वार्षिक प्रतिवेदन
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2014-15

ICAR-Central Research Institute for Jute and Allied Fibres
Barrackpore, Kolkata - 700120, West Bengal
(An ISO 9001:2008 Certified Institute)
www.crijaf.org.in

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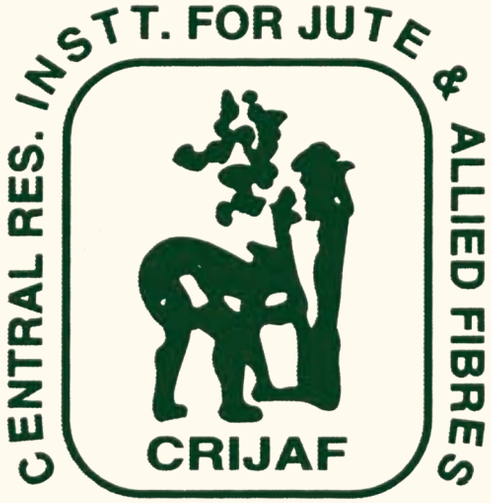

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Front cover: Centre: Jute fibre, Clockwise: Inflorescence of sunnhemp, ramie and flax

Back cover: Centre: Transverse section of jute stem, Clockwise: Secondary somatic embryo of jute, stem rot lesions, mealybug and its parasitoids

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Contents

Preface

Jute and allied fibre crops are versatile natural bast fibre yielding crops with considerable commercial, environmental and socio-economic importance having multifarious end users, mostly grown in the tropical and South-East Asian countries. India is the single largest producer of jute goods in the world, contributing about 60% of the global production which has made impressive strides on the front of jute productivity. In our journey towards achieving excellence in research and development for improving the productivity and profitability of jute and allied fibre crops, ICAR-Central Research Institute for Jute and Allied Fibres (ICAR-CRIJAF) could successfully reorient the research programmes, upgrade the facilities, improve the linkages and emphasized the capacity building of human resources to harness the institutional objective in totality. During last one year, the institute has developed many farm-worthy technologies to further enhance the growth of productivity of the mandate crops. Continuous effort of this institute could maintain the raw jute production of 11.4 million bales per annum.

The diversity in the pool of wild accessions of jute species was enhanced through a fruitful exploration in Southern Odisha. Comparatively less flowering of 11 *tossa* jute mutants consistently for 3 years may make some headway in the development of premature flowering resistance. A high-density RAD-seq-based single nucleotide polymorphism linkage map has been constructed for jute using an intraspecific biparental mapping population. A unique trait of histological fibre content and its genetic architecture have been resolved. This population may be used for molecular tagging of useful genes underlying abiotic stress tolerance. *De novo* transcriptome sequencing and analysis of bast tissues identified genes was done and pathways associated with lignin biosynthesis in lignocellulosic jute fibres has been resolved. In the front of varietal development, 3 varieties i.e., JROG 1 of *tossa* jute, JRJ 610 of sunnhemp and JRF 2 of flax have been released. JRF 2 is the first released variety of fibre flax. Besides, two varieties of kenaf i.e., JMBG 4 and Central Kenaf JBMP-2, four varieties of roselle i.e., Central Roselle JBRP-1, Central Roselle AMV-9, CRIJAF R-2 and CRIJAF R-8 were identified for release.

The popularization of microbial consortium-mediated jute and mesta retting technology was the flagship promotional programme which could be successfully implemented through 800 multi-locational demonstrations. The jute cultivar, Tarun (18.1 kg fibre/kg N) showed highest agronomic nitrogen use efficiency. The sustainable yield index of jute and rice was maximum in jute-rice-garden pea and jute-rice-babycorn-jute (leafy vegetable) sequence respectively. These technologies will certainly evolve the ways for economic and sustainable production of jute. The research programmes undertaken on pest and disease management could establish the mechanism of resistance against Bihar hairy caterpillar, the EIL-based insecticide spray optimization for control of jute pests, antagonistic and growth promotional potential of native *Trichoderma* strains and new entomopthogenic fungus of mealybug. Differentially expressed gene encoding regions were used to design primer sets to identify stem rot resistant varieties of jute.

The institute has made a good start by publishing the hindi magazine *"Resha Kiran"* as a step forward towards popularizing CRIJAF technologies in hindi. The promotional and outreach programmes of the institute got new thrust through ICT-based extension services. By incorporating new technologies for diversified crops and allied agricultural activities in jute-based cropping system through TSP generated positive impacts on the livelihood of the tribal groups. Gender mainstreaming was emphasized through various women-centric activities. The institute's performance was recognized in various forums which could earn awards for the scientists and ICAR championship for the volley ball team.

I acknowledge the efforts of the scientists of ICAR-CRIJAF who have done a commendable job to accomplish the volume of research and documentation work successfully. I sincerely express my acknowledgement to the Chairman and members of Research Advisory Committee for valuable suggestions in shaping the research programmes of the institute. I am grateful to Dr. S. Ayyappan, Hon'ble Secretary, DARE and Director General, ICAR for his leadership and direction. I express my sincere gratitude and thanks to Prof. S. K. Datta, Former Deputy Director General (Crop Science) and Dr. J. S. Sandhu, Deputy Director General (Crop Science), Dr. N. Gopalakrishnan, Assistant Director General (Commercial Crops), Indian Council of Agricultural Research, New Delhi for their constant encouragement and support.

P G Karmakar 8/6/15

Place: Barrackpore
Date: 08.06.2015

(P. G. Karmakar)
Director

Executive Summary

Crop Improvement

- A total of 103 accessions including wild and cultivated species of jute and allied fibre (JAF) crops *i.e.*, *C. aestuans* (43), *Boehmeria* spp. (25) *C. olitorius* (24), *H. sabdariffa* (05), *Urena* spp. (01), other fibre spp. (03) have been collected and 1165 accessions of *C. capsularis* (956), *H. sabdariffa* (59), *H. cannabinus* (67) and wild species (83) were regenerated. Newly collected 146 accessions have been characterized for different morphometric traits and 180 accessions of jute were evaluated *in vivo* for stem rot resistance. 738 germplasm accessions of JAF crops have been distributed to different indenters.
- In ramie, 155 stocks belonging to five population were studied for start codon targeted (SCoT) polymorphism. The populations exhibited high SCoT polymorphism, high genetic differentiation and moderate gene flow.
- In *tossa* jute, 16 promising F_4 populations were advanced to the F_5 generation. One F_4 line with high tolerance to premature flowering was identified.
- Fifteen progenies emanated from interspecific hybridization of kenaf and wild relatives exhibited high sterility which was functional in nature, causes formation of either rudimentary anthers or inhibition of anther dehiscence.
- Eight *tossa* jute mutants consistently exhibited less flowering compared to check varieties JRO 8432 and JRO 204 when screened for premature flowering resistance for three years.
- Diversity analysis using SSR markers divided 60 mutants of *tossa* jute along with two cultivars JRO 524 and JRO 8432 into six clusters. Both cultivars were grouped together and were distinct from the mutants.
- For induction of mutation and estimation of LD_{50} dose, three genotypes of mesta were irradiated to 10 different doses of gamma ray. LD_{50} for genotype MT 150 and Long calyx was 500Gy while for HS 4288 was 300Gy.
- Studies on residual heterosis for fibre yield and yield attributing traits in F_2 generation of *tossa* jute revealed that selection in F_2 derived from high heterotic F_1 will be misleading and selections based on F_2 population mean will be useful in selecting the transgressive segregants for yield and yield attributing characters.
- BC mapping population for *macrophomina* resistance was developed in *C. olitorius.* A total of 8 RGA markers and 16 SSR markers showing parental polymorphism were identified.
- A total of 134 *C. olitorius* germplasm were evaluated for morphological and fibre anatomy characters. Parental polymorphism has been studied using 86 SSR and 77 SRAP markers of which 14 SSR and 31 SRAP markers were found to be polymorphic.
- A group of *tossa* jute mutant germplasm accessions along with check variety JRO 524 were screened for fibre anatomy characters for four years (2012 – 2015). Three mutants namely OMU 05, OMU 07 and OMU 19 were found better than JRO 524 for fibre anatomy traits including bark cross-section length, protophloic fibre length, secondary phloic fibre wedge length, secondary phloic fibre wedge diameter at wedge base, secondary phloic fibre wedge diameter at mid-wedge, fibre bundles/wedge in mid wedge, fibre bundles/wedge at wedge base, and number of fibre cells/bundle.
- To develop a model for prediction of fibre quality from the early growth stages, prediction sampling for fibre quality in jute at 90 days after sowing (DAS) was most accurate.
- In a 7×7 diallel analysis of *tossa* jute, four F_1s were identified better than checks with fibre yield of more than 16 g/plant. Highest standard heterosis (55.2%) was obtained from cross KOM 62 × JRO 524 (17 g/plant).
- Out of 27 advanced populations of *tossa* jute, two were superior to JRO 524 and JRO 204. These two entries were contributed for IET of AINP JAF for 2015-16.
- Two SSR markers namely, MJM 631 and MJM 458 were selected for developing marker-based assay for varietal purity testing. MJM 631 and MJM 458 can specifically distinguish JRO 524 from JRO 204.
- A total of 600 germplasm lines of *C. olitorius* were evaluated for fibre strength and fineness. Five lines showing fineness between 1.3-1.4 tex and 3 lines showing fibre strength between 28-32 g/tex were selected for utilization in hybridization programme.
- A new *tossa* jute variety JRO 2407 (Samapti) was tested with two reference varieties for second growing cycle under DUS testing at ICAR-CRIJAF, Barrackpore and CSRSJAF, Bud Bud. Candidate variety was distinct for seed colour.
- For DNA finger printing of jute varieties out of 156 SSR markers, 100 showed successful amplification and only 14 markers showed polymorphism among the varieties.
- A RIL mapping population of *C. capsularis* was phenotyped at two growth stages and parental polymorphism study identified 10 RGA and 18 SSRs markers.
- In kenaf, out of 25 F_6 families evaluated, five YVM resistant lines outperformed the best check for fibre recovery and fibre yield.

- Based on plant height and basal diameter a total of 43 individual plants from 23 F_4 and 28 single plants from 13 F_2 populations of roselle were selected.
- In roselle a total of 20 promising germplasm lines with fresh leaf yield >40g/plant were selected for leafy vegetable purpose besides 20 germplasm lines with fresh calyx yield >25 g/plant were identified for calyx purpose.
- The ramie gum contains about 34.3 – 40.8% hemicellulose and 15.2 – 16.6% pectin, while the fibre is 96.1% holocellulose. Pollination studies revealed that self-pollination in ramie achieved by between stem geitonogamy and isolation distance has been determined as 500 m.
- In sunnhemp, fluorescent microscopic study of the pistils revealed that incompatibility reactions were taking place at ovary level. So this can be considered as a case of "ovarian self-incompatibility"

Seed Science and Technology

- Seed priming through 4 h steeping either in 4% KNO_3 or 2% NaCl followed by 96 h incubation improved the seed germination and seedling vigour in jute.
- In jute seed crop, application of 50 kg K_2O/ha and 45 kg S/ha with recommended dose of N and P increased number of branches/plant, pod length, pods/plant and jute seed yield to maximum extent.
- During *kharif* 2014-15, 11.90 q breeder seed of 12 jute varieties comprising of 4 *white* jute *viz*., C 517, C 532, JRC 212 and JRC 212 and 8 *tossa* jute varieties *viz*., JRO 204, S 19, JBO 2003H, JRO 128, JRO 8432, JRO 66, JRO 524, JRO 878 were produced. Furthermore, about 331.9 kg of nucleus seeds of released varieties of jute, mesta and sunnhemp were produced.
- Under mega seed project 705.0 q seeds of different crops (mungbean, mustard, dhaincha, wheat, paddy, sunnhemp, mesta and jute) have been produced. In addition to this, planting material of sisal (50,000 bulbils) and ramie (50 q rhizome) were also produced and distributed to the farmers.
- Under NFSM programme, 50 q foundation jute seed of six varieties namely, JBO 2003H, JRO 204, S 19, JRO 128, JRO 8432, JRO 66 were produced.
- Certified jute seed production programme under 'Seed Village' scheme with farmers' participatory approach has been taken up at Bankura, West Bengal implemented through PPP.

Biotechnology

- *De novo* transcriptome sequencing and analysis of bast tissues identified genes and pathways associated with lignin biosynthesis in lignocellulosic jute fibres.
- A high-density SNP linkage map, from the cross Sudan Green (SG) × bast-fibre-shy (bfs), has been developed in *tossa* jute using RAD sequence. Seven linkage groups (LG1-LG7) containing a total of 503 RAD markers with genome coverage of 87.0% were identified. Total length of the linkage map was 358.5 cM with an average marker interval of 0.72 cM.
- Synteny mapping of jute RAD markers to model eudicot species showed that jute has maximum syntenic relationship with cocoa (47.5% homology) followed by diploid cotton (29.2% homology).
- A unique trait of histological fibre content (FC) in jute has been identified which represents the total number of fibre cell bundles (FCBs) in an entire stem transvere section at 90 days after germination (DAG). This trait was also highly correlated with plant height.
- A total of nine QTLs, one each for histological fibre content (FC), fibre yield and root weight, three each for plant height and base diameter were identified using the RAD linkage map. The QTL qFC-l1 was detected on top of a single-SNP (C/T) marker Co_Sb0237 (GIC = 1) at 40.2 cM on linkage group 1 (LG1) consistently across the two environments.
- Micropropagation in jute, mesta and ramie was attempted to standardise the protocols. High number of repetitive secondary embryos with distinct globular, heart-shaped, and cotyledonary stages were observed in auxin free liquid culture supplemented with IAA and kinetin.
- Eleven miRNA homologs have been identified from 14 ESTs of *C. capsularis*. Among these, 3 miRNA homologs *viz.*, osa-miR5538, hbr-miR6173 and gma-miR5368 are conserved in different ESTs. All the five miRNA homologs from a miRNA family miR393 were present in a single EST.

Soil Health and Nutrient Management

- In long term fertilizer experiment during last 43 years yield of jute, rice and wheat ranged from 8.71 to 24.93 q/ha, 14.31 to 31.18 q/ha and 7.05 to 29.75 q/ha, respectively, under different treatments with maximum yield and uptake in 150% NPK. The integrated nutrient management resulted in a positive influx of nutrients by increasing soil organic carbon, available nitrogen, phosphorus and potassium varying from 5.60 to 8.90 g/kg, 227 to 306 kg/ha, 10 to 81 kg /ha and 127 to 213 kg/ha, respectively. Organic amended plot had highest values of very labile and less labile carbon pools.
- For soil test and resource based plant nutrient management in jute based cropping system, jute (cv. JRO 204), rice (cv. NDR 97) and garden pea (cv. Azad pea) exhibited the highest yield, response ratio and B:C ratio under ST-TY + FYM @ 5t/ha over RDF and farmers' practice for various yield targets.

- Integrated application of FYM, *Azotobacter* and PSB with inorganic fertilizer (ST-TY) increased the yield and agronomic efficiency of P and K fertilizers over RDF in jute and rice.
- The addition of FYM in jute-rice-wheat system improves soil aggregation and enhances P sequestration in macro-aggregates. Structural indices were found higher in the soil receiving organic amendments (NPK+FYM) than the soil with inorganic fertilizers (NPK) and without any fertilizer.
- The application of elemental S @ 45 kg S/ha recorded the maximum availability of S (16.4 kg/ha) in post-harvest soil after the harvest of jute and mesta.
- Increased level of nitrogen significantly enhanced the Nitrate Reductase (NR) activity and chlorophyll content of jute at 35 DAS. The jute cultivars Tarun (18.1 kg fibre/kg N) showed highest agronomic nitrogen use efficiency (ANUE) followed by S 19 and JRO 204 while maximum apparent recovery (AR) was recorded with JRO 204 (44.9 %) followed by JRO 66, Tarun, JRO 524 and S 19 (37.1 – 38.8 %).

Crop Husbandry

- In terms of jute productivity, *Azotobater* dynamics and dehydrogenase activity (DHA) in soil jute-rice-garden pea cropping system was superior. While maximum system productivity was obtained in jute-rice-baby corn-jute (leafy vegetable) cropping system. Sustainable yield index (SYI) of jute was the highest (0.87) in jute-rice-garden pea sequence, while SYI of rice and system productivity was the highest in jute-rice-baby corn-jute (leafy vegetable). Among nutrient management practices, SYI of jute, rice and system productivity was the highest in 100% RDF + with crop residue.
- Sowing of jute in open furrow with one irrigation in furrow and recommended dose of fertilizer (N: P: K:: 60:30:30), reduced the irrigation requirement by 40 percent and produced 26.66 q /ha fibre, which was 1.02 q higher over traditional flat-bed method of sowing. One flood irrigation followed by soil mulching (at field capacity) by CRIJAF nail weeder at RDF produced 27.99 q jute fibre /ha and which is 2.35 q higher over traditional flood irrigation system.
- Maximum fibre yield (15.46 q/ha) and the highest WUE (4.52 kg fibre/ha-mm) were obtained in drip irrigation applied @ 4 l/hr/plant for 4 hrs at 2 weeks interval and soil application of Zinc sulphate @ 20 kg/ha together with Borax @ 15 kg/ha.
- The net returns and B:C ratio of jute-rice-ashwagandha were significantly higher than jute-rice-potato, although the jute equivalent yield (JEY) was higher in case of later. Among sisal intercrop with MAPs the net return was the highest with safed musli intercrop, but the highest B:C ratio was recorded with aromatic grass vettiver.
- The residual effect of sunnhemp as green manure applied prior to rice crop was assessed to the tune of 30 kg N/ha on succeeding wheat crop.
- Micronutrient application of zinc sulphate @ 30 kg/ha and borax applied @ 10 kg/ha significantly improved the fibre yield of sunnhemp.
- In flax, application of nitrogen @ 80 kg/ha with three split *i.e.* ⅓ at basal + ⅓ at 21 DAS + ⅓ at 45 DAS along with phosphorus and potassium @ 40 kg/ha at basal dose optimized the fibre yield.

Biotic and Abiotic Stresses

- The egg laying behavior of Bihar hairy caterpillar, *Spilosoma obliqua* exhibited significant differences in preference for oviposition among the wild and cultivated species of jute. The mean number of egg clusters and eggs/cluster were significantly less in the wild species as compared to *C. olitorius* which indicates non-preference for wild species of jute for oviposition by *S. obliqua.*
- Two sprays of spiromesifen 240 SC @ 0.7 ml/L at 36 and 46 DAS and profenophos 50 EC @ 2.5 ml/L at 66 and 76 DAS were optimum for protecting the jute crop each against yellow mite and lepidopteran pests. Multiple pests yield-loss infestation relationship was Y=34.5826-0.219 (YM)-0.095 (BHC+SL) (R^2= 0.87) at 55 DAS. The EILs were determined during the crop stage at which both the pests significantly affected the yield. Individual EIL for yellow mite and lepidopteran pests were 42 mites/cm^2 area on second unfolded leaf and 10% plant damage, respectively.
- Artificial diet composition for *S. obliqua,* comprising of soybean seed powder + cabbage leaf powder + jute leaf powder as base ingredients supported the larval growth comparable to the jute leaf (natural diet). In terms of larval survival, the diet with base ingredients of soybean seed powder (5 g) and jute leaf powder (5 g) was the best with significantly highest survival.
- The toxicity of novel insecticides i.e., indoxacarb 15.8 EC and spinosad 45 SC against *S. obliqua* was 3.63-fold and 3.28-fold more than profenophos. Relative toxicity indicates imidacloprid to be 1075.71-fold more toxic to whiteflies followed by diafenthiouron (314.29-fold), flonicamid (285.71-fold), spiromesifen (250.26- fold) than dimetheoate.
- Inoculation of jute seed (cv. JRC 212) with conidial suspension of *Beauveria bassiana* (ITCC 6551) as endophyte @ 10^8 cfu/ml caused considerable reduction in stem weevil infestation (15-30%) in white jute. Endophytic colonization and the hyphal growth of the fungus in the leaf tissues of treated jute plants was confirmed with scanning electron microscopy.
- Entomopathogenic fungus isolated from infected mealybug was identified as *B. bassiana* based on

cultivation in selective media and PCR with *B. bassiana*-specific primers. Pathogenicity and the efficacy of this isolate was confirmed which caused 85% mycosis and mortality on mealybug crawlers and 30% mycosis on the adults treated with condial suspension.

- Among 7 released varieties and 2 wild species of kenaf least survival of mealybug adults among the varieties was on JRM 3 (1.22/plant). The number of crawlers on the host plants from the surviving adults was significantly high and low in WHIN-47(439.69) and WHIJ-50 (39.28) respectively. The survival of crawler was least in WHIJ-50 (35.66%) and maximum in HC 583 (60%). The female developmental period was prolonged (22 days) in WHIJ-50 compared to 16.33 days in HC 583.
- The virus-vector relationship of mesta yellow vein mosaic virus (MYVMV) indicated that the transmission of the virus was more with increase in the pre-acquisition starvation feeding period. The pre-acquisition starvation period of 6 hr or more resulted in 100% transmission of virus. The post-acquisition starvation periods of vector also had similar effect on MYVMY transmission. Fifteen viruliferous whiteflies were sufficient to cause 100% disease transmission in 21-day old mesta plants.
- The occurrence of leaf folder, *Pleuroptya* sp. (Lepidoptera: Crambidae) and collar rot pathogen, *Sclerotium* sp. recorded for the first time on ramie crop in India were identified and documented as new pest and disease.
- The role of host and pathogen inoculum age on successful development of stem rot disease development was ascertained. Increasing plant age had positive effect on length of the lesion caused by the pathogen which was more at 70 DAS compared to the younger plants. Fresh culture (24 h-old) of *M. phaseolina* was most infective, the pathogenicity reduced further with increasing age of disease inoculum.
- With increasing plant population density the incidence of jute stem rot increased and was more in broadcast than line sown crop. Line sowing reduced the disease incidence due to better aeration, adversely affecting the development of favorable micro-climate for the disease.
- Rhizosphere colonization of different *Trichoderma* strains on jute plants (25 DAS) under pot culture exhibited maximum colonization by TVC1 (300 x 10^3 cfu/g dry soil) followed by NBAII TH-1 and NBAII TH-10 (183 x 10^3 cfu/g dry soil). In terms of antagonistic and growth promotion potential, the native isolate TVC 1 consistently performed better (56.8% growth inhibition) and recorded maximum vigour index.
- All the five strains of *Pseudomonas fluorescens* (NBAII-RJ 9, NBAII-GR 3, MTCC 6035, MTCC 1749, Pf-1) favoured plant growth promotion activity through production of oxidase, IAA, lipase, siderophore, fluorescence and phosphate solubilisation. Wheat grain was the most supportive substrate for mass multiplication of *Trichoderma* with significantly high population of the bioagents.
- Foliar application of carbendazim 0.25% and hexaconazole 0.1% were most effective in the management of leaf blight of ramie caused by *Curvularia eragrostidis.*
- Application of pre-emergence herbicide, pretilachlor 50% EC @ 0.9 L/ha at 48 hrs of sowing in irrigated condition and one hand weeding, controlled grass and broad leaved weeds, *Trianthema portulacastrum* in particular with maximum fibre yield.
- The soil penetration resistance varied mostly between 10-30 cm profiles depths. Within this depth the magnitude of the soil PR, 2MPa obtained similarly in 100% NPK+FYM treated plots and tilled fallow plots is significantly lesser than the 100% NPK treated and control plots due to better soil physical health by addition of FYM/organic matter.
- The reduction in accumulation of total dry matter, bark dry matter and leaf relative water content ranged from 49.7-70.7, 54.1-75.9, and 25.9-39.2, respectively among all the five jute varieties grown under deficit soil moisture stress (>4 bar soil moisture tension or <10% soil moisture).

Farm Mechanization and Post-Harvest Technology

- The seed drill for sowing of pulses like green gram and lentil as inter crop with jute was developed by modifying the existing seed drill to 5 drums with 20 cm spacing, increasing the diameter of seed dispensers and converting the furrow openers to hoes.
- Manually operated weeder suitable to operate in line sown jute and other crops was developed. The weeder consists of MS flat body frame, wheel, tyne attachment frame (share type, hoe type and scrapper) and handle with 10.5 kg weight. It operates on a single cast iron wheel of 51 cm diameter with adjustable handle. The field capacity and weeding efficiency was 0.022 ha/h and 86.17%, respectively with 7.4% plant damage.
- Jute leaf remover is a simple tool to remove leaves from matured standing/harvested jute plants. It is made of MS flat and its working part is grooved for proper holding of the plants during operation. The operation involves pressing of upper jaw with handle and pulling of plant which can detach leaves from 5-6 plants per minute.
- Effective xylan- and pectin- degrading microbes were observed in the retting water samples collected from six districts. S-3, S-7 and S-9 strains had high ligninolytic potential whereas the PJRB2 strain of CRIJAF microbial

consortium was the highest xylanase producer. During retting, complex organic matters degrade to simpler compounds, increasing the level essential nutrients such as N, P, K, Ca and Mg in the retting water.

- The improved microbial formulation mediated retting was promoted through 776 large scale demonstrations in 6 districts of West Bengal, Nagaon district of Assam, Kishanganj and Purnea districts of Bihar, Vizianagaram district of Andhra Pradesh. In 71.5% cases the reduction of retting duration was 4-7 days. Better fibre colour was obtained by 82.9 % farmers. Most remarkable benefit of improved retting technology was uniform fibre recovery throughout the length of jute stem. The average yield and income advantage was 191 kg/ha and Rs. 4,590/ha respectively. Majority (86%) of the jute farmers were 'Satisfied' to 'Very Satisfied' on the outcome of this technology.
- Out of the promising pectinolytic strains, S33 and S11 isolates were selected based on least cellulase and maximum pectinase activity. S33 isolate exhibited maximum polygalacturonase (PG) activity. The degumming efficiency of S33 and S11 under laboratory scale (2-5 gm dry ramie fibre) were 22.1 and 23.4% (weight loss basis) compared to 26% in chemical degumming. Out of 96 samples collected from agricultural wastes and jute retting tanks, 6 isolates of degumming microbes have been selected on the basis of least cellulase activity.

Jute and Allied Fibre Informatics

- Sunnhemp information system has been developed on aspects of variety, crop cultivation, weed management, soil and water management, pest and disease management. The existing version of JAFexpert for jute crop is upgraded to make it more informative and user-friendly.
- Mapping of jute and mesta area and productivity in India was done in the GIS environment on the basis of six years (2005-06 to 2010-11) average data. Among the 17 jute growing districts of West Bengal, maximum area under jute (>15%) is in the districts of Murshidabad and Nadia. Productivity of jute fibre increased at the rate of 40.5 kg/ha per year from 1993-94 (21.1 q/ha) to 2005-06 (24.8 q/ha).
- Mobile advisory service was provided to 427 farmers by sending 16500 text SMSs on jute production technologies like improved jute varieties, nutrients management, weed management, pest and diseases management and post-harvest technologies and precautionary measures on weather excesses on 18 occasions.

Technology Assessment and Transfer

- In FLDs, among the high yielding jute varieties, JRO 204 was superior in terms of yield (32.53 q/ha. Integrated Weed Management (IWM) technology improved the yield by 1.62-5.05 q/ha.Nail weeder-mediated weeding enhanced yield by 3.04-5.05 q/ha and economised weeding by saving Rs. 6348-9438/ha. The advantages in intercultural operation and mechanical/chemical weeding due to the line sowing through 4-row seed drill reduced the cost of cultivation by Rs. 3740-5512/ha. Application of sulphur @30kg/ha along with recommended dose of fertilizer (RDF) i.e. 60:30:30 was superior in sustaining the fibre yield of jute in drought condition with maximum net return (Rs. 42,309/ha).
- Under FLD on improved retting technology, a total of 22 demonstrations on jute and mesta crop were conducted in different districts of West Bengal, Bihar, Assam and Andhra Pradesh using CRIJAF SONA a talc based microbial consortium for retting. It improved the quality of jute and mesta fibre (by at least 1 to 2 grades), reduced the retting duration (by 6 to 7 days) and enhanced higher fibre recovery compared to the conventional retting method.
- Most of the farmers (37%) viewed ICT as a favourable tool for farm communication among which customised SMS delivery through SMS is the most preferred method. Lack of training and availability to learn ITC is perceived to be the principal barrier in ICT-based farm communication.
- In addition to this, the technologies were also disseminated through various extension activities viz. demonstrations, famers-scientist interactions, krishi mela, trainings, awareness camps. The technologies/extension activities also got published in local dailies and telecasted in local TV channels, All India Radio (AIR).

Tribal Sub Plan

- Activities under TSP were undertaken with the objective to bring more area under jute and allied fibre crops in tribal dominated areas through improved technological intervention to enhance the livelihood security of the tribal farm families in two blocks of North 24 -Parganas, one block each of Dakshin Dinajpur, Nadia and Bankura districts in West Bengal.
- Improved jute production technology, microbial retting of jute with 'CRIJAF SONA'', vegetable cultivation in jute fabric based soil columns, scientific rearing of fish, poultry and duck rearing introduced in the adopted villages elevated the livelihood security of tribal farm families.
- New plantations of sisal taken up in Odisha and Jharkhand and distribution of planting materials of ramie among the tribal farmers in Assam, Meghalaya and Arunachal Pradesh States could expand the area of these crops.

- Awareness about the soil testing and soil test based crop response was generated among the tribal farmers. Besides, improved jute production technologies were demonstrated in 6 villages of West Bengal, Odisha and Assam covering 86 ha area and 338 tribal farmers participated in the programme under AINPJAF-TSP.
- Human Resource Development (HRD) programmes were structured and organized under the TSP primarily intended to impart the understanding of improved technologies to the tribal farmers through 33 trainings and demonstrations.

AINP on J&AF

- In the front of varietal development, 3 varieties i.e., JROG 1 of tossa jute, JRJ 610 of sunnhemp and JRF 2 of flax have been released. JRF 2 is the first released variety of fibre flax. Besides, two varieties of kenaf i.e., JMBG 4 and Central Kenaf JBMP-2, four varieties of roselle i.e., Central Roselle JBRP-1, Central Roselle AMV-9, CRIJAF R-2 and CRIJAF R-8 were identified for release.
- Seventy five germplasm each in *tossa* jute, white jute and kenaf and 158 accessions of roselle were evaluated with their 2 respective checks varieties at various locations of AINPJAF centres. Elite strains of jute and allied fibre crops were also evaluated in multi-location trials *viz.*, IETs, AVTs and adaptive trials.
- Application of pre-emergence herbicide, pretilachlor @ 900 ml/ha along with one hand weeding or use of nail weeder twice (5 and 10 DAE) followed by one hand weeding (for intra row weeding) reduced weed biomass and increased fibre yield of jute.
- Use of CRIJAF microbial consortium (CRIJAF SONA) has effectively reduced retting duration by 6 to 7 days, increased fibre strength by 3 to 4 g/tex and improved colour and lusture of the fibre at Bahraich, Kalyani and Amadalavalasa centers while at Nagaon, Kendrapara and Katihar centres, the retting duration in jute was reduced by 9-10, 6 and 6-8 days, respectively.
- The yellow mite infestation was more consistent across the centres with maximum infestation of 8.62, 10.38, 25.62, 64.45, 89.33 and 129.39 mite population/cm^2 leaf area on 2nd unfolded leaf at Nagaon, Kendrapara, Coochbehar, Bahraich, Katihar and Barrackpore, respectively coinciding at 45 DAS to 75 DAS during last week of May to mid-June.
- Seed treatment with azoxystrobin + difenoconazole @ 1.0ml/kg seed + spraying of azoxystrobin + difenoconazole @ 0.075% at 45 DAS was most effective for stem rot management in jute at Kendrapara, Barrackpore, Coochbehar, Nagaon and Katihar.

Women Empowerment

- Gender mainstreaming in agriculture is very important as women play a significant and crucial role in agricultural and allied activities. Skill and entrepreneurship development among the tribal farm women will have a far reaching impact on tribal farming.
- ICAR-CRIJAF took initiative to introduce drudgery reducing implement i.e. nail weeder for jute cultivation among the tribal women. Introduction of such implement had a positive impact on the working condition of such farm women.
- Literacy classes for farm women were initiated as the first step for empowering such group to impart education and to improve their knowledge of farming activities which will build self confidence among the farm women, develop awareness recent developments in farming.
- Entrepreneurship development activities among farm women could activate 11 Self Help Groups of two villages of North 24 Pgs and initiated fresh impetus among the tribal farmers particularly the women to generate earnings for the SHG .
- Nutritional security of tribal farm women was improved by introducing crop diversification particularly through pulses, vegetables and integration of fishery, poultry and duckery.
- The women cell of ICAR-CRIJAF organised the celebration of International Women's Day 2015 on 9th March 2015 participated by 60 women and self-help groups (SHGs) from adjoining villages. The theme for the programme was "Empowering Women: Empowering Humanity"

Krishi Vigyan Kendra

- Krishi Vigyan Kendra (KVK), Burdwan conducted 10 On Farm Trials (OFTs) for evaluation of various technologies, 15 Front Line Demonstrations (FLDs) of established technologies, 58 trainings participated by 3555 farmers, farm women, rural youths and extension workers.
- The KVK also arranged and organised exposure visits, field day, method demonstration, technology week, animal health camps and similar other activities for making awareness among the farmers and other stakeholders about the new technologies in agriculture, horticulture, animal husbandry and other allied activities.

कार्यकारी सारांश

फसल सुधार

- पटसन एवं समवर्गीय रेशा फसलों के कृषित एवं अकृषित कुल 103 जननद्रव्यों का संकलन किया गया जिनमें *सी. एस्टुएन्स* (43), *बोहमेरिया* स्पेसीज (25), *सी. ऑलीटोरियस* (24), *एच. सब्दरीफा* (05), *यूरेना* स्पेसीज (01) एवं अन्य रेशा फसलों (03) के जननद्रव्य शामिल थे। कुल 1165 जननद्रव्यों का पुनर्उद्भवन भी किया गया जो सादा पटसन (956), रोजेल (59), केनॉफ (67) तथा अकृषित (83) रेशा फसलों से सम्बधित थे। इसके अतिरिक्त 146 नव संकलित रेशा फसलों का उनके विभिन्न गुणों के लिए मूल्यांकन एवं वर्गीकरण तथा 180 जननद्रव्यों का तना सड़न रोग के प्रति प्रतिरोधिता हेतु प्रयोगशाला में मूल्यांकन भी किया गया। विभिन्न शोधकर्ताओं की मांग के अनुरूप कुल 2738 जननद्रव्यों का संवितरण भी सुनिश्चित किया गया है।
- रेमी के पाँच समुदायों से प्राप्त कुल 155 जननद्रव्यों का आणि वक स्तर पर बहुरूपता परीक्षण किया गया जो उच्च एस.सी.ओ. टी. बहुरूपता, उच्च आनुवांशिक विविधता तथा मध्यम जीन बहाव वाले पाये गये।
- तोषा पटसन के 16 उत्कृष्ट एफ$_4$ संततियों का उन्नयन एफ$_5$ पीढ़ी में किया गया जिनमें से एक मात्र की पहचान पूर्वपक्कवन पुष्पन के प्रति सहिष्णु के रूप में हुई।
- केनाफ के अन्तरजातीय संकरण से विकसित कुल पन्द्रह संततियों में क्रियात्मक नर–बन्ध्यता पायी गयी। जिसका मुख्य कारण या तो अविकसित परागकोष बनना अथवा परागकोष का स्फुटन नहीं होना है।
- लगातार तीन वर्षों तक पुष्पन प्रतिरोधिता परीक्षण के दौरान तोषा पटसन के आठ उत्परिवर्तियों में, चेक प्रजाति जे.आर.ओ.–8432 एवं जे.आर.ओ.–204 की तुलना में अत्यन्त कम पुष्पन देखा गया।
- तोषा पटसन के 60 उत्परिवर्तीयों तथा दो प्रजातियों नामतः जे.आर.ओ.–524 तथा जे.आर.ओ.–8432 की विविधता विश्लेषण एस.एस.आर. मार्कर की सहायता से की गयी तथा इन्हें कुल छह समूहों में विभाजित किया गया। दोनों प्रजाति एक ही समूह के थे किन्तु उत्परिवर्तीयों से भिन्न पाये गये।
- उत्परिवर्तन तथा एल.डी.$_{50}$ मात्रा के आकलन हेतु मेस्ता के तीन प्रभेदों को गामा–रे की दस अलग–अलग मात्राओं से विकिरणि ात कराया गया। एम.टी.–150 तथा लौंग कैलिक्स प्रभेदों की एल.डी.$_{50}$ 500जी.वाई. जबकि एच.एस. 4288 की 300जी.वाई दर्ज की गयी।
- तोषा पटसन के एफ$_2$ पीढ़ी में विद्यमान रेशा उपज एवं इससे सम्बद्ध गुणों के लिए अवशिष्ट संकर योग के अध्ययन से ज्ञात हुआ कि उत्कृष्ट संकरों के निष्पादन के आधार पर एफ$_2$ संततियों का चयन भ्रामक हो सकता है। अर्थात् एफ$_2$ संतति के औसत निष्पादन के आधार पर आगामी संततियों में रेशा उपज एवं अन्य गुणों हेतु एकल–पादप का चयन प्रभावी पाया गया है।
- तोषा पटसन में *मैक्रोफोमिना* के प्रति प्रतिरोधिता हेतु एक बी. सी. मैपिंग समुदाय को विकसित किया गया है। पैत्रिक बहुरूपता प्रदर्शित करने वाले कुल 8 आर.जी.ए. तथा 16 एस.एस.आर. मार्कर्स की पहचान की गयी है।
- तोषा पटसन के कुल 134 जननद्रव्यों का मूल्यांकन उनके रूपात्मक तथा रेशा संरचना गुणों के आधार पर किया गया है। कुल 86 एस.एस.आर. तथा 77 एस.आर.ए.पी. मार्कर्स की सहायता से पैत्रिक बहुरूपता का अध्ययन किया गया जिनमें से 14 एस.एस.आर. तथा 31 एस.आर.ए.पी. मार्कर्स बहुरूपी पाये गये।
- तोषा पटसन की प्रारंभिक वृद्धि अवस्था में ही उनकी रेशा गुणवत्ता के अनुमान हेतु एक मॉडल विकसित करने के उद्देश्य से 10 प्रजातियों का मूल्यांकन किया गया। बुआई के 90 दिनों बाद वाली फसलों की रेशा गुणवत्ता का 120 दिनों के फसल की रेशा गुणवत्ता से सार्थक तथा धनात्मक सह–संबंध पाया गया। इस प्रकार पटसन के रेशे की गुणवत्ता का अनुमान 90 दिनों की फसलावधि में ही लगाया जा सकता है।
- तोषा पटसन के 7×7 डायएलील विश्लेषण के दौरान चार संकरों की रेशा उपज 16 ग्रा./पौधा से भी अधिक दर्ज की गई जो चेक प्रजातियों से बेहतर थी। संकर संयोग के.ओ.एम.–62 × जे.आर. ओ.–524 (17 ग्रा./पौध) ने सर्वाधिक मानक संकर ओज (55.2 प्रतिशत) दर्ज कराया।
- तोषा पटसन के कुल 27 उन्नत प्रभेदों में से दो को चेक की तुलना में बेहतर पाया गया। इन दोनों प्रभेदों को ए.आई.एन.पी. के अन्तर्गत वर्ष 2015–16 के दौरान आई.ई.टी. परीक्षण हेतु नामित किया गया है।
- प्रजाति शुद्धता जाँच हेतु मार्कर आधारित एसे विकसित करने के क्रम में पटसन के विशिष्ट कुल 60 एस.एस.आर. मार्कर्स से दो एस.एस.आर. मार्कर्स नामतः एम.जे.एम.–631 तथा एम.जे.एम. 458 का चयन किया गया है। ये दोनों मार्कर्स विशेष रूप से जे.आर. ओ.–524 तथा जे.आर.ओ.–204 को चिन्हित करने में सक्षम है।
- तोषा पटसन के कुल 600 जननद्रव्यों का मूल्यांकन उनकी रेशा

महीनता तथा रेशा मजबूती हेतु किया गया। पाँच जननद्रव्यों की रेशा महीनता 1.3–1.4 टेक्स तथा रेशा मजबूती 28–32 ग्रा./टेक्स पायी गयी जिन्हें संकरण कार्यक्रम के लिए चयनित किया गया है।

- तोषा पटसन की नवीन प्रजाति जे.आर.ओ. 2407 (समाप्ति) का डी.यू.एस. परीक्षण दो संदर्भ प्रजातियों के साथ लगातार दूसरे वर्ष बैरकपुर तथा बुदबुद केन्द्रों पर किया गया। जाँच प्रजाति के बीज का रंग अलग पाया गया।
- पटसन में डी.एन.ए. फिंगर प्रिंटिंग हेतु कुल 156 एस.एस.आर. मार्कर्स का मूल्यांकन किया गया जिनमें से 100 एस.एस.आर. मार्कर्स ने सफलता पूर्वक प्रवर्धन दर्शाया किन्तु केवल 14 मार्कर्स ही प्रजातियों की बहुरूपता निरूपित कर सके।
- सादा पटसन के एक आर.आई.एल. समुदाय में दो वृद्धि अवस्थाओं के दौरान वाह्य गुणों को तथा पैत्रिक बहुरूपता का अध्ययन कर 10 आर.जी.ए. एवं 18 एस.एस.आर. मार्कर्स की पहचान की गयी।
- केनॉफ के 25 एफ$_6$ समुदायों के रेशा उपज तथा पित्त सिरा मोजैक रोग के प्रति प्रतिरोधकता के आधार पर कुल पाँच समुदायों को चेक की तुलना में उत्कृष्ट पाया गया।
- पौधे की ऊँचाई तथा तने की मोटाई के आधार पर रोजेल के 23 एफ$_4$ तथा 13 एफ$_2$ संततियों से क्रमशः 43 तथा 28 एकल पादप का चयन किया गया।
- पत्तेदार शाक–भाजी के इस्तेमाल के उद्देश्य से रोज़ेल के कुल 80 जननद्रव्यों का मूल्यांकन किया गया जिनमें से 50 जननद्रव्यों में पोषक तत्वों की मात्रा भी आकलित की गयी है। करीब बीस जननद्रव्यों के ताजे पत्तों का भार 40 ग्रा./पौधा से भी अधिक दर्ज की गयी। इसके अतिरिक्त रोजेल के 120 जननद्रव्यों का मूल्यांकन उनकी वाह्यदलपुंज उत्पादन क्षमता तथा इससे संबंधित गुणों के लिए भी किया गया जिनमें से 20 जननद्रव्यों की वाह्यदलपुंज उपज क्षमता 25 ग्रा./पौधा से भी अधिक दर्ज की गयी।
- रेमी गोंद में लगभग 34.3–40.8 प्रतिशत तक हेमीसेल्यूलोज तथा 15.2–16.6 प्रतिशत तक पेक्टिन पाया गया जबकि रेमी रेशा 96.1 प्रतिशत होलोसेल्यूलोज का बना होता है। एक अध्ययन के अनुसार रेमी में परागण मुख्यतः एक ही क्लोन के अलग–अलग तनों में विकसित परागकणों के द्वारा होता है। तथा इसमें 500 मीटर की पृथक्करण दूरी निर्धारित की गयी है।
- फ्लैक्स के विभिन्न संततियों से उद्भावित कुल 99 एकल पौधों का मूल्यांकन उनकी रेशा उपज क्षमता के लिए किया गया है।
- सनई में जायांग (पिस्टिल) के फ्लोरिसेन्ट सूक्ष्मदर्शी अध्ययन से ज्ञात हुआ कि इसमें अनिषेचन की क्रिया अण्डाशय स्तर पर निर्धारित होता है। अतः सनई में स्व–अनिषेच्य प्रक्रिया को "अण्डाशय आधारित स्व–अनिषेच्य" की संज्ञा दी जा सकती है।

बीज विज्ञान एवं प्रौद्योगिकी

- पटसन बीज को 4 प्रतिशत पोटेशियम नाइट्रेट या 2 प्रतिशत सोडियम क्लोराइड के घोल में 4 घंटे तक डुबो कर अस्तर (प्राइमिंग) चढ़ाकर 96 घंटे तक की ऊष्मायन अवधि से बीज की प्रजनन क्षमता तथा ताकत में वृद्धि दर्ज की गयी।
- पटसन बीज फसल में 50 कि.ग्रा. पोटाश तथा 45 कि.ग्रा./हे. सल्फर के प्रयोग से, पौधे की शाखाओं की संख्या, फली की संख्या फली की लंबाई तथा बीज की उपज में बढ़ोतरी दर्ज की गयी।
- वर्ष 2014–15 के दौरान पटसन की 12 प्रजातियों का कुल 11.90 कु. जनक बीज का उत्पादन किया गया जिसमें सादा पटसन के चार नामतः जे.आर.सी.–517, 532, 212 एवं 321 तथा तोषा पटसन की आठ प्रजातियाँ उदाहरणार्थ, जे.आर.ओ. 204, एस. –19, जे.बी.ओ.–2003 एच., जे.आर.ओ. 128, जे.आर.ओ. 8432, 66, 524 तथा 878 शामिल हैं। इसके अतिरिक्त कुल 331.9 कि. ग्रा. केन्द्रक बीज भी उत्पादित किया गया जिसमें पटसन की 27, मेस्ता की 9 तथा सनई की चार प्रजातियां शामिल है।
- वृहत बीज परियोजना के अन्तर्गत विभिन्न फसलों के कुल 705 कु. बीज का उत्पादन किया गया जिसमें मूंग, सरसों, ढैंचा, गेहूँ, धान, सनई, मेस्ता तथा पटसन मुख्य थे। इसके अतिरिक्त सीसल का 50000 रोपण सामग्री तथा रेमी का 50 कु. राईजोम का उत्पादन भी किया गया है।
- एन.एफ.एस.एम. परियोजना के अन्तर्गत पटसन की छह प्रजातियों के कुल 50 कु. आधारीय बीज का उत्पादन किया गया जिनका नाम जे.बी.ओ.–2003 एच, जे.आर.ओ. 204, एस. 19, जे.आर.ओ. 128, जे.आर.ओ. 8432 तथा जे.आर.ओ. 66 हैं।
- पश्चिम बंगाल के बांकुड़ा में बीज ग्राम योजना के अन्तर्गत कृषकों की सहभागिता सुनिश्चित करके पटसन बीजोत्पादन का कार्य प्रारंभ किया गया है जिसमें सार्वजनिक–निजी भागीदारी के अन्तर्गत दादा भाई सीड फार्म, नदिया को भी इस कार्यक्रम में शामिल किया गया है। इस कार्यक्रम के माध्यम से पटसन की प्रजाति जे.आर.ओ.–204 के कुल 10.76 कु. प्रमाणित बीज का उत्पादन करके कृषकों के मध्य विपणित किया गया है।

जैव प्रौद्योगिकी

- पटसन में रेशा संश्लेषण करने वाले जीन की संरचना का विस्तृत विश्लेषण करके लिगनिन जैव संशलेषण को निर्धारित करने वाली

प्रक्रिया पथ की गुत्थी को सुलझाने में सफलता प्राप्त हुई है।

- तोषा पटसन में आर.ए.डी. अनुक्रम की मदद से संकर संयोग सुडान ग्रीन × बी.एफ.एस. के लिए एक उच्च घनत्व वाले एस.एन.पी. सहलग्नता मानचित्र को विकासित किया गया है। इल्यूमिना–हाईसेक 2000 अनुक्रमक के माध्यम से 100 बी.पी. के कुल 680,254,155 रीड्स उद्भवित किये गये हैं। कुल 503 आर. ए.डी. मार्कर्स, जो लगभग 87 प्रतिशत जीनोम को प्रतिनिधित्व करते हैं, वाले कुल सात सहलग्नता समूह (एजी–1–एल.जी. 7) की पहिचान की गयी है। सहलग्नता मानचित्र की कुल लम्बाई 358.5 सेन्टी मार्गन तथा औसत मार्कर अन्तराल 0.72 सेन्टी मार्गन पायी गयी। एल.जी.–1 की मार्कर्स संख्या अधिकतम (139) जबकि एल.जी.–7 की न्यूनतम (22) पायी गयी। दो लोकस के बीच अधिकतम दूरी 16.6 सेन्टी मार्गन आंकी गयी जो कि लिंकेज ग्रुप 7 में अवस्थित थे।
- पटसन आर.ए.डी. मार्कर्स के कुटुम्बकीय मानचित्रण के अध्ययन से ज्ञात हुआ कि पटसन का अधिकतम कुटुम्बकीय संबंध कोकोआ (47.5 प्रतिशत समानता) से था जिसके बाद द्विगुणित कपास (29. 2 प्रतिशत समानता) का स्थान है।
- पटसन में एक अनूठी "उत्तकीय रेशा सामग्री" (एफ.सी.) लक्षण को चिन्हित किया गया है जिसके माध्यम से बुआई के 90 दिनों बाद वाली फसल के किसी भी हिस्से में कुल फाइबर बंडल की संख्या देखी जा सकती है। यह लक्षण पौधे की ऊँचाई (आर=0.82) तथा तने की मोटाई (आर.=0.77) से उच्च धनात्मक सह–संबंध रखता है।
- आर.ए.डी. सहलग्नता मानचित्र की मदद से कुल नौ क्यू.टी.एल. की पहचान की गयी है जिनमें एक–एक का संबंध उत्तकीय रेशा सामग्री, रेशा उपज एवं जड़ भार, जबकि तीन–तीन का संबंध पौधे की ऊँचाई तथा तने की मोटाई से है। लगातार दो वातावरण में परीक्षण के आधार पर क्यू.टी.एल. क्यू.एफ.सी.–एल 1 को सहलग्नता समूह–1 के एकल–एस.एन.पी. मार्कर को–एस. बी. 0237 के शीर्ष पर चिन्हित किया गया है। संयुक्त विश्लेषण में कुल फिनोटाइपिक विभिन्नता 10.2–10.6 प्रतिशत तक पायी गयी।
- पटसन, मेस्ता तथा रेमी में सूक्ष्म–प्रर्वधन प्रोटोकाल के मानकीकरण का प्रयास किया गया है। आई.ए.ए. तथा काईनेटिन से युक्त ऑक्सीन रहित तरल संवर्धन माध्यम में दिल के आकार का गोलाकार द्वितीयक भ्रूण उच्च संख्या में विकसित होते हुए देखा गया है।
- सादा पटसन के 14 ई.एस.टी. से कुल 11 एम.आई.आर.एन.ए. की पहिचान की गयी है। इनमें से 3 एम.आई.आर.एन.ए. नामतः ओ.एस.ए.–एम.आई.आर.–5538, एच.वी.आर.–एम.आई.आर.–6173 तथा जी.एम.ए.–एम.आई.आर.–5368 विभिन्न ई.एस.टी. के लिए संरक्षित है। सभी पाँचों एम.आई.आर.एन.ए. एक ही ई.एस. टी. से संबंधित थे। 45 प्रतिशत एम.आई.आर.एन.ए. होमोलॉग टी.आई.आर. 1 प्रोटीन को एनकोड करने वाले ई.एस.टी. थे जबकि 27 प्रतिशत होमोलॉग क्लोरोप्लास्ट 23 एस. तथा 4.5 एस. राइबोसोमल आर.एन.ए. जीन के ई.एस.टी. से संबंधित थे।

मृदा स्वास्थ्य एवं पोषक तत्व प्रबंधन

- दीर्घकालिक उर्वरक परीक्षण के 43 वर्षों के दौरान विभिन्न उपचारों में पटसन, धान एवं गेहूँ की उपज की सीमा क्रमशः 8.71 से 24.93 कु./हे., 14.31 + 31.18 कु./हे., एवं 7.05 से 29.75 कु./हे. प्राप्त हुई तथा अधिकतम उपज 150 प्रतिशत एन.पी. के. के प्रयोग से प्राप्त हुआ। समन्वित पोषण प्रबंधन से मृदा में जैविक कार्बन, नत्रजन, फॉस्फोरस तथा पोटाश की उपलब्धता में एक सकारात्मक अन्तःप्रवाह क्रमशः 5.60 से 8.90 ग्रा./कि.ग्रा./हे. दर्ज की गयी। जैविक संशोधित प्रक्षेत्र में अधिकतम मात्रा में अत्यधिक परिवर्तनशील तथा कम परिवर्तनशील संग्रहित कार्बन पाया गया।
- पटसन आधारित फसल पद्धति के लिए, पटसन (जे.आर. ओ.–204), धान (एन.डी.आर.–97) तथा मटर (आजाद पी.) के विभिन्न निर्धारित उपज की मात्रा, एस.टी.टी.वाई आधारित उर्वरकों के प्रयोग के साथ 5 टन गोबर खाद के प्रयोग से अधिकतम उपज प्रतिक्रिया तथा लाभ–लागत अनुपात की प्राप्ति हुई, जो की ससंतुति उर्वरकों की मात्रा और कृषकों की विधि से ज्यादा था। गोबर का खाद *एजोटोबेक्टर* तथा पी.एस.बी. के साथ एस.टी. टी.वाई. आधारित उर्वरकों की मात्रा के प्रयोग से, केवल संस्तुति उर्वरकों का प्रयोग की तुलना से ज्यादा पटसन तथा धान की उपज तथा शस्यिक (एग्रोनोमिक) क्षमता प्राप्त हुयी।
- पटसन–धान–गेहूँ फसल पद्धति में गोबर की खाद के उपयोग से मृदा एकत्रीकरण में सुधार तथा फॉस्फोरस की जस्ती (बड़े मृदा एकल) में वृद्धि हुई। मृदा की संरचानात्मक सूचकांक में अकार्बनिक उर्वरक के प्रयोग तथा बिना प्रप्तांक की तुलना में कार्बनिक संशोधन में बेहतर प्राप्त हुई।
- अमिश्रित सल्फर 45 कि.ग्रा./हे. की दर से उपयोग करने पर इसकी मृदा उपलब्धता (16.4 कि.ग्रा./हे.) पटसन तथा मेस्ता की कटाई उपरान्त ज्यादा की प्राप्ति हुई।
- पटसन नत्रजन के अधिकतम मात्रा के प्रयोग से नाइट्रेट रीडक्टेज तथा पर्णहरित की मात्रा 35 दिनों की फसलावधि में अधिकतम पायी गयी। अधिक नत्रजन उपयोग दक्षता पटसन की प्रजाति तरूण (18.1 कि.ग्रा./कि.ग्रा. नत्रजन) में पायी गयी इसके बाद

एस–19 तथा जे.आर.ओ.–204 में पायी गयी जबकि नत्रजन अधिकतम स्पष्ट वसूली जे.आर.ओ. 204 (44.9 प्रतिशत) में इसके बाद जे.आर.ओ.–66, जे.आर.–524 तथा एस.–19 (37.1–38.8 प्रतिशत) में पायी गयी।

फसल प्रबंधन

- पटसन–धान–मटर फसल चक्र में पटसन की उत्पादकता, इसका स्थायी फसल सूचकांक, मृदा में *ऐजोटोबेक्टर* तथा डिइाइड्रोडिनेज की सक्रियता अधिकतम पायी गयी जबकि प्रणाली उत्पादकता तथा इसका स्थायी फसल सूचकांक अधिकतम पटसन–धान–बेबीकॉर्न–पटसन साग से प्राप्त हुआ। विभिन्न पोषण तत्व प्रबंधन के बीच में, अधिकतम स्थायी फसल सूचकांक 100 प्रतिशत संस्तुत उर्वरक की मात्रा के साथा फसल अवशेषी के मिश्रण के उपयोग में प्राप्त हुआ।
- समतल खेत में पारंपरिक ढंग से पटसन की बुआई करने की अपेक्षा खुले कुंड में पटसन की बुआई, सिंचाई तथा नत्रजन :फॉस्फोरसः पोटाशः: 60:30:30 कि.ग्रा./हे. का उपयोग करने से सिंचाई की आवश्यकता 40 प्रतिशत कम हो गयी, इससे 26.66 कु./हे. रेशे की उपज की प्राप्ति हुयी, जो पारंपरिक विधि से 1.02 कु./हे. ज्यादा था। एक पारंपरिक सिंचाई सैलाब विधि के बाद नेल वीडर से मृदा पल्लवीकरण, (जब मृदा भुरभुरी हो) से 27.99 कु./हे. रेशे की प्राप्ति हुयी जो पारंम्परिक विधि से 2.35 कु./हे. ज्यादा था।
- सीसल में टपक (ड्रिप) विधि सिंचाई से, जिसमें पानी बहाव की दर 4 ली./पौधा 4 घंटे तक सिंचाई देने के साथ जिंक सल्फेट की 20 कि.ग्रा./हे. तथा बोरेक्स 15 कि.ग्रा./हे. के प्रयोग से अधिकतम सीसल रेशे की उत्पादकता तथा जल उपयोग क्षमता की प्राप्ति हुयी।
- पटसन–धान–अश्वगंधा फसल पद्धति में अधिक शुद्ध लाभ तथा लाभ लागत अनुपात की प्राप्ति हुई, हालांकि अधिकतम पटसन समकक्ष उपज पटसन–धान–आलू से प्राप्ति हुई। सीसल के अन्तरफसलीय पद्धति में सफेद मुसली अन्तः फसल से अधिकतम शुद्ध लाभ प्राप्त हुआ लेकिन लाभ लागत अनुपात सुगंधित घास खस (वेटिबर) से प्राप्त हुआ।
- धान की रोपाई से पूर्व सनई के हरी खाद के रूप में उगाने से धान पश्चात् बोई गयी गेहूँ की फसल को भी लगभग 30 कि. ग्रा./हे. की दर से नत्रजन अवशेष के रूप में प्राप्त हुआ है।
- सनई में सूक्ष्म तत्वों जैसे कि जिंक सल्फेट 30 कि.ग्रा./हे. तथा बोरेक्स 10 कि.ग्रा./हे. के उपयोग से रेशे की उपज में वृद्धि पायी गयी।
- फ्लैक्स (अलसी) में 80 कि.ग्रा./हे. नत्रजन का उपयोग तीन बराबर भागों में – एक तिहाई भाग बुआई के साथ, एक तिहाई बुआई के 21 दिनों के बाद, एक तिहाई बुआई के 45 दिनों के बाद तथा 40 कि.ग्रा. फोस्फोरस एवं पोटाश केवल बुआई के साथ, का प्रयोग उत्तम पाया गया।

जैविक एवं अजैविक तनाव

- बिहार रोमिल सूंड़ी के अण्डोत्सर्जन तथा अण्डे देने की पसंद पटसन के कृषित और अकृषित जातियों में सार्थक रूप से भिन्न पाई गई। अण्डगुच्छ और प्रत्येक अण्डगुच्छ में अण्डों की संख्या पटसन के अकृषित जाति में सार्थकतापूर्वक कम पायी गयी।
- पटसन की फसल को पीली मकड़ी तथा लेपिडोपटेरियन कीड़ों से सुरक्षित करने के लिए स्पाइरोमेसिफेन 240 एस.सी. 0.7 मि. ली./ली. की दर से छिड़काव (36 तथा 46 दिनों बुआई उपरान्त) तथा प्रोफेनोफॉस 50 ई.सी. 2.5 मि.ली./ली. की दर से छिड़काव (66 और 77 दिनों बुआई उपरान्त) सर्वोत्तम पाया गया। पचपन दिनों के बुआई उपरान्त बहुप्रजातीय कीड़ों के संक्रमण से उपज क्षति के संबंध में ये समीकरण $Y=34.5826 - 0.219 (YM) - 0.095 (BHC+SL)$ ($R^2=0.87$) स्थापित हुआ। पीली मकड़ी की आर्थिक क्षति स्तर 42 मकड़ी/वर्ग से.मी. पत्रक क्षेत्र तथा लेपिडोपटेरियन कीड़ों के आर्थिक क्षति स्तर 10 प्रतिशत पौधों की क्षति तक निर्धारित किया गया।
- बिहार रोमिल सूंड़ी के लार्वा के वृद्धि के लिए कृत्रिम आहार जिसमें आधाारीय घटक सोयाबीन बीज का पाउडर + पत्तागोभी के पउडर + पटसन पत्ते का पाउडर समाहित था को प्राकृतिक आहार (पटसन पत्ते) की तुलना में उत्तम पाया गया है। लार्वा को जीवित रहने के लिए सोयाबीन बीज पाउडर (5 ग्रा.) एवं पटसन पत्ते का पाउडर (5 ग्रा.) अति सर्वोत्तम पाया गया।
- नई कीटनाशियों में इण्डोक्साकार्ब 15.8 ई.सी. तथा स्पाइनोसाड 45 एस.सी. की विषाक्तता बिहार रोमिल सूड़ी के प्रति प्रोफेनोफॉस की तुलना में क्रमशः 3.63 तथा 3.28 गुना अधिक पायी गयी। सापेक्षिक विषाक्तता से यह दर्शाया गया कि डायमेथोयेट की तुलना में सफेद मक्खी के प्रति इमिडाक्लोप्रिड की विषाक्तता (1075.71 गुना), डायाफेनथायोयूरोन (314.29 गुना), फ्लोनिकामिड (285.71 गुना), स्पाइरोमेसिफेन (250.26 गुना) अधिक पाया गया।
- सादा पटसन के प्रजाति जे.आर.सी.–212 के बीजों को जब बुवेरिया बैसियाना (आई.टी.टी.सी.–6551) के कोनिडियल घोल से इनॉकुलेट किया गया तो तना घुन के संक्रमण में महत्वपूर्ण कमी (15–30 प्रतिशत) देखी गयी। उपचारित पौधों के पत्तियों के उत्तकों को इलेक्ट्रोन माइक्रोस्कोप (सूक्ष्मदर्शी) में देखने से

इन्डोफाईटिक समूहों एवं हाईफल वृद्धि की पुष्टि हुई।

- संक्रमित मिलीबग से जिस इन्टोमोपौथौजेनिक कवक को निकाला गया उसको बी. बैसियाना के रूप में चिन्हित किया गया। इसकी संक्रमणता तथा प्रभाव की भी पुष्टि हुई जिसमें पाया गया कि इसके द्वारा 85 प्रतिशत माइकोसिस तथा मिलीबग के क्रॉलर्स की विनाशता तथा वयस्कों को जब कॉनिडियल घोल से उपचारित किया गया तो 30 प्रतिशत माइकोसिस हुआ।
- केनॉफ के 7 कृषित प्रजातियों और 2 अकृषित प्रजातियों में से जे. आर.एम.–3 पर सबसे कम मिलीबग वयस्क (1.22 प्रति पौधा) बचे पाये गये। बचे हुए वयस्कों के क्रॉलर्स सबसे अधिक डब्ल्यू.एच. आई.एन.–47 (439.69) में पाया गया जबकि सबसे कम डब्ल्यू.एच. आई.जे.–50 (39.28) में पाया गया। क्रॉलरों का अस्तित्व सबसे कम डब्ल्यू.एच.आई.एन.–050 (35.66 प्रतिशत) में तथा सबसे ज्यादा एच.सी. 583 (60 प्रतिशत) में था। मादा विकास अवधि एच.सी. 583 (16.33 दिन) की अपेक्षा डब्ल्यू.एच.आई.जे.–050 (22 दिन) में ज्यादा थी।
- मेस्ता येलोवेन मोजैक विषाणु के वाहक संबंधों से ये पता चला कि पोषण पाने की अवधि जितनी अधिक होती है विषाणु का संप्रेषण उतना ही अधिक होता है। अगर वाहक कीट के पोषण की अवधि 6 घंटे की हो तो विषाणु संप्रेषण दर 100 प्रतिशत तक होती है। इक्कीस दिन के मेस्ता के पौधों पर शत–प्रतिशत रोग संप्रेषण हेतु केवल 15 संक्रमित सफेद मक्खियों की संख्या ही पर्याप्त थी।
- रेमी के फसल में पहली बार पर्ण आवरण, जो कि प्लूयरोटोपा स्पे. (लेपीडोप्टेराः क्रैमबीडी) द्वारा उत्पन्न हुआ, पाया गया। साथ ही, कॉलर रॉट रोगाणु स्कलेरोशियम स्पे. को भी पहली बार चिन्हित किया गया। इन दोनों पीड़क और रोग को नांमाकित तथा दर्ज कर लिया गया।
- तना सड़न विकास में, पोषक पौधे तथा रोगजनक के संक्रमण अवधि की भूमिका को चिन्हित कर लिया गया है। पौधे की आयु बढ़ने के साथ ही चित्ती का आकार भी बढ़ा हुआ पाया गया जो कि 70 दिन वाले पौधे में उससे कम अवधि के पौधे की अपेक्षा ज्यादा था। रोग संक्रमण क्षमता, इनोकुलम की बढ़ती आयु के साथ घटता है तथा एम. फैजीओलीना का 24 घंटे पुराना कल्चर सबसे कम प्रभावी पाया गया।
- पंक्ति में लगाये पौधे की तुलना में छिटकवां विधि से लगाए गये पटसन पौधे में तना सड़न ज्यादा पाया गया क्योंकि पौध घनत्व बढ़ने के साथ तना सड़न का संक्रमण बढ़ता है। ऐसा इसलिए होता है क्योंकि पंक्तिबद्धता होने से पौधे में वायु का अच्छा गमन होता है जो कि रोग पैदा करने वाले वातावारण पर विपरीत प्रभाव पैदा करता है।
- पच्चीस दिनों के पटसन पौधों पर जब ट्राइकोडर्मा के विभिन्न विभेदों का संवर्द्धन देखा गया तो–टीवी.सी.–1 (300×10^3 सी. एफ.यू./ग्रा. शुष्क मिट्टी) में सबसे ज्यादा एवं इसके बाद एन.बी. ए.आई.आई. टी.एच.–1 तथा एन.बी.ए.आई.आई.टी.एच. 10 (183×10^3 सी.एफ.यू./ग्रा. शुष्क मिट्टी) का स्थान था। जहां तक रोग वृद्धि पर इनके प्रभाव की बात है तो टी.वी.सी.–1 आइसोलेट में सबसे ज्यादा समरूपता (56.8 प्रतिशत वृद्धि रोधक) तथा सबसे ज्यादा पुष्टता सूचकांक भी दर्ज किया गया।
- स्यूडोमोनस फ्लूरोसेन्स के पाँचों विभेदों (एन.बी.ए.आई.आई.–आरकृ जे. 9, एन.बी.ए.आई.जी.आर.–3, एम.टी.सी.सी. 6035, एम टी सी सी 1749 तथा पी एफ–1) ने ऑक्सीडेज, आई.ए.ए., लाइपेज, सीडेरोफोर, फ्लूरोसेन्स तथा फॉस्फेट घुलनशीलता को उत्पन्न कर पौध सवंर्धन में सहायता की। ट्राइकोडर्मा के वृहत पैमाने पर गुणात्मक वृद्धि हेतु, जिसमें कि अधिकतम बीजाणु संख्या होती है, के लिए गेहूँ दाने के सब्सट्रेट काफी सहयोगी पाये गये।
- रेमी में करवुलेरिया एरेग्रोस्टीडिस द्वारा उत्पन्न पर्ण चित्ती रोग को कार्बेन्डाजीम (0.25 प्रतिशत) तथा हेक्साकोनाजोल (0.1 प्रतिशत) के पर्णीय छिड़काव द्वारा सबसे प्रभावी ढ़ंग से प्रबंधन किया गया।
- अंकुरण पूर्व शाकनाशी, प्रेटिलाक्लोर (50 प्रतिशत ईसी) 0.9 लि./है. की दर से बुआई से 48 घंटा पूर्व प्रयोग करने से तथा साथ में एक मानवीय श्रम द्वारा खरपतवारों तथा चौड़ी पत्ती वाली खरपतवारों खासकर ट्राइएन्थेमा पोर्टूलैकेस्ट्रम का नियंत्रण अच्छे से होता है तथा रेशा उपज भी अधिकतम होता है।
- मृदा प्रोफाईल के 10–30 सेंमी. गहराई पर मृदा भेदन प्रतिरोध में सबसे ज्यादा भिन्नता देखी गयी। इस गहराई पर मृदा पी आर का आकार 2 MPa प्राप्त किया गया जो कि शत–प्रतिशत एन.पी. के.+एफ.वाई.एम. उपचारित प्लॉटस् में था जबकि खुदे हुए परती भूमि में यह सार्थक रूप से नियंत्रित प्लॉट्स और शत प्रतिशत एन.पी.के. प्लॉट्स से कम था।
- भूमि नमी अभाव वाले (> 4 बार भूमि नमी तनाव अथवा < 10 प्रतिशत भूमि आर्द्रता) जगह पर जब पटसन के पाँच प्रजातियों को उगाया गया तो उनके कुल शुष्क भार, छाल शुष्क भार, पर्ण सापेक्ष जल मात्रा में कमी देखी गयी जिनका स्तर क्रमशः 49. 70–70.70, 54.10–75.90 और 25.90–39.20 पाया गया।
- मृदा पी.एच. 7.98 तथा ई सी (डी एस/मी.): 0.829, 2.831 तथा 4.432 जो कि क्रमशः 0–30 सें.मी., तथा 60–90 सें.मी. मृदा गहराई पर था, में ऑलीटोरियस के प्रजाति जे.आर.ओ. 8432 तथा कैपसूलरिस के प्रजाति जे.आर.सी. 512 को उगाने पर, उपज को प्रभावित करने वाले गुणों का सबसे ज्यादा मान देखा गया। शुष्क भार क्रमशः 135 ग्रा. एवं 98 ग्रा. एवं 98 ग्रा. तथा बीज उपज

क्रमशः 1012 कि.ग्रा./है. एवं 749 कि.ग्रा./है. पाया गया।

फार्म यंत्रीकरण एवं कटाई उपरांत तकनीकी

- पटसन के साथ अंतर फसल के रूप में दलहनी फसलों जैसे मूंग तथा मसूर की बुआई हेतु वर्तमान बीजकयंत्र (सीड ड्रिल) को संशोधित करके 5 ड्रम वाला बनाया गया है जो 20 से.मी. के अंतराल में बुआई कर सकता है।
- पटसन एवं अन्य फसलों में से खरपतवार हटाने वाले उपकरण को विकसित किया गया है। इसकी क्षेत्र क्षमता 0.022 हे./घंटा एवं निराई दक्षता 86.17 प्रतिशत है।
- खड़े अथवा कटे हुए पटसन के पौधे से पत्तियाँ छुड़ाने के लिए एक औजार तैयार किया गया है। यह औजार एक मिनट में 5–6 पौधों से पत्तियां हटा सकता है।
- पश्चिम बंगाल के छः जिलों से सड़न (रेटिंग) जल के नमूने एकत्रित किए गए। इन नमूनों में प्रभावी जायलान एवं पेक्टिन विघटित करने वाले सूक्ष्मजीवी देखे गये हैं। क्रिजेफ सूक्ष्मजीवी मिश्रण में एस–3, एस–7 एवं एस–9 स्ट्रेन अधिक लिग्नोलाइटिक क्षमता वाली हैं जबकि पी.जे.आर.बी.–2 स्ट्रेन अधिकतम जाइलानेज उत्पादक हैं।
- उन्नत सूक्ष्मजीवी मिश्रण द्वारा सड़न की प्रक्रिया को बढ़ावा देने के लिए कुल 776 बड़े पैमाने पर प्रदर्शन किये गये। यह प्रदर्शन पश्चिम बंगाल के जिलों में, असम के नौगांव जिले में, बिहार के किशनगंज एवं पुर्णिया जिलों तथा आंध्रप्रदेश के विजियानगरम जिले में किये गये। इस उन्नत तकनीकी से सड़न करने पर सड़न अवधि 4–7 दिनों तक कम हो जाती है एवं रेशों का रंग भी निखर जाता है। इस तकनीकी द्वारा किसान 4590 रूपये प्रति हेक्टर अतिरिक्त कमाई कर सकता है। इस तकनीकी से अधिकतम (86 प्रतिशत) किसान बहुत संतुष्ट थें।
- आशाजनक पेक्टिनोलाइटिक नस्लों में से एस–33 एवं एस–11 नस्लों को चुना गया है। ये नस्लें कम सेल्यूलोज तथा अधिक पेक्टिनेज गतिविधि रखत हैं। इन नस्लों की रेमी के रेशे से गोंद छुडाने की क्षमता प्रयोगशाला पैमाने पर (2–5 ग्राम सूखा रेमी–रेशा) क्रमशः 22.1 प्रतिशत एवं 23.4 प्रतिशत आंकी गई है। जबकि रासायनिक विधि की क्षमता 26 प्रतिशत है। कृषि अपशिष्ट एवं पटसन सड़न तालाबों में से कुल 96 नमूने एकत्रित किये गये। इनमें से न्यूनतम सेल्यूलेज गतिविधि के आधार पर छह गोंद छुड़ाने वाले सूक्ष्मजीवों का चयन किया गया।

पटसन एवं समवर्गीय रेशा सूचना विज्ञान

- सनई सूचना तंत्र को विकसित किया गया है। इसमें सनई उत्पादन के विभिन्न पहलुओं जैसे किस्मों, खरपतवार प्रबंधन, मृदा एवं जल प्रबंधन, कीट एवं रोग प्रबंधन को समायोजित किया गया है। जैफएक्सपर्ट (जूट) के मौजूदा स्वरूप को सुधार कर ज्यादा सूचना एवं उपभोक्ता उपयोगी बनाया गया है।
- जी.आई.एस. के द्वारा पटसन एवं मेस्ता उत्पादन क्षेत्रों एवं उत्पादकता को भारत के मानचित्र में दर्शाया गया है। पटसन उत्पादन करने वाले पश्चिम बंगाल के 17 जिलों में से अधिकतम क्षेत्रफल मुर्शिदाबाद एवं नदिया जिलों के अंतर्गत है। वर्तमान में पटसन रेशा उत्पादकता 21.1 कु./हे. से बढ़कर 24.8 कु./हे. हो गई है।
- पटसन उत्पादन की विभिन्न तकनीकों जैसे किस्में, पोषक तत्व प्रबंधन, खरपतवार प्रबंधन कीट एवं रोग प्रबंधन एवं कटाई उपरांत तकनीकी आदि विषयों पर 427 किसानों को मोबाइल सलाहकार सेवा के द्वारा 16500 एस.एम.एस. भेजे गये।

प्रौद्योगिकी हस्तान्तरण

- पटसन की अग्रिम पंक्ति प्रदर्शन में अधिक रेशा उपज देने वाली प्रजातियों में से जे.आर.ओ.–204 द्वारा सर्वाधिक उपज (32.53 कु./हे.) दर्ज की गई। समन्वित खरपतवार प्रबंधन द्वारा रेशा उपज में 1.62–5.05 कु./हे. तक वृद्धि हुई। 'नेल वीडर' द्वारा खरपतवार प्रबंधन से उपज में 3.04–5.05 कु./हे. तक वृद्धि के साथ–साथ 6,348–9,438 रू./हे. तक की बचत हुई। बहु पंक्ति सीड ड्रील द्वारा अन्तःकर्षण तथा यांत्रिक/रासायनिक विधि द्वारा खरपतवार के प्रबंधन में सुविधा होने से 3,740–5,512 रू0/हे. तक की बचत हुई। सूखे की दशा में पारम्परिक विधि की तुलना में संस्तुत उर्वरकों (60:30:30) के साथ–साथ तथा सल्फर (30 कि.ग्रा./है.) प्रयोग करने से अधिकतम शुद्ध आय 42,309 रू0/हे. की प्राप्ति हुई। पटसन एवं मेस्ता की फसल में क्रिजेफ सोना द्वारा उन्नत सड़न तकनीक के कुल 22 प्रदर्शनों का आयोजन पश्चिम बंगाल, बिहार, असम एवं आंध्र प्रदेश में किया गया। इससे पटसन एवं मेस्ता रेशे की गुणवत्ता में वृद्धि (1–2 श्रेणी) के साथ–साथ शीघ्र सड़न (सामान्य से 6–7 दिन पहले) देखी गई। इसके अतिरिक्त इस विधि से, पारम्परिक सड़न की तुलना में, अधिक रेशा की प्राप्ति भी हुई।
- अधिकतम कृषकों के अनुसार, संचार प्रौद्योगिकी (आई.सी.टी.) कृषि संचार के लिए एक अनुकूल माध्यम है। उनके द्वारा एस एम एस आधारित कस्टमाइज्ड सूचना वितरण को सर्वाधिक वरीयता दी गई। कृषि संचार की उपलब्धता तथा इसमें प्रशिक्षण की सुविधा का अभाव इसके प्रसार में मुख्य अवरोधक थे।
- इसके अतिरिक्त विभिन्न प्रसार गतिविधियों द्वारा भी तकनीकों का प्रचार–प्रसार किया गया जिनमें प्रदर्शन, वैज्ञानिक–किसान

वार्तालाप, कृषि मेला, प्रशिक्षण, चेतना शिविर प्रमुख थे। साथ–ही–साथ स्थानीय समाचार पत्रों, टी.वी चैनल और ऑल इण्डिया रेडियो में हमारे तकनीकों/गतिविधियों के बारे में भी छपा और प्रसारित हुआ ताकि अधिक से अधिक किसान भाई इसका लाभ उठा सकें।

आदिवासी उपयोजना (टी.एस.पी.)

- आदिवासी कृषक परिवारों की जीविका सुरक्षा बढ़ाने के लिए उत्तर 24 परगना जिले के दो ब्लॉक एवं दक्षिण दिनाजपुर, नदिया एवं बांकुड़ा जिलों के एक–एक ब्लॉक में आदिवासी उपयोजना (टी.एस.पी.) की गतिविधियाँ शुरू की गई।
- कृषि संबंधित कई गतिविधियाँ जैसे पटसन उत्पादन की उन्नत तकनीकी, 'क्रिजेफ सोना' से पटसन की सड़न विधि, पटसन के कपड़े के स्तम्भ में सब्जी उत्पादन, मछली पालन, मुर्गी एवं बतख पालन आदि शुरू की गयीं जिससे आदिवासी कृषक परिवारों की जीवनयापन शैली में सुधार हुआ।
- उड़ीसा एवं झारखण्ड में सीसल का नया पौध रोपण किया गया इसी प्रकार असम, मेघालय एवं अरूणाचल प्रदेश राज्यों में रेमी की रोपण सामग्री वितरित की गई।
- मृदा परीक्षण एवं मृदा परीक्षण आधारित फसल प्रतिक्रिया के बारे में आदिवासी किसानों में जागरूकता उत्पन्न की गई। इसके अलावा पश्चिम बंगाल, ओडिशा एवं असम के 6 गाँवों में पटसन उत्पादन की उन्नत तकनीकों का प्रदर्शन किया गया।
- मानव संसाधन विकास कार्यक्रम के अंतर्गत आदिवासी परिवारों को 33 उन्नत उत्पादन तकनीकों का प्रशिक्षण दिया गया।

अखिल भारतीय नेटवर्क परियोजना

- तीन प्रजातियों जिनमें तोषा पटसन की जे.आर.ओ.जी.–1, सनई की जे.आर.जे.–610 तथा फ्लैक्स की जे.आर.एफ.–2 प्रजातियों को विमोचित किया गया। जे.आर.एफ.–2 फ्लैक्स की पहली विमोचित प्रजाति है। इसके अतिरिक्त केनॉफ की जे.बी.एम.जी. तथा जे. बी.एम.पी.–2, रोजेल की चार प्रजातियाँ यथा केन्द्रीय रोजेल जे. बी.आर.पी.–1, केन्द्रीय रोजेल ए.एम.वी.–9, क्रिजेफ आर.–2 एवं क्रिजेफ आर.–8, को चिन्हित कर विमोचन के लिए भेजा गया है।
- तोषा तथा सादा पटसन के अलग–अलग 75 तथा रोजेल के 158 जननद्रव्यों का मूल्यांकन उनके चेक प्रजातियों के साथ विभिन्न केन्द्रों पर किया गया। पटसन एवं समवर्गीय रेशा फसलों के विकसित नवीनतम प्रभेदों का बहुस्थानीक मूल्यांकन भी विभिन्न परीक्षणों जैसे आई.ई.टी., ए.वी.टी. तथा अनुकूली परीक्षण के अन्तर्गत किया गया।
- अंकुरण पूर्व शाकनाशी प्रेटिलाक्लोर 900 मि.ली./हे. के साथ हाथ से एक निराई अथवा दो बार नेल वीडर चलाने (अंकुरण के 5 एवं 10 दिन बाद) तथा हाथ से एक निराई (पंक्तियों में) करने से खरपतवार की संख्या में कमी के साथ पटसन रेशा उपज में सार्थक वृद्धि होती है।
- क्रिजेफ द्वारा विकासित पाउडर आधारित सूक्ष्मजीवी सम्मिश्रण (क्रिजेफ सोना) के प्रयोग से बहराईच, कल्याणी तथा अमाडालवालसा में पटसन एवं मेस्ता सड़न अवधि 6–7 दिनों तक कम हो गई, रेशा शक्ति 3–4 ग्रा./टेक्स बढ़ा साथ ही रेशा के रंग और चमक में भी उन्नति हुई। जबकि नौगांव, केन्द्रापाड़ा तथा कटिहार में सड़न अवधि क्रमशः 9–10 दिन, 6 दिन तथा 6–8 दिनों तक कम हुई।
- पीली माइट का प्रकोप लगभग सभी केन्द्रों पर देखा गया। इसका अधिकतम प्रकोप नौगांव, केन्द्रपाड़ा, कूचबिहार, बहराईच, कटिहार तथा बैरकपुर में क्रमशः 8.62, 10.38, 25.62, 64.45, 89. 33 तथा 129.39 माईट संख्या/वर्ग से.मी. तक पायी गयी जिसे मई के अंतिम सप्ताह से मध्य जून तक बुआई के 45–75 दिनों के अन्तराल पर देखा गया।
- केन्द्रपाड़ा, बैरकपुर, कूचबिहार, नौगांव तथा कटिहार केन्द्रों पर एजॉक्सीस्ट्रोबीन और डाईफेनॉकोजोल 1.0 मि.ली./ कि.ग्रा. बीज की दर से बीजोपचार तथा बुआई के 45 दिनों उपरान्त एजौक्सिस्ट्रोबीन डाईफेनॉकोनाजोल 0.075 प्रतिशत का छिड़काव पटसन तना सड़न रोग के प्रबंधन में अत्यन्त प्रभावी पाया गया।

महिला सशक्तिकरण

- आदिवासी महिलाओं में श्रम को कम करने के लिए क्रिजेफ द्वारा निर्मित 'नेल वीडर' उपकरण से अवगत कराया गया।
- कृषि महिलाओं को सशक्त बनाने के लिए गांवों में क्रिजेफ द्वारा साक्षरता कक्षाएं शुरू की गयी जिससे महिलाओं में आत्मविश्वास की वृद्धि होगी और वे कृषि संबंधित विकासों के बारे में जागरूक होंगीं।
- कृषि महिलाओं में उद्यमिता विकास की गतिविधियों के द्वारा उत्तर 24 परगना के 11 स्वसहायता समूहों को क्रियाशील किया गया है।
- फसल विविधिकरण की तकनीकों जैसे दलहनों, सब्जियों एवं मछली पालन, बतख एवं मुर्गी पालन के समायोजन से आदिवासी कृषि महिलाओं की पोषण सुरक्षा में सुधार हुआ है।
- क्रिजेफ की महिला इकाई द्वारा 9 मार्च, 2015 को अंर्तराष्ट्रीय महिला दिवस का आयोजन किया गया जिसमें आस–पास के

गाँवों से कुल 60 महिलाओं तथा स्वसहायता समूहों ने भाग लिया। इस कार्यक्रम का मुख्य विषय "महिला सशक्तिकरण : मानवता सशक्तिकरण" था।

कृषि विज्ञान केन्द्र

- कृषि विज्ञान केन्द्र, बर्द्धमान ने 10 ऑन फार्म ट्रायल (ओ.एफ.टी.), 15 प्रथम पंक्ति प्रदर्शन (एफ.एल.डी.), 58 प्रशिक्षणों का आयोजन किया जिनमें फसल उत्पादन एवं पशुपालन की तकनीकों के बारे में बताया गया। इन आयोजनों में 3555 किसानों, कृषि महिलाओं, ग्रामीण जवानों तथा कृषि विस्तार कार्यकर्ताओं ने हिस्सा लिया।
- कृषि विज्ञान केन्द्र ने किसानों एवं अन्य हिस्सेदारों में जागरूकता लाने के लिए कृषि बागवानी, पशुपालन की विभिन्न तकनीकों के विषय पर विभिन्न भ्रमणों, क्षेत्र दिवस, विधि प्रदर्शन तकनीकी सप्ताह, पशु स्वास्थ्य शिविरों का आयोजन किया गया।

Introduction

ICAR-Central Research Institute for Jute and Allied Fibres is one of the oldest premier research institutes of NARS conducting basic, strategic, anticipatory and applied research on all aspects of jute and allied fibre crops. The institute popularly known as ICAR-CRIJAF was initiated with the inception of Indian Central Jute Committee (ICJC) in 1936. Subsequently, Jute Agriculture Research Laboratory (JARL) was established in 1938 at Dhaka, now in Bangladesh which was later shifted to Chinsura in West Bengal in 1948, and then to Barrackpore, and finally established at the present place (Nilgunj, Barrackpore) in 1953 as Jute Agricultural Research Institute (JARI). ICJC was taken over by Indian Council of Agricultural Research (ICAR) in 1966. The institute was rechristened to its present name, Central Research Institute for Jute and Allied Fibres (CRIJAF) in January, 1990. To carry out research on jute and allied fibres and seed production, four research stations i.e., Ramie Research Station, Sorbhog, Assam (in 1959), Sisal Research Station, Bamra, Odisha (in 1962), Sunnhemp Research Station, Pratapgarh, Uttar Pradesh (in 1963) and Central Seed Research Station for Jute and Allied Fibres, Bud Bud, West Bengal (in 1956) were established. The institute has played major role in developing and popularizing more than 50 varieties of jute and allied fibre crops which have doubled the productivity with considerable reduction in harvest period which enabled this crop to establish in the cropping sequence of different jute and allied fibres growing states. Besides the institute has developed important technologies related to crop production and protection, improved retting, improved machineries for fibre extraction and intercultural operation, and seed production. ICAR-CRIJAF is also leading in jute genomic research, maintenance of related database and germplasm of jute and allied fibre crops.

Location

It is located at 88°26E longitude and 22°45N latitude at an altitude of 9 m above mean sea level. The institute is situated at 5 km east of Barrackpore Railway Station and is well connected with NSCB International Airport, Kolkata (18 km) and Howrah Railway Station (35 km).

Mission

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

Vision

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

Mandate

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

Organizational Setup

The main institute has 3 divisions *viz.,* Crop Improvement, Crop Production, Crop Protection and Agricultural Extension section at the headquarters to meet research and extension needs in specific areas. The main institute has well-equipped laboratories pertaining to genomics, phenomics, biotechnology, biochemistry, fibre quality, physiology, soil science, microbiology, plant protection and agricultural chemicals. The regional stations with farm and laboratory facilities work on specific mandate crops and seed production. The research management is supported by different sections/cells like PME cell, administration, finance and accounts, purchase and store, library, farm, meteorological unit etc. The institute and the stations have the facility of well laid out research farm with irrigation facility for conducting the field experiments and seed production.

Sunnhemp Research Station, Pratapgarh, Uttar Pradesh

In 1963, on the recommendation of Indian Central Jute Committee (ICJC) the Sunnhemp Research Station was established at Pratapgarh, UP. For a short period it was under the control of Director, Directorate of Jute Development. Later on from 1966 it was under the control of Jute Agricultural Research Institute, JARI (presently ICAR-CRIJAF). The Station moved over to its present campus in 1974. The research on crop improvement, seed and fibre production technology of sunnhemp is exclusively done by this station. It has a research farm, laboratories, office and staff quarters in 9.18 ha campus.

Ramie Research Station, Sorbhog, Assam

Ramie Research Station (RRS) of ICAR-CRIJAF was established at Sorbhog, Assam in 1959 in 56 ha area. This station is engaged in the development of improved technology for ramie crop cultivation which is very specific to NE states. Since its inception, RRS is playing important role in development and promotion of technology, generation and distribution of planting materials for area expansion and profitable ramie cultivation.

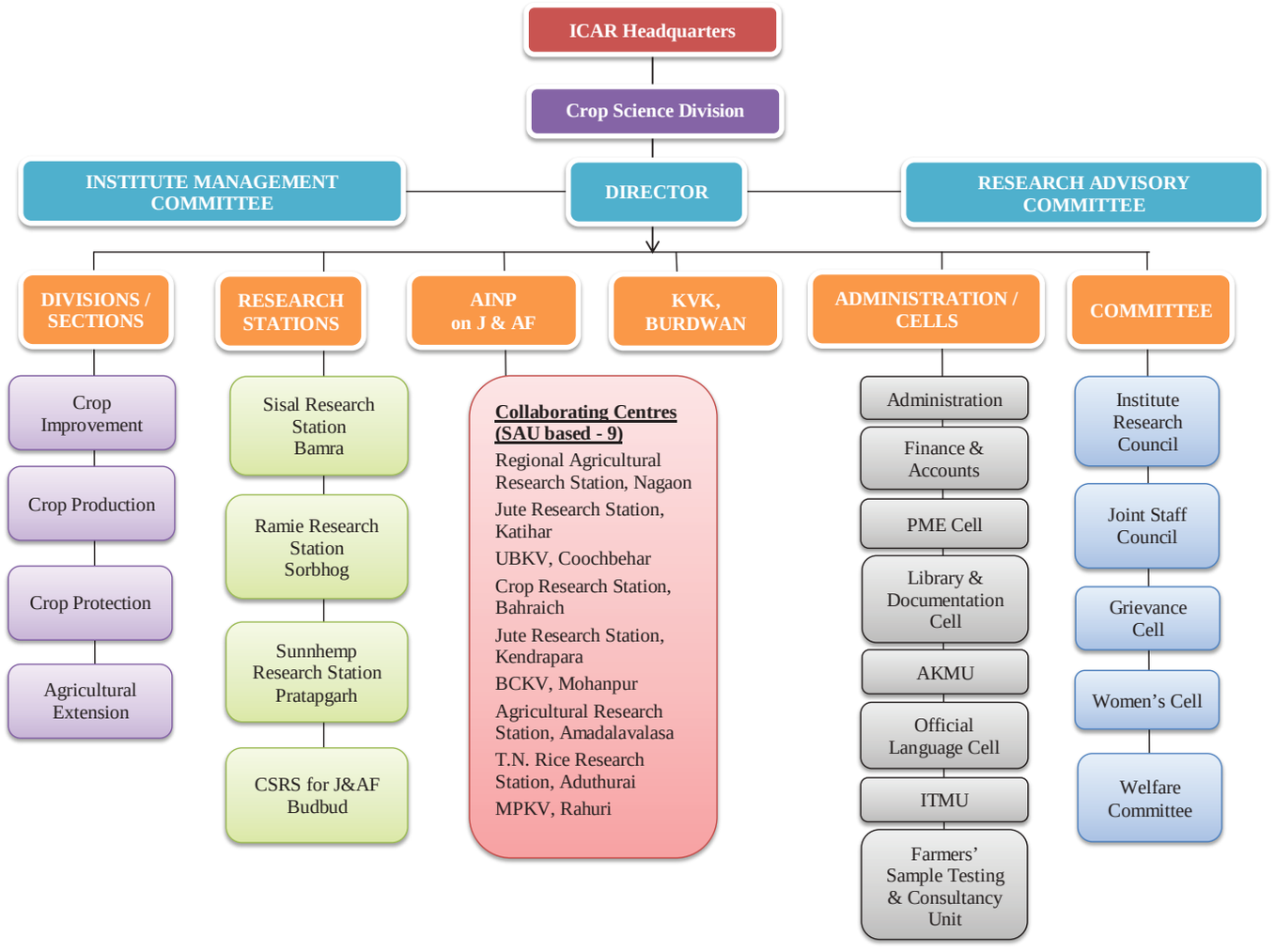
Sisal Research Station, Bamra, Odisha

Sisal Research Station (SRS) was established in 1962 in Sambalpur district of Odisha. This research station mainly deals with research on sisal, a hard fibre crop. The research station has an area of 107.7 ha with mandate of maintenance of agave germplasm, improvement of sisal for yield, quality, biotic, abiotic stress, development of economically viable and sustainable production technology and cropping system with sisal and entrepreneurship development. Recently thrust was given on sisal area expansion programme.

Central Seed Research Station for Jute and Allied Fibres, Bud Bud, West Bengal

Central Seed Research Station for Jute and Allied Fibres (CSRSJAF) previously known as Central Nucleus Jute Seed Multiplication Farm, was established in 1962 at Bud Bud, Burdwan, West Bengal. The station has 65 ha research farm, seed processing and storage unit, mobile seed processing unit, combined harvester to support the quality seed production activity. This station mainly deals with the production of nucleus seed of jute and allied fibres through maintenance breeding, production of breeder seed of jute, mesta and sunnhemp and production of quality seed (foundation, certified & TL) of jute and other field crops.

Organogram



All India Network Project on Jute and Allied Fibres (AINP JAF)

The coordinating cell of All India Network Projects on Jute and Allied Fibres (AINP JAF) is headquartered in the institute. At present, this project has 15 centres including 9 SAU-based and 6 ICAR-institute based collaborative centres for multilocational evaluation of varieties, validation of production and protection technologies and quality evaluation of the fibres of jute and allied fibre crops.

Krishi Vigyan Kendra (KVK), Bud Bud, Burdwan, West Bengal

KVK, Bud Bud was established in 2005 in 18 ha area in the campus of Central Seed Research Station for Jute and Allied Fibres, Bud Bud, Burdwan under the administrative control of ICAR-CRIJAF. The KVK is actively involved in the transfer of technology through On-farm trials, frontline demonstrations, capacity building through hand-on training and other promotional extension activities in agriculture and other allied fields of horticultural crops, animal husbandry, fishery and home science. The KVK is well equipped with facilities like trainees hostel, soil testing laboratory, seed production unit and demonstration units like vermicompost production unit, integrated farming system, well maintained mix-fruit orchard, portable carp hatchery, goatery etc.

Agricultural Knowledge Management Unit (AKMU)

Agricultural Knowledge Management Unit (AKMU) facilitates the e-governance and manages research information on jute and allied fibre crops. It provides stable, secured and uninterrupted internet facility to the whole campus. In order to implement the online ICAR-ERP solution the facility of high speed internet connectivity along with secured Wi-Fi systems have been created. The unit is also responsible for maintenance and updation of institute website. The backbone for operating the e-extension, mobile advisory services and other related activities is also supported by AKMU.

Institute Technology Management Unit (ITMU)

Institute Technology Management Unit (ITMU) deals with protection of intellectual properties (IPs), their maintenance and commercialization of the technologies developed by the institute. ITMU chaired by the Director is the apex decision making body of the institute regarding IP management and their commercialization. It also looks after consultancy, contract research, patents, technology protection protocols, licensing etc.

Prioritization, Monitoring and Evaluation (PME) Cell

The PME cell of ICAR-CRIJAF was established as per guidelines of the Council. The PME cell of the Institute is working as “Single window” system for priority setting, research monitoring and evaluation, maintenance of data bases related to projects, achievements, technologies developed, publication etc. PME cell assists the Director of the institute in evaluation, assessment, monitoring, management and co-ordination of all the on-going in-house as well as externally funded projects.

Library

The institute library, information and documentation unit has rich collection of books and journals especially on jute and other allied fibre crops such as sisal, ramie, flax, sunnhemp, mesta, etc. It serves the research community with the information at their desks. This library maintains the rare collections of many research, policy papers and books with respect to jute. It is the only library which maintains and provide services to researchers, students and other stakeholders specific to jute and allied fibre crops.

Human Resource Development

The institute has been recognized for research work for M.Sc and Ph.D programmes by the Presidency University, Calcutta University and R.K.M. Vivekananda University. Beside, the institute also conducts short term summer training for M.Sc students of SAUs and general universities (Govt. or private) on payment of appropriate fees. The extension section of the institute also conducts training to farmers and the other stakeholders of jute and allied fibre sector.

Management Information System (MIS)/ Financial Management System (FMS) Unit

For effective control of Management Information System and Financial Management System of the institute, ICAR-ERP solution was implemented at ICAR-CRIJAF. The infrastructural facility and the human resources have been appropriately developed for effective implementation of e-governance. The institute also acts as the nodal centre for providing necessary guidance to the other ICAR-institutes in Eastern India for successful implementation of MIS-FMS. The MIS-FMS unit of the institute actively attends the doubts and any specific problem faced by the employees while working in ERS solution.

Women Cell

The institute women cell addresses the issues related to grievances of women employees in the HQ and in different regional research stations. This cell also organizes training and awareness programmes for the women on agriculture and other allied activities for enhancing their income and over all involvement in the management of family and welfare of the society.

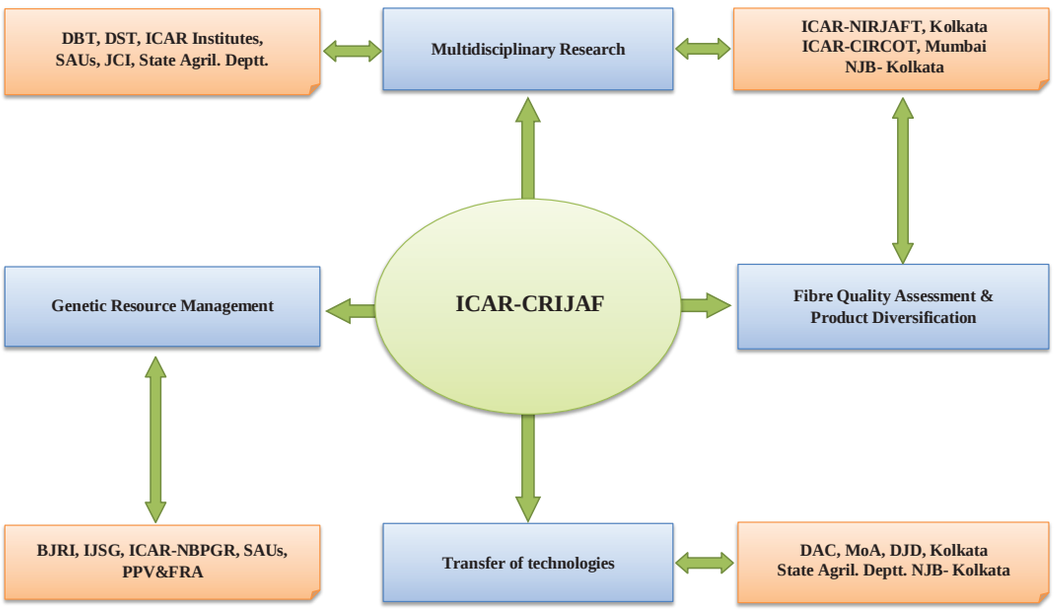
Regional Centre of National Agricultural Education Accreditation Board

On recommendation of the accreditation board of ICAR, this institute (ICAR-CRIJAF) has been selected as the nodal centre for eastern and north-eastern region for facilitating the submission of self-study reports of the agricultural universities/colleges and other modalities required for accreditation.

Linkages

Apart from the 9 SAUs engaged in research on JAF crops, the institute has strong linkage with national and international organizations in the field of research, training and policy matters. The institute has R & D collaboration with national funding bodies like DBT, BARC, NASF, NJB, DST (West Bengal), and NFSM (DAC, MoAC). Besides collaborative programmes are also going on with DJD, ICAR-NIRJAFT, ICAR-CIRCOT, IJIRA, JCI, NJB for research, training and developing effective policies for the sector. The international organization like BJRI, Dhaka and IJSG, Dhaka are also associated for R & D activities on jute with ICAR-CRIJAF.

Linkages



1. Crop Improvement

1.1 Genetic Resource Management

Collection, evaluation, characterization, conservation and utilization of jute and allied fibre (JAF) germplasm were conducted as continuous activities of NAGS, ICAR-CRIJAF Barrackpore.

1.1.1 Germplasm exploration and conservation

A total of 78 accessions including wild and cultivated species of jute and allied fibres (*Corchorus aestuans*: 43; *C. olitorius*: 24; *H. sabdariffa*: 5; *Urena* sp. 01; other fibre spp. 03) were collected from the south western part of Odisha constituting Ganjam, Gajapati and Kandhamal districts in collaboration with ICAR-NBPGR in December, 2014 (Fig. 1.1). In 2014-15, a total of 1165 germplasm accessions of JAF (*C. capsularis:* 956, *H. sabdariffa:* 59, *H. cannabinus:* 67, Wild: 83) were regenerated at ICAR-CRIJAF, Barrackpore *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar and Maruthi R.T.).*

Corchorus aestuans *Corchorus olitorius* *Hibiscus sabdariffa*

Fig. 1.1. Jute and allied fibre crop species in the natural habitat

The genepool of Ramie Research Station (RRS) was enriched with 25 germplasm accessions of *Boehmeria* spp. collected from lower Assam, North Bengal and Sikkim during the month of February, 2015. All the 25 accessions were planted in the introduction plot of RRS for further study and characterization. As per the preliminary identification of accessions, three accessions are cultivated type (*Boehmeria nivea*) *(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande).*

1.1.2 Characterization, evaluation and utilization

Newly collected accessions of *Corchorus* (*C. olitorius*, *C. trilocularis*, *C. aestuans*, *C. fascicularis*, *C. pseudo-olitorius*), *Hibiscus* (*H. sabdariffa*, *H. cannabinus*, *H. suratensis*), *Crotalaria* spp. and *Urena* spp. collected from Tamil Nadu and Kerala were characterized using morphological and quantitative traits for the second year. Most of *Hibiscus sabdariffa* accessions were bristleless, a desirable trait for mesta crop. Further, a total of 180 accessions (*C. olitorius*: 100 and *Corchorus* wild species: 80) were screened *in vivo* for stem rot resistance and three accessions (*C. aestuans*- WCIN-136; *C. fascicularis*-WCIJ-28, WCIJ-150) were found to be resistant against the biotic stress (Fig. 1.2). A wide cross between *C. olitorius* and *C. aestuans* (stem rot resistant) was made to introgress the stem rot resistance to cultivated background and to study the genetics of disease resistance. The F_1 phenotypically resembles the *olitorius* parent with normal leaves and pods but stem, stipule and petiole pigmentation resembles *C. aestuans* *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar and Maruthi R.T.).*

C. fascicularis (WCIJ-28) *C. aestuans* (WCIN-136)

Fig. 1.2. Stem rot resistant accessions of *Corchorus* spp.

A total of 155 ramie stocks from five populations were investigated for start codon targeted (SCoT) polymorphism. Polymorphic information content and resolving power of the SCoT markers were 0.69 and 3.22, respectively. The Indian ramie populations exhibited high SCoT polymorphism (>50%), high genetic differentiation (GST = 0.27) and moderate gene flow (Nm = 1.34). Analysis of molecular variance identified significant differences for genetic polymorphism among the population explaining 13.1% of the total variation. Cluster analysis supported population genetic analysis and suggested close association between introduced and domesticated genotypes (Fig. 1.3).

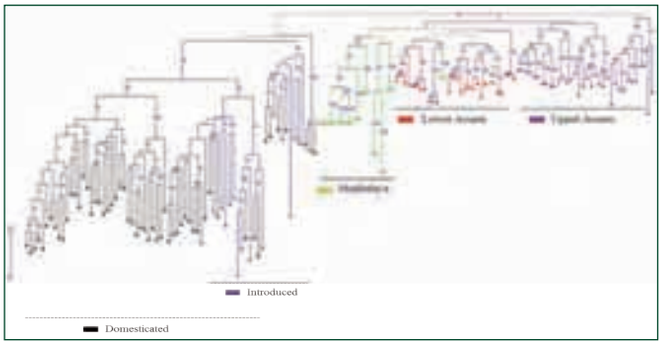


Fig. 1.3. Dendrogram showing relationship of *B. nivea* populations based on Jaccard's similarity coefficient. Bootstrap values are indicated at each node

Close genetic association between ramie populations of lower Assam with both Meghalaya and Upper Assam

indicates a gradient of pollen and gene flow from Meghalaya to Lower Assam and Upper Assam. In contrast, the genetic distance between ramie populations of Upper Assam and Meghalaya are higher, which indicates a barrier of gene flow *(Source: NFBSFARA FQ 3030. Contributors: P. Satya, S. Mitra (CRIJAF) and D.P. Ray (NIRJAFT)).*

In ramie, previously identified seven germplasm lines were evaluated for fibre yield and attributing traits for two cuttings in off season (winter) under irrigated conditions at RRS, Sorbhog, Assam (Table 1.1). Furthermore four germplasm accessions (3 exotic, 1 indigenous) of ramie were evaluated for three different concentrations (0.2%, 0.4% & 0.6%) of glyphosate to assess herbicide tolerance. Data collected on plant height and number of sprouts/plant at 45 DAS. Accession R-67-34 was found to have somewhat tolerance (Table 1.2) *(Source: RB 1.0. Contributors: A.K. Sharma and S.P. Gawande).*

Table 1.1. Evaluation of ramie germplasm during off season (winter) irrigated conditions

Genotypes	Plant height (cm)		Basal diameter (cm)		Fibre recovery (%)	
	I Cutting	II Cutting	I Cutting	II Cutting	I Cutting	II Cutting
R-1411	109.33	86.67	1.00	0.80	3.28	2.97
R-1415	90.00	101.33	0.87	0.93	3.36	3.68
R-1420	111.67	85.00	0.87	0.90	2.64	2.32
R-1421	120.00	96.67	0.97	1.00	2.29	1.95
R 67-20	106.00	100.67	1.07	1.07	3.57	2.77
R- 51	109.33	97.67	0.97	0.90	2.66	2.23
R 67-34	108.33	96.67	0.90	0.93	2.95	2.60
C.D. (5%)	10.39	-	-	0.15	0.44	0.44
SE(m)	3.34	6.66	0.06	0.04	0.14	0.14
C.V.	5.36	12.15	10.08	8.69	8.19	8.91

Table 1.2. Evaluation of diverse ramie germplasm against different doses of herbicide

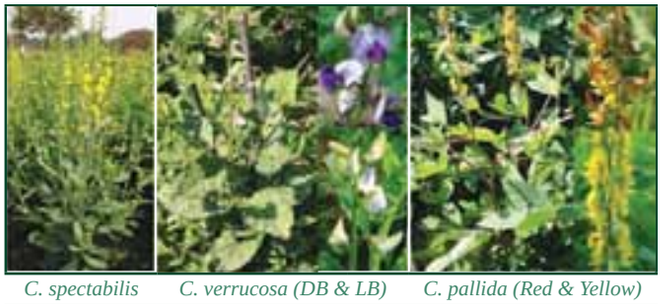
Geno-type	Glyphosate concentrations							
	Control		0.20%		0.40%		0.60%	
	Sprouts /m²	Plant height (cm)	Sprouts /m²	Plant height (cm)	Sprouts /m²	Plant height (cm)	Sprouts /m²	Plant height (cm)
R 1411	30	120.5	26	138.5	23	125.0	14	45.0
R 67-34	38	115.0	35	128.5	30	115.0	21	55.5
R 1410	25	85.3	16	90.0	8	35.5	2	10.0
R 1425	28	105.5	23	117.0	15	95.3	5	40.0

A total of 139 accessions of Flax (*Linum usitatissimum*) were evaluated along with 4 checks namely, JRF-2, JRF-4, FT-895 and FT-897. Fibre yield/plant varied from 0.24 to 2.38 g (Table 1.3) *(Source: SNHB 1.8. Contributors: Babita Chaudhary, M.K. Tripathi and H. Bhandari)*

Table 1.3. Range of different traits of flax germplasm evaluated during 2013-14

Characters	Range
Plant height (cm)	71.40-133.80
Basal diameter (mm)	2.14-7.18
Primary branches/plant	1.0-4.6
Days to first flowering	50.0-63.0
Days to 50% flowering	63.0-90.0
Days to maturity	115.0-131.0
Green weight/10 plant (g)	75.0-470.0
Fibre weight/10 plant (g)	2.43-23.82
Seed yield/plant (g)	0.78-1.51
Dry weight/10 plant (g)	10.0-100.0

A total of 96 accessions of wild species of *Crotalaria* were classified into eight species based on botanical characteristics and herbarium was prepared for species identification. Out of eight, five species were identified (Fig. 1.4). All the wild species were characterized using 25 descriptor characters *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar and Maruthi R.T.).*



C. spectabilis *C. verrucosa (DB & LB)* *C. pallida (Red & Yellow)*

C. incana *C. retusa*

Fig. 1.4. Different species of *Crotalaria* identified

1.1.3 Distribution

A total of 2738 germplasm accessions (*Corchorus* spp.; 2330, *Hibiscus* spp.; 329, *Crotalaria* spp.; 66, wild spp.; 13) of JAFs have been distributed to different indenters including scientists of ICAR-CRIJAF, AINP on Jute and Allied Fibres and other institutes *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar and Maruthi R.T.).*

1.1.4 Pre-breeding

A total of 36 F_4 populations originated by crossing cultivated and wild *Corchorus* species were evaluated for plant height and basal diameter. The plant height over populations varied from 358 cm to 412 cm with a mean of 372.6 cm. Basal diameter of the populations varied from 1.41 cm to 1.92 cm with a mean of 1.76 cm. Based on these characters, a total of 16 F_4 populations were advanced to the F_5 generation.

Pre-breeding materials of *C. olitorius* was evaluated for tolerance to premature flowering. An F_4 line exhibited high tolerance to premature flowering when sown on 1st March, 2014. Progeny lines were harvested from individual plants and a total of 42 F_5 progeny lines are being evaluated for tolerance to premature flowering by sowing on 17th February, 2015. Flowering data were recorded on 35 DAS and 65 DAS (Fig. 1.5). Three F_5 progenies did not flower at 35 DAS, but exhibited 36% flowering at 65 DAS *(Source: JB 9.4. Contributors: P. Satya, S.K. Pandey and Maruthi R.T.)*

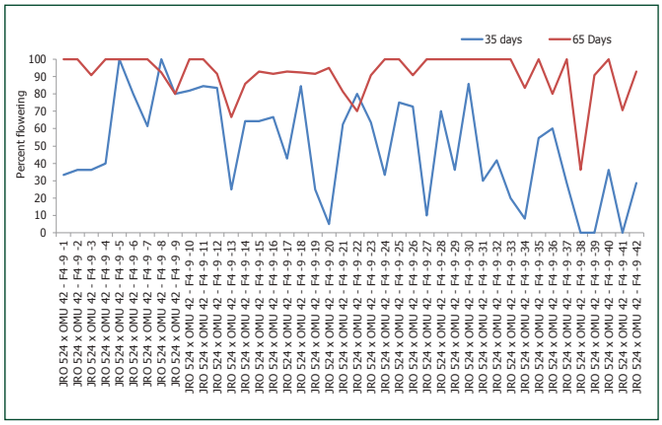


Fig. 1.5. Extent of flowering in 42 F_5 progenies of *C. olitorius* at 35 and 65 DAS

A total of 42 progenies emanated from interspecific hybridization of kenaf and wild relatives were found intermediate to both cultivated and wild types with branching habit. Among these 35 progenies exhibited high sterility. A total of 15 progenies could be advanced to the next generation. Three sets of kenaf lines having male sterility were identified and the sterility was functional in nature, causing formation of either rudimentary anthers or inhibition of anther dehiscence. It was observed that under low temperature, sterility is induced, while under high temperature anther dehiscence takes place leading to restoration of fertility. Phenological studies showed that up to 31st January, extent of complete sterility was 77.14% while extent of semi-sterility was 19.84%. After 31st March, the fertile plants increased up to 22.6% (Fig. 1.6). The male sterile lines could be maintained by either growing at high temperature regions or by sib-mating with the fertile lines derived from single plant *(Source: JB 9.4. Contributors: P. Satya, S.K. Pandey and Maruthi R.T.).*

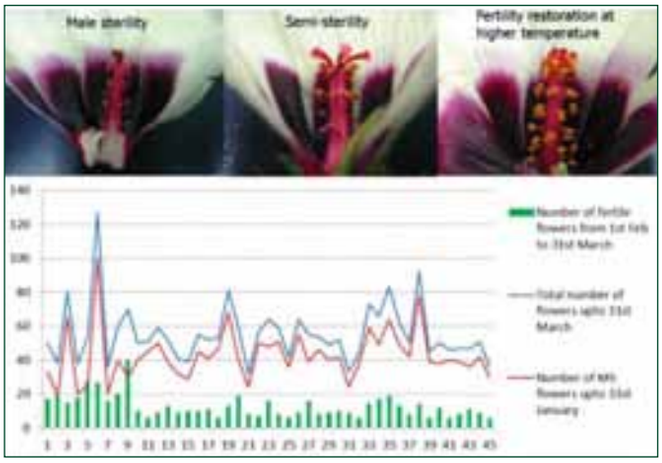


Fig. 1.6. Phenological studies on male sterility in kenaf

1.1.5 Mutation breeding

A total of 104 *tossa* jute (*C. olitorius* L.) mutants (M_6) were sown under short day condition at ICAR-CRIJAF, Barrackpore on 3rd February of year 2013, 2014 and 2015 to screen premature flowering resistant mutant(s). Year wise performance of mutants (Table 1.4) revealed that eight mutants performed well over checks namely, JRO 8432 and JRO 204. Moreover, these mutants recorded lesser percentage of flowering compared to erstwhile best source of premature flowering resistance in *tossa* jute *i.e.* Tanganayika 1 and Sudan Green *(Source: 35/14/01/2014-BRNS. Contributors: S.B. Choudhary and H.K. Sharma).*

Table 1.4. Performance of superior mutants during 2013-2015 for premature flowering resistance

Genotypes	Flowering %		
	2013	2014	2015
PFR–20	3.60	4.20	8.09
PFR–32	0.00	0.00	7.74
PFR–59	0.00	0.00	0.00
PFR–65	0.00	0.00	2.58
PFR–66	8.16	3.23	2.32
PFR–69	2.86	7.89	7.16
PFR–71	1.41	1.28	4.95
PFR–73	7.14	8.00	2.08
Tanganayika 1	29.56	26.00	25.70
Sudan Green	25.88	24.29	24.95
JRO 204	38.76	30.66	20.26
JRO 8432	64.55	52.46	31.68

Genetic diversity of 60 mutant genotypes of *C. olitorius* along with two cultivars JRO 524 and JRO 8432 was studied using 23 SSR markers. Amplified fragment size ranged from 104 bp to 650 bp with an average of 262.4 bp. The polymorphism information content (PIC) varied from 0.06 to 0.98 with an average value of 0.45. The Jaccard's

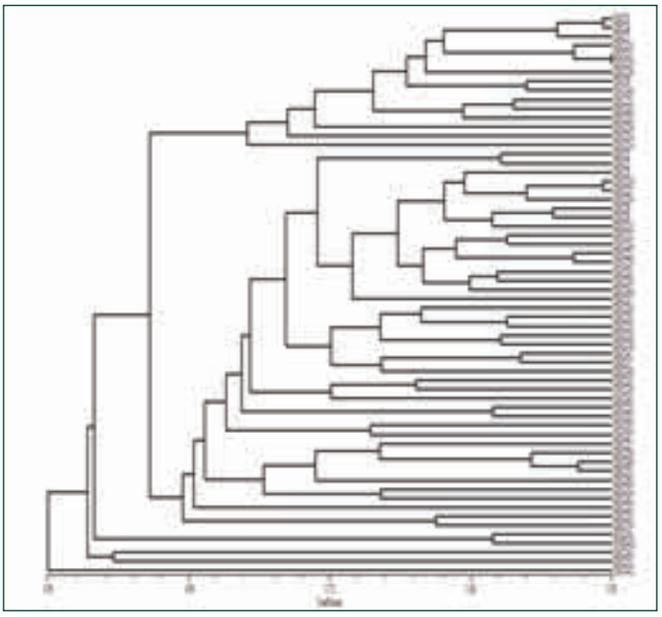


Fig. 1.7. Genetic association of mutants of *C. olitorius* based on SSR polymorphism

similarity coefficient between two genotypes in the selected set of genotypes varied from 0.48 (OMU-20 and OMU-42) to 0.91 (OMU-15 and OMU-16) with an average of 0.68. A dendrogram constructed on the basis of similarity coefficient values identified six clusters at J=0.65 (Fig. 1.7). The largest cluster comprised of 42 mutant genotypes, followed by a second cluster of 15 genotypes, respectively. The other clusters contained 1–3 genotypes. The two cultivars JRO 204 and JRO 8432 were grouped together (J=0.84) being distinct from the mutants. OMU-40, OMU-42 and OMU-52 each formed single cluster *(Source: TMJ 1. Contributors: P. Satya, A.B. Mandal, K. Meena, H.K. Sharma and S.B. Choudhary).*

Three genotypes of mesta *viz.*, MT 150, HS 4288 and Long calyx-H were irradiated to 10 different doses of gamma-ray (100Gy, 200Gy, 300Gy, 400Gy, 500Gy, 600Gy, 700Gy, 800Gy, 900Gy, 1000Gy) for induction of mutation and estimation of LD_{50} dose. LD_{50} for MT 150 and Long calyx-H was 500Gy while for HS 4288 it was 300Gy. Effect of different treatments on germination and growth of mesta depicted in Fig. 1.8 & 1.9, respectively *(Source: JB 1.1. Contributors: S.B. Choudhary, H.K. Sharma, A. Anil Kumar and Maruthi R.T.).*

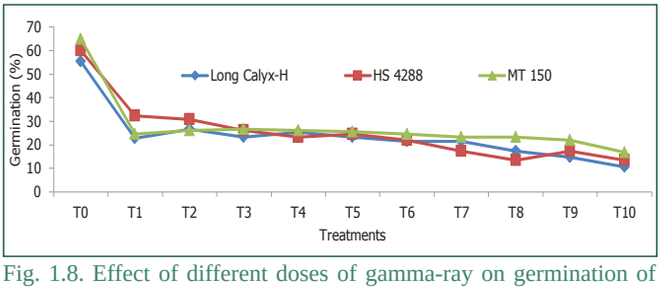


Fig. 1.8. Effect of different doses of gamma-ray on germination of mesta

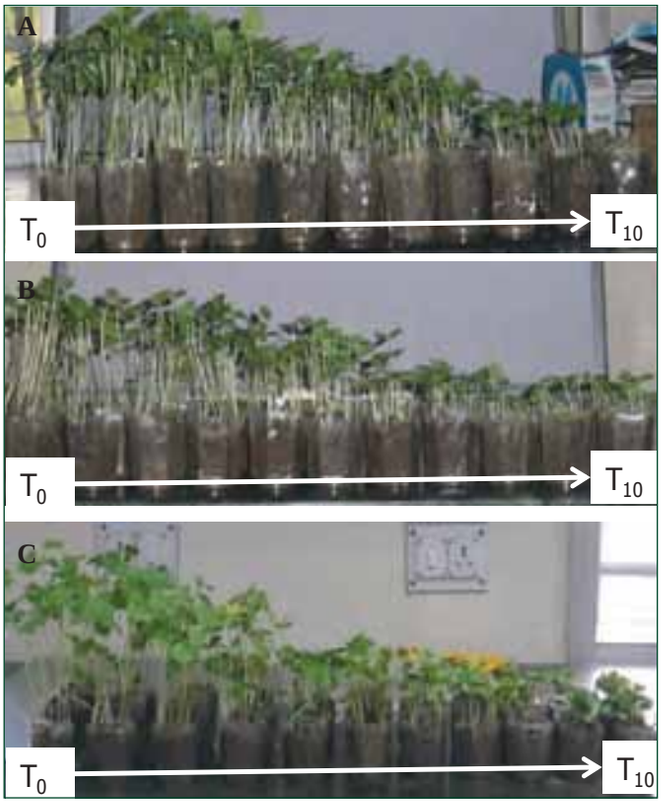


Fig. 1.9. Effect of different doses of gamma-ray on growth of mesta genotypes (A) long calyx-H (B) HS 4288 (C) MT 150

1.2 *Tossa* Jute (*Corchorus olitorius*)

1.2.1 Heterosis in *C. olitorius*

The residual heterosis for fibre yield and yield attributing characters in F_2 generation of *tossa* jute was estimated. Among F_2s, plant height ranged from 232.33 to 341.67 cm, basal diameter ranged from 8.77 to 20.33 cm. Further, fibre yield/plant varied from 5.73 to 14.6 g. Highest fibre yield in F_2 crosses was recorded in OMU-19 × OIN-255 (14.6 g) followed by OIN-255 × OEX-29 (13.06 g) and OEX-29 × OEX-32 (12.84 g). For fibre yield/plant significant mid-parental heterosis in F_2 population was recorded in three crosses *i.e.* OMU-19 × OIN-255 (51.56%), OIN-255 × OEX-29 (34.25%) and OEX-29 × OEX-32 (28.33%) while, significant heterobeltiosis was recorded in two crosses *i.e.* OMU-19 × OIN-255 (42.21%) and OIN-255 × OEX-29 (24.84%) (Fig. 1.10). Expression of heterosis in F_2 and subsequent generations depends on gene action, heritability and genetic advance for yield attributing characters. Cross OMU-19 × OIN-255 and OIN-255 × OEX-29 expressed significant heterobeltiosis in F_2 generation and non-significant heterosis in F_1, might be due to fixation of additive genes in F_2 generation. These results indicate selection in F_2 derived from high heterotic F_1 will be misleading and selections based on F_2 population mean will be useful in selecting the transgressive segregants for yield and yield attributing characters *(Source: JB 9.1. Contributors: A. Anil Kumar, C.S. Kar and J. Mitra).*

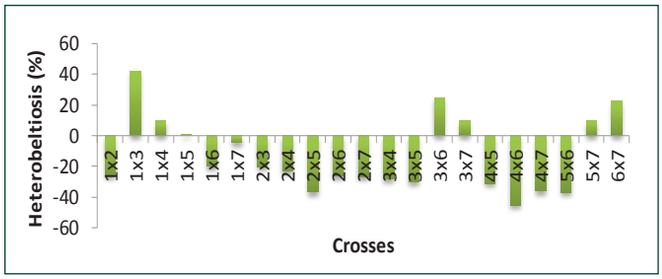


Fig. 1.10. Better parent heterosis of 21 F_2 populations of *tossa* jute

1.2.2 Genetics of resistance to stem rot disease in jute

F_1 involving resistant and susceptible genotypes of *C. olitorius* was developed and also backcrossed to obtain F_2 and BC_1F_1 populations. 120 polymorphic AFLP fragments were eluted out of 42 primer combinations and were checked for unique band. Out of 120 eluted bands only 78 were successfully sequenced and primers were designed from these 78 sequences. A total of 8 RGA markers and 16 SSR markers showing polymorphism between pairs of parental genotypes of BC mapping population of *C. olitorius* were identified. Genomic libraries of 47 genotypes were prepared with mean size of 657 bp. The library pool was sequenced independently on NextSeq 500 to generate up to 1-3 million reads per sample. *(Source: DBT funded project. Contributors: P. Satya and H.S. Balayn)*

1.2.3 Genetic analysis of fibre anatomy characters in *C. olitorius*

A total of 134 germplasm accessions were evaluated for four morphological and nine fibre anatomy characters. Plant height ranged from 184 cm to 391.4 cm with a mean of 329.1 cm. Basal diameter ranged from 9.5 to 19.2 mm (mean 13.8 mm). Average stick diameter was 11.7 mm. Fibre yield/plant varied from 3.6 g to 26.6 g with a mean of 13.6 g. Average bark width was 1.32 mm, while average fibre wedge length was 1.00 mm. Number of fibre cells per fibre bundle varied from 12.8 to 36.8 with an average 23.59 fibre cells per bundle (Table 1.5).

Table 1.5. Fibre anatomy characters of jute germplasm

Anatomical characters	Mean±SD
Bark width (mm)	1.32±0.46
Outer cell layer width (mm)	0.06±0.02
Fibre wedge length (mm)	1.00±0.19
Fibre wedge diameter at base of wedge (mm)	0.48±0.24
Fibre wedge diameter at middle of wedge (mm)	0.19±0.08
Fibre wedge diameter at top of wedge (mm)	0.09±0.03
Fibre bundle number in middle of wedge	2.72±1.58
Fibre bundle number at base of wedge	6.97±3.11
Fibre cell number per bundle	23.59±4.36

Correlation analysis of anatomical characters revealed significant correlation of bark width with fibre wedge length (0.40) and wedge diameter at middle (0.20). Fibre wedge length also exhibited significant correlation with wedge diameter at middle (0.39). A mapping population from cross (OMU 7 × JRO 524) has been developed containing 162 lines. Parental polymorphism has been studied using 86 SSR and 77 SRAP markers. Of these, 14 SSR markers and 31 SRAP markers have been found to be polymorphic. *(Source: TMJ 1. Contributors: P. Satya, S.B. Choudhary, H.K. Sharma, A.B. Mandal, K. Meena).*

1.2.4 Identification of germplasm accessions carrying superior fibre anatomy traits

A group of mutant germplasm accessions along with check variety JRO 524 were screened for fibre anatomy characters for four years (2012 – 2015) including bark cross-section length (A), protophloic fibre length (B1), secondary phloic fibre wedge length (C), secondary phloic fibre wedge diameter at wedge base (D), secondary phloic fibre wedge diameter at mid-wedge (G), secondary phloic fibre diameter at top of the wedge (F), fibre bundles/wedge in mid wedge (H1), fibre bundles/wedge at wedge base (H2), and number of fibre cells/bundle (I). Based on the four years' performance, superior accessions were identified having better fibre anatomy characters (Table 1.6 & 1.7, Fig. 1.11 & 1.12). For bark diameter, OMU 07, OMU 59, OMU 05, OMU 18, OMU 02, OMU 19 and OMU 09 were superior to JRO 524 (1.07 cm). Fibre wedge length was highest for OMU 05 (1.25 cm) followed by OMU 59, OMU 07, OMU 18, OMU 19, OMU 02 and JRO 524. Average number of fibre bundles per wedge at mid wedge region and wedge base were 5.10±0.96 and 7.85±1.12, respectively. The accessions OMU 18, OMU 05, OMU 07, OMU 09, OMU 19, OMU 02 and OMU 15 produced more fibre bundles than JRO 524 (3.92) at mid wedge region.

Table 1.6. Average performance of superior accessions over check JRO 524 for fibre anatomy characters during four years (2012-15)

Genotype	Bark cross-section length (A) (cm)	Genotype	Fibre wedge length (C) (cm)
OMU 07	1.65	OMU 05	1.25
OMU 59	1.59	OMU 59	1.20
OMU 05	1.55	OMU 07	1.16
OMU 18	1.39	OMU 18	1.15
OMU 02	1.35	OMU 19	0.99
OMU 19	1.26	OMU 02	0.89
OMU 09	1.18	JRO 524	0.89
JRO 524	1.07	OMU 09	0.67
OMU 15	0.79	OMU 15	0.55
Mean	1.31	Mean	0.97
SD	0.28	SD	0.24

Table 1.7. Average performance of superior accessions over check JRO 524 for fibre anatomy characters during four years (2012-15)

Genotype	Fibre bundles / wedge in mid wedge (H1)	Genotype	Fibre bundles / wedge at wedge base (H2)
OMU 18	6.24	OMU 05	9.59
OMU 05	6.20	OMU 19	9.11
OMU 07	5.65	OMU 07	8.69
OMU 09	5.36	OMU 18	8.35
OMU 19	5.3	OMU 15	7.36
OMU 02	5.17	OMU 59	7.21
OMU 15	4.53	OMU 09	7.06
JRO 524	3.92	JRO 524	7.01
OMU 59	3.47	OMU 02	6.3
Mean	5.10	Mean	7.85
SD	0.96	SD	1.12
Genotype	Protophloic fibre length (B1) (cm)	Genotype	Fibre wedge diameter at base (D) (cm)
OMU 09	0.36	OMU 05	0.61
OMU 07	0.34	OMU 07	0.55
OMU 02	0.29	OMU 19	0.54
OMU 59	0.28	OMU 18	0.51
OMU 19	0.15	OMU 09	0.44
OMU 15	0.13	OMU 15	0.41
OMU 05	0.13	OMU 02	0.40
JRO 524	0.12	JRO 524	0.37
OMU 18	0.11	OMU 59	0.36
Mean	0.21	Mean	0.46
SD	0.10	SD	0.09
Genotype	Fibre wedge diameter at mid-wedge (G) (cm)	Genotype	Number of fibre cells / bundle (I)
OMU 05	0.42	OMU 18	28.39
OMU 07	0.35	OMU 07	26.49
OMU 19	0.33	OMU 59	25.83
OMU 09	0.31	OMU 02	25.76
OMU 18	0.26	OMU 05	25.10
OMU 15	0.24	OMU 09	24.54
OMU 59	0.21	OMU 19	23.67
OMU 02	0.21	JRO 524	17.75
JRO 524	0.19	OMU 15	15.47
Mean	0.28	Mean	23.67
SD	0.08	SD	4.25

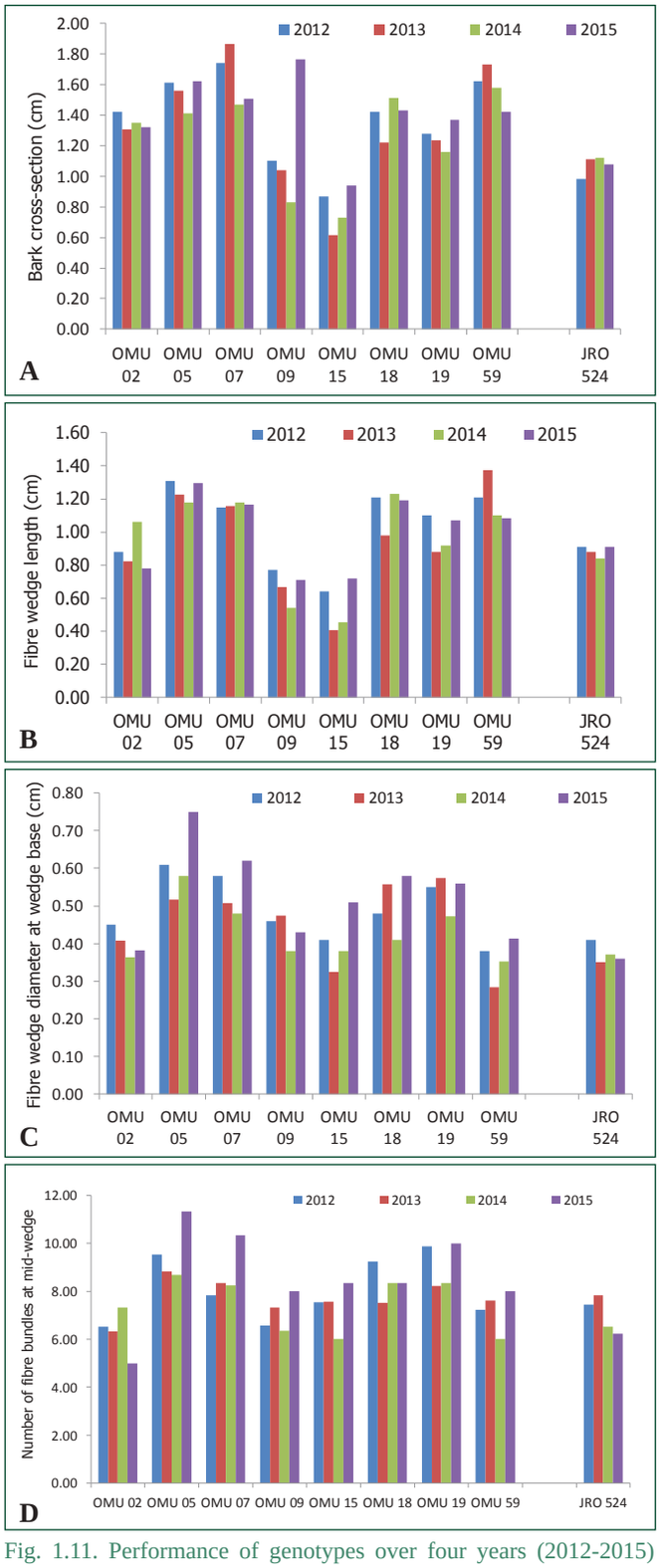


Fig. 1.11. Performance of genotypes over four years (2012-2015) for fibre anatomy characters (A) bark cross section (B) fibre wedge length (C) Fibre wedge diameter at wedge base (D) Number of fibre bundles at mid-wedge

However, at fibre wedge base, the accessions OMU 05, OMU 19, OMU 07, OMU 18, OMU 15, OMU 59 and OMU 09

produced higher fibre bundles than JRO 524 (7.01). More amount of protophloic fibres were produced by OMU 09, OMU 07, OMU 02, OMU 59, OMU 19, OMU 15 and OMU 05 than JRO 524 (length 0.12 cm). Fibre wedge diameter varied from 0.36 cm to 0.61 cm. The accessions OMU 05, OMU 07, OMU 19, OMU 18, OMU 09, OMU 15 and OMU 02 exhibited higher fibre diameter at base than JRO 524. Number of fibre cells/ fibre bundle varied from 15.47 to 28.39. Accessions OMU 18, OMU 07, OMU 59, OMU 02, OMU 05, OMU 09 and OMU 19 produced more number of fibre cells per fibre bundle than JRO 524 (17.75). *(Source: TMJ 1. Contributors: P. Satya, S.B. Choudhary, H.K. Sharma, A.B. Mandal, K. Meena).*

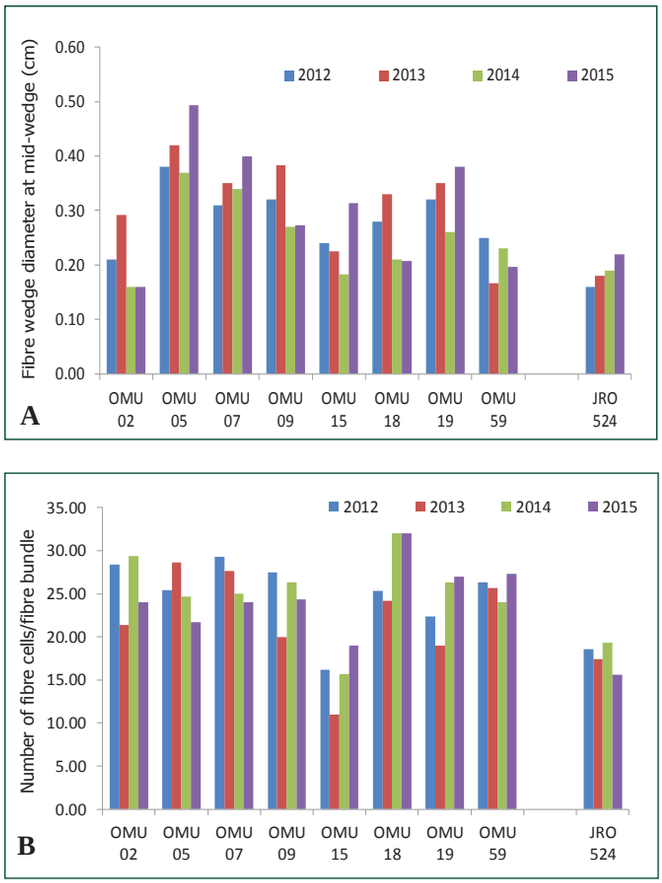


Fig. 1.12. Performance of genotypes over four years (2012-2015) for fibre anatomy characters (A) Fibre wedge diameter at mid-wedge (B) Number of fibre cells/fibre bundle

1.2.5 QTL mapping for fibre quality in *tossa* jute

Phenotyping of 162 RILs of *tossa* jute at two environments namely, ICAR-CRIJAF, Barrackpore and CSRSJAF, Bud Bud revealed significant diversity of the population for plant height, fibre yield and fibre fineness. During histological study RIL population recorded significant diversity for fibre bundle wedges. Further, two parents of the RIL namely, JRO 524 and OIN-572 were found distinct for 28 SSRs markers *(Source: JB 9.2. Contributor: S.B. Choudhary, D. Sarkar, H.K. Sharma, Kanti Meena, A. Bera and H. Bhandari)*

1.2.6 Development of screening technique for prediction of jute fibre quality

With an objective to standardize sampling method for fibre extraction at specific growth stages of jute, 10 *C. olitorius* varieties (JROM 1, JRO 2407, JBO 1, CO 58, Ira, JRO 204, JRO 128, S 19, JRO 8432 and JRO 524) were grown for green fibre with an ultimate aim to develop a model for prediction of fibre quality from the early growth stages. Two different sampling methods were employed for extraction of green fibre and retted fibre. Procedure for extraction of green fibre has been standardized. Data on fibre quality, specifically fibre tenacity and fineness of ten *olitorius* varieties were recorded at 3 different stages *i.e.* 60 DAS, 90 DAS and 120 DAS following uniform retting condition and duration. Differential changes of both fibre fineness and tenacity with duration of harvest were observed across varieties (Fig. 1.13) Fibre fineness and strength data of 90 DAS showed significant positive correlation (0.72 and 0.57) with final quality data of 120 DAS. Therefore, sampling for fibre quality can be done earliest at 90 DAS for prediction of final fibre quality *(Source: JB 9.8. Contributor: C.S. Kar and M. Kumar).*

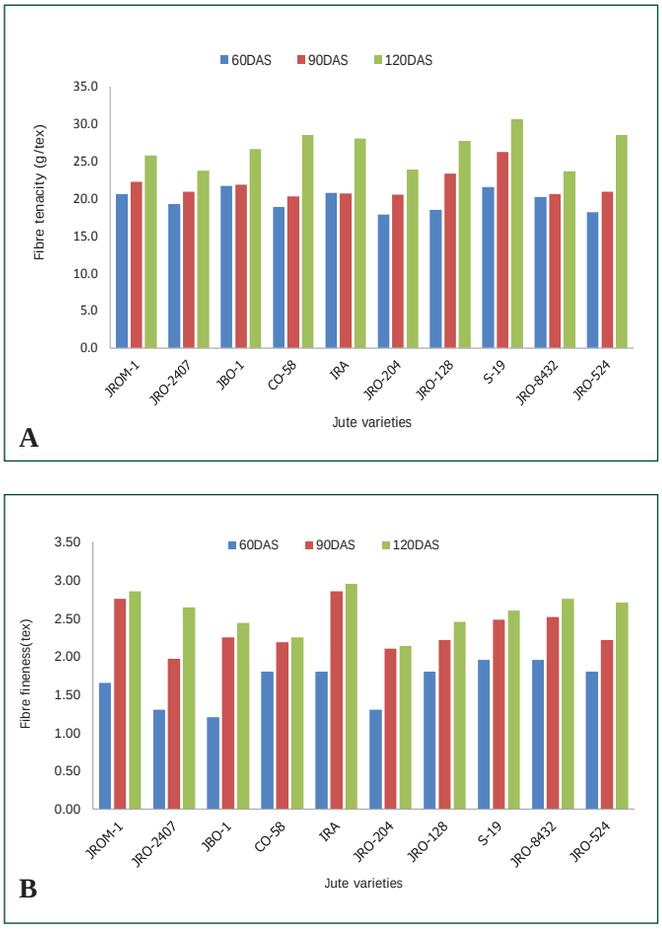


Fig. 1.13. Fibre quality parameters (A) fibre tenacity (B) fibre fineness, in *tossa* jute varieties at three different stages of harvesting

1.2.7 Varietal development in *tossa* jute

Identification of F_1

In 2013, 42 different crosses (21 F_1 and 21 reciprocals) attempted in 7×7 diallel fashion and 756 cross pods

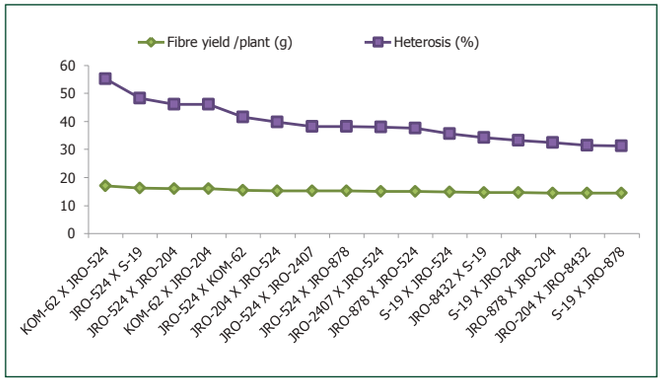


Fig. 1.14. Performance of selected F_1s identified from 7×7 diallel cross

were harvested. Seven parents namely, JRO 524, JRO 204, S 19, KOM 62, JRO 2407, JRO 8432 and JRO 878 along with 42 different crosses were grown during 2014 for identification of true hybrid. True F_1s were identified in the entire cross combinations with the help of anthocyanin pigmentation, leaf shape, and molecular markers. Four F_1s namely, KOM 62 × JRO 524, JRO 524 × S 19, JRO 524 × JRO 204 and KOM 62 × JRO 204 identified with fibre yield more than 16 g/plant compared to JRO 524 (11 g/plant) and JRO 204 (10 g/plant). Highest standard heterosis of 55.2% was obtained from KOM 62 × JRO 524 (17 g/plant) over JRO 524 (Fig. 1.14).

Selection in F_3 Generation

Generation advancement of 257 single plant selection of 26 F_3 populations and selection of high yielding lines were done. 15 bulks were selected from 26 F_3 population based on plant height (>3.5 m) and fibre yield (>17.00 g/plant). Best population derived from cross combination of JRO 128 × OIN-154 was identified with average plant height 3.68 m and fibre yield 18.17 g/plant.

Station trial

Out of 27 advanced populations, two populations originating from OIN-004 × OIN-125 (35.12 q/ha) and OIN-054 × OIN-154 (32.83 q/ha) were found superior to JRO 524 (31.91 q/ha) and JRO 204 (32.73 q/ha). These two entries (named as JROCS 3 and JROCS 4) were contributed for IET of AINP JAF for 2015-16 *(Source: JB 9.9. Contributors: C.S. Kar)*

1.2.8 Development and validation of marker-based assay for varietal purity testing in jute

With the objective of development and validation of marker-based assay for varietal purity testing in jute, two specific SSR markers namely MJM 631 and MJM 458 were selected out of 60 jute specific SSR markers screened and utilized for two varieties namely, JRO 524 and JRO 204. Row or column based sampling was found equivalent to individual sampling method for detecting impurity in both varieties. It was observed that MJM 458 can specifically distinguish JRO 524 from JRO 204 (Fig. 1.15). Grow out test was carried out from breeder seed of JRO 524 and JRO 204. Off types recorded 0.03% and 0.04%, respectively *(Source: JB 9.7. Contributors: C.S. Kar, A. Bera and J. Mitra)*

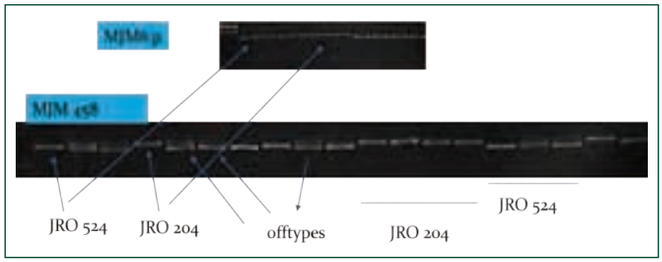


Fig. 1.15. SSR primer MJM 458 and MJM 631 distinguishes off-types in JRO 204 and JRO 524

1.2.9 Breeding for drought tolerance in *tossa* jute

A total of 600 germplasm line of *C. olitorius* evaluated for fibre strength and fineness revealed wide variation for these traits (Table 1.8). Fibre strength ranged from 16 g/tex to 32 g/tex with mean 21 g/tex, whereas fineness varied from 3.2 tex to 1.3 tex with mean 2.2 tex. Five lines showing fineness (1.3-1.4 tex) and 3 lines showing strength between 28-32 g/tex were identified for use in hybridization programme.

Table 1.8. Frequency distribution of fibre strength and fineness in *tossa* jute germplasm

Fibre strength (g/tex)	No. of accession	Fibre fineness (tex)	No. of accession
16-20	188	1.3-1.8	11
20-24	363	1.8-2.3	421
24-28	46	2.3-2.5	101
28-32	3	2.5-3.3	67
Total	600	Total	600

All possible crosses were made among 20 drought tolerant and 5 susceptible lines in *tossa* jute. Molecular profiling of resistant and susceptible lines using SSR (primer P1) specific for DREB1 gene showed amplification of 700 base pair fragment in two accessions namely, OIN-574 and OIN-276 (Fig. 1.16), while a 596-bp fragment was observed in two accessions namely, OIN-636 and OIN-565 using primer P2. These markers may be associated with drought stress tolerance in *C. olitorius* and may be used in selection of drought tolerant genotypes in breeding programs *(Source: TMJ 2. Contributors: J. Mitra, S.K. Pandey, S.B. Choudhary, H.K. Sharma and A. Anil Kumar).*

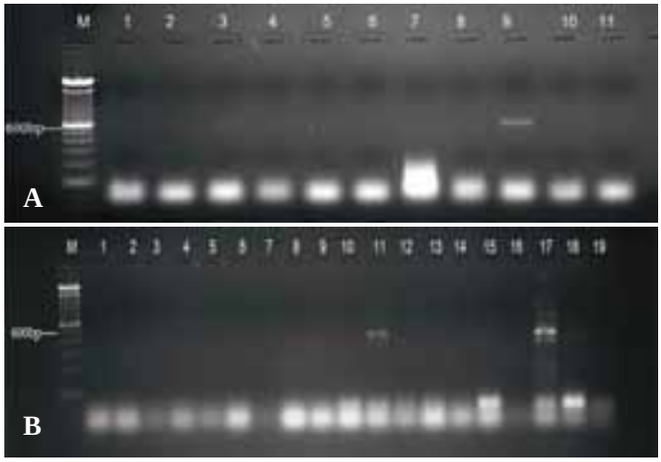


Fig. 1.16. PCR amplification profiles of *C. olitorius* germplasm using primer P1 (A) and primer P2 (B)

(A) M- DNA ladder 100-bp. 1-OIN 280, 2-OIN 222, 3-OIN 574, 4- OIN 568, 5-OIN 631, 6-OIN 219, 7-OIN 287, 8-OIN 212, 9-OIN 276, 10- OIN 572, 11-OIN 216

(B) M- DNA ladder 100-bp. 1-OIN 566, 2-OIN 633, 3-OIN 637, 4-OIN 571, 5-OIN 569, 6-OIN 634, 7-OIN 564, 8-OIN 632, 9-OIN 567, 10-OIN 278, 11-OIN 636, 12-OIN 576, 13-OIN 575, 14-OIN 214, 15-OIN 215, 16-OIN 635, 17-OIN 565, 18-OIN 570, 19-OIN 573

1.2.10 Protection of jute varieties and DUS testing

A new *tossa* jute variety JRO 2407 (Samapti) was tested with two reference varieties (S 19 and JRO 878) for second growing cycle to observe distinctiveness, uniformity and stability at ICAR-CRIJAF, Barrackpore (Nodal centre) and CSRSJAF, Bud Bud (Co-Nodal centre). This candidate variety was distinct for seed colour (green). The other *tossa* jute variety, Bidhan Rupali was also tested during this year along with reference variety JRO 632. This variety was distinct for stem colour, stipule colour and colour of leaf lamina, leaf vein, leaf petiole (pale green). Twenty reference varieties of *tossa* jute *viz*. JRO 204, Ira, JRO 632, JRO 3690, JRO 66, JRO 524, JRO 7835, JRO 878, JRO 8432, S 19, JRO 128, JRO 620, Chinsurah Green, Sudan Green, Tanganyika-1, JRO 36E, JRO 2345, KOM 62, TJ 40 and CO 58 and 17 varieties of white jute *viz*. JRC 212, JRC 80, JRC 698, JRC 7447, JRC 4444, Padma, JRC 321, Monalisa, UPC 94, Bidhan Pat 1, Bidhan Pat 2, Bidhan Pat 3, KC 1, KTC 1, D 154, JRC 517 and JRC 532 were maintained and characterized under DUS Project. Application for registration of two new jute varieties *viz*. JROM 1 (*tossa* jute) and JRCM 2 (white jute) has been accepted by the PPV & FR Authority *(Source: DAC. Contirbutor: J. Mitra and S. Biswas).*

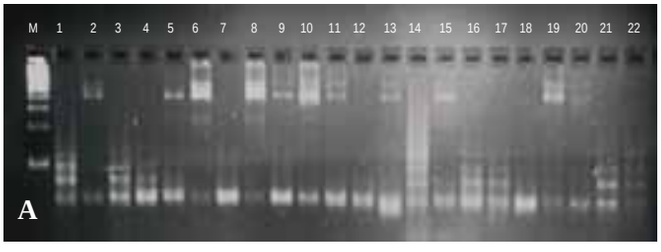
1.2.11 Finger printing of jute varieties

To identify suitable polymorphic DNA markers with respect to 46 varieties of jute including *C. olitorius* (24) and *C. capsularis* (22) a total of 156 SSR markers were screened. Out of these, 100 SSR markers showed successful amplification and only 14 marker showed polymorphism among these varieties. Amplification of one marker using primer MJM 569 is depicted in Fig. 1.17 Based on polymorphism among varieties with respect to 14 SSR markers, 24 varieties of *C. olitorius* and 20 of *C. capsularis* were clustered into a number of group (Table 1.9) *(Source: JB 9.5. Contributors: J. Mitra, C.S. Kar and A. Anil Kumar)*

Table 1.9. Level of polymorphism and grouping of jute varieties based on 14 SSR markers

Marker	Primer sequence	Degree of polymorphism	No. of groups	
			CO	CC
MJM 569	F:CGCCAGAGAAGCAAATGTAAC R:TAGAGCTCACCAGAGACTGCC	High	4	4
MJM 581	F:CTTATGATTTGCTGGACCCAA R:CACGCTAGCAAGTGATGAATCT	High	5	3
MJM 608	F:GGGTGATTCAAGGTTGTCAAA R:CCTTACGCGTTACAAATCCAA	High	6	4
MJM 618	F:CGTTATCAAGCAAATCCAACC R:CATCTGGTGACTGCTTCGTCT	High	6	2
MJM 590	F:AGCTTGACATGATTACGCCAG R:AACCACGAAGACAGAGCAAGA	Moderate	4	4
MJM 591	F:TGTCACTTGCCTATGATCGTG R:AAACAACACCATGAACAGCAT	Moderate	3	5
MJM 592	F:CGAACGTTTCGGCAAATATAA R:CTCGAATTTGATTGGGAGTCA	Moderate	2	6
MJM 606	F:GGTACTGGTGCATGCTGATTT R:TTCTGTGGAACCTGAGCATCT	Moderate	5	3
MJM 610	F:GCATGATCTCTTGCATTTGGT R:CATAGAAGCCCAACCAGAACA	Moderate	7	4
MJM 614	F:TCTTGATGAATTTCCATTCGG R:ACTTCCATCAGAACATCCAGC	Moderate	3	5
MJM 617	F:TTTCATGCTCATCCCTCTCTC R:ATTCTAGCGCCACACAGAGAA	Moderate	4	2
MJM 626	F:ACCAAATTCACAACCACCATC R:TGAAGAGAAATGGATGAGAGGG	Moderate	5	4
MJM 610	F:AGAACACGTTCACCAGACAGC R:TTCTTGATTCCAAACTGGGTG	Moderate	2	2
MJM 634	F: AAAGAAGCACTGAGGATGGGT R:AGGGAAGAAACTCAGCACCAT	Moderate	3	3

CO: *C. olitorius*, CC: *C. capsularis*



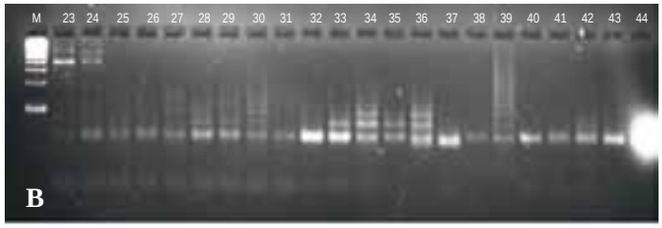


Fig. 1.17. Banding pattern of jute varieties (A) 1-22 and (B) 23-44 through SSR primer MJM 569

1-JRO 204, 2-JRO 7835, 3-JRO 2407, 4-S-19, 5-JRO 878, 6-Bidhan Rupali, 7-CO-58, 8-JRO-524, 9-JRO-632, 10-JRO-620, 11-KOM-62, 12-JRO-128, 13-JRO-8432, 14 -JRO-2345, 15-JRO-3690, 16-Sudan green, 17-JRO-66, 18-JBO-1, 19-Tanganyika-1, 20-Tarun, 21-JROM-1, 22-Chinsurah green, 23 -IRA, 24-TJ -40, 25-JRC 7447, 26-JRCM -2, 27-JRC -532, 28-KC -1, 29-JRC -698, 30-JBC -5, 31-JRC-212, 32-BP-3, 33-D-154, 34-BP-1, 35-JRC-80, 36-BP-2, 37-JRC-4444, 38-JRC-321, 39-UPC-94, 40-JRC-517, 41-Monalisa, 42-JRC-9057, 43-KTC-1, 44-Padma

1.3 White Jute (*Corchorus capsularis*)

1.3.1 Conventional Breeding

Station trial of 10 lines along with three checks (JRC 517, JRC 532, JRC 698) resulted in identification of two high yielding lines (denominated as JRCJ 8 and JRCJ 9) and these two lines were nominated to IET trial (2015-16) under AINP on JAF. Through screening of a new set of 600 accessions based on plant height and basal diameter, 15 promising lines were identified for hybridization programme *(Source: JB 8.4. Contributors: J. Mitra, C.S. Kar and A. Anil Kumar).*

1.3.2 Development of mapping population

A RIL mapping population of *C. capsularis* (CIM-036 × JRC 412) was phenotyped at ICAR-CRIJAF at two growth stages. Parental polymorphism study identified 10 RGA markers and 18 SSRs. A total of 20 polymorphic SSRs showing polymorphism between the parental genotypes of the RIL mapping population derived from the cross CIM 036 × JRC 412 of *C. capsularis* were identified *(Source: DBT funded project. Contributors: P. Satya and H.S. Balayn).*

1.4 Kenaf (*Hibiscus cannabinus*)

1.4.1 Conventional Breeding

Out of 25 F_6 families of kenaf identified during 2013-14, 15 promising kenaf resistant lines (KRL) were evaluated for fibre yield and its contributing traits. All selected lines did not show YVM disease symptom whereas all check varieties were severely infected with this disease and incidence was more than 90% (Fig. 1.18). Five promising lines namely, KRL-2, KRL-3, KRL-5, KRL-9 and KRL-12 performed significantly better than the best check variety HC 583 in terms of fibre recovery (%) (Fig. 1.19). These lines outperformed the best check for many other agronomic traits also despite their immune response to YVM disease *(Source: JB 8.5. Contributors: S.K. Pandey, P. Satya, H.K. Sharma, S. Satpathy and R.K. De).*

Fig. 1.18. Immune response of Line KRL-9

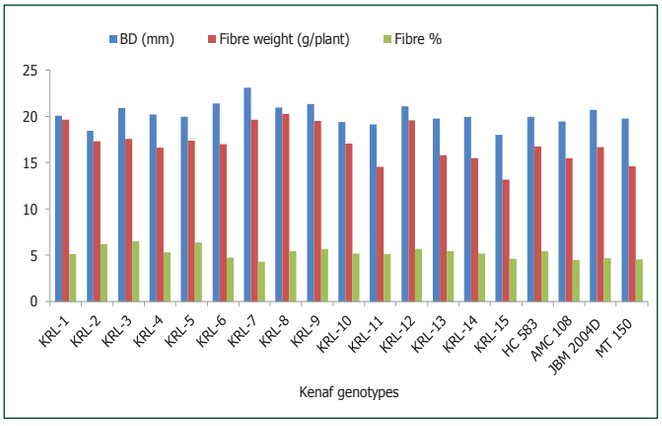


Fig. 1.19. Performance of 15 selected kenaf lines for fibre yield

1.5 Roselle (*Hibiscus sabdariffa*)

1.5.1 Conventional breeding

A total of 43 individual plants belonging to 23 segregating populations (F_4) were selected based on plant height and basal diameter in roselle. Plant height of selected plants varied from 310 to 450 cm with a mean of 399.07 cm whereas basal diameter ranged between 15.35 to 28.61 mm with an average of 20.75 mm.

From another set of 47 F_2 populations, 28 single plants (plant height: 402.50-456.67 cm, basal diameter: 17.05-21.85 mm) belonging to 13 F_2 populations (REX-58 × RIJ-35, REX-63 × RIJ-27, REX-63 × RIJ-36, REX-63 × RIJ-208, RIJ-04 × RIN-12, RIJ-06 × REX-64, RIJ-36 × REX-03, REX-21 × RIJ-35, RIJ-36 × RIN-299, RIJ-06 × RIN-208, RIJ-35 × REX-01, REX-58 × RIN-36, RIJ-04 × REX-64) were selected.

A total of 20 individual plants were selected from 11 exotic germplasm lines (REX-10, REX-16, REX-23, REX-33, REX-34, REX-49, REX-52, REX-62, REX-63, RIJ-17, RIJ-37, RIJ-39) based on plant height and basal diameter. Plant height and basal diameter of these selected plants ranged from 360-475 cm and 16.33-26.32 mm, respectively *(Source: JB 9.6. Contributors: H.K. Sharma, A. Anil Kumar, Maruthi R.T. and A.R. Saha).*

1.5.2 Evaluation for diversified uses in roselle

A total of 80 germplasm lines were evaluated for leafy vegetable purpose (Table 1.10). Out of these, 50 lines were evaluated for leaf nutrient content (crude protein 11.55 to 22.08%; phosphorus 0.261 to 0.361%; potassium 0.616 to 1.47 % dry wt. basis). A total of 20 lines with fresh leaf weight more than 40g/plant were identified *(Source: JB 9.6. Contributors: H.K. Sharma, A. Anil Kumar, Maruthi R.T. and A.R. Saha).*

Table 1.10. Descirptive statistics of roselle germplasm lines evaluated for leafy vegetable purpose.

Variable	Mean±SD	Range
Leaf area (cm^2)	63.42±11.65	41.59-109.39
Leaf length (cm)	8.66±1.26	5.47-12.47
Leaf width (cm)	11.71±1.39	8.83-14.85
Foliage yield/plant (g)	54.83±21.88	17.32-137.88
Fresh leaf yield/plant (g)	31.32±12.42	11.18-80.45

Further a total of 120 germplasm lines of roselle were evaluated for calyx yield and attributing traits of which 20 lines with fresh calyx weight more than 25g/plant were identified (Table 1.11). For fresh calyx yield two promising genotype namely, Extra long calyx-2014-1 (69.92 g/plant), Long calyx 2014-2 (55.50 g/plant), were top performer (Fig. 1.20) *(Source: JB.9.6. Contributors: H.K. Sharma, A. Anil Kumar, Maruthi R.T. and A.R. Saha).*

Table 1.11. Descirptive statistics of roselle germplasm lines evaluated for calyx purpose

Variable	Mean±SD	Range
Plant height (cm)	285.44±65.20	102.00- 383.00
Branches/plant	7.08±2.60	0.80-15.50
Pods/plant	17.30±8.10	1.60-63.00
Fresh calyx weight/plant (g)	18.77±10.75	2.30-69.92
Dry calyx weight/plant (g)	2.12±1.20	0.18-6.58

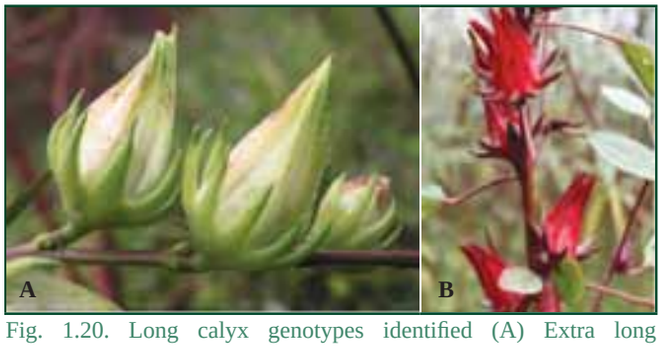


Fig. 1.20. Long calyx genotypes identified (A) Extra long calyx-2014-01 (B) Long calyx-2014-02

1.5.3 Screening for drought tolerance in roselle

A total of 89 germplasm lines of roselle were screened for drought tolerance using PEG along with seven varieties of mesta (Fig. 1.21). None of the check varieties was found to be tolerant. However, confirmation for drought tolerance in germplasm lines through controlled pot culture is required *(Source: TMJ 2. Contributors: J. Mitra, S.K. Pandey, S.B. Choudhary, H.K. Sharma and A. Anil Kumar).*

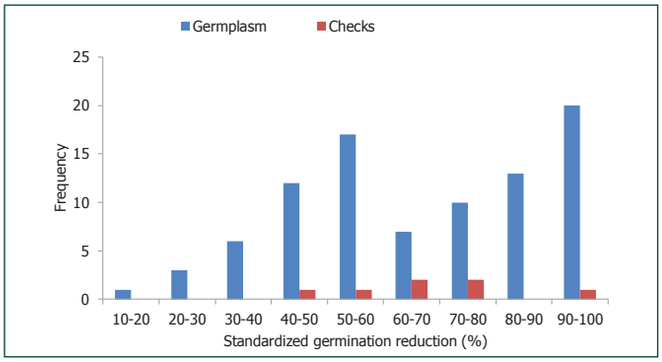


Fig. 1.21. Standardized germination reduction of roselle germplasm lines and checks screened with PEG

1.6 Ramie (*Boehmeria nivea*)

1.6.1 Genetic improvement

On the basis of the performance of the genotypes in station and AINP trials a cross was made between R 1414 × R 67-34. F_1 seed of this cross was harvested and sown in the seed nursery for further study. In another experiment 13 ramie clones were evaluated for fibre yield and its attributing traits. Plant height and basal diameter varied from 94 to 245 cm, 0.6 to 1.5 cm respectively, and fresh fibre yield/plant ranged from 2.6 to 15.6g (Fig. 1.22) *(Source: RB 2.4. Contributors: A.K. Sharma, P. Satya, K. Selvaraj and S.P. Gawande).*

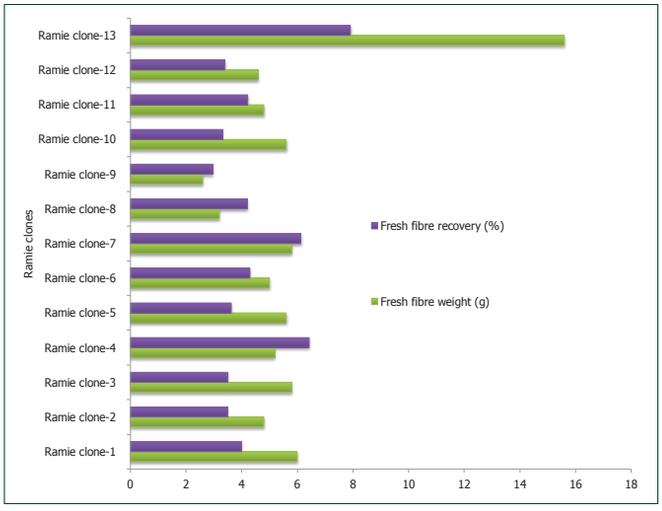


Fig. 1.22. Performance of ramie clones for fresh fibre recovery and fresh fibre weight

1.6.2 Characterization of gummy substance, breeding behaviour study and genetic diversity analysis in ramie

It was found that ramie gum contains about 34.3 – 40.8% hemicellulose and 15.2 – 16.6% pectin, while the fibre is 96.1% holocellulose. Characteristic FT-IR spectrum for hemicellulose in ramie gum has been determined. Methods for sugar fractionation in ramie gum using HPLC have been standardized using acetonitrile-water and tri-ethanol amine. Peaks for pectin, mannose, arabinose, rhamnose, xylose and glucose have been identified in gum. Complete degumming improves strength by 1–1.5 g/tex, while fineness increases by 0.2–0.3 tex. Methods have been developed for localization of gum in ramie plant using staining techniques and phase contrast microscopy. Inflorescence structure, flowering phenology and reproductive behavior of ramie has been studied in detail. Genetic exchange is minimal between early and late flowering genotypes due to typical male and female flowering phenology. Temperature plays a major role in reproductive success in late flowering genotypes. Pollination studies indicate that seed set varies from 75 – 80% in ramie, of which self-pollinated seed is less than 46%. Much of the self-pollination is achieved by between stem geitonogamy. Cross pollination is favoured by dispersal of pollen with a very high speed, possibly one of the fastest examples of organ movement in biological world. The isolation distance of ramie has been determined as 500 m *(Source: NFBSFARA FQ 3030. Contributors: P. Satya, S. Mitra (CRIJAF) and D.P. Ray (NIRJAFT).*

1.7 Flax (*Linum usitatissimum*)

1.7.1 Genetic improvement

F_1 generations of 5 crosses, F_2 generations of 4 crosses, F_3 generations of 20 crosses, F_4 generation of 12 crosses, F_6 generation of 15 crosses and 3 backcross (JRF-2 × FT-897) × JRF-2, (JRF-4 × JRF-2) × JRF-2 and (H-25 × JRF-2) × JRF-2 were grown for generation advancement and evaluation of fibre yield. Total of 99 selected single plant progenies from different generations (F_4 and F_5 generations and germplasm) of flax have been evaluated for high fibre yield *(Source: SNHB 1.8. Contributors: Babita Chaudhary, M.K. Tripathi and H. Bhandari).*

1.8 Sunnhemp (*Crotalaria juncea*)

1.8.1 Genetic improvement:

A total of 25 selected populations were evaluated. Plant height ranged from 231.4 to 270.4 cm and fibre yield varied from 8.3 to 12.2 q/ha (Fig. 1.23). A total of 14 F_2 crosses of sunnhemp were evaluated for fibre yield. Dry fibre weight ranged from 2.0 g-5.0 g/plant (Table 1.12) *(Source: SNHB 1.9. Contributors: Babita Chaudhary, M.K. Tripathi and S.K. Pandey)*

Table 1.12. Performance of 14 F_2 crosses of sunnhemp for different traits at SHRS, Pratapgarh during 2014

Crosses	Plant height (cm)	Basal diameter (mm)	Fibre yield (g/plant)
SUIN-001 × SH-4-17	260.5	11.60	2.00
SUIN-19-4 × SH-4-3	283.6	10.20	5.00
SUIN 19-4 × SH-4-20	229.9	10.60	2.22
SUIN-21 × SH 4-3	277.5	10.70	2.89
SUIN21 × SH-4-17	269.8	11.52	2.00
SUIN-21 × SH-4-20	265.1	10.45	4.17
SUIN-30-1 × SH-4-3	269.6	10.54	2.33
SUIN-30-1 × SH-4-17	251.9	10.36	2.86
SUIN-30-1 × SH-4-20	280.1	10.90	2.35
SUIN-36-1 × SH-4-3	285.9	10.68	3.75
SUIN 36-1 × SH-4-17	272.6	11.20	2.88
SUIN-38-1 × SH-4-3	277.4	11.33	3.13
SUIN 38-1 × SH-4-17	278.2	10.24	2.50
SUIN-38-1 × SH-4-20	261.3	10.69	2.20
Range	229.9-285.9	10.2-11.6	2.0-5.0
Mean±SD	268.8±14.76	10.8±0.46	2.9±0.88

1.8.2 Breeding behaviour and mechanism of self-incompatibility in sunnhemp

To revalidate the results of breeding behaviour of sunnhemp the trial was repeated with three treatments on four varieties (K 12 yellow, K 12 Black, SH 4 and SUN 053) in the flowering season 2014-15. The results (Table 1.13) showed that 55-70% of cross pollinated flowers set pods across varieties. Whereas selfed and completely bagged flowers (Control) showed approximately 3% of pod setting, hence it overrules the presence of any type of physical barrier for self-pollination and hints the possibility of a genetic control.

Table 1.13. Pod-set from controlled pollination treatments.

Treat-ments	2013-14	2014-15			
	K 12 Y pod set (%)	K 12 Y pod set (%)	K 12 B pod set (%)	SH 04 pod set (%)	SUN 053 pod set (%)
Selfing	2.89	3.27	2.78	2.27	1.6
Crossing	51.02	55.67	58.87	68.97	57
Control	3	2.20	1.30	1.89	2

The mechanism of genetic barriers in selfing was assessed by observing the growth of pollen tubes into the style and the ovary of both self and cross pollinated pistils using aniline blue staining method. The study revealed that in both the cases pollen germinates and pollen tube reaches the ovary but the ovule is unable to develop into mature seed in selfed flowers, the pistils of selfed flowers abscise after few days of pollination. Since the incompatibility reactions are taking place at ovary level so this can be considered as a case of "ovarian self-incompatibility" (OSI) *(Source: JAFSP 2.3. Contributors: Maruthi, R.T., S.K. Pandey, Babita Chaudhary and S.K. Sarkar).*

2. Seed Science and Technology

2.1 Seed Research

2.1.1 Seed quality enhancement for mitigating biotic and abiotic stresses in jute (*Corchorus olitorius* L.)

For standardization of seed priming, seeds were steeped for different durations (1h, 1.5h, 2h, 2.5h, 3h, 3.5h and 4h) in NaCl and KNO_3 solutions (2%, 4%, 6% and 8%) @ 220 ml/100g seed followed by incubation (24h, 48h, 72h and 96h) for repairing of ill effects of seed deterioration. Subsequently seeds were dried back to original moisture content. Seed priming through 4h steeping in 4% KNO_3 followed by 96 h incubation recorded significantly higher seed germination (48%) and seedling vigour (VI-187.2) compared to control (seed germination-21.5% and VI-39.1) (Fig. 2.1). Seed priming with NaCl through 4h steeping in 2% NaCl followed by 96 h incubation was the best treatment which recorded significantly higher seed germination (44%) and seedling vigour (VI-168.1) whereas only 22% germination and 38.3% vigour index was noted in the control (Fig. 2.2) *(Source: TMJ 10. Contributors: A. Bera, C.S. Kar, M. Kumar and S.K. Sarkar)*

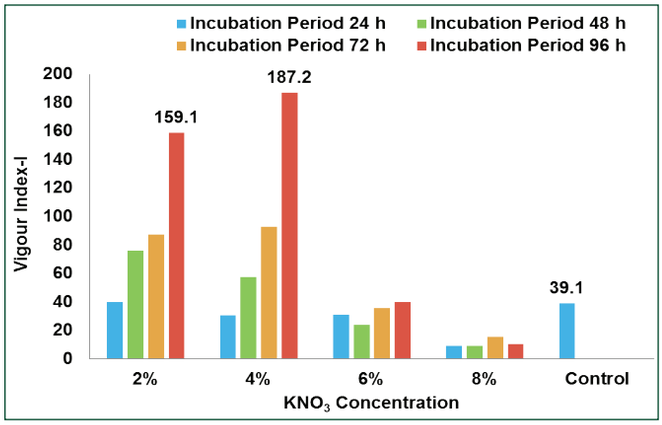


Fig. 2.1. Effect of seed priming with KNO_3 on seedling vigour of jute

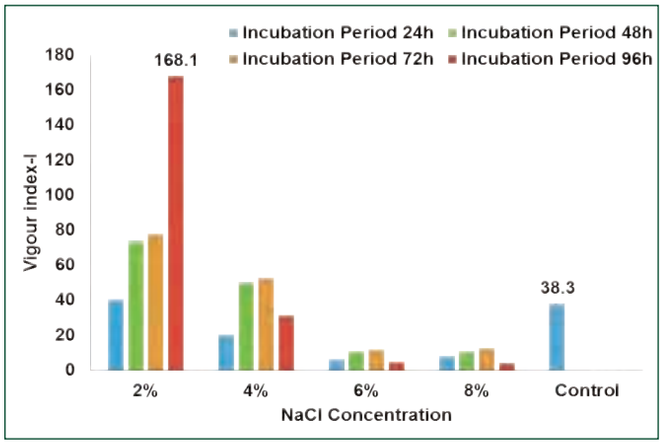


Fig. 2.2. Effect of seed priming with NaCl on seedling vigour of jute

2.1.2 Effect of sulphur and potassium application on yield and quality of jute seed

The experiment was conducted at ICAR-CRIJAF Barrackpore and CSRSJAF, Bud Bud Burdwan. At Barrackpore, application of 50 kg K_2O/ha resulted in higher number of branches/plant, pod length as well as pods/plant there by significantly higher jute seed yield as compared to control and 25 kg K_2O/ha but was at par with 75 kg K_2O/ha (Table 2.1). Significantly higher number of branches/plant and pods/plant were recorded with the application of 45 kg S/ha compared to other sulphur doses. Hence, significantly higher seed yield of jute was recorded with the application of 45 kg S/ha over all other sulphur doses.

Table 2.1. Effect of sulphur and potassium on seed yield and its attributing traits in jute at Barrackpore and Bud Bud

Treatment	Branches/plant	Pods/plant	Seed yield (q/ha)
Barrackpore			
Potassium levels (kg K_2O / ha)			
0 (Control)	3.6	15.8	5.5
25	4.3	18.0	6.8
50	4.7	19.2	7.3
75	4.6	18.7	7.0
LSD (P=0.05)	0.37	1.49	0.49
Sulphur levels (kg S / ha)			
0 (control)	3.1	14.1	5.1
15	4.3	17.7	6.4
30	4.7	19.4	7.2
45	5.1	20.6	7.8
LSD (P=0.05)	0.33	1.04	0.46
Bud Bud			
Potassium levels (kg K_2O / ha)			
0 (Control)	2.1	6.9	3.7
25	2.4	8.1	4.8
50	2.5	8.7	5.2
75	2.7	9.2	5.5
LSD (P=0.05)	0.31	0.93	0.54
Sulphur levels (kg S / ha)			
0 (control)	1.9	6.6	3.6
15	2.3	7.9	4.6
30	2.6	8.8	5.3
45	2.9	9.7	5.8
LSD (P=0.05)	0.12	0.55	0.31

In Bud Bud, application of 75 kg K_2O/ha resulted in higher number of branches/plant, pod length as well as pods/plant

as compared to other treatments. Application of 75 kg K_2O/ha resulted in significantly higher jute seed yield *(Source: JA 6.6. Contributors: Amarpreet Singh, M. Kumar, S.P. Mazumdar, A. Bera and D.K. Kundu)*

2.2 National Seed Project (Crops)

2.2.1 Breeder seed production

During *kharif* 2014-15, 11.90 q of breeder seeds were produced against DAC indent of 10.87 q with a production surplus of 1.03 q. Breeder seeds of 12 jute varieties comprising four *white* jute varieties *viz*. C 517, C 532, JRC 212 and eight *tossa* jute varieties *viz*. JRO 204, S 19, JBO 2003 H, JRO 128, JRO 8432, JRO 66, JRO 524, JRO 878 were produced (Table 2.2). Single Window System (SWS) is under operation for distribution and supply of different types of seeds *(Source: NSP. Contributors: C.S. Kar, A. Bera, S. Biswas and Monu Kumar).*

Table 2.2. Breeder seed production of jute varieties during 2014-15

Variety	DAC indent (q)	Production (q)
C 517	0.05	0.09
C 532	0.06	0.11
JRC 321	0.10	0.16
JRC 212	0.03	0.10
JBO 2003 H	0.40	0.48
JRO 204	0.84	1.00
S 19	0.05	0.12
JRO 128	2.62	2.80
JRO 8432	0.28	0.36
JRO 66	1.25	1.30
JRO 524	4.90	5.00
JRO 878	0.29	0.38
Total	10.87	11.90

2.2.2 Production and maintenance of nucleus seeds

Seed harvested from selected individual true to the type plants of a variety were used to raise progeny rows. Progeny rows found to be true to the type of varieties (jute, mesta and sunnhemp) were bulked to constitute nucleus seed. About 331.9 kg of nucleus seeds of the released varieties of jute (27 varieties; 223.9 kg) (Fig. 2.3 & 2.4), mesta (9 varieties; 42 kg), and sunnhemp (4 varieties; 66 kg) were produced for breeder seed production in *kharif* 2015-16 *(Source: NSP. Contributors: C.S. Kar, A. Bera, S. Biswas and Monu Kumar).*

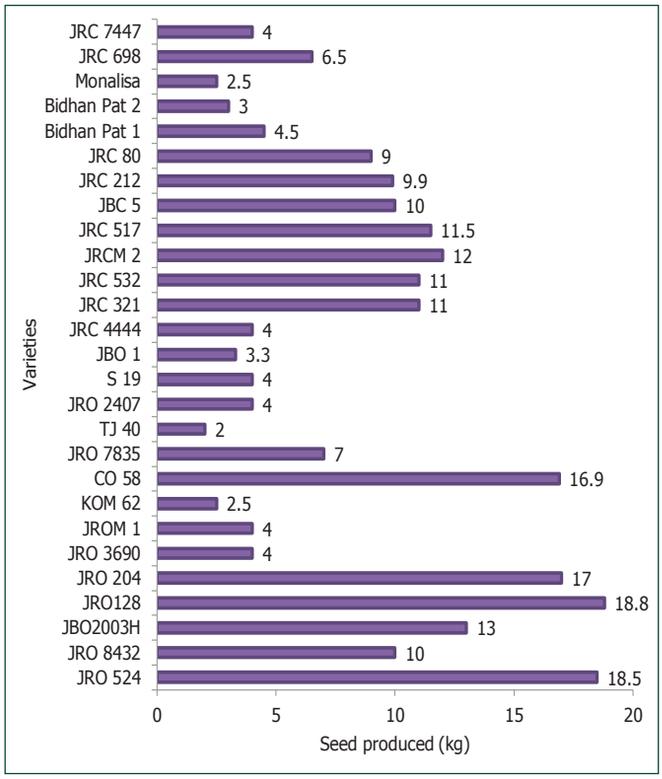


Fig. 2.3. Nucleus seed production of jute varieties

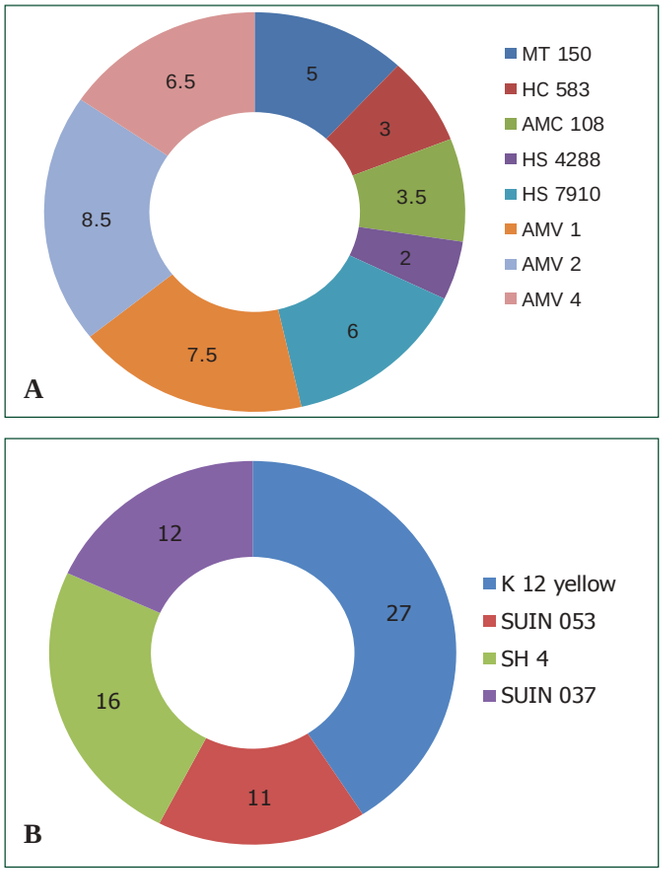


Fig. 2.4. Nucleus seed production (kg) of (A) mesta (B) sunnhemp varieties

2.2.3 Grow out test

Grow out test (GOT) was carried out to assess the genetic purity of the breeder seeds of all the indented varieties of jute prior to their supply to the indenters. On the basis of important morphological characters related to leaf shape, pigmentation on leaf, stem, flowering behaviour, capsule/ pod, seed coat colour etc. off-types were identified and its extent was worked out (Fig. 2.5) *(Source: NSP. Contributors: C.S. Kar, A. Bera, S. Biswas and Monu Kumar).*

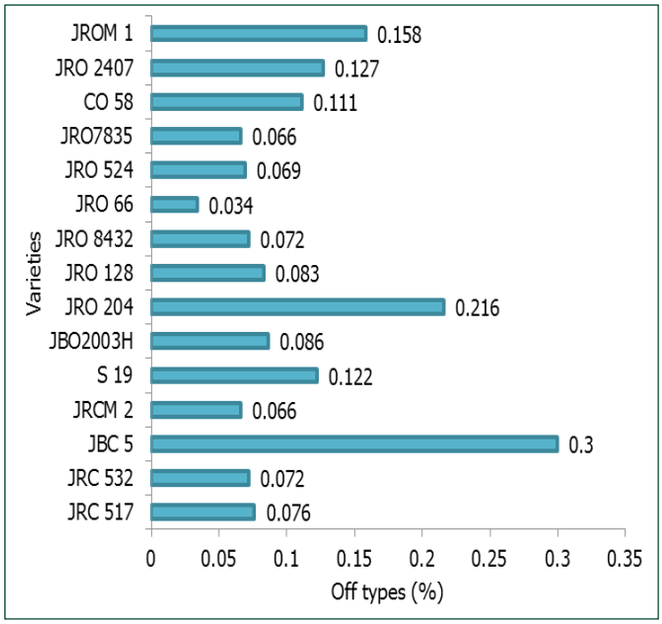


Fig. 2.5. Off types observed in different varieties of jute in Grow Out Test (GOT)

2.3 ICAR Seed Project (Mega Seed Project)

2.3.1 Seed production

Seeds of different crops were produced under this project for distribution among farmers. A total of 705.0 q of seeds have been produced (Fig. 2.6). In addition to this planting materials of sisal (50,000 suckers) and ramie (50 q rhizomes) were also produced *(Source: MSP. Contributors: C.S. Kar, A. Bera, S. Biswas and Monu Kumar).*

2.3.2 Certified seed production and seed village programme under NFSM on commercial crop jute

Under this programme 50 q foundation seed (5.62 q at CSRSJAF, Bud Bud and 44.38 q at CRIJAF, Barrackpore) of six jute varieties namely, JBO 2003 H, JRO 204, S 19, JRO 128, JRO 8432, JRO 66 were produced. Certified jute seed production programme under Seed Village Scheme with farmers' participatory approach has been taken up at Bankura, West Bengal and Public Private Partnership (PPP) has been established with the involvement of Dada Bhai Seed Farm, Nadia, West Bengal. A total of 10.76 q certified seed of JRO 204 has been produced and marketed under PPP mode *(Source: NFSM. Contributor: C.S. Kar).*

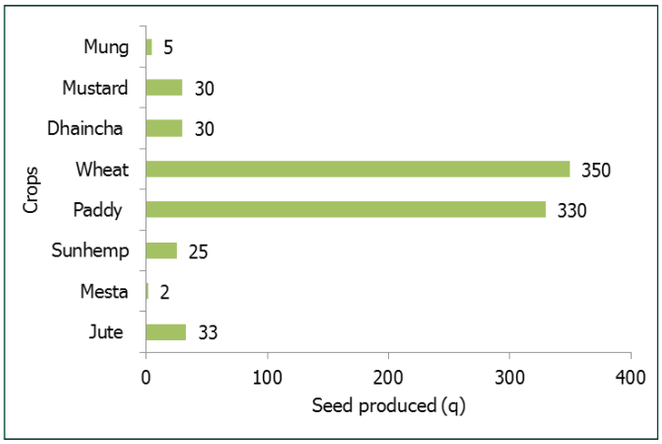


Fig. 2.6. Seed production of different crop species under mega seed project

2.3.3 Seed Day

To create awareness regarding importance of quality seed as vital input for increasing productivity two "Seed Day" programmes were organized one each at Central Seed Research Station for Jute & Allied Fibres (CSRSJAF), Bud Bud on 29th November, 2014 and on 6th December, 2014 at ICAR-CRIJAF, Barrackpore (Fig. 2.7). The farmers were appraised about the importance of quality seed and new HY varieties of jute. More than 400 farmers of different districts of West Bengal participated in these programmes *(Source: MSP. Contributors: C.S. Kar, A. Bera, S. Biswas and Monu Kumar).*

Fig. 2.7. Farmers interacting with scientists during Seed Day at ICAR-CRIJAF

3. Biotechnology

3.1 *De novo* Transcriptome Sequencing and Analysis of Bast Tissues to Identify Genes Associated with Lignin Biosynthesis in *White* Jute

Employing comparative RNA-seq-based bast transcriptomics that used a *deficient lignified phloem fibre* (*dlpf*) mutant and its wild-type (WT) jute (*Corchorus capsularis* L.) (Fig. 3.1 & 3.2), we discovered genes and their isoforms involved in lignin biosynthesis in jute fibres via upstream shikimate-aromatic amino acid (AAA) and downstream monolignol pathways.

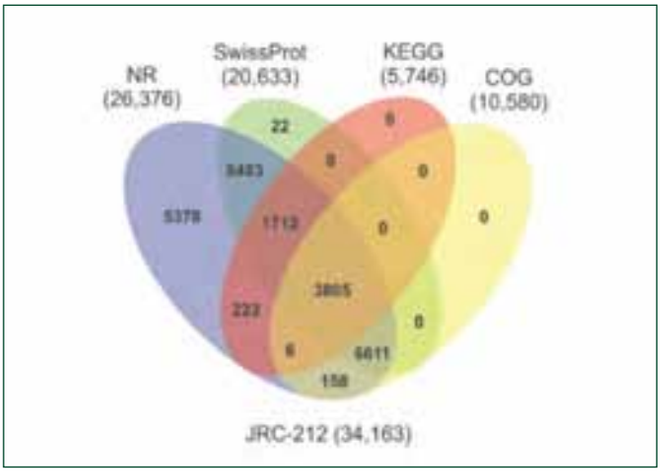


Fig. 3.1. Functional annotation results of the bast transcriptome of *C. capsularis* cv. JRC-212. Values within parentheses represent the total number of unigenes

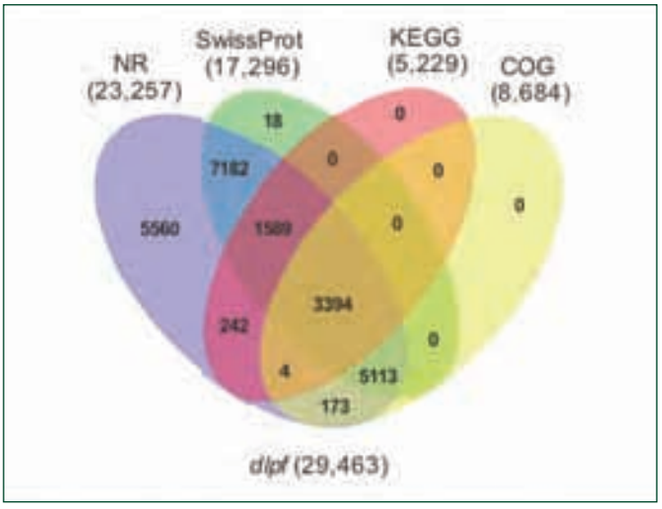


Fig. 3.2. Functional annotation results of the bast transcriptome of *C. capsularis* mutant *dlpf*. Values within parentheses represent the total number of unigenes

Altogether 60 WT and 57 mutant unigenes were mapped to the shikimate-AAA pathway. Whereas 91 WT and 85 mutant unigenes, excluding those corresponding to peroxidase and other phenol oxidases that are involved in lignin polymerization were mapped to the monolignol pathway. Following cross-validation that allowed us to eliminate unwanted proteins by checking the conserved motifs, we identified a total of 38 isoforms of 16 genes, 37 of them being homologous, involved in the shikimate-AAA pathway, with their sequence and coding region lengths ranging from 515 to 2,749 bp and 73 to 670 aa, respectively.

There were two homologous isoforms identified for *DAHPS* (3-deoxy-D-*arabino*-heptulosonate 7-phosphate synthase) that encodes the enzyme catalyzing an aldol condensation of phosphoenolpyruvate and D-erythrose 4-phosphate to produce DAHP, the first committed step of the shikimate-AAA pathway (Fig.3.3). Maximum numbers

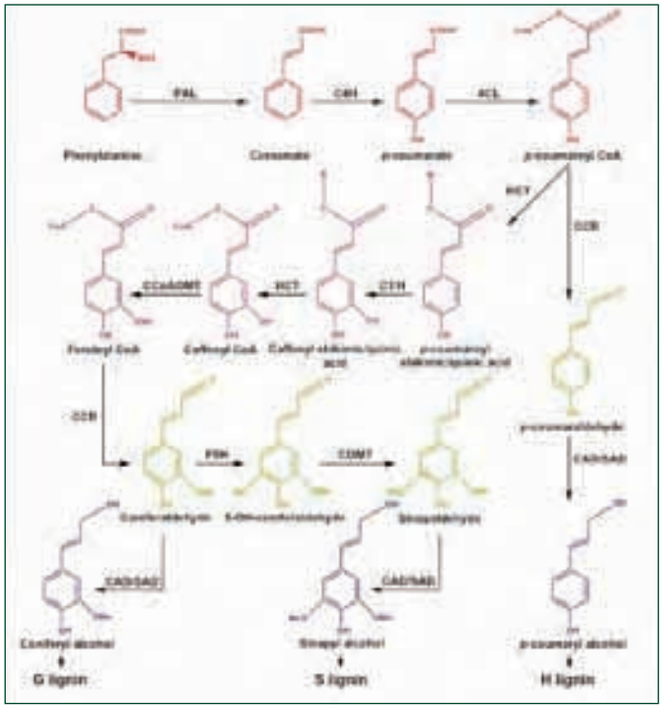


Fig. 3.3. Monolignol biosynthetic pathway in jute fibres. The pathway was reconstructed by identifying genes that encode corresponding enzymes in *C. capsularis* cv. JRC-212 and its mutant dlpf, using BLASTx annotation of the Kyoto Encyclopedia of Genes and Genomes (KEGG) database based on KEGG Automatic Annotation Server (KAAS) and BRITE hierarchies followed by cross-validation of protein families. CAD/SAD, cinnamyl alcohol dehydrogenase/ sinapyl alcohol dehydrogenase (EC 1.1.1.195); CCoAOMT, caffeoyl-CoA O-methyltransferase (EC 2.1.1.104); CCR, cinnamoyl-CoA reductase (EC 1.2.1.44); C3'H, 5-O-(4-coumaroyl)-D-quinate/ shikimate 3'-hydroxylase (EC 1.14.13.36); C4H, cinnamate 4-hydroxylase (EC 1.14.13.11); 4CL, 4-coumarate:CoA ligase (EC 6.2.1.12); COMT, caffeic acid O-methyltransferase (EC 2.1.1.68); F5H, ferulate 5-hydroxylase (EC 1.14.-.-); HCT, shikimate O-hydroxycinnamoyltransferase (EC 2.3.1.133); PAL, phenylalanine ammonia-lyase (EC 4.3.1.24)

of isoforms (6-9 each) were identified for *DHD-SDH* (3-dehydroquinate dehydratase/ shikimate dehydrogenase), *ADT-PDT* (arogenate/prephenate dehydratase) and *PPY-AT* (phenylpyruvate aminotransferase). However, only one homologous isoform was discovered for *DHQS* (3-dehydroquinate synthase), *SK* (shikimate kinase), *EPSPS* (5-enolpyruvylshikimate 3-phosphate synthase), *CS* (chorismate synthase), *ADH* (arogenate dehydrogenase), *PPA-AT* (prephenate aminotransferase) and *IGPS* (indole-3-glycerol phosphate synthase).

We discovered a total of 43 isoforms of all ten genes involved in monolignol biosynthesis, with 33 of them being homologous in WT and its mutant. Their sequence and coding region lengths ranged from 619 to 3,567 bp and 119 to 778 aa, respectively. There were six genes with more than one isoform. Three homologous isoforms were identified each for *PAL* (phenylalanine ammonia-lyase) and *C4H* (cinnamate 4-hydroxylase). Maximum numbers of isoforms were identified for *HCT* (shikimate *O*-hydroxycinnamoyltransferase) and *CAD* (cinnamyl alcohol dehydrogenase), with the latter having the highest number of homologous isoforms (10) amongst all monolignol genes discovered here. Although five isoforms were identified for *CCoAOMT* (caffeoyl-CoA *O*-methyltransferase), three of them were found to be homologous in WT and its mutant.

Most of the proteins of the shikimate-AAA pathway were closely related to *Theobroma cacao*, *Vitis vinifera* and *Glycine max* proteins. Multiple isoforms of a shikimate-AAA protein were clustered with those characterized from more than one plant species. A similar trend was observed in the phylogenetic analysis of monolignol proteins (Fig. 3.4).

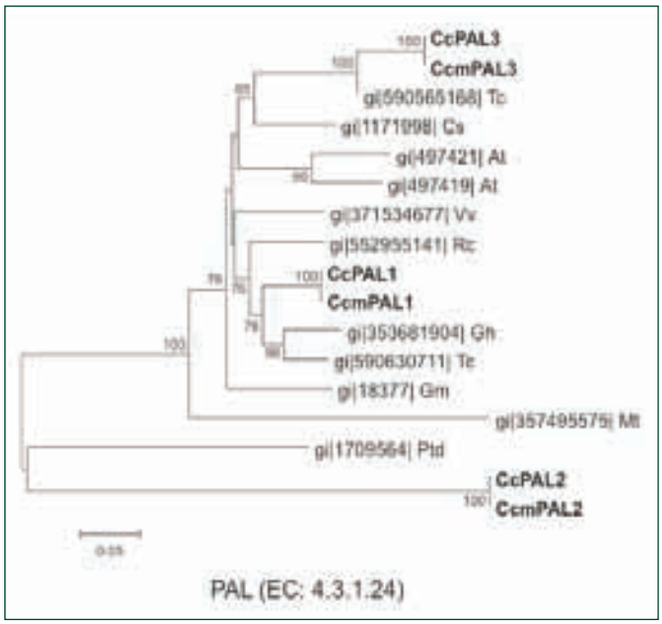


Fig. 3.4. Unrooted phylogenetic tree of phenylalanine ammonia-lyase (PAL) proteins of jute (*C. capsularis*) fibres and those characterized from other plant species. Numbers at nodes represent % occurrence in 1,000 bootstrap replicates (> 50% values only shown), and the bar indicates evolutionary distance

Exactly the same phylogenetic relationships were established for C4H. CCR and some of the isoforms of CAD and CCoAOMT (Fig. 3.5) were closely related to *G. hirsutum* proteins, whereas one of our candidate 4CL proteins had high sequence similarity with that from *G. max*. CcCAD2 and its ortholog were found to be closely related to a sinapyl alcohol dehydrogenase (SAD) protein from *Populus tremula* x *P. tremuloides*, whereas CcCAD5 was weakly related to *Plantago major* SAD protein.

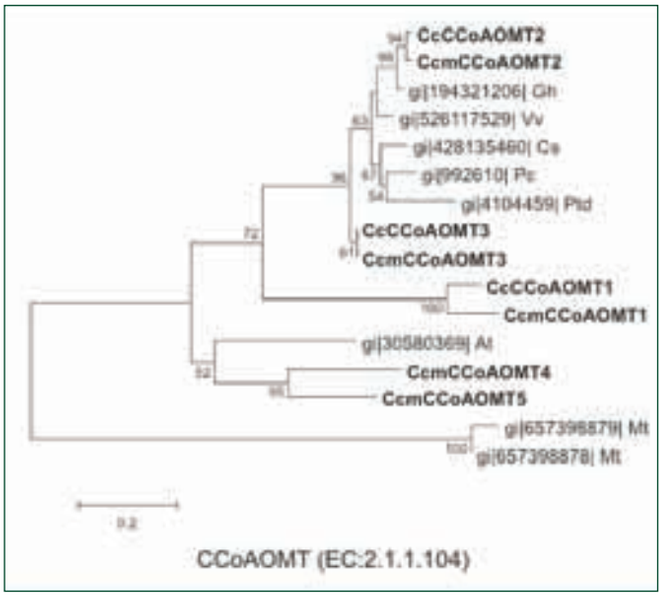


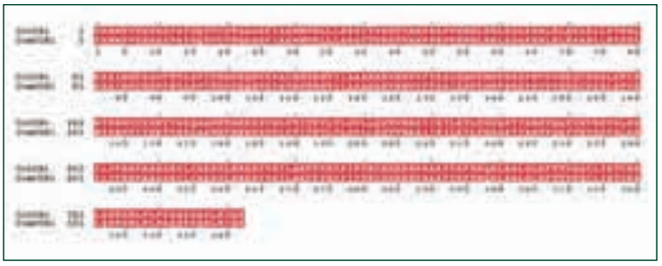
Fig. 3.5. Unrooted phylogenetic tree of caffeoyl-CoA O-methyl-transferase (CCoAOMT) proteins of jute (*C. capsularis*) fibres and those characterized from other plant species. For other details, see Fig. 3.4

Although nearly half of the mutant isoforms had strictly conserved WT residues (Fig. 3.6), many were characterized by stretches of extra or missing residues with or without single to multiple aa substitutions (Fig. 3.7).

Nevertheless, the identification of few mutant isoforms having strict homologies with their corresponding WT homologs but differing in 1-2 aa residues (Fig. 3.7) points to potential mutations in coding regions.

We further performed qRT-PCR to validate selected lignin genes and their differential expression in the mutant as compared to that in its corresponding WT. The absence of any candidate mutations in the coding region of the mutant homolog of the *COMT* gene categorically proves that S-lignin-deficient *dlpf* is not a COMT mutant. However, *CcCAD7* remained strongly and consistently down-regulated in mutant bast tissues irrespective of growth stages, perhaps one of the most decisive changes that seems

to account for chronic lignin deficiency in mutant phloem-fibre cell wall. This was supported by a 3-fold decline in CAD (conAD) activity in mutant bast tissues at 30 days after germination. *CcCAD7* down-regulation at the later growth stage was accompanied by several folds reduction in the expression of *CcCCR1*, *CcF5H1* and *CcCOMT1* that might have resulted in a diminished pool of CAD substrates (cinnamaldehydes).



(A)

(B)

Fig. 3.6. Multiple sequence alignment of **(A)** cinnamoyl-CoA reductase (*CCR*) and **(B)** 5-*O*-(4-cumaroyl)-D-quinate/shikimate 3'-hydroxylase (*C3'H*) genes and their isoforms associated with the monolignol biosynthetic pathway in jute (*C. capsularis*) fibres. Red box with white characters denote strict identity

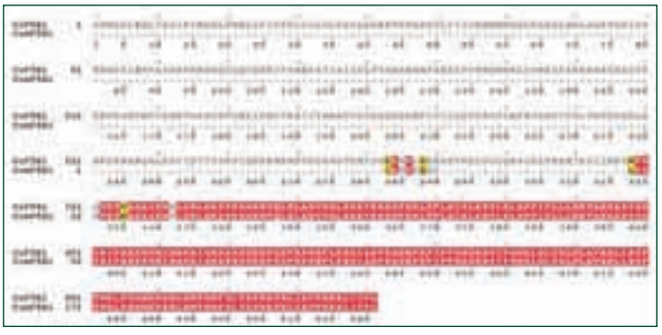


Fig. 3.7. Multiple sequence alignment of ferulate 5-hydroxylase (*F5H*) gene and its mutant homolog involved in the monolignol biosynthetic pathway of jute (*C. capsularis*) fibres, showing missing amino acid (aa) residues with multiple aa substitutions. Red box with white characters denote strict identity

The mutant isoform of CcCAD7 lacks 18 WT residues upstream. Since CAD is known to have multiple substrate (*p*-coumaraldehyde, coniferaldehyde and sinapaldehyde) specificities, detailed functional analysis supported by K_m studies would allow us to confirm whether these deletions are responsible for reduced substrate-binding efficiency and/or altered substrate specificity of CcCAD7 in mutant bast tissues. However, *CcCAD7* down-regulation did not affect plant growth and development in the mutant, except for increased susceptibility to *Macrophomina* stem rot. These effects make CAD a promising target for reducing fibre lignin content of high-yielding jute varieties using forward or reverse genetics approaches *(Source: JBT. 4.1. Contributor: D. Sarkar and P. Satya).*

3.2 Genomics for Augmenting Fibre Quality Improvement in *Tossa* Jute

3.2.1 A high-density RAD-seq-based SNP linkage map of jute (*Corchorus olitorius* L.)

A high-density SNP linkage map, for the cross Sudan Green (SG) × *bast-fibre-shy* (*bfs*), has been developed in dark jute (*C. olitorius*) using restriction-site-associated DNA sequencing (RAD-seq). Illumina-HiSeq 2000 sequencing generated a total of 680,254,155 100-bp reads. There were 50,569,723 reads for the two founders and 629,684,432 reads for the 176 F_2 individuals (Fig. 3.8).

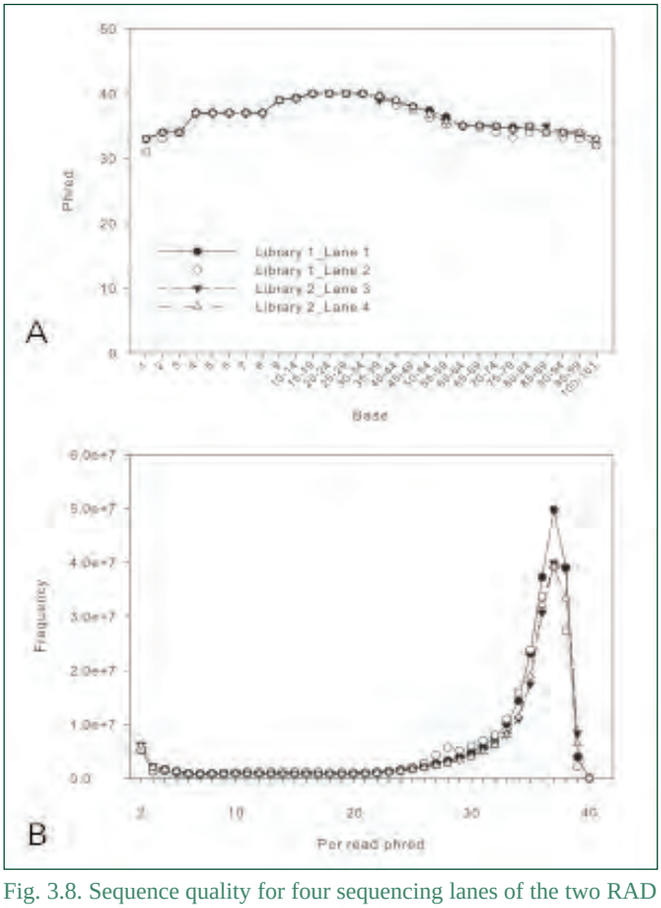


Fig. 3.8. Sequence quality for four sequencing lanes of the two RAD libraries in terms of the per-base phred scores (**A**) and the per-read phred scores and their frequencies (**B**). The 176 F_2 progenies from the SG x bfs mapping population are split between two RAD libraries and sequenced in four lanes of flow cells on an Illumina HiSeq 2000 platform

The F_2 progeny had a mean number of 3,577,752 reads (SD 1,865,107), with minimum and maximum numbers of 35,241 and 13,488,252 reads, respectively. Finally, 613 codominant RAD markers present in at least 85% progeny were retained for linkage map construction. Most of the RAD markers (79.1%) supported a single SNP, and the relative proportions of A/G-G/A and C/T-T/C SNPs were 32.4 and 29.3 %, respectively.

Seven linkage groups (LG1-LG7) containing a total of 503 RAD markers were identified (Fig. 3.9). The total length of the linkage map was 358.5 cM, with an average marker interval of 0.72 cM (Table 3.1). LG2 had the longest (112.5 cM) and LG6 the shortest (7.4 cM) genetic distance, whereas LG1 had the highest (139) and LG7 the lowest (22) numbers of markers.

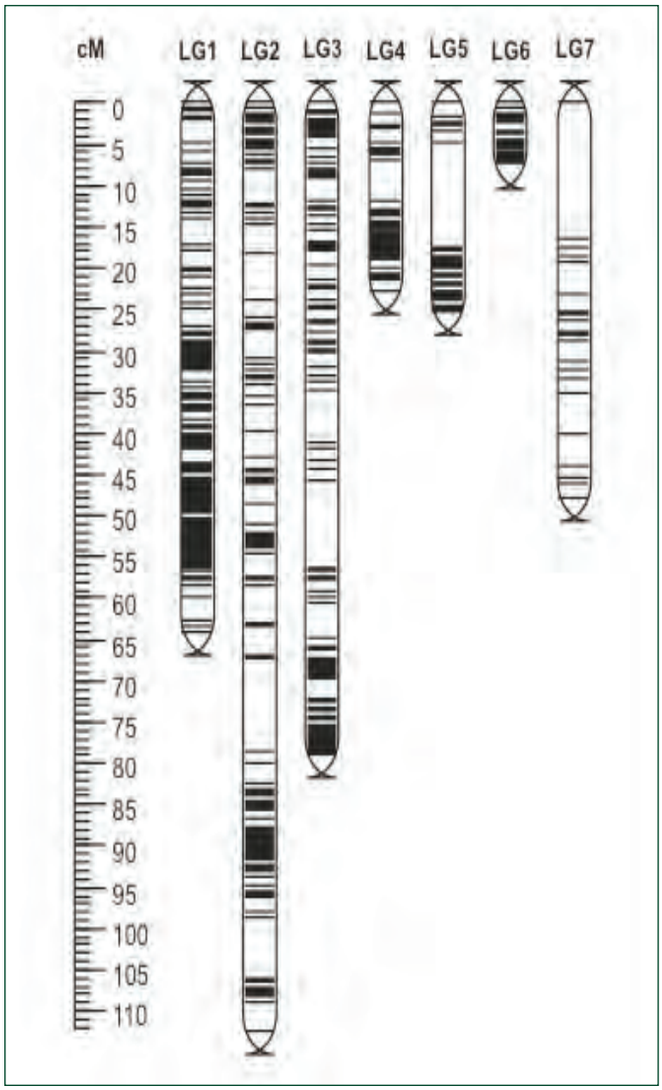


Fig. 3.9. A restriction-site-associated DNA (RAD) linkage map of jute comprising 503 RAD markers that supported 638 SNPs spanning a total genetic distance of 358.5 cM over seven linkage groups. Horizontal lines represent the position of mapped RAD loci on each linkage group. The scale is based on Kosambi centiMorgan (cM)

Table 3.1. Summary of the restriction-site-associated DNA (RAD) linkage map of jute constructed using the SG x *bfs* intercross F_2 mapping population

Linkage group	Number of RAD markers	Number of SNPs[a]	Length (cM)	Average marker interval (cM)[b]
LG1	139	176	64.0	0.46
LG2	119	159	112.5	0.95
LG3	114	139	79.0	0.70
LG4	48	63	22.6	0.48
LG5	32	36	25.3	0.82
LG6	29	33	7.4	0.26
LG7	22	32	47.7	2.27
Average	71.9	91.1	51.2	0.72
Total	503	638	358.5	-

[a] A maximum of 3 SNPs were called per haplotype that refers to the configuration of SNPs at a RAD locus

[b] Derived by dividing the summed recombination factions from all mapped intervals by the number of intervals

The longest gap between two mapped loci (16.6 cM) was detected in LG7. To account for chromosome ends extending beyond terminal markers, we estimated the genome length using two different approaches. Both methods estimated the total genome to be 370.4 cM, implying that the linkage map represents 96.8 % of the genome length. The estimated genome length was converted to a genome coverage of 87.0 %.

Given that the length and size of the genome are 370.4 cM and ~350 Mb, respectively, genome-wide corrected recombination rate (cM/Mb) for jute (*C. olitorius*) was estimated to be 1.058, which is 2.5-, 3.0- and 4.0-fold lesser than that of *T. cacao* (jute's closest syntenic species), *Oryza sativa* and *Arabidopsis thaliana*, respectively.

3.2.2 Comparative genomics (synteny mapping) between jute and other eudicot species

Synteny mapping of jute RAD markers to model eudicot species showed that jute had maximum syntenic relationship with cocoa (47.5 % homology) followed by diploid cotton (29.2 % homology). Less than 15 % of RAD sequences were mapped to the other eudicot genome sequences, the lowest being that to *A. thaliana* (~5 %). There were no one-to-one syntenic relationships between jute linkage groups and diploid cotton chromosomes (Fig. 3.10). As high as 12 of 44 markers with significant blastn hits on LG1 were aligned to chr4 of diploid cotton.

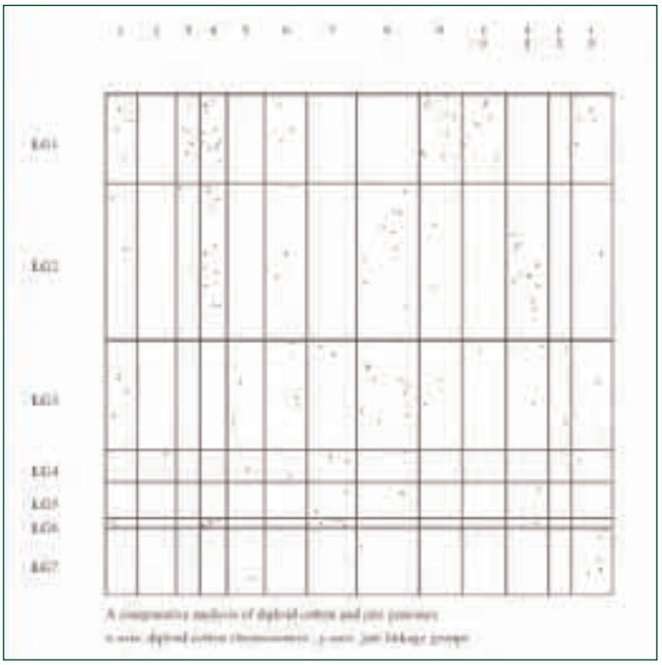


Fig. 3.10. The Oxford grid-based random plot showing comparative analysis of jute genome with that of diploid cotton (*Gossypium raimondii*). Dots represent the comparative genome-wide positions of homologous loci. The X-axis is proportional to physical length, while the Y-axis is proportional to Kosambi centiMorgan (cM). LG, linkage group

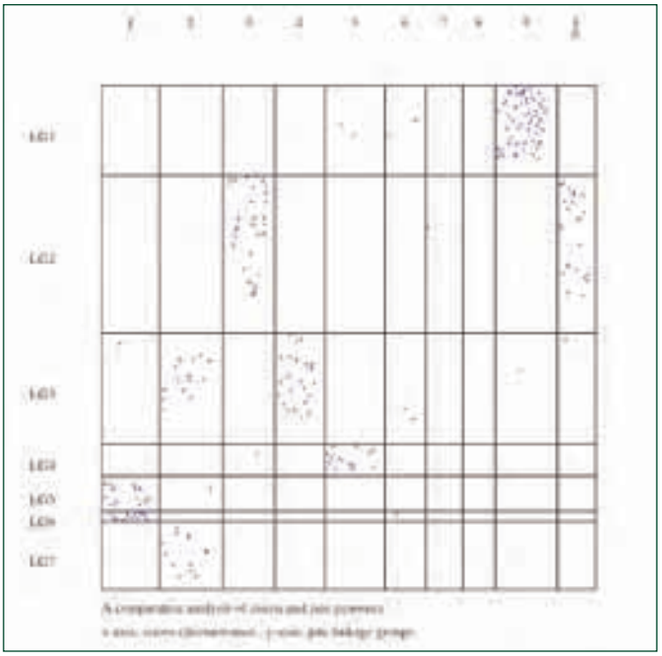


Fig. 3.11. The Oxford grid-based random plot showing comparative analysis of jute genome with that of cocoa (*Theobroma cacao*). Dots represent the comparative genome-wide positions of homologous loci. The X-axis is proportional to physical length, while the Y-axis is proportional to Kosambi centiMorgan (cM). LG, linkage group

By comparison, five syntenic pairs of jute linkage groups and cocoa chromosomes, viz., LG1/chr9, LG4/chr5, LG5/chr1, LG6/chr1 and LG7/chr2 had 94.2, 93.8, 93.3, 88.2 and 100.0 % of markers with significant blastn hits, respectively, showing one-to-one alignment to cocoa chromosomes (Fig. 3.11). Of the seven jute linkage groups, one had one-to-one, two had one-to-two and three had one-to-three syntenic relationships with cocoa chromosomes.

Cocoa and diploid cotton probably diverged from a common ancestor about 33.7 mya. Our results suggested the possibility of an ancient paleopolyploid event followed by an increase of DNA driving the course of chromosomal evolution in jute.

3.2.3 Histological fibre content in jute

We have identified a unique trait of histological fibre content (FC) in jute. FC represents the total number of fibre cell bundles (FCBs) in an entire stem transversal section at 90 days after germination (DAG). The total fibre content (F_T) was expressed as $F_T = F_R \times F_C$, where F_R is the mean ratio of the total number of FCBs to the number of FCBs in the first FCB layer nearest the cambium and F_C is the total number of FCBs in the first FCB layer nearest the cambium in the entire transversal section over all triangular wedges (Fig. 3.12).

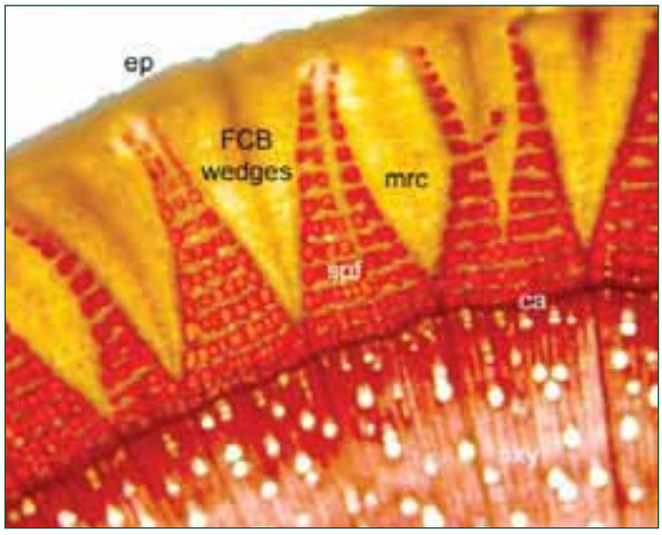


Fig. 3.12. Mäule ($KMnO_4$-HCl)-stained transversal section of the stem base segment of a 90-day-old plant of *Corchorus olitorius* cv. Sudan Green, showing fibre cell bundles (FCBs) and triangular FCB wedges that are used to determine histological fibre content (FC) per plant. *ca* cambium, *ep* epidermis, *mrc* medullary ray cells, *spf* secondary phloic fibre, *sxy* secondary xylem

FC represents a single histological trait that reflects development-specific cambial activity leading to the formation of secondary phloic FCBs. Using simple lignin-specific histological staining of free-hand stem cross-sections, a large population can be quickly screened for FC. This trait was also highly correlated with PH (r_s = 0.82, *P* x 0.01) and SBD (r_s = 0.77, *P* x 0.01), the two major yield components of jute. The relatively high heritability of FC (93.7 %), comparable to that of FY (93.2 %), indicated that

much of the phenotypic variance was genetically controlled in the $F_{2:3}$ families and suitable for QTL mapping.

3.2.4 QTL mapping of histological fibre content and correlated yield traits in jute

A total of nine QTL, one each for FC, fibre yield (FY) and root weight (RW) and three each for plant height (PH) and stem base diameter (SBD), was identified using the RAD linkage map. The QTL *qFC-l1* was detected on top of a single-SNP (C/T) marker Co_Sb0237 (GIC = 1) at 40.2 cM on linkage group 1 (LG1) consistently across the two environments and the pooled data, accounting for 10.2-10.6 % of the phenotypic variance in FC (Fig. 3.13).

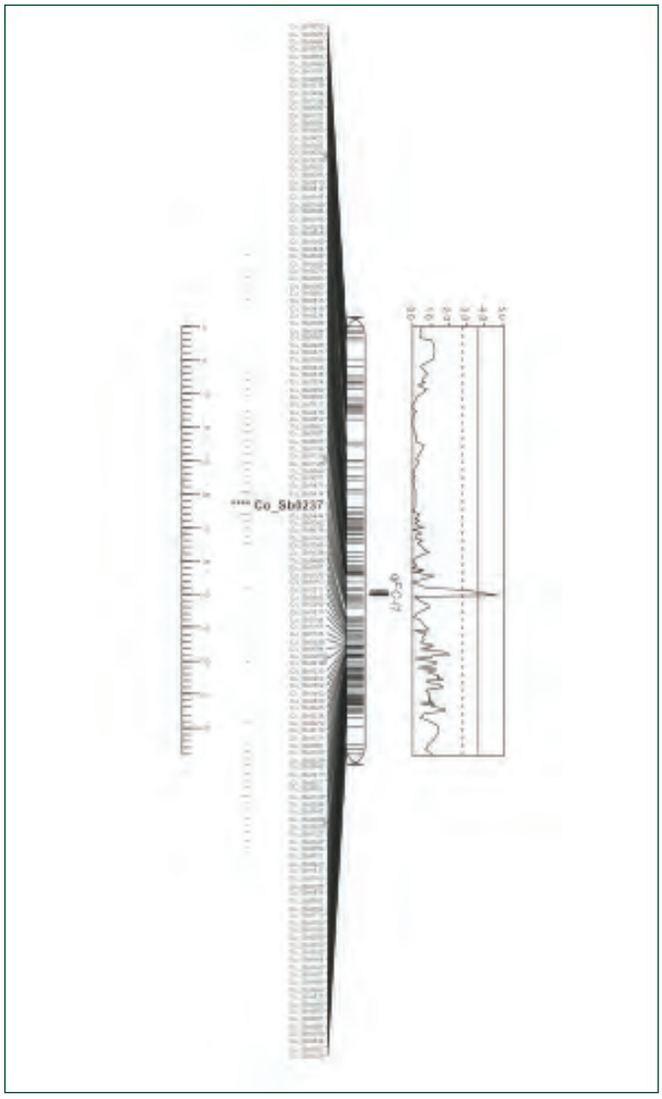


Fig. 3.13. QTL for histological fibre content (FC) on top of a single SNP (C/T) RAD marker Co_Sb0237 at 40.2 cM on linkage group 1 (LG1) across the two environments and the pooled data. Asterisks denote Kruskal-Wallis test-based marker significance

One QTL each for FY (*qFY-l1*), RW (*qRW-l1*), PH (*qPH-l1*) and SBD (*qSBD-l1*) were detected exactly at the same position on LG1 (GIC = 1), accounting for 7.5-8.1, 7.2-9.2, 6.3-8.2 and 6.3-10.3 % of the phenotypic variance, respectively (Fig. 3.14). Additive effects were always positive for all five QTL, indicating that increased trait values were conferred by the female (SG) alleles and associated with homozygous inheritance of C allele of the C/T SNP at the marker Co_Sb0237.

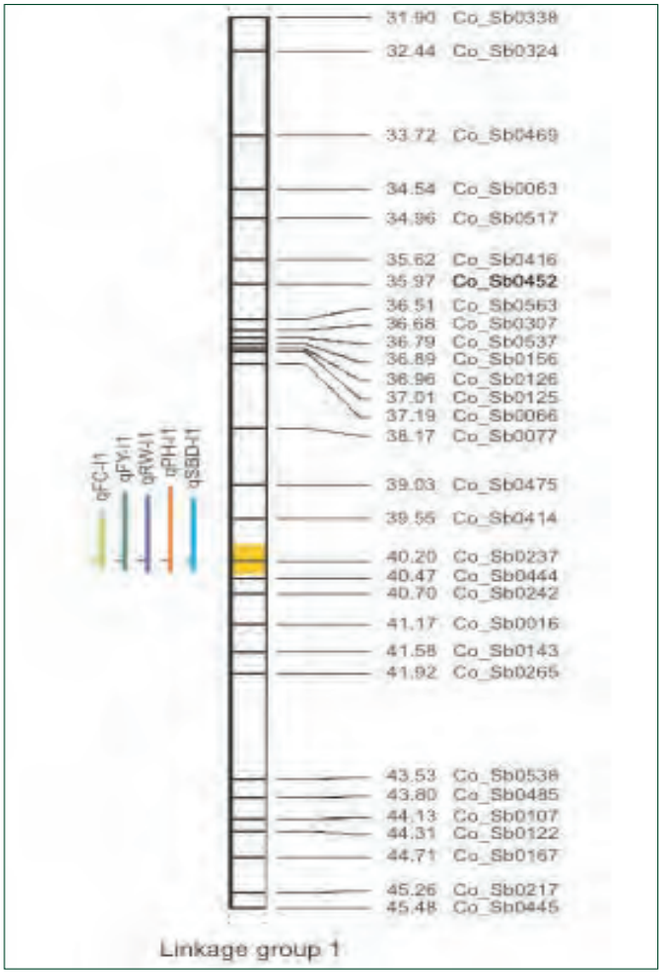
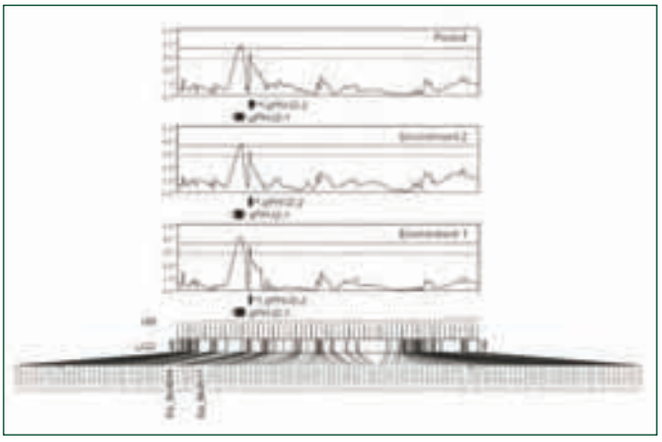


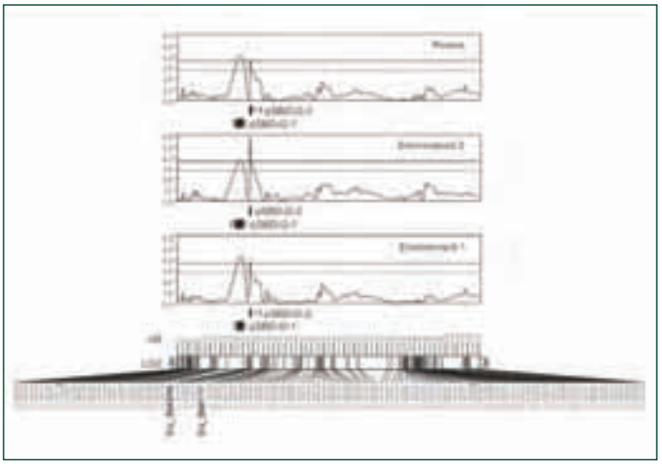
Fig. 3.14. A QTL hot-spot for bast fibre yield in jute on linkage group 1 (LG1), consisting of QTL for histological fibre content (FC), fibre yield (FY), plant height (PH), stem base diameter (SBD) and root weight (RW)

All five QTL showed varying degrees of partial dominance. Whereas positive dominance always occurred at *qFC-l1*, negative dominance consistently occurred at the other QTL, suggesting that heterozygosity (C/T for the marker) was always favorable for the expression of FC, but not necessarily for FY, RW, PH and SBD. Two QTL linked in repulsion were identified each for PH and SBD on LG2 consistently across the two environments and the pooled data (Fig. 3.15). The linked QTL *qPH-l2-1* and *qPH-l2-2*, with enhancing alleles from bfs (male) and SG (female), respectively, were on top of single-SNP (C/T) markers Co_Sb0254 and Co_Sb0117 at 24.0 and 26.9 cM, respectively. Together, they accounted for 16.6-17.5 % of the phenotypic variance in PH.

Based on the pooled data, *qSBD-l2-1* was more likely to be located at 23.1 cM on LG2. Together, *qSBD-l2-1* and *qSBD-l2-2* explained 16.9-17.8 % of the phenotypic variance in SBD. Both *qPH-l2-1* and *qSBD-l2-1* showed varying degrees of overdominance, with the latter displaying a very large effect (4.19-10.19 mm) across the two environments and the pooled data. By comparison, small overdominance occurred at *qPH-l2-2* and *qSBD-l2-2*, with a nearly complete dominance at both loci in Environment I.



(A)



(B)

Fig. 3.15. Two QTL linked in repulsion for plant height (PH) (A) and stem base diameter (SBD) (B) on top of two single-SNP (C/T) markers Co_Sb0254 and Co_Sb0117 at 24.0 and 26.9 cM, respectively on linkage group 2 (LG2) across the two environments and the pooled data

3.2.5 QTL candidate gene mapping and analysis in jute

QTL mapping resolved 12 RAD loci within the FC-related QTL intervals (36.3-40.5 cM) on LG1 as defined by a 2-LOD score drop (Figs. 3.14 and 3.15). We could identify only two candidate genes for this QTL region, corresponding to genes *TCM_032988* and *TCM_042007* on cocoa chromosome 9 encoding laccase 17 (LAC17) and nitrate excretion transporter 1 (NAXT1), respectively. Another candidate orthologue of the gene *TCM_022157* on cocoa chromosome 9 encoding a ribosomal protein L11 family protein was identified in the vicinity (43.5) of this FC-related QTL cluster on LG1. A total of eight RAD loci enclosed the intervals (19.9-30.9 cM) of the two linked QTL for PH and SBD on LG2 (Fig. 3.16). Three candidate genes were identified for this QTL region, corresponding to genes *TCM_040995*, *TCM_026930* and *TCM_015147* on cocoa chromosome 3 encoding β-6 tubulin isoform 1, tubulin β-7 chain and chromosome transmission fidelity 8-like protein isoform 1, respectively. Adjacent to this LG2 QTL region (32.9 cM), we also identified a candidate orthologue of the gene *TCM_014957* which is located on cocoa chromosome 3 and encodes a AGC (CAMP-dependent, CGMP-dependent and protein kinase C) kinase family protein *(Source: NASF. Contributor: D. Sarkar).*

3.3. Tissue Culture

3.3.1 Micropropagation in jute

Three day old *in-vitro* germinated seedlings (var. JRC 517 and JRO 524) were used for axillary bud culture on MS medium containing different concentrations of IAA (0-3.0 mg/l) and Kinetin (0-3.0 mg/l) for 4 weeks.

The explant obtained from seedlings of jute (var. JRC 517 and JRO 524) responded to shoot induction on 0.07 mg/l IAA and 0.5 mg/l Kinetin. Multiple shoots were detached from mother explants and cultured on MS fortified with 0.5 mg/l Kinetin. The number of shootlets increased significantly for the next two repeated subculture and reduced thereafter with maximum number of shootlets produced during the second subculture. The average number of shootlets/explant was 2.92 ±0.17 on 0.03 mg/l IAA and 0.5 mg/l Kinetin.

Vigorous rooting (100%) with maximum average number of roots (8.07±0.19) observed on ½ MS supplemented with 1.5 mg/l IBA. *Ex-vitro* rooting using IBA or NAA (5, 10, 20 mg/l) for 5 min (pulse treatment) showed 62 % shootlets responded to rooting on 20 mg/l IBA with maximum number of roots/explant (2.08±0.27). Plants were acclimatized successfully under the greenhouse condition. However, *in-vitro* rooted plantlets (86%) responded to survival well compared to *ex-vitro* (93%). Acclimatized plants were robust and displayed no morphological abnormalities (Fig. 3.16) *(Source: JB 9.3. Contributors: Asit B. Mandal and Kanti Meena)*

Fig. 3.16. Micropropagation from axillary node in *C. olitorius* (A) Individual shootlets in rooting media with 0.5 mg/l IBA; (B) Young healthy micriprogation plantlets in the green house.

3.3.2 Micropropagation in mesta

Twenty three combinations of plant growth regulators (NAA, BAP, Kinetin, 2, 4-D, TDZ and IAA) in MS medium containing vitamins of B_5 medium were assessed for *in-vitro* culture response involving cotyledon and hypocotyl explants from mesta (kenaf and roselle). Maximum callus proliferation (97.8%) was noticed in var. HS 4288 on MS containing 2 mg/l 2,4-D,0.1 mg/l NAA and 2 mg/l Kinetin in *H. sabdariffa*, whereas in *H. cannabinus* maximum (66.8%) was observed in var. MT 150 on MS containing 0.8 mg/l IAA and 0.05 mg/l TDZ. Shootlets were regenerated only in var. HS 4288 on 3.0 mg/l BAP with 0.2 mg/l IAA, which were rooted on hormone free MS basal medium (Fig. 3.17) *(Source: JB 9.3. Contributors: Asit B. Mandal and Kanti Meena).*

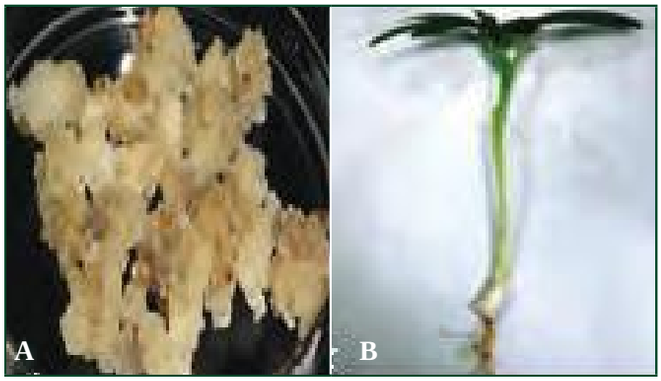


Fig. 3.17. Micropropagation in *H. sabdariffa* var. HS 4288 **(A)** Callus on proliferation media containing half dose of callus induction hormones **(B)** Whole plant.

3.3.3 Micropropagation in ramie

In-vitro micropropagation protocol has been initiated, using different explants *viz*. shoot tip, nodal explant and from field grown plants. The multiplication rate was found to be low by using shoot tip (from axenic culture) and nodal explants. However, shoot tip explants from field grown materials showed superior performance. Multiplied shootlets have been separated and plants with profuse rooting (10-15/plants) have been developed are now ready for acclimatization *in-vitro* and hardening in the green house for further growth (Fig. 3.18) *(Source: JB 9.3. Contributors: Asit B. Mandal and Kanti Meena).*

Fig. 3.18. *In-vitro* micropropagation in ramie: (A) Cultured nodal explant showing bud breaking on MS containing 1mg/l BAP + 1mg/l Kinetin + 0.1mg/l TDZ (B) nodal explant showing profuse rooting on NAA (C) Multiple shoot induction from mother culture (D) Individual plant ready for hardening.

3.3.4 Somatic embryogenesis in jute

The exceedingly high number of repetitive secondary embryos with distinct globular, heart-shaped, and cotyledonary stages were observed in auxin free liquid culture than those cultured in solid culture system supplemented with IAA and Kinetin.

Mature somatic embryos with proper rooting achieved after 60 days of culture on IAA and Kinetin containing media. Somatic embryos were clearly bipolar (Fig. 3.19), with distinct shoot and root poles as well as they had no vascular connections with the explant *(Source: JB 9.3. Contributors: Asit B. Mandal and Kanti Meena).*

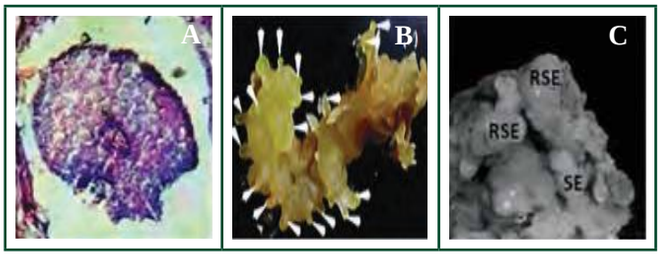


Fig. 3.19. Section of RSEs developing on young leaf of jute cultured on MS medium containing 2,4,D at 30 and 60 d. (A) LS through green globular somatic embryo showing polarity by developing procambium strand at end without vascular connection with the maternal tissue, the narrow row of cells connected to the explant is similar to suspensor (B) Maturation of repetitive secondary somatic embryo (RSE) in liquid culture (arrow) (C) A scanning electron micrograph of SE

3.3.5 Anther culture for production of doubled-haploids in jute

F_1 seeds developed by hybridizing jute varieties (JRC 517, JRC 532, JRC 321) and different stem rot resistance genotypes (CIM 034 and CIM 064) of *C. capsularis*, were grown in the pots. Flower buds containing anthers with uni-nucleated pollen were cultured on MS fortified with 3.0 mg/l 2, 4-D, 0.5 mg/l NAA and 0.5 mg/l IAA.

The percentage of callus induction was very low (30-35). After 21 days of culture the calli were sub cultured on to callus proliferation medium (MS supplemented with vitamins of B_5+ 3.0 mg/l 2,4-D + 1.0 mg/l NAA+ 3 mg/l Kinetin). Profuse callus proliferation was observed in JRC 517. Proliferated calli were transferred to plantlet regeneration medium. Unfortunately no calli showed response to regeneration medium. *(Source: JBT 4.2. Contributors: Kanti Meena and Asit B. Mandal).*

Hybridization has been made between *Macrophomina* resistance genetic stocks with widely adapted *tossa* jute varieties. The anthers of the successful hybrids have been

cultured for *in-vitro* plantlet regeneration. In spite of development of prolific callus on MS medium supplemented with diverse synthetic plant growth regulators till date no plantlet could be developed, indicating further modification in the protocol is necessary *(Source: TMJ 1. Contributors: P. Satya, Asit B. Mandal, Kanti Meena, S.B. Choudhary and H.K. Sharma)*

3.4 Optimization of Transgene Integration in Jute

To optimize the protocol for transgenic development *Agrobacterium* strain (LBA 4404) was used harbouring pB121 plasmid carrying *gus* gene. The *Agrobacterium* culture was microinjected into propagated jute plantlets after excising the apical meristem tip. Infected plantlets cultured in micropropagation medium, where bud breaking was observed followed by transfer to the rooting medium. Putative plantlets were used for GUS analysis involving different plant parts. The transient expression of uidA gene was further confirmed by PCR analysis. Out of 52 plantlets exposed to agrobacterium mediated genetic transformation only 38 showed positive PCR amplicons which indicates the extent of transient level transgene expression (Fig. 3.20). For hardening the positive plantlets were transferred to pots in glasshouse for 4 weeks *(Source: JB 9.3. Contributors: Asit B. Mandal and Kanti Meena).*

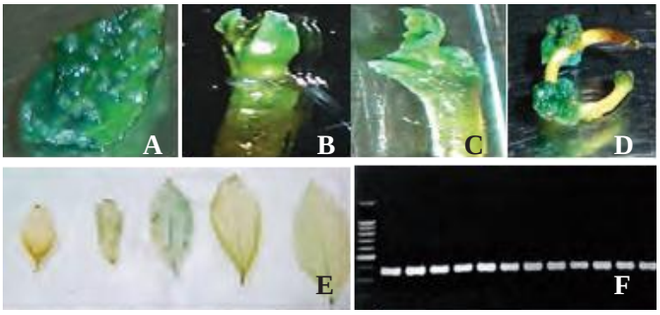


Fig. 3.20. Different steps in *Agrobacterium* -mediated genetic transformation in jute (A-E) Transient *gus* expression in different plant parts (F) PCR analysis of putative transgenic plants

3.5 Bioinformatics for Jute and Allied Fibres

Out of 35,828 previously known mature miRNAs across all the kingdoms, 21,864 non-redundant miRNAs were used in this study. Total number of EST and GSS sequences available in NCBI database have been shown in table 3.2.

Eleven miRNA homologs have been identified from 14 ESTs of *C. capsularis*, but none from *C. olitorius*. Among these, 3 miRNA homologs *viz*., osa-miR5538, hbr-miR6173 and gma-miR5368 are conserved in different ESTs. All the five miRNA homologs from a miRNA family miR393 were present in a single EST (gb|JK714322.1|). The miRNA homologs identified in *C. capsularis* were 100% identical to the previously known miRNAs with E value <1 and matching score >36.

Table 3.2. Total number of jute and allied fibre crops EST and GSS sequences available in NCBI database

Crops	Total number of ESTs	Total number of GSS
Corchorus capsularis and *Corchorus olitorius*	858	0
Boehmeria nivea	421	0
Hibiscus cannabinus and *Hibiscus sabdariffa*	44	0
Crotalaris juncea	0	0
Agave sisalana	0	0
Linum usitatissimum	2,86,872	80,340

Three of the miRNA homologs shared homology with soybean (*Glycine max*) followed by 2 with rice (*Oryza sativa*). One each shared homology with rubber (*Hevea brasiliensis*), sweet orange (*Citrus sinensis*), peach (*Prunus persica*), arabidopsis (*Arabidopsis thaliana*), human (*Homo sapiens*) and house mouse (*Mus musculus*) respectively (Fig. 3.21)

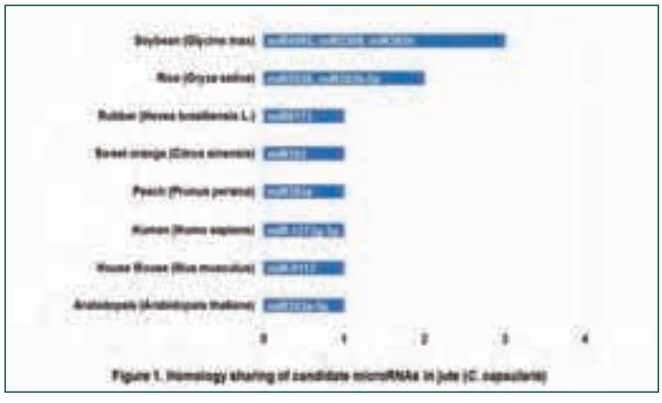


Fig. 3.21. Homology sharing of candidate micro RNAs in jute (*C. capsularis*)

Jute ESTs having sequences homologous to miRNAs were found to be encoding different genes or proteins. Based on the information on ESTs, the miRNA homologs were divided into 9 functional groups. Forty five per cent of the miRNA homologs were from ESTs encoding auxin-responsive factor TIR1-like protein followed by 27% from ESTs encoding Chloroplast 23S and 4.5S ribosomal RNA (rRNA) genes. Eighteen percent each of the miRNA homologs were from ESTs encoding unknown genes/ proteins, ribosomal protein L2 (rpl2) gene like protein and chloroplast 16S ribosomal RNA (16S rRNA) gene, respectively. Similarly, 9% each of the miRNA homologs were from ESTs encoding O-glucosyltransferase like protein, chloroplast 23S rRNA gene, RNA-binding glycine-rich protein-1 and Chloroplast tRNA-Ala, tRNA-Ile, 16S rRNA, tRNA-Val, rps12, rps7, ndhB genes, respectively *(Source: JBT 4.3. Contributors: L.L. Kharbikar, A.B. Mandal, R.K. De, H.K. Sharma, S.P. Gawande, and D. Sarkar).*

4. Soil Health and Nutrient Management

4.1 Soil Health

4.1.1 Long Term Fertilizer Experiment (LTFE)

Long-term (43 years) effect of continuous application of farmyard manure and inorganic fertilizers either alone or in combination on crop yields, nutrient uptake and soil properties were evaluated in a permanent field trial in jute-rice-wheat cropping system. During the period under report, jute (cv. JRO 524), rice (cv. Khitish) and wheat (cv. UP 262) were cultivated with different combination of fertilizer and manurial treatments.

Crop yield: Jute fibre and grain yields of rice and wheat during 43 year were influenced by various treatments (Table 4.1). In case of jute, the highest fibre yield was recorded in 100% NPK+FYM treatment (24.93 q/ha) which was at par with 150% NPK. During the last 43 years of experiment, the yield of jute, rice and wheat ranged from 8.71 to 24.93 q/ha, 14.31 to 31.18 q/ha and 7.05 to 29.75 q/ha, respectively, under different treatments. The lowest crop yields were recorded in control and the highest in 150% NPK treatment. Reduction in the quantum of inputs (50% NPK) and exclusion of one or more nutrients resulted in significant reduction in yields of jute, rice and wheat than 100% NPK. The highest sustainable yield index (SYI) value of 0.46, 0.41 and 0.41 for jute, rice and wheat, respectively, were obtained with 100% NPK+FYM treatment in jute and 150% NPK treatment in rice and wheat. Lower SYI of rice in S free treatment was attributed to significant loss of productivity due to depletion of S level in soils. This indicates significant role of S in rice production. The higher SYI in NPK+FYM as compared to recommended dose of NPK could be attributed to nutrients contribution of organic manure and improvement in soil physical and microbial properties.

Nutrient uptake: Uptake of NPK by component crops was significantly lower under control and imbalanced use of fertilizers compared to balanced use of fertilizers. In jute and rice, highest uptake of N, P and K was observed in 100% NPK+ FYM treatment which was at par with 150% NPK treatment (Fig. 4.1 and 4.2). However, in wheat highest uptake of N, P and K was observed with 150% NPK fertilizer treatment (Fig.4.3).

Soil properties: The integrated nutrient management resulted in a positive influx of nutrients by increasing soil organic carbon, available nitrogen, phosphorus and potassium varying from 5.60 to 8.90 g/kg, 227 to 306 kg/ha, 10 to 81 kg /ha and 127 to 213 kg/ha, respectively (Table 4.2). Highest available N was observed in 150% NPK treated plot while the highest available P and K were observed in 100% NPK+FYM treated plots.

Changes in different carbon pool: Soil organic carbon (SOC) pools are classified under very labile, labile, less labile and non labile pools. Very labile pool and labile pool together were designated as active pool. Similarly, summation of less labile and non labile pools constituted the passive pool of SOC in the experimental soil. Jute-rice-wheat cropping system improved the SOC content, being greater in 0-15 cm and declining with soil depth (Fig. 4.4 and 4.5). At different soil depths, relatively higher proportion of carbon fraction was in surface soil and it decreased with increasing soil depth. Among the four carbon fractions determined, their distribution followed the order: very labile pool >non-labile pool >labile pool > less labile pool. The first two fractions i.e. very labile and labile pools of SOC are the most easily oxidisable fractions comprising mainly fungal hyphae, decaying young organic matter, polysaccharides, and other microbial products. Balanced fertilization (100% NPK), in general, maintained a higher values than the imbalanced one, with NPK+FYM containing the highest value. Distribution of C pool varied with depth and active C pool was larger than that of passive C pool. Among the treatments, organic amended plot had highest values of very labile and less labile carbon pools and these were noticeable in lower depths also. Very labile pool is most sensitive to change due to treatments and depth but increase of more resistant less labile pool might last long and cause a perceptible change in SOC under long term *(Source: JC 5.2. Contributors: D.K. Kundu, S. P. Mazumdar, A. R. Saha, B. Majumdar and A.K. Ghorai).*

Table 4.1. Yield and long term SYI of jute, rice and wheat

Treatment	Yield (q/ha)			Long term SYI		
	Jute	Rice	Wheat	Jute	Rice	Wheat
50% NPK	16.59 ^{de}	23.38 ^{d}	20.83^{f}	0.28	0.27	0.25
100% NPK	21.78 ^{b}	28.33 ^{b}	24.54^{c}	0.40	0.35	0.33
150% NPK	24.55 ^{a}	31.18 ^{a}	29.75^{a}	0.45	0.41	0.41
100% NPK+HW	18.37 ^{c}	24.53 ^{d}	22.86^{de}	0.38	0.35	0.32
100% NPK+Zn	21.76 ^{b}	26.55^{c}	26.59^{b}	0.32	0.30	0.32
100% NP	17.99 ^{cd}	23.72 ^{d}	22.26^{e}	0.33	0.33	0.32
100% N	15.72 ^{e}	21.59 ^{e}	18.95^{g}	0.29	0.29	0.26
100% NPK+FYM	24.93 ^{a}	30.14 ^{a}	26.89^{b}	0.46	0.39	0.36
100% NPK – S	18.76 ^{c}	24.27 ^{d}	23.72^{cd}	0.36	0.29	0.33
Control	8.71^{f}	14.31^{f}	7.05^{h}	0.12	0.15	0.09

*Means in a column followed by a common letter are not significantly different by DMRT at 5% level

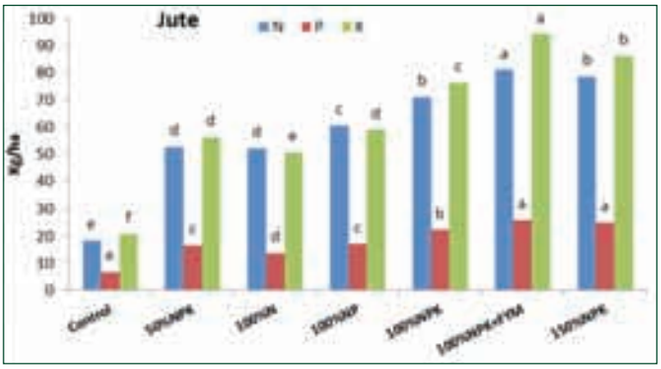


Fig. 4.1. Nutrients uptake by jute under different treatments

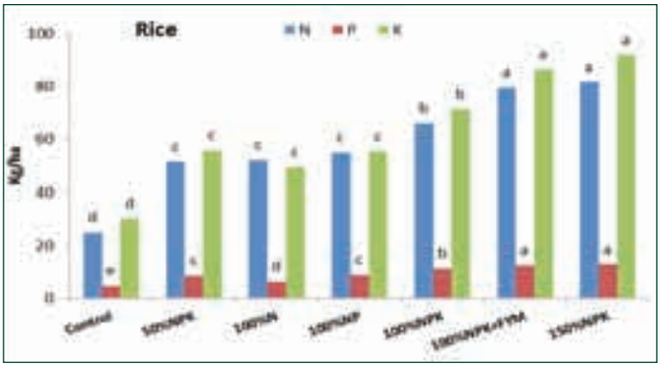


Fig. 4.2. Nutrients uptake by rice under different treatments

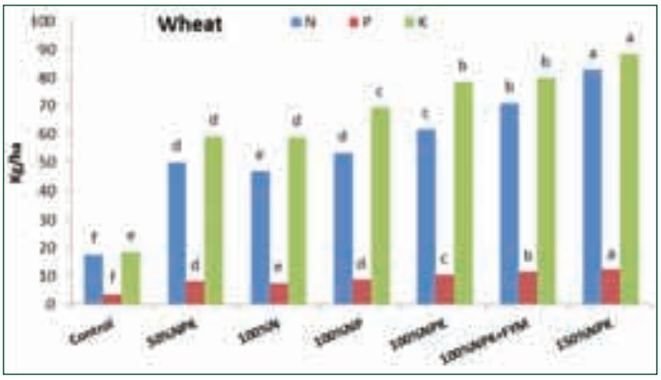


Fig. 4.3. Nutrients uptake by wheat under different treatments
* Uptake of a nutrient under different treatments followed by a common letter are not significantly different by DMRT at 5% level

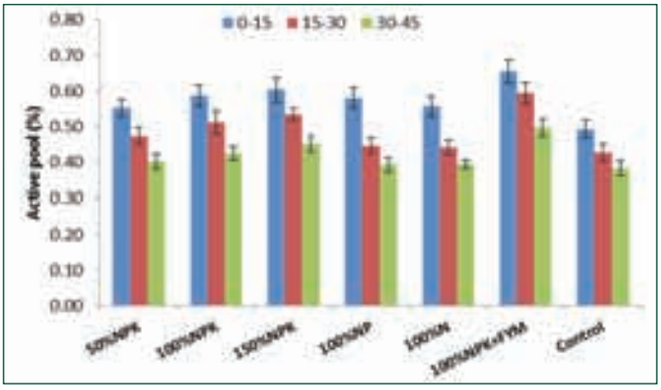


Fig. 4.4. Effect of different nutrient management on active soil organic carbon

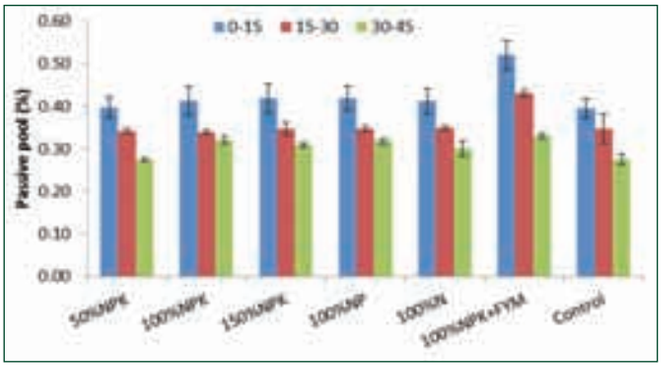


Fig. 4.5. Effect of different nutrient management on passive pool of soil organic carbon

Table 4.2. Effect of chemical fertilizers and organic manures on physicochemical properties of surface soil (0-15 cm)

Treatments	pH	EC (ds/m)	Organic carbon (g/kg)	Available Nutrients		
				N (kg /ha)	P (kg /ha)	K (kg/ ha)
50% NPK	7.62^{b}	0.16^{d}	6.8^{d}	259^{d}	41^{c}	166^{d}
100% NPK	7.62^{b}	0.17^{cd}	7.1^{c}	274^{c}	65^{b}	186^{b}
150% NPK	7.56^{c}	0.17^{cd}	7.3^{b}	306^{a}	80^{a}	212^{a}
100% NPK+HW	7.61^{b}	0.16^{d}	7.1^{c}	269^{c}	60^{b}	169^{d}
100% NPK+Zn	7.60^{b}	0.17^{c}	7.0^{c}	274^{c}	57^{b}	175^{c}
100% NP	7.62^{b}	0.16^{d}	7.0^{c}	267^{d}	60^{b}	128^{f}
100% N	7.63^{b}	0.17^{c}	6.6^{d}	267^{d}	10^{d}	127^{f}
100% NPK+FYM	7.50^{d}	0.23^{a}	8.9^{a}	290^{b}	81^{a}	213^{a}
100% NPK – S	7.63^{b}	0.18^{b}	6.8^{d}	274^{c}	56^{b}	178^{c}
Control	7.66^{a}	0.16^{d}	5.6^{e}	227^{e}	12^{d}	142^{e}

*Mean values in a column followed by a common letter are not significantly different by DMRT at 5% level

4.2 Nutrient management

4.2.1. Soil test and resource based integrated plant nutrient supply system

4.2.1.1 Development of targeted yield equations and follow up trials in jute-rice- vegetable pea cropping sequence

Sunnhemp, rice and potato were grown to develop the basic data and targeted yield equation for sunnhemp in a field with created fertility gradient using maize as exhaustive crop and graded levels of N, P and K (Table 4.3). The application of fertilizers as per ST-TY without and with FYM achieved the target of 35 q/ha fibre production of jute (JRO 204) with (-) 7.0 and (+) 4.0 % yield deviation, respectively (Table 4.4). Integration of FYM (5 t/ha) with fertilizers as per soil test values and targeted yield (35 q/ha) equation recorded highest response ratio (12.9 kg/kg NPK) and B:C ratio (2.05) over RDF (6.9 kg/kg NPK, 1.68) and farmers' practice (4.6 kg/kg NPK, 1.49). In follow up trails (Rice cv. NDR-97), application of fertilizers as per ST-TY without and with FYM was achieved the target of 40 q/ha grain

Table 4.3. Basic data and targeted yield equations for sunnhemp (cv. SUIN 037)

Basic Data	N	P	K	Targeted yield equations
Nutrient requirement (kg/q)	9.36	2.17	13.32	FN= 19.90T-0.69SN-0.32ON
Soil efficiency (%)	32.51	26.91	52.15	FP=7.55 T – 0.94SP -0.25 OP
Fertilizer efficiency (%)	47.04	28.70	136.77	FK= 9.74T -0.38SK -0.42 OK
Organic efficiency (%)	14.92	7.11	56.95	

Table 4.4. Average fibre yield, yield response and B: C ratio against fixed target of jute (JRO 204) under follow-up trials

Treatment	Fibre yield (q/ ha)	RR (kg/ kg NPK)	B:C ratio
Control (0:0:0)	20	-	1.20
Farmers' practice (23:59:59)	29	6.7	1.63
RDF (80:40:40)	31	6.9	1.68
ST-TY (35 q /ha) (85:24:29)	33 (-7%)	9.6	0.83
ST-TY (35 q /ha) +FYM @ 5 t/ha (82:22:27)	36 (+4%)	12.9	2.05

Table 4.5. Average grain yield, yield response, and B: C ratio against fixed target of rice (cv. NDR97) under follow-up trials

Treatment	Grain yield (q/ ha)	RR (kg/ kg NPK)	B:C ratio
Control (0:0:0)	24		1.14
Farmers' practice (60:59:59)	32	4.6	1.49
RDF (80:40:40)	35	6.6	1.35
ST-TY (40 q /ha) (49:13:14)	37 (-8%)	17.2	1.54
ST-TY (40 q /ha) + FYM @ 5 t/ha (42:10:10)	41 (+2%)	27.1	1.72

production of rice with (-) 8.0 and (+) 2.0 % yield deviation, respectively (Table 4.5). Integration of FYM (5 t/ha) with fertilizers as per soil test values and targeted yield (40 q/ha) equation recorded highest response ratio (27.1 kg/kg NPK) and B:C ratio (1.72) over RDF (6.6 kg/kg NPK, 1.35) and farmers' practice (4.6 kg/kg NPK, 1.49). Follow up trails of garden pea (cv. Azad pea) at farmers' field achieved the yield target of 110 q/ha with (-) 3.0 % yield deviation in ST-TY based nutrient without FYM whereas addition of FYM with ST-TY based fertilizer achieved the target (110 q/ha) (Table 4.6). Integration of FYM (5 t/ha) with fertilizers as per soil test values and targeted yield (110 q/ha) equation recorded highest response ratio (18 kg/kg NPK) and B:C ratio (2.76) over RDF (14.0 kg/kg NPK, 2.36) and farmers practice (13.0 kg/kg, NPK 2.17) *(Source: JC 5.6. Contributors: A. R. Saha, B. Majumdar and S. P. Mazumdar).*

Table 4.6. Average pod yield, yield response, and B: C ratio against fixed target of pea under follow-up trials

Treatment	Pod yield (q/ha)	RR (kg/ kg NPK)	B:C ratio
Control (0:0:0)	73		2.01
Farmers practice (50:30:30)	82	13	2.17
RDF (30:60:50)	93	14	2.36
ST-TY (100 q /ha) (90:35:65)	104	16	2.62
ST-TY (100 q /ha) + FYM @ 5 t/ha (87:32:62)	106	18	2.69
ST-TY (110 q/ ha) (108:40:72)	107	16	2.68
ST-TY (110 q /ha) + FYM @ 5 t/ha (104:38:70)	110	18	2.76

4.2.2 Long term effect of ST-TY equation based INM on yield, value addition, nutrient budgeting and quality of soil under jute-rice-lentil sequence

Under long term trial on jute-rice-lentil sequence, application of fertilizers as per ST-TY could achieve the target of 40 q/ ha of jute fibre with (-) 6.87 % yield deviation. Integration of ST-TY with FYM achieved the targeted yield of jute fibre (35 q/ha) with (+) 1.99 % yield deviation. Agronomic efficiency of P and K fertilizers apparently increased with the integration of FYM and biofertilizers with inorganic fertilizer (on ST-TY) over RDF (Table 4.7). In case of rice, application of fertilizers as per ST-TY could achieve the target of 50 q/ha of rice with (-) 1.8 % yield deviation. Integration of ST-TY with FYM and biofertilizers achieved the targeted yield of rice (40 q/ha) with (+) 18.5 % yield deviation. Integration of inorganic fertilizer with FYM and biofertilizer increased agronomic efficiency of P and K fertilizers (Table 4.8). Initial soil fertility status also maintained with the application of fertilizers as per ST-TY with and without FYM except K. Integrated application of fertilizers as per ST-TY with FYM significantly increased enzymatic activity over FP and RDF after rice. Application of fertilizer as per ST-TY along with FYM and biofertilizers increased the fibre yield of jute and grain yield of rice and lentil. Application of FYM and bio-fertilizers with soil test and targeted yield (ST-TY) based fertilizers application increased yield and agronomic efficiency (AE) *(Source: JC 5.6 A. Contributors: A. R. Saha, B. Majumdar and S. P. Mazumdar).*

Table 4.7. ST-TY based fertilizers application on fibre yield and agronomic efficiency of jute in jute-rice-lentil sequence

Treatment	Fertilizer dose (kg/ha) for jute			Fibre yield (q/ha)	Agronomic efficiency (kg/kg)		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
T_1- Control	0	0	0	18.58			
T_2-ST-TY(40 q/ha)	161	48	74	37.25	11.6	38.9	25.2
T_3-ST-TY(35 q/ha)	127	40	61	33.17	11.5	36.5	23.9
T_4-T_3+FYM (5 t/ha	117	37	57	35.70	14.6	46.3	30.0
T_5-T_3+Azot+PSB	117	37	57	34.33	13.5	42.6	27.6
T_6-T_4+Azot+PSB	117	37	57	37.00	15.7	49.8	32.3
T_7-FYM @ 5 t/ha	0	0	0	23.03	-	-	-
T_8-T_7+Azot.+PSB	0	0	0	29.55	-	-	-
T_9-RDF	80	40	40	25.98	9.2	18.5	18.5
T_{10}-Farmers' practices	23	59	59	23.85	22.9	8.8	8.8

Table 4.8. ST-TY based fertilizers application on grain yield and agronomic efficiency of rice in jute-rice- lentil sequence

Treatment	Fertilizer dose (kg ha) for rice			Grain Yield (q/ ha)	Agronomic efficiency (kg/kg)		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
T_1- Control	0	0	0	28.0	-	-	-
T_2-ST-TY(50 q/ha)	135	35	65	49.1	15.6	60.3	32.5
T_3-ST-TY(40 q/ha)	82	25	46	42.8	18.0	59.2	32.2
T_4-T_3+FYM (5 t/ha)	78	23	43	45.9	22.9	77.8	41.6
T_5-T_3+Azot+PSB	78	23	43	42.5	18.6	63.0	33.7
T_6-T_4+Azot+PSB	78	23	43	47.4	24.9	84.3	45.1
T_7-FYM @ 5 t/ha	0	0	0	32.8	-	-	-
T_8-T_7+Azot.+PSB	0	0	0	34.6	-	-	-
T_9-RDF	80	40	40	38	12.5	25.0	25.0
T_{10}-Farmers' practices	59	30	30	35.7	12.8	25.7	25.7

4.2.3 Phosphorus distribution and availability in an Inceptisol under intensive cultivation of jute-rice-wheat cropping system

Effect of continuous application of inorganic fertilizers and organic manures on soil aggregation, and distribution of P in different aggregate fractions under long term (43 years) jute-rice-wheat cropping system was studied in a sandy clay loam soil of Inceptisol at Barrackpore, West Bengal.

The addition of FYM improved the formation of macroaggregates with a concomitant decrease in the proportion of microaggregates (Fig. 4.6). Among the macroaggregates, the 0.25-0.50 mm fraction was greatest in amount. In general, structural indices were found higher in the soil receiving organic amendments (NPK+FYM) than those receiving only inorganic fertilizer NPK and the control. Macroaggregates had higher P density as compared to microaggregates (Fig. 4.7). Application of FYM in conjunction with chemical fertilizers improved concentrations of total phosphorus in all sizes of water stable aggregates. It is concluded that addition of FYM in jute-rice-wheat system improves soil aggregation and enhances P sequestration in macroaggregates *(Source: JC 6.4. Contributors: S.P. Mazumdar, A.R. Saha and D.K. Kundu).*

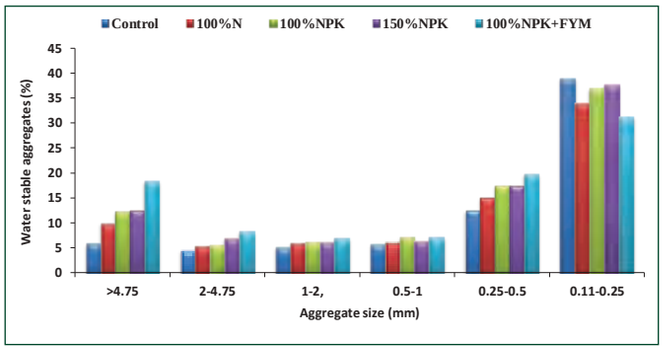


Fig. 4.6. Impact of nutrient management practices on aggregate size distribution after 42 years of jute-rice-wheat cropping in 0-15 cm soil layer

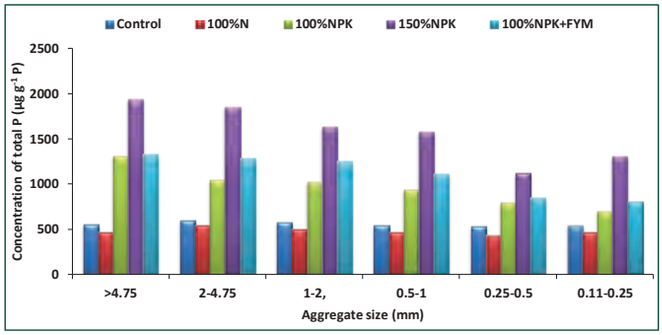


Fig. 4.7. Effect of inorganic fertilizers and organic manure on phosphorus distribution pattern under various aggregate size groups

4.2.4 Study on the influence of species and sulphur levels on yield, sulphur-use efficiency and changes in different forms of sulphur in jute and mesta using (^{35}S) tracer

In experiment 1, four varieties of jute i.e., JRO 204, JRO 8437, JRO 524, JBO 1 and 4 levels of sulphur i.e., 0, 15, 30 and 45 kg S/ha were used resulting a total of 16 treatment combinations in RBD. Experiment 2 included four mesta varieties (JBM 2004 D, MT 150, AMC 108, HC 583) and four sulphur levels (0, 15, 30 and 45 kg S/ha). Recommended doses of nitrogen, phosphorus and potassium were applied as basal application in each plot before sowing. Application of sulphur upto 45 kg/ha significantly increased the plant height, basal diameter and fibre yield (by 27%) of jute. JRO 204 produced the highest fibre yield which was 12.5%, 11% and 4% greater than JRO 8437, JBO 1 and JRO 524, respectively (Table 4.9). The application of elemental S also increased the soil available S content as compared to control and application of 45 kg S/ha recorded the maximum availability of S (16.4 kg/ha) in post-harvest soil. Large genotypic differences were found in almost all the major

Table 4.9. Fibre yield and yield attributes of jute varieties as influenced by sulphur application

Sulphur level (kg/ha)					
Varieties	S0	S15	S30	S45	Mean
Fibre yield (q/ha)					
JRO 204	28.9	31.1	32.9	33.7	31.6
JRO 8437	24.5	28.2	29.5	30.4	28.1
JRO 524	27.8	29.5	31.6	33.3	30.5
JBO 1	21.2	29.8	30.4	32.6	28.5
Mean	26	30	31	33	
LSD (P=0.05) V=0.38, S=0.38, V X S= 0.76					
Plant height (cm)					
JRO 204	284	292	301	308	296.3
JRO 8437	268	275	282	301	281.6
JRO 524	278	288	297	308	292.9
JBO 1	264	270	277	289	274.8
Mean	274	282	289	302	
LSD (P=0.05) V=5.19, S= 5.19, V X S= NS					
Basal diameter (cm)					
JRO 204	1.70	1.77	1.84	1.88	1.8
JRO 8437	1.54	1.64	1.75	1.80	1.7
JRO 524	1.62	1.76	1.79	1.83	1.8
JBO 1	1.61	1.68	1.76	1.80	1.7
Mean	1.62	1.71	1.78	1.83	
LSD (P=0.05) V=0.04, S= 0.04, VXS = NS					

Table 4.11. Influence of sulphur application level on available sulphur in the surface soil (0-15 cm)

Available sulphur (kg/ha) of post-harvest jute soil					
Varieties	S0	S15	S30	S45	Mean
JRO 204	9.48	11.47	13.48	12.78	12.8
JRO 8437	8.88	13.79	14.88	13.80	13.8
JRO 524	8.85	12.17	14.07	12.40	12.4
JBO1	8.91	11.43	13.62	12.64	12.6
Mean	9.0	12.2	14.0	16.4	
LSD (P=0.05) V=0.65, S=0.65, V X S= NS					
Available sulphur (kg/ha) in post-harvest mesta soil					
JBM 2004 (D)	8.48	10.47	12.81	13.00	11.19
MT 150	8.88	10.79	13.22	13.32	11.55
AMC 108	7.85	11.50	12.73	14.54	11.65
HC 583	7.24	10.43	12.62	14.28	11.14
Mean	8.1	10.8	12.8	13.8	
LSD (P=0.05) V=NS, S=0.74, V X S =NS					

parameters of mesta (fibre yield, sulphur uptake). It has been observed that the varieties differed in their fibre yield with maximum yield in MT 150 and lowest in AMC 108 (Table 4.10) Application of 45 kg S/ha resulted in maximum yield, and availability of S. Available S content in the soil after the harvest of JRO 8437 and MT150 reached the maximum in 0-15 cm. (Table 4.11) *(Source: BRNS. Contributors: S. P. Mazumdar, and D.K. Kundu).*

Table 4.10. Fibre yield and yield attributes of mesta varieties as influenced by sulphur application

Sulphur level (kg/ha)					
Varieties	S0	S15	S30	S45	Mean
Fibre yield (q/ha)					
JBM 2004(D)	19.3	22.8	25.0	25.6	23.2
MT 150	20.3	22.7	25.3	26.0	23.6
AMC 108	18.2	20.1	22.0	22.6	20.7
HC 583	18.0	22.6	24.1	24.6	22.3
Mean	18.9	22.0	24.1	24.7	
LSD (P=0.05) V=0.79, S=0.79, V X S=NS					
Plant height (cm)					
JBM 2004(D)	315	317	317	322	318
MT 150	304	309	321	334	317
AMC 108	305	309	321	329	316
HC 583	303	306	311	315	309
Mean	307	311	317	325	
LSD (P=0.05) V=NS, S= 18.3, V X S= NS					
Basal diameter (cm)					
JBM 2004(D)	1.99	2.12	2.20	2.25	2.14
MT 150	2.01	2.05	2.15	2.30	2.13
AMC 108	2.01	1.96	2.13	2.13	2.06
HC 583	1.96	1.98	2.07	2.17	2.04
Mean	1.99	2.03	2.14	2.21	
LSD (P=0.05) V=NS, S= 0.11, V X S=NS					

4.2.5 Improvement of nitrogen use efficiency (NUE) in jute

Uptake as well as utilization of nitrogen by the *olitorius* jute varieties for yield enhancement was studied to understand the physiological and biochemical basis for NUE in jute. Fifteen *Corchorus olitorius* genotypes including 13 released varieties and 2 germplasm were grown in field at two nitrogen levels, 0 and 80 kg N/ha. The available N, P_2O_5 and K_2O content of the experimental soil before sowing was 251.0, 30.0 and 110.0 kg/ha, respectively. Prior to jute, maize crop was grown as an exhaustive crop.

4.2.5.1 Growth and biomass accumulation

Plant height and base diameter of *oltorius* jute at harvest (120 DAS) was significantly influenced by nitrogen application

(Table 4.12). Maximum plant height was recorded with Tarun (338 cm) at 80 kg N/ha level and with JRO 620 (245 cm) in absence of nitrogen. The *olitorius* varieties Tarun and S 19 recorded comparatively more plant height both with and without nitrogen while JRO 66 and JBO 2003 – H also recorded taller plants in absence of nitrogen (Table 4.12). The base diameter was found to be higher in JRO 620 (1.16 cm) followed by Chinsurah Green (1.16 cm) and Bidhan Rupali (1.14 cm) in absence of nitrogen while at 80 kg N/ha level, higher base diameter was recorded with JRO 7835 (1.68 cm), Tarun (1.63 cm) and Bidhan Rupali (1.64 cm). At 80 kg N/ha level, leaf dry weight of *olitorius* jute at harvest was highest with JRO 128 followed by JRO 204 and S 19 while in absence of nitrogen, JRO 128 recorded maximum leaf dry weight followed by Tanganyika 1 and S 19. The bark dry weight was maximum with Tarun both at 80 kg N/ha and in absence of applied nitrogen. At 80 kg N/ha level, *olitorius* varieties JRO 128, S 19, JBO 2003-H and JRO 7835 also recorded comparatively higher bark dry weight while without nitrogen treatment, JRO 204, JRO 632 and S 19 also recorded higher bark weight. Maximum wood dry weight was recorded with Tarun at 80 kg N/ha followed by S 19, JBO 2003 H, JRO 128 and JRO 204 while in absence of applied nitrogen, JBO 2003 H recorded maximum wood dry weight followed by Tarun, JRO 66 and JRO 632. The total above ground dry weight was highest with Tarun at 80 kg N/ha level followed by S 19, JBO 2003 H and JRO 204 while in absence of applied nitrogen, the dry matter production was in the order of JBO 2003 H >Tarun> JRO 128 > S 19 (Fig 4.8).

4.2.5.2 Nutrient uptake

At both no nitrogen and 80 kg N/ha levels, highest N uptake by leaf at harvest by *olitorius* varieties was recorded with JRO 128 followed by Tarun and S 19 while maximum N uptake by bark was recorded with Tarun followed by S 19 and JRO 128. Similarly, maximum N uptake by wood was recorded with Bidhan Rupali followed by Tarun and JBO 2003 H. The total N uptake by *olitorius* jute varieties at harvest was highest with Tarun followed by JRO 204 and JRO 128 at both nitrogen levels (Fig 4.9).

4.2.5.3 Nitrate Reductase (NR) activity and chlorophyll content in leaf

Application of nitrogen recorded significant increase in Nitrate Reductase (NR) activity of jute at 35 DAS. In absence of applied nitrogen, maximum NR activity in jute leaf was recorded with JRO 632 followed by Tanganyika 1, JRO 8432 and S 19 while at 80 kg N/ha level, NR activity was highest with JRO 204 followed by S 19 and JRO 620. The NR activity of JRO 632, JRO 524 and Tanganyika 1 decreased with increased level of N supply from outside. At 120 DAS, the NR activity in absence of applied nitrogen was significantly higher with JRO 632, JRO 8432 and JRO 204 over rest of the *olitorius* genotypes while at 80 kg N/ha, highest NR activity was recorded with JRO 66 closely followed by JRO 8432 (Fig 4.10 and 4.11). JRO 8432 among the test genotypes maintained relatively higher NR activity both at early and late growth stage. However, NR activity of JRO 128, JRO 632, JRO 204 and JRO 8432 decreased significantly with increased external N supply.

At 35 DAS, higher content of chlorophyll a, chlorophyll b and total chlorophyll in leaf were recorded with JRO 620, Chinsurah Green, JRO 204 and JRO 524 both in presence and absence of applied nitrogen. Similarly at 120 DAS, JRO 632, JRO 204 and S 19 recorded higher content of chlorophyll a, chlorophyll b and total chlorophyll in leaf both at no nitrogen and 80 kg N/ha levels (Fig 4.12 and 4.13).

4.2.5.4 Fibre yield and nitrogen use efficiency

Maximum fibre yield was recorded with Tarun (32.52 q/ha) followed by JRO 204 (30.56 q/ha) and S 19 (28.45 q/ha) at 80 kg N/ha level while in absence of applied nitrogen, maximum fibre yield was recorded with JRO 204 (18.76 q/ha) which statistically at par with that of Tarun, JRO 66, JBO 2003 H, JRO 8432 and JRO 524 (Table 4.12). The agronomic nitrogen use efficiency (ANUE) was highest with Tarun (18.1 kg fibre/kg N) followed by S 19 and JRO 204 while maximum apparent recovery (AR) was recorded with JRO 204 (44.9 %) followed by JRO 66, Tarun, JRO 524 and S 19 (37.1 – 38.8 %) *(Source: TMJ 9. Contributors: S. Mitra, J. Mitra, D. Saha, Mukesh Kumar and A. Singh).*

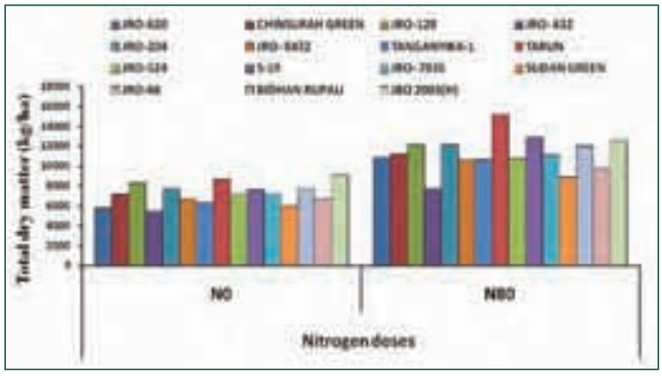


Fig. 4.8. Effect of nitrogen on total dry matter of jute genotypes

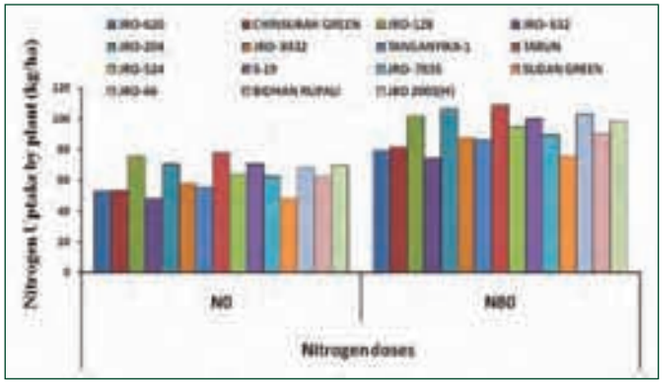


Fig. 4.9. Nitrogen uptake by jute genotypes

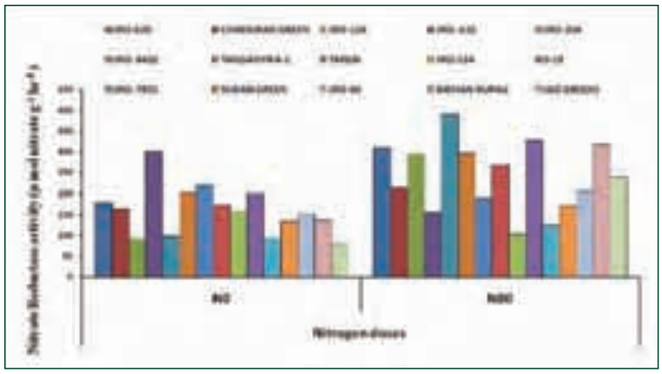


Fig. 4.10. Effect of nitrogen on nitrate reductase activity of jute genotypes at 35 DAS

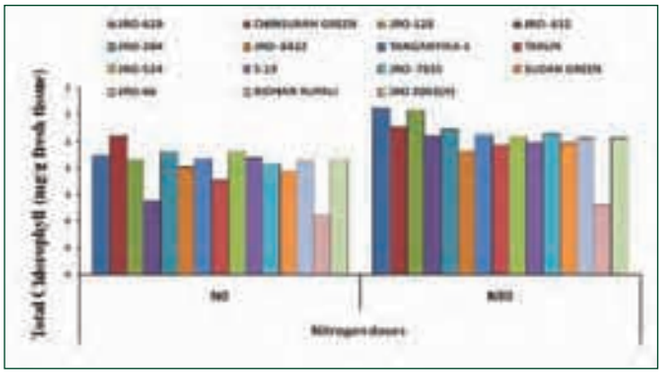


Fig. 4.12. Effect of nitrogen on total chlorophyll content of jute genotype at 35 DAS

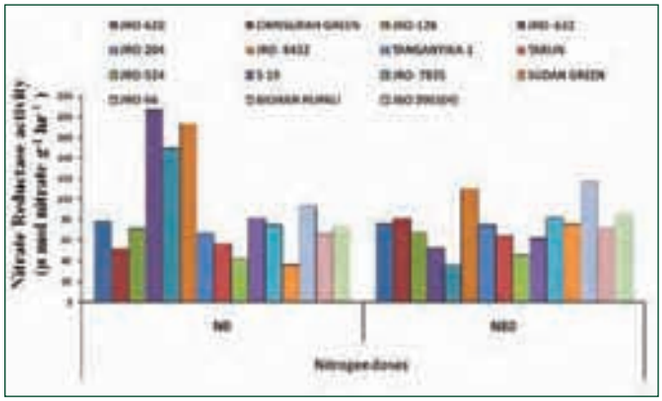


Fig. 4.11. Effect of nitrogen on nitrate reductase activity of jute genotypes at 120 DAS

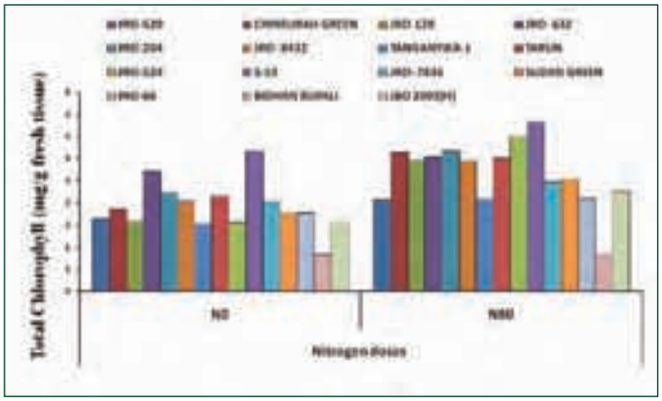


Fig. 4.13. Effect of nitrogen on total chlorophyll content of jute genotype at 120 DAS

Table 4.12. Effect of nitrogen on plant height, basal diameter, fibre yield and agronomic nitrogen use efficiency (ANUE) and apparent recovery of *olitorius* jute genotypes

Treatments	Plant height (cm)		Basal diameter (cm)		Fibre yield (q/ha)		ANUE (kg fibre / kg N applied)	Apparent recovery (%)
Varieties	N_0	N_{80}	N_0	N_{80}	N_0	N_{80}	N_{80}	N_{80}
JRO 620	245	285	1.16	1.57	12.88	23.58	13.4	32.6
Chinsurah green	226	311	1.12	1.75	13.65	22.85	11.5	35.4
JRO 128	226	313	1.06	1.73	15.86	23.19	9.2	32.8
JRO 632	1840	274	0.74	1.34	13.84	18.53	5.9	32.3
JRO 204	2110	275	0.96	1.50	18.76	30.56	14.8	44.9
JRO 8432	214	310	0.98	1.57	17.15	23.88	8.4	36.4
Tanganyika 1	197	278	0.92	1.61	15.10	21.06	7.5	39.1
Tarun	239	338	1.10	1.63	18.05	32.53	18.1	38.8
JRO 524	224	280	1.04	1.51	16.98	26.82	12.3	38.0
S 19	231	303	0.98	1.62	15.42	28.45	16.3	37.1
JRO 7835	195	290	0.98	1.68	16.20	23.17	8.7	34.0
Sudan green	208	282	0.90	1.64	12.05	21.75	12.1	33.9
JRO 66	233	290	1.06	1.56	17.50	22.88	6.7	42.8
Bidhan Rupali	214	261	1.14	1.64	15.75	20.83	6.4	34.6
JBO 2003(H)	235	259	1.04	1.64	17.60	24.28	8.4	36.5
LSD (P=0.05)	11.0		NS		1.87		-	-

5. Crop Husbandry

5.1 Jute

5.1.1 Productivity assessment and nutrient management of selected jute based cropping system

Five jute based cropping sequences were assessed under nutrient and crop residue management practices for their productivity. Cropping sequence significantly influenced on jute fibre yield and system productivity, but did not significantly influence the rice yield (Table 5.1). Significantly higher jute fibre yield (32.8 q/ha) was recorded in jute-rice-garden pea sequences. System productivity of jute-rice-baby corn-jute (leafy vegetable) cropping sequence was higher than other cropping sequences. Nutrient management practices had non-significant effect on fibre yield. Sustainable yield index (SYI) of jute was the highest (0.87) in jute-rice-garden pea sequence while SYI of rice and system productivity was the highest in jute-rice-baby corn-jute (leafy vegetable). Among nutrient management practices, 100% RDF with crop residue had maximum SYI of jute, rice and system productivity.

Table 5.1. Effect of different cropping sequence and nutrient management practices on jute fibre yield, rice yield, system productivity and SYI‡

Treatment	Jute		Rice		Cropping System	
	Fibre yield (q/ha)	SYI	Grain yield (q/ha)	SYI	System productivity (q/ha)	SYI
Cropping sequences						
Rice-rice			47.0	0.73	44.0	0.28
Jute-rice-wheat	27.9	0.82	49.9	0.79	78.3	0.39
Jute-rice-baby corn-jute (leafy vegetable)§	27.6	0.79	49.5	0.80	149.0	0.90
Jute-rice-garden pea	32.8	0.87	51.9	0.71	94.1	0.53
Jute-rice-mustard¥-mung§	29.5	0.81	51.5	0.73	81.3	0.49
LSD (P=0.05)	2.4		NS		13.3	
Nutrient management						
75% RDF + no crop residue#	27.6	0.80	48.1	0.74	96.3	0.56
75% RDF + with crop residue	29.1	0.82	49.3	0.75	98.9	0.56
100 % RDF + no crop residue	29.9	0.83	51.3	0.75	103.8	0.57
100% RDF + with crop residue	31.2	0.86	51.1	0.78	103.6	0.57
LSD (P=0.05)	1.8		NS		NS	

¥Mustard was sown in zero tillage; §crop was sown in relay with previous crop in sequence; # crop residue of rice, wheat and corn @ 4 t/ha and pea and mung @ 2t/ha were incorporated in the respective cropping sequences. ‡SYI is calculated for three year *i.e.* 2012-15

Soil microbes and dehydrogenase activities (DHA) in soil were also influenced by different cropping sequences and nutrient management practices. The highest population of *Azotobacter* and DHA were recorded in jute-rice-garden pea sequence while, phosphorus solubilizing bacteria population was higher in both jute-rice-baby corn-jute (leafy vegetable) and jute-rice-garden pea sequences (Fig. 5.1) *(Source: JA 5.6. Contributors: Mukesh Kumar, S. Mitra, A. K. Ghorai and B. Majumdar).*

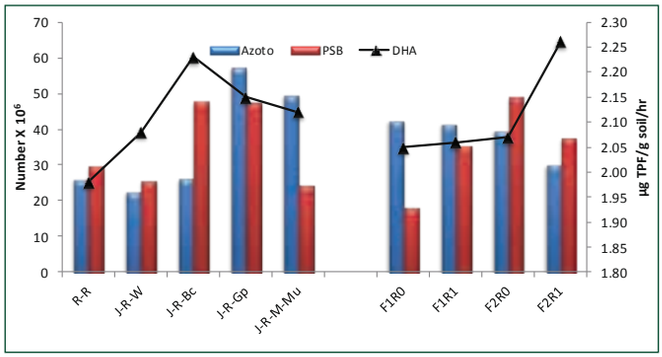


Fig. 5.1. Effect of cropping sequence and nutrient management on soil microbes and DHA enzymes (J-Jute, R-Rice, W-Wheat, Bc-Baby corn; M-Mustard, Mu-Mung bean; F1-75% NPK; F2-100% NPK; R0-No residue; R1-Residue incorporation).

5.1.2 Prospects of growing medicinal and aromatic plants in jute based cropping systems

The economic feasibility of growing medicinal and aromatic plants (MAPs) in the traditional jute cropping system was explored by evaluating the performance of jute, rice and MAPs in cropping system mode. In jute (fibre)-rice-MAPs cropping system, five medicinal and aromatic crops and one traditional crop *i.e.* potato was grown after jute-rice in split plot design in two fertility levels. The jute equivalent yield (JEY) was significantly higher for jute-rice-potato (100.4 q/ha) as compared to jute-rice-MAPs. But the net returns and B: C ratio was significantly higher with jute-rice-ashwagandha (₹ 98,771 /ha and 2.28, respectively) as compared to jute-rice-potato (₹ 71,106 / ha and 1.41 respectively) (Table 5.2).

In another jute (fibre cum seed crop)-MAPs and spices-summer rice cropping system, jute was raised for fibre as well as seed followed by medicinal, aromatic and spices *viz.* isabgol, asalio, nigella, fenugreek, coriander and garden pea followed by summer rice. The fibre and the seed yield of jute varied from 31.78 to 34.24 q/ha and 3.86 to 4.71 q/ha, respectively. In this cropping system coriander was most profitable among the MAPs and traditional crops with a B:C ratio of 2.43 (Table 5.3). *(Source: JA 6.9. Contributors: M. S. Behera, D. K. Kundu, S. Satpathy, A. K. Jha, Amarpreet Singh and R. K. Naik).*

Table 5.2. Interaction effect of cropping system and fertility levels on jute (fibre) equivalent yield (JEY) (q/ha), net return (₹/ha) and B:C ratio in jute-rice-MAPs systems

Treat-ments	*C_1	C_2	C_3	C_4	C_5	C_6	Mean
Jute equivalent yield (q/ha)							
$^{\$}F_1$	66.63	72.25	74.89	72.24	61.97	98.41	74.39
F_2	70.63	74.25	76.89	74.24	63.97	102.41	77.06
Mean	68.63	73.25	75.89	73.24	62.97	100.41	
LSD (P=0.05)	C= 1.57 F= 0.92 CXF= 2.24						
Net return (₹/ha)							
F_1	89,528	98,571	95,064	81,022	76,998	71,006	85,364.83
F_2	89,728	98,971	96,864	81,042	77,198	71,206	85,834.83
Mean	89,628	98,771	95,964	81,032	77,098	71,106	
LSD (P=0.05)	C= 136.95 F= 72.63 CXF= 177.92						
B:C Ratio							
F_1	2.17	2.26	2.10	1.80	2.01	1.39	1.96
F_2	2.21	2.30	2.12	1.90	2.05	1.43	2.00
Mean	2.19	2.28	2.11	1.85	2.03	1.41	
LSD (P=0.05)	C= 0.07 F= 0.02 CXF= 0.05						

*C_1 = Jute-rice-asalio; C_2 = Jute-rice-ashwaganda; C_3 = Jute-rice-isabgol; C_4 = Jute-rice- mint; C_5 = Jute-rice-senna; C_6 = Jute-rice-potato; $^{\$}F_1$ = RDF to all crops; F_2 = RDF to all crops with 5 t FYM/ha to rice

Table 5.3. Yield and B:C ratio of MAPs and spices in jute (fibre-cum seed)-MAPs and spices-summer rice cropping systems

Treatments	Yield of MAPs and spices (q/ha)	B:C ratio (MAPs and Spices)
Cropping systems		
Jute-nigella-summer rice	5.2	1.94
Jute-asalio-summer rice	4.8	2.29
Jute-fenugreek-summer rice	8.0	2.35
Jute-garden pea-summer rice	32	1.55
Jute-coriander-summer rice	10	2.43
Jute-isabgol-summer rice	5.9	2.22
Fertility levels		
RDF to all crops F_1	9.35	2.13
RDF to all crops with 5 t FYM/ha to rice	12.64	2.13

5.1.3 Irrigation methods and soil water conservation practices for improving water productivity in jute

One irrigation in flat bed method of sowing at recommended fertilizer dose (N: P: K: 60:30:30), could produce 25.64 q /ha jute fibre. At RDF, in open furrow sowing with one irrigation in furrow, reduced the irrigation requirement by 40 percent and produced 26.66 q /ha fibre which was 1.02 q higher over traditional flat bed method of sowing. At RDF and one flood irrigation followed by soil mulching (at field capacity) by CRIJAF nail weeder produced 27.99 q jute fibre /ha which is 2.35 q higher over traditional flood irrigation system. Soil mulching by nail weeder maintained 4-5% more soil moisture over normal plots and maintained lower soil moisture tension before drying (Fig 5.2).

Fig. 5.2. Soil moisture tension due to nail weeder operation

Table 5.4. Jute fibre yield under different water and nutrient management schedules

Treatment	Fibre yield (q/ha)	Irrigation & rain water received (mm) #	RWUE (kg fibre/ ha-mm)
Flat bed sowing			
N:P:K:: 60:30:30 & one irrigation	25.64	1077	2.38
N:P:K:: 80:40:40 & one irrigation	28.00	1077	2.59
N:P:K:: 60:30:30, one irrigation & nail weeder at 5 DAE	27.99	1077	2.59
N:P:K:: 80:40:40, one irrigation & nail weeder at 5 DAE	28.54	1077	2.64
N:P:K:: 60:30:30 & two irrigation	28.75	1127	2.55
N:P:K:: 80:40:40 & two irrigation	27.95	1127	2.48
N: P: K:: 60:30:30, two irrigations & nail weeder twice one after each irrigation.	28.87	1127	2.56
N:P:K:: 60:30:30 & three irrigation	29.21	1172	2.48
N:P:K:: 60:30:30 & one irrigation and mung waste 2t/ha	28.43	1077	2.64
Open Furrow sowing			
N:P:K:: 60:30:30 & one irrigation	26.66	1057	2.52
LSD (P=0.05)	NS	-	-

Total rainfall during crop growing period was 1027 mm

Nutrient management: At recommended fertilizer dose (N: P: K: 60:30:30), one flood irrigation in flat bed sowing,

and mulching with pulse waste @2t/ha yielded 28.44 q jute fibre /ha. Fertilizer dose of N: P: K: 80:40:40 with one flood irrigation in flat bed sowing could produce 28.0 q jute fibre/ ha.

Retting under low volume water: In Murshidabad district due to paucity of retting water farmers ret the jute crop in shallow pits on puddled soil in jute field. As a contingent measure to save water for retting the conventional mud floor of shallow retting pits were lined with tarpaulin sheet (200 gauge, 30 ft × 36 ft), where defoliated jute (145 days old) bundles from 666 m^2 were arranged in two alternate layers (Fig. 5.3). Small jute bundles of 10-12 cm diameter were placed at 60 cm apart in between jute bundles to enhance uniform jute retting. In addition, 60 kg soil from native retting tank, 0.5 kg ammonium sulphate, 0.5 kg molasses and 50 kg dried sunnhemp twigs were applied in retting pit. As per the need, the pits were watered for 4 hours only and retting of jute was completed in 23 days. In comparison to conventional method, this process reduced the requirement of water by 84% and saved around ₹20,000/ha. It also reduced the retting duration by 2-3 days. Besides, farmers earned an additional return of ₹200/q due to improvement of fibre grade. It also helped the farmers to extract jute fibre in hygienic situation *(Source: TMJ 5.0. Contributor: A. K. Ghorai).*

Fig. 5.3. *In situ* jute retting in Mushidabad in tarpauline sheet tank

5.1.4 Utilization of jute fabrics (gunny bags) in agricultural crop production

Experiments were conducted at ICAR-CRIJAF and farmer's field to find out possibilities of large scale use of gunny bags made of jute fabrics for crop diversification in waterlogged and wasteland situation. Jute fabric-based soil columns were prepared in waterlogged rice field (depth of hydrograph varied from 0-30 cm during crop growth) for sowing cucurbits, solanaceous (tomato, brinjal) and leguminous vegetables crops on the elevated soil columns (30 cm ht × 45 cm dia). These crops were successfully grown and found to be economically viable on gunny bag reinforced soil columns. This planting system could diversify the cropping system and produced 20-50 t vegetables along with 3.5 t rice/ha. It also increased cropping intensity of rice field. Soil moisture in columns up to 15 cm depth was found to be lower (18.46%) than ridges (21.24%) and thus provided better rhizospheric condition over ridge planting (Fig. 5.4). In saline soil, the vegetable yield ranged between 15-20 t/ha along with 3-4 t rice/ha. In medium land (0 to 30 cm ponding depth), this method can be adopted for producing early cole crops, brinjal, ginger, dioscorea, peas, French beans etc. avoiding waterlogging stress using 11-30 cm high soil column (Fig 5.5). In wasteland (no ground water contribution) maize, green gram and short duration vegetables can be grown in rain fed *kharif* season on soil columns of 22 cm height and 45 cm diameter (Fig 5.6). This method is highly useful for diversifying the cropping pattern in waterlogged soil with economic utilization of jute fabric-made gunny bags which are highly bio-degradable with repetitive use at least for two seasons. *(Source: JA 6.7. Contributors: A K. Ghorai, D. K. Kundu and A. Singh).*

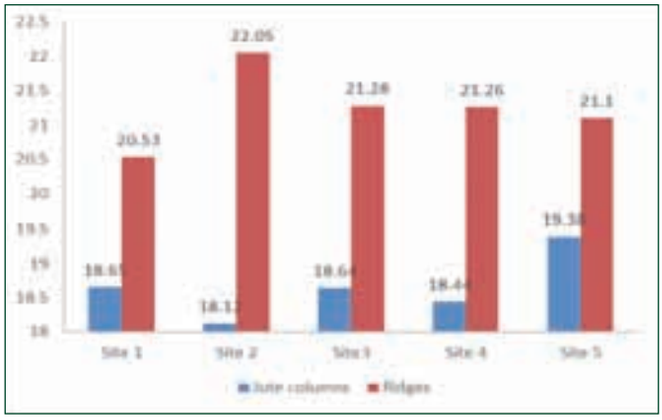


Fig. 5.4. Soil moisture status in jute fabric-based soil columns at different planting sites

Fig. 5.5 Cultivation of radish (A), *kharif* onion (B) and ginger (C) on soil columns in medium lands

Fig. 5.6 Preparation of jute fabric (gunny bag)-made soil columns (A) and cucurbits (B) on soil columns along with rice in saline soil.

5.2 Sisal

5.2.1 Use of micro-irrigation and micronutrients to improve fibre yield and water use efficiency of sisal

A field experiment at Sisal Research Station, Bamra conducted consequently for four years indicated that application of micronutrients and micro-irrigation had significant effect on leaf length, number of harvested leaves and dry fibre yield of sisal (Table 5.6). Drip irrigation applied @ 4 l/hr per plant for 4 hrs at 2 weeks interval and soil application of zinc sulphate @ 20 kg/ha together with borax @ 15 kg/ha (I_3M_4) produced the longest sized leaf (97.2 cm) before harvest, maximum number of harvested leaves (1,48,533 leaves/ha) and highest fibre yield (1546 kg/ha). Sisal fibre yield obtained with I_2M_4 (1493 kg/ha) was statistically comparable with that of I_3M_4 (1546 kg/ha), which indicated that duration of drip irrigation to sisal could be reduced to half without any significant reduction in fibre yield.

Table 5.6. Effect of micro-irrigation and micronutrient treatments on growth and fibre yield of sisal recorded during third year after planting

Treatment combination	Leaf length before harvesting (cm)	Harvested leaves / ha (x 10^3)	Weight of harvested green leaves (t/ha)	Dry fibre weight (kg/ha)
I_1M_1	73.9	112.8	20.9	786
I_1M_2	76.6	120.1	23.3	880
I_1M_3	77.6	124.4	25.0	946
I_1M_4	80.7	126.0	28.1	1106
I_2M_1	82.3	128.0	28.4	1173
I_2M_2	85.1	132.3	30.1	1226
I_2M_3	86.4	132.8	31.1	1280
I_2M_4	93.9	144.0	37.3	1493
I_3M_1	83.8	129.5	28.7	1200
I_3M_2	88.7	135.9	34.0	1400
I_3M_3	90.4	139.9	35.5	1426
I_3M_4	97.2	148.5	38.3	1546
LSD (P=0.05)	I: 2.5 M: 4.1 IxM: 2.2	I: 4.89 M: 2.61 IxM: 4.96	I: 3.72 M: 2.65 IxM: 3.55	I: 105 M: 100 IxM: 77

I_1: No irrigation; I_2: Drip irrigation with discharge @ 4 l/hr for 2 hrs at 2 week interval; I_3: Drip irrigation with discharge @ 4 l/hr for 4hrs at 2 week interval; M_1: No micronutrient; M_2: Zn as Zinc Sulphate @20 kg/ha soil application; M_3: Boron as Borax @15 kg/ha soil application; M_4: Zn as Zinc Sulphate @ 20 kg/ha + B as Borax @ 15 kg/ha soil application. Date of harvesting leaves for fibre extraction: 10th Feb, 2015

Among the irrigation treatments, drip irrigation discharged @ 4 l/h for 2 hrs at 2 week interval (I_2) produced the maximum WUE (3.91 kg fibre/ha-mm) (Table 5.7); and among the micronutrient treatments, application of zinc sulphate @ 20 kg/ha + borax @ 15 kg/ha (M_4) gave the maximum WUE (4.18 kg fibre/ha-mm). The drip irrigation @ 4 l/h for 2 hrs at 2 week interval in combination with application of micronutrients zinc sulphate 20 kg/ha + borax 15 kg/ha produced the highest WUE of 4.52 kg fibre/ha-mm *(Source: SLC 1.3. Contributors: D.K. Kundu, S. Sarkar, A.R. Saha, A.K. Jha and M.S. Behera).*

Fig 5.7. Experimental field view of sisal at SRS, Bamra

Table 5.7. Effect of micro-irrigation and micronutrients application on water use efficiency of sisal (kg fibre/ha-mm water)

Treatments	I_1 (CU*=258.5 mm)	I_2 (CU=330.6 mm)	I_3 (CU=402.6 mm)	Mean (CU=330.6 mm)
M_1	3.04	3.55	2.98	3.18
M_2	3.40	3.71	3.48	3.53
M_3	3.66	3.87	3.54	3.68
M_4	4.28	4.52	3.84	4.18
Mean	3.60	3.91	3.46	

*CU= Consumptive use of water

5.2.2 Production potential and economic benefit of intercropping of medicinal and aromatic plants (MAPs) in sisal plantation

The feasibility of growing medicinal and aromatic plants as intercrops in sisal based cropping system was studied at SRS, Bamra, Odisha. The MAPs ideal for semi-arid conditions viz., vettiver, kalmegh, ashwagandha, asalio, isabgol, lemon grass, citronella, aloe-vera, palmarosa, muskdana, safed musli and with a traditional crop (horse gram) were evaluated for yield in the interspaces of sisal. All the intercrops were successfully established in the sisal inter row spaces. The net return was highest in safed musli

cultivation, but the maximum B:C ratio (2.9) was recorded in aromatic grass, vettiver. The traditional crop *i.e.* horse gram recorded ₹12542/ha and 1.26 net retuen and B:C ratio respectively (Fig. 5.8) *(Source: JA 6.9. Contributors: M.S. Behera, D.K. Kundu, S. Satpathy, A.K. Jha, Amarpreet Singh and R.K. Naik).*

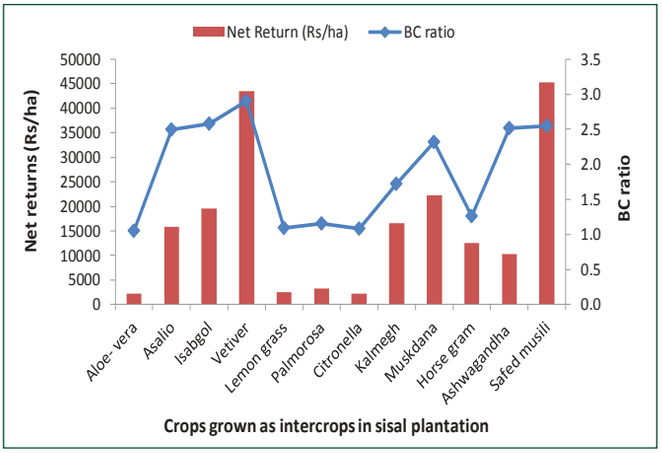


Fig. 5.8 Net returns and B:C ratio of MAPs grown in sisal plantation

Fig. 5.9. Field view of Vettiver (A) and Isabgol (B) grown in sisal plantation

5.2.3 Assessment of area of sisal grown for soil conservation and its fibre production potential

Study has been initiated with field survey and collection of information on sisal grown for soil conservation and its fibre production potential in different states of the country. The sisal plantation established for soil conversation in the state of Odhisa is contributing maximum area and production of fibre constituting 6 soil conservation ranges. The present area of sisal grown for soil conservation in Odhisa is 3625.5 ha out of which 80.8% plantation area is extracted for fibre. The average fibre recovery is 3.5- 4% with 107 kg/ ha production from these plantations of 5-40 years old. The fibre production can be improved by enhancing the plantation area for extraction and proper maintenance of existing plantation through SHGs and cooperative societies as it has been initiated in the Koraput district of Odisha. Besides the extraction process presently in the practice may be improved by introduction of efficient mechanical decorticator to reduce the cost of extraction *(Source: SLA 1.5. Contributors: M.S. Behera, A.K. Jha and R.K. Naik).*

5.3 Sunnhemp

5.3.1 Residual effect of sunnhemp on wheat in rice-wheat cropping system

Sunnhemp was grown as green manure crop and incorporated into the soil for decomposition for three consecutive years before transplanting of rice crop. From fourth year onwards wheat crop was grown in graded levels of nitrogen in green manure treated plots and in control where recommended dose of fertilizers (120:60:40 kg/ha) was applied to assess the residual effect of green manuring in wheat. The yield attributes and yield of wheat were influenced significantly due to residual effect of green manuring. Wheat yield increased significantly with increase in nitrogen dose up to 120 kg/ha being at par with the dose of 150 kg/ha in green manure treated plots (Table 5.8). The yield obtained (46.28 q/ha) from control plot (without green manuring) with the use of 120kg N/ha was statistically similar to the yield recorded (46.54 q/ha) under the effect of 90 kg N/ha (with green manuring). The residual effect of sunnhemp green manure applied to preceeding rice crop was assessed to the tune of 30 kg N/ha on succeeding wheat crop *(Source: SNHA 1.6. Contributors: M.K. Tripathi and S.P. Mazumdar).*

5.3.2 Effect of zinc and boron on growth and fibre yield of sunnhemp

The highest fibre yield (9.44 q/ha) of sunnhemp was recorded with the application of zinc sulphate @ 30 kg/ha being at par with 20 kg/ha (9.23 q/ha) (Table 5.9). Similar trend of zinc application was noticed on plant height, basal diameter and green biomass too. Borax applied @ of 10 kg/ha recorded significantly higher fibre yield (9.02 q/ ha) compared to control (8.29 q/ha). The yield variation

between borax application of 5.0 and 10 kg/ha was found to be non-significant *(Source: SNHA 2.1. Contributors: M. K. Tripathi, A. R. Saha, S. Mitra and B. Chaudhary).*

Table 5.8. Yield and yield attributes of wheat as influenced by residual effect of sunnhemp

Treatment	Tillers/m^2	Grains/spike	Grain yield (q/ha)
Only GM	214.4	29.53	22.06
GM+30 kg N/ha	256.0	34.60	32.49
GM+60 kg N/ha	289.5	37.57	40.43
GM+90 kg N/ha	314.5	39.20	46.54
GM+120 kg N/ha	333.5	40.60	52.61
GM+150 kg N/ha	334.4	40.93	53.73
120 kg N/ha	315.6	39.10	46.28
LSD (P=0.05)	31.5	2.91	5.75

Table 5.9. Effect of zinc and boron on yield and yield attributes of sunnhemp

Treatment	Plant height (cm)	Basal diameter (mm)	Fibre yield (q/ha)
Zinc sulphate			
0 kg/ha	218.3	8.17	7.79
10 kg/ha	241.4	9.06	8.62
20 kg/ha	260.7	9.67	9.23
30 kg/ha	266.3	9.92	9.44
LSD (P=0.05)	18.9	0.52	0.57
Borax			
0 kg/ha	232.0	8.68	8.29
5 kg/ha	242.6	9.11	8.64
10 kg/ha	254.6	9.47	9.02
15 kg/ha	257.5	9.55	9.12
LSD (P=0.05)	18.9	0.52	0.57

5.4 Flax

5.4.1 Effect of NPK on growth and yield of flax (*Linum usitatissimum* L.)

The highest fibre yield of flax (18.98 q/ha) was recorded under the effect of nitrogen applied @ 80 kg/ha being at par with 60 kg/ha (17.89 q/ha) (Table 5.10). Schedule of nitrogen application also exerted significant variations in yield and yield attributes of flax. The highest fibre yield (17.60 q/ha) was observed with the application of nitrogen in three split doses *i.e.* ⅓ basal + ⅓ at 21 DAS + ⅓ at 45 DAS followed by ½ basal + ¼ at 21 DAS + ¼ at 45 DAS (16.98 q/ha). The yield increased significantly with increasing levels of phosphorus and potassium up to 40 kg/ha (17.39 q/ha and 16.11 q/ha, respectively) being at par with the application of 60 kg/ha (18.41 q/ha and 16.30 q/ha, respectively) (Table 5.11) *(Source: SNHA 2.0. Contributors: M.K. Tripathi and B. Chaudhary).*

Table 5.10. Effect of nitrogen and its scheduling on yield and yield attributes of flax

Treatment	Plant height (cm)	Basal diameter (mm)	Fibre yield (q/ha)
Nitrogen levels			
20 kg/ha	88.8	3.36	12.55
40 kg/ha	101.1	3.81	15.82
60 kg/ha	110.4	4.21	17.89
80 kg/ha	114.4	4.42	18.98
LSD (P=0.05)	8.9	0.34	1.18
Nitrogen schedule			
½ basal + ½ at 21 DAS	97.3	3.68	14.85
½ at 21 DAS + ½ at 45 DAS	100.3	3.84	15.79
½ basal + ¼ at 21 DAS + ¼ at 45 DAS	107.3	4.08	16.98
⅓ basal + ⅓ at 21 DAS + ⅓ at 45 DAS	109.8	4.20	17.60
LSD (P=0.05)	8.99	0.34	1.18

Table 5.11. Effect of phosphorus and potassium on yield and yield attributes of flax

Treatment	Plant height (cm)	Basal diameter (mm)	Fibre yield (q/ha)
Phosphorus			
0 kg/ha	83.6	3.21	10.83
20 kg/ha	96.3	3.63	14.41
40 kg/ha	106.1	4.12	17.39
60 kg/ha	112.3	4.30	18.41
LSD (P=0.05)	7.14	0.35	1.14
Potassium			
0 kg/ha	90.6	3.43	13.69
20 kg/ha	97.8	3.75	14.94
40 kg/ha	103.4	3.96	16.11
60 kg/ha	106.5	4.11	16.30
LSD (P=0.05)	7.14	0.35	1.14

6. Biotic and Abiotic Stresses

6.1 Biotic Stress

6.1.1 Pest management

6.1.1.1 Jute

Evaluation of jute germplasm against insect pests

Least yellow mite population (23.43 mites/cm^2 leaf) was observed on the *olitorius* germplasm, OIN 380 during 25 days after sowing (DAS). Whereas, in later stage of the crop *i.e*. 55 DAS and 70 DAS, none of the lines showed less than 50.00 mites/cm^2. The stem weevil infestation was not significant and none of the line showed > 5.00% of plant damage. Although the weevil infestation was low (<5%) in JRO 66 (0.43%), OMU 28 (1.52%) and JRO 632 (1.63%) were least infested at 40, 50 and 70 DAS respectively. The plant damage by semilooper infestation was high on OIN 977 (62.83%) at 85 DAS as compared to least infestation of 8.50% and 16.70% on OIN 619 and OMU 28 at 55 DAS and 70 DAS, respectively. Among the *capsularis* germplasm, yellow mite population was severe and it ranged from 2.39 mites/cm^2 to 64.33 mites/ cm^2 of leaf. The peak infestation of yellow mite was at 40 DAS which gradually declined later on and was least at 70 DAS. The infestation of stem weevil was moderate with highest infestation of 4.77% plant damage on CIN 464 at 30 DAS. The germplasm, CIN 01 was least damaged (0.61%). None of the germplasm showed immune reaction. The infestation of semilooper was high in all the germplasm lines across different stages of the crop. The germplasm line, CIJ 12 recorded least infestation of 4.20% at 40 DAS and its damage increased to 17.80% at 70 DAS *(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).*

Oviposition preference of Bihar hairy caterpillar (BHC), *S. obliqua* on wild and cultivated jute species

No-choice Test

The mean number of egg clusters laid by BHC differed significantly on different jute species (F = 2.296; df = 2; P = 0.001) (Fig. 6.1A) which were 3.6 ± 0.3, 3.0 ± 0.6, 3.3 ± 0.3, 3.0 ± 0.6, 1.0 ± 0.6, and 2.0 ± 1.2 on *C. olitorius*, *C. fascicularis*, *C. trilocularis*, *C. pseudo-olitorius*, *C. tridens*, and *C. aestuans*, respectively. Similarly, significant difference among host plant species was observed in relative oviposition preference by the adults of hairy caterpillar based on number of eggs/cluster. The wild species *C. tridens* and *C. aestuans* were least preferred with the lowest mean number of eggs/cluster (77.2 ± 8.2 and 75.2 ± 38.8, respectively) as compared with 174.0 ± 2.7 on *C. olitorius* (F = 2.170; df = 2; P = 0.001) (Fig. 6.1B) *(Source: JE 1.2. Contributors: B.S. Gotyal and S. Satpathy).*

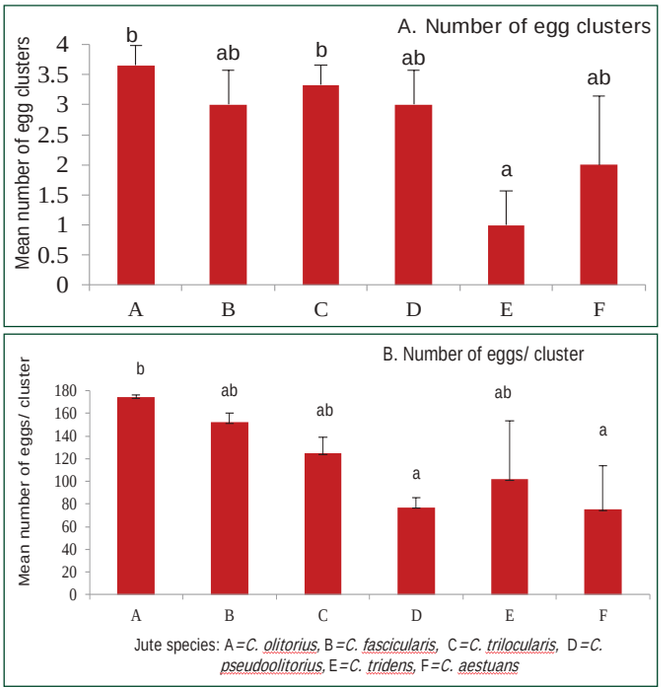
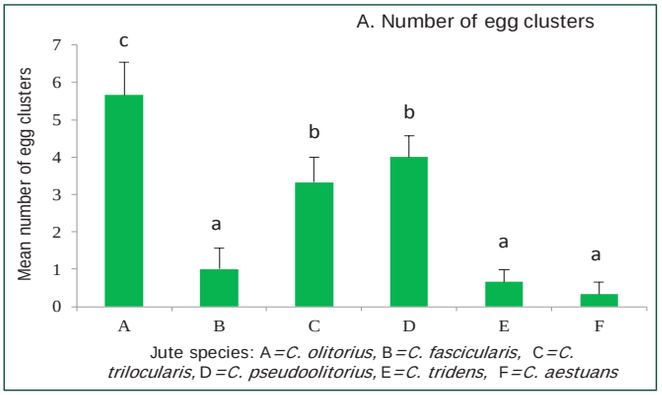


Fig. 6.1. Mean number of egg clusters (A) and eggs per cluster (B) laid by *S. obliqua* on jute species in no-choice test

Multiple-choice Test

The proportion of eggs laid (egg clusters and eggs per cluster) was greater on the cultivated than the wild jute species (Fig. 6.2A). Among the wild species, number of egg clusters differed significantly. *C. tridens*, *C. aestuans*, *C. trilocularis*, and *C. fascicularis* were least preferred (with 0.7 ± 0.3, 0.3 ± 0.3, 0.3 ± 0.7, and 1.0 ± 0.6 egg clusters, respectively), *C. pseudo-olitorius* was moderately preferred (with 4.0±0.6 egg clusters), and *C. olitorius* was most preferred (with 5.7 ± 0.9 egg clusters) (F = 13.23; df = 2; P = 0.001). The total number of eggs/cluster also varied across the cultivated and wild species (F = 9.918; df = 2; P = 0.001). The least preferred were *C. aestuans*



and *C. fascicularis* (with 7.7 ± 7.7 and 41.0 ± 16.3 eggs/cluster, respectively) and the most preferred was the cultivated *C. olitorius* (with 603.7 ± 8.4 eggs/cluster) (Fig. 6.2B) *(Source: JE-1.2. Contributors: B. S. Gotyal and S. Satpathy).*

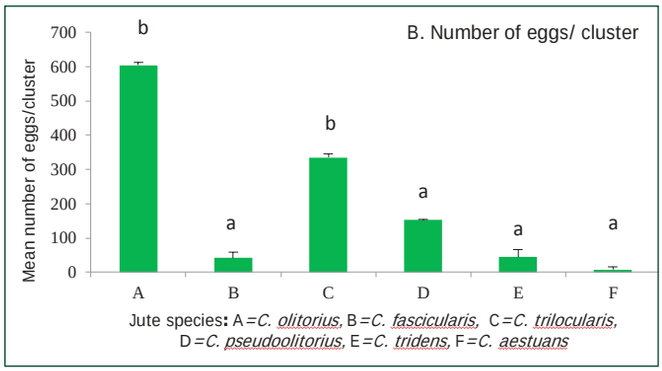


Fig. 6.2. Mean number of egg clusters (A) and eggs per cluster (B) laid by *S. obliqua* on jute species in multiple-choice test

Biochemical content in cultivated and wild jute species

The jute species with distinct effect on the biological parameters of BHC had significant variation in content of phenol, protein and polyphenol oxidase activity. Except C. *trilocularis* (20.62 µg/g) and *C. pseudo-olitorius* (11.00 µg/g), all the wild species had significantly high phenol content (43.46-62.25 µg/g) than *C. olitorius* (37.82 µg/g) which was reverse in case of protein i.e, the wild species had significantly less protein (10.05-19.18 µg/g) than *C. olitorius* (22.00 µg/g) (Table 6.1). Significantly high peroxidase activity was noticed in *C. tridens* (2.34 µg/ml) *(Source: JE 1.2. Contributors: B. S. Gotyal and S. Satpathy).*

Table 6.1. Estimation of biochemical contents in cultivated and wild jute species

Jute species	Biochemical contents		
	Phenol (µg/g)	Protein (µg/g)	Polyphenol oxidase (µg/ml)
C. olitorius	37.82	22.00	1.72
C. fascicularis	43.46	17.79	1.12
C. trilocularis	20.62	18.31	1.23
C. pseudo-olitorius	11.00	19.18	1.11
C. tridens	62.25	10.05	2.34
C. aestuans	55.62	14.61	1.10
LSD (P=0.05)	1.92	3.07	0.87

Optimization of pesticide application for insect pest management in jute

Differential population of yellow mite and infestation levels of lepidopteran pests (BHC and semilooper) was created by applying foliar spray of spiromesifen 240 SC @ 0.7 ml/lit and profenophos 50 EC @ 2.5 ml/lit, respectively at different frequency and intervals (Table 6.2 & 6.3). Yellow mite population was first noticed at 35 DAS, thereafter, increased to 96.68 mite/cm^2 at 45 DAS in the untreated control (T_1 & T_3). Latter on the populations declined naturally by 65 DAS. The lepidopteran infestation initiated from 55 DAS, varied significantly from 13.60 to 16.76% in different treatments which attained maximum 54.50% at 75 DAS in the untreated control (Table 6.3). Highest yield was recorded with two sprays of profenophos 50 EC and spiromesifen 240 SC (T_4). Against yellow mite, two sprays of spiromesifen (T_2 &T_4) at 36 and 46 DAS proved more effective with higher yield. As pesticide applications were made as dictated by regular monitoring, two sprays were deemed essential for protecting the crop from yellow mite. As far as lepidopteran pests were concerned, yield with two sprays of profenophos 50 EC at 66 and 76 DAS was significantly higher than that in completely unprotected crop (T_3). Two sprays of spiromesifen and profenophos were considered optimum for protecting the crop each against yellow mite and lepidopteran pests *(Source: JE 1.4. Contributors: K. Selvaraj and B. S. Gotyal).*

Determination of single- and multiple-pests-economic injury levels for jute

The multiple-pests economic injury levels (EILs) on JRO 204 jute variety was established by deriving individual and multiple-pest-yield-loss based regressions at different crop growth stages through yield-infestation relationships (Table 6.4). Yellow mite population significantly affected the crop

Table 6.2. Mean yellow mite population on jute (cv. JRO 204) in different treatments for yield infestation relationships

Treatment	Insecticide applied at different DAS		Yellow mite/cm^2 leaf area					Fibre (q/ha)
	Spiromesifen	Profenophos	35 DAS	45 DAS	55 DAS	65 DAS	75 DAS	
T_1-Yellow mite (YM) alone	-	66, 76	65.16	96.68	70.09	21.08	9.77	26.52
T_2-Semilooper (SL) and Bihar hairy caterpillar (BHC) alone	36, 46		58.47	2.09	0.5	8.41	2.40	30.59
T_3-YM+SL+BHC (no spray)	-	-	61.91	70.46	31.20	18.02	8.17	23.75
T_4-Insect-free crop (completely protected)	36, 46	66, 76	62.90	0.42	0.14	2.69	4.22	34.02
LSD (P=0.05)	-	-	NS	6.13	7.36	7.58	2.97	1.43

yield at 45, 55 and 65 DAS. Lepidopteran pests, did not show any significant effect on yield at any crop growth stages. However, based on pest infestation at different crop growth stages and fibre yield, multiple yield-infestation relationship (Y=34.5826-0.219(YM)-0.095 (BHC+SL)) was significant (R^2=0.87) for combined infestations of yellow mite and lepidopteran pests at 55 DAS during the crop season *(Source: JE 1.4. Contributors: K. Selvaraj and B.S. Gotyal).*

Table 6.3. Mean lepidopteran pest infestation (%) on jute (cv. JRO 204) in different treatments for yield infestation relationships

Treatment	Insecticide applied at different DAS		Infestation (%)					Fibre (q/ha)
	Spiromesifen	Profenophos	55 DAS	65 DAS	75 DAS	85 DAS	95 DAS	
T_1-Yellow mite (YM) alone	-	66, 76	15.05 (22.83)	27.08 (31.36)	1.88 (7.88)	0.16 (2.29)	1.46 (6.94)	26.52
T_2-Semilooper (SL) and Bihar hairy caterpillar (BHC) alone	36, 46		13.60 (21.64)	51.15 (45.66)	54.50 (47.58)	30.00 (33.21)	15.77 (23.40)	30.59
T_3-YM+SL+BHC (no spray)	-	-	14.32 (22.24)	37.54 (37.78)	43.12 (41.05)	22.38 (28.23)	14.6 (22.46)	23.75
T_4- Insect-free crop (completely protected)	36, 46	66, 76	16.76 (21.77)	33.49 (35.36)	2.62 (9.35)	0.42 (3.72)	1.02 (5.80)	34.02
LSD (P=0.05)	-	-	NS	3.24	4.38	2.50	3.10	1.43

* Figures in the parenthesis are arc sin transformed values

Table 6.4. Regression equations for the effect of different insect pests at various stages of crop

Crop age	Treatment	Regression equation	R^2	Signifi-cance
35 DAS	Yellow mite (YM)	Y=32.3363-0.058 (YM)	0.10	NS
45 DAS	Yellow mite	Y=31.6004-0.1008 (YM)	0.78	0.05
55 DAS	Yellow mite	Y=32.4011-0.074 (YM)	0.71	0.001
65 DAS	Yellow mite	Y=33.6683-0.3627 (YM)	0.65	0.05
75 DAS	Yellow mite	Y=33.0388-0.703 (YM)	0.38	NS
55 DAS	Lepidopteran	Y=40.5947-0.830 (BHC+SL)	0.56	NS
65 DAS	Lepidopteran	Y=25.2349-0.0933 (BHC+SL)	0.69	NS
75 DAS	Lepidopteran	Y=29.864-0.0444 (BHC+SL)	0.47	NS
85 DAS	Lepidopteran	Y=29.7106-0.0748 (BHC+SL)	0.06	NS
95 DAS	Lepidopteran	Y=30.1661-0.1762 (BHC+SL)	0.09	NS
55 DAS	YM+ Lepidopteran	Y=34.5826-0.219 (YM)-0.095 (BHC+SL)	0.87	0.001

The EILs were determined during the crop stage at which both the pests significantly affected the yield. Individual EIL for yellow mite and lepidopteran pests were 42 mites/cm^2 area on second unfolded leaf and 10% plant damage, respectively. Further multiple regression was used to determine iso-loss points, based on which, iso-loss equations were established *(Source: JE 1.4. Contributors: K. Selvaraj and B.S. Gotyal).*

Isolation, purification and estimation of *Bacillus thuringiensis cry* protein

Thirty isolates derived from jute growing soil samples were analyzed for the presence of delta endotoxins by performing SDS-PAGE. The protein content in the endotoxin from various Bt isolates was quantified by using Bovine Serum Albumin as the standard. The protein quantified for various Bt isolates was in the range of 0.157-0.286 mg/ml *(Source: JE 1.5. Contributors: V. Ramesh Babu, B.S. Gotyal, K. Selvaraj and S.P. Gawande).*

Mass rearing of *Spilosoma obliqua* on artificial diet

As a pre-requisite for pheromone isolation and characterization from the adult females of *S. obliqua*, the standardization of protocol for mass rearing on semi-synthetic diet was initiated (Fig 6.3). The base ingredients of *S. obliqua* diets (i.e. jute leaf powder, cabbage leaf powder, soybean seed powder) were manipulated on different combinations and proportions. Among which diet composition comprising of soybean seed powder + cabbage leaf powder + jute leaf powder supported the larval growth, statistically equivalent to natural diet i.e. jute leaf (Table 6.5). After 13 days of feeding also this combination was best among all the diets with maximum larval weight (410 mg) however it was significantly less than the natural diet (503.55 mg). In

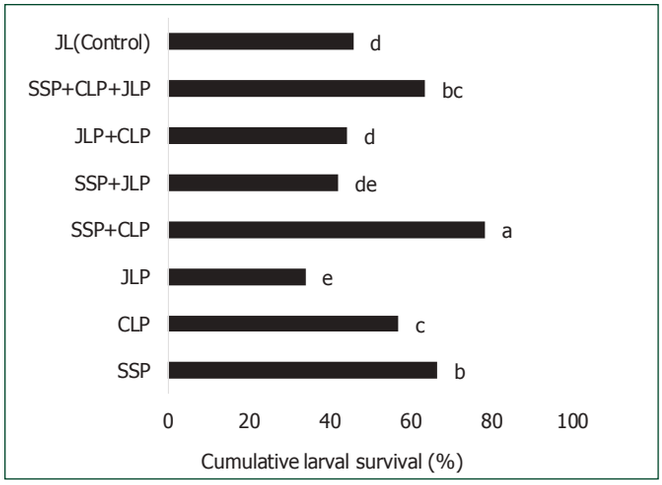
Fig. 6.3. Rearing of Bihar hairy caterpillar on artificial diet

terms of larval survival, the diet with base ingredients of soybean seed powder (5g) and jute leaf powder (5g) was the best with significantly highest survival (Fig. 6.4) *(Source: JE 1.6. Contributors: V. Ramesh Babu, B.S. Gotyal and S. Satpathy).*

Table 6.5. Effect of different combination of base ingredients of artificial diet on *S. obliqua* larval weight

Base ingredient	Larval weight (mg)		
	5 DAF	9 DAF	13 DAF
SSP	126.89^{b}	269.33^{ab}	371.33^{bc}
CLP	118.89^{b}	240.89^{b}	352.44^{cd}
JLP	59.55^{d}	162.00^{c}	200.22^{e}
SSP + CLP	136.22^{b}	251.11^{b}	410.22^{b}
SSP + JLP	87.33^{cd}	166.00^{c}	231.33^{e}
JLP + CLP	113.77^{cb}	176.89^{c}	214.66^{e}
SSP + CLP+ JLP	169.78^{a}	259.33^{b}	322.66^{d}
Control (Jute leaf)	172.44^{a}	312.22^{a}	503.55^{a}
LSD (P=0.05)	28.83	48.19	42.59

SSP-Soybean seed powder, CLP-Cabbage leaf powder and JLP-Jute leaf powder



JLP=Jute leaf powder, SSP=Soybean seed powder, CLP=Cabbage leaf powder

Fig. 6.4. Effect of different combination of base ingredients of artificial diet on *S. obliqua* larval survival

Relative toxicity of new insecticide molecules against *Spilosoma obliqua*

The relative toxicity of commercially available novel insecticides *viz.*, indoxacarb 14.5 SC and spinosad 45 SC possessing diversified modes of action were assessed against conventionally used insecticide *viz.*, profenophos 50 EC. The laboratory bioassay with third instar (10-day old) larvae of *S. obliqua*, recorded 0.19% and 0.21% LC_{50} for indoxacarb and spinosad, respectively and were 3.63-fold and 3.28-fold more toxic than profenophos (Table 6.6) *(Source: TMJ 7.0. Contributor: V. Ramesh Babu).*

Table 6.6. Relative toxicity of new insecticide molecules against *Spilosoma obliqua*

Insecticide	LC_{50} (%)	Regression equation	Relative toxicity	χ^2
Indoxcarb	0.19	Y=22.87x+6.81	3.63	0.59
Spinosad	0.21	Y=19.9x+7.61	3.28	0.61
Profenophos	0.69	Y=15.67x+5.91	--	0.12

Endophytic colonization of *Beauveria bassiana* in jute

Seed inoculation with conidial suspension of *B. bassiana* isolates caused endophytic colonization of the fungal entomopathogen. Earlier it was detected by PCR with *B. bassiana*-specific primers and culturing on selective media. Recently, scanning electron microscopy (SEM) also confirmed the hyphal growth (Fig. 6.5) of the fungus in the leaf tissues of treated plants *(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B.S. Gotyal).*

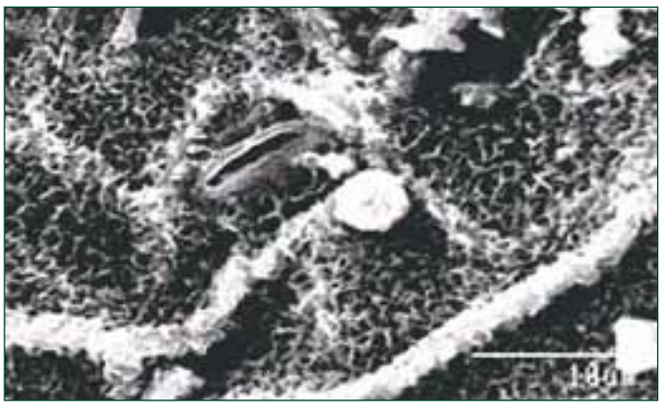


Fig. 6.5. SEM of endophytic *B. bassiana* in jute leaf tissues

Effect of endophytic *B. bassiana* on stem weevil infestation in white jute

B. bassiana (10^8 cfu/ml) treated seeds (cv. JRC 212) caused considerable reduction in stem weevil infestation (15-30%) in white jute as compared to untreated check (56%) (Fig. 6.6). Twelve *B. bassiana* strains *viz.*, ITCC 6552, 6551, 5409, 4796, 6063, 4668, 5408, 6645, 6869, 4563, 6892 and 6726 were introduced into white jute plants through seed treatment with conidial suspensions for managing

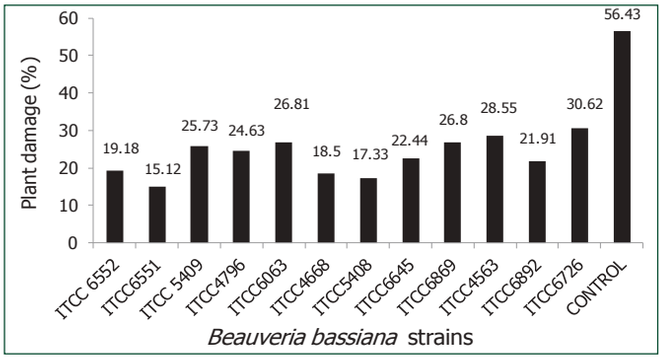


Fig. 6.6. Infestation of stem weevil in different *B. bassiana* strains treated with jute plants

stem weevil. ITCC 6551, ITCC 5408 and ITCC 4668 were most effective with 15.12%, 17.33% and 18.50% of infestation respectively compared to 56.43% in control *(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B.S. Gotyal).*

In vivo compatibility of *B. bassiana* with common pesticides

To test *in vivo* compatibility, *B. bassiana* inoculated (through seed) jute plants were sprayed with different concentrations of pesticides and the survival of the fungal entomopathogen was assessed after three days of spray on selective media as well as by PCR with *B. bassiana*-specific primers. *B. bassiana* was compatible with cypermethrin 10 SC, λ-cyhalothrin 5 EC, profenophos 50 EC, quinalphos 25 EC and dicofol 18.5 SC. It was incompatible with carbendazim *in vitro* even at 25 ppm but was compatible *in vivo* upto 50 ppm *(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B.S. Gotyal).*

Isolation of *B. bassiana* from naturally infected mealybug, *Phenacoccus solenopsis*

B. bassiana was isolated from naturally infected mealybug. The entomopathogen was identified as *B. bassiana* based on culturing in selective media and PCR with *B. bassiana*-specific primers. Pathogenicity and the efficacy of this newly isolated *B. bassiana* isolate was evaluated by spraying its conidial suspension on crawlers as well as adults of mealybug. This isolate could cause 85% mycosis and mortality on treated mealybug crawlers and 30% mycosis on the adults (Fig. 6.7) *(Source: JM 8.1. Contributors: C. Biswas, S. Satpathy and B.S. Gotyal).*

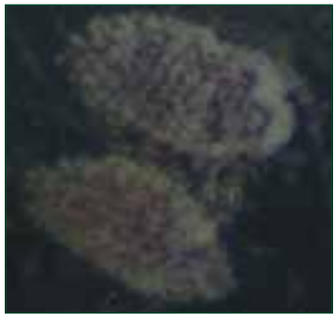


Fig. 6.7. Mycosis and death of mealybug crawlers treated with *B. bassiana*

Effect of date of sowing and acaricides on yellow mite infestation in jute

On the basis of yellow mite infestation at 55 DAS, the earliest sown crop in the last week of March harboured maximum population. The foliar spray of abamectin 1.8 EC (0.015%) had significant effect in reducing the mite population. The pre-disposing factors for infestation of major insect pests in jute has been determined for development of long term forecast model *(Source: TMJ 7. Contributors: B.S. Gotyal, K. Selvaraj and S. Satpathy).*

6.1.1.2 Mesta

Management of spiral borer, *Agrilus acutus* in mesta

Preventive application of insecticides as soil application and seed treatment were evaluated against spiral borer of kenaf as the spiral galls on the base of the plants caused by this cryptic insect initially is expressed during the later stage of the crop. During the peak period significantly least number of plants were damaged (7.68%) in the crop with seed treatment of thiamethoxam 70WS @ 5g/kg being at par with the extent of plant damage in imidacloprid 600 FS@ 5ml/kg (8.25%) and chlorpyriphos 20 EC @ 5ml/kg (7.68%) compared to 20.56% in control (Fig. 6.8). Overall mean plant damage across all the period of observations recorded least plant damage (4.10%) in chlorpyriphos treated crop being at par with seed treatment of thiamethoxam (4.22%) and imidacloprid (4.65%) *(Source: JM 1.1. Contributors: S. Satpathy and B.S. Gotyal).*

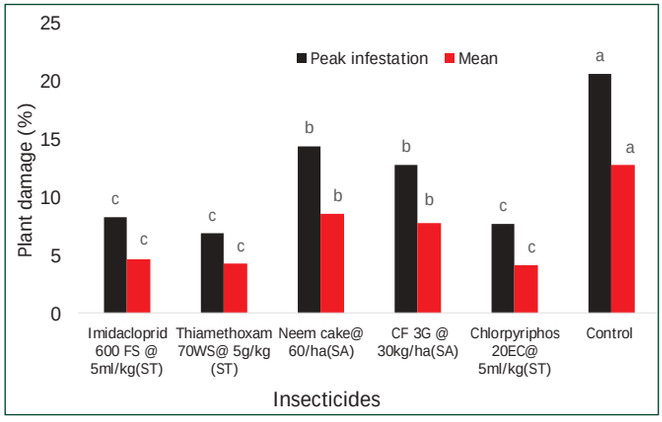


Fig. 6.8. Effect of different insecticides on spiral borer of kenaf

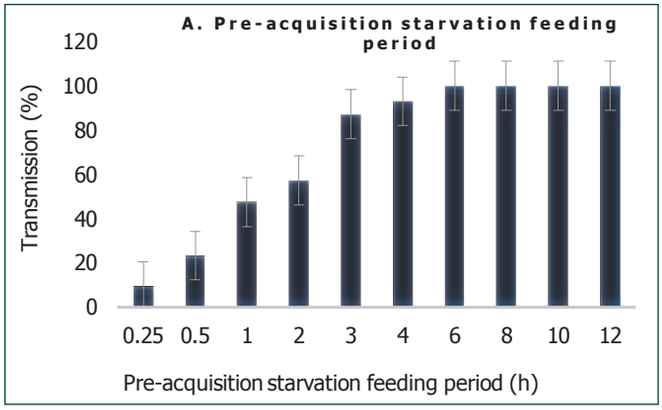
Relative host suitability, growth and survival of mealybug, on kenaf species

Seven released varieties of kenaf (*H. cannabinus*) along with 2 wild species i.e., *Hibiscus acetocella* (WHIN-47) and *Hibiscus* sp. (WHIJ-50) were evaluated under laboratory condition for relative host suitability, growth and survival of mealybug (*Phenacoccus solenopsis)* as the basis for resistance. Development of 10 uniform freshly emerged crawlers released on the terminal leaf of each 25-day-old kenaf seedlings in to adults after 20 days of release varied from 0.44/plant in *Hibiscus* sp. (WHIJ-50) to 3.78/plant in *H. acetocella* (WHIN-47). Least survival of mealybug adults among the varieties was on JRM 3 (1.22/plant). The number of crawlers on the host plants from the surviving adults was significantly high and low in WHIN-47 (439.69) and WHIJ-50 (39.28) respectively. The crawler settlement on other varieties of *H. cannabinus* varied from 157.36/plant in JRM 3 to 438.04/plant in HC 583. The survival was least in WHIJ-50 (35.66%) and maximum in HC 583 (60%). Adult developmental period of male varied from 23.66 days in HC 583 to 27 days in WHIJ 050. The female developmental period was prolonged (22 days) in WHIJ-50 compared to 16.33 days in HC 583 *(Source: JM 1.1. Contributors: S. Satpathy and B.S. Gotyal).*

Virus-vector relationship of mesta yellow vein mosaic virus (MYVMV)

With increase in the pre-acquisition starvation feeding period, the transmission of the virus also increased (Fig.

6.9A). The pre-acquisition starvation period of 6 hr or more resulted in 100% transmission of virus. The post-acquisition starvation periods of vector also had significant effect on the rate of transmission of MYVMY (Fig. 6.9B).



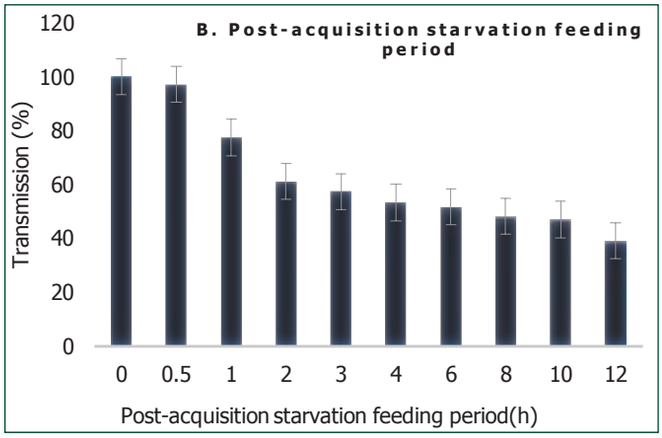


Fig. 6.9. Effect of pre-acquisition (A) and post-acquisition (B) starvation feeding period on transmission of MYVMV in mesta

In between 24 hrs of acquisition and inoculation periods each there was reduction in the virus transmission with enhancement of post-acquisition starvation period. Without any starvation period the transmission was 100% which reduced to 39.05% in case 12 hrs post-acquisition starvation feeding period. While optimizing the number of vectors causing the transmission of MYVMV, it was evidenced that 15 viruliferous whiteflies with 24 hrs acquisition access feeding in infected plants can cause 100% disease transmission in 21-day old mesta plants (Fig. 6.10 A & B) *(Source: JM 8.6. Contributors: P.N. Meena, V. Ramesh Babu and S.K. Pandey).*

Toxicity of different insecticides on the vector, *Bemisia tabaci*

Relative toxicity of novel and conventional insecticides was assessed on whiteflies through laboratory bioassay. Four insecticides with diversified mode of action viz., imidacloprid, flonicamid, spiromesifen and diafenthiouron were used for assessing the LC_{50}. Imidacloprid was most toxic (LC_{50}6.6 ppm) to whiteflies followed by diafenthiouron (LC_{50}22.59 ppm), flonicamid (LC_{50}24.85 ppm), spiromesifen (LC_{50}28.37 ppm) and least toxic was dimetheoate (LC_{50}7100 ppm) respectively. Relative toxicity indicates imidacloprid to be 1075.71-fold more toxic followed by diafenthiouron (314.29-fold), flonicamid (285.71-fold), spiromesifen (250.26- fold) than dimetheoate *(Source: JM 8.6. Contributors: P.N. Meena and V. Ramesh Babu).*

Fig. 6.10. Rearing of whiteflies on cotton plant (A) and symptoms of virus on test plant after pre-acquisition feeding period (B)

6.1.1.3 Ramie

Incidence and seasonal abundance of important insect pests of ramie

Several insect pests viz., Indian red admiral caterpillar, leaf beetle, leaf eating caterpillar, lady bird beetle, leaf folder, white grub, termites and *Apogonia* sp. were observed as important insect pests of ramie (Fig. 6.11). These insect pests were active during different period of the year, with sporadic to very high (90%) level of incidence depending on the prevailing climatic condition particularly temperature and relative humidity. Unidentified insect specimens were sent to National Project on Insect Biosystematics (NPIB), Division of Entomology, IARI New Delhi for further taxonomic identification. The leaf folder with high incidence was identified as *Pleuroptya* sp. (Lepidoptera: Crambidie) (ID No. 2117LEP 004-006/14.) This is the first report of occurrence of these insect pests on ramie in India *(Source: RBN 2.5. Contributors: S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma).*

Fig. 6. 11. Ramie leaf folder larva (A) and leaf eating beetle (B)

6.1.2 Disease management

6.1.2.1 Jute

Standardization of optimum conditions for successful stem rot disease development in jute

The role of host and pathogen inoculum age on successful stem rot symptoms development were ascertained. Fresh pathogen inoculum (24 h-old) was more infective and produced the highest lesion length upon inoculation on a jute stem (Fig. 6.12). Under the field conditions and on detached stem, this method produced 6.4 cm and 6.5 cm lesion length, respectively after 2 days of inoculation. However, infectivity of the fungus, as measured in terms of lesion size, reduced significantly with the increase of pathogen age. Least lesion length (4 cm) was produced with 7-day old pathogen culture inoculum. Among the host variables, plant age significantly influenced symptoms development (Fig. 6.13). Increasing plant age had positive effect on lesion development. Young plants of 20 days after sowing (DAS) were least affected from stem inoculation and produced lesion length of 1.4 cm after 2 days of inoculation. As the crop attained 70 days, lesion length upon stem inoculation became significantly highest. This was on par with that of the 60 DAS age *(Source: JM 8.5. Contributors: K. Mandal, C. Biswas and C.S. Kar).*

Fig. 6.12. Lesions produced on detached jute stem upon inoculation with *M. phaseolina* of 1, 2 and 7 days old culture plates

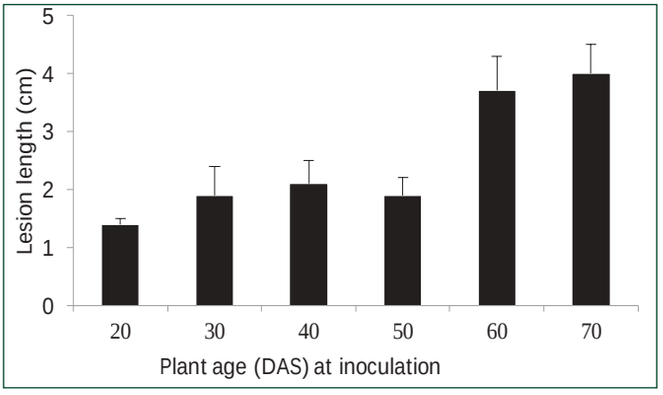


Fig. 6.13. Stem rot disease development at different plant age

Identification of defense related genes against stem rot in jute

Whole transcriptome analysis generated more than 7.2 million reads corresponding to 1.5 million nucleotides of cDNA sequences from *C. capsularis*. The tissues had best BLASTX alignments to the *Arabidopsis thaliana* proteome. GO annotations using the *A. thaliana* proteome as reference showed that the transcriptome of this species covered a wide range of biological processes. *In silico* analysis of transcript abundance using the DEGseq approach identified 1715 contigs in *M. phaseolina* inoculated asymptomatic jute plants. GO annotation distribution showed that 158 of the identified genes were involved in response to abiotic or biotic stimuli showing several related pathways. The most frequent molecular functions of the identified defence-related genes were hydrolases, protein binding transferases and transporters. However, one of the highly represented categories was phytohormone signalling including ethylene, jasmonic acid (JA), salicylic acid (SA), and abscisic acid (ABA) *(Source: TMJ 7. Contributor: C. Biswas).*

Designing gene-specific primers to identify stem rot resistant jute varieties

Differentially expressed gene encoding regions were used to design primer sets to identify stem rot resistant varieties (Table 6.7) *(Source: TMJ 7. C. Biswas).*

Table 6.7. Group of gene-specific primers designed to identify stem rot resistant varieties

Gene name	Forward primer (5'–3')	Reverse primer (5'–3')	Tm (^{0}C)	Product size (bp
JAZ	TGAGCACTTC-CATAAGGACAGA	AATGTAAAGGGTG-GGGTAAAGC	59	418
MSD1	CACTTCATTTTCA-CATTCCAACT	AAGGGACCAAG-GACCTCTCATCG	62	427
WIN1	AGTCAAACT-TATCTCGCAACG-GG	TCTTTAGAAACAT-TCACCACAGC	61	495
SCF (TIR1)	GATGGAGA-GAGATTTTATGGG	ATGGAAGTATT-GAATGAGGAG	59	305
AMME CR1	TCTT-GACCTTCTTCAG-CACCATA	ATACCAC-GACTTCTTCTTC-CAGTTCT	59	432
FUM1	CTGCTGTTGGAT-GTTACCCCT	TA-ATCTTGTTCTTCTG-CCCCG	56	345
26 r RNA	CGGCTTGACTTG-GCAGGAC	GTAGTTTCTTTGCT-CATTCTATCGG	57	220

Effect of plant population density and sowing methods on stem rot of jute

Significant effect of jute sowing methods (broadcast and line sowing) and plant population density on the incidence of stem rot, *M. phaseolina* was observed. With increasing plant population density the incidence of stem rot increased reaching peak of 16.3 and 27.4% in highest plant population density of 10 lakh/ha, respectively, in line sown and broadcast crop (Fig. 6.14). Under optimum plant population level of 5-6 lakh /ha, the stem rot incidence was moderate with 7-9% in line sown and 10-17% in broadcast crops. With similar level of plant population, jute stem rot was always low in line sown crops than the broadcast crops.

Line sowing reduced the stem rot incidence due to better aeration, adversely affecting the development of favourable micro-climate for the disease *(Source: JM 8.0. Contributor: R.K. De).*

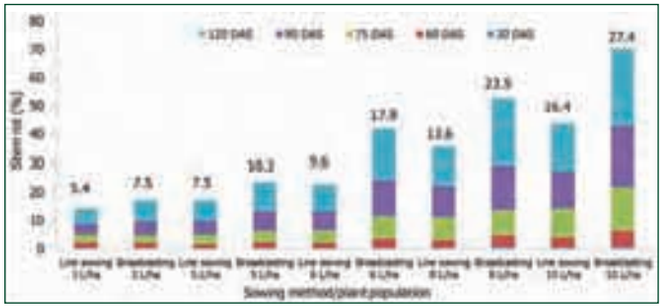


Fig. 6.14. Effect of plant population density and sowing methods on stem rot of jute

Bleaching powder for management of stem rot of jute

The radial growth of *M. phaseolina* was completely checked in food poisoning technique *in vitro* at 5000 µg/ml of bleaching powder both at 24 and 48 h after incubation. At lower dose growth inhibition decreased. At 1000 µg/ml, 96.6% inhibition was observed after 48 h During further incubation of 24 h at a concentration of 5000 µg/ml of bleaching powder, no fresh growth was observed indicating complete inhibition of *M. phaseolina* (Fig. 6.15).

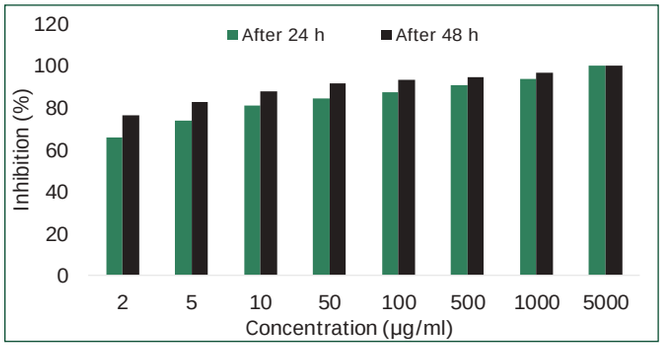


Fig. 6.15. Effect of bleaching powder on mycelial growth inhibition of *M. phaseolina in vitro*

In the field, soil application of bleaching powder @ 30 kg/ha 7 days prior to sowing was found best against jute stem rot. It restricted stem rot incidence of jute to 3 and 5.1 % as compared to 14.5 and 27.2 % in untreated check at 90-120 DAS, respectively (Table 6.8) *(Source: JM 8.0. Contributor: R.K. De).*

Variability of jute stem rot pathogen, *M. phaseolina*

All the ten isolates collected from different jute growing places of India were purified, proved to be pathogenic and produced typical symptoms of jute stem rot on both jute species, *i.e. C. olitorius* (cv. JRO 8432) and *C. capsularis* (cv. JRC 412) and pathogenicity was tested. Variation in growth pattern and colony characters of isolates of *M. phaseolina* was observed *(Source: JM 8.0. Contributor: R.K.De).*

Table 6.8. Effect of soil application of bleaching powder on stem rot of jute (cv. JRO 8432)

Treatment	Stem rot incidence (%)			
	30 DAS	60 DAS	90 DAS	120 DAS
5 kg/ha (2 DBS)	0.11 (1.55)	0.45 (3.82)	3.71 (11.09)	10.38 (18.79)
10 kg/ha (2 DBS)	0.05 (0.75)	0.28 (2.98)	3.11 (10.14)	9.10 (17.56)
20 kg/ha (2 DBS)	0.06 (0.84)	0.24 (2.76)	3.23 (10.34)	7.92 (16.34)
30 kg/ha (7 DBS)	0.06 (0.78)	0.22 (2.62)	3.05 (10.05)	5.15 (13.11)
50 kg/ha (7 DBS)	0.11 (1.52)	0.17 (2.35)	4.08 (11.65)	6.33 (14.57)
80 kg/ha (10 DBS)	0.05 (0.76)	0.22 (2.63)	4.91 (12.71)	6.74 (15.03)
100 kg/ha (15 DBS)	0.13 (1.17)	0.23 (2.71)	3.96 (11.44)	8.12 (16.55)
120 kg/ha (15 DBS)	0.11 (1.52)	0.16 (2.31)	3.44 (10.68)	7.43 (15.79)
150 kg/ha (15 DBS)	0.06 (0.82)	0.19 (2.49)	4.29 (11.93)	7.71 (16.07)
Control	0.54 (4.56)	4.31 (11.98)	14.59 (22.45)	27.23 (31.44)
LSD (P=0.05)	(2.26)	(0.82)	(1.73)	(1.37)

DBS-days before sowing, *Figures in the parentheses represent angular conversion values

Fungicidal effect of *Abroma augusta* leaf extract against *M. phaseolina*

The pure water extract of both young and old leaves of *A. augusta* was evaluated against *M. phaseolina* using poisoned food technique. The radial growth inhibition of *M. phaseolina* was increasing with higher concentration of test botanical. The extract of younger leaves showed greater inhibition on test pathogen as comparison to old leaves. Mycelial growth inhibition in concentration of 5, 10, 15, 25 and 50 % younger leaf extract was 8.8, 13.6, 17.5, 28.8 and 42.2%, respectively after 96 h (Fig. 6.16) *(Source: JM 8.0. Contributor: R.K. De).*

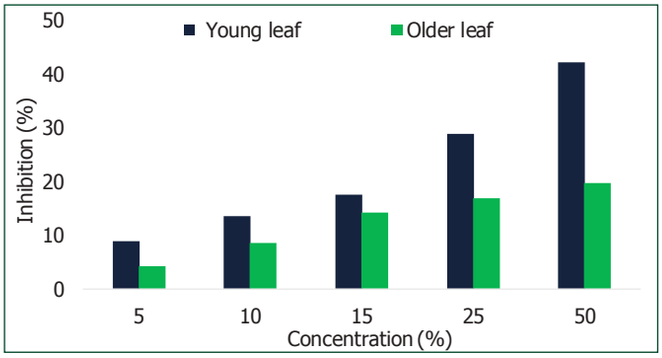


Fig. 6.16. Effect of *Abroma augusta* leaf extract against *M. phaseolina* in jute under *in vitro* condition

Growth dynamics and rhizosphere colonization of *Trichoderma* isolates

Four *Trichoderma harziamum* isolates (NBAII TH-8, NBAII TH-1, NBAII TH-10, MTCC-8799) and five *Trichoderma viride* isolates (TV-H, TV-10, TV-1, TV-23, MTCC-3144) procured from ICAR-NBAIR, Bengaluru and CSIR-IMT, Chandigarh, respectively along with 6 native *T. viride* isolates (TVC-1, TVC-2, TVC-3, TVC-4, TVC-5 and TVC-6) were tested for their bio-control efficacy against

the stem rot pathogen, *M. phaseolina*. Growth dynamics of all the actively growing *Trichoderma* isolates were assessed in PDA media at 24 h intervals and continued upto 72 h. Consistently the radial growth was higher in TVC 1 (2.5 cm at 24 h and 8.5 cm at 72 h) and NBAII TH-10 (2.4 cm at 24 h and 8.4 cm at 72 h). Rhizosphere colonization of different *Trichoderma* strains was measured under pot culture technique at 25 DAS. Maximum rhizosphere colonization was recorded in TVC1 (300 x 10^3 cfu/g dry soil) followed by NBAII TH-1 and NBAII TH-10 (183 x 10^3 cfu/g dry soil).

Growth Inhibition

The bio-control potential of different *Trichoderma* isolates was assessed against *M. phaseolina*. The native isolate TVC 1 consistently performed better (56.8% growth inhibition) followed by TVC 4. Among exotic isolates, NBAII TH10, NBAII TH1 also performed better. Performance of TVC 1 was better over the study period i.e. 24 h-120 h than other isolates (Fig. 6.17).

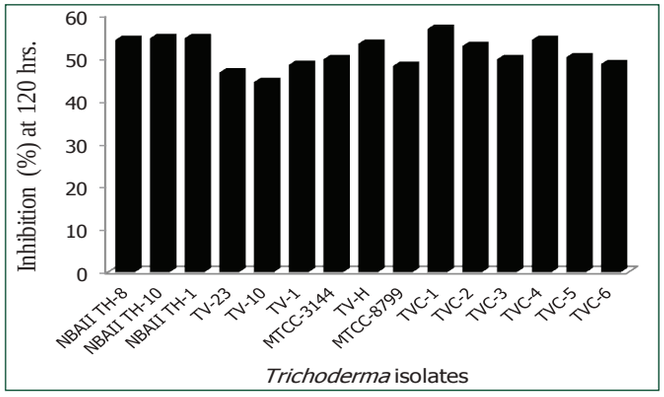


Fig. 6.17. Effect of *Trichoderma* strains on growth inhibition of *M. phaseolina* under *in vitro*

Growth promotion activity of *Trichoderma* strains

Growth promotion activities was measured in terms of vigour index [(VI = germination % x (RL+SL)] under pot culture condition. Out of 15 isolates of *Trichoderma*, native isolate TVC 1 recorded maximum VI (600) and leaf area (36.9 cm^2) at 15 DAS (Fig. 6.18a & 6.18b).

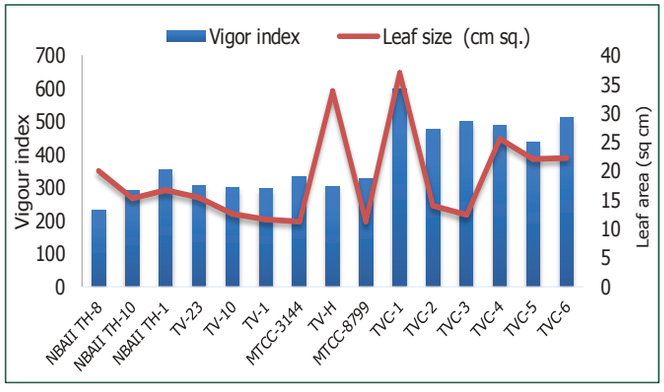


Fig. 6.18a. Effect of *Trichoderma* strains on vigour index and leaf size

Disease control potential

Jute (cv. JRO 204) seeds was sown in the pots containing sterilized soil mixed with 48h old culture of *Trichoderma* isolates and *M. phaseolina* in 50:50 ratio and incubated for 3 days. Germination as well as emergence of seedlings were monitored regularly. All the native isolates were better in reducing pre-emergence rotting (26-38%) than exotic isolates (60-74%). Least post emergence rotting was observed in TVC 1 (0.33%) followed by NBAII TH-1 (1.0%) (Fig. 6.19) *(Source: TMJ 7. Contributor: S. K. Sarkar).*

Fig. 6.18b. Effect of different *Trichoderma* strains on seedling growth

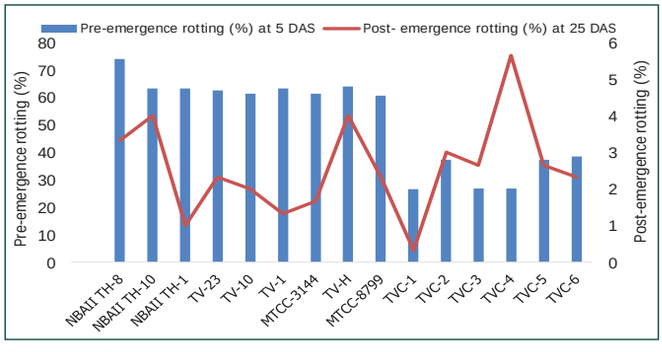


Fig. 6.19. Effect of *Trichoderma* strains on emergence rotting due to *M. phaseolina*

Fungicidal effect of plant essential oils against stem rot pathogen of jute

Fresh oils of 2 species of Cymbopogan, 2 species of Mentha, *Lippia geminata*, Eucalyptus, Bottle brush were extracted by hydro-distillation in Clevenger apparatus. Turmeric oil was extracted in hexane from turmeric rhizome powder in Soxhlet apparatus. Two major fractions of turmeric oil (TLC pure) were isolated by liquid-liquid partitioning, column chromatography and prep-TLC. Out of the eight oils, turmeric oil was most effective (IC_{50} 0.011%). Turmerone and *Ar*-turmerone (TLC pure), the main active constituents of turmeric oil were isolated and tested against the fungus. *Ar*-turmerone (IC_{50} 0.006%) was more effective than turmerone (Table 6.9). Essential oils were found effective

both in arresting fungal growth and spore formation of *M. phaseolina*. Turmeric oil and leaf essential oils inhibited the radial growth and spore formation better than other extract. Mixtures of turmeric rhizome oil with the individual leaf oils (at IC_{25} dose level) were found more effective in controlling the fungal growth than turmeric oil alone. Ar-turmerone in combination with the leaf oils exhibited superior combined efficacy. Chemical characterization of the oils revealed similarities in composition among the leaf oils but turmeric rhizome oil differed in composition from the leaf oils.

Table 6.9. Effect of plant extracts on *M. phaseolina* causing stem rot disease of jute

Extract	IC_{50} (%)	IC_{25} (%)
Citronella oil	0.013	0.009
Lemon grass	0.019	0.016
Mentha arvensis	0.018	0.013
Mentha piperata	0.026	0.018
Turmeric oil	0.011	0.007
Ar-turmerone	0.006	0.003
Turmerone	0.054	0.016
Curcumin mixture	0.123	0.061
Lippia oil	0.022	0.015
Eucalyptus oil	0.017	0.014
Bottle brush oil	0.034	0.022

IC - inhibition concentration

6.1.2.2. Mesta

Incidence of mesta stem rot, *Sclerotinia sclerotiorum*

Although stem rot of mesta is a minor disease, the incidence of the disease was as high as 5-10% in seed crops at CRIJAF-Research Farm during December-February, 2014-15. The infected plant neither yields any fibre nor seeds. The disease appears as water soaked areas on any parts of stem which turn into brown patches visible from distance. Finally, the infection girdles the stem completely (Fig. 6.20). The portions above the affected part may ultimately wilted, die backed and break away. The surface of the affected parts is covered with white strands of fungus. Brown coloured sclerotia observed on the mycelial mat which later on turn into black at maturity. The sclerotia were also noticed in bolls. The fungus was isolated from the infected portion and pathogenicity test was confirmed *(Source: JM 8.7. Contributors: S.K. Sarkar, A. Bera and A.N. Tripathi).*

Fig. 6.20. Different stages of mesta stem rot, *S. sclerotiorum*

Incidence of leaf blight, *Phyllosticta hibiscini* of roselle

This disease was recorded first time in roselle from CRIJAF-Research Farm during September, 2014. The pathogen mostly infects the plant from the margin of the leaf and progresses towards vein and petiole causing blighting of leaf which is favoured by high humid condition (Fig. 6.21). Under dry condition, the symptom is restricted and black pin head like pycnidia develops on the infected surface. The pathogen was isolated in PDA media which produces highly branched hyaline mycelia with black dot like pycnidia having profuse hyaline, single celled, elliptical conidia. Clamydospore are also produced in the culture media. Using the same culture bit, pathogenicity test by detached leaf technique was confirmed.

Fig. 6.21. Different stages of symptom by *Phyllosticta hibiscini* of roselle

In vitro scaling and mass multiplication of bioagents and PGPR

On the basis of *in vitro* parasitization, TV-01, NBAII TV-23, MTCC 793, and MTCC 3144 strains of *T. viride* and NBAII TH-8, NBAII TH-10, TH-1, and MTCC 8799 strains of *T. harzianum* were scored under scale 1. Although *T. viride* strain, MTCC 3144 was scored under class 1 against *S. sclerotiorum*; however, it was scored under class 2 against *M. phaseolina.* Easily, available solid substrates i.e. wheat grains, wheat bran, and jute seeds were tested for mass multiplication of bioagents. Wheat grain was most supportive substrate for mass multiplication of *Trichoderma* with significantly high population of the bioagents (Table 6.10). Five strains of *P. fluorescens* (NBAII-RJ 9, NBAII-GR 3, MTCC 6035, MTCC 1749, Pf-1) were characterized for plant growth promotion activities. All the isolates favoured plant growth promotion activity through qualitative and quantitative estimation for production of oxidase, IAA, lipase, siderophore, fluorescence and phosphate solubilisation *(Source: JM 8.4. Contributors: A.N. Tripathi, R.K. De and S.K. Sarkar).*

Table 6.10. Effect of different substrates on the population of *Trichoderma* strains after 15 days of incubation

Substrate	Population of *Trichoderma* strains (x 10^9 cfu/g)				Mean
	MTCC-3114	NBAII Tv -23	NBAII TH-8	NBAII TH-10	
Wheat grain	1.50	1.30	1.40	1.2	1.35
Wheat bran	1.00	0.80	0.90	0.7	0.85
Jute seed	0.53	0.40	0.50	0.3	0.43
Maize grain	0.40	0.30	0.40	0.4	0.37
Mean	0.85	0.70	0.80	0.65	-
LSD (P=0.05)	Strain = 0.15; Substrate = 0.15; Strain × Substrate = 0.94				

Pesticide residue analysis in edible parts of jute and mesta

Jute and mesta leaves treated with insecticides (cypermethrin 10 EC, profenophos 50 EC), acaricides (abamectin 1.8 EC, fenazaquin 10 EC) and fungicides (azoxystrobin, trifloxystrobin, metalaxyl) were collected from treated experimental plots at different time intervals for residue analysis conducted at Export Testing Laboratory, BCKV, Mohanpur Nadia, West Bengal. After 30 day of spraying, residues of the pesticides either went below detection limit (BDL) or only traces were detected which were well within the permissible limit (PL) *(Source: Exploratory Project. Contributor: H. Chowdhury).*

6.1.2.3 Ramie

Evaluation ramie germplasm against diseases

All the 53 genotypes (exotic and indigenous) showed considerable variation in the level of resistance against economically important diseases of ramie. The exotic germplasm line, R-1415 and Saikishon were graded as highly resistant to anthracnose leaf spot and mosaic. Whereas two genotypes (R-1438 and R-45) were susceptible to anthracnose leaf spot and genotype R-1445 and R-1429 were highly susceptible to mosaic *(Source: RBM 2.5. Contributors: S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma).*

Survey and surveillance of important diseases of ramie

During 2014, the diseases such as, anthracnose leaf spot, *Curvularia* leaf blight, *Cercospor*a leaf spot, damping off and yellow mosaic were found to be the prominent diseases of ramie crop. The infected samples causing collar rot were collected and isolated in the laboratory on PDA medium (Fig. 6.22). These fungal isolates were further studied and identified on the basis of symptoms, isolations and morphological observations and were also sent to Indian Type Culture Collection (ITCC), New Delhi for further confirmation. This fungal pathogen was identified as *Sclerotium* sp, (ITCC Id. No.9150.13) causing collar rot of ramie. This is the first report of occurrence of these pathogen on ramie in India (Fig. 6.22) *(Source: RBM 2.5. Contributors: S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma).*

Fig. 6.22. Sclerotium rot or collar rot (A) infected plant in field (B) Mycelial growth of the fungus on collar region of the stem (C) Culture of stem rot pathogen on PDA medium

Efficacy of fungicides against *Curvularia* leaf blight of ramie

For field evaluation of different fungicides against leaf blight of ramie, *Curvularia eragrostidis*, the foliar spraying was done at 12 days after previous harvest during the month of August when the incidence of disease was very high. Carbendazim 0.25% and hexaconazole 0.1% were effective with 67.03 and 65.75% disease reduction over control respectively (Fig. 6.23) *(Source: RBM 2.5. Contributors: S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma).*

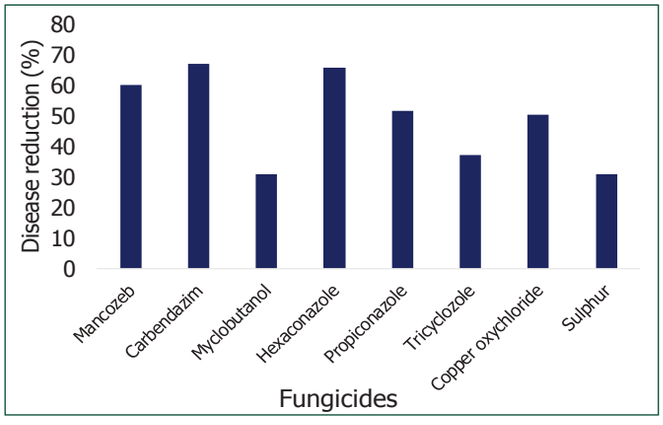


Fig. 6. 23. Effect of different fungicides on *Curvularia* leaf blight control

6.1.2.4 Sisal

Survey and surveillance of the zebra disease of sisal

Nineteen villages of Jharsugura, Sambalpur and Sundargarh district of Odisha were surveyed for occurrence of zebra disease in sisal plantation. The disease incidence in the surveyed area ranged from 18.9-28.8% in *Agave sisalana* and 23.6-48.3% in Bamra Hybrid-1 (Table 6.11). In nursery stage, the disease severity ranged from 1.6-36.0% in *Agave sisalana* and 2.9-46.3% in Bamra Hybrid-1. In case of 2-3 years old suckers, disease severity ranged from 1.7-36.2% in *Agave sisalana* and 3.5-47.1% in Bamra Hybrid-1. Minimum temperature showed significantly negative correlation with disease severity in both the varieties in

the nursery stages and 2-3 years old suckers (Table 6.12) *(Source: SLM 1.0. Contributors: A.K. Jha, R.K. De, S. Sarkar and A.N Tripathi).*

Table 6.11. Zebra disease severity in sisal

Date	Disease severity in nursery stage		Disease severity in 2-3 years old suckers	
	Agave sisalana	Bamra Hybrid-1	*Agave sisalana*	Bamra Hybrid-1
15th June	1.6 (7.2)	2.9 (9.6)	1.7 (7.5)	3.5 (10.7)
30th June	4.6 (12.2)	10.1 (18.4)	4.7 (12.4)	11.1 (19.4)
16th July	11.8 (20.0)	17.6 (24.7)	12.2 (20.3)	19.4 (26.0)
31st July	19.5 (26.1)	25.3 (30.1)	20.2 (26.7)	26.5 (30.9)
16th Aug	25.5 (30.2)	34 .0 (35.6)	25.2 (30.0)	35.2 (36.4)
31st Aug	29.3 (32.7)	40.3 (39.4)	28.9 (32.4)	41.3 (39.9)
15th Sept	33.8 (35.5)	44.0(41.5)	32.6 (34.8)	45.4 (42.3)
30th Sept	35.3 (36.4)	46.0 (42.7)	35.8 (36.7)	46.7 (43.1)
15th Oct	36 (36.8)	46.3 (42.8)	36.2 (37.0)	47.1 (43.3)
LSD (P=0.05)	2.7	3.3	2.4	3.0

Figures in parentheses are arc sin transformed value

Table 6.12. Correlation coefficient (r) between disease severity and weather variables during 2014-15

Weather parameter	Disease severity in nursery stage		Disease severity in 2-3 years old suckers	
	Agave sisalana	Bamra Hybrid-1	*Agave sisalana*	Bamra Hybrid-1
Max. Temp.	-0.08	-0.12	-0.06	-0.13
Min. Temp.	-0.92*	-0.92*	-0.93*	-0.92*
Av. Temp.	-0.60	-0.63	-0.59	-0.64
Rainfall (mm)	0.01	0.01	0.02	0.03
Max. RH (%)	0.21	0.26	0.19	0.28
Min. RH (%)	0.56	0.59	0.55	0.60

*Significant at 5% level

Out of 11 spp. tested under natural epiphytotic condition, none were resistant to the zebra disease. One spp. (*A. miradorensis*) showed moderately resistant reaction and three spp. (*A. cantala, A. aungustifolia* and *A. ameniensis*) showed moderately susceptible and rest 7 spp. showed susceptible and highly susceptible reaction. Out of 58 germplasm, 11 were resistant, 12 were moderately resistant and 35 were susceptible to highly susceptible in reaction towards the disease *(Source: SLM 1.0. Contributors: A.K. Jha, R.K. De, S. Sarkar and A.N Tripathi).*

6.1.3 Weed Management

6.1.3.1 Jute and mesta

Low-cost ecofriendly technologies for weed management in jute and mesta

Application of pre-emergence herbicide, pretilachlor 50% EC @ 0.9 litre/ha at 48 hrs of sowing in irrigated condition and one hand weeding, controlled grass and broad leaved weeds, *Trianthema portulacastrum* in particular and produced 22.3 q jute fibre/ha (Table 6.13). Among post-emergence herbicides, application of quizalofop 10 EC @ 38 ml/ha and propaquizafop 10 EC @ 90 ml/ha with one manual weeding produced 24.5 q and 25.70 jute fibre /ha, respectively. In broadcast jute, CRIJAF nail weeder operation at 4-5 days after crop emergence (DAE) followed by one hand weeding controlled composite weeds in early stage simultaneously developed line and produced the highest fibre yield of 28.4 q/ha. This weed management practice saved 50 to 70% of total weeding cost incurred in jute (Fig. 6.24).

Fig. 6.24. Simultaneous weed control, weeding, thinning, line arrangement and soil mulching in jute using CRIJAF nail weeder

Table 6.13. Effect weed management practices on weed population (35 DAE) and fibre yield of jute

Treatment	Grass/m^2	Broad leaf weed/m^2	Sedge/ m^2	Fibre (q/ha)
Control	8.21 (67.7)	7.61 (60.0)	11.34 (134.7)	21.2
CRIJAF nail weeder + one hand weeding	6.81 (46.3)	6.14 (39.7)	7.48 (58.7)	28.4
Quizalofop ethyl 10 EC @ 38 ml/ha at 15 DAE+ one hand weeding	9.20 (94.0)	6.71 (47.7)	8.45 (72.0)	24.5
Propaquizafop 10EC@ 90 ml/ha + one hand weeding	9.01 (84.0)	7.22 (53.7)	9.13 (84.0)	25.7
Ethoxysulfuron @ 20 g/ha + one hand weeding	21.51 (159.0)	5.70 (32.7)	3.92 (20.0)	23.5
Gylyphosate 41% SL @ 2.05 l/ha with CRIJAF herbicide applicator + 1HW	3.45 (12.0)	5.37 (30.7)	20.46 (444.0)	14.1
Pretilachlor 50 EC @ 0.9 l/ha +one hand weeding	0.71 (0.0)	3.22 (10.0)	6.84 (46.7)	22.3
Two manual weeding	9.18 (97.3)	4.92 (25.7)	10.76 (125.3)	15.7
LSD (P=0.05)	4.40	2.70	5.79	3.65

Original value in parentheses

Weed control by smothering

In clay soil, jute (cv. JRO-204) intercropped green gram (cv. TMB 37, duration 54 days) with 1:1 ratio produced 59.6 q jute fibre equivalent/ha (42.5 q jute fibre, 6.8 q pulse grains) and produced 2 t pulse wastes/ha (Table 6.14). In FLDs' on jute and mung intercropping, in Hoogly, 24 PGS (N)

and Murshidbad, 30-35 q jute fibre and 6-7 q mung grain were harvested (Fig. 6.25) *(Source: TMJ 4.0, A.K. Ghorai, Mukesh Kumar, Shamna, A. and A, G. Jagannadham).*

Fig. 6.25. Jute (JRO-204) (1:1) and mung (TMB-37) intercropping at Singur, Hoogly

Table 6.14. Effect of different weed management treatments on fibre yield of jute

Treatment	Plant population (lakhs/ha)	Plant height (cm)	Fibre weight (q/ha)	Jute equivalent yield (q/ha)
Jute + *Basella alba* (vine spinach)+ 2HW	5.67	347.3	35.0	35.0
Jute + *Basella alba* (vine spinach)+ 2HW	6.43	353.7	49.2	49.2
Jute +green gram (Sonali) + pretilachlor @ 0.9 L/ha +1 HW	6.67	358.0	37.5	53.4 (4.8)
Jute + green gram (TMB-37) +pretilachlor @ 0.9 L/ ha +1 HW	6.10	369.3	42.5	59.6 (6.8)
Jute + green gram (Pusa 9531) + pretilachlor @ 0.9 L/ ha +1 HW	6.57	367.3	39.2	57.6 (7.4)
CRIJAF nail weeder at 5 DAE and scrapper at 21 DAE +1HW	9.40	364.0	49.2	49.2
Glyphosate @ 1.23 L/ ha +2 HW	10.90	355.0	50.0	50.0
Jute + green gram (Meha)+ pretilachlor 0.9 L/ha +1 HW	5.37	317.0	32.5	54.8
Two manual weeding (15 and 30 DAS)	11.27	332.0	55.0	55.0
Control	11.17	337.7	54.2	54.2
LSD (P=0.05)	1.58	26.5	13.9	14.62

6.2. Abiotic Stress

6.2.1. Water stress

Determination of water productivity of tossa jute under deficit moisture stress condition

Soil penetration resistance up to 80 cm profile depth was measured with a cone type penetrologger in plots treated with 100% NPK+FYM (@10t/ha), 100% NPK and control (without NPK and FYM) under jute-rice-wheat cropping sequence continuously for 43 years, and in tilled fallow plot at CRIJAF-Research Farm, Barrackpore. Scrutiny of the penetrologger graphs obtained from different plots under treatments revealed that the soil penetration resistance among the treatments varied mostly between 10-30 cm profiles depths. Within this depth the magnitude of the soil PR, 2MPa obtained similarly in 100% NPK+FYM treated plots and tilled fallow plots is significantly lesser than the 100%NPK treated and control plots (Fig. 6.26). This higher soil PR, 2-4 Mpa for the latter two treatments is most possibly due to non-addition of organic matter which hinders to improve soil structure and friability.

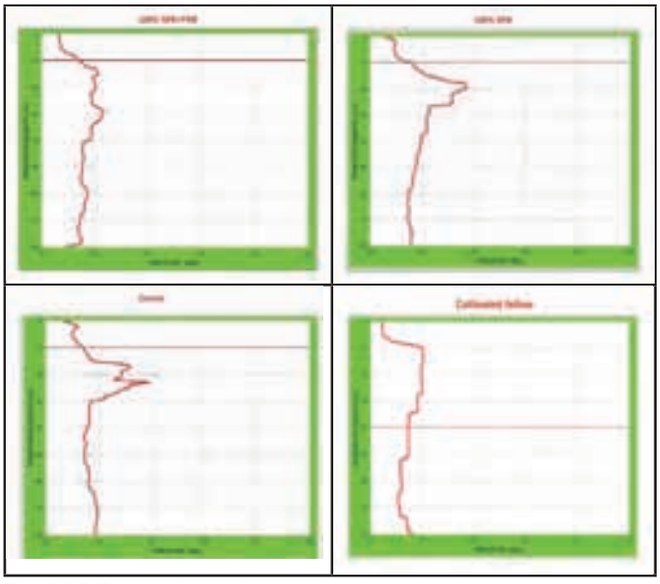


Fig. 6.26. Penetration resistance of soil profile of long term fertilizer experiment at Barrackpore

Soil moisture stress was imposed after 45 DAS to five selected jute (*C. olitorius)* varieties, viz. JRO 128, JRO 204, JRO 8432, S 19 and JRO 524 to study the response in biomass accumulation and leaf relative water content. Reduction in accumulation of total dry matter, bark dry matter and leaf relative water content ranged from 49.7 to 70.7, 54.1 to 75.9, and 25.9 to 39.2%, respectively among all the five jute varieties grown under deficit soil moisture stress (>4 bar soil moisture tension or <10% soil moisture) (Fig. 6.27). The relationship between above ground biomass (bark+stick+leaf) and below ground biomass (root biomass) up to the 20 cm soil depth using pooled data of three replicated five selected varieties was found linear with the coefficient determination (R^2=0.6835). The regression equation (y = 0.1117x + 1.2793, where y=root biomass, g/plant and x=above ground biomass, g/plant) can be used to predict jute root biomass up to 20 cm soil depth for Barrackpore region (Fig. 6.28) *(Source: JC 6.5. Contributors: D. Barman, D.K. Kundu, A.K. Ghorai, S. Mitra and M. Ramesh Naik).*

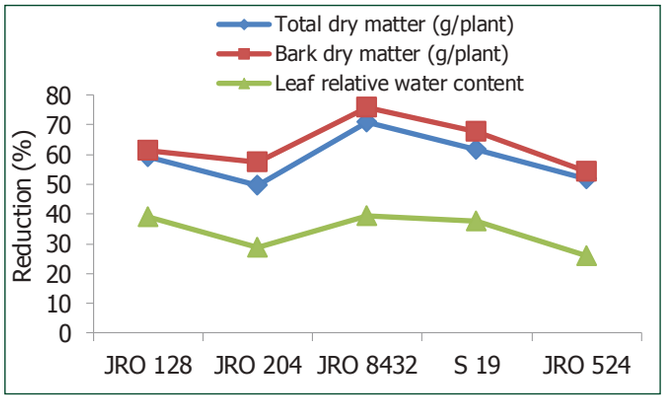


Fig. 6.27. Reduction of accumulation of total- and bark- dry matter and leaf relative water content of jute under deficit soil moisture stress (>4 bar tension)

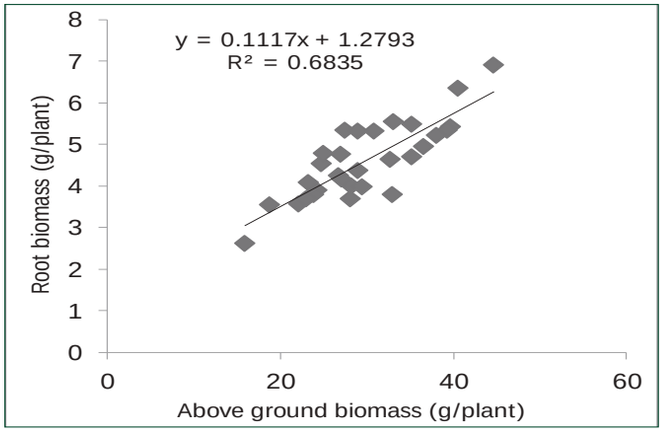


Fig. 6.28. Relationship between root biomass and above ground biomass (bark+stick+leaf)

6.2.2. Salinity stress

Screening of jute varieties for salinity stress

Field experiment was conducted at Canning Town (Saline soil) with jute seed crop during September 2014 to January 2015 using five *C. capsularis* varieties *viz* JRC 698, JRC 532, JBC 5, JRC 321 and JRC 517, three *C. olitorius* varieties *viz* JRO 524, JRO 2407 and JRO 8432. During experiment period soil chemical characters were analyzed and recorded as soil pH: 7.98, EC (dS/m): 0.829, 2.831 and 4.432 at 0-30 cm, 30-60 cm, and 60-90 cm depth. Among jute species *C. olitorius* (cv. JRO-8432) produced highest yield attributing characters *viz* fresh weight (510 g/plant) dry weight (135 g/plant) and seed yield (1012 kg/ha) (Table 6.15). Among five varieties of *C. capsularis*, JRC-517 had highest fresh weight (316 g/plant) dry weight (98 g/plant) and seed yield (749 kg/ha). It revealed that in saline soil, the species *C. olitorius* performed better than *C. capsularis* *(Source: JA 6.8. Contributors: M. Ramesh Naik, D. Barman, U.K. Mandal and R.T. Maruthi).*

Table 6.15. Growth and seed yield of jute varieties in saline soil at Canning Town

Varieties	Shoot length (cm)	Root length (cm)	Leaf area index	Fresh weight (g)	Dry weight (g)	Seed yield (kg/ha)
Corchorus olitorius						
JRO 524	144	24.3	3.56	392	109	796.9
JRO 2407	142	22.8	2.61	420	116	765.6
JRO 8432	151	26.3	3.71	510	135	1012.0
Corchorus capsularis						
JRC 698	126	16.3	2.77	299	82	550.0
JRC 532	126	17.4	1.68	261	67	492.7
JBC 5	152	17.6	2.96	295	89	427.1
JRC 321	145	19.3	2.31	314	91	525.0
JRC 517	142	16.2	2.57	361	98	749.0

7. Farm Mechanization and Post-Harvest Technology

7.1 Farm Mechanization

7.1.1 Development of multi-crop manual seed drill

For sowing of green gram as inter crop with jute, the existing 4-row seed drill was modified as multi-crop seed drill (Fig. 7.1). In the existing one meter seed box shaft, one extra seed box was fitted to make it 5-row with row to row spacing of 20 cm each. The diameter of seed dispensers on the periphery of the seed boxes were increased from 2.5 mm to 3.5 mm for smooth dropping of green gram seeds. The existing straight furrow openers of the seed drill were modified to hoes for easy movement in the soil during its operation. The modified seed drill was operated in the farmers' field in Hooghly, North 24 Parganas, Murshidabad and Nadia districts of West Bengal for intercropping of jute with green gram and other pulses.

Fig. 7.1. Multi-crop manual seed drill

7.1.2 Development of jute weeder for Gangetic alluvial soil

Manually operated weeder suitable to operate in line sown jute and other crops was designed (Fig. 7.2). The weeder consists of body frame, wheel, tyne attachment frame (share type, hoe type and scrapper) and handle. The body frame was made with MS flat (1.25 mm x 0.6 mm) instead of GI pipe for its durability and to withstand the pressure exerted during its operation. The weeder operates on a single cast iron wheel of 51 cm diameter for less rolling resistance. The overall dimensions of the weeder including the adjustable handle are 53 cm width, 162 cm length and 92 cm height from the ground and its weight is 10.5 kg. The weeder was evaluated attaching scrapper tool in line sown jute crop. The field capacity and weeding efficiency was 0.022 ha/h and 86.17%, respectively with 7.4% plant damage. The performance index of the weeder with scrapper attached was 1755.45. It is easy to operate and involves less human drudgery, the draft requirement is 8.31 kgf. This implement with share type tyne, can be used for seed bed preparation in small area *(Source: JAE 3.4. Contributors: R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha).*

Fig. 7.2. Jute weeder

7.1.3 Development of jute leaf remover

Simple tool to remove leaves from matured standing/ harvested jute plants was fabricated (Fig. 7.3). The tools were made of MS flat and its working part was grooved for proper holding of the plants during operation. The groove facilitates easy removal of leaves without injuring the fibre of the plant fed singly. The working principle involves pressing of upper jaw with handle and pulling of plant. The upper jaw automatically returns back to its position due to spring action. Leaves from 5-6 plants can be removed per minute *(Exploratory Project. Contributors: R.K. Naik, D.K. Kundu and M.S. Behera).*

Fig. 7.3. Jute leaf remover

7.2 Post Harvest Technologies

7.2.1 Upscaling and refinement of microbial retting consortium of jute

Microbial diversity analysis of retting water samples collected from 6 different places of 3 districts of West Bengal *i.e.* Hooghly, Nadia and North 24 Parganas were analyzed for total count of pectin, xylan and lignin degrading microbes. High level of xylan degraders with a mean of 25 x 10^8 cfu/ml of retting water was observed with samples of Kumro, while samples of Haringhata had much higher lignin (16 x 10^{14} cfu/ml of retting water) and pectin degraders (52 x 10^{13} cfu/ml of retting water).

7.2.1.1 Lignin degrading microbes

The ligninolytic potential of the isolated strains was assessed by their ability to utilize aromatic lignin-monomers as sole carbon source. The decolorization of ligninolytic indicator dyes by S-3, S-7 and S-9 strains was higher with azure-B and toludine blue agar medium compared to other strains, which were selected for further studies (Fig 7.4 & 7.5) *(Source: TMJ 6.0. Contributors: B. Majumdar, A.R. Saha, S. Sarkar, S.K. Jha and S.K. Sarkar).*

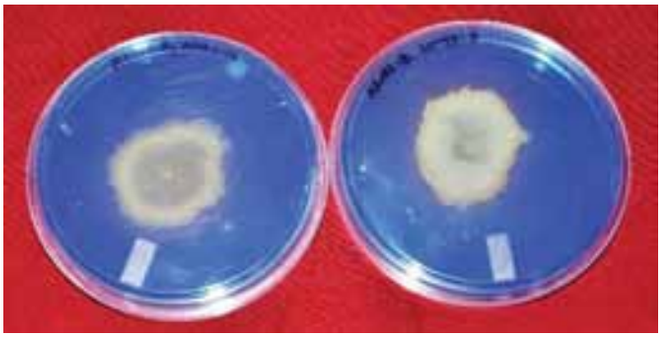


Fig. 7.4. Decolorization of azure-B containing plate

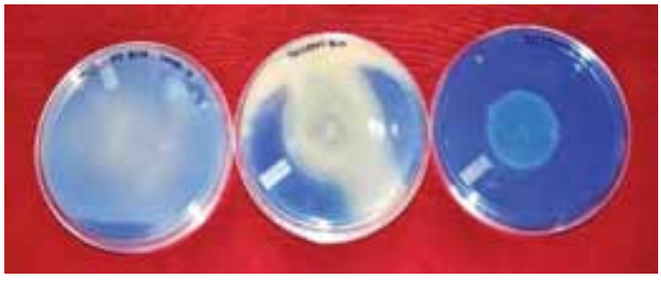


Fig. 7.5. Decolorization of toludine blue containing plate

7.2.1.2 Xylanase production by immobilized cells of *Bacillus pumilus*

Among three strains of *Bacillus pumilus* of CRIJAF microbial consortium, the PJRB2 strain is the highest xylanase producer. Xylanase production capacity of immobilized cells of *B. pumilus* with 5% Ca-alginate beads were optimum beyond which xylanase production was reduced. The immobilized cell initiates maximum enzyme production from 48 h and retain the same level up to 72 hr at 150 RPM. Maximum xylanase production was retained up to fourth repeated cycle.

7.2.1.3 Isolation, quantification and identification of genomic DNA of microbes from retting water

The DNA of retting microbes were trapped in the pre-sterilized 0.22 µ filter paper by filtering 20 ml samples of retting water followed by incubation of retting microbes in nutrient broth medium at 34°C for 24 hr. After the desired growth, genomic DNA was isolated by using hipura TM water DNA kit. Quantification of DNA indicated high gram positive bacterial DNA and moderate amount of gram negetive bacterial DNA in retting microbes (Table 7.1).

Table 7.1. Quantification of genomic DNA of retting microbes

Sample	260/280 (for protein)	230/260 (for RNA)	Amount of DNA (µg/ml)
S_1(gram positive)	1.35	0.83	221
S_1 (gram negative)	0.80	0.80	50
S_2 (gram positive)	1.30	1.02	139
S_2 (gram negative)	0.75	0.90	72

7.2.1.4 Plant nutrient sources from retting water

During retting, complex organic matters degrade to simpler compounds and essential nutrients such as N, P, K, Ca and Mg. The pH of retting water varied from 6.2 to 7.4. The available P content was much higher (462.8- 2040.7 ppm) in the water samples of Goaldah whereas the samples of Kumro contained high level of available N (13.1-20.5 ppm). Potassium level was much higher in Singur (25.7-93.8 ppm) and Goaldah (13.8-75.1 ppm) water samples. The available N, P, K, Ca and Mg were higher at the end of retting. *(Source: TMJ 6.0. Contributors: B. Majumdar, A.R. Saha, S. Sarkar, S.K. Jha and S.K. Sarkar).*

7.2.2 Promotion of microbial formulation mediated retting among farmers

Improved retting with CRIJAF microbial formulation "CRIJAF SONA" were promoted through 776 large scale demonstrations on farmers' field condition in 6 districts of West Bengal, Nagaon district of Assam, Kishanganj and Purnea districts of Bihar, Vizianagaram district of Andhra Pradesh (Fig. 7.6 & 7.7). The retting duration was reduced by at least 6 to 7 days with microbial formulation compared to conventional retting. Fibre strength of treated samples was higher by 2.8 to 4.5 g/tex over the controlled samples. Farmers earned higher price for the quality fibre produced with CRIJAF SONA (Fig 7.7). In Assam, farmers of 4 villages of two districts viz. Nagaon and Morigaon got additional price @ ₹ 300 to 500/q jute fibre produced with CRIJAF SONA. In Srikrishnapur and Metiagachha villages of Nadia district, retting duration was reduced by 6 to 7 days with additional price (₹ 410 to 500/q) for fibres.

Fig.7.6. Distribution of CRIJAF SONA to farmers and demonstration on microbial retting at Kalna, Burdwan

Fig 7.7. Mesta retting demonstration at Vizianagaram, Andhra Pradesh and golden fibre obtained with CRIJAF SONA

7.2.3 Impact analysis of field demonstrations of "CRIJAF SONA"

The impact analysis of improved jute retting technology was studied on the basis of feedback from 35 field demonstrations conducted during August, 2014 in 14 blocks of North 24 Parganas district. This technology reduced the retting duration by 1-8 days. In 71.5% cases the reduction of retting duration was 4-7 days as compared to the conventional retting methods. Better fibre colour (yellowish to bright golden) was obtained by 82.9 % farmers and only 17.1 % observed slight improvement or no apparent improvement in fibre colour. One of the remarkable benefits of improved retting technology were uniform fibre recovery throughout the length of jute stem. The average yield and income advantage was 191 kg/ha and ₹ 4,590/ha respectively. Majority (86%) of the jute farmers were 'Satisfied' to 'Very Satisfied' on the outcome of this technology (Fig. 7.8) *(Source: TMJ 6. Contributors: B. Majumdar, A.R. Saha, S. Sarkar, S.K. Jha and S.K. Sarkar).*

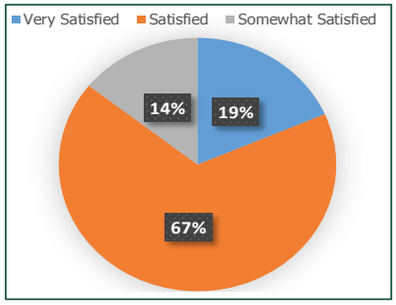


Fig. 7.8. Farmer's response to improved microbial jute retting technology

7.2.4 Refinement and up scaling of eco-friendly microbial degumming technology in ramie

Out of the promising pectinolytic strains, S33 and S11 isolates were selected based on least cellulase and maximum pectinase activity. The pectinase activities were evaluated at varying substrate concentration and pH condition of the growth media. Maximum polygalacturonase (PG) activity of S33 and S11 was recorded at 0.5-0.75% pectin concentration levels. The pectate lyase (Pel) activity was found highest at 0.5-0.75% and 0.25-0.75% pectin concentration for S33 and S11, respectively (Fig. 7.9 & 7.10). S33 isolate produced highest PG activity with ammonium chloride followed by ammonium sulphate and isolate S11 recorded highest activity with casin hydrolysate followed by ammonium sulphate (Fig. 7.11). The degumming efficiency of S33 and S11 under laboratory scale (2-5 gm dry ramie fibre) were 22.1 and 23.4% (weight loss basis) compared to 26% in chemical degumming. The residual gum content of the degummed ramie fibre ranged from 1.7-2.5%. Out of 96 samples collected from agricultural wastes and jute retting tanks, 6 isolates of degumming microbes have been selected on the basis of least cellulase activity *(Source: TMJ 8. Contributors: S. Mitra and A. Singh).*

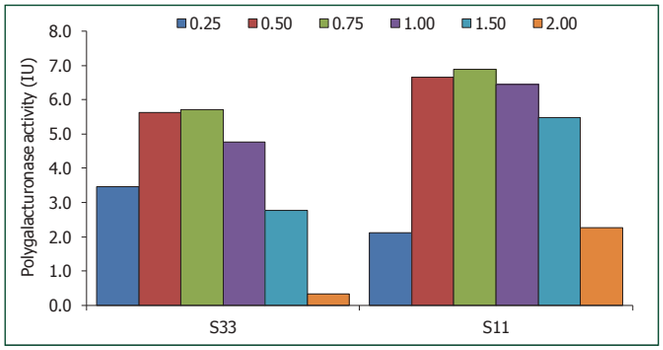


Fig. 7.9. Effect of pectin concentration (%) on polygalacturonase activity (IU)

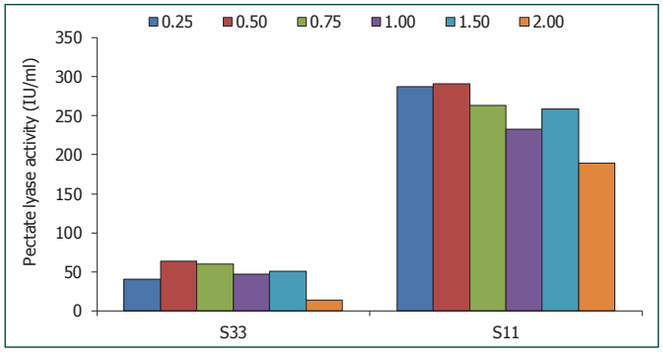


Fig. 7.10. Effect of pectin concentration (%) on pectate lyase activity (IU/ml)

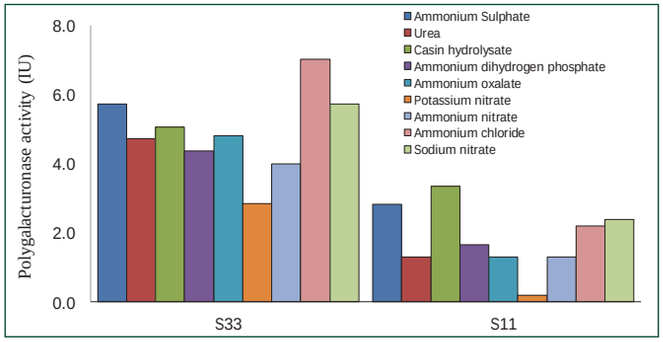


Fig. 7.11. Effect of nitrogen source on polygalacturonase activity (IU)

8. Jute and Allied Fibre Informatics

8.1 Development of Jute and Allied Fibre Informatics

The existing version of JAFexpert for jute crop has been upgraded to make it more user-friendly. The Jute Expert System (JES) has been improved on different aspects including (i) result page in "Question and Answer session" to make it brief and to the point, (ii) master page so that system administration can effect pattern changes through graphical use interface (GUI), (iii) set minimum support price (MSP) as default values in cost of production information.

The availability of updated information on sunnhemp cultivation as fibre crop is very scanty. Sunnhemp Information System (Fig. 8.1) has been developed on aspects of variety, crop cultivation, weed management, soil and water management, diseases and insect-pests management. Knowledge was obtained from domain experts, literature, e-resources, farmers and extension workers which were represented in the knowledge base with a series of rules and algorithms. The application programming interface (API) and integration of modules for sunnhemp crop is available. Relation between tables through entity relationship (ER) and data flow diagram (DFD) from one table to another has been prepared. Content management system (CMS) is prepared for sunnhemp interface to manage design of web page in a collaborative environment to allow editing and modifying content as well as maintenance from a central interface.

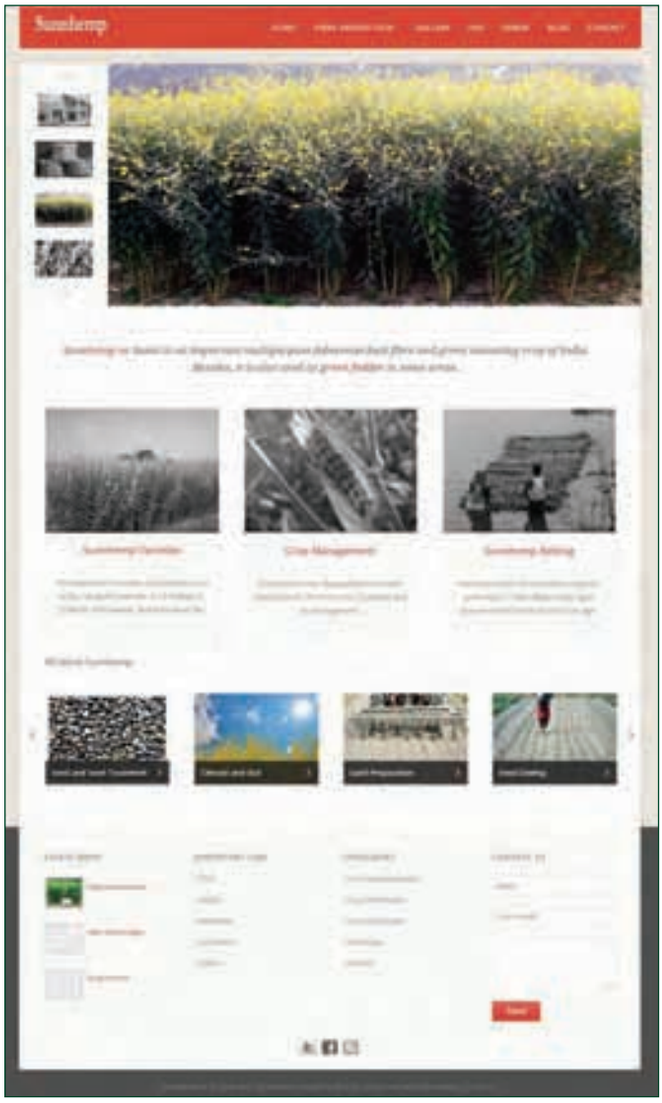


Fig. 8.1. Webpage of sunnhemp expert system

In Mesta Expert System (MES), varietal search (by name, location, and yield), variety description, insect-pest identification and management and retting module have been incorporated. Retting and weed management videos have also been included as supplementary features for easy comprehension of users. The existing database of jute and mesta has been updated.

8.2 Information and Communication Technology (ICT) Based Extension Services

Mobile advisory service for farmers have been initiated. During 2014-15 jute season, 427 farmers were selected for ICT based extension services from different extension centers of ICAR-CRIJAF. Text SMS on jute production technologies like improved jute varieties, nutrients management, weed management, pest and diseases management, post-harvest technologies and precautionary measures on weather excesses were posted time to time. Overall 16500 text SMS were sent on 18 occasions.

An offline information system in HTML format has been prepared and installed on kiosk located at extension section of ICAR-CRIJAF, now available to public, containing short general information on jute cultivation and institute related scientific information.

8.3 Jute Area and Productivity Mapping Through GIS

Mapping of jute and mesta growing areas of India was done in the GIS environment on the basis of average data of six years (2005-06 to 2010-11). The identified area was classified into four groups, *viz*. only jute, only mesta, jute and mesta, and no jute or mesta (Fig. 8.2).

West Bengal shares about 80% of India's jute acreage. The distribution of jute acreage in West Bengal was mapped (Fig. 8.3) through GIS. Among the 17 jute growing districts, maximum area under this crop (>15%) is in the districts of Murshidabad and Nadia, <1% area fall under the districts

of Darjeeling, Birbhum, Bankura, West Midnapur, East Midnapur, Howrah and South 24-Parganas and there was no record of cultivation of jute crop in the districts of Purulia.

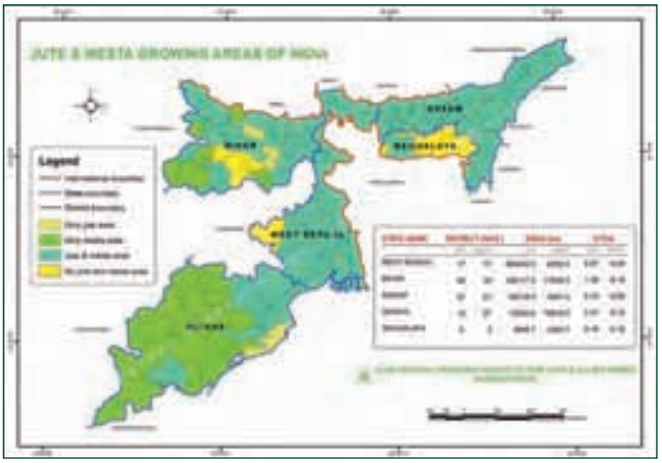


Fig. 8.2 Jute and mesta growing areas of India

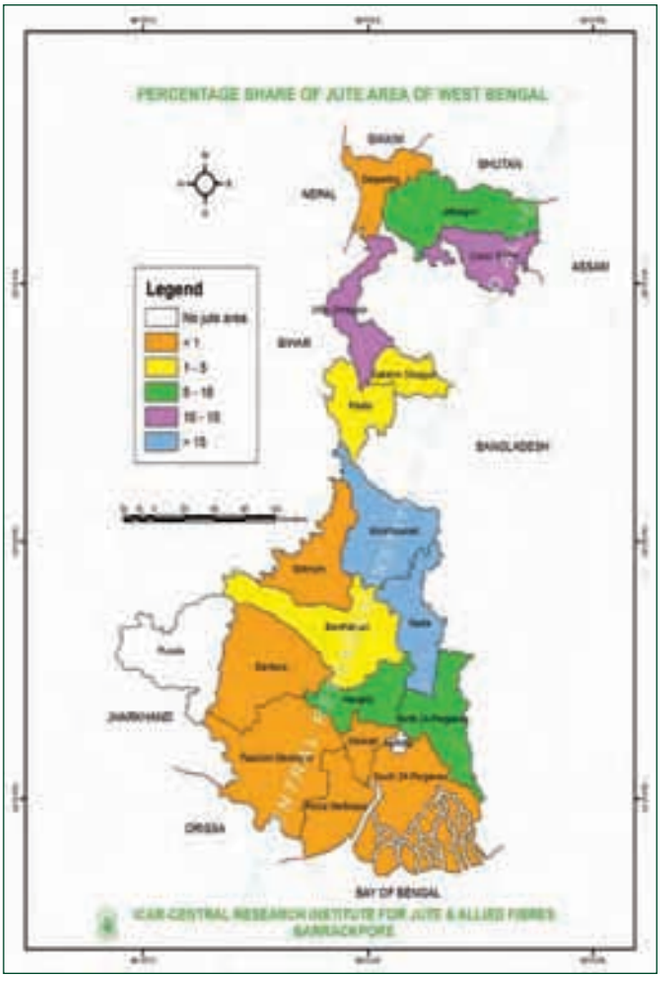


Fig. 8.3. Percentage share of jute growing area of West Bengal

Jute fibre productivity of West Bengal was mapped (Fig. 8.4) by classifying into four groups, *viz.* very low (<20 q/ha), low (20-25 q/ha), medium (25-30 q/ha) and high (>30 q/ha).

Productivity of jute fibre increased at the rate of about 40.5 kg/ha per year from 1993-94 to 2005-06 which may be due to adoption of improved varieties, production and protection technologies (Fig. 8.5) *(Source: TMJ 3. Contributors: A.K. Chakraborty, C.S. Kar, Shamna A., A.K. Ghorai, R.K. De, D. Barman, K. Selvaraj, M.K. Tripathi, A.K. Sharma and A.K. Jha).*

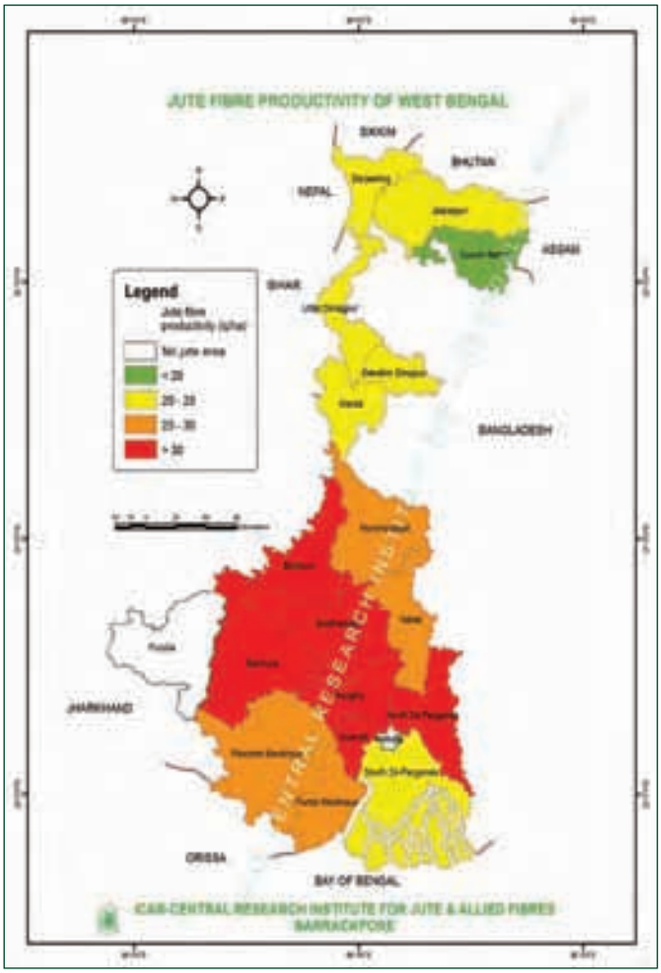


Fig. 8.4. Jute fibre productivity of West Bengal

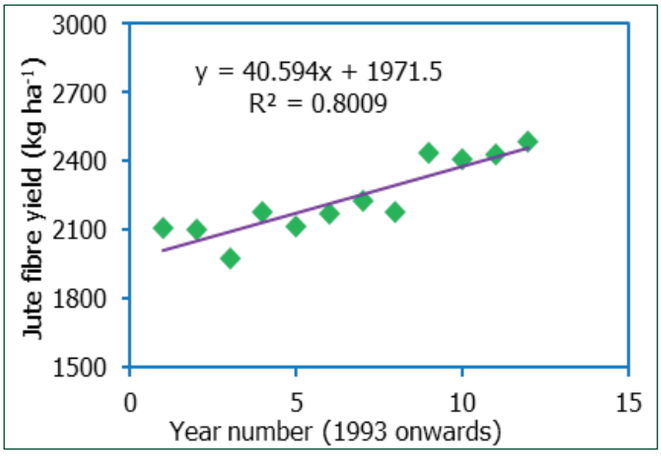


Fig. 8.5. Jute fibre productivity trend of West Bengal

9. Technology Assessment and Transfer

9.1 Frontline Demonstration (FLD)

Frontline demonstration on latest high yielding varieties and other improved production technologies of jute were organized in villages of Nadia, North 24 Parganas, Murshidabad, Hooghly and Burdwan districts of West Bengal through the extension centres of the institute and Krishi Vigyan Kendra, Burdwan in collaboration with Directorate of Jute Development, Ministry of Agriculture, under Mini Mission-II (MM-II) of Jute Technology Mission Programme. Altogether, 288 demonstrations covering 50 ha on jute were conducted in the above districts (Table 9.1).

Table 9.1. Area covered under each component of FLD

Name of the Village	No. of farmers	Area (ha)				
		Improved varieties	Multi row seed drill	Integrated weed management	Drought management	Total
Kumra (North 24 Parganas)	42	0.29	-	9.37	-	9.66
Madhusudanpur (Hooghly)	72	0.73	3.48	7.00	-	11.21
Brahmapur (Nadia)	53	0.64	2.36	7.00	-	10.00
Devkundu (Murshidabad)	67	0.53	-	5.14	3.53	9.20
Natungram (Burdwan)	54	10.00	-	-	-	10.00
Total	288	12.19	5.84	28.51	3.53	50.07

9.1.1 Varietal evaluation

The *tossa* jute varieties *i.e.* JRO 204 (Suren), JRO 2407 (Samapti), CO 58 (Sourav), JROM 1 (Pradip) were demonstrated for assessing yield performance in the farmer's field in 12.19 ha area in five districts of West Bengal. All recommended package of practices were followed. The highest fibre yield of jute irrespective of the locations (Table 9.2) was obtained from the variety JRO 204 (32.53 q/ha). It was followed by CO 58 (31.13 q/ha), JROM 1 (31.03 q/ha) and JRO 2407 (30.92 q/ha). Local check yielded 26.89 q/ha fibre giving a net return of ₹ 11,239 against ₹ 59,514 cost of cultivation. Highest benefit-cost ratio was obtained in JRO 204 (1.59) followed by CO 58 (1.56), JROM 1 (1.55) and JRO 2407 (1.48).

Table 9.2. Economics of growing improved jute varieties

Variety	Fibre yield (q/ha)	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
JRO 204 (Suren)	32.53	54,329	85,977	31,648	1.59
JRO 2407 (Samapti)	30.92	61,291	92,653	30,029	1.48
CO 58 (Sourav)	31.13	56,656	1,17,449	31,431	1.56
JROM 1 (Pradip)	31.03	59,825	93,406	33,581	1.55
Local Check (JRO 524)	26.89	59,514	72,863	11,239	1.23

Price of jute fibre and jute stick were ₹ 2,100-2,300/q and ₹ 200-500/q, respectively

9.1.2 Integrated Weed Management (IWM)

Demonstrations on pre-emergence herbicide *i.e.* application of pretilachlor@3 ml/l and post-emergence herbicide (quizalofop ethyl @1.5ml/l) and mechanical weeding by nail weeder was conducted in the farmer's field in 28.51 ha in 4 districts (Table 9.3). Across the locations, IWM resulted in 1.62-5.05 q/ha more fibre yield over farmer's practice (26.12-30.12 q/ha). Maximum gain in fibre yield was from use of nail weeder (3.04-5.05 q/ha) followed by quizalofop ethyl (1.62-3.79 q/ha) and application of

Fig. 9.1. JRO 204 in Farmer's field under FLD

Fig. 9.2. Nail weeder demonstration in FLD plots

pretilachlor (2.03 q/ha). Maximum saving on cost of human labour was from using of nail weeder (₹ 6,348-9,438/ha) followed by application of quizalofop ethyl (₹ 3,482-8,048/ha) and pretilachlor (₹ 803/ha).

Table 9.3. Economics of jute cultivation under IWM

Location/ Particulars	IC (₹/ha)	HLC (₹/ha)	CC (₹/ha)	FY (q/ha)	GR (₹/ha)	NR (₹/ha)	B:C
Brahmapur (Nadia)							
Quizalofop ethyl	15,264	56,785	62,049	32.54	95,613	33,564	1.54
FP	15,236	63,357	68,593	30.12	87,348	18,755	1.27
Madhusudanpur (Hooghly)							
Quizalofop ethyl	13,859	46,224	60,083	29.62	7,99,74	19,891	1.33
Nail weeder	11,287	43,358	54,645	31.17	84,159	29,514	1.54
FP	11,857	49,706	61,563	26.12	70,524	8,961	1.14
Devkundu (Murshidabad)							
Quizalofop ethyl	13,973	43,337	57,300	30.42	98,865	41,565	1.72
Preitlachlor	13,061	50,571	63,632	28.66	93,145	29,513	1.46
Nail weeder	13,084	41,937	55,021	29.67	96,428	41,407	1.75
FP	15,712	51,375	67,087	26.63	86,548	19,461	1.29
Kumra (North-24 Parganas)							
Quizalofop ethyl	12,875	40,160	53,035	27.82	72,332	19,297	1.36
Nail weeder	11,755	38,902	50,657	29.56	76,856	26,199	1.51
FP	14,026	45,372	59,398	26.20	68,120	8,722	1.14

IC-Input Cost, HLC-Human Labour Cost, CC-Cost of Cultivation, FY-Fibre Yield, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmer's Practice

9.1.3 Line sowing

Demonstrations on manual four row seed drill were conducted in an area of 5.84 ha in two villages (Table 9.4). It helped in increasing the fibre yield by 2.85-2.88 q/ha and saved the cost of human labour in jute cultivation by ₹ 3,740-5,512/ha over farmer's practice. The effect of this intervention was found maximum at Madhusudanpur (₹ 12,558/ha) on the basis of net return.

Fig. 9.3. Line sown jute crop through seed drill

Table 9.4 Economics of jute cultivation under line sowing

Treatment	IC (₹/ha)	HLC (₹/ha)	CC (₹/ha)	FY (q/ha)	GR (₹/ha)	NR (₹/ha)	B:C
Madhusudanpur (Hooghly)							
MRS	12,359	44,194	56,553	28.97	78,072	21,519	1.38
FP	11,857	49,706	61,563	26.12	70,524	8,961	1.14
Brahmapur (Nadia)							
MRS	14,772	49,617	64,389	33.00	94,714	30,325	1.47
FP	15,236	53,357	68,593	30.12	87,348	18,755	1.27

IC-Input Cost, HLC-Human Labour Cost, CC-Cost of Cultivation, FY-Fibre Yield, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmer's Practice

9.1.4 Drought management practices

Frontline demonstration on three drought management practices were laid out in 3.53 ha (Table 9.5) at Devkundu village. Highest fibre yield enhancement was obtained from application of sulphur @30 kg/ha over recommended dose of fertilizer (RDF) i.e. 60:30:30 (8.50 q/ha) followed by augmented nutrition *i.e*. 80:40:40 (7.85 q/ha) and RDF with single irrigation (5.54 q/ha). Farmer's practice gave 23.43 q/ha fibre. In terms of net returns, RDF + Sulphur (₹ 42,309 /ha) was better than augmented nutrition (₹ 35,043 /ha) and RDF + single irrigation (₹ 32,542 / ha).

Table 9.5. Economics of jute cultivation under drought management practices

Treatment	IC (₹/ha)	HLC (₹/ha)	CC (₹/ha)	FY (q/ha)	GR (₹/ha)	NR (₹/ha)	B:C
RDF+ Single irrigation	12,017	49,594	61,611	28.97	94,153	32,542	1.52
RDF+ Sulphur	12,708	48,756	61,464	31.93	1,03,773	42,309	1.68
Augmented nutrition	14,813	51,804	66,617	31.28	1,01,660	35,043	1.52
FP	11,370	45,714	57,084	23.43	76,148	19,064	1.33

IC-Input Cost, HLC-Human Labour Cost, CC-Cost of Cultivation, FY-Fibre Yield, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmer's Practice

Farmers were satisfied with the performance of technological interventions like improved varieties of jute, line sowing through multi row seed drill, integrated weed management through mechanical as well as pre and post-emergence herbicides and drought management practices. All the improved varieties of jute gave 15–20% more fibre yield in comparison to local varieties. Line sowing through multi row seed drill reduced the seed rate by 30% which saved input cost on seed and simultaneously facilitated in carrying out other agricultural operations in the field.Weed management through herbicide reduced the labour cost by saving ₹ 3,500–₹ 8,000/ha. Similarly, use of nail weeder

was effective in soil mulching and reduced the dependency on herbicides. Application of elemental sulphur (in rainfed condition) was simple, compatible to their production system and profitable as it increased the fibre yield by 36% over traditional practices. Finally, all these methods helped in reducing the cost of cultivation by ₹ 4,000 to ₹ 12,000/ha over the traditional practices *(Source: DAC (JEXA 4.7). Contributors: S.K. Jha, S. Kumar, S. Sarkar, Shamna A. and R.K. Naik).*

Fig. 9.4. Scientists monitoring FLD fields

9.1.5 Improved retting technology

Under FLD on improved retting technology, 22 demonstrations on jute and mesta crop were conducted in different districts of West Bengal, Bihar, Assam and Andhra Pradesh using CRIJAF SONA, a talc based microbial consortium. Altogether 1326 farmers participated and got benefitted through this programme.

Use of CRIJAF SONA, a talc based microbial consortium, was found effective in improving the quality of fibre of jute and mesta (by at least 1 to 2 grades) for retting under stagnant water. It also reduced the retting duration (by 6 to 7 days) and enhanced higher fibre recovery *(Source: NFSM. Contributors: C.S. Kar, S. Sarkar, B. Majumdar and S.K. Jha).*

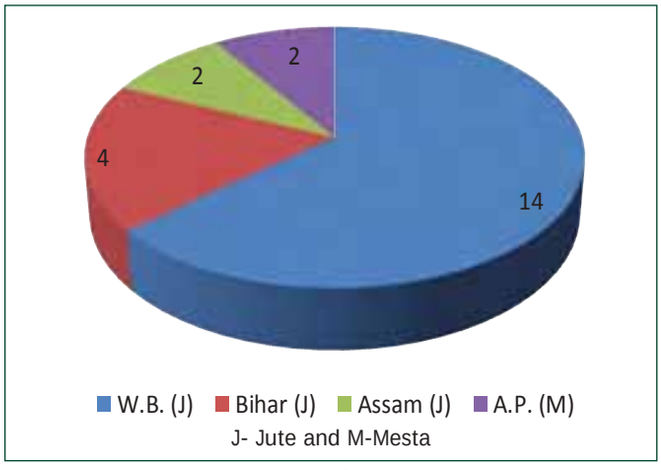


Fig. 9.5. Statewise demonstration of improved retting technology

9.2 Performance of New *Tossa* Jute Varieties

Experiments were conducted at farmers' field with new *tossa* jute varieties i.e., JRO 204 (Suren), JRO 2407 (Samapti), CO 58 (Sourav), and JROM 1 (Pradip) at Haringhata (Nadia), Habra-1 (North 24 Parganas), Singur (Hooghly), Beldanga (Murshidabad) and Galsi (Burdwan) blocks of West Bengal in participatory mode to analyse the yield performance of the high yielding *tossa* jute varieties.

Among the newer *tossa* jute varieties, the productivity was the highest in JRO 204 (32.53 q/ha) followed by CO 58 (31.13 q/ha), JROM-1 (31.03 q/ha), and JRO 2407 (30.92 q/ha) (Fig. 9.6). The highest fibre yield of JRO 204 was attributed mainly to higher plant height (347.5 cm) at

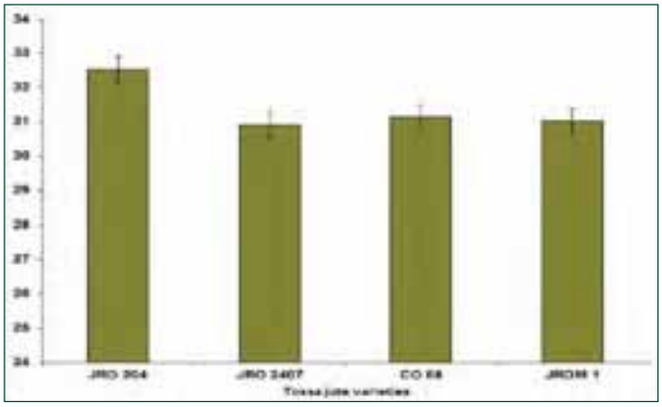


Fig. 9.6. Performance of different *tossa* jute varieties in terms of fibre yield (q/ha)

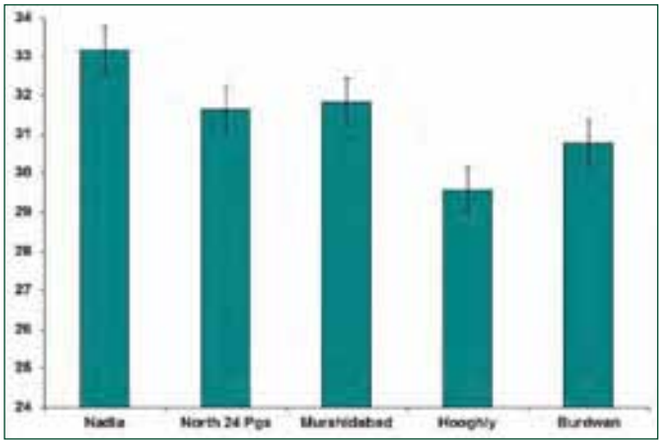


Fig. 9.7. Fibre yield (q/ha) of *tossa* jute varieties at different locations in farmers' fields

harvest. Irrespective of the varieties, the highest jute productivity was obtained at Haringhata, Nadia (33.18 q/ha) followed by Beldanga, Murshidabad (31.83 q/ha), Habra-1, North 24 Parganas (31.65 q/ha), Galsi, Burdwan (30.78 q/ha) and Singur, Hooghly (29.57 q/ha) (Fig. 9.7). The variety JRO 204 outperformed (32.53 q/ha) other varieties in most of the intensively jute growing districts of West Bengal *(Source: JEXA 5.2, Contributors: S. Sarkar, S.K. Jha, S. Kumar, Shamna, A., B. Majumdar, C. Biswas and B.S. Gotyal).*

9.3 Attitude and Perception of Farmers Towards ICT Based Extension

Farmer's attitude towards using ICT tools for farm communication revealed that most of the farmers (36.92 %) had favourable attitude followed by 30.76 % with least favorable attitude and 32.30 % as most favorable attitude towards ICT tools. Mobile (SMS) advisory with a provision to provide customised information was recognised as the most preferred ICT tools for technology transfer (Fig. 9.8).

Fig. 9.8. Farmers' preference for different methods used for transfer of technology

Most of the respondents (80%) perceived that useful, timely and need based customised information on farming activities cannot be delivered using ICT based transfer of technology. Major barriers for ICT based technology transfer perceived by the farmers were lack of training and availability to learn ICT (95.38 %), no privilege given to farmers to use ICT based extension contact (92.3 %), lack of confidence to use ICT (84.61 %), language barrier (73.84 %) and lack of skills to use ICT (67.69 %) *(Source: JEXA 5.1, Contributors: Shamna, A., and A. Chakraborty)*.

9.4 Analysis of the Outcome of Technological Interventions under TSP

The technological interventions in Makaltala and Farmania villages, North 24 Parganas on improved jute cultivation enhanced the fibre yield by 25% with an additional income of ₹ 12,000/ha. For ensuring the nutritional security intercropping of green gram with jute yielded 15 q/ha of jute and 3.6 q/ha of pulse. Green gram provided nutritional support to the farm families. CRIJAF SONA, the talc based microbial formulation improved the colour, lustre and quality of the fibre as well as reduced the retting duration from 22 days to 15 days and additional income of ₹ 500/q of fibre.

Vegetable cultivation in jute based columns in rice fields ensured the harvest of 1 ton vegetables/ha in addition to 5.4 t rice. Farmers were guided technically and supported financially for input use in mustard and coriander cultivation. As a result of which an additional yield of 1.5-2 t/ha of mustard was obtained. The productivity of village ponds were improved through scientific fish farming. The farm women were trained in preparation of fancy jute bags and folders. One of the SHGs has started preparing the bags and earned a profit of ₹ 16,800/- by selling the jute bags.

Analysis of the extent of tribal women participation in farming activities indicated that participation of tribal farm women during the crop seasons were 28.3 man days which was 11.81, 9.48 and 7.01 man days in mustard, paddy and jute cultivation respectively. The involvement of women was more in transplantation, weeding and harvesting activities.

The profile of the tribal farm women revealed that most of them were illiterate, middle aged, had high economic motivation and social participation. The independent variables like age, education, social participation and economic motivation had significant relationship with participation of tribal women in farming activities (Table 9.6). Age and economic motivation had significant negative and positive influence on participation in farming *(Source: JEXA 5.4, Contributors: Shamna, A., S. Sarkar, S.K. Jha and S. Kumar).*

Fig. 9.9. Jute fabric based columns are being prepared by women

Table 9.6. Relationship between independent variables on participation of tribal women in farming activities

Independent variables	Co-relation Coefficient(r)
Age	-0.620**
Education	0.493**
Family Type	0.151^{NS}
Family Dependency Ratio	-0.236^{NS}
Income	0.067^{NS}
Social Participation	-0.320*
Economic Motivation	0.760**
Mass Media Participation	0.090^{NS}
Extension Participation	-0.14^{NS}
Decision Making Pattern	-0.0055^{NS}
Level of Knowledge in Farming	-0.269^{NS}

** Significant at 1 % level ; NS- Non-significant ; * Significant at 5% level

9.5 Other Extension Activities

Ninety **farmers-scientists interactions** were organized in different extension centres in Burdwan, Dakshin Dinajpur,

Hooghly, Murshidabad, Nadia and North24-Parganas to resolve various problems encountered by the farmers particularly in jute and other field crops. Five **exposure visits** were organized at the institute in which 116 visitors consisting of farmers, opinion leaders and students from Odisha, Bihar and West Bengal visited the institute to acquaint themselves on recent advances in jute and allied fibre crops. Eleven **training programmes** for farmers and farm women were organized to impart training on jute and allied fibre production technologies and other allied agricultural activities attended by 593 participants. Four **awareness camps** were arranged for farmers of Hooghly, Dakshin Dinajpur and North 24-Parganas districts on improved jute and fish production technology and animal health. Besides the FLDs, 30 **demonstrations** were organized on microbial formulation aided jute retting technology, nail weeder and line sowing of jute. The institute actively participated in 13 **agri-fairs and exhibitions** at state and national level to showcase the improved production technologies of jute and allied fibres for the benefit of farmers and stakeholders.

The promotional activities/events and technologies attracted extensive **media coverage** being highlighted in the local dailies, AIR and TV channels. The improved jute retting technology using "CRIJAF SONA" attained very wide coverage through leading newspapers of West Bengal, Bihar and Andhra Pradesh. The technologies on other allied fibres were published in the local newspapers and AIR centres in Odisha, UP, Bihar and Assam *(Source: JEXA 4.7 and TSP. Contributors: S. Sarakr, S.K. Jha, S. Kumar and Shamna A.).*

Fig. 9.10. Scientists explaining the visitors during exhibition

Fig. 9.11. Demonstration of nail weeder in the farmers' field

Fig. 9.12. Farmers interacting with scientists about mesta seed crop

Fig. 9.13. Demonstration of sisal fibre extractor operation to the farmers

10. Tribal Sub Plan (TSP)

Activities were undertaken under the Tribal Sub Plan (TSP) with the objective to bring more area under jute and allied fibre crops in tribal dominated areas through improved technological intervention to enhance the livelihood security of the tribal farm families. The major activities in jute and jute based cropping sequences, animal husbandry and fishery components were implemented in two blocks of North 24 Parganas, one block each of Dakshin Dinajpur, Nadia and Bankura districts in West Bengal. Sisal plantation and agricultural activities were undertaken in Sambalpur and Jharsuguda districts of Odisha and Ranchi district of Jharkhand, and the area expansion of ramie in NE states including Assam, Meghalaya and Nagaland.

10.1 Enhancement of Livelihood Security of Tribal Farmers of North 24 Parganas

With an objective to enhance the livelihood security of tribal farmers, the TSP is being implemented at Makaltala and Farmania villages of Habra-1 block and Paschim Simla village of Baduria block of North 24 Parganas district.

10.1.1 Improved jute production technology

Improved jute production methods were demonstrated to the tribal farmers. Seeds of two high yielding *tossa* jute varieties (JRO 204 and S-19) were distributed to the farmers for sowing in 18 ha area. Line sowing of jute was advocated and demonstration on use of seed drill was conducted.

Fig. 10.1. Demonstration on improved jute variety and jute - green gram strip cropping

For effective weed management, demonstrations were conducted on use of nail weeder in the farmer's field. Sixty seed drills and nail weeders were distributed to the farmers of North 24 Parganas. 'Sonali' a short duration, disease resistant green gram variety was introduced in Makaltala village through TSP programme. Strip cropping of green gram with jute was demonstrated in 0.2 ha area of 3 farmers. As an insurance crop, green gram stabilized the production and return under adverse condition of drought and price fluctuation in jute. Besides, it improved the nutritional status of tribal farmers.

10.1.2 Improved microbial retting of jute with 'CRIJAF SONA'

In order to improve the fibre quality, retting of jute using talc based microbial formulation 'CRIJAF SONA' was introduced. The retting technology using this formulation was demonstrated to tribal farmers and 400 kg talc-based retting formulation was distributed among them. All the tribal farmers of the villages used 'CRIJAF SONA' for jute retting purpose which could improve the quality and enhanced the price of the fibres.

Fig. 10.2. Demonstration on improved microbial retting of jute

10.1.3 Introduction of vegetable cultivation in jute fabric based soil columns

The technology was demonstrated in an area of 0.2 ha which enhanced the cropping intensity, net income per unit area in waterlogged paddy field and increased the remuneration through assured crop production. This is a very low cost technology which needs minimum resources. The crops grown in columns yielded more than the normal cultivation.

Fig. 10.3. Jute fabric based columns and vegetables in columns just after harvest of paddy

10.1.4 Improved fish, poultry and duck rearing

Fish fingerlings of suitable breeds were distributed to the farmers of Makaltala and Farmania villages. Awareness camps were organised and trainings were imarted to the tribal farmers on fish farming practices. Tribal Women Self

Fig. 10.4. Vaccination of poultry birds in a camp and a tribal woman showing the grown up fish

Help Groups were trained on poultry and duckery management practices. Eleven Self Help Groups (comprising 110 farm women) were provided with Vanaraja poultry birds and ducklings of Khaki Campbell breeds.

10.1.5 Entrepreneurship development through diversified use of jute fibre and fabrics

In addition to the agricultural and allied activities, the tribal women were also imparted two skill based trainings for preparation of jute fancy bags for 25 tribal women. One of the SHGs has made a profit of ₹ 16,800/- by selling jute bags/folders in this year itself. *(Source: TSP, Contributors: Shamna, A and S.K. Jha).*

Fig. 10.5. Training on jute bag preparation

10.2 Enhancement of Livelihood Security of Tribal Farm Families of Dakshin Dinajpur

Dakshin Dinajpur is one of the tribal populated (16.12%) districts of West Bengal. The TSP activities were conducted in Tapan block of Dakshin Dinajpur. In total 70 tribal families (farmers and farm women) were benefitted through improved production technologies of jute and other crops, scientific method of animal husbandry, poultry bird and duck rearing.

10.2.1 Dissemination of improved production technology of jute

Improved jute production technology including *tossa* jute variety (cv. JRO 204), line sowing by jute seed drill, weed management by nail weeder, balanced fertilizer use and split application of N fertilizer and improved microbial retting by deploying 'CRIJAF SONA' were incorporated in the technology dissemination programme. Implementation of these integrated production technology enhanced the productivity by 29-33%.

Fig. 10.6. Demonstration on seed drill and line-sown crop

10.2.2 Improved microbial retting of jute by CRIJAF SONA

For effective jute retting in stagnant water, improved microbial jute retting technology using 'CRIJAF Sona' was introduced among the tribal farmers. The jute farmers were trained and provided with formulation resulting good quality jute fibre within 9-11 days of retting which increased the jute quality by 1-2 grades with a reduction of 6-9 days retting duration.

10.2.3 Dissemination of improved production technology of mustard

Mustard is a preferred crop after jute-paddy in the rotation by the tribal farmers of the Dakshin Dinajpur district. Improved mustard production technology including quality seed, balanced use of fertilizer, need based irrigation and integrated pest management measures resulted in higher mustard productivity.

Fig. 10.7. Training on improved microbial retting and field demonstration of mustard production technology

10.2.4 Improved rearing of cattle and goat

Considering the poor health and low productivity of farm animals, scientific method of cattle and goat rearing was introduced in the adopted villages for increasing the economic output from the animals. Mineral mixtures developed by ICAR-ERS, NDRI, Kalyani were made

Fig. 10.8. Interface meeting on animal health camp and growth of khaki campbell ducklings

available to the cattle owned tribal families for restoration of health of their cattle. '*Interface meeting cum animal health camp*' and '*Awareness cum vaccination camp*' were conducted in the adopted village to raise disease-free farm animals by the tribal farmers.

10.2.5 Improved rural poultry bird and duck rearing

General poultry breed improvement was taken up by popularising Rhode Island Red chicks and Khaki Campbell ducklings. Ten families each were considered for Rural Poultry Bird and Khaki Campbell duck rearing programmes. Improved poultry feeds for birds of different

stages and the ducks were made available to the farmers for better nourishment and productivity. Farmers were trained and units were established for production of azolla as feed for poultry birds *(Source: TSP, Contributors: S. Sarkar, B. Majumdar and C. Jana).*

10.3 TSP on Sisal

Expansion of sisal area through new plantation were taken up in Sadhopada village of Sambalpur and Jammal village of Jharsuguda districts of Odisha and 2.0 ha area in Sursu village of Jharkhand. Improved production technology of sisal such as double row planting system, use of fertilizers, intercropping with annual legumes were demonstrated in 20 ha tribal farmers field in Sambalpur and Jharsuguda districts of Odisha. Sisal Research Station, Bamra organised

Fig. 10.9. Sisal plantation by tribal farmers at Sursu village in Ranchi, Jharkhand

training programmes for tribal farmers on quality planting materials and improved production technology of sisal and other field crops. Improved production technology of toria and quality seeds for 10 ha area were made available to the tribal farmers of Odisha *(Source: TSP. Contributor: A.K. Jha).*

10.4 TSP on Ramie

New plantation of 5 ha ramie was initiated in Uttar Burikhamar village of Chirang district of Assam. These farmers were linked with the KVK, Chirang and State

Fig. 10.10. Ramie plantation in tribal areas of Assam

Department of Agriculture. The local tribal farmers of Barpeta district were given technical know-how about improved management practices for successful ramie plantation. Ramie propagating material were generated, processed, and distributed among the tribal farmers for area expansion of the crop in the NE States *(Source: TSP, Contributors: A.K. Sharma and S.P. Gawande).*

10.5 TSP on Soil Test Crop Response (STCR)

Targeted yield equations of jute (cv. JRO 204), rice (cv. Khitish) and lentil (cv. B 256) developed by STCR of CRIJAF were verified in different villages of Nadia district for jute (3.2 ha), paddy (1.36 ha) and lentil (6.9. ha) through front line demonstrations (FLDs) under TSP. *(Source: TSP, Contributor: A.R. Saha).*

Fig. 10.11. Training on use of Soil Testing Kits and its distribution to trainees by the Director, CRIJAF

10.6 TSP under AINP on JAF

The Tribal Sub Plan programme had been conducted in 6 villages of West Bengal, Odisha and Assam covering 86 ha area and 338 tribal farmers participated in the programme. The improved production technologies of both fibre and seed crop of jute as well as the improved microbial

Fig. 10.12. Improved retting demonstration in Naogaon under TSP

retting technology developed by ICAR-CRIJAF had been demonstrated to the farmers. In Coochbehar and Alipurduar districts, the farmers had been demonstrated the improved production technologies of both fibre and seed jute crop. Line sowing in jute with CRIJAF Multi Row Seed Drill recorded 12% increase in fibre yield over broadcasting (22.86 q/ha) at Srikrishnapur and Matiagacha villages in North 24 Paraganas district of West Bengal and the farmers of these villages had got more price of jute fibre (₹ 500/q) using 'CRIJAF Sona' and the retting duration was also

reduced by 6-7 days. In Keonjhar district of Odisha, the fibre yield and net return of jute in demonstration fields on improved production and crop protection technologies, on an average, was higher by 8-11% and by ₹ 17,000-18,000/ha, respectively, over farmers' practice. At Nagaon and Morigaon districts of Assam, the fibre yield of jute variety Tarun under improved package of practice recorded 20-25% higher fibre yield over farmers' practice. Use of 'CRIJAF SONA' reduced retting duration by 6-7 days, recorded improvement in fibre strength by 1.6-3.5 g/tex and also fetched higher price (₹ 375-500/q) over farmers' practice in Assam *(Source: TSP, Contributors: S. Mitra and S.K. Pandey).*

10.7. HRD Programmes under TSP

Human Resource Development (HRD) programmes were structured and organized under the TSP primarily intended to impart the understanding of improved technologies to the tribal farmers to accelerate the technology adoption process. The training programmes conducted during the year are depicted in tabulated form (Table 10.1) *(Source: TSP, Contributor: S. Sarkar).*

Table 10.1. HRD for tribal farmers conducted under TSP

Event	Place and Date	No. of trainees	Remark
Training on "Improved production technology of jute"	Tapan, Dakshin Dinajpur 8-9 Apr., 2014	50	TSP-Institute
Training and demonstration on "Jute seed drill for line sowing of jute in farmers' fields"	Tapan, Dakshin Dinajpur 9 Apr., 2014	50	TSP-Institute
Demonstration of "Nail weeder's field operation"	Makaltala, North-24 Pgs, 15 Apr., 2014	100	TSP-Institute
Training and demonstration on "Improved microbial retting of jute"	Tapan, Dakshin Dinajpur, 25 Jul., 2014	40	TSP-Institute
Training and demonstration on "Improved microbial retting of jute"	Makaltala, North 24 Pgs, 31 Jul., 2014	75	TSP-Institute
Training and demonstration on "Improved microbial jute retting technology"	KVK, Dakshin Dinajpur, 12 Aug., 2014	35	TSP-Institute
Demonstration on "Improved microbial jute retting technology"	Pashim Simla, North-24 Pgs, 12 Aug., 2014	75	TSP-Institute
Field training programmes on "Use of CRIJAF microbial consortium for improved retting"	Nagaon, Assam, 13,16,19,25 Aug., 2014	100	TSP-AINPJAF
Training programme on"Jute cultivation and seed production"	Coochbehar, West Bengal, 9 Sept., 2014	156	TSP-AINPJAF
Training on "Integrated pest and disease management in jute"	Kendrapara, Odisha, 22 Sept., 2014	50	TSP-AINPJAF
Training programme on "Improved production technologies of jute"	Kendrapara, Odisha, 24 Sept., 2014	50	TSP-AINPJAF
Training on "Rearing of Vanaraja birds and Khaki Campbell ducks"	Makaltala, Farmania, North-24 Pgs, 24-25 Sept., 2014	75	TSP-Institute
Training on "Soil Test and Targeted Yield based system of jute fibre production"	Haringhata, Nadia 25 Sept., 2014	46	TSP-STCR
Training on "Improved production technology of sisal"	Bamra, Odisha 24-26 Sept., 2014	30	TSP-Institute
Training programme on"Improved method of retting using CRIJAF microbial formulation"	Kendrapara, Odisha, 26 Sept., 2014	50	TSP-AINPJAF
Interaction meet on "Farmers' feedback towards improved production technology of jute"	Makaltala, North-24 Pgs, 27 Sept., 2014	45	TSP-Institute
Training on "Improved mustard production technology for North-Bengal"	KVK, Dakshin Dinajpur, 17 Nov., 2014	48	TSP-Institute
Training on " Fertilizer recommendation based on soil test and target yield approach for improved crop productivity"	Karakanali, Bankura 9 Dec., 2014	50	TSP-STCR
Training on "Improved goat rearing by the tribal farm women"	KVK, Dakshin Dinajpur, 22 Dec., 2014	40	TSP-Institute

Event	Place and Date	No. of trainees	Remark
Training on “Poultry bird rearing and duck farming”	KVK, Dakshin Dinajpur, 23 Dec., 2014	40	TSP-Institute
Training on “STCR and demonstration of Soil Testing Kit to the tribal farmers”	KVK, Dakshin Dinajpur, 23 Dec., 2014	50	TSP-STCR
Farmers’ awareness camp on fishery	Makaltala, North-24 Pgs, 22 Jan., 2015	45	TSP-Institute
Training on “Making of jute bag by the tribal women”	CRIJAF, North-24 Pgs, 23-27 Jan., 2015	40	TSP-Institute
Farmers’ Exposure visit	Panagarh, Burdwan 1-3 Feb., 2015	40	TSP-KVK
Seed Day cum training on “Quality seed production”	Bamra, Odisha 3 Feb., 2015	135	TSP-NSP
Awareness-cum training on “Animal health”	KVK, Dakshin Dinajpur 16 Feb., 2015	40	TSP-Institute
Training on “Animal disease and vaccination”	KVK, Dakshin Dinajpur 17 Feb., 2015	40	TSP-Institute
Training on ‘Soil test and target yield based fertilizer application for maximization of crop productivity”	CRIJAF, Barrackpore 9-11 Mar., 2015	50	TSP-STCR
Farmers’ training programme on “Improved production technology of sisal”	Bamra, Odisha 18-20 Mar., 2015	30	TSP-Institute
Training on “Entrepreneurship development by using jute fabric for the tribal women”	Makaltala, North-24 Pgs 19-24 Mar., 2015	30	TSP-Institute
Training programme on “Improved rearing method of Khaki Campbell ducks and rural poultry birds”	Paschim Simla, North-24 Pgs, 20-21 Mar., 2015	30	TSP-Institute
Training on “Improved production technologies of jute and mesta”	CRIJAF, Barrackpore 24-26 Mar., 2015	50	TSP-AINPJAF
Training on “Improved jute seed production technology”	CRIJAF, Barrackpore, 26-28 Mar., 2015	50	TSP-NSP

11. AINP on Jute and Allied Fibres (AINPJAF)

AINPJAF functions through 9 SAUs and 4 ICAR institute-based centres with its headquarter at ICAR-CRIJAF, Barrackpore. During the year 2014-15, total 52 projects comprising of 209 trials were conducted on jute (*Corchorus capsularis* and *C. olitorius*), mesta (*Hibiscus cannabinus* and *H. sabdariffa*), sunnhemp (*Crotalaria juncea*), flax (*Linum usitatissimum*), ramie (*Boehmeria nivea*) and sisal (*Agave* sp.) under crop improvement, crop production and crop protection programmes.

11.1 Crop Improvement

Under crop improvement programme 26 projects comprising of 118 trials on JAF crops were conducted which includes germplasm evaluation, national hybridization programme and multi-location yield evaluation trials (IET, AVT-I and AVT-II).

11.1.1 Varieties identified for release

In the front of varietal development, 3 varieties i.e., JROG 1 of *tossa* jute, JRJ 610 of sunnhemp and JRF 2 of flax have been released. JRF 2 is the first released variety of fibre flax. Besides, two varieties of kenaf i.e., JMBG 4 and Central Kenaf JBMP-2, four varieties of roselle i.e., Central Roselle JBRP-1, Central Roselle AMV-9, CRIJAF R-2 and CRIJAF R-8 were identified for release.

11.1.2 Germplasm evaluation

Seventy five germplasm each in *tossa* jute, white jute, kenaf and 158 accessions of roselle were evaluated with their 2 respective check varieties at different locations during 2014-15.

White jute (*C. capsularis*): An overall mean of 9.8±1.6 g/ plant was recorded for fibre yield over the five locations with a range of 7.0 g/plant (CEX-15) to 12.4 g/plant (CIN-364). Three genotypes, CIN- 364, CIN-367 and CIN 138 outperformed JRC 517.

***Tossa* jute (*C. olitorius*):** Average fibre yield over six locations was recorded to be 10.0±0.9 g/plant with a range of 8.5 to 12.4 g/plant. Twelve genotypes outperformed check variety JRO 204 for fibre yield.

Roselle (*H. sabdariffa*): Based on evaluation over two locations for fibre yield and component traits, 7 accessions exhibited higher fibre yield than the check variety AMV 5.

Kenaf (*H. cannabinus*): Evaluation was done at Aduthurai centre where only one accession *i.e.*, KIJ-164 outperformed check variety AMC 108 for fibre yield.

11.1.3 National hybridization programme

***C. capsularis*:** F_4 progenies of white jute were evaluated in five centres. Progenies of the cross combination CIN-149 × JRC 321 recorded highest fibre yield at Kalyani and progenies of CIJ-100 × JRC 212 surpassed check JRC 698 for green biomass and fibre yield.

***C. olitorius*:** Thirty-six F_3 progenies at five locations exhibited a mean fibre yield of 9.2±0.9 g/plant. Progenies from OIJ-015 X OIN-028 exhibited highest fibre yield.

H. sabdariffa: A total of 150 F_4 progenies of roselle were evaluated at Amadalavalasa centre. Selection of 194 progeny plants have been carried out for advancement in next generation.

11.1.4 Yield evaluation trials

Tossa jute (*C. olitorius*)

IET: Check variety JRO 524 recorded 36.15 q/ha of fibre yield whereas, NJ-7050 stood second (34.01 q/ha) and closely followed by another check variety JRO 8432 (33.74 q/ha).

AVT I: Five test entries with two checks namely, JRO 524 and JRO 8432 were tested for fibre yield at seven locations. Check variety JRO 8432 turned out to be the best performer and recorded 31.36 q/ha fibre yield followed by NJ-7005 (28.87 q/ha).

AVT II: Pooled analysis of average yield over locations and years (grand) revealed that KRO-4 recorded the highest fibre yield (27.73 q/ ha) followed by check variety JRO 8432 with fibre yield of 27.09 q/ha.

White jute (*C. capsularis*)

IET: Trial was constituted with 8 test entries including two checks namely, JRC 517 and JRC 698 and conducted over seven locations. Test entry BCCC-4 turned out to be the best performer with fibre yield of 32.76 q/ha.

AVT I: The trial was comprised of four test entries and two check varieties JRC 698 and JRC 517 and was conducted over seven locations. BCCC-3 (25.35 q/ha) recorded highest fibre yield followed by NCJ-28-1-1 (25.23 q/ha).

AVT II: Based on pooled analysis, test entry BCCC-2 (25.57 q/ha) was the best among all test entries followed by NCJ-28-14 (25.15 q/ha) and JRCJ-3 (24.79 q/ha).

Roselle (*H. sabdariffa*)

IET: Six test entries and two check varieties were evaluated in seven locations. Test entries JRHS-2 (27.79 q/ha) and JRHS-1 (27.29 q/ha) turned out to be significantly superior over the best check AMV 5 (25.79 q/ha).

AVT I: Four test entries with two checks were tested for fibre yield in seven locations. Test entry AHS-49 was found to be the best performer with 24.77 q/ha fibre yield. This

was followed by JRR-2012-1 which recorded 23.46 q/ha fibre yield.

AVT II: Considering mean performance over locations and year (grand) test entry AHS-230 recorded the highest fibre yield (27.87 q/ha) followed by AHS-233 (25.94 q/ha).

Kenaf (*H. cannabinus*)

IET: The trial was conducted with four test entries and two checks namely, HC 583 and AMC 108 over seven locations. Check variety AMC 108 (33.98 q/ha) was found to be the best performer which was very close to the test entry JRK-2013-1 (33.90 q/ha).

AVT I: The trial was conducted with four test entries along with two checks namely, HC 583 and AMC 108 at seven locations. Test entry JRK-2011-2 (26.43 q/ha) outperformed the best check variety AMC 108 (25.83 q/ha) followed by JRK-2011-1 (25.80 q/ha) and JRK-2011-4 (24.15 q/ ha).

Sunnhemp (*C. juncea*)

IET: The trial was conducted with six test entries along with two checks over five locations. Entries Sanai-11 (11.87 q/ha), Sanai-12 (11.47 q/ha) and JRS-2013-1 (11.43 q/ha) were better performing entries over both the checks.

AVT I: The trial was conducted with four promising entries and two checks over five locations. None of the test entries performed better than the best check SH 4 (10.17 q/ha).

AVT II: Pooled analysis of data showed that test entry SUIN-5 (9.30 q/ha), SUIN-3 (9.09 q/ha), SUIN-4 (8.75 q/ ha) and SUIN-1 (8.69 q/ha) performed better than the best check SH 4 (8.42 q/ha).

Ramie (*B. nivea*)

AVT I: Test entry R-1415 produced maximum fibre yield (15.59 q/ha/yr) at Sorbhog whereas maximum green weight (634 q/ha/yr) was obtained in the entry R-1518 with less dry fibre recovery (1.9 %).

Flax (*L. usitatissimum*)

IET: Out of 6 entries, JRF-13 (17.9 q/ha) and JRF-10 (17.1 q/ha) performed better than check variety JRF 2 (15.7 q/ha) at Pratapgarh.

AVT I: Test entry JRF-9 (97.76 cm) attained maximum plant height followed by JRF-8 (94.33 cm) and JRF-6 (92.19 cm).

11.2 Crop Production

In crop production programme, 15 research projects comprising of 53 trials were conducted on jute and allied fibre crops at different AINP centres. The new *C. capsularis* genotype under adaptive trial, NDJC-2011, recorded significantly higher fibre yield over check varieties at Bahraich, Uttar Pradesh only. The kenaf entry JBMP-2 recorded significantly higher plant height and fibre yield (9.31 q/ha) over the check variety HC 583 at Amadalavalasa. Soil test and targeted yield (ST-TY) based fertilizer application recorded higher fibre yield of jute over recommended doses of fertilizer (RDF) at Bahraich and Katihar. Similarly, ST-TY based fertilizer application recorded higher fibre yield of mesta over RDF at Aduthurai. In acid soil of Nagaon, targeted yield of jute (3.5t/ha) was achieved with application of inorganic fertilizer (150% NPK on ST-TY) along with FYM and lime.

Application of pre-emergence herbicide pretilachlor @ 900 ml/ha along with one hand weeding or use of nail weeder twice (5 and 10 DAE) followed by one hand weeding (for intra row weeding) reduced weed biomass and increased fibre yield of jute and is recommended for weed management in jute for Nagaon region. Similarly, application of butachlor 5G or 50% EC @ 1.5 kg a.i./ha along with one hand weeding or use of nail weeder twice (5 and 10 DAE) is recommended for weed control in jute for Bahraich region. At Coochbehar, highest fibre yield (27.17 q/ha) of jute was recorded with two hand weeding closely followed by application of pretilachlor @ 900 ml/ ha + one hand weeding at 15 DAE. Use of Nail weeder alone or in combination with scrapper followed by one hand weeding is recommended for weed control in *olitorius* jute at Kalyani, West Bengal. Application of quizalofop ethyl @ 60 g/ha at 15 DAE followed by one hand weeding at 15-20 days after herbicide application recorded highest fibre yield of jute with significant reduction in weed biomass and is recommended for weed control in jute in Kendrapara, Odisha and Katihar, Bihar. Application of quizalofop ethyl @ 60 g/ha at 15 DAE along with one hand weeding at 15-20 days after herbicide application at Aduthurai, Tamil Nadu performed best in management of weed. Application of pretilachlor 50% EC @ 900 ml/ha at 45-58 hours of irrigation followed by one hand weeding at 15 DAE is recommended for weed control in mesta at Amadalavalasa, Andhra Pradesh. Use of nail weeder twice at 5-6 DAE and 10 DAE or a combination of nail weeder once at 5-6 DAE, scrapper once at 15 DAE and one hand weeding at 15 DAE is recommended for weed control in sunnhemp at Pratapgarh, Uttar Pradesh.

Use of ICAR-CRIJAF microbial consortium (CRIJAF Sona) has effectively reduced retting duration by 6 to 7 days, increased fibre strength by 3 to 4 g/tex and improved colour and lusture of the fibre at Bahraich, Kalyani and Amadalavalasa centers while at Nagaon, Kendrapara and Katihar centres, the retting duration in jute was reduced by 9-10, 6 and 6 to 8 days, respectively. Similarly, in mesta, the reduction in retting duration by 6 to 8 days using CRIJAF Sona was observed at Aduthurai, Tamil Nadu. CRIJAF Sona was tested in farmers' fields in North 24 Parganas district of West Bengal, Nagaon district of Assam and Kendrapara district of Odisha under the Tribal Sub Plan programme of AINP and similar reduction in retting duration and improvement in fibre quality in jute was observed in farmers' field condition also.

Maximum green biomass of mesta was recorded at 160 kg N/ha level with kenaf varieties MT 150 at Bamra, Odisha (481.5 q/ha) and with JBM 2004 D at 160 kg N/ha level at Aduthurai, Tamil Nadu (729.3 q/ha).

Sowing of mesta on mid-May with 60 cm x 10 cm spacing and topping at 45 DAS recorded significantly higher seed yield (7.66 – 9.44 q/ha) of the crop at Aduthurai, Tamil Nadu and is recommended for the region.

Maximum fibre yield of flax was recorded with 30th October sowing (19.46 q/ha) and 15 cm row spacing (15.23 q/ha) at Pratapgarh, Uttar Pradesh while maximum biomass of the crop was recorded with 5th January sowing and 15 cm row spacing at Wellington, Tamil Nadu.

11.3 Crop Protection

During 2014-15, eleven projects comprising of 38 trials were conducted in jute and allied fibre crops at different AINP centers under crop protection programme.

Survey and surveillance of insect pests and diseases of jute were carried out in different AINP centres. The yellow mite infestation was more consistent across the centres with maximum infestation of 8.62, 10.38, 25.62, 64.45, 89.33 and 129.39 mite population/cm^2 leaf area on 2nd unfolded leaf at Nagaon, Kendrapara, Coochbehar, Bahraich, Katihar and Barrackpore, respectively coinciding at 45 DAS to 75 DAS during last week of May to mid-June. Maximum infestation of Bihar hairy caterpillar was noticed at Barrackpore (80.66%) followed by Katihar (12.67%) occurred at 75 and 85 DAS, respectively during June-July. Jute semilooper infestation was observed at Katihar, Coochbehar, Nagaon, Kendrapara and Barrackpore. The period of semilooper infestation was from second fortnight of May to last week of August with maximum of 100.00, 16.36, 13.26, 41.00 and 20.68% plant damage, respectively from 65 DAS to 120 DAS. Stem weevil infestation was noticed in all the centres except Coochbehar and Bahraich. At Nagaon, Kendrapara, Katihar and Barrackpore maximum stem weevil infestation was found from second fortnight of May to mid-July with 4.61%, 10.66%, 14.3% and 53.33% plant damage at 45 DAS to 85 DAS. Maximum incidence of anthracnose disease was observed after 95 DAS in August to the extent of 3.34% and 22.68% at Katihar and Nagaon, respectively. The maximum incidence of stem rot was observed during July to August with 1.00%, 6.18%, 7.60%, 7.96%, 9.65% and 9.82% at Nagaon, Coochbehar, Bahraich, Barrackpore, Kendrapara and Katihar, respectively. The severity of root rot was maximum at Nagaon, Kendrapara, Katihar, Bahraich, Coochbehar and Barrackpore with incidence of 18.86%, 10.41%, 8.42%, 4.35%, 2.69% and 2.46%, respectively.

Among the *tossa* jute (*C. olitorius*) germplasms, the accessions, OIN-01, OIN-52, OIN-72, OIN-111, OIN-77 and OIN-32 were least susceptible (<5.00 mites/cm^2 leaf) to yellow mite at Kendrapara and Coochbehar while two lines namely, OIN-112 and OIN-17 were less susceptible (< 2.00%) to stem weevil infestation. In Nagaon the white jute germplasm, CIN-99 was immune to stem weevil. The white jute accessions, CIN-06, CIN-15, CIN-11, and CIN-59 were less susceptible to stem rot while CIN-15 and CIN-65 were least susceptible to root rot at Bahraich.

On the basis of disease incidence in the elite germplasms, OIN-853 line was found to be least susceptible to stem rot at Coochbehar and Barrackpore.

The effect of sowing time and insecticides on insect pests of jute indicated that at Barrackpore the late crop sown on 15th April harboured significantly more mite than the early (15th March) sown crop. Similar trend was observed in Coochbehar, Katihar, Kendrapara and Nagaon. At Barrackpore, the fibre yield of earlier sown (15th March) crop with foliar spray of fenazaquin 10 EC @ 0.015% at 45 and 60 DAS resulted in significantly higher fibre yield (30.34 q/ha). The foliar spray of lamdacyahalothrin 5EC @ 0.0030% at 70 and 80 DAS was most effective on semilooper and Bihar hairy caterpillar with significantly less plant damage. At Coochbehar significantly less mite infestation and more fibre yield of jute was recorded in fenazaquin 10 EC (0.015%) treatment. At Kendrapara also the crop protected with fenazaquin and profenophos reduced mite and semilooper infestation significantly with maximum yield (26.81 q/ ha). At Katihar the best treatment against sucking and lepidopteran pests was found with abamectin 1.8 EC (0.015%) followed by lamdacyhalothrin 5 EC (0.003%).

For management of stem rot under integrated crop management system, the incidence of stem rot was higher (331.99 codex) in 15th March sown crop, which was lower (206.06) in 30th March sown crop at Kendrapara. Seed treatment with *T. viride* @ 10 g/kg + butachlor @ 2 kg a.i. / ha as pre-emergence application + spraying of carbendazim 50 WP @ 0.1% + spraying of profenophos @ 0.10% at 15 days interval significantly reduced insect pests and root rot incidence at Kendrapara with maximum fibre yield (29.45 q/ha).

In ecofriendly management of insect pests and diseases of jute, the integrated organic module consisting of FYM @ 5 t/ha + seed treatment with Azotobactor 5 g/kg + PSB 5 g/kg seed + *T. viride* 5 g/kg seed+ soil application 2 kg/ ha at 21 DAS + *P. fluorescens* spray @ 0.2% at 45 DAS + neem oil @ 0.03% was most effective against jute stem rot at Coochbehar and Nagaon.

At Amadalavalasa, seed treatment with cymoxanil 8% WP @ 3 g/kg and 0.3% foliar spray at 120 DAS was found most effective against foot rot of mesta being at par with metalaxyl MZ 8% WP (seed treatment @ 2 g/kg and 0.2% foliar spray) while, maximum fibre yield (34.36 q/ ha) was recorded in the later.

Foliar application of spiromesifen 240 SC @ 0.7 ml/lit at 35 DAS and 50 DAS was most effective for management of yellow mite in jute with maximum fibre yield at Barrackpore, Coochbehar, Katihar, Nagaon and Kendrapara centres.

Seed treatment with azoxystrobin + difenoconazole @ 1.0 ml/kg seed + spraying of azoxystrobin + difenoconazole @ 0.075% at 45 DAS at Kendrapara, Barrackpore, Coochbehar, Nagaon and Katihar was most effective for stem rot management in jute.

Dr. Subrat Gupta IAS, Jute Commissioner, Govt. of India, addressing the scientists in 28th Annual Workshop of AINPJAF at ICAR-CRIJAF, Barrackpore

Director, ICAR-CRIJAF, Dr P. G. Karmakar addressing the delegates in 28th Annual Workshop of AINPJAF at ICAR-CRIJAF, Barrackpore

Inaugural address by Hon'ble ADG (CC), ICAR, Dr. N. Gopalakrishnan in 28th Annual Workshop of AINPJAF at ICAR-CRIJAF, Barrackpore

Dr. S. Mitra, Network Coordinator, AINPJAF presenting the annual report of AINPJAF in 28th Annual Workshop of AINPJAF at ICAR-CRIJAF, Barrackpore

12. Krishi Vigyan Kendra

During 2014-15, Krishi Vigyan Kendra, Burdwan planned and implemented the On Farm Testing/Trials (OFT) for evaluation of various technologies, Front Line Demonstrations (FLD) of established technologies, trainings for farmers, farm women, rural youths and extension workers etc. besides conducting other extension activities like exposure visits, field day, method demonstration, technology week and similar other activities.

12.1 On Farm Trials

Ten OFTs were conducted by the KVK for evaluation and popularization of different recommended technologies among the farmers and by the farmers in different villages of Burdwan. The salient findings of these OFTs are depicted below.

- Evaluation of performance of improved *Olitorius* jute varieties namely JRO 2407, CO 58 and JRO 128 under rainfed and medium upland situation of Burdwan District indicated that all the improved cultivars produced significantly more fibre compared to local check (JRO 524).
- In comparison to application of nitrogen in 2 splits and potassium in single split in SRI (*kharif*) method of cultivation under medium upland situation of Burdwan, nitrogen application in 3 and 4 splits and potassium in 2 splits resulted in significantly higher production of paddy.
- The early cauliflower varieties, Trisha and Dawn 175 were when evaluated in comparison to local one indicated that Trisha as well as Dawn 175 were superior in terms of early curd initiation while the former was best in curd compactness and yield.
- Seed tuber treatment with mancozeb in addition of *Trichoderma* and foliar spray of fungicide (Metalaxyl + Mancozeb) was most effective in management of late blight incident in potato.
- Fish production by application of lime in split doses (4 split doses at one month interval) supported maximum IMC fish production (12.75 q/ha) compared to farmers' practice and pH based single dose lime application.
- Effect of regular application of organic fertilizer in split doses along with application of lime and feeding the fish with supplementary fish feed showed that maximum production could be obtained in case of commercial fish feeding (22.75 q/ha) followed by conventionally prepared fish feed (18.3 q/ha) and farmers practice (10.2 q/ha).
- The organic source of Se (0.5 ppm) and Vit E (50 µg/duck/day) improved egg production in deshi duck under backyard management practices compared to inorganic source of Se and Vit E. Hatchability of duck eggs under incubator was increased in organic sources supplemented groups (70%).
- The growth performance of broiler in probiotics (non-antibiotic growth promoters) supplemented group was significantly higher (1.95 kg at 38 day) than other technology option groups (1.82 kg at 38 days).
- SHG had positive impact on livelihood security of its member. The livelihood vulnerability of both types of SHG members (male and female) decreased due to significant reduction in human health shocks, crop-livestock shocks, economic shocks, market shocks and natural disaster shocks. However there was high reduction in vulnerability of women than men SHG members. Formation of SHG also led to improvement in human capital. Financial capital increased more in female SHG. Livelihood sources also increased due to formation of SHG.
- Locally prepared weaning food for infants had significant weight gain in all the cases as compared to conventional diet of rural infants (khichdi, smashed potato etc.). 'Assam Mix' (composed of rice, moong, groundnut and sesame) when fed as weaning food performed better.

12.2 Front Line Demonstrations (FLDs)

A total of 245 FLDs were conducted on jute, mustard, lentil, tomato, banana, maize, vegetables and fodder (rice bean, oat, berseem). In animal sciences, FLDs were conducted on cattle, poultry and piggery. The salient findings of the FLDs are given below in Table 12.1.

Table 12.1. Details of FLDs conducted at KVK, Burdwan

Number of demonstration	Technology demonstrated	Remarks
Jute (54)	Improved cultivar (cv. JRO 204, CO 58)	JRO 204 (29.6 q/ha) and CO 58 (30.4 q/ha) recorded yield increase of 8% and 11%, respectively, over local check JRO 524 (27.4 q/ha)
Jute (62)	Improved retting with 'CRIJAF SONA'	Retting consortium aided retting reduced the duration by 3-8 days and enhanced the return by Rs. 125-450/q
Mustard (15)	Sulfur and boron nutrition	There was 8.9 % increase in yield through sulfur and boron nutrition in mustard
Lentil (15)	Improved cultivar (cv. WBL 81)	Yield of lentil increased from 9.7 q/ha to 11.2 q/ha.
Tomato (15)	Improved cultivar (cv. Abhilash)	Adoption of cv. Abhilash can improve the tomato yield by 20% over the local variety

Brinjal (5)	Improved variety (cv. Bhangar)	The yield increased by 16.3 % by using Bhangar (250 q/ha) over local variety (215 q/ha)
Rice bean (fodder) (5)	Improved variety (cv. Bidhan-2) and fertilizer application	37.74% increase in yield was obtained in improved practice (281 q/ha) over local check (204 q/ha)
Oat as fodder (10)	Improved variety (cv. Kent) and method of sowing	15.33% increase in yield was obtained in improved practice (456 q/ha) over local check (396 q/ha)
Berseem as fodder (5)	Package demonstration (cv. Wardan)	12.38 % increase in yield was obtained in improved practice (708 q/ha) over local check (630 q/ha)
Diversified vegetables (7)	Growing of solanaceous vegetables and okra with cucurbits	Yield increased to 116.7 q/ ha in diversified vegetables with FYM compared to 96.7q/ha only cucurbits.
Cross-bred cow (10)	Region specific mineral supplementation to cross-bred cow	39.36% increase in milk yield was obtained in supplemented group (1045 kg/lactation) over local check (750 kg/lactation)
Rural poultry production (10)	Improved rural poultry breed (RIR) rearing	Egg production increased in demonstration group (99 nos/ hen/ 5 month) over local checked (50 nos/ hen/ 5 month)
Pig production (10)	Prolific breed (Ghungroo) evaluation in low input system	25.7% increase in yield was obtained at slaughter age in improved practice (48.4 kg/ pig) over local check (38.5 kg/pig)
Monosex tilapia culture (8)	Package of practices	41% increase in the yield in case of tilapia over local check
Culture of Bhetki (7)	Package of practices	35% increase in the yield in case of bhetki over local check

12.3 Trainings

Various training programmes on agriculture, horticulture, animal and fishery sciences, plant protection, agricultural extension and home sciences (Table 12.2) were conducted by the KVK for effective dissemination of various improved technologies among stakeholders.

Fig. 12.1. Training on improved production technology of jute

Table 12.2. Details of training programmes conducted by KVK, Burdwan

Target group	No. of Trainings	No. of participants						
		General			SC/ST			Trainee day
		Male	Female	Total	Male	Female	Total	
Farmers & Farm Women	39	1546	529	2075	483	301	784	2075
Rural youth	12 (3 days each)	185	81	266	118	82	200	800
Extension functionaries	3	45	0	45	15	0	15	60
Vocational training	4 (7 days each)	52	35	87	25	35	60	620
Total	58							3555

Fig. 12.2. Training on grafting technique

12.4 Production of seed materials at KVK farm and distribution to the farmers

- Foundation seeds of paddy (MTU 7029) : 240 q
- Seedlings of improved varieties/hybrids of tomato, brinjal and cauliflower: 50,000
- Saplings of guava and lime:100 (nos.) each

12.5 Other Extension Activities

- Field Days for horizontal dissemination of the technologies on jute, paddy, mustard, livestock, rice bean, oat, nutritional garden and other horticultural crops.
- Animal Health Camp for mass vaccination against Peste Des Petits Ruminants (PPR) diseases of livestock
- Farmers' Exposure Visits (3) in different places/ organizations
- Film show exhibition to the farmers
- Self-help group, Farm Science Club and *Mahila Mandal* convener meeting
- Kisan Mela in collaboration with ICAR-IVRI-ERS

- Participation in agricultural fairs organized by Govt. of West Bengal (*Mati Utsav* and *Mati Tirtha Krishi Katha*)

Fig. 12.3. Demonstration on improved retting technology of jute

Fig. 12.4. Field day on improved retting technology of jute

12.6 Technology Week and Krishi Mela

Technology Week (25th Feb – 1st March, 2015) was conducted at KVK in collaboration with Department of Agriculture, Govt of West Bengal and one corporate

Fig. 12.5. Technology week-cum-District Krishi Mela in KVK

partner of Mahindra. Nearly 650 farmers participated from nearby and adopted villages. The technologies demonstrated in the Krishi Mela to the farmers during the Technology week were *Tribal Agriculture, Integrated farming system, Chandra hatchery, Low cost seedling raising techniques for vegetables, Vermicomposting technology, SRI technology, Backyard poultry, Goatary, Women empowerment, Improved technologies on jute and Poly house for nursery vegetables.*

12.7 Kisan mela

Kisan Mela was organized on 11th November, 2014 at KVK in joint collaboration of ICAR-CRIJAF, Barrackpore and ICAR-ERS-IVRI, Kolkata to demonstrate various profitable technologies to practicing farmers, farm women and rural youths of the area. Dr. P. Biswas, VC, WBUAFS inaugurated the fair where officials from various ICAR institutes participated.

Fig. 12.6. Kisan Mela in collaboration with ICAR-IVRI-ERS

12.8 Special programme on Food and Nutrition

The "Nutrition Day" was celebrated on the occasion of National Nutrition Week, 1-7 September, 2014.The awareness programme was held at Kurisa village of Kalna-I block. In the programme Supervisors, Anganwadi workers of ICDS scheme, ASHA (Accredited Social Health Activists) workers, panchayat members, teachers, village women, pregnant and lactating women, adolescent girls and school students participated. Different extension programmes (demonstrations/ video shows) were arranged for making nutritional recepies viz. rice based weaning food preparation by using cheap and locally available resources.

Fig. 12.7. Hands on training on low cost nutritious food production

12.9 Workshop on World Veterinary Day-2014

World Veterinary Day, 2014 was observed by KVK CRIJAF on April 26, 2014 sponsored by NABARD with the theme "ANIMAL WELFARE". Three animal health-cum-awareness camps were organized at Kondaipur, Nurkona and Bud Bud villages of Galsi-I block. In these camps, 97 ducks, 200 chicks and 200 goats were vaccinated against Duck Plague, PPR and Ranikhet disease, respectively.

Fig. 12.8. Vaccination camp for goat and chicks

12.10 Workshop on World Food Day-2014

One workshop on the theme "Family Farming: Feeding the world, caring for the earth" was organized on 16th October, 2014. The pivotal role of family farming in agriculture to eradicate hunger and preservation of natural resources was emphasized in the programme. Around 50 farmers and farm women from various blocks of the district attended the program. Senior officials from state agriculture department participated in the farmers' scientist interaction organized during the occasion. They also deliberated on various options of family farming.

12.11 XI SAC Meeting

The XIth meeting of Scientific Advisory Committee (SAC) of the KVK was held on June 18, 2014 under the Chairmanship of Dr. P.G. Karmarkar, Director, CRIJAF. The Head of Divisions and scientists of CRIJAF, the representative of Zonal Project Directorate, Kolkata and senior officials of state line departments, farmer representatives and media also participated. Meaningful recommendations emanated like promotion of jute technologies, use of biological control measures for disease and pest management, drudgery reduction of farm women, fish fingerling production, introduction of export oriented crops, impact assessment of KVK technology, etc.

Fig. 12.9. XIth Scientific Advisory Committee meeting

12.12 Awareness camps on 'Clean India Campaign'

KVK CRIJAF conducted series of awareness camps on environmental cleanliness in adopted villages, apart from keeping office and farm area of the KVK clean, to realize Mahatma Gandhi's dream of a clean India. Farmers were made aware of different activities, like conversion of agricultural wastes into organic manures, maintaining hygienic cattle and other livestock environment, regular pond management etc.

Fig. 12.10. Animal shed disinfection during Swachh Bharat campaign

12.13 Recognition

Three farmers under the guidance of CRIJAF KVK, Burdwan were conferred as "Innovative Farmers" by ICAR for developing and adopting innovative fish hatchery, integrated farming system and improved pig farming.

12.14 Literatures released/published

The activities of KVK were widely published by the leading newspapers. Besides, technical bulletins (1), research papers (3), and book chapters (1) on important areas were also published by the KVK.

12.11. Shri Purnendu Basu, MIC (Ag.), W.B. visiting KVK pavilion in Mati Utsav

13. Training and Capacity Building

13.1 Trainings Organized by ICAR-CRIJAF

Topic	Venue & Date	No. of participants
Improved Microbial Retting of Jute	Singur, Hooghly 15 July, 2014	65
Improved Quality Seed Production Techniques of Field Crops	CSRSJAF, Bud Bud 27 November, 2014	250
Improved Jute Seed Production Technology	ICAR-CRIJAF Barrackpore 16-18 December, 2014	37
Harvesting and Post-harvest Operations in Sisal for Quality Fibre	SRS, Bamra 26-27 December, 2014	51
Improved Jute Seed Production Technology	ICAR-CRIJAF Barrackpore 29-31 December, 2014	35
Technological Advances in Production of Jute and Allied Fibre Crops	ICAR-CRIJAF, Barrackpore 16-21 March, 2015	32

Director, ICAR-CRIJAF addressing the trainees

Field visit of farmers during training on seed production

Training on sisal nursery raising

Trainees with Director, ICAR-CRIJAF

13.2 Seminar/ Symposium/ Conference/ Workshop attended by the Scientists

Programme	Institute/Venue and Date	Name of the participant/s
International Conference on 'Natural Fibres'	ICAR-NIRJAFT & ICAR-CRIJAF Oberoi Grand, Kolkata, 01-03 August, 2014	All the Scientists of ICAR-CRIJAF
All India Seminar on 'Appropriate Farm Mechanization for Small and Marginal Farmers'	Institution of Engineers, Kolkata 08-09 August, 2014	Dr. B. Majumdar Dr. S. Sarkar Dr. S.K. Jha Er. R. K. Naik
International Conference on 'Bioscience State-of-the Art Advancement'	Lakesong Resort, Kumarakan, Kerala 11-12 September, 2014	Dr. P. Satya
National Symposium on 'Management Options for Enhancing Farm Productivity and Livelihood Security under Changing Climate'	OUAT, Bhubaneswar 29-31 October, 2014	Dr. M.S. Behera
International Conference on 'Emerging Trends in Biotechnology'	JNU, New Delhi 06-09 November, 2014	Dr. D. Saha
7th National Education Congress-2014	ICAR Research Complex NEH Region, Umian 08-11 November, 2014	Dr. S.B. Choudhary
International Conference on 'Technological Intervention in Agricultural Science for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014)'	Nagaland University 11-13 November, 2014	Dr. A.K. Sharma Dr. (Mrs.) Babita Chaudhary Dr. S.P. Gawande
National Symposium on 'Climate Resilient Forage Production and its Utilization'	BCKV, Mohonpur 13-14 November, 2014	Dr. C. Jana
National Seminar on 'Agricultural Diversification for Sustainable Livelihood and Environmental Security'	PAU, Ludhiana 18-20 November, 2014	Dr. Amarpreet Singh
India Biodiversity Meet-2014	ISI, Kolkata 21-23 November, 2014	Dr. A.N. Tripathi
National Seminar on 'Developments in Soil Science-2014'	ANGRAU, Hyderabad 24-27 November, 2014	Dr. D.K. Kundu Dr. A.R. Saha Dr. B. Majumdar Dr. (Mrs.) S.P. Mazumdar
Workshop on 'Open access to Agriculture Knowledge for Inclusive Growth and Development'	ICAR-NAARM, Hyderabad 29-30 October, 2014.	Dr. C.S. Kar Dr. H. Chowdhury
International Conference on 'Bioscience Research for Nutritional Security, Environmental Conservation & Human Health, 2014 (ICBNEH, 2014)'	ICAR-IINRG, Ranchi 22-24 December, 2014	Dr. Shailesh Kumar
National Conference on 'Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management-2014'	ICAR-DRR, Hyderabad 13-14 December, 2014	Dr. S.K. Pandey Dr. (Mrs.) Babita Choudhary
Second International Conference on 'Bio-resource and Stress Management'	ANGRAU, Hyderabad 07-10 January, 2015	Dr. M.S. Behera Dr. Amarpreet Singh Mr. M. Ramesh Naik
Conference on 'Indigenous Innovation and Foreign Technology Transfer in Fertilizer Industry: Needs, Constraints and Desired Simplification'	ICAR-CRIJAF, Barrackpore 17 January, 2015	All the Scientists of ICAR-CRIJAF
National Seminar on 'Soil Resilience- 2015'	TNAU, Coimbatore 21-22 January, 2015	Dr. (Mrs.) S.P. Mazumdar
Workshop on 'Making Engineering Scientists Contribution more Meaningful to Stakeholders and the Nation'	NASC, New Delhi 16-17 February, 2015	Er. R.K. Naik
Agri-Biotechnology Summit-2015	HITEC City, Madhapur, Hyderabad, 16-18 February, 2015	Mr. L.L. Kharbikar
XII Agricultural Science Congress-2015: on 'Suitable Livelihood Security for Smallholder Farmers'	ICAR-NDRI, Karnal 03-06 February, 2015	Dr. A.N. Tripathi
International Conference on 'Natural Resources Management for Food Security and Rural Livelihood'	NASC, New Delhi 13-15 February, 2015	Dr. Ritesh Saha

13.3 Training undergone by the Scientists and Staff Members

Training Programme	Place & Date	Name of Participant
Scientists		
Refresher Course on 'Agricultural Research Management'	ICAR-NAARM, Hyderabad 14-26 July, 2014.	Dr. M.S. Behera
Management Development Programme on 'Leadership Development (Pre-RMP)'	ICAR-NAARM, Hyderabad 15-26 July, 2014	Dr. S. Satpathy
Training on 'Advances in Molecular Diagnostic of Emerging Plant Disease for Biosecurity'	ICAR-IIHR, Bangalore 01- 21 August, 2014	Dr. S.P. Gawande
Summer School on 'Breeding by Design'	PAU, Ludhiana 07- 27 August, 2014	Dr. A. Anil Kumar
Training Programme on 'Analysis of Experimental Data'	ICAR-NAARM, Hyderabad 10-15 November, 2014	Dr. S.K. Pandey
ICAR Winter School on 'Diagnosis Assessment and Management of Salt Affected Soils and Poor Quality Waters to Improve Productivity and Livelihood Security'	ICAR-CSSRI, Karnal 11 November-01 December, 2014	Mr. M. Ramesh Naik
International Summer School on 'Plant Disease Epidemiology'	IGKVV, Raipur 30 March-03 April, 2015	Dr. A.N. Tripathi
SMS /Technical officers		
Training on 'Planning, Implementation, Monitoring and Evaluation of Micro Enterprises'	SIPRD, Kalyani 21-25 July, 2014	Dr. Monica Suresh Singh, SMS, KVK
Training on 'Home Science Knowledge Management'	ANGRAU, Hyderabad 03-23 September, 2014	Ms. Poli Saikia, SMS, KVK
Training on 'Soil Testing Plant Analysis and Water Quality Assessment'	ICAR-IARI, New Delhi 04-24 September, 2014	Mr. Sk. Abdulla (TO)
Winter School on 'Advanced Technique for Assessment of soil health, GHG emission and Carbon Sequestration in Rice under Changing Climate Scenario and Mitigation Strategies'	ICAR-CRRI, Cuttack 11 November-01 December, 2014	Dr. D. Ghorai, SMS, KVK
Winter School on 'Advanced Extension Strategy for Communication and Management Skill for Extension Personnel'	BCKV, Kalyani, 03-23 December, 2014	Dr. Monica Suresh Singh, SMS, KVK
Administrative Staffs		
Special Training Programme for the Employees of ICAR	ISTM, New Delhi 24 November-05 December, 2014	Sri. M.K. Roy
Workshop on 'Purchase Management in Government (Assistants and Equivalent)'	ISTM, New Delhi 01 December, 2014	Sri. C.K. Verma
Special Training Programme on 'Pension and other Retirement Benefits for officials dealing with Pension cases'	ISTM, New Delhi 06-09 March, 2015	Sri. S.K. Bala

13.4 Memorandum of Understanding (MoU) with Universities for Human Resource Development

During 2014-15, MoUs were signed with Presidency University and Calcutta University, Kolkata to facilitate exchange of research facilities and human resource development. Besides, as per the MoU of ICAR with Ramakrishna Mission Vivekananda University, Belur, West Bengal following students were guided by the scientists of the institute at various capacities.

Students of different universities guided by scientists of ICAR-CRIJAF

Level	Ramakrishna Mission Vivekananda University	Presidency University	Calcutta University
M. Sc.	1	-	2
Ph.D.	1	1	1

14. Meetings/Events

14.1 ICAR-CRIJAF, Barrackpore

- An interaction meeting between ICAR-CRIJAF and ICAR-NIRJAFT was held on 22 June, 2014 at ICAR-CRIJAF, Barrackpore to discuss the retting technology developed by both the institutes and validation of the technology at farmers' field under the supervision of both the institutes and JCI, Kolkata.
- 'Sensitization on Implementation of ICAR-ERP Solution' was organized at ICAR-CRIJAF, Barrackpore on 30 July, 2014.

ICAR-CRIJAF and ICAR-NIRJAFT scientists interface meeting

- 'Farmers' Day-2014' was organised at ICAR-CRIJAF, Barrackpore on 5 August, 2014 to sensitize the farmers about the recent developments on improved production technologies of jute and allied fibres.
- International Conference on 'Natural Fibres' was co-organised by ICAR-CRIJAF and ICAR-NIRJAFT at Grand Oberoi, Kolkata on 1-3 August, 2014. 250 delegates including scientists, industrialists and policy makers related to jute and allied fibres sectors from different countries participated in this conference.

Progressive jute farmer felicitated by dignitaries during Farmers' Day

- 'Hindi Pakhwara' was organised to make awareness in Hindi language and to generate interest among officials to use Hindi language more in official works at ICAR-CRIJAF, Barrackpore during 15-29 September, 2014.
- The 'Swachha Bharat Abhiyan' (Cleanliness drive) was launched at ICAR-CRIJAF, Barrackpore on 2 October, 2014. All the staff of the institute initiated the programme by cleaning the institute campus led by Prof. Swapan Kr. Datta, Deputy Director General (CS) and Dr. P.G. Karmakar, Director, ICAR-CRIJAF. At the outset the 'Swachhta Pledge' was administered by Prof. S. K. Datta to all the staff of the institute which was followed by cleaning of roads and lawn in front of the institute.

Prof. S.K. Datta, Hon'ble DDG (CS), New Delhi and Dr. P.G. Karmakar, Director ICAR-CRIJAF taking part in 'Swachha Bharat Abhiyan'

- 'ICAR Zonal Sports Tournament (Eastern Zone) 2014' was organized during 14-17 October, 2014 by ICAR-CRIJAF at State Armed Police (SAP) 2nd Battalion Grounds, Barrackpore, West Bengal. 418 sports persons from 17 ICAR institutes participated in this meet in 21 events.

Inaugural address by Director, ICAR-CRIJAF in ICAR zonal (Eastern) sports tournament

- 'Vigilance Awareness Week' was observed during 27 October–3 November, 2014 on the theme 'Combating Corruption-Technology as an enabler' at ICAR-CRIJAF, Barrackpore, all the sub-stations and KVK. One special lecture was arranged on the theme delivered by AGM (Adm), Rifle Factory (MoD, GoI), Barrackpore.

'Vigilance Awareness pledge' administered by Director, ICAR-CRIJAF

- ICAR-CRIJAF observed 'National Integration Day' to commemorate Sardar Vallabhai Patel's birth anniversary on 31 October, 2014 during which the pledge was also administered by the Director to all the staff.

Formation of human chain during National Integration Day

- The 31st Institute Management Committee (IMC) meeting of ICAR-CRIJAF was held on 22 November, 2014 at Barrackpore.
- 'Seed Day' was organised at ICAR-CRIJAF, Barrackpore on 6 December, 2014 to appraise the farmers about the importance of quality seed for production of jute and allied fibres.
- National Conference on 'Indigenous innovation and foreign technology transfer in fertilizer industry: needs, constraints and desired simplification' was organized on 17 January, 2015 at ICAR-CRIJAF, Barrackpore. In this occasion, Dr. S.K. Mukherjee-Dr. K.K. Rohatgi-Mukherjee Annual Endowment Lecture on 'Indian Agriculture-Transforming the Nation' was delivered by Dr. S. Ayyappan, Hon'ble Secretary, DARE and DG (ICAR), New Delhi.

Endowment Lecture deivered by Hon'ble Secretary, DARE and DG (ICAR)

- 'Institute Foundation Day' was celebrated on 10 February, 2015.
- 28th Annual Workshop of AINP on Jute and Allied Fibres was organised during 13-14 February, 2015 at ICAR-CRIJAF, Barrackpore, West Bengal.
- 'International Women's Day' was organized at ICAR-CRIJAF, Barrackpore on 9 March, 2015 on the theme 'Empowering Women: Empowering Humanity'.
- 'MIS-FMS Project Appraisal Meeting' was organized at ICAR-CRIJAF, Barrackpore on March 21, 2015 to review the progress of ICAR–EPR. Scientists and staff members of ICAR-IASRI; ICAR-NIRJAFT, ICAR-CIFRI and ICAR-ZPD-II attended.
- Research Advisory Committee (RAC) meeting of the institute for 2014-15 was held at ICAR-CRIJAF, Barrackpore on 17-18 April, 2015.
- The Institute Research Council (IRC) meeting of the institute for 2014-15 was held to review the proposal of new projects as well as progress of the ongoing in-house projects and achievements of externally funded research projects during 24 & 28 April, 2015.

14.2 Central Seed Research Station on Jute and Allied Fibre, Bud Bud, West Bengal

- 'Seed Day' was organized at Bud Bud, Burdwan on 23 December, 2014 to enlighten the farmers about the importance of quality seed for production of jute and allied fibres and to aware about their rights on plant variety protection.

14.3 Sisal Research Station, Bamra, Odisha

- 'Hindi Day' was organized on 15 September, 2014 to create awareness among staff members regarding the use of Hindi in official work.

Dignitaries releasing bulletin on jute seed production

- 'Seed Day' was organized at Sisal Research Station, Bamra, Odisha on 3 February, 2015.

Inauguration of 'Seed Day' at SRS, Bamra

14.4 Ramie Research Station, Sorbhog, Assam

- 'Farmers Awareness cum Field Day on Ramie Cultivation' was organised at Ramie Research Station (CRIJAF), Sorbhog on 25 August, 2014
- 'Hindi week' was celebrated on 12-17 September, 2014 to create awareness among staff members regarding the use of Hindi in official work.

Awareness cum Field Day on Ramie at RRS, Sorbhog

14.5 Sunnhemp Research Station, Pratapgarh, Uttar Pradesh

- 'Farmers' Field Day' was organised at Revrhia village of Pratapgarh on 13 August, 2014 to create awareness among the farmers about improved production technology of sunnhemp.
- 'Hindi week' was celebrated from 14-20 September, 2014 to create awareness among staff members regarding the use of Hindi in official work.

Sunnhemp 'Field Day' at Revrhia, Pratapgarh

15. Awards/Recognitions

15.1 Awards

- Dr. D.K. Kundu, Pr. Scientist & Head (Crop Production) received 'Purusottam Jiban Dash Memorial Bio-Research-Best Paper Award 2014' of the GCBR, Bhubaneswar, Odisha on 12 December, 2014.
- Dr. Sabyasachi Mitra, Pr. Scientist (Agronomy), awarded with 'Best Poster Award' for the research paper 'Enhancement of pectinase production by *Bacillus subtilis* for biochemical degradation of pectin in ramie fibre' in International Conference on 'Natural Fibres' organized by the Indian Natural Fibre Society, ICAR-NIRJAFT, ICAR-CRIJAF, NJB at Kolkata on 1-3 August, 2014.

Dr. Sabyasachi Mitra receiving the 'Best Poster Award'

- Dr. Amarpreet Singh, Scientist (Agronomy) received 'FAI (Fertilizer Association of India) Golden Jubilee Award' for outstanding doctoral research in fertilizer usage during FAI annual seminar 2014 held on 10 December, 2014 at New Delhi.
- Dr. Amarpreet Singh, Scientist (Agronomy) received 'The Mosaic Company Foundation Award' for Outstanding Doctoral Research in the area of Plant Nutrition 2014-15 during 21 February, 2015 at Gurgaon, Haryana.

Dr. Amarpreet Singh receiving the 'Mosaic Foundation Award'

- Dr. A.K. Sharma, Sr. Scientist (Plant Breeding) was awarded with 'Young Scientist Award-2014' by Society for Recent Development in Agriculture in the International Conference on "Technological Interventions in Agricultural Sciences for enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014)" during 17-19 February, 2015 at Dimapur, Nagaland.

Dr. A.K. Sharma receiving the 'Young Scientist Award-2014'

- Dr. Babita Chaudhary, Sr. Scientist (Plant Breeding) received 'Best Oral Presentation Award' in National Conference on 'Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management' organized by the Society for Scientific Development in Agriculture and Technology 13-14 December, 2014 at ICAR-DRR, Hyderabad.

Dr. Babita Chaudhary receiving the 'Best Oral Presentation Award'

- Dr. Babita Chaudhary, Sr. Scientist (Plant Breeding) received 'Major R.S. Yadav SRDA Award 2014' in the International Conference on 'Technological Intervention in Agricultural Sciences for Enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014)' during 17-19 February, 2015 at Dimapur, Nagaland.
- Dr. S. P. Gawande, Scientist (Plant Pathology) awarded with 'SRDA Gold Medal' by the Society for Development in Agriculture in the International Conference on 'Technological Interventions in Agricultural Sciences for enhanced Productivity, Nutritional Quality and

Value Addition (TIAS-2014)' on 18 February, 2015 at Dimapur, Nagaland.

- Dr. S.P. Gawande, Scientist (Plant Pathology) awarded with 'Second Best Oral Presentation Award' in the International Conference on 'Technological

Dr. S. P. Gawande receiving the 'SRDA Gold Medal'

Interventions in Agricultural Sciences for enhanced Productivity, Nutritional Quality and Value Addition (TIAS-2014)' during 17-19 February, 2015 at Dimapur, Nagaland.

Dr. Ritesh Saha, Senior Scientist is being awarded with NAAS Associate Fellowship - 2014 by Hon'ble Secy. DARE and DG, ICAR

- Dr. Ritesh Saha, Senior Scientist (Soil Physics) received the prestigious NAAS Associate Fellowship for the year 2014 by National Academy of Agricultural Sciences, New Delhi
- Dr. Ritesh Saha, Senior Scientist (Soil Physics) received the prestigious Dr. B C Deb Memorial award for Popularization of Science for the year 2014-15 by Indian Science Congress Association, Kolkata.

15.2 Recognition

- Indian Council of Agricultural Research selected ICAR-CRIJAF as the Regional Office for National Agricultural

Dr. D.K. Kundu is being felicitated for delivering 4th Dr. N.P. Datta Memorial Lecture award

Education Accreditation Board (NAEAB) for Eastern and North Eastern Region. Dr. S.K. Sarkar, Pr. Scientist (Plant Pathology) has been selected as Regional Co-coordinator.

- Dr. D. K. Kundu, Pr. Scientist & Head (Crop Production) delivered the 4th Dr. N. P. Datta Memorial Lecture of Indian Society of Soil Science organized at BAU, Ranchi on 15 September, 2014.
- Dr. D. Sarkar delivered invited talk on 'Plant Genome Size Estimation by Laser Flow Cytometry' at International Workshop on 'DNA Cell Cycle and DNA Ploidy' organized by University of Calcutta and Beckton Dickinson at Kolkata on 12 December, 2014.
- ICAR-CRIJAF won a total of 11 medals (5 gold, 3 silver and 3 bronze) in different events in ICAR Zonal Sports Tournament (Eastern Zone), 2014 organized by ICAR-CRIJAF, Barrackpore during 14-17 October, 2014. ICAR-CRIJAF team was declared ICAR Volleyball Champion in the ICAR-Inter-Zonal Sports Tournament held at ICAR-NDRI, Karnal during 11-14 March, 2015.

ICAR-CRIJAF team with ICAR volleyball championship trophy

16. Research Projects

16.1 In-house Research Projects

Project. no.	Project title and investigator(s)	Duration	Results cited in page no.
Crop Improvement			
JB 1.1	Introduction, maintenance, characterization and conservation of jute, mesta and flax germplasm: *P.G. Karmakar (till 21.04.2014), S.B. Choudhury (w.e.f. Feb. 2011), H.K. Sharma (w.e.f. April 2012), A. Anil Kumar (w.e.f. 22.11.2012) and D. Saha (w.e.f. 04.09.2014)*	1997-Long term	1, 2, 4
JB 8.5	Development of improved genotypes of mesta resistant to biotic stress with enhanced fibre yield and quality: *S.K. Pandey, P. Satya, H.K. Sharma, S. Satpathy and R.K. De.*	2010-15	10
JB 9.1	Improvement of fibre yield in tossa jute through heterosis breeding: *A. Anil Kumar, C.S. Kar and J. Mitra*	2011-15	4
JB 9.2	QTL mapping for fibre quality in tossa jute: *S.B. Choudhary, P.G. Karmakar, D. Sarkar, H.K. Sharma, K. Meena, A. Bera and H. Bhandari*	2012-15	7
JB 9.3	Towards development of jute transgenics (*C. olitorius* and *C. capsularis*) tolerant to biotic and abiotic stress tolerance for enhanced production at sustainable scale: *A.B. Mandal and K. Meena*	2012-17	22, 23
JBT 4.1	Biotechnology for jute and allied fibres improvement: *D. Sarkar and P. Satya*	2009-14	16, 17, 18
JBT 4.2	*In vitro* culture to develop productive double haploid lines in *capsularis* jute with premium quality to attain farm prosperity: *K. Meena, A. B. Mandal and R.K. De*	2013-16	23
JAFSP 2.3	Investigation of breeding behaviour and mechanism of self-incompatibility in Sunnhemp: *H.R. Bhandari (till 01.01.2014), Maruthi, R.T. (w.e.f. 02.01.2014), S.K. Pandey, Babita Chaudhary and S.K. Sarkar*	2013-16	12
JB 9.4	Utilization of pre-breeding materials for genetic improvement of jute and kenaf: *P. Satya, S. K. Pandey and Maruthi R.T.*	2014-17	3
JB 9.5	Development of DNA fingerprint for varietal identification in jute: *J. Mitra, C. S. Kar and A. Anil Kumar*	2014-18	9, 10
JB 9.6	Evaluation and selection for high fibre yield and other diversified uses in roselle (*H. sabdariffa*): *H. K. Sharma, A. Anil Kumar, Maruthi R.T. and A.R. Saha*	2014-16	10, 11
JB 9.7	Development and validation of marker-based assay for varietal purity testing in jute: *C.S. Kar, A. Bera and J. Mitra*	2014-15	8
JB 9.8	Development of screening technique for prediction of jute fibre quality: *C.S. Kar and M. Kumar*	2014-15	7
JB 9.9	Selection and evaluation of genotypes with high yield and quality in *C. olitorius*: *C.S. Kar*	2014-17	8
JBT 4.3	Bioprospecting of jute and allied fibre crops for diseases and water associated stress signaling genes through computational characterization on micro RNAs: *L.L. Kharbikar, A.B. Mandal, R.K. De, H.K. Sharma, S.P. Gawande and D. Sarkar*	2014-16	24
Crop Production			
SLC 1.3	Use of micro-irrigation method and micro-nutrients to improve fibre yields and water use efficiency of sisal: *D.K. Kundu, S. Sarkar, A.R. Saha and A.K. Jha*	2011-15	35
JA 5.6	Assessment of productivity and nutrient management for selected jute based cropping system: *M. Kumar, A.K. Ghorai, S. Mitra and B. Majumdar*	2011-16	32
JA 6.4	Studies on combined efficacy of plant extracts with synthetic insecticides and fungicides against pest and diseases of jute and mesta: *H. Chowdhury, S.K. Sarkar, R.K. De and K. Selvaraj*	2012-16	46, 47
JC 6.5	Determination of water productivity of tossa jute (*Corchorus olitorius*) genotypes under deficit moisture stress condition: *D. Barman, D.K. Kundu, A.K. Ghorai and S. Mitra*	2012-15	50, 51
JA 6.6	Effect of sulphur and potassium application on yield and quality of jute seed: *A. Singh, M. Kumar, S.P. Mazumdar, A. Bera and D.K. Kundu*	2013-16	13, 14
JC 6.4	Phosphorus distribution and availability in an inceptisol under intensive cultivation of jute-rice-wheat cropping system: *S. P. Mazumdar, A.R. Saha and D.K. Kundu*	2013-16	28
JA 6.7	Use of jute fabrics and gunny bags in agricultural fields: *A.K. Ghorai, D.K. Kundu and A. Singh*	2014-16	34, 35
JA 6.8	Studies on the effect of salinity stress on *capsularis* and *olitorius* jute: *M. Ramesh Naik, R.T. Maruthi, D. Barman and U.K. Mandal (from RRS, Canning Town)*	2014-15	51
JA 6.9	Prospect of growing medicinal and aromatic plants in jute and sisal based cropping system: *M.S. Behera, S. Satpathy, D.K. Kundu, A.K. Jha, R.K. Naik and A. Singh*	2014-17	32, 33, 35, 36

SLA 1.5	Assessment of area of sisal grown for soil conservation measure and its fibre production potential: *M.S. Behera, A.K. Jha and R.K. Naik*	2014-16	36
JAE 3.4	Development of manual multi-crop seed drill and dry land weeder for Gangetic alluvial soil: *R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha*	2014-17	52
Crop Protection			
JE 1.1	Integrated management of kenaf pests with special reference to mealybug: *S. Satpathy and B.S. Gotyal (w.e.f. April, 2012)*	2009-15	42
JM 8.0	Management of stem rot of jute: *R.K. De, C. Biswas and S.K. Sarkar*	2009-15	44, 45
JE 1.2	Identifying the sources and mechanism of resistance against major pests of jute: *B.S. Gotyal and S. Satpathy*	2010-15	38, 39
JM 8.1	Studies on *Beauveria bassiana* for managing jute pests and diseases: *C. Biswas, S. Satpathy and B.S. Gotyal*	2010-15	41, 42
JE 1.4	Determination of single and multiple pests economic injury levels in jute: *K. Selvaraj and B.S. Gotyal*	2012-15	39, 40
JM 8.4	Exploitation of potential bio-agents and PGPR for bio-management of stem rot and growth promotion of jute: *A.N. Tripathi, R.K. De and S.K. Sarkar*	2012-16	47, 48
JM 8.3	Studies on variability of *Macrophomina phaseolina* infecting jute and mesta: *R.K. De, A.N. Tripathi and C.S. Kar*	2012-17	45
JE 1.5	Identification of *Bacillus thuringiensis* (Berliner) isolates for management of major lepidopteran pests of jute: *V. Ramesh Babu, B.S. Gotyal, K. Selvaraj and S.P. Gawande*	2012-16	40
JM 8.5	Basic studies to understand process of stem rot disease development in jute: *K. Mandal, C. Biswas and C.S. Kar*	2013-15	44
JM 8.6	Molecular detection and management of mesta yellow vein mosaic virus: *P.N. Meena, V. Ramesh Babu and S.K. Pandey*	2014-18	42, 43
JM 8.7	Investigation on diseases of mesta seed crop and seed health testing: *S.K. Sarkar and A. Bera*	2014-17	47
JE 1.7	Impacts of elevated temperature and carbon dioxides on crop-pest interaction in jute: *K. Selvaraj, B.S. Gotyal and V. Ramesh Babu*	2014-17	-
JE 1.6	Preliminary studies on sex pheromones of major insect pests of jute and allied fibre crops: *V. Ramesh Babu, B.S. Gotyal and S. Satpathy*	2014-17	40, 41
Agricultural Extension			
JEXA 5.2	Studies on performance of newer *olitorius* jute varieties in farmers' field of five districts of West Bengal: *S. Sarkar, S.K. Jha, S. Kumar, Shamna A., B. Majumdar, C. Biswas and B.S. Gotyal*	2013-15	59
JEXA 5.1	Attitude and perception of farmers towards ICT based extension: *Shamna A. and A. K. Chakraborty*	2013-15	60
JEXA 5.3	Impact of improved jute production technologies on farmers' economy in major jute growing districts of West Bengal: *S.K. Jha, S. Sarkar, S. Kumar, Shamna A. and A.K. Chakraborty*	2014-16	-
JEXA 5.4	An analysis on the outcome of technological interventions under Tribal Sub Plan in Makaltala and Farmania villages: *Shamna A., S.K. Jha, S. Sarkar and S. Kumar*	2014-16	60
All India Network Project on Jute and Allied Fibres			
AINPJAF	All India Network Project on Jute and Allied Fibres: *S. Mitra and S.K. Pandey*	Long Term	67, 68, 69, 70
Sunnhemp Research Station, Pratapgarh, U.P.			
SNHA 1.6	Residual effect of sunnhemp on wheat in rice-wheat cropping system: *M.K. Tripathi*	2010-15	36
SNHA 2.0	Effect of NPK on growth and yield of flax (*Linum usitatissimum* L): *M.K. Tripathi and Babita Chaudhary*	2010-15	37
SNHB 1.8	Breeding of flax (*Linum usitatissimum*) for high yield and superior fibre quality: *Babita Chaudhary, H.R. Bhandari and M.K. Tripathi*	2011-16	2, 12
SNHB 1.9	Population improvement of sunnhemp for fibre yield: *Babita Chaudhary, S.K. Pandey and M.K. Tripathi*	2011-16	12
SNHA 2.1	Effect of micronutrients Zn and B on growth and yield of sunnhemp: *M.K. Tripathi, Babita Chaudhary and A. R. Saha*	2014-16	36, 37
Ramie Research Station, Sorbhog, Assam			
RB 1.0	Collection, maintenance and evaluation of ramie germplasm: A.*K. Sharma and S.P. Gawande*	Long term	1, 2, 57

RB 2.4	Development of high yielding genotypes with enhanced fibre quality through hybridization: *A.K. Sharma, P. Satya, K. Selvaraj and S.P. Gawande*	2013-Long term	11
RBM 2.5	Indexing and identification of diseases and insect pests of ramie and development of IPM module: *S.P. Gawande, B.S. Gotyal, A.N. Tripathi and A.K. Sharma*	2013-16	43, 48
Sisal Research Station, Bamra, Odisha			
SLM 1.0	Studies on disease distribution, intensity and identification of sources of resistance against *Phytophthora* spp. causing zebra disease of sisal (*A. sisalana)*: *A.K. Jha, S. Sarkar and R.K. De*	2012-15	48, 49
Central Seed Research Station for Jute and Allied Fibres, Burdwan, West Bengal			
BSP 1.0 (NSP)	Breeder seed production of jute, mesta and sunnhemp: *C. S. Kar, A. Bera and H.R. Bhandari (Upto 01.01.2014), S. Biswas and Monu Kumar*	Long-term	14, 15
Technology Mission on Jute			
TMJ 1	Development of high yielding and better quality jute genotypes by integrating conventional and advanced strategies: *P. Satya*	2013-17	3, 4, 5, 6, 7, 23, 24
TMJ 2	Genetic enhancement of jute and mesta for drought response and fibre quality: *J. Mitra*	2013-17	8, 9, 11
TMJ 3	Development of jute and allied fibres informatics: *A.K. Chakraborty*	2013-17	55, 56
TMJ 4	Development of low cost eco-friendly technologies for weed management in jute and mesta: *A.K. Ghorai*	2013-17	49, 50
TMJ 5	Improving water productivity of jute and mesta and its retting under low volume water: *A.K. Ghorai*	2013-17	33, 34
TMJ 6	Up-scaling and refinement of microbial retting consortium and popularization of microbial formulation mediated retting among farmers: *B. Majumdar*	2013-17	53, 54
TMJ 7	Management of stem rot disease and major insect pests of jute: *C. Biswas*	2013-17	41, 42, 44, 46
TMJ 8	Refinement and up-scaling of eco-friendly microbial degumming technology in ramie: *S. Mitra*	2013-17	54
TMJ 9	Improvement of nitrogen use efficiency (NUE) in jute in relation to bast fibre yield: *S. Mitra*	2013-17	29, 30, 31
TMJ 10	Seed quality enhancement for mitigating biotic and abiotic stresses in jute (*Corchorus olitorius*): *A. Bera*	2013-17	13

16.2 Externally Funded Projects

Sponsor	Project title and investigator(s)	Duration	Results cited in page no.
Mega Seed Project (MSP)	Seed production in agricultural crops and fisheries: *C.S. Kar, A. Bera, S. Biswas, Monu Kumar, M.K. Tripathi and A.K. Jha*	Long-term	15
DAC	Protection of jute varieties and DUS testing of jute: *J. Mitra*	Long-term	9
DAC (JEXA 4.7)	Front Line Demonstration (FLD) on jute under Mini Mission-II of Jute Technology Mission: *S.K. Jha*	Long-term	57, 58, 59
NASF, ICAR	Genomics for augmenting fibre quality improvement in jute: *D. Sarkar*	2011-16	19, 20, 21, 22
NASF, ICAR	Understanding biosynthesis and genetics of gum content in ramie (*Boehmeria nivea*) for developing low gum genotypes: *P. Satya*	2012-16	1, 2, 12
DBT	Genetic analysis of resistance to stem rot in jute: *P. Satya*	2012-15	5, 10
AICRP, LTFE (JC 5.2)	To study changes in soil quality, crop productivity and sustainability under jute-rice-wheat cropping system (LTFE) AICRP: *D.K. Kundu, A.R. Saha, B. Majumdar, A.K. Ghorai and S. P. Mazumdar*	Long-term	25, 26
AICRP-STCR (JC 5.6)	Soil test and resource based integrated plant nutrient supply system for sustainable agriculture (AICRP): *A.R. Saha and B. Majumdar*	Long-term	26, 27
AICRP-STCR (JC 5.6a)	Long term effect of ST-TY equation based INM on yield, value addition, nutrient budgeting and quality of soil under jute-rice-lentil sequence: *A. R. Saha and B. Majumdar*	Long-term	27, 28
RKVY	Geo-spatial approach to study of agri-horti intercropping model in red and laterite soil of West Bengal: *D. Barman*	2014-17	-
BRNS	A study on the influence of species and sulphur levels on yield, sulphur use efficiency and changes in different forms of sulpher in jute and mesta using (^{35}S) tracer: *S. P. Mazumdar*	2013-16	28, 29
BRNS	Induction and characterization of tossa jute (*Corchorus olitorius*) mutants for fibre yield attributes and quality parameters: *S.B. Choudhury*	2014-16	3
NFSM	Commercial crop-jute: C.S. Kar, B. Majumdar, S. Kumar and S.K. Jha	2014-16	15, 59

17. Publications

17.1 Research Papers

Annamalai, M., Kaushik, H.D. and Selvaraj, K. (2015). Bioefficacy of *Beauveria bassiana* (Balasamo) Vuillemin and *Lecanicillium lecanii* Zimmerman against *Thrips tabaci* Lindeman. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, doi:10.1007/s40011-014-0475-8.

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Biswas, S., Datta, M. and Ngachan, S.V. (2015). Mushroom cultivation a prosperous venture for improvement of livelihood of poor tribals in Tripura. *Journal of Mycopathological Research*, 53(1): 31-39.

Brahmanand, P.S., Kumar, A., Roy Chowdhury, S., Ghosh, S., Kundu, D.K., Mandal, K.G., Singandhupe, R.B., Nanda, P. and Reddy, G.P. (2014). Performance evaluation of rice under intermittent irrigation and drainage in eastern India. *GCBR BioResearch (Bhubaneswar)*, 1(2): 24-30.

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18. Library, AKMU, ITMU and PME Cell

18.1 Library, Information and Documentation Unit

The library has rich collection of over 10,300 books and 11,720 bound volume of journals especially on jute and other fibre crops such as sisal, ramie, flax, sunnhemp, mesta, etc. The library procures documents on different subjects like Agronomy, Plant Breeding, Genetics, Soil Science, Agricultural Statistics, Seed Science and Technology, Plant Pathology, Environmental Sciences, Plant Physiology, Entomology, Nematology, Agricultural Engineering with respect to jute and allied fibre crops. The library holds popular magazines, newsletters and annual report of various research organizations, proceedings, research highlights of the ICAR institutes, SAUs and other useful reading materials received from different relevant organizations. ICAR-CRIJAF publications were distributed to over 350 organizations in India and abroad. It subscribed 55 numbers of journals including Indian and Foreign journals during the year under report. The institute publications like annual report, AINPJAF annual report, JAF news, Resha Kiran (hindi), bulletines etc were distributed to different institutes, stakeholders of jute and allied fibres and visitors. AGRIS CD is available from 1971 to 2005 for easy access of abstracts of different publications. Library also provided the internet and reprography service to the readers along with Document Delivery Services (DDS) by Consortium for e-Resources in Agriculture (CeRA) to access different journals online. Under the DDS, the library has sent copies of publications as per request to researchers in different institutes *(Source: Library, Contributor: H. Chowdhury).*

18.2 Agricultural Knowledge Management Unit (AKMU)

The AKMU primarily manages information on research and other related matters pertaining to the mandate crops besides oversee the internet facility, institute website maintenance and the proper implementation of ICAR-ERP solution. The National Knowledge Network (1Gbps) connectivity has been provided by National Informatics Centre and it has been implemented since last year. The performance is satisfactory in terms of bandwidth transmission. The campus local area network has been strengthened with the replacement of Cat 5 UTP with Cat 6 UTP cable and unmanaged switches with 1Giga managed switches, keeping the existing OFC backbone with centralized monitoring system for easy maintenance of the network. New OFC backbone for internet connectivity has been extended to the Farm and Engineering Section. In addition, this cell maintains and updates the ICAR online databases, information and progress reports. Support is provided to MIS-FMS unit for in-house training on awareness and implementation of the ICAR-ERP solution under MIS-FMS. All types of institute tenders notices are uploaded to the online Central Public Procurement Portal (CPPP). The institute website http://www.crijaf.org.in is developed and maintained on regular basis by this cell. This cell also provides support to the staffs for maintenance of computer systems and extends full-fledged multimedia support to organize and conduct all types of meetings, seminars, symposium, workshops, video conferencing etc. *(Source: AKMU, Contributors: C.S. Kar and N. Paul).*

Dr. S. Ayyappan, Secretary, DARE & DG, ICAR visiting institute library

18.3 Institute Technology Management Unit (ITMU)

As per the Council's Intellectual Property Policy, 2006 the institute has established ITMU which has been in the forefront of technology commercialization. The varieties/hybrids and technologies recommended by the institute are also handled by ITMU for commercialization. The unit is also actively involved in '**prior art search'** on jute and allied fibres as well as documentation and digitalization of the database. Registration of jute varieties and updated status of their protection have been documented and digitalized.

18.3.1 Application of patents and follow up action

- Application has been filed against the First Examination Report on the Patent Application No. 1367/KOL/2006 ("An improved seed sowing machine") after clarification of the specific claims raised by the Patent office against the invention.
- The First Examination Report on the Patent Application No. 1036/KOL/2008 (An improved process of large scale degumming of ramie fibre) was received from the Assistant Controller and the response to the claims is under process.
- Apart from "An improved seed sowing machine" (Patent Application No. 1367/KOL/2006) and "An

improved process of large scale degumming of ramie fibre" (Patent Application no. 1036/KOL/2008), the other three applications on "An improved herbicide applicator" (Patent Application no. 319/KOL/2010), "Nail weeder" (Patent Application no. 386/KOL/2010) and "A microbial consortium used in faster retting of jute and mesta" (Patent Application no. 418/KOL/2011) were submitted previously. The applications are under process *(Source: ITMU, Contributor: D.K. Kundu).*

18.3.2 Trademark

- Application for registration of the trademark "CRIJAF SONA" (Application No. 2753810, dated 11.06.2014) has been filed in the Trademark Registry Office, Kolkata

18.3.3 Commercialization of the technologies

- ICAR-CRIJAF has signed an MoU with M/s Akriti (LATH) a leading Engineering Firm in Sambalpur district of Odisha on 26.04.2014 to manufacture and market 'CRIJAF Ramie and Sisal Fibre Extractor'
- Non-exclusive licensing has been awarded to a second firm, M/s Krishi Udyog, Samabaya Pally (Bally), Howrah-711205, West Bengal on 25.07.2014 for manufacturing and marketing of 'Nail Weeder' and 'Herbicide Applicator' developed by ICAR-CRIJAF.
- ITMC recommended to award the non-exclusive license for production and sale of 'CRIJAF SONA' for a period of 10 years on the terms and conditions mutually agreed between M/s. West Bengal Pharmaceutical and Phytochemical Development Corporation Ltd. (WBPPDCL) (a Govt. of West Bengal undertaking) and ICAR-CRIJAF *(Source: ITMU, Contributor: D.K. Kundu).*

18.4 Prioritization, Monitoring and Evaluation (PME) Cell

The PME cell of ICAR-CRIJAF was established as per guidelines of the Council. It comprises of a group of five scientists headed by a Principal Scientist and two technical officers. The PME of the Institute is working as "Single window" system for priority setting, research monitoring and evaluation, maintenance of data bases related to projects, achievements, technologies developed, publication etc. Important activities performed by the cell are conducting Institute Research Council (IRC) meeting, and Project Monitoring Committee (PMC) meetings, maintaining Research Project Files (RPFs), coordinating online submission of Half Yearly Progress Monitoring (HYPM) report of all the Scientists of the Institute, updating online programme–PERMISNET and PIMS-ICAR, formulating Results Framework Documents (RFDs) of the institute, preparing Monthly Progress Report (MPR), Quarterly Progress Report (QPR), Annul Plan, DARE report, ATR of Directors' Meet and Regional Committee Meetings and coordination of research audit of the institute. The PME cell also facilitates in providing the research information of the institute to other departments and stakeholders *(Source: PME cell, Contributors: S.K. Sarkar and N. Paul).*

19. Women Empowerment

19.1 Gender Mainstreaming in Agriculture among Tribal Community

The major livelihood of most of the evolved tribal communities are agriculture and allied activities which can be uplifted through appropriate interventions for economic and technical empowerment of women. In any agriculture based activity the role of women is immense and the case is not different with the tribals. Women play a significant and crucial role in agricultural and allied activities including the crop and livestock production, horticulture, post harvest operations, agro and social forestry, fisheries, etc. Skill development among the tribal farm women regarding the new simple agriculture technologies and entrepreneurship development will have a far reaching impact on tribal farming.

19.2 Introduction of Women Friendly Tool for Weed Control in Jute

Jute is a labour intensive crop. Although involvement of tribal farm women in farming activities during the jute season was less compared to other crops in respect of the total man-days required during the season, the operations like weeding was mostly done by women. Manual weeding in jute involves lots of drudgery among farm women as the critical period for weeding coincides with extreme hot and humid weather. Tribal farm women were not using any specific implement to carry out farm operations particularly weeding. ICAR-CRIJAF took initiative to introduce drudgery reducing implement i.e. nail weeder for jute cultivation. Sixty nail weeders were provided to farm women in two villages of North 24 Parganas. Demonstration cum training on use of nail weeder was also organised. This low cost, simple implement is very easy to handle and the mechanical weeding can be done in a standing posture which is less uncomfortable than manual uprooting of weeds. Introduction of such implements had a positive impact on the working condition of such farm women.

19.3 Functional Literacy Campaign

Majority (70%) of the farm women in the selected two villages were illiterate and had poor knowledge on farming. Literacy classes were initiated as the first step for empowering such group to impart education and to improve their knowledge of farming activities. Helping the farm women in reading and writing will build self confidence among the farm women, develop awareness about farm magazines, newspapers and other literatures. The farm women had shown greater enthusiasm in attending this endeavour and have taken the campaign in a positive spirit. At present forty farm women are attending the classes on literacy.

Fig. 19.1. Farm women operating nail weeder.

Fig. 19.2. Empowering women through vocational training and literacy programmes

19.4 Entrepreneurship Development among Farm Women

For entrepreneurship development among farm women several trainings were imparted to women Self Help Groups (SHG) on preparation of jute bag and other handicraft. Trainings were also organised for the farm women on rearing of improved breeds of poultry (Vanaraja) and duck (Khaki Campbell). These trainings could activate 11 Self Help Groups of two villages of North 24 Pgs and initiated fresh impetus among the tribal farmers particularly the women to generate earnings for the SHG.

19.5 Enhancing Nutritional Security of Tribal Farm Women

Malnutrition among the farm women and children is very common which is more serious particularly in case of tribals who rely on very marginal diets. Crop diversification particularly through pulses, vegetables and integration of fishery, poultry and duckery can provide base for balanced

food for these farm women. Intercropping and strip cropping of short duration green gram with jute, vegetable cultivation in jute based soil column, practising backyard poultry and scientific fish rearing are some of the interventions introduced in the adopted villages to enhance the nutritional security of the farm women. The women cell had also organised exposure visits for the farm women to provide first hand information on green gram and vegetable cultivation.

Fig. 19.3. Training on jute bag preparation for women

Fig. 19.4. Farm women displaying green gram harvest

19.6 Celebration of International Women's Day at ICAR-CRIJAF

The women cell of ICAR-CRIJAF organised the celebration of International Women's Day 2015 on 9th March 2015. The theme for the programme was "Empowering Women: Empowering Humanity". In this event 60 farm women from nearby villages had participated. A lecture was also organised for farm women on "Self Help Group registration and account management" which was delivered by Deputy Manager, State Bank of India, Sewli Branch, Barrackpore. The lecture elaborated about the procedure for registration and operation of SHGs, loan facility and small savings particularly for women. The participants appreciated the lecture as most of them belonged to SHGs. The entrepreneurs trained by the institute who had taken up various activities were rewarded on this occasion *(Source: Women Cell. Contributors: Shamna A. and S.P. Mazumdar).*

Fig. 19.5. Celebration of Women's Day at ICAR-CRIJAF

20. राजभाषा कार्यान्वयन (Official Language Implementation)

भाकृअनुप–केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान के लक्ष्य, कार्यक्षेत्र तथा राजभाषा गतिशीलता

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान एक प्रमुख राष्ट्रीय संस्थान है जिसे पटसन एवं समवर्गीय रेशा उत्पादन में वृद्धि हेतु आवश्यक अनुसंधान तथा उसे किसानों तक पहुँचाने का दायित्व सौंपा गया है। इस संस्थान की स्थापना वर्तमान स्थान नीलगंज, बैरकपुर, कोलकाता में सन् 1953 के दौरान हुई जिसका कुल क्षेत्रफल 62.8 हेक्टेयर है।

संस्थान के अनुसंधान कार्य को तीन प्रभागों नामतः फसल उन्नतिकरण (Crop Improvement), फसल उत्पादन (Crop Production) और फसल सुरक्षा (Crop Protection) तथा पाँच अनुभागों जैसे – जैव प्रौद्योगिकी, कृषि अभियांत्रिकी, फार्म मशीनरी एवं पॉवर, कृषि विस्तार तथा कृषि मौसम विज्ञान के अंतर्गत व्यवस्थित किया गया है। इन अनुसंधान प्रभागों एवं अनुभागों की सहायता हेतु फार्म, वर्कशाप, पुस्तकालय, संस्थान प्रौद्योगिकी प्रबन्धन एकक, कृषि अनुसंधान सूचना प्रणाली कक्ष, प्रशासन अनुभाग, वित्त व लेखा अनुभाग भी कार्यरत हैं। संस्थान में मौलिक, सामरिक तथा क्षेत्र अनुकूल अनुसंधान कार्य हेतु आवश्यक प्रयोगशालाएँ व क्षेत्रीय सुविधाऐं उपलब्ध हैं।

संस्थान ने पटसन एवं समवर्गीय रेशा तथा बीजों से संबंधित अनुसंधान कार्य हेतु देश के विभिन्न भागों में 4 अनुसंधान केन्द्रों की स्थापना की है, जो निम्नवत हैं:

1. रेमी अनुसंधान केन्द्र, सरभोग, असम (वर्ष 1959 में स्थापित), कुल क्षेत्र 60 हेक्टेयर ।
2. सीसल अनुसंधान केन्द्र, बामरा, ओड़िशा (वर्ष 1962 में स्थापित), कुल क्षेत्र 106.4 हेक्टेयर ।
3. सनई अनुसंधान केन्द्र, प्रतापगढ़ उत्तर प्रदेश (वर्ष 1963 में स्थापित), कुल क्षेत्र 12.4 हेक्टेयर ।
4. केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र, बुदबुद, बर्दवान, पश्चिम बंगाल (वर्ष 1956 में स्थापित), कुल क्षेत्र 86.1 हेक्टेयर ।

इन केन्द्रों के अलावा बहु–स्थानीय परीक्षण तथा तकनीकी प्रणालियों की पुनः स्थापना हेतु अखिल भारतीय पटसन एवं समवर्गीय रेशा नेटवर्क परियोजना के तहत विभिन्न राज्य कृषि विश्वविद्यालयों में 9 तथा भारतीय कृषि अनुसंधान परिषद के संस्थानों में 4 केन्द्र स्थापित हैं तथा इन केन्द्रों का नोडल एकक बैरकपुर मुख्यालय है।

यह संस्थान नवम्बर 2006 में प्रारम्भ किया गया एम.एम–I (टेकनोलॉजी मिशन ऑन जूट) का नोडल केन्द्र भी है। जिसके प्रथम चरण में पूरे देश में 8 विभिन्न परियोजनाओं के अन्तर्गत कुल 15 सहयोगी केन्द्रों के माध्यम से अत्यन्त उत्साहवर्धक परिणाम प्राप्त होने के कारण इस परियोजना का दूसरा चरण भी प्रारंम्भ किया गया है।

राजभाषा गतिविधियाँ

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान में भारत सरकार की राजभाषा नीति का अनुपालन सुनिश्चित करने के लिए संस्थान में एक राजभाषा प्रकोष्ठ है, इसमें एक वरिष्ठ वैज्ञानिक हिन्दी प्रभारी के रूप में तथा एक सहायक कार्यरत हैं।

इस संस्थान के वैज्ञानिकों द्वारा कृषकों के जीवनयापन में गुणात्मक सुधार हेतु उन्हें पटसन एवं समवर्गीय रेशे वाली फसलों के महत्वपूर्ण कृषि तथ्यों से अवगत कराया जाता है। कृषि के क्षेत्र में इस संस्थान की सकारात्मक भूमिका रही है। विकासात्मक गतिविधियों एवं जानकारियों को अन्य भाषाओं के साथ–साथ हिन्दी में भी किसानों तक पहुँचाने में यह संस्थान प्रयासरत है। इसी क्रम में संस्थान के द्वारा हिन्दी में एक गृह पत्रिका 'रेशा किरण' का प्रकाशन भी प्रारम्भ किया गया है। के.प.स.रे.अ.सं. एक वैज्ञानिक संस्थान होते हुए भी यहाँ राजभाषा हिन्दी को काफी बढावा दिया जाता है। उन्होंने कहा कि हमारा कर्तव्य बनता है कि हिन्दी की अस्मिता को बनाए रखने और इसकी गरिमा को बढ़ाने के लिए पूरी निष्ठा से कार्यालीन कार्यों में हिन्दी का अधिकाधिक प्रयोग करें।

संस्थान के राजभाषा अनुभाग ने हिन्दी पदों के अभाव के बावजूद संस्थान में कार्यरत वैज्ञानिक/अधिकारियों के बलबूते राजभाषा के प्रचार–प्रसार हेतु अनेकों उल्लेखनीय कार्य किए गए हैं। भाकृअनुप –के.प.स.रे.अ.सं. में हुई इन उपलब्धियों का संक्षिप्त विवरण प्रस्तुत हैं:–

प्रशासनिक उपलब्धियाँ

संस्थान ने प्रशासन के क्षेत्र में भी काफी महत्पूर्ण उपलब्धियाँ प्राप्त की हैं:–

- सभी विहित फार्मों एवं मानक मसौदे लगभग द्विभाषी हैं।
- अधिकांश रजिस्टरों के शीर्षक द्विभाषी हैं। बाकी रजिस्टरों के शीर्षक द्विभाषी रूप में किये जा रहें हैं।
- संस्थान में अधिकांश रबड़ की मोहरें, नाम पट्ट, शीर्षक–पत्र इत्यादि द्विभाषी हैं। समय–समय पर आवश्यकतानुसार मोहरें एवं नाम पट्ट द्विभाषी रूप में बनवाये जाते हैं।

- संस्थान की राजभाषा कार्यान्वयन समिति की बैठकों में होने वाली चर्चाएं सिर्फ और सिर्फ हिन्दी में होती हैं।
- अन्य भाषा–भाषी कर्मचारियों के हिन्दी शब्द ज्ञान हेतु प्रतिदिन हिन्दी का एक शब्द लिखा जाता है।
- हिन्दी अनुभाग में प्रविष्टियाँ, टिप्पणी एवं मसौदा लेखन व अन्य कार्य हिन्दी में होते हैं।
- संस्थान के कम्प्यूटरों में द्विभाषी रूप में काम करने की सुविधा उपलब्ध है तथा बाकी में हिन्दी सॉफ्टवेयर के माध्यम से द्विभाषी रूप में काम करने की व्यवस्था की जा रही है।
- संस्थान के अन्य भाषा–भाषी अधिकारियों/कर्मचारियों को हिन्दी में प्रशिक्षण देने के लिए हिन्दी शिक्षण योजना के अन्तर्गत राजभाषा कक्ष द्वारा संस्थान में ही हिन्दी कक्षायें चलायी जाती हैं। नवम्बर, 2014 वर्ष में 18 अधिकारियों एवं कर्मचारियों ने प्राज्ञ परीक्षायें उत्तीर्ण किये।
- हिन्दी अनुभाग में प्रविष्टियाँ, टिप्पणी, मसौदा लेखन व अन्य कार्य हिन्दी में होते हैं।
- हिन्दी में प्राप्त पत्रों के शत–प्रतिशत उत्तर हिन्दी में ही दिए जाते हैं।
- संस्थान में धारा 3(3) के अन्तर्गत आने वाले संस्थान के सभी दर आमंत्रण, निविदा–प्रपत्र, निविदा सूचनाएं एवं बिक्री सूचनायें आदि द्विभाषी रूप में जारी किए जाते हैं।
- संस्थान में राजभाषा विभाग के आदेशों के अनुसार संस्थान के स्वीकृत बजट में पुस्तकालयों के लिए निर्धारित कुल अनुदान राशि का 50 प्रतिशत हिन्दी पुस्तकों की खरीद पर व्यय के लक्ष्य को ध्यान में रखते हुए संस्थान में प्रयोग किए जाने वाले विज्ञान, शब्दकोष, सरकारी टिप्पणियाँ एवं कार्यालय उपयोगी संदर्भ पुस्तकें मँगवाई जाती हैं।
- संस्थान में मूल रूप से हिन्दी में काम करने पर दी जानेवाली प्रोत्साहन योजना को वर्ष 2001 से लागू किया गया है।
- भारतीय कृषि अनुसंधान परिषद् के दिनांक 31.03.1991 के परिपत्र के अनुसार संस्थान की राजभाषा कार्यान्वयन समिति की बैठकें आयोजित की जाती हैं।
- कार्यालय में प्रयुक्त सभी उपस्थिति पंजी के शीर्षक व शीर्षनाम तथा उनमें अधिकारियों/कर्मचारियों के नाम हिन्दी और अंग्रेजी दोनों भाषाओं में लिखे जाते हैं।

संस्थान में एक दिवसीय हिन्दी कार्यशाला का आयोजन

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता की राजभाषा कार्यान्वयन समिति के तत्वावधान में दिनांक 05 जुलाई, 2014 को एक दिवसीय हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला की अध्यक्षता संस्थान के निदेशक, डा. पी. जी. कर्मकार जी ने की। निदेशक महोदय ने अपने अभिभाषण में कहा कि संघ की राजभाषा नीति का मूल उद्देश्य हिंदी को जनमानस की भाषा के रूप में विकसति करना है ताकि सरकारी गतिविधियों व उपलब्धियों को आमजन तक आसानी से उपलब्ध कराई जा सके। इस नीति से सरकारी काम–काज में पादर्शिता के साथ–साथ जनमानस में हमारी विशेष पहचान बनेगी। उन्होंने संस्थान के अधिकारियों एवं कर्मचारियों से आग्रह किया कि वे कार्यशाला में प्राप्त व्यावहारिक ज्ञान

संस्थान के निदेशक डा. पी.जी. कर्मकार, एक दिवसीय हिन्दी कार्यशाला में प्रतिभागियों को संबोधित करते हुए।

का पूरा–पूरा लाभ उठाएं और कार्यालयीन कार्यों में उनका ज्यादा से ज्यादा प्रयोग करें। डा. एस. सत्पथी, प्रभागाध्यक्ष, फसल सुरक्षा ने अपने वक्तव्य में कहा कि राजभाषा विभाग, गृह मंत्रालय के अनुदेशों के अनुसार वर्ष में चार हिंदी कार्यशालाएं अवश्य आयोजित होनी चाहिए। कार्यशालाओं के आयोजन से अधिकारियों और कर्मचारियों को हिंदी में काम करते समय आने वाली कठिनाइयों को दूर करने में मदद मिलती है। डा. एस. मित्रा, प्रधान वैज्ञानिक एवं प्रभारी,

हिन्दी कार्यशाला में भाग ले रहे संस्थान के वैज्ञानिक, अधिकारी एवं कर्मचारीगण।

ए.आई.एन.पी. ने कहा कि राजभाषा हिंदी जन सम्पर्क की ऐसी भाषा है जिसे हमारे देश में ही नहीं, अपितु विदेशों में भी प्रर्याप्त सम्मान व प्रतिष्ठा प्राप्त हो रही है। उन्होंने समस्त अधिकारियों एवं कर्मचारियों

से कार्यालयीन कार्य यथासम्भव हिंदी में करने का आह्वान किया। प्रशासनिक अधिकारी, श्री एन.सी. दे ने कहा कि कार्यालयों में राजभाषा हिंदी में कार्य करने की आवश्यकता है। जिन कार्मिकों को हिंदी का कार्यसाधक ज्ञान नहीं है, उन्हें हिन्दी में कार्यसाधक ज्ञान हेतु हिंदी प्रवीण एवं प्राज्ञ में प्रशिक्षण प्राप्त करने का अनुरोध भी किया। इसके साथ ही उन्होंने बताया की मई, 2014 में आयोजित हिन्दी प्रवीण परीक्षा में संस्थान के चौदह अधिकारियों एवं कर्मचारियों ने सफलता प्राप्त की जिनमें अधिकांश ने 70 प्रतिशत से अधिक अंक अर्जित किए इसके लिए उन्होंने सभी को बधाई दिया।

कार्यशाला में व्याख्यान हेतु श्रीमती पूनम दीक्षित, सहायक निदेशक (राजभाषा), हिन्दी शिक्षण योजना, भारत सरकार, गृह मंत्रालय, राजभाषा विभाग, निजाम पैलेस, कोलकाता को आमंत्रित किया गया था। उन्होंने राजभाषा नीति, नियम तथा हिन्दी में टिप्पण, पत्र लेखन एवं मसौदा लेखन आदि विषयों पर विस्तृत जानकारी प्रदान करायीं तथा कार्यालयीन कार्यों में हिंदी में आम तौर पर प्रयोग में आने वाले

मुख्य वक्ता श्रीमती पूनम दीक्षित, सहायक निदेशक (रा.भा.), हि.शि.यो., गृ.म., भारत सरकार, निजाम पैलेस, कोलकाता प्रतिभागियों को प्रशिक्षण प्रदान करती हुईं।

शब्दों के लिंग तथा उनकी पहचान के मूल नियमों की जानकारी देते हुए सोदाहरण समझाया और प्रतिभागियों से अभ्यास भी करवाया। साथ ही उन्होंने प्रतिभागियों द्वारा उठाए गए प्रश्नों का समाधान भी किया। इस कार्यशाला में संस्थान के अधिकारियों एवं कर्मचारियों ने उत्साहपूर्वक भाग लिया। डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने कहा कि हिंदी केवल कागजों की भाषा बनकर न रहे, इसे हमें अपने चिन्तन की भाषा बनाने की आवश्यकता है तभी हिंदी का प्रसार मनोनुकूल हो सकेगा और इसमें हम सभी को बराबर का सहयोग देना होगा। उन्होंने आगे सभी अधिकारियों एवं कर्मचारियों से संस्थान द्वारा प्रकाशित होने वाली पत्रिका "रेशा किरण" हेतु सामग्री जैसे–कविता, कहानी, वैज्ञानिक लेख आदि हिंदी कक्ष को उपलब्ध कराने का अनुरोध भी किया।

कार्यशाला का समापन डा. सुनीति कुमार झा, वरिष्ठ वैज्ञानिक, कृषि प्रसार के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ।

संस्थान में एक दिवसीय हिन्दी कार्यशाला का आयोजन

केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता की राजभाषा कार्यान्वयन समिति के तत्वावधान में दिनांक 24 मार्च, 2015 को संस्थान में एक दिवसीय हिन्दी कार्यशाला का आयोजन किया गया। इसकी अध्यक्षता संस्थान के निदेशक, डा.

हिन्दी प्रभारी, डा. एस.के. पाण्डेय हिन्दी कार्यशाला में शामिल प्रतिभागियों को संबोधित करते हुए।

पी.जी. कर्मकार जी ने की। निदेशक महोदय ने अपने अध्यक्षीय संबोधन में कहा कि संघ की राजभाषा नीति का मूलमंत्र सद्भावना, प्रेरणा एवं प्रोत्साहन है, इनके माध्यम से ही हम कर्मचारियों को राजभाषा में कार्यालयीन कार्य करने हेतु प्रेरित करते हैं और धीरे–धीरे हम अपने लक्ष्य की ओर अग्रसर हो रहे हैं। उन्होंने वार्षिक पत्रिका 'रेशा किरण' के प्रथम संस्करण के प्रकाशन पर खुशी जाहिर की तथा रेशा किरण की एक प्रति मुख्य वक्ता को भी दिया। डा. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन प्रभाग ने कहा कि भारत सरकार की राजभाषा नीति सीधी, सरल एवं प्रेरणादायी है, हम सब का कर्तव्य है कि राजभाषा को अपनाकर हम अपने कार्यालय में इसका अधिकाधिक प्रयोग करें। डा. सिंताशु सरकार, प्रभारी, कृषि प्रसार ने भी राजभाषा में कार्य करने पर बल दिया। प्रशासनिक अधिकारी, श्री एन.सी. दे ने समस्त अधिकारियों एवं कर्मचारियों से कार्यालयीन कार्य यथासंम्भव हिंदी में करने का आह्वान किया। डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, राजभाषा ने बताया की नवम्बर, 2014 में आयोजित हिन्दी प्रवीण परीक्षा में संस्थान के अट्ठारह अधिकारियों एवं कर्मचारियों ने सफलता प्राप्त की जिनमें अधिकांश ने 70 प्रतिशत से अधिक अंक अर्जित किए इसके लिए उन्होंने सभी को बधाई दिया।

कार्यशाला में व्याख्यान हेतु डा. रमेश मोहन झा, प्राध्यापक, हिन्दी शिक्षण योजना, भारत सरकार, गृह मंत्रालय, राजभाषा विभाग, निजाम पैलेस, कोलकाता को आमंत्रित किया गया था। उन्होंने राजभाषा नीति, नियम तथा हिन्दी में टिप्पण, पत्र लेखन एवं मसौदा लेखन आदि विषयों पर विस्तृत जानकारी प्रदान की तथा हिंदी भाषा के

मुख्य वक्ता डा. रमेश मोहन झा, प्राध्यापक, हि.शि.यो., गृ.म., भारत सरकार, निजाम पैलेस, कोलकाता हिन्दी कार्यशाला में प्रतिभागियों को प्रशिक्षण प्रदान करते हुए।

मानकीकरण पर विस्तार से चर्चा करते हुए शुद्ध व मानक वर्तनी से प्रतिभागियों को अगवत कराया, साथ ही, हिंदी भाषा की व्याकरणिक संरचना का सोदाहरण परिचय दिया। साथ ही उन्होंने प्रतिभागियों द्वारा उठाए गए प्रश्नों का समाधान भी किया। इस कार्यशाला में संस्थान के 60 अधिकारियों एवं कर्मचारियों ने भाग लिया।

संस्थान में हिन्दी पखवाड़ा का आयोजन

सरकारी काम–काज में राजभाषा हिन्दी के प्रति जागरूकता पैदा करने तथा उसके प्रभावों में गतिशिलता लाने के उद्देश्य से संस्थान में 15 से 29 सितम्बर, 2014 के दौरान हिन्दी पखवाड़ा का आयोजन किया गया जिसका उद्घाटन संस्थान के निदेशक, डा. पी.जी. कर्मकार

हिन्दी पखवाड़ा के उद्घाटन सत्र में संस्थान के अधिकारियों एवं कर्मचारियों को स्वागत भाषण प्रस्तुत करते हिन्दी प्रभारी, डा. एस. के. पाण्डेय।

द्वारा किया गया तथा मुख्य अतिथि/वक्ता के रूप में डा. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय संघटन को आमंत्रित किया गया था। उद्घाटन समारोह में संस्थान के सभी अधिकारियों/कर्मचारियों ने उत्साहपूर्वक भाग लिया। कार्यक्रम का संचालन करते हुए डा. सुरेन्द्र कुमार पाण्डेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने इस अवसर पर उपस्थित अधिकारियों एवं कर्मचारियों को संस्थान की राजभाषा कार्यान्वयन समिति की ओर से हार्दिक अभिनन्दन करते हुए उन्हें हिन्दी पखवाड़ा के दौरान आयोजित किए जाने वाली विभिन्न हिन्दी प्रतियोगिताओं की जानकारी देते हुए उनसे अनुरोध किया कि वे विभिन्न हिन्दी प्रतियोगिताओं में अधिकाधिक संख्या में भाग लेकर इस आयोजन को सफल बनाएं। डा. पी.जी. कर्मकार, निदेशक, के.प.स. रे.अ.सं. ने अपने संबोधन में कहा कि हिन्दी एक सरल भाषा है तथा हम अपनी अभिव्यक्ति इसके माध्यम से आसानी से कर सकते हैं। उन्होंने आगे कहा कि हिंदी ही एक ऐसी भाषा है जो सम्पूर्ण राष्ट्र को एक सूत्र में पिरोने में सफल रही है। अतः हिंदी की व्यापकता को देखते हुए सभी कर्मचारी एवं अधिकारी अपने–अपने कार्यों में हिंदी

संस्थान के निदेशक, डा. पी.जी. कर्मकार, हिन्दी पखवाड़ा के उद्घाटन सत्र में प्रतिभागियों को संबोधित करते हुए।

को ही अपनाएं। उन्होंने कहा कि भाषा प्रयोग से ही आगे बढ़ती है और हम सभी को उन्मुक्त हृदय से इसे अपनाना होगा तभी हम हिंदी को विश्व पटल पर आलोकित कर सकेगें। आगे उन्होंने कहा कि हमारा संस्थान 'ग' क्षेत्र में स्थित होने के बावजूद भी हिंदी के क्षेत्र में सराहनीय कार्य करते हुए संस्थान की गृह पत्रिका 'रेशा किरण' की प्रथम संस्करण को प्रकाशित करने जा रहा है जिसके लिए सभी बधाई के पात्र हैं। उन्होंने हिन्दी पखवाड़ा के दौरान विभिन्न प्रतियोगिताओं में सभी अधिकारियों एवं कर्मचारियों को बढ़–चढ़कर हिस्सा लेने का आहवान करते हुए शुभकामनाएं भी दीं। डा. एस. सतपथी, प्रभागाध्यक्ष, फसल सुरक्षा ने अपने अभिभाषण में सभी अधिकारियों एवं कर्मचारियों से अपना अधिकतम कार्यालयीन कार्य हिंदी में करने का अनुरोध किया। इसके साथ–साथ संस्थान द्वारा प्रकाशित होने वाली हिन्दी

मुख्य अतिथि, एवं वक्ता डा. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय संगठन, हिन्दी पखवाड़ा के उद्घाटन सत्र में अधिकरियों एवं कर्मचारियों को संबोधित करते हुए।

पत्रिका 'रेशा किरण' की प्रथम संस्करण के प्रकाशन के लिए शुभ–कामनाएं भी दी जिसका विमोचन पखवाड़ा के समापन सत्र में किया जाना सुनिश्चित था। डा. एस. मित्रा, प्रधान वैज्ञानिक एवं प्रभारी, अखिल भारतीय पटसन एवं समवर्गीय रेशा परियोजना ने कहा कि राजभाषा का कार्यालयीन कार्यों में अधिकाधिक प्रयोग अपरिहार्य है और इस दिशा में सीमित साधनों के बावजूद अब तक हमारी प्रगति उत्साहवर्द्धक रही है। डा. सिंताशु सरकार, प्रधान वैज्ञानिक तथा प्रभारी, कृषि प्रसार ने सभागार में उपस्थित समस्त कर्मचारियों से आग्रह किया कि प्रत्येक व्यक्ति हिंदी सीखने का संकल्प ले जिससे हिंदी न केवल जनसाधारण की भाषा बने बल्कि कार्यालयीन कामकाज में उसका निरंतर प्रयोग भी हो। श्री एन.सी. दे, प्रशासनिक अधिकारी ने अपने संबोधन में कहा कि भारत में विभिन्न प्रकार की भाषाएं बोली जाती हैं जिनमें हिंदी संपर्क भाषा का दायित्व निभा रही है साथ ही हमारी राजभाषा भी है। उन्होंने आगे कहा कि जिस तरह हिंदी पखवाड़ा प्रतियोगिताओं में अधिकारी/कर्मचारी भाग लेते हैं उसी जोश और जज्वात के साथ दैनंदिन कार्यों में भी हिंदी का प्रयोग जारी रखें। अंत में डा. एन. सिंह, पूर्व प्राचार्य, केन्द्रीय विद्यालय संघटन ने अपने संबोधन में उपस्थित अधिकारियों/कर्मचारियों का स्वागत करते हुए हिंदी भाषा के संबंध में और संविधान में की गई व्यवस्थाओं पर सारगर्भित भाषण देते हुए कहा कि राष्ट्र के प्रत्येक जनमानस को एक सूत्र में बांधने के लिए हिंदी, एक सफल माध्यम है तथा हम सबका नैतिक दायित्व है कि इसके विकास में अपना विशिष्ट योगदान दें ताकि राजभाषा हिन्दी को नए आयाम तक पहुंचाया जा सके।

हिन्दी पखवाड़ा के दौरान संस्थान के हिन्दीत्तर भाषी तथा हिन्दी भाषी अधिकारियों/कर्मचारियों को हिन्दी कार्य के प्रति अभिरूची जागृत करने के उद्देश्य से विभिन्न प्रकार की 10 लिखित तथा मौखिक प्रतियोगितायें आयोजित की गईं जिसमें संस्थान के अधिकांश अधिकारियों/कर्मचारियों ने बड़े ही उत्साहपूर्वक भाग लिया। दिनांक 27.09.2014 को वैज्ञानिक विचार गोष्ठी भी आयोजित की गई जिसमें

हिन्दी पखवाड़ा समारोह के अवसर पर हिन्दी प्रतियोगिताओं में भाग ले रहे प्रतिभागीगण।

संस्थान से वैज्ञानिक लेख पुस्तिका एवं हिंदी पत्रिका प्रकाशित करने हेतु कई महत्वपूर्ण सुझाव दिये गये तथा संस्थान के सभी वैज्ञानिकों ने ''रेशा' किरण' के प्रथम संस्करण के प्रकाशन हेतु हिंदी कक्ष तथा संस्थान के सभी कर्मचारियों को बधाई दिया।

संस्थान में बड़े ही उत्साहपूर्ण वातावरण में हिन्दी पखवाड़ा समापन समारोह का आयोजन दिनांक 29 सितम्बर, 2014 को किया गया।

हिन्दी पखवाड़ा के समापान समारोह में प्रतिभागियों को संबोधित करते हुए मुख्य अतिथि, डा. आर. एस. पाण्डेय।

इस अवसर पर डा. आर.एस. पाण्डेय, पूर्व वैज्ञानिक अधिकारी एवं विभागीय अध्यक्ष, अनुसंधान विकास एवं प्रशिक्षण प्रभाग, एम.ए.टी.एम.ओ., सी.जी.ओ. कॉम्पलेक्स, साल्ट लेक, कोलकाता मुख्य अतिथि के तौर पर आमंत्रित थे। कार्यक्रम की अध्यक्षता संस्थान के निदेशक एवं अध्यक्ष, राजभाषा कार्यान्वयन समिति, डा. पी. जी. कर्मकार ने की तथा इस अवसर पर डा. एस. सतपथी, प्रभागाध्यक्ष, फसल सुरक्षा,

हिन्दी पखवाड़ा समापन समारोह के दौरान राजभाषा गृह पत्रिका 'रेशा किरण' के प्रथम अंक का विमोचन करते हुए मंचासिन निदेशक महोदय एवं अन्य गणमान्य व्यक्ति।

डा. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन, डा. एस. मित्रा, प्रभारी, ए.आई.एन.पी. एवं श्री एन.सी. दे, प्रशासनिक अधिकारी भी मंचासीन थे। पखवाड़ा के समापन समारोह में हिंदी पत्रिका 'रेशा किरण' के प्रथम अंक का विमोचन मुख्य अतिथि, डा. आर.एस. पाण्डेय तथा निदेशक महोदय के कर–कमलों द्वारा सम्पन्न हुआ।

निदेशक महोदय, डा. पी.जी. कर्मकार, ने अपने अध्यक्षीय भाषण में कहा कि संस्थान के सभी वैज्ञानिकों तथा कर्मचारियों को राजभाषा हिंदी को बढ़ावा देने के लिए ज्यादा से ज्यादा हिंदी में कार्य करने

का प्रयास करना चाहिए। 'रेशा किरण' के प्रथम संस्सकण के प्रकाशन पर इस पत्रिका से जुडे सभी सदस्यों तथा हिंदी कक्ष को हार्दिक बधाई देते हुए इसकी निरंतरता को बनाये रखने की उन्होंने अपील किया। डा. एस. सतपथी, प्रभागाध्यक्ष, फसल सुरक्षा ने सभागार में उपस्थित समस्त सदस्यों से अनुरोध किया कि वे अपना अधिकाधिक कार्य हिंदी में निष्पादित करें ताकि संस्थान के लिए एक अनुकरण ीय उदाहरण स्थापित हो सके। उन्होंने 'रेशा किरण' के प्रकाशन पर सभी को बधाई दिया। डा. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन ने कहा कि राजभाषा का प्रयोग बढ़ाने के लिए सभी को आगे बढ़कर प्रयास करना होगा। इस अवसर पर उन्होंने 'रेशा किरण' के सफल प्रकाशन के लिए हिन्दी कक्ष तथा संस्थान के सभी कर्मिकों को बधाई दिया। डा. एस. मित्रा, प्रधान वैज्ञानिक एवं प्रभारी, ए.आई.एन. पी., ने अपने अभिभाषण में कहा कि हमारा दायित्व है कि हम हिंदी का अधिकाधिक प्रचार–प्रसार करें और अपना अधिकाधिक कार्य हिंदी में करें ताकि हमारा राजभाषा के प्रति रूचि बरकरार रहे। श्री एन. सी. दे, प्रशासनिक अधिकारी ने अपने संबोधन में राजभाषा हिंदी के अधिकाधिक प्रयोग के महत्व को रेखांकित किया तथा सभी पुरस्कार विजेताओं को बधाई देते हुए आह्वान किया कि वे अपने कार्यालयनी

विभिन्न प्रतिभागिताओं में सफल प्रतिभागियों को पुरस्कृत करते हुए संस्थान के निदेशक, डा. पी. जी. कर्मकार।

कार्य में राजभाषा हिंदी का प्रयोग कर अपने कर्तव्य का पालन करें। साथ ही 'रेशा किरण' के प्रकाशन पर प्रसन्नता व्यक्त करते हुए हिंदी कक्ष तथा अन्य लेखकों को हार्दिक बधाई दिया। मुख्य अतिथि/वक्ता, डा. आर.एस. पाण्डेय ने अपने भाषण में कहा कि हिंदी भाषा की महत्ता दिन प्रतिदिन बढ़ रही है। उन्होंने राजभाषा के विकास के लिए उठाए गए कदमों पर प्रकाश डाला। उन्होंने सभागार में उपस्थित सभी अधिकारियों/कर्मचारियों को स्वरचित कविता–पाठ भी सुनाया। साथ ही 'रेशा किरण' के सुंदर प्रकाशन हेतु बधाई देते हुए कहा कि यह पत्रिका अत्यन्त ही उत्कृष्ट एवं गुणवत्ता युक्त है तथा यह पुरस्कृत होने के सभी मानकों को पूर्ण करता है।

अंत में सभी विजेता प्रतियोगियों को (क्रमशः प्रथम, द्वितीय एवं तृतीय) संस्थान के निदेशक, डा. पी.जी. कर्मकार, डा. एस. सतपथी, प्रभागाध्यक्ष, फसल सुरक्षा, डा. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन, डा. एस. मित्रा, प्रधान वैज्ञानिक एवं प्रभारी, ए.आई.एन.पी, मुख्य अतिथि, डा. आर.एस. पाण्ड़ेय तथा श्री एन.सी.दे, प्रशासनिक अधिकारी के कर–कमलों द्वारा पुरस्कार प्रदान किया गया।

हिन्दी पखवाड़ा समापन सत्र का सफल संचालन डा. सुरेन्द्र कुमार पाण्ड़ेय, वरिष्ठ वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया। कार्यक्रम का समापन डा. सुनीति कुमार झा, वरिष्ठ वैज्ञानिक के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ ।

सनई अनुसंधान केन्द्र, प्रतापगढ़, उत्तर प्रदेश में हिन्दी सप्ताह का आयोजन

सनई अनुसंधान केन्द्र, प्रतापगढ़ में हिन्दी सप्ताह का आयोजन दिनांक 14 से 20 सितम्बर, 2014 तक किया गया। उद्घाटन सत्र में डा. शैलेन्द्र द्विवेदी, जिला उद्यान अधिकारी, प्रतापगढ़ तथा विशिष्ट

सनई अनुसंधान केन्द्र, प्रतापगढ़ में आयोजित हिन्दी सप्ताह के उद्घाटन सत्र को संबोधित करते हुए प्रभारी वैज्ञानिक, डा. मनोज कुमार त्रिपाठी।

अतिथि डा. अखिलेश पाण्डेय, प्रोफेसर, मनिश्वर दत्त, स्नातकोत्तर महाविद्यालय, प्रतापगढ़ मुख्य अतिथि के रूप में उपस्थित रहे। डा. पाण्डेय ने अपने संबोधन में हिंदी भाषा के इतिहास, विकास एवं महत्वता पर प्रकाश डाला। डा. द्विवेदी ने अपने व्याख्यान में लोगों से कहा कि हमें अपना कार्य हिंदी में करने पर गौरवानित होना चाहिए। केन्द्र में हिंदी सप्ताह के अंतर्गत विभिन्न प्रतियोगिताएं आयोजित की गयी जिसमें केन्द्र के कर्मचारियों एवं अधिकारियों ने उत्साहपूर्वक

मुख्य अतिथि, डा. शैलेन्द्र द्विवेदी, जिला उद्यान अधिकारी, प्रतापगढ़, सनई अनुसंधान केन्द्र के अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

सहभागिता दर्ज करायी। कार्यक्रम का समापन 20 सितम्बर, 2014 को हुआ। समापन समारोह में मुख्य अतिथि के रूप में श्री अतुल कुमार, उपजिलाधिकारी, प्रतापगढ़ उपस्थित थे। अतिथियों ने इस अवसर पर हिंदी के अधिकाधिक प्रयोग पर बल देते हुए वैज्ञानिक समुदाय से आह्वान किया कि वे अपना शोधकार्य हिन्दी में प्रकाशित करें जिससे आम जनमानस उसे समझ सके। हिंदी सप्ताह के समापन समारोह के अवसर पर प्रथम, द्वितीय व तृतीय स्थान प्राप्त करने वाले प्रतिभागियों को पुरस्कृत भी किया गया।

कार्यक्रम का संचालन, डा. मनोज कुमार त्रिपाठी, वरिष्ठ वैज्ञानिक एवं प्रभारी तथा धन्यवाद प्रस्ताव डा. बबिता चौधरी, वरिष्ठ वैज्ञानिक द्वारा किया गया।

रेमी अनुसंधान केन्द्र, सरभोग, असम में हिन्दी सप्ताह

रेमी अनुसंधान केन्द्र सरभोग, असम में दिनांक 12 से 17 सितम्बर, 2014 के दौरान हिन्दी सप्ताह का आयोजन किया गया जिसका

रेमी अनुसंधान केन्द्र, सरभोग के प्रभारी वैज्ञानिक, डा. ए.के. शर्मा हिन्दी सप्ताह समापन सत्र के दौरान मुख्य अतिथि श्री टी.के. बनर्जी को स्वागत करते हुए।

उद्घाटन दिनांक 12 सितम्बर, 2014 को हुआ। हिन्दी सप्ताह की अध्यक्षता केन्द्र के प्रभारी वैज्ञानिक, डा. अमित कुमार शर्मा ने की। दिनांक 14 सितम्बर को आयोजित कार्यक्रम में केन्द्र के वैज्ञानिक डा. एस.पी. गवांडे ने हिन्दीत्तर भाषी विशेष रूप से 'ग' क्षेत्र में स्थित असम के लोगों को देश के विकास में हिन्दी के महत्व पर विस्तार से

मुख्य अतिथि श्री टी.के. बनर्जी रेमी अनुसंधान केन्द्र, सरभोग के कर्मचारियों को संबोधित करते हुए।

प्रकाश डाला। राजभाषा सप्ताह के अंतिम दिन दिनांक 17 सितम्बर, 2014 को कृषि ज्ञान प्रतियोगिता एवं भाषण प्रतियोगिता भी आयोजित की गयी। इस अवसर पर मुख्य अतिथि ए/10 सी.आर.पी.एफ. कम्पनी के कार्यकारी प्रभारी श्री टी.के. बनर्जी ने सफल प्रतिभागियों को पुरस्कार वितरित किया तथा हिन्दी के माध्यम से राष्ट्र के विकास में सभी के योगदान का आह्वान किया। हिन्दी भाषण प्रतियोगिता में मो. समशूल हक ने प्रथम तथा श्री दिनेश दास ने द्वितीय स्थान प्राप्त किया। कार्यक्रम में श्री बीरबल रामचियारी, श्री मुनिन्द्र कुमार दास, श्री आनंद बसुमतारी तथा रंजन दास ने अपने विचार रखे। कार्यक्रम में केन्द्र के सभी कर्मचारियों के अलावा सी.आर.पी.एफ. कम्पनी के जवानों ने भी भाग लिया। कार्यक्रम का संचालन पंकज कुमार दास, सहायक, रेमी अनुसंधान केन्द्र ने किया।

सीसल अनुसंधान केन्द्र, बामरा, ओडिशा में हिन्दी दिवस

सीसल अनुसंधान केन्द्र, बामरा, ओडिशा में दिनांक 15 सितम्बर, 2014 को हिन्दी दिवस का आयोजन किया गया जिसकी अध्यक्षता केन्द्र के प्रभारी वैज्ञानिक डा. अजित कुमार झा ने की। डा. झा ने अपने अध्यक्षीय सम्बोधन में केन्द्र के समस्त अधिकारियों एवं कर्मचारियों को राष्ट्र की एकता एवं समरसता को बनाये रखने में राजभाषा हिन्दी के महत्व को विस्तार से समझाया। कार्यक्रम में उपस्थित सभी कर्मिकों को केन्द्र के दैनिक क्रिया कलापों में हिंदी के अधिकाधिक प्रयोग पर बल देते हुए सभी का आह्वान किया कि हिन्दी को राजभाषा का

सीसल अनुसंधन केन्द्र, बामरा में हिन्दी दिवस समारोह के दौरान केन्द्र के कर्मचारियों को संबोधित करते हुए प्रभारी वैज्ञानिक, डा.ए.के.झा।

दर्जा प्राप्त है जिसका उचित स्थान दिलाना हम सभी भारतीय का मूल कर्तव्य है। इस दौरान हिन्दी तात्कालिक भाषण प्रतियोगिता का आयोजन भी किया गया जिसमें केन्द्र के कर्मचारियों ने बढ़–चढ़कर हिस्सा लिया। कार्यक्रम के अन्त में केन्द्र के सभी कर्मचारियों ने अपने कार्यालयीन कार्यों में यथा सम्भव हिन्दी का प्रयोग करने का आह्वान करते हुए सीसल के नवीनतम अनुसंधान उपलब्धियों को जनजातीय समुदायों में उनकी स्थानीय भाषा के साथ–साथ हिन्दी के माध्यम से से भी पहुंचाने का संकल्प लिया (स्रोतः डा. एस.के. पाण्डेय एवं मनोज कुमार राय)।

21. Committees

21.1 Research Advisory Committee (RAC)

The Research Advisory Committee (RAC) meeting of the institute for 2014-15 was held during 17-18 April, 2015 under the Chairmanship of Prof. S.K. Sanyal, former Vice Chancellor, BCKV, West Bengal. Dr. N. Gopalakrishnan, AGD (CC), ICAR, Dr. K.K. Satapathy, former Director, ICAR-NIRJAFT, Dr. K. Ramaraju, Director, Centre for Plant Protection Studies, TNAU and Dr. M.A.A. Baig, Former Professor, OUAT attended the meeting as members.

Dr. D. Nag, Director, ICAR-NIRJAFT and Dr. P.K. Das former Professor, BCKV also attended the meeting as special invitee. Dr. D.K. Kundu, Head, Crop Production Division acted as the member secretary. The Research Advisory Committee (RAC) expressed its satisfaction by noting the commendable performance of the scientists at ICAR-CRIJAF during the last one year. The RAC was satisfied with the Action Taken Report (ATR) presented in this meeting. In addition to carrying forward the studies being conducted by the scientists in response to the recommendations of the RAC made in 2014, the present meeting of the RAC made the following specific recommendations for further strengthening of the research activities of the Institutes.

- Strengthening of study on bioinformatics of genomic resources of jute and allied fibres
- Exploring potential of hybrid production in kenaf using male sterility system
- Utilization of multi-parents mapping population in tossa jute to enhance linkage map saturation
- Development of high yielding flax genotypes suitable to changing climate
- Conduct of basic and strategic research on weed ecology and environmentally safe herbicides for controlling weeds in jute and mesta
- Development of water saving retting technology including ribbon retting of jute and mesta
- Development of conservation agriculture practices for jute and allied fibre crops based cropping systems
- Critical appraisal of the impact of jute fibre production technologies on the environment
- Development of artificial screening protocol for important pests and disease by standardization of techniques with high repeatability. Prioritization of germplasm screening for resistance against jute stem rot in sick plot
- Characterization of biochemical and volatile organic compounds in jute and allied fibres imparting specific behavioural response in insects
- Long term impact analysis of improved varieties and technologies disseminated by ICAR-CRIJAF

The Chairman and the members of the RAC appreciated the efforts of the Director and all the scientists of ICAR-CRIJAF for their excellent research work for development and identification of new improved varieties and development of technologies to bring economic prosperity to the farmers engaged in production of jute and allied fibre crops. The committee also appreciated the efforts made by Dr. P.G. Karmakar, Director, ICAR-CRIJAF and Dr. D.K. Kundu, Member Secretary, RAC for excellent organization of the RAC meeting and monitoring of the research activities.

21.2 Institute Management Committee (IMC)

The 31st Institute Management Committee (IMC) meeting of ICAR-CRIJAF for 2014-15 was held on 22 November, 2014 under the chairmanship of Dr. P.G. Karmakar, Director, ICAR-CRIJAF. Other members present in the meeting were Dr. Satyananda Sushil, Plant Protection Advisor, Government of India, Dr. M. Singh, Head, Crop Improvement Division, ICAR-IIVR, Varanasi and Dr. (Mrs.) Mayabini Jena, Pr. Scientist, ICAR-CRRI, Cuttack.

Mr. N.C. Dey, AO, ICAR-CRIJAF as Member Secretary, organized the meeting. Heads of the Divisions/Section, Scientist In-charge, AINP on JAF, Scientist in-charge of Regional Stations, PC (I/c), KVK, Burdwan, Scientists in-charge, PME cell and the SFAO, ICAR-CRIJAF, were also present in the meeting.

21.3 Institute Research Council (IRC)

The Institute Research Council (IRC) meeting for the year 2014-15 was organized on 24th and 28th April, 2015 under the Chairmanship of Dr. P.G. Karmakar, Director, ICAR-CRIJAF to review the on-going inhouse research projects and the new research project proposals submitted by the scientists. Research activities of the institute were reoriented in different programmes under which relevant projects were included. All the HoDs, Scientists from the regional station and In-charge, KVK, Bud Bud were also present in the IRC meeting.

The progress of ongoing research projects were reviewed, further 13 new research project proposals were discussed and necessary modifications were recommended. After completion of due time, 20 research projects were concluded with specific recommendation and 2 projects were merged with existing projects.

21.4 Project Monitoring and Evaluation Committee (PMC)

The project monitoring and evaluation committee meeting was held on 27 August, 2014 under the chairmanship of Director, ICAR-CRIJAF and external members to evaluate the 6 concluded projects during, 2013-14. Out of 6 projects, two were graded as excellent, three as very satisfied and one as satisfied.

21.5 Results Framework Document (RFD) Committee

Results Framework Document (RFD) Committee has been constituted as per the guidelines of the ICAR. The committee meets periodically to discuss and finalize the success indicators of the monthly RFD, midterm and annual RFD performance report before sending to ICAR. The institutes set **"Excellent"** performance standard and achieved a total composite score of 97.5% in the annual (1 April, 2014 to 31 March, 2015) performance evaluation report (Annexure - I).

22. Distinguished Visitors

Name of visitor	Affiliation	Date
Dr. Debashis Nag	Director, ICAR-NIRJAFT, Kolkata	22.05.14, 13.02.15
Prof. S. K. Sanyal	Former Vice-Chancellor, BCKV, Mohanpur	11.06.14
Mr. Sujit Mitra	Director (Crop Science), ICAR, New Delhi	18.06.14
Mrs. Punam Dixit	Asstt. Director (Official Language), Kolkata	05.07.14
Prof. Swapan Kr. Datta	DDG (Crop Science), ICAR, New Delhi	19.09.14, 02.10.14
Dr. H. S. Sen	Former Director, ICAR-CRIJAF, Barrackpore	19.09.14
Dr. K. K. Satapathy	Former Director, ICAR-NIRJAFT, Kolkata	19.09.14
Dr. Satyananda Sushil	Plant Protection Advisor, Govt. of India, New Delhi	22.11.14
Dr. D. L. N. Rao	Project Coordinator (Biological Nitrogen Fixation), ICAR-IISS, Bhopal	27.11.14
Dr. R. K. Pal	Director, ICAR-NRC Pomegranate, Solapur	23.12.14
Dr. D. K. Sharma	Director, ICAR-CSSRI, Karnal	31.12.14
Dr. A. K. Patra	Director, ICAR-IISS, Bhopal	16.01.15
Dr. S. Ayyappan	Secretary, DARE & DG, ICAR, New Delhi	17.01.15
Prof. Tapash Dasgupta	Director, Institute of Agril. Science, Calcutta University, Kolkata	24.01.15
Dr. N. Gopalakrishnan	ADG (Commercial Crops), ICAR, New Delhi	13.02.15
Dr. Subrata Gupta, IAS	Jute Commissioner, Govt. of India, Kolkata	13.02.15
Dr. Jeet Singh Sandhu	DDG (Crop Science), ICAR, New Delhi	15.02.15

Dr. S. Ayyappan, Secretary, DARE & DG, ICAR is visiting institute campus

Secretary, DARE & DG, ICAR is interacting with scientists

Dr. J.S. Sandhu, Hon'ble DDG (Crop Science) is releasing institute publications

Prof. S. K. Sanyal Former Vice Chancellor, BCKV addressing the farmers

Dr. S. Gupta IAS, Jute Commissioner, GoI interacting with ADG (CC), Director, ICAR-CRIJAF & NIRJAFT

Dr. N. Gopalakrishnan, ADG (Commercial Crops), ICAR addressing RAC meeting

Mr. Sujit Mitra, Director, Crop Science observing the renovation work at ICAR-CRIJAF

Dr. A.K. Patra, Director, ICAR-IISS interacting with ICAR-CRIJAF scientists

23. Staff Position

Table 23.1. Staff position of ICAR-CRIJAF along with the sub-stations as on 31.03.2015

Category	Sanctioned strength	Staff in position					Total
		CRIJAF (HQ)	Sub-station				
			CSRSJAF	RRS	SRS	ShRS	
Scientist	74+1 (RMP)	44	03	02	01	02	52
Technical	108	40	07	05	04	04	60
Administration	62	25	01	03	02	02	33
SSS	92	26	02	00	02	02	32

Table 23.2. Staff position at Krishi Vigyan Kendra, Bud Bud, Burdwan as on 31.03.2015

Designation	Sanctioned strength	Persons in position
Programme Coordinator	01	00
Subject Matter Specialist	06	06
Farm Manager	01	01
Programme Asstt. (Computer)	01	01
Programme Asstt.	01	01
Office Supdt. cum Accountant	01	01
Stenographer	01	01
Driver	02	02
Supporting Staff	02	02
Total	16	15

24. Personnel

24.1 Staff in Position

Name	Designation	E-mail id
Dr. P. G. Karmakar	Director (w.e.f. 21.04.2014)	pgkcrijaf@yahoo.com
Dr. S. Satpathy	Director (Actg.) (up to 20.04.2014)	satp1@rediffmail.com
Division of Crop Improvement		
Dr. J. Mitra	Pr. Scientist (Plant Breeding)	jiban15@rediffmail.com
Dr. Asit B. Mandal	Pr. Scientist (Plant Breeding)	amandal2@rediffmail.com
Dr. D. Sarkar	Pr. Scientist (Biotechnology)	debabrata_s@yahoo.com
Dr. C. S. Kar	Pr. Scientist (Plant Breeding)	chandanskar@gmail.com
Dr. P. Satya	Sr. Scientist (Plant Breeding)	satyapratik123@rediffmail.com
Dr. D. Saha	Sr. Scientist (Biotechnology) joined on 26.05.2014	dipsaha72@yahoo.com
Dr. S. Dutta	Sr. Scientist (Biotechnology) joined on 18.11.2014	subhojit@email.com
Dr. A. K. Chakraborty	Scientist (Agril. Statistics)	asimkumarc@yahoo.in
Dr. S. B. Choudhary	Scientist (Plant Breeding)	shashigen@gmail.com
Dr. Amit Bera	Scientist (Seed Technology)	amitbera.iari@gmail.com
Dr. H. K. Sharma	Scientist (Plant Breeding)	harrygpb@gmail.com
Sri L. L. Kharbikar	Scientist (Biotechnology)	lkhabikar@crijaf.org.in
Smt. Kanti Meena	Scientist (Biotechnology)	kantimeena@gmail.com
Dr. Anil Kumar	Scientist (Plant Breeding)	anil.arroju@gmail.com
Dr. Maruthi R. T.	Scientist (Plant Genetics)	maru7806@gmail.com
Sri Basudev Ghosh	Technical Officer	bghosh.crijaf@gmail.com
Division of Crop Production		
Dr. D. K. Kundu	Pr. Scientist (Soil Science) & Head	kundu_crijaf@yahoo.com
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Dr. B. Majumdar	Pr. Scientist (Soil Science)	bijju5@rediffmail.com
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Dr. Mukesh Kumar	Scientist (Agronomy)	mukesh_agro@rediffmail.com
Dr. R. K. Naik	Scientist (Farm Machinery & Power)	ranjanagrieng@rediffmail.com
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Sri M. Ramesh Naik	Scientist (Agronomy)	rameshag16@gmail.com
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Sri Sk. Phirose	Technical Officer	skphirose1@gmail.com
Sri D. C. Dey	Technical Officer	-
Smt. Gita Das	Technical Officer	-
Sri D. K. Patra	Technical Officer	patradillipkumar6@gmail.com
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Dr. S. Satpathy	Pr. Scientist (Entomology) & Head	satp1@rediffmail.com
Dr. R. K. De	Pr. Scientist (Plant Pathology)	rkde@rediffmail.com

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Dr. S. K. Sarkar	Pr. Scientist (Plant Pathology) & I/C w.e.f. 12.03.15	surjapath@gmail.com
Dr. R. K. Naik	Scientist (Farm Machinery & Power) w.e.f. 12.03.15	ranjanagrieng@rediffmail.com
Ramie Research Station, Sorbhog, Assam		
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Sunnhemp Research Station, Pratapgarh, Uttar Pradesh		
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Dr. Babita Chaudhary	Sr. Scientist (Plant Breeding)	babitac@crijaf.org.in
Sri Om Prakash	Sr. Technical Officer	-
Central Seed Research Station for Jute and Allied Fibres, Bud Bud, West Bengal		
Dr. S. Biswas	Pr. Scientist (Plant Pathology) & I/C	subrata.biswas57@gmail.com
Sri H. R. Bhandari	Scientist (Plant Breeding) on study leave	hempbg@gmail.com
Sri Monu Kumar	Scientist (Plant Breeding) joined on 07.04.2014	monuiari10@gmail.com
Sri L. N. Ghosh	Technical Officer	lnghoshcrijaf@gmail.com
Library		
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Krishi Vigyan Kendra (KVK), Burdwan		
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Results Framework Document Cell		
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Farm Management Committee		
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Dr. A. K. Ghorai	Pr. Scientist (Agronomy)	ghorai1960@yahoo.co.in
Dr. Mukesh Kumar	Scientist (Agronomy)	mukesh_agro@rediffmail.com
Dr. R. K. Naik	Scientist (Farm Machinery & Power)	ranjanagrieng@rediffmail.com
Dr. A. Bera	Scientist (Seed Technology)	amitbera.iari@gmail.com

24.2 Promotion

Name	Designation	Promoted to	w. e. f.
Dr. S. K. Pandey	Sr. Scientist	From RGP ₹ 8000 to ₹ 9000	10.07.12
Dr. Babita Chaudhary	Sr. Scientist	From RGP ₹ 8000 to ₹ 9000	30.12.13
Dr. Shailesh Kumar	Sr. Scientist	From RGP ₹ 8000 to ₹ 9000	27.07.14
Dr. S. P. Gawande	Scientist	From RGP ₹ 6000 to ₹ 7000	03.05.14
Dr. S. P. Mazumdar	Scientist	From RGP ₹ 6000 to ₹ 7000	15.12.13
Dr. H. K. Sharma	Scientist	From RGP ₹ 6000 to ₹ 7000	04.11.13
Dr. Mukesh Kumar	Scientist	From RGP ₹ 6000 to ₹ 7000	15.12.13
Dr. R. K. Naik	Scientist	From RGP ₹ 6000 to ₹ 7000	27.06.10

Sri A. Mukhopadhyay	STA	TO	01.01.14
Sri Dilip Kr. Patra	STA	TO	01.07.14
Sri Sankar Kr. Mallick	STA	TO	01.07.14
Sri Harun Purty	STA	TO	01.07.14
Sri Hare Krishna Das	TA	STA	15.03.14
Sri Bitan Das	TA	STA	29.05.14
Sri Om Prakash	TO	STO	01.01.14
Sri Kamal Kr. Banik	Technician	Sr. Technician	14.05.14

24.3 Superannuation

Name	Designation	Date of Retirement	Place of Posting
Smt. Debi	SSS	30.04.14	Bud Bud
Sri K. P. Nath	SFAO	31.05.14	Barrackpore
Sri Ramesh Chandra Roy	TO	30.05.14	Bud Bud
Sri Dilip Chandra Dey	STO	31.07.14	Barrackpore
Sri Madan Chandra Das	SSS	31.07.14	Sorbhog
Sri Jayanta Kumar Das	Assistant	31.08.14	Barrackpore
Smt. Laxmi Singh	SSS	31.08.14	Pratapgarh
Sri Harun Purty	STA	30.09.14	Bamra
Smt. Minati Das	Assistant	30.10.14	Barrackpore
Sri Sukumar Samajdar	SSS	31.12.14	Barrackpore
Sri Arun Kumar Patra	SSS	31.12.14	Barrackpore
Sri Anil Rishi Das	SSS	31.12.14	Barrackpore
Sri Gopal Mondal	SSS	31.12.14	Barrackpore
Sri Samir Kanti Dutta	TO	31.01.15	Bud Bud
Sri Sankar Karmakar	TA	31.01.15	Barrackpore
Sri Ganesh Ch. Kundu	TO	31.01.15	Barrackpore
Sri Sadhan Ch. Mondal	SSS	31.01.15	Barrackpore
Sri Jaladhar Mishra	TO	28.02.15	Barrackpore

SFAO= Sr. Finance & Account Officer, STA= Sr. Technical Assistant, TO= Technical Officer, STO= Sr. Technical Officer, SSS= Skilled Supporting Staff

25. Financial Statement and Revenue Generation

The expenditure during 2014-15 including the regional stations under plan and non-plan was ₹ 352.24 lakh and ₹ 2378.94 lakh respectively (Table 25.1). The budgets and expenditure with respect to AINPJAF, TMJ and KVK is given in table 25.2. Revenue generation at the HQ and the sub-stations was ₹ 44.02 lakh. The statement of revenue generation at ICAR-CRIJAF Barrackpore, CSRSJAF, Bud Bud; Ramie Research Station, Sorbhog; Sisal Research Station, Bamra and Sunnhemp Research Station, Pratapgarh are presented in table 25.3

Table 25.1. Financial Statement of ICAR-CRIJAF for the year 2014-15

(₹ in lakhs)

Sub-head	Non-Plan		Plan	
	R.E. 2014-15	Expenditure up to 31.03.2015	R.E. 2014-15	Expenditure up to 31.03.2015
Establishment Charges	1430.00	1425.75	0.00	0.00
Wages	365.00	364.37	0.00	0.00
Retirement Benefit	295.00	287.44	0.00	0.00
O.T.A.	0.30	0.16	0.00	0.00
T.A.	8.00	8.00	14.00	13.87
Loans & Advances	23.00	12.30	0.00	0.00
Other Charges	167.50	166.03	282.00	280.01
Works-Maintenance				
a) Residential	34.20	34.18	0.00	0.00
b) Non-Residential	40.00	39.92	0.00	0.00
c) Equipments & others	14.00	13.94	0.00	0.00
d) Minor Works	12.00	11.51	0.00	0.00
Major works	0.00	0.00	12.55	12.52
HRD	0.00	0.00	9.00	8.85
Equipments	5.00	4.98	7.70	7.31
Vehicle	7.50	7.38	0.00	0.00
Information Technology	0.00	0.00	24.50	24.45
Furniture	3.00	2.98	0.00	0.00
Library Books & Journals	0.00	0.00	5.25	5.23
Total	2404.50	2378.94	355.00	352.24

Table 25.2. Financial Statement for AINP on Jute and Allied Fibres, Technology Mission on Jute and KVK for the year 2014-15

(₹ in lakhs)

Head	Target	Achievement
AINPJAF	365.00	364.26
TMJ	75.00	74.97
KVK	123.00	122.96

Table 25.3. Revenue generated at ICAR-CRIJAF and its sub-stations

(₹ in lakhs)

Institutes/ Sub-stations	Revenue
ICAR-CRIJAF (HQ), Barrackpore	23.39
Central Seed Research Station for Jute and Allied Fibres, Bud Bud, Burdwan	7.23
Ramie Research Station, Sorbhog	6.14
Sisal Research Station, Bamra, Sambalpur	5.36
Sunnhemp Research Station, Pratapgarh	1.90
Total	44.02

26. Agricultural Meteorology

Table 26.1. Meteorological data of ICAR-CRIJAF, Barrackpore, West Bengal

Month	Temperature (˚C)		RH (%)		Rainfall (mm)	Rainy days	Bright sunshine hour (hrs)	Evaporation (mm)	Soil temperature (˚C)					
									Morning			Noon		
	Max	Min	Morning	Noon					5 cm	15 cm	30 cm	5 cm	15 cm	30 cm
Apr-14	37.67	25.33	86.23	36.43	0.0	00	8.51	5.99	2.61	29.72	31.75	33.65	41.45	37.89
May-14	36.89	26.54	85.87	52.96	88.0	07	7.86	7.00	4.49	30.13	31.65	33.75	45.36	37.56
Jun-14	33.98	26.65	90.33	70.10	316.4	12	4.01	4.23	3.38	29.57	30.13	31.53	36.78	34.46
Jul-14	31.72	26.46	94.19	80.89	324.8	16	2.45	2.32	2.33	28.60	28.98	29.90	32.84	31.61
Aug-14	32.22	26.08	95.25	76.03	297.4	14	3.45	2.82	2.71	28.20	28.82	29.81	33.18	31.55
Sep-14	32.24	25.88	94.36	74.10	184.0	10	4.88	2.78	1.74	27.75	28.55	29.68	33.19	31.57
Oct-14	31.49	23.09	93.54	66.51	64.8	04	6.00	2.77	1.41	25.25	26.31	28.08	31.75	29.72
Nov-14	29.69	16.42	93.16	44.10	0.0	00	6.85	2.08	0.80	19.37	21.14	23.96	28.01	25.22
Dec-14	25.27	12.40	96.67	52.67	0.0	00	5.58	1.59	1.53	15.07	17.13	20.01	23.96	20.95
Jan-15	24.61	12.86	96.29	56.22	13.2	01	5.42	1.81	2.11	15.04	16.98	19.67	24.83	21.55
Feb-15	28.88	15.58	94.67	45.89	4.2	01	6.56	2.70	2.15	19.71	20.87	22.98	30.55	26.42
Mar-15	32.58	15.00	92.87	41.25	45.0	02	7.16	4.06	2.79	23.93	25.61	27.00	35.31	31.27

Table 26.2. Meteorological data of Sunnhemp Research Station, Pratapgarh, Uttar Pradesh

Month	Temperature (^{0}C)		RH (%)		Rainfall (mm)	Rainy days
	Max	Min	Morning	Noon		
Apr-14	37.70	20.40	74.70	43.90	2.4	01
May-14	39.17	24.52	68.94	41.65	19.6	02
Jun-14	39.76	27.58	74.00	43.40	29.6	05
Jul-14	34.09	25.96	87.46	68.26	283.2	13
Aug-14	33.87	26.01	88.00	67.45	68.0	10
Sep-14	34.15	24.40	87.40	70.70	39.0	07
Oct-14	31.72	19.80	87.03	67.06	174.4	03
Nov-14	29.30	11.20	84.90	49.80	0.0	00
Dec-14	20.54	06.84	93.68	59.84	2.8	01
Jan-15	17.19	08.43	94.29	74.58	59.5	05
Feb-15	26.10	11.81	86.40	55.53	6.4	03
Mar-15	29.85	15.24	82.46	49.33	53.3	07

Table 26.3 Meteorological data of Ramie Research Station, Sorbhog, Assam

Month	Temperature (^{o}C)		Rainfall (mm)	Rainy days	Soil temperature (^{o}C) (Morning)		Soil temperature (^{o}C) (Noon)		RH (%)	
	Min	Max			5 cm	15 cm	5 cm	15 cm	Morning	Noon
Apr-14	20.09	33.03	083.4	07	23.66	25.02	36.77	31.80	81	58
May-14	22.97	30.03	762.2	19	25.19	26.49	34.17	30.71	95	80
Jun-14	25.00	31.42	676.2	19	27.17	28.52	36.02	32.25	95	87
Jul-14	25.77	31.88	527.0	25	28.51	29.54	36.83	33.08	97	87
Aug-14	25.50	29.66	784.6	23	27.85	28.87	35.49	32.45	98	89
Sep-14	24.34	30.81	419.4	15	26.81	28.03	34.86	31.67	96	83
Oct-14	20.73	30.52	025.8	01	26.69	25.32	33.66	30.26	89	75
Nov-14	15.51	29.14	000.0	00	20.13	21.69	31.55	27.94	91	77
Dec-14	10.76	25.40	000.0	00	14.41	16.29	26.33	22.02	95	71
Jan-15	10.00	25.53	018.8	02	13.98	15.29	26.15	21.97	96	68
Feb-15	10.32	26.88	006.5	01	15.78	17.27	28.51	23.47	90	67
Mar-15	14.42	30.33	030.6	04	20.47	22.12	33.73	27.67	90	63

Table 26.4 Meteorological data of Sisal Research Station, Bamra, Odisha

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Rainy days	Evapo-ration (mm)	Soil temperature (°C)			
								Morning		Noon	
	Max	Min	Morning	Noon				5 cm	15 cm	5 cm	15 cm
Apr-14	39.6	19.6	60	19	010.6	01	4.6	26.1	29.2	49.4	34.7
May-14	40.4	22.7	64	27	077.2	04	5.8	28.9	31.0	52.3	35.3
Jun-14	31.9	25.1	75	47	094.1	04	5.3	29.7	31.0	55.2	34.3
Jul-14	31.7	22.8	81	70	461.4	22	2.7	26.5	28.3	32.0	29.3
Aug-14	29.8	22.3	84	81	356.8	19	2.1	27.0	28.3	32.0	29.8
Sep-14	31.6	22.2	79	71	198.6	14	2.3	27.0	28.1	34.0	30.7
Oct-14	32.7	18.1	79	45	014.5	02	3.1	25.7	26.7	35.7	34.3
Nov-14	31.8	10.0	76	73	000.0	00	3.3	18.4	20.5	36.7	33.3
Dec-14	27.2	7.1	76	76	000.0	00	3.0	13.7	17.1	32.1	25.4
Jan-15	26.6	7.6	58	56	015.8	03	3.1	13.9	16.5	32.3	26.1
Feb-15	31.8	9.6	74	74	011.4	01	4.1	17.2	19.3	38.0	31.5
Mar-15	36.4	12.6	64	30	005.8	02	5.3	22.2	23.5	43.9	37.5

Annexure-I

Results-Framework Document (RFD)

for

ICAR-Central Research Institute for Jute and Allied Fibres

(2013-2014)

Address: Barrackpore, Kolkata- 700120, (WB)
www.crijaf.org.in

Section 1: Vision, Mission, Objectives and Functions

Vision

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

Mission

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

Objectives

1. Development of improved cultivars
2. Development and identification of appropriate crop production & protection technologies
3. Technology dissemination and capacity building

Functions

1. To conceptualize, formulate/prioritize, initiate and monitor research projects aimed at productivity/production of jute and allied fibres, including in frontier and emerging areas of research.
2. To organize All-India multi-location, coordinated testing and identification of technologies to conceptualize, formulate/prioritize, initiate and monitor research projects aimed at enhancing productivity of jute and allied fibresin diverse ecologies under AINP on Jute and Allied Fibres.
3. To coordinate breeder seed production of jute and allied fibres.
4. To disseminate knowledge and skills through formal training, on-farm demonstrations and information and communication technologies.
5. Human resource development as required in changing scenario in science and technology

Section 2: Inter-se Priorities among Key Objectives, Success Indicators and Targets

Sl No.	Objectives	Weight	Actions	Success indicators	Unit	Weight	Target/criteria value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1	Development of improved cultivars	49	Evaluation of genetic material	Germplasm evaluated	Number	10	100	80	60	40	30
				Entries tested in AICRP trials for multi-location testing	Number	10	20	15	12	10	08
			Development of improved cultivars	Varieties identified for release	Number	10	4	3	2	1	-
			Seed production programme	Breeder seed produced	Weight (t)	10	1.4	1.1	1.0	0.8	0.7
				Certified + truthfully labeled seed produced	Weight (t)	9	9.2	8.7	7.0	6.0	5.0

Sl No.	Objectives	Weight	Actions	Success indicators	Unit	Weight	Target/criteria value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
2	Development and identification of appropriate crop production & protection technologies	20	Development & testing of new technologies	New technologies tested/validated	Number	10	4	3	2	1	-
				Technologies recommended	Number	10	4	3	2	1	-
3	Technology dissemination and capacity building	20	Demonstrations conducted	FLD + OFT conducted	Number	10	250	200	180	160	140
			Farmers/ Extension officials training programmes organized	Trainings organized	Number	10	10	8	7	6	5
	Efficient functioning of RFD system	3	Timely submission of draft RFD 2013-14 for approval	On-time submission	Date	2	15-5-13	16-5-13	17-5-13	20-5-13	21-5-13
			Timely submission of results of RFD 2012-13	On-time submission	Date	1	1-5-13	2-5-13	5-5-13	6-5-13	7-5-13
	Administrative Reforms	4	Implement ISO 9001 as per approved action plan	Implementation (%)	%	2	100	95	90	85	80
			Prepare an action plan for innovation	On-time submission	Date	2	30-7-13	10-8-13	20-8-13	30-8-13	10-9-13
	Improving internal efficiency/responsiveness/ service delivery of ministry/department	4	Implementation of sevotttam	Independent Audit of Implementation of Citizen's Charter	%	2	100	95	90	85	80
				Independent Audit of implementation of public grievance redressal system	%	2	100	95	90	85	80

Section 3: Trend Values of the Success Indicators

Sl. No.	Objectives	Actions	Success Indicators	Unit	Actual value for 2011-2012	Actual value for 2012-2013	Target value for 2013-2014	Projected Value for 2014-2015	Projected Value for 2015-2016
1	Development of improved cultivars	Evaluation of genetic material	Germplasm evaluated	Number	100	148	80	90	100
			Entries tested in AICRP trials for multi-location testing	Number	20	22	15	20	25
		Development of improved cultivars	Varieties identified for release	Number	3	4	3	3	3
		Seed production programme	Breeder seed produced	Weight (t)	1.51	1.35	1.10	1.20	1.40
			Certified + truthfully labeled seed produced	Weight (t)	10	14.35	8.7	9.5	10.5
2	Development and identification of appropriate crop production and protection technologies	Development & testing of new technologies	New technologies tested/validated	Number	5	3	3	4	5
			Technologies recommended	Number	3	2	3	2	3
3	Technology dissemination and capacity building	Demonstrations conducted	FLD + OFT conducted	Number	179	200	200	225	250
		Farmers/ Extension officials training programmes organized	Trainings organized	Number	10	8	8	10	12
	*Efficient functioning of RFD system	Timely submission of draft RFD (2013-14) for approval	On-time submission	Date			16-5-13		
		Timely submission of results of RFD(2012-13)	On-time submission	Date			2-5-13		
	Administrative Reforms	Implement ISO 9001 as per approved action plan	Implementation (%)	%			95		
		Prepare an action plan for innovation	On- time submission	Date			10-8-13		
	Improving internal efficiency/ responsiveness/service delivery of ministry/ department	Implementation of sevotttam	Independent Audit of Implementation of Citizen's Charter	%			95		
			Independent Audit of implementation of public grievance redressal system	%			95		

Section 4A: Acronyms

Sl. No.	Acronym	Description
1	AINP	All India Net Work Project
2.	JAF	Jute and Allied Fibres
3.	DAC	Department of Agriculture and Cooperation
4.	DJD	Directorate of Jute Development
5.	FLD	Front line Demonstration
6.	OFT	On Farm Trial
7.	NGO	Non-Government Organization
8.	HYV	High yielding Varieties
9.	TSP	Tribal Sub Plan
10.	DoE	Directorate of Extension
11.	AICRP	All India Coordinated Research Project

Section 4B: Description and Definition of Success Indicators and Proposed Measurement Methodology

Sl. No.	Success Indicator	Description	Definition	Measurement	General comments
1.	Germplasm evaluated	Source materials for improved varieties to be developed	Material generated /screened from the basic germplasm	Number of germplasm evaluated for unique charcters	
2.	Entries tested in AICRP trials for multi-location testing	Promising varieties with unique charcters to be tested under multi locational trial	Material generated from the basic germplasm and other improved lines	Number of new improved entries tested	
3.	Varieties identified for release	Breeding lines tested along with checks in multi-location trials through All India Network project and the best performing entries compared to checks are identified as new improved varieties for release	Best performing entries identified as a new variety for release	Number of such varieties identified	
4.	Breeder seed produced	Produce from nucleus and breeder seed is the starting point in seed chain of producing quality seeds for farmers	Breeder seed is the starting point in seed chain which is multiplied/converted in to foundation /certified seed	Quantity produced (Quintals)	
5.	Certified + truthfully labeled seed produced	Certified seed is produced from foundation seed under the guidance of state seed certification agency following certain criteria, while truthfully leveled seed is produced from certified seed for distribution among farmers for cultivation.	Certified seed is produced from foundation seed under the supervision of state seed certification agency while truthfully labeled seed is produced by multiplication of certified seed	Quantity produced (Quintals)	

Sl. No.	Success Indicator	Description	Definition	Measurement	General comments
6.	New technologies tested/validated	Appropriate production and protection technologies for alleviating various abiotic and biotic stresses and thereby enhancement of jute and allied fibre productivity and conservation of natural resources	New crop production technologies on weed and water management, improved retting, disease and pest management of jute and allied fibre crops	Number of such technologies developed, tested and validated	
7.	Technologies recommended	New crop production and protection technologies recommended for farmers use	Technologies after validation are recommended for the use of farming community	Number of such technologies recommended	
8.	FLD + OFT conducted	Trials and demonstrations conducted for technology testing and proving the technology potential production	On-farm trials aims at testing new technologies under farmers condition and management, by using farmers own practice as control. Frontline demonstration is the field demonstration conducted on farmers field under the close supervision of scientists	Number	
9.	Trainings organized	Capacity building activities related to knowledge and skill improvement/ development programmes conducted for farmers, rural youth and extension personnel	Training is a process of acquisition of new skills, attitude and knowledge in the context of preparing for entry into a vocation or improving productivity in an organization or enterprise	Number	

Section 5: Specific Performance Requirements from other Departments

Location type	State	Organization Type	Organization Name	Relevant Success Indicator	What is requirement from this organization	Justification for this requirement	Please quantify your requirement from this Organization	What happened your requirement is not met
Central Govt.	-	Department	Department of Agriculture & cooperation	Breeder seed produced	Indent for quantity of Breeder seed	Variety wise indent for breeder seed	Quantity of breeder seed is produced as per the indent	Less or more quantity of breeder seed will be produced
State Govt.	West Bengal, Assam, Bihar, Odisha & Uttar Pradesh	Department	Department of Agriculture	Certified + Truthfully labeled seed produced	Indent for quantity of certified + TL seed	Variety wise indent for certified & TL seed	Quantity of certified & TL seed is produced as per the indent	Less or more quantity of certified & TL seed will be produced
Central & State Govt.	West Bengal, Assam, Bihar, Odisha & Uttar Pradesh	Directorate & Department	Directorate of Jute Development (DJD) & Department of Agriculture	Front line demonstrations conducted	Availability of funds, effective implementation	Funds from DJD is required for FLD,s & help from state govt. for effective implementation	Fund at the right time from DJD & effective implementation plan by state govt. ensures requisite nos of FLD,s	Less no of FLD,s will be conducted
Central & State Govt.	West Bengal, Assam, Bihar, Odisha & Uttar Pradesh	Directorate & Department	Directorate of Jute Development (DJD), Directorate of Extension (DoE) & State Govt.	Trainings organized	Availability of funds & beneficiary state govt. officials for trainings	Funds from DJD & DoE is required for organization of trainings & availability beneficiary officials for trainings from state govt.	Fund at the right time from DJD & DoE & timely availability of trainee officers from state govt.	Less no of trainings on improved technologies will be conducted

Section 6: Outcome/Impact of Activities of Organization

Sl No.	Outcome/impact of organization	Jointly responsible for influencing this outcome/impact with following department (s)/ministry (ies)	Success indicators	Unit	2011-12	2012-13	2013-14	2014-15	2015-16
1	Area covered with new improved HYV	State governments of West Bengal, Assam, Bihar, Uttar Pradesh and Odisha	Area under new improved HYV*	ha	1800	2142	2285	2485	2714
2	Area expansion in allied fibre crops	State governments of Assam, Uttar Pradesh and Odisha	Area brought under allied fibre crops*	ha	21.55	40	50	60	70

* (Based on participatory farmer's research, on-farm trials and FLDs of CRIJAF, achievement of TSP)

Annual (April 1, 2013 to March 31, 2014) Performance Evaluation Report in respect of RFD 2013-2014 of RSCs i.e. Institutes

Name of the Division: Crop Science
Name of the Institute: ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore, Kolkata, West Bengal
RFD Nodal Officer: Dr. B. Majumdar, Pr. Scientist

Sl. No	Objectives	Weight	Action	Success Indicators	Unit	Weight	Target / Criteria Value					Achievement	Performance		Percent achievements against Target values of 90% Col	Reasons for shortfalls or excessive achievements, if applicable
							Excellent (100%)	Very good (90%)	Good (80%)	Fair (70%)	Poor (60%)		Raw score	Weighted score		
1	Development of improved cultivars Dev	49	Evaluation of genetic material	Germplasm evaluated	Number	10	100	80	60	40	30	90	95	9.5	112.5	More scientific man power availability
				Entries tested in AICRP trials for multi-locational testing	Number	10	20	15	12	10	08	20	100	10.0	133.3	More promising entries were make available
			Development of improved cultivars	Varieties identified for release	Number	10	4	3	2	1	-	06	100	10.0	200	Promising IET & AVT results
			Seed production programme	Breeder seed produced	Weight (t)	10	1.4	1.1	1.0	0.8	0.7	1.85	100	10.0	168.2	Favourable weather
				Certified + truthfully labeled seed produced	Weight (t)	09	9.2	8.7	7.0	6.0	5.0	9.5	100	9.0	109.2	Favourable weather

Sl. No	Objectives	Weight	Action	Success Indicators	Unit	Weight	Target / Criteria Value					Achievement	Performance		Percent achievements against Target values of 90% Col	Reasons for shortfalls or excessive achievements, if applicable
							Excellent (100%)	Very good (90%)	Good (80%)	Fair (70%)	Poor (60%)		Raw score	Weighted score		
2	Development and identification of appropriate crop production & protection technologies	20	Development & testing of new technologies	New technologies tested/ validated	Number	10	4	3	2	1	-	3	90	9.0	100	-
				Technologies recommended	Number	10	4	3	2	1	-	3	90	9.0	100	-
3	Technology dissemination and capacity building	20	Demonstrations conducted	FLD + OFT conducted	Number	10	250	200	180	160	140	256	100	10.0	128.0	More fund under TSP
			Farmers/ Extension officials training programmes organized	Trainings organized	Number	10	10	8	7	6	5	10	100	10.0	125	More fund under TSP
4.	Efficient functioning of RFD system	3	Timely submission of draft RFD 2013-14 for approval	On-time submission	Date	2	15-5-13	16-5-13	17-5-13	20-5-13	21-5-13	04-5-13	100	2.0	-	
			Timely submission of results of RFD 2012-13	On-time submission	Date	1	1-5-13	2-5-13	5-5-13	6-5-13	7-5-13	30-4-13	100	1.0	-	
	Administrative Reforms	4	Implement ISO 9001 as per approved action plan	% implementation	%	2	100	95	90	85	0	100	100	2.0		CRIJAF has been awarded with ISO 9001: 2008 certificate on 27/3/14
			Prepare an action plan for innovation	On-time submission	Date	2	30-7-13	10-8-13	20-8-13	30-8-13	10-9-13	29-7-13	100	2.0	-	
	Improving internal efficiency/responsiveness/service delivery of ministry/department		Implementation of Sevotttam	Independent Audit of Implementation of Citizen's Charter	%	2	100	95	90	85	80	100	100	2.0		
				Independent Audit of implementation of public grievance redressal system	%	2	100	95	90	85	80	100	100	2.0		
										Total Composite Score				97.5		

Rating: Excellent

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