efficient local strains of antagonistic microbes for disease control, mass scale production of bio agents and biological yield boosters in combination and their popularization amongst the farmers. Formulation, mass scale production and safe packaging of biocides for insect pest management.

viii) Develop a cost-effective, eco-friendly and socially compatible protocol in IPM for productivity enhancement and quality improvement in fibres for each agro-climatic condition.

ix) Exploring the usefulness of the RNMV (Rice Necrosis Mosaic Virus) based technology (utilizing isolated RNMV- induced growth hormone) for higher yield in jute and other bast fibre crops.

x) Technology assessment and refinement in farming system mode under different agro-climatic conditions. Identification of farming situations and constraints, contribution of production factors, impact assessment and development of technology modules for increasing productivity of jute in inefficient zone

8.2 New Initiatives

Plant genetic resources

The status of jute and allied fibre germplasm

The status of jute and allied fibre germplasm CRIJAF collected a moderate size genepool of jute and allied fibres of their own and by joining with the international programme. Nearly 5000 germplasm of these crops have been collected from the country and abroad. The date, exclusive collection of sunnhemp, sisal, ramie and flax germplasm haves not been carried out. Those are collected only at the time of exploration for of jute and mesta germplasm. Therefore, they hardly exceed over 100 in number in each crop.

Areas of diversity of jute and allied fibre crops

Jute and mesta show maximum diversity in Africa while India is a secondary center of diversity. Collection has been made from India and East Africa though Republic of South Africa represents the maximum number of species of jute (*Corchorus*). Sunnhemp (*Crotalaria*) is considered to be native to Indian sub-continent. Sisal (Agave) is native to Mexico and tropical and sub-tripical America. Ramie (*Boehmeria*) is believed to be indigenous to eastern Assia, from Japan to China and Malaysia while flax (*Linum*) is native to Central Asia, Near east and Mediterranean region. But main areas of production of flax lies in Europe and Canada having cooler climate.

Strategy for Indigenous collection

Based on earlier experiences and lessons learnt from the past and ongoing germplasm collection programmes, crop-wise prospective areas are earmarked for future collection programmes.

Crop	Prospective areas for exploration and collection
Jute and mesta	Southern states like Tamil Nadu, Kerala and north eastern states
Sunnhemp	States like Uttar Pradesh, Bihar, Madhya Pradesh, Chhattisgarh, Maharastra, parts of Karnataka, Tamil Nadu, Andhra Pradesh and Orissa
Flax	Central and Western India,
Ramei	Assam, Meghalaya, Arunachal Pradesh, Sikkim, Uttaranchal, Himachal Pradesh (Kangra valley). Tamil Nadu (Nilgiri hills) and western ghats
Sisal	drier region of Orissa, A.P., M.P., Chattisgarh, Hills of Uttaranchal and U.P.

Strategy for Exotic collection

Priority-wise direct exploration may be launched in countries like Republic of South Africa (for jute), Mexico or Brazil (for sisal and other fibre crops) since jute is not cultivated in South Africa.

For ramie, sisal and flax, no organized efforts have been made so far to collect variability from the respective centers of origin (Mexico for sisal; Mediterranean region, Central Asia and near-east and other European countries flax. Eastern Asian countries for ramie, and Zaire and Mozambique for Roselle.

A list of germplasm with trait specificity of different fibre crops and their availability from different countries are provided for initiating future germplasm collection.

Countries of availability for trait specific germplasm of cultivated and wild jute

Species	Traits	Country of availability
C. capsularis	Quality fibre	S. Africa, Tanzania
C. olitorius	Water logging tolerant	Botswana, Senegal, Mozambique & N. Australia
C. angolensis	High yield & quality fibre	Angola & Namibia
C. kirki	Taller plant in wild condition	Botswana, Mozambique, S. Africa & Zimbabwe

C. merxmuelleri	High yield & quality fibre	Namibia, Otijihorongo Reserve & Omaruru
C. tridens	Fine fibre	Ghana, Nigeria, Angola
C. trilocularis	Fine fibre	Mozambique, Malawi, Sudan, Somalia, Zambia & Zimbabwe
C. asplenifolius	Drought tolerant	Zimbabwe, Mozambique, Botswana & Namibia
C. cinerascens	Drought tolerant	Ethiopia, S. Africa & Somalia
C. depressus	Drought tolerant	Ethiopia, Sudan & Mauritania
C. erinoceus	Drought tolerant	Somalia & Sudan
C. erodiodes	Drought tolerant	Socotra
C. junodii	Biotic stress tolerant	Mozambique & S. Africa,
C. pinnatipartitus	Biotic stress tolerant	Botswana & S. Africa
C. saxatilis	Biotic stress tolerant	Zaire & Zambia
C. gillettii	Biotic stress tolerant	Kenya
C. sulcatus	Able to colonize on extremely shallow soil	Zambia and Zaire
C. hirtus	Able to colonize on extremely shallow soil	S.America & Caribbean Islands
C. siliquosus	Able to colonize on extremely shallow soil	Central America

Countries of availability for trait specific germplasm of cultivated Kenaf (H. C. mesta) & Roselle (H. S. mesta)

Species	Traits	Country of availability
H. cannabinus	Early maturing, disease tolerant	Iran, Guatemala, Dahomey, Ivory cost, Nigeria & El Salvador
	Photo-insensitive	Cuba, Guatemala
	Better seed yield	Everglade-52-104, 53-30, 71, 52-119 from S. Vietnam
	Anthracnose resistance	Var.714, 722, 7804 & Qingpi No.3 from China & S. Vietnam
	Early maturing	Var. Cuba 977-044, Cuba 108, 2032 from Thailand
	High yield	Tashkent
	Moderately nematode resistance	Australia and USDA

	Anthracnose resistance and Photo-insensitive	Var. Everglade-52-41, 71, 52-1, Guatemala-2A,38F from Florida (USA) & S. Vietnam
	Higher yield and disease resistance	Var. Sudan early, Sudan late, Sudan – 1from S. Vietnam, Angola, Thailand, &Sudan
	Medium yielder and disease resistance	Var. Suwan from Korea
	High yield and disease resistance	Var. Purja from S. Africa & adjacent countries
H. sabdariffa	High yielder	Var. T-HS-53, T-HS-30, T-HS-24, T-HS-2, T-HS-22 from S. Vietnam
	Dark brown fibre	Var. Phu-Yen from S. Vietnam
	Better fibre yield	Var. Thai Red from S. Vietnam &Thailand
	Better fibre yield	Var. Java-152, 153 from S.Vietnam & Indonesia

Countries of availability for trait specific wild mesta germplasm

Species	**Traits**	**Country of availability**
H. radiatus	High quality and resistance to rot diseases.	India, Bangladesh, Burma & Australia
H. diversifolius	Moderately resistance to root knot nematode.	Africa & Australia
H. acetosella	Resistance to root-knot nematodes.	Angola
H. vitifolius	Drought tolerance & strong silvery fibre.	India, Bangladesh, Sri Lanka & Burma.
H. surattensis	Resistance to root-knot nematode.	West tropical Africa
H. fostellatus	Resistance to root-knot nematode.	West tropical Africa.
H. tiliaceus	Tolerance to swampy condition.	India, Burma, Sri Lanka
H. ficulneus	White and strong fibre.	India

Countries of availability for trait specific germplasm of ramie, flax, sunnhemp and sisal

Species	**Traits**	**Country of availability**
B. nevia (Ramie)	High yield	Var. Pudzone 10, Lembang A, Bandung A from Indonesia
	High yield	Var. Clone 16, 38, 99, 1001 from Malaysia
	High yield	Var. Tej-Hsoem-Tze, Ti-Sham, Tinan, Nanhua, Aho from Taiwan

	High yielder and easily decorticated.	Var. 4-11-30, F-502, F-512, Shirokawa, Murakami (P.I.205492), Tatsutyama, Kuaminami-No.1, Kusminsmi No.2, Kumamoto, Koshin, Tochigi-112, Miyazaku-110 (P.I.87521) Hukuthi, Miyazaku-112, Saikeiscishin (P.I.-159366) from Japan
	Better fibre yield	Mainland China, Brazil, Philippines, Taiwan, Korea and Florida, USA.
L. usitatissimum (Flax)	High yield	France, Netherland, Belgium, Poland and USSR (Eastern part)
Cr. juncea (Sunnhemp)	Nematode resistant cover crop	Var. Topic sun from Florida (USA).
A. sisalana (Sisal)		Mexico, Brazil

Biotechnology

The major future thrust area where biotechnology can intervene should cover each and every aspect of jute and allied fibre crops starting from the germplasm characterization, variety development, input cost minimization to transgenic development and unraveling the genomic blueprint for utilization of potential desired genes. Following are the major thrust areas of research in future biotechnology:

Medium Term Goals

- Characterization of germplasm and varieties of jute and allied fibre crops using molecular markers
- Development of morphological, genetic and molecular linkage map
- Identification of QTLs responsible for yield, fibre fineness and disease resistance
- Improvement of microorganism/consortium involved in retting
- Development of high throughput diagnostics for important diseases

Long Term Goals

- Discovery and characterization/sequencing of candidate gene(s) and tissue specific promoters from substantial collection of jute mutants by microarray approach for quality improvement
- Standardization of *Agrobacterium* or biolistic mediated transformation using non-homologous gene(s) for biotic stress (Fungal, viral diseases, insect pests) tolerance, abiotic stress (drought, water logging) tolerance and herbicide resistance.
- Construction of BAC Library in jute and sequencing

Flax fibre

Importance of flax fibre

Flax, a bast fibre crop, is obtained *from Linum usitatissimum* L. of family Linaceae. This fibre is comparatively non-lignified, soft, flexible and lustrous.

India needs about 1000 tons of flax fibre annually, presently imported from Belgium and Holland costing around 400 million rupees. Fine long flax fibre is used for making canvas, hose pipe, fish net, shoe sewing threads and various other textiles required for defence sector. The demand for flax fibre is likely to be increased particularly in apparel sector in future, because it is more suitable for manufacturing apparel fabrics as well as other value-added products.

Potential areas for flax cultivation

The agro-climatic conditions of Kangra valley in Himachal Pradesh during rabi season are very much similar to the requirements of this crop. Different elevations on the Himalayas, mountainous ranges of the South India, some districts of North-West of Simla and the Punjab may be found suitable for flax cultivation, if other cultivation requirements are available and appropriate, and the expenses of transit would not be too great for marketing.

Crucial issues to be addressed for flax cultivation

Even though there is a good demand for of flax fibre in the country, cultivation of flax is yet to take off substantially. There are several reasons behind this paradox.

Farmers of our country should be sensitized about the bright prospects of this crop. Incidentally, CRIJAF has developed high fibre yielding elite strains from exotic germplasm by selection and hybridization, in addition to production and retting technologies appropriate for our agro-climatic conditions. It is therefore, envisaged that if the growers are encouraged to take interest on this crops and adopt the technologies generated by CRIJAF, gradually the cultivation of flax will snow ball to the extent that India becomes a flax producing country. Along with sensitization of the farmers timely supply of good quality seed of improved varieties / strains requires to be assured. For this purpose organized system of flax seed production and distribution should be developed.
Flax fibre being a raw material of industrial importance, quality standards are to be maintained. Post harvest operations like retting and scutching determine the fibre quality to a great extent. Farmers should be educated properly on these aspects. Critical input like scutching machine and retting facilities should be made available to the farmers with affordable cost.

Assistance in marketing this fibre is also an important basic aspect. Farmers are not aware of the market. Liaison should be developed between the growers and buyers. If necessary, market may be established near the growing regions.

In order to firmly establish the cultivation of flax for fibre, it is absolutely necessary that Government may give every encouragement and help that it is in its power to give, and that what ever may be the nature of encouragement and help, it should not be withdrawn before a reasonable period.

Harnessing productivity in moisture stress and cropping / farming system mode

Future projection of of productivity (as per road map on productivity targets)

	Year 2007	**2010**	**2015**	**2025**
Per unit area (q/ha)	22.5	27.0	32.0	38.0
Per unit time (kg/day)	18.8(110 days)	24.5 (110 days)	29.0 (110 days)	38.0 (100)
Per unit energy (kg/MJ/ha)	0.29	0.35	0.38	0.45

Prospect of plant type based yield breakthrough

Unlike grain crops, economic yield in jute is a part of the vegetative biomass. Nevertheless, technological options to improve the genetic yield level of jute and allied fibre crops would be no different from those of other crops. Tailoring of more productive (both yield and quality) plant type, exploitation of hybrid vigor and genetic engineering of biosynthesis of fibre mass and up-regulation of cellular and metabolic events leading to finer quality fibre are broadly the short and long-term strategies for directed yield improvement.

Manipulation of photosynthetic system

Whatever increases achieve in crop photosynthesis resulting to higher biomass and economic yield have been through promotion of both leaf area and leaf longevity under improved agronomic management. Very little has been done to enhance leaf photosynthesis by manipulation of key photosynthetic enzymes. Several laboratories have demonstrated the possibilities of redirecting biosynthetic pathways through gene transfer technology to make plants produce more biomass and natural products. There is thus tremendous scope to resort to such innovative approaches for directed improvement of economic yield in jute and allied fibres as well.

9. PROGRAMME AND PROJECTS ON TIME SCALE FOR FUND REQUIREMENTS

Programme	Projects on a time scale				Fund requirements	
		2007-2012	2012-2017	2017-2025	XI plan	Total
Crop improvement for productivity enhancement with special reference to biotic & abiotic stress and quality improvement for targeted quality traits for each jute & allied fibre crops.	Characterization of germplasm both at morphological and molecular level and genetic divergence analysis, evaluation for economically important characters and cataloguing / documentation leading to registration of identified germplasm; genetic resource management with GIS and RS technology.				7722 lakhs	57753 lakhs
	Enhanced utilization of germplasm resources through introgression of desirable traits from genotypes of cultivated and wild species; development of pre-breeding materials to broaden the genetic base of cultivars.					
	Development of improved varieties through utilization of pre-breeding materials. Integrating marker assisted selection in the conventional breeding programme involving hybridization and mutagenesis to improve its efficacy.					
	Exploitation of hybrid vigour for productivity improvement.					

	Development of transgenic for resistance to abiotic stress and better quality parameters for diversified uses.					
	Genetic manipulation of lignin biosynthesis for achieving improved fibre fineness.					
Crop production technologies in farming system mode with special reference to moisture use & nutrient stress in each agro-climatic condition prevailing in jute and allied fibre crop grown areas.	Developing appropriate farming system module, which should be socially acceptable and cost-effective.					
	Package of interculture operations with special emphasis on weed management for crops which should be cost-effective and eco-friendly suiting to each agro-climatic condition.					
	Soil fertility management with special attention to use locally available organics and biofertilizers in each agro-climatic condition. Attention also to be paid to residual recycling and nutrient balance.					
	Water management scheduling under moisture stress for each agro-climatic condition.					
	Contingency plan to mitigate yield loss under drought and excess rain conditions.					
	Quality disease free and higher seed production technology.					

	Use of the new school of thought to increase productivity of jute & allied fibres through RNMV inoculation and develop commercial seed production protocol.					
	Crop weather interaction study for forecasting of growth behaviour and yield pattern.					
Evolving appropriate plant protection measures for each agro-climatic region prevailing in jute and allied fibre crop grown areas.	Weather based model with refinement for forecasting of important pest & disease outbreak and their impact on crop yield and fibre quality in each agro-climatic condition.					
	Systematic characterization and improvement of beneficial microbes through biotechnological interventions for productivity enhancement and quality improvement in fibres for each agro-climatic condition.					
	Identification of efficient local strains of antagonistic microbes for disease control, mass scale production of bioagents for productivity enhancement and quality improvement in fibres in each agro-climatic condition.					

	Develop a cost-effective, eco-friendly and socially compatible protocol in IPM for productivity enhancement and quality improvement in fibres for each agro-climatic condition.					
	Production of healthy jute seed to get quality jute seed to minimize reduction in production and quality besides spread of the disease					
Post harvest operations for improved quality of fibres with special attention to meet industrial demands.	Develop appropriate microbial/ biotechnological intervention for faster and improved retting of jute, mesta, ramie and sunnhemp for quality fibre.					
	Biochemical intervention for cost-effective, eco and user-friendly technology for degumming of ramie fibre.					
	Develop module for medium and long term quality storage of whole jute & mesta plants to ensure continuous supply of raw material to paper pulp industry.					
Mechanization of farm activities for higher productivity and economic return suited to different economic class of farmers.	Design portable machine for fibre extraction, which will be cost effective, eco and user-friendly for each fibre crop.					
	Develop wheel-hoe which will be cost-effective and user-friendly, as well as low energy requiring.					

	Develop multiple row seeder which will be cost-effective and user-friendly, as well as low energy requiring.					
Transfer of technology and human resource development in jute / allied fibre crop grown areas in different agro-climatic conditions.	Technology assessment and refinement in farming system mode.					
	Develop protocol for fast and efficient communication linkage on improved technologies among jute/allied fibre grown areas.					
	Act as facilitator for entrepreneurship development particularly among women and unemployed youth and economic benefit.					
	Determination of contribution of production factors, identification of constrains and impact.					
	Identification of farming situations, constrain and development of technology modules for increasing productivity of jute in inefficient zones.					
	Documentation of indigenous technologies and its blending with scientific information for development of appropriate technology.					
	Human resource development under different agro-climatic condition.					
	Fund requirement	7722 lakhs	12962 lakhs	37069 lakhs		

10. LINKAGE, COORDINATION AND EXECUTION ARRANGEMENTS

10.1 Linkages

Linkages or partnerships are needed to be forged to meet the twin objectives of generating knowledge and technology and enhancing the research capability. Objectives can be achieved easily and in relatively less time through collaborative research with the regional, national as well as international institutions. Collaboration with others also has many synergistic benefits viz. speeding the transfer of information and advanced research methodologies, shortening the resources. Ultimately, this makes it possible to disseminate economical innovations to farmers rapidly.

National

Inter institutional research programmes with ICAR Institutes and AICRP centers.

State Agricultural Universities and other Universities for basic and applied research.

National Institute for Research on Jute and Allied Fibres Technology, Kolkata – for developing varieties with good fibre quality and for technological researches on jute and allied fibres, keeping in view the development of value added products.

National Bureau of Plant Genetic Resources, New Delhi

National Research Centre on Plant Biotechnology, New Delhi

National Research Centre for DNA Fingerprinting, New Delhi

Indian Jute Industries Research Association, Calcutta – Fundamental and applied research on jute and its products.

Bose Institute, Calcutta – Molecular Genetics research activities.

Calcutta University, Kolkata

Directorate of Jute Development, Government of India –Government of India – For developmental activities concerning the jute and allied fibres cultivation and application of scientific methods of cultivation both at macro- and micro- levels.

Office of the Jute Commissioner, Ministry of Textiles, Government of India – Cooperating and collaborating on all matters related to the development of jute.

Department of Biotechnology – Biotechnology programmes.

India Meteorological Department, Government of India, Pune – Data processing, training and instrumentation.

REGIONAL

States Departments of Agriculture.

NGO’s

INTERNATIONAL

International Jute Study Group (IJSG), Dhaka.

10.2 Coordination and execution arrangements

Research

Divisions / Sections

Crop Improvement
Crop Production
Crop Protection
Soil Science & Microbiology
Agril. Extension
Agril. Engineering
Agril. Statistics
Agril Meteorology

Scientist In-charge

Sunnhemp Research Station, Pratapgarh, U.P.
Sisal Research Station, Bamra, Orissa
Ramie Research Station, Sorbhog, Assam
Central Seed Research Station for Jute & Allied Fibres, Bud Bud, Burdwan, W.B
Programme Coordinator, KVK, Bud Bud

All India Network Project on Jute & Allied Fibres

Regional Agricultural Research Station, Nagaon
Jute Research Station, Katihar, Bihar
Jute Research Station, Coochbehar
Crop Research Station,, Bahraich
Jute Research Station, Kendrapara, Orissa
B.C.K.V. Main Campus, Kalyani, W.B.
Mesta Research Station, Amadalavalasa
T.N. Rice Research Station, Aduthurai
MPKV, Rahuri
ICAR Research Complex for NEH Region,
Tripura Centre, Lembucherra (Voluntary center)

Technology Mission in Jute (MM I)

University of Hyderabad
University of Kalyani
Orissa University of Agriculture & Technology
Uttar Banga Krishi Viswavidyalaya
Mahatma Phule Krishi Viswavidyalaya
Acharya NG Ranga Agricultural University
Tamilnadu Agricultural University
Acharya N G Ranga Agricultural University, Hyderabad
Viswa Bharati
Calcutta University
Assam Agricultural University
Narendra Deva University of Agriculture & Technology
Central Institute of Research for Cotton Technology

Developmental activity

Directorate of Jute Development, Govt. of India
Department of Agriculture of various State Governments
Office of the Jute Commissioner, Ministry of Textiles, Government of India.
Indian Jute Industries Research Association, Calcutta
Department of Biotechnology, Government of India
National Institute for Research on Jute and Allied Fibres Technology, Kolkata
Department of Science and Technology, Government of India.

Public – private partnership in jute and allied fibre research

The research funds are limited, mostly allocated to public research organization by the government depending on specific research agenda. Private sector R & D, in general, is though guided by immediate profit motivation, an appropriate synergy with the strategic and basic research mode adopted by public sector should be developed to meet the time / targeted objectives. Globalization and free trade would definitely give a fillip to investment in private sector R & D in future. Thus this is the appropriate time for creating a platform for initiating collaborative research programmes for mutual benefit. For such joint efforts; researchable issues, nature of partnership and specific roles of private sector are placed below :

Organizations	**Researchable issues**	**Nature of partnership**	**Specific roles of private sector**
Jute industries	Quality improvement Retting method improvement Mechanical fibre	Joint research funds – like competitive funds; logistic support by private sector for mini-scale experiments and	Providing information on market demands; phase-wise monitoring the progress suitable to technological

	extraction Ascertaining product specific quality parameters Product diversification specially with allied fibres Contract farming	full funds for contract farming	requirements; mutually agreeable IPR issues (credit sharing) and appreciating the unavoidable difficulties to attain deliverables in the biological systems
Paper mills	Pulp and paper making Preservation of raw materials round the year	Private sector to provide funds for raw material development and logistic supports for pilot-scale experiments	As mentioned above
Farmers' organizations	Developing economic package of production and constraint analysis in inefficient zones	Public sector to provide funds and HR; private sector to effectively respond	Frequent holding of joint meetings to overcome the crucial issues at the farmers' fields and provide desired data and other relevant information
NABARD	Front line demonstrations and exploring non-traditional areas	Private sector to provide funds and CRIJAF to provide HR and other facilities	Phase-wise monitoring the progress and holding joint meetings to decide mutually agreeable future course of actions
Seed industries*	Location specific seed production technologies; seed viability and preservation	Joint research funds; private sector to conduct mini-scale experiments	Phase-wise monitoring the progress and highlighting the critical requirements for technology commercialization

* Jute seed market is almost the monopoly of seed traders because public sector has little control over the seed production system. With the lessons learnt from the past experiences on seed market fluctuations, it is desirable that public sector play a proactive role and control while persuing seed research and technology. Appropriate policy and programmes are required for grooming new jute seed production technologies – all for stabilizing jute seed market.

11. CRITICAL INPUTS

11.1. Funds

The programme activities and priorities have already been enunciated in earlier items. In order to undertake these activities, manpower and supporting infrastructural facilities are needed to be strengthened. Moreover, the ageing infrastructures need to be modernized.

Simultaneously, there is an urgent necessity of manpower development by providing appropriate training courses – both long term and short term – of the scientists as well as technicians to achieve the goals / priorities set forth. Further, the HRD has to be continuous education through refresher courses, seminars, workshops etc. to keep them abreast with the latest developments in the research. The renovated and modernized infrastructural facilities will enable the Institute to undertake demanding basic and strategic research during the decades to come. New equipments will be needed to carry out the planned programmes, some old and out dated equipment still need to be replaced.

Supplementary funding through special projects will be sought to provide additional support for germplasm improvement programmes, quality upgradation of raw jute and mesta and other strategic research activities. Programmes on biotechnological research need special and additional financial support to create centralized infrastructure facilities. Staff participation in meetings, workshops and training courses, publications require supplemented financial support.

Estimated financial outlay from 2007-08 to 2024-25

(Rs. In Lakhs)

Year	2007-08	2008-09	2009-10	2010-11	2011-12
Plan	197.48	230.73	276.00	386.30	541.53
Non Plan	997.52	1097.27	1207.00	1327.70	1460.56
Total	**1195.00**	**1328.00**	**1483.00**	**1714.00**	**2002.09**

Year	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019.20 2019-20
Plan	582.44	611.00	629.00	629.00	705.00	790.00	782.00	801.00
Non Plan	1606.52	1767.00	1943.00	2138.00	2352.00	2587.00	2846.00	3130.00
Total	**2188.96**	**2378.00**	**2572.00**	**2767.00**	**3057.00**	**3377.00**	**3628.00**	**3931.00**

Year	2020-21	2021-22	2022-23	2023-24	2024-25
Plan	882.00	970.00	1070.00	1177.00	1294.00
Non Plan	3430.00	3780.00	4140.00	4510.00	4880.00
Total	**4312.00**	**4750.00**	**5210.00**	**5687.00**	**6174.00**

11.2. Manpower

Human resources development must be a major concern for the next decade. Staff must constantly invest in their professional development so as to stay abreast of their disciplines and thereby ensure access to the potential through new science. All research professionals must be sensitized to new developments and their potential applications. This will be achieved through regular updating of senior scientists and bench training of young scientists in the advanced technology available in India and abroad, as well as through regular participation of the scientists in the national and international conferences, seminars, symposia and congress etc. Additional manpower in the form of Research Associates/Fellows will also be deployed.

Revised Scientific Cadre Strength of the Institute (Disciplinewise)

CRIJAF Headquarter, Barrackpore, West Bengal

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	6	2	1	9
2.	Genetic & Cytogenetics	2	1	0	3
3.	Agronomy	4	1	1	6
4.	Agril. Extension	2	1	0	3
5.	Plant Pathology	4	1	1	6
6.	Agril. Ento.	4	1	1	6
7.	Plant Physiology	2	1	0	3
8.	Soil Sc. / Chem./ Fer.	4	1	1	6
9.	Microbiology	1	1	0	2
10.	Farm M / Power	1	1	0	2
11.	Physics	1	0	0	1
12.	Ag. Statistics	1	0	0	1
13.	Computer Appl.	0	0	0	0
14.	Ag. Meteorology	0	0	0	0
15.	Nematology	2	0	0	2
16.	Eco-Botany	1	0	0	1
17.	Biotechnology	1	0	1	2
18.	Biochemistry	1	1	0	2
19.	Ag. Chemistry	0	0	0	0
SUB TOTAL		37	12	6	55

S.R.S., Bamra, Orissa

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	0	0	1

2.	Agronomy	1	0	0	1
3.	Pl. Pathology	1	0	0	1
4.	Soil Sc. & Chem.	0	0	0	0
SUB TOTAL		3	0	0	3

A.I.N.P. & J. A.F., Barrackpore

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	0	1	0	1
2.	Agronomy	1	0	0	1
3.	Ag. Statistics	1	0	0	1
4.	Eco-Botany	1	0	0	1
5.	Project Coordinator	0	0	0	0
6.	Pl. Pathology	0	0	0	0
7.	Soil Sc. / Chem	0	0	0	0
SUB TOTAL		3	1	0	4

R.R.S., Sorbhog, Assam

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	1	0	2
2.	Agronomy	1	0	0	1
3.	Pl. Pathology	1	0	0	1
4.	Soil Sc. / Chem	0	0	0	0
SUB TOTAL		3	1	0	4

Sh.R.S., Pratapgarh, U.P.

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	1	0	2
2.	Agronomy	1	0	0	1
3.	Agril. Ento.	1	0	0	1
4.	Microbiology	1	0	0	1
5.	Pl. Pathology	1	0	0	1
SUB TOTAL		5	1	0	6

CSRSJAF, Bud Bud, Burdwan

Sl. No.	Discipline	Scientist	Sr. Scientist	Pr. Scientist	Total
1.	Plant Breeding	1	0	0	1
2.	Seed Tech.	1	0	0	1
SUB TOTAL		2	0	0	2
GRAND TOTAL		**53**	**15**	**6**	**74**

NOTES :

1. By the year 2008 nearly ninety percent of the existing scientists particularly those in the Principal Scientist cadre will reach superannuation. This will necessitate a thorough alteration of the present composition of the existing cadre among the different disciplines. In this category total strength has been proposed to remain same, while the distribution among the disciplines along with inclusion of some new disciplines have been proposed with due weightage to new areas of work being proposed in the Perspective Plan.

2. For technical, administrative and supporting activities, the cadre strength would remain same as of now. Early action would be taken for filling up the posts of scientific manpower as has been proposed.

11.3. Human resource development

Training of manpower in frontier areas of science and technology to develop capabilities for undertaking basic research in areas of genomics, transgenics, bioinformatics, interspecific gene transfer from wild species and marker assisted selection for the desired improvement in fibre quality, resistance/tolerance to biotic and abiotic stress, exploitation of hybrid vigour, for research on applications of GIS and RS technology and for addressing bioethics, IPR issues and for development of appropriate technology will be undertaken. This will be achieved through regular updating of senior scientists and bench training of young scientists in the advanced technology available in India and abroad, as well as through regular participation of the scientists in the national and international conferences, seminars, symposia and congress etc. Additional manpower in the form of Research Associates/Fellows will also be deployed.

For capacity building in emerging areas like genome sequencing, molecular breeding, *in vitro* techniques, input use efficiency, quality analysis, isotope analysis and carbon partitioning, microbiology , GIS and crop modeling the detailed training programmes are given below

Training of Scientists in Different Disciplines

Sl.No.	Training Area	Discipline	Duration	Justification

1.	Plant Transformation technology using vector system, Genetic marker technology, Peptide display analysis, Gene expression system, Antiviral protein, DNA fingerprinting, Expressed Sequence Tag, DNA micro-arrays, Proteomics, Functional Genomics	Biotechnology, Crop Protection, Genetics	6 months to 2 years	As the present thrust area is on development of transgenics against biotic and abiotic stresses. Nothing is known about the genomics of jute, so for better utilization of jute it is essential to give thrust on these newly evolved technologies.
2.	Marker assisted selection and QTL analysis	Plant breeding Biotechnology, Crop Protection, Genetics	6 months to 2 years	The working knowledge on genetic marker technology is required to identify genetic diversity and to identify QTLs for fine quality fibres and other desirable traits
3.	Signal transduction in host : pathogen interaction	Crop Protection	2 years	As the present work on RNMV technology required the complete understanding on the basis of the host : pathogen interaction
4.	Bio-computing and Bioinformatics	Biotechnology, Crop Protection, Genetics	6 month	It is necessary to interpret correctly all the sequence information data of both plant and pathogen origin for successful utilization of generated data
5.	Remote Sensing and GIS (Mapping, Trend analysis, Biometric modeling)	Agronomy, Soil Science, Crop Protection	6 months	No work has been carried out regarding the area mapping, disease mapping, soil profile analysis on jute through remote sensing. These are very much essential to develop any biometric forecasting model
6.	Advance method of soil testing	Agronomy, Soil Science	6 months	A new method of soil testing is required as they are more accurate and less cumbersome. This training will be helpful for exploration of soil parameter for development of

				sustainability indicator
7.	Soil and water management	Agronomy, Soil Science	6 months	Jute crop is very much sensitive to soil and water management. Training on this field will help in exploitation of newer technology for its cultivation
8.	Computer training on Expert system development, Neural networking, Prediction system development	Crop Protection, Extension, statistics	6 months	For dissemination of scientific knowledge and technology (Pest and Disease management strategies, forecasting of pest and disease incidence) to the cliental this training will be helpful.
9.	Methodology of constraint analysis	Extension	3 months	It is essential to know the constraints for adoption technologies by the farmers to help development of appropriate technology.
10.	Methodology of impact assessment	Extension	3 months	The Institute is conducting research and demonstrations under on-farm conditions, the impact of which is essential to know that can help to give direction in technology development and dissemination.
11.	Methodology of project evaluation	Extension	3 months	The programmes conducted by the Institute need to be evaluated for its ultimate outcome by adopting appropriate methodologies.

a) Infrastructure facilities:

There is a need for creating necessary infrastructure facilities so that in next 10 years plant breeders are able to use marker assisted selection and QTL analysis in the improvement of jute and allied fibre crops. Strengthening of infrastructure and human resources for undertaking research on quality traits in jute and allied fibre crops especially for developing simple, rapid, reliable techniques for high throughput screening of germplasm for quality characters in breeding programme and for identification, validation and utilization of molecular markers for genes controlling quality characters is most important. Institutional infrastructure with respect to transgenic development and biosafety testing has to be strengthened in consonance with the identified priorities. Attempt should be made to consolidate the facilities and to build up technological capabilities. There is a strong need to strengthen research capabilities and HRD in organic farming.

Establishment of the following facilities for undertaking research utilizing cutting edge technology is being pursued

i) Centralized facilities for undertaking research on biotechnology of jute and allied fibre crops
ii) Fibre quality testing laboratory
iii) DUS testing facility
iv) Water management laboratory
v) GIS laboratory
vi) Soil water plant consultancy laboratory
vii) Controlled retting facility

12. RISKS ANALYSIS

A) Risk involving the Institute / ICAR

Labour intensive high cost inputs and low remunerations may discourage farmers to continue jute cultivation. Need to reduce the cost of cultivation through development of location specific cost effective and user friendly production practices.

New generation farmers may be averse for traditional retting method due to drudgeries. Necessary to develop user friendly cost effective retting method in limited water.

Inappropriate use of pesticides may affect the health of farmers and their families and that the net returns from pesticides use may be negative when health costs are included. Integrated pest management using bioresources is needed to be developed for minimal pesticides usage.

Increasing demand for quality raw jute. It is necessary to develop location specific varieties yielding good quality fibre.

B) Risk involving the cost

Jute and allied fibre crops cultivation may be forced out of traditional areas due to low returns. Need to evolve cropping systems for increasing the overall annual returns to farmers.

Stiff competition from cheaper synthetic substitutes is being faced by jute. Need to arise consumer awareness and preference for biodegradable materials like jute and mesta for developing value added products.

13. REVIEW

Review, reporting and evaluation of projects are the important elements of any research. Project review and evaluation are multifaceted approaches. Review is the processes through which one has to keep track of changes in the significant elements of the operating environment of the continuing relevance of the goals and their importance with respect of one another of the resource flows and the extent of the impact of the researches. For resources flows, budgets and other sources of information determine the judicious use of resource allocations in accordance with the priorities established.

Project review should be carried out at regular intervals by DRC, SRC, Research Advisory Committee and Management committee. Project reporting should manifest as monthly reports, quarterly reports, annual reports etc.

Evaluation is the process to judge the quality of efforts, the rate at which progress is being made and whether the objectives are being achieved; which simply implies having objectives against which to measure progress of the project.

Project evaluation should be carried out in order to (i) re-allocate resources / funds to different components of the project, (ii) Modify the original goals and schedule, if necessary, (iii) Change the priority of the project if needed, (iv) Terminate the project if objectives are achieved. The evaluation of projects may be done by independent consultants i.e. by a panel of experts; by a team of scientists from other organizations / Peer Review or QRT.

Project reporting should be in the form of monthly reports, quarterly reports and annual reports which may be circulated to members of the bodies (RAC / MC etc.). Publishing will be an explicit reference point in establishing the performance objectives. However, it is pertinent to note that good applied science can be done with less emphasis on publishing. It is essential to seek a balance between conducting useful research and publishing its results. A boundary line be considered for the publications of inventions so as to protect the IPRs.

14. RESOURCE GENERATION

(Rs. in Lakhs)

Sl. No.	Name of Plan	YEARS					TOTAL
		1997-98	1998-99	1999-00	2000-01	2001-02	

1	IX th Plan actuals	23.48	12.46	14.81	18.86	12.89	**82.50**

Sl. No.	**Name of Plan**	**YEARS**					**TOTAL**
		2002-03	**2003-04**	**2004-05**	**2005-06**	**2006-07**	
2	X th Plan actuals	13.84	13.58	24.23	17.20	19.80	**88.65**

Sl.No.	**Name of Plan**	**YEARS**					**TOTAL**
		2007-08	**2008-09**	**2009-10**	**2010-11**	**2011-12**	
3	XI th Plan Projection	18.00	19.00	20.00	21.00	22.00	**100.00**

15. OUTPUTS

Jute has been under cultivation in this country for nearly two centuries now. Raw jute consisting of jute and mesta has been traditionally in use as a source of raw material for packaging industry only so far. In the recent times, its importance as a versatile source for diversified application, in the textiles industry, in the paper industry, in building & automotive industry, as soil saver, as decorative & furnishing material, etc. has been recognized and its demand in a number of countries is on the rise at an increasing rate. Nearly about 12% of the jute products are commercially being exported from this country to about 120 countries in the world. It earns foreign exchange of about Rs. 1000/- crores per annum and the trend is on the increase. In case of allied fibre crops, ramie, in particular, has been identified as one of the finest vegetable fibres for using fabric & apparel industry, cordage industry, hose pipe, water bags, as well as in pharmaceutical & chemical industry. Sisal is another allied fibre crop useful for items like rope, fancy fibre articles and number of other items for agriculture & domestic uses, as well as in pharmaceutical & chemical industry. In the field of jute and allied fibres, apart from their use in hessian and sacks as packaging materials, no other value added use, except in very recent time, has been commercially explored. The main advantages are that these natural products are biodegradable and renewable, and in that sense, highly cost-effective.

Following are the areas in which CRIJAF made progress towards commercialization in the past:

1. Seeds of jute and allied fibre crops having higher productivity and improved quality.

2. RNMV inoculated (energized) jute seed viz., 524-E with higher productivity and lesser input requirement.

3. CRIJAF Bast Fibre Extractor to facilitate machine retting with much less cost involvement.

4. Decorticator for fibre extraction in sisal and ramie.

5. Eco-friendly and cost-effective technology for degumming of ramie fibre.

6. Neem-based biocides and IPM package for cost-effective and eco-friendly pest and weed management.

7. Protocol for tissue culture in sisal

Products/process under development :

i. Molecular marker development (RAPD, AFLP and STMS) for jute diversity analysis has been initiated which will prove its usefulness in future marker assisted selection programme for desirable traits like fibre fineness in jute.

ii. Quick and reliable diagnostic tools (radiolebelled probe, PCR based tool and serological kit) for identification of geminivirus involved with yellow vein mosaic disease of mesta (*Hibiscus cannabinus* and *H. sabdariffa*) is under process of development and validation.

iii. Lignin is a limiting factor for obtaining fine fibre quality in jute. Correlation between lignin and peroxidase has been found and a serological diagnostic kit for direct quantification of peroxidase has been standardized.

iv. Identification of key molecule/element for RNMV induced growth promotion has been undertaken which will prove its usefulness in future for commercialization.

v. Characterization of different bio-control agents in respect to their efficacy has been undertaken which will be helpful for identification and development of more efficient strain in future.

vi. Degumming of ramie fibre and retting of jute fibre with enzymatic intervention have been started which have prospect for commercialization in future.

16. OUTCOME

Marketing raw jute fibre and products -- emerging issues, future demand–supply situation and the imperatives

In its journey for about 160 years, jute market has faced many ups and downs because of fluctuating prices. Various government policies and assistances have always been launched at different stages to stabilize the market, so much so that, jute industry, except a handful few, never came out of conservative managerial mind-set, because profit remained almost assured even without going for industrial modernization. Naturally into this gap, came the synthetic fibre in the packaging trade initially slowly during seventies, and then made its presence felt from eighties onwards, and invaded the market forcefully so much that jute fibre has already lost the cement segment. Lackadaisicalness of jute industry has been ill paid, market situation becoming more and more tentative and without vision. Fresh initiatives are must for the turn around of jute market since the raw jute (jute and kenaf) sector should not indefinitely depend upon a protected marketing condition provided by a special legislation called the Jute Packaging Materials (compulsory uses in packaging commodities) Act, 1987. It has to develop itself to withstand the competition being thrown by man-made (synthetic) fibre in the packaging trade.

In efforts to revitalize the jute market, most important is the fact that the products (both fibre and goods) are to be cost and quality competitive to those of synthetic fibre in domestic and international markets based on its inherent strength. Fibres basically being eco-friendly in production, annually renewable, biodegradable having low extensibility, high frictional resistance and flexibility, offer various inherent advantages over synthetic fibre, which is however cheaper and possibly more design friendly. For increasing global export market share and domestic consumption, the future marketing policies for this family of natural fibres be so framed that it gets an edge while countering the inroads already made by synthetics in the trade. Important considerations for this purpose are given below :-

i) The proper marketing strategies should lead to more and more consumption of these fibres and products at remunerative prices to create interest amongst the growers to produce more, and of better quality.

ii) Existing marketing facilities are grossly inadequate to properly sell huge quantities of fibre grown by the farmers and also the products produced by the organized sector and unorganized sector. Nevertheless, the industry must modernize and upgrade their machineries to a certain level so that the product cost become less and able to mitigate the threat of competition from synthetic fibres. This crucial issue has remained overlooked for long.

iii) Separate marketing strategies are to be developed for domestic and export markets, so that the ratio of domestic to export markets rise from the present 82% : 18% to 65% : 35% and 50% : 50% by 2015 and 2025 years, respectively. Exportability in most cases determines its values in the background of present economic conditions, particularly globalization or open trade policies.

iv) In order to boost export earnings, sprut in marketing efforts and level of research efforts on ongoing product diversification is called for. Existing various market promotion and market development activities related to priority diversified product category at the moment includes : jute yarn, shopping and carry bags, food grade jute bags (FGJP), jute / jute blended floor coverings, hessian, sacking and CBC, gift articles and life style products. New and new products are expected to be added to this list in the near future. Jute geotextiles is expected to share a large market very shortly. Likewise, there may be huge market for raw jute for paper and pulp if the technologies claimed to have been developed are found commercially viable.

v) Quality assurance capabilities for both fibre and products should be adequate. The issue of quality standards and assurances for jute products are becoming more and more important, both in export and domestic markets. This is more relevant in cases of quality yarns and diversified products.

vi) Market intelligence service through collection, compilation, analysis and dissemination of information and sponsoring market research – an area that has never been touched upon.

Generic issues relating to market promotion and development

Besides various product specific export promotion activities, the following generic issues are also to be reckoned with :-

Life cycle analysis to increase its competitiveness.

Negating the impact of 'green house gases' is of worldwide concern – the inherent advantages of jute and allied fibre plants open the possibility of jute industry's participation in the carbon credit trade while setting up disposal protocol of products.

Generic campaign with the cutline 'say yes to jute' should be persued more vigorously.

Impact assessment and steps for removal of Tariff and non-Tariff barriers be analysed.

IPR issues need to be appropriately tackled.

Increasing consumer awarness and highlighting environmental advantages. There is no visible cooperative effort from industry-side to promote the image of Indian jute goods in the world market.

Launching, continuation and implementation of different incentive schemes meant for diversified products and jute goods, in general, should continue in the coming decades. At present, such schemes are : jute service scheme, jute raw material bank scheme, market support scheme, jute entrepreneurs assistance scheme, micro-finance scheme, external market assistance scheme and duty entitlement pass book scheme.

Demand – supply projection of raw jute

Keeping above facts and projections in consideration along with the present trends of growth in fibre production, national productivity, jute goods production and its status in jute industries and decentralized sector in the last five decades, demand – supply projection of raw jute fibre for the next two decades may be made as follows:

In lakh bales (1 bale = 180 kg)

	2006-07	**2007-08**	**2008-09**	**2009-10**	**2010-11***	**2011-12**
Demand	102.0	110.0	116.0	122.0	128.0	134.0
Supply	105.0	110.0	115.0	120.0	125.0	130.0
Opening Stock	10.0	13.0	13.0	12.0	10.0	7.0
Closing Stock	13.0	13.0	12.0	10.0	7.0	3.0

	2012-13	**2013-14**	**2014-15****	**2015-16**	**2016-17**	**2017-18**
Demand	140.0	146.0	150.0	154.0	158.0	162.0
Supply	135.0	140.0	145.0	150.0	155.0	160.0
Opening Stock	3.0	-	-	-	-	-
Closing Stock	(-) 2.0	(-) 6.0	(-) 5.0	(-) 4.0	(-) 3.0	(-) 2.0

	2018-19	**2019-20*****	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**
Demand	166.0	170.0	176.0	182.0	188.0	192.0	198.0
Supply	165.0	170.0	175.0	180.0	185.0	190.0	195.0
Opening Stock	-	-	-	-	-	-	-
Closing Stock	(-) 1.0	-	(-) 1.0	(-) 2.0	(-3.0)	(-) 2.0	(-) 3.0

N.B. : Domestic consumption should maintain steady growth althroughout and global export share must increase more than the present level. It may also be noted that there is expected to a big gap between demand and supply of raw materials to the industries in the near future. Therefore, the growth in fibre production vis-à-vis national productivity must be substantially increased to meet the growing demand. Use of raw jute for paper and pulp has not been included.

* Increased production of non-wovens, geo-textiles and composites for automotives is anticipated.

** Arrival of new diversified products in the trade, which are now showing promise.

*** Arrival of new innovative products where bulk consumption of fibre is expected e. g. nano-composites & bio-composites.

Export potential and marketability of research output and its impact in WTO regime

Existing various incentive schemes for market promotion and market development activities have although made a good beginning in the last decade, what remains to be ascertained in the future is the identification of product-wise weakness in the supply chain, and appropriate measures to overcome these limitations. This platform does not allow space to discuss these aspects in detail. Nevertheless, all the efforts should be directed to enhance the export of jute products, particularly for those proved favourable in the export chain, the list is given below :

Sl.No.	Focus products	Target markets
1	Yarn	Belgium, Turkey, Spain, Egypt, Saudi Arabia, Morocco, Algeria and China
2	Food grade jute products	Africa, Latin America, UAE, Argentina and Turkey
3	Shopping & hand bags	USA, Germany, UAE and Japan
4	Floor coverings	USA, UK, Germany, France, Italy and Netherlands
5	Specialty hessian & value-added jute fabrics	USA, Germany, UK and UAE
6	Soil saver	USA and Western Europe
7	Home textiles, Made ups, Gifts and Life style products	USA, UK, Germany, France, Italy and Netherlands

Quality yarn, blended yarn (jute / allied fibres), jute geo-textiles and food grade jute products (hydrocarbon free) have great potentials in both domestic and international markets. Fine yarn weighing less than 12 lbs for manufacturing floor coverings, fabric and other diversified products merit special consideration in R & D sector.

Provided that the market needs in terms of cost, quality and delivery of established jute diversified products are met satisfactorily by Indian producers and suppliers, and technological developments are properly backed by sustained and concerted research policies and efforts in the coming ecades; development and commercialization of various categories of diversified products may be envisaged as follows :

Period	Diversified products in export chain / domestic market
Upto 2010	Fine yarn and blended yarn, shopping & carry bags, floor coverings, geo-textiles, speciality packaging and industrial textiles.
2010 - 2015	All the above items, paper and pulp, composites (particle board, door compontnts etc), speciality composites for automotives, non-woven

	products, pharmaceuticals, industrial chemicals, seed oil etc.
2016 - 2025	All the above items, bio-composites, nano-composites, ligno-cellulose based speciality products.

In line with the continuous efforts on competing systhetic fibre, the major imperatives for the growth of jute and allied fibres are :

Improvement in agricultural research and fibre processing of technologies, up gradation of industrial technologies and their machineries, for cost reduction of fibre and products, quality improvement of fibre and products, bridging of the gap between future demand and supply, and quick response to market needs in case of various product categories.

For the increasing demand of quality fibre for diversified products, concerted approaches to increase the share of allied fibres in the raw jute trade are required. Biotechnological methods for quality improvement *per se* or by improved retting methods are to be adopted.

Even though important parameters of fibre quality of allied fibres like ramie, sisal and flax are better for manufacturing certain diversified products, but their production in India have not been at all satisfactory. Against world production of about 3 lakh Mt ramie fibre, 0.25 lakh Mt sisal fibre and 0.0004 lakh Mt flax fibre, India contributes only 75 t ramie fibre and 2500 Mt sisal fibre while flax fibre is totally imported costing around 400 million rupees. Demand for quality fibre is on the rise, thus improvement in R & D and creating marketing facilities for these fibres is the immediate need.

Although pulp and paper making from raw jute plant or fibre is a prospective possibility, its commercialization needs integrated approaches.

Development of new plant or fibre based products for certain specific applications.

Aggressive strategies for marketing, specially for creating a new "brand" image of jute.

Sustained investment on R & D and HRD.

Effective public-private partnership approach in all the above area.

The bottom line is product diversification and must be the principal focus for increasing the global market share, which, in turn, demands that (i) organized jute industry should be more responsive to this consolidating phenomenon, (ii) the overall pattern of product manufacturing should be changed as shown below :

Sl. No.	**Product category**	**Present mix**	**Future mix**	
			2010	**2025**
1	Sacking	62%	35%	25%
2	Hessian	20%	15%	15%
3	Yarn	6%	15%	15%
4	Jute diversified products and	12%	20%	25%

	pulp & paper making			
5	Non-conventional value-added products (like Technical textile)	0%	10%	10%
6	Composites	0%	5%	5%
7	New products	0%	0%	5%

17. SCIENTIFIC DIVISIONS

INSTITUTE MANAGEMENT COMMITTEE → **DIRECTOR** ← RESEARCH ADVISORY COMMITTEE

DIRECTOR

- **DIVISIONS / SECTIONS**
  - Crop
  - Crop Production
  - Crop Protection
  - Agril.
  - Agril. Statistics
  - Agril. Extension
  - Farm Machinery &
  - Biotechnology
- **AINP on J&AF**
  - **Collaborating Centres SAU-based (9)**
    1. Regional Agricultural Research Station, Nagaon
    2. Jute Research Station, Katihar, Bihar
    3. Jute Research Station, Coochbehar
    4. Crop Research Station,, Bahraich
    5. Jute Research Station, Kendrapara, Orissa
    6. B.C.K.V. Main Campus, Kalyani, W.B.
    7. Mesta Research Station, Amadalavalasa
- **TECHNOLOGY MISSION ON JUTE**
  - **Collaborating Centres (13)**
    1. University of Hyderabad
    2. University of Kalyani
    3. Orissa University of Agriculture & Technology
    4. Uttar Banga Krishi Viswavidyalaya
    5. Mahatma Phule Krishi Vidyapeeth
    6. Acharya NG Ranga Agricultural University
    7. Tamilnadu Agricultural University
    8. Andhra Pradesh Agricultural University
    9. Viswa Bharati
    10. Calcutta University
    11. Assam Agricultural
- **KRISHI VIGYAN KENDRA.**
- **RESEARCH STATIONS**
  - Sisal Res. Station,
  - Sunnhemp Res. Station,
  - Ramie Res Station, Sorbhog
  - CSRS for J&AF Budbud
- **SERVICES**
  - Library
  - Research Management
  - Administration
  - ARIS Cell
  - Official Language Cell
  - Farmers' Sample Testing &
- **COMMITTEES**
  - Institute Research
  - Institute Research
  - Grievance Cell
  - Women's Cell
  - Welfare Committee