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ICAR

# वार्षिक प्रतिवेदन
# ANNUAL REPORT
# 2018-19

**ICAR-Central Research Institute for Jute and Allied Fibres**

*ISO 9001 : 2015 Certified Institute*

Barrackpore, Kolkata 700120, West Bengal

CENTRAL RESEARCH INSTITUTE FOR JUTE AND ALLIED FIBRES
CRIJAF

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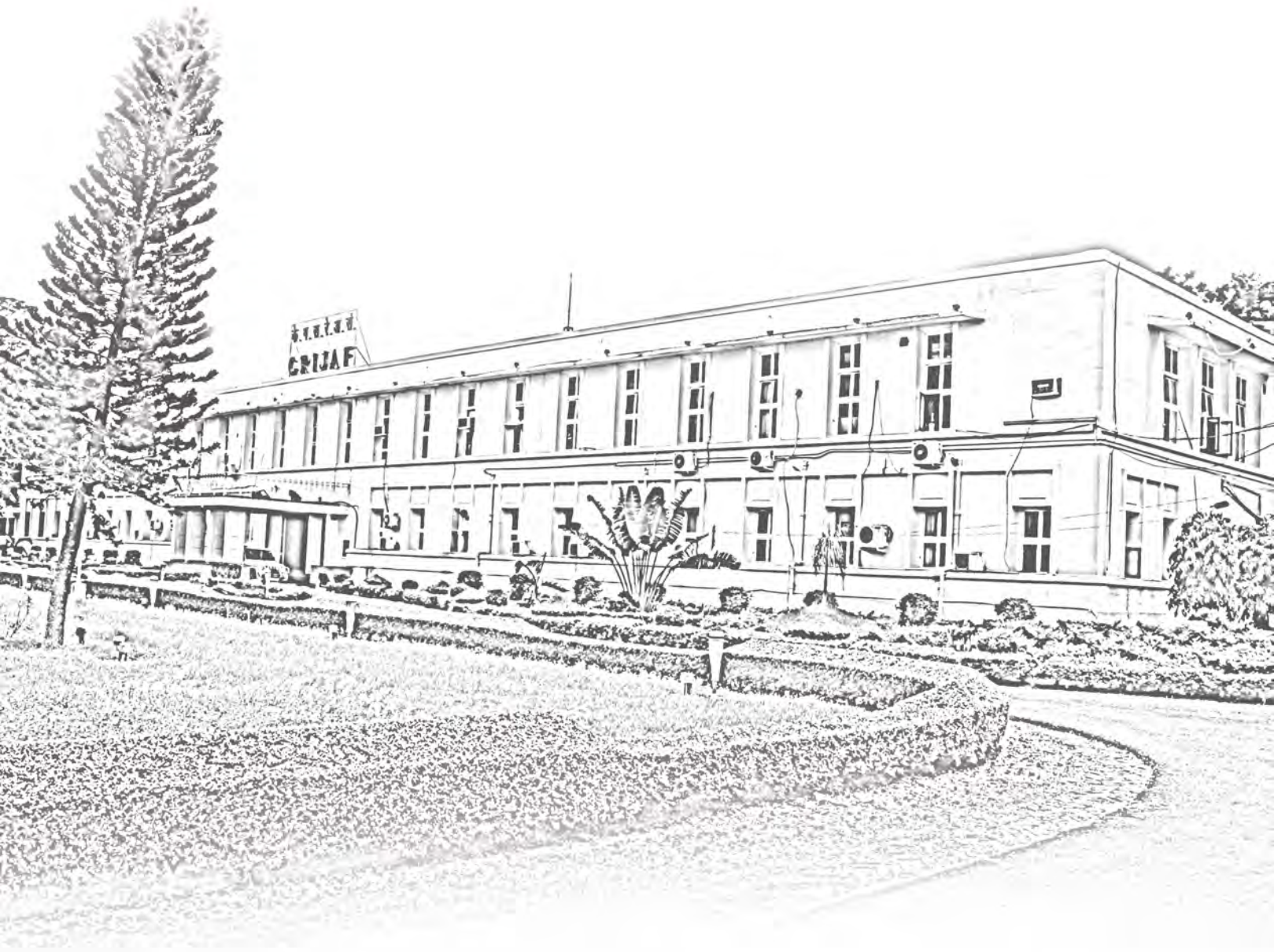
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## Editors

S. Satpathy, S.K. Sarkar, R.T. Maruthi, R. Saha, A.K. Singh, P. Satya, A. Bera and M.L. Roy

## Technical Assistance

Mr. Manoj Kumar Roy and Dr. (Mrs.) Pradipta Samanta

## Cover Page Design

S. K. Sarkar, A. Bera and Mrs. Sukla Chakraborty

## Photography

K. Banik

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3, Gokul Baral Street, Kolkata- 700 012, India
# +91-9830249800

# Contents

# *Preface*

Jute and mesta together cover only 0.4-0.5% of the total area in the country which contributes approx. Rs. 7000 crores (0.32%) of India's value of output from agriculture. Although the area under cultivation has witnessed a decline of 15.5% during last five years, the production of raw jute remained stable in the range of 10-12 million bales due to increase in productivity. Declining of area under jute cultivation due to competition from other field crops is going to put forth new challenges in sustaining the growth of jute productivity to meet the domestic and export requirements. In jute sector also it is the time to increase the production of quality fibres while maintaining the profitability of the farmers. In this aspect, synergies among researchers, policy makers, regulators and industries are to be explored to develop a solid value chain for proper production, marketing and export while keeping in mind the interest of all the stakeholders.

During the last decade the primary challenge was to popularize CRIJAF varieties among the farmers. One good indicator is that the varietal replacement with the latest high yielding jute varieties has zoomed during the recent years particularly after large scale seed production of CRIJAF varieties by NSC and proper policy back up by other Govt. Institutions. In the endeavour for developing new varieties of allied fibre crops release of one variety each of kenaf (JMBP 4) and sunnhemp (SUIN 3) during 2018-19 will provide better alternative varieties for growers.

The adverse effect of climate aberration in jute cultivation as early drought, premature flowering, greater intensity of biotic stresses and improper retting has become more frequent. JuteMet, an integrated web-based agro-meteorological database management system-cum-agro-advisory system developed by the Institute will prove effective to address the climate related jute production constraints in the form of agricultural advisory services. Newly designed power operated jute ribboner can extract ribbons from the freshly harvested jute plants without breaking the sticks. Such advancement in fibre extraction will make a great stride in cost effective mechanization of post-harvest operation. Although bio-retting has already been widely adopted by the farmers, still innovations are to be amalgamated with the existing technologies for better sustenance under adverse climatic condition.

The extent of epizootic due to viral infection witnessed in the natural field population of hairy caterpillar indicates it's promise as an alternate effective biocontrol agent for management of this pest in jute. The virus has been characterized and identified. Infectivity study indicates its potential as an alternative biocontrol agent which is very much infective against initial early instars of the insect. Preliminary research reflects the promise of nanosilica and nanozinc in the management of important pests and diseases of jute.

In the process of doubling farmer's income, empowering farmers with latest farm technologies will be the primary step. Besides, the challenge is to channelize the resources and inputs from within the farm which needs focus on research for JAF crop based system approach. Accordingly cropping and farming systems are to be standardized and popularized suited for the local agro-climatic condition. The mega promotional activities for popularization of CRIJAF technologies jointly with NJB and JCI have touched to 2 lakh famers. The impact study indicates that integrated adoption of these technologies easily witness 10-15% yield advantage.

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 am grateful to Dr. Trilochan Mohapatra, Hon'ble Director General, ICAR for his leadership and direction. I express my sincere gratitude and thanks to Dr. A. K. Singh, Deputy Director General (Crop Science) and Dr. R. K. Singh, Assistant Director General (Commercial Crops), ICAR, New Delhi for their constant encouragement and support.

Place: Barrackpore
Date: 04.07.2019

(Jiban Mitra)
Director (Actg.), ICAR-CRIJAF

# Executive Summary

## Crop Improvement

- A total of 108 germplasm lines of wild and cultivated species of jute and allied fibres were collected through explorations from different districts of Telangana and Maharashtra. A total of 436 accessions were characterized and evaluated. Besides, 914 accessions were regenerated and 712 accessions of JAFs were distributed to different indenters.
- A total of 1023 MAGIC lines (MLs) representing 341 ML families were advanced to $ML_4$-$RI_6$ generation. Genetic analysis of β-galactosidase activity in jute revealed a 9:7 $F_2$ segregation ratio suggesting complementary gene action. A total of 167 advanced breeding lines were screened for resistance against stem rot disease, about 12% of lines were found moderately resistant.
- In sunnhemp, five artificial pollination treatments were attempted to study the extent to which herkogamy reduces sexual interference. Stigmatic samples were harvested at different time intervals to compare the pollen tube growth behaviour across the pollination treatments.
- Six RILs with superior fibre yield and resistant to stem rot disease were identified for resistance against stem rot disease. Four-year evaluation against stem rot disease categorised *C. olitorius* accession OIN-456 as highly susceptible and OIN-154-1 as resistant, wild *Corchorus* germplasm lines WCIN-136-1 (*C. aestuans*) and WCIJ-150-1 (*C. fascicularis*) as highly resistant.
- From station trials, five *C. olitorius* and seven *C. capsularis* entries showing superior biomass yield over check varieties JRO 204 and JRC 517, respectively were selected. Two entries from each species were nominated for AINPJAF trials 2019-20.
- In kenaf, out of 45 $F_2$ populations evaluated, 12 $F_2$ populations showed better performance over the best check for fibre yield and a total of 639 single plants were selected from these populations based on plant height and base diameter.
- In roselle, 7 x 7 half-diallel mating was attempted using seven promising lines selected from 50 germplasm lines for fibre yield and its contributing traits.
- In flax, out of nine $F_1$ populations, six populations, namely H-31 x FT-1001, H-43 x FT-1017, NATASJA x NFT-1, H-31 x FT-1001, H-43 x FT-1017 and NATASJA x HIM-ASLI-2 showing heterosis were selected for generation advancement.

## Seed Science and Technology

- The fertilizer dose N 80 kg, $P_2O_5$ 40 kg, $K_2O$ 80 kg/ha and nitrogen applied in three splits i.e, 50% N at 21-28 DAS coinciding with weeding and thinning, 25 % N at 42 DAS coinciding with topping of apical bud initiation and 25% N at 56 DAS coinciding with active branching improved seed yield and yield parameters in *olitorius* jute cv. JRO 204.
- Seed coating of *tossa* jute with polymer @16 g/kg of seed showed highest seedling vigour during entire storage duration and recorded significantly higher fibre yield.
- A total of 15 q breeder seed of 15 varieties of jute and 2 varieties of sunnhemp were produced. Further, about 2.87 q of nucleus seeds of 29 varieties of jute, 11 varieties of mesta, 4 varieties of sunnhemp and one variety of flax were produced.
- Under ICAR seed project, 512.77 q seeds of different crops (jute, mesta, sunnhemp, dhaincha, paddy, wheat and mustard) were produced. In addition to this, planting material of sisal (50,000 bulbils and suckers) and ramie (50 q rhizome) were also produced and distributed to the farmers.
- In seed production programme under NFSM commercial crops, 1.60 q breeder seed of mesta (AMV 5), 6 q of TL seed of jute (JRO 204 and JRO 524) and 0.50 q of TL seed of roselle (HS 7910) were produced at Amadalavalasa (AP) and Gulbarga (Karnataka) and Arsha (Purulia, West Bengal).

## Biotechnology

- Through RAD sequencing, 1110 loci were mapped to the draft genome of *C. olitorius* cv. JRO-524 (Navin), of which 798 (72%) are present within 563 genes belonging to three main GO categories and 42 sub-categories. A *C. olitorius* association mapping population comprising 225 accessions from 15 countries were grouped into nine geographic populations. Based on STRUCTURE analyses, 125 and 96 accessions were assigned to Indian and African groups, respectively. The four Indian populations significantly differentiated from both the African populations. Based on RAD-SNP selection, it may be inferred that bast fibre production was an artificial while abiotic and biotic stresses were natural selection pressures during *C. olitorius* adaptation.
- Twelve β-galactosidases from jute were identified and classified under six subfamilies, the closest homologs being from *Theobroma cacao*, *Gossypium raimondii* and *G. hirsutum*. An animal type β-galactosidase was found to be present in jute and other higher plants. The animal-type β-galactosidase was gained in higher plants from prokaryotes, and not by horizontal gene transfer.
- Aquaporins were identified from jute having a size of 227 to 318 amino acids. Based on distribution of Froger's positions (P1–P5), the P2, P3, P4 and P5 positions in the jute AQPs were found to be highly conserved, whereas the P1-P5 position exhibited variations. The Co and Cc AQP 3D protein structure contains the conserved hour-glass model with a pore-forming integral membrane protein containing α-helical bundle forming six TM helices and two additional short helicesVariable expression patterns of the jute aquaporin genes were also observed in different tissues.

- A total of 13 heat shock factors were identified from jute and position of DNA binding domains were identified. The corresponding molecular weight of the proteins varied from 23.5 to 58.7 kD with a mean of 40.2 kD. The number of introns per gene varied from one to three. A total of 34 heat shock factor genes were identified from flax genome, physically mapped onto 14 of 15 flax chromosomes and were phylogenetically clustered into three broad groups and 15 sub-groups.
- Mining of published jute genomes resulted into a total of 875 LTRs from *C. capsularis*, 851 from *C. olitorius* O4 genome and 868 from the JRO524 genome. A total of 479 miniature inverted–repeat transposable elements (MITEs) from *C. capsularis* and 379 and 344 MITEs from *C. olitorius* O4 and JRO524 genomes, respectively were identified. A total of 48 pairs of each EST-SSR and ILP markers were evaluated in 24 accessions of *C. juncea* germplasm and few markers showed cross-species transferability.
- Of 124 $T_2$ flax plants harbouring cry1A(b) with ubiquitin promoter, 19 plants showed distinct 421bp amplicons (Fig. 3.19) indicating stable integration (15.32%). Micro-propagation derived stemlets of ramie were grown in the field and clonal fidelity were tested using RAPD and ISSR.

**Soil and Nutrient Management**

- Long term effect of inorganic fertilizers and farmyard manure indicated that the highest yield of jute, rice as well as wheat can be obtained in 100% NPK+ FYM treatment. The 150% NPK treatment was found to be at par with the application of 100% NPK+ FYM. Integrated use of organic manure and inorganic fertilizers resulted in positive influx of nutrients thereby increased OC, available N, P, and K in the soil.
- Carbon footprint and energy use pattern of the four most important natural bast fibres viz. jute, kenaf, flax and sunnhemp showed that the carbon footprints of all the fibre crops were in the order of 566, 520, 445 and 423 kg $CO_2$-eq/t of fibre for jute, flax, kenaf and sunnhemp, respectively. The carbon based sustainability index for jute (2.27) and kenaf (2.07) were highest due to better carbon use efficiency.
- The net ecosystem exchange (NEE) of $CO_2$ in high biomass producing jute agro-ecosystem using Eddy Covariance Technique indicated that the cumulative NEE from the jute agroecosystem over the entire jute growing season was -268.49 g C/$m^2$ or -984.46 g $CO_2$/$m^2$ (-2.68 t C/ha or -9.84 t $CO_2$ /ha).
- Soil organic carbon sequestration studied in various ramie based cropping systems revealed that soil organic carbon (SOC), labile carbon and microbial biomass was significantly improved under long term ramie cultivation (15 years).
- IPNS targeted yield equations of jute (cv. CO-58) and onion (cv. Sukhsagar) were developed. The field verification trials on onion and mustard (cv. B9) at farmers' fields revealed that application of fertilizers as per ST-TY without and with FYM achieved the target of 15 q/ha mustard seed yield with (+) 3.33 and (+) 13.3 % deviation, respectively. Application of fertilizers as per ST-TY without and with FYM achieved the target of 22 t/ha bulb yield of onion with higher B: C ratio as compared to RDF and farmers' practice.
- Under long term trial on jute-rice-lentil sequence, integration of ST-TY with FYM achieved the targeted yield of 35 q/ha and 40 q/ha jute fibre with (+) 2.8 % and (-) 7.5 % yield deviation. Application of fertilizers as per ST-TY could achieve the target of 50 q/ha and 40 q/ha of rice with (-) 4.0% and (+) 7.5 % yield deviation, respectively. Integration of ST-TY with FYM and bio fertilizers achieved the targeted yield of rice (40 q/ha) with (+) 22.5 % yield deviation.

**Crop Husbandry**

- Estimation of competition effects in jute-mungbean intercropping system showed that the optimum yield (of intercrop) is achieved from an optimum plant density of 4.0 lakh and 2.7 lakh/ha of jute and mungbean, respectively. The optimum spatial arrangement of plants to achieve this is to sow crops in 15 cm bands (two lines are formed after nail weeder application during weeding), jute and mungbean being sown in 14 cm apart alternate bands.
- The radiation and water use efficiency in terms of photosynthetically active radiation (PAR), relative water contents (RWC) and chlorophyll contents (SPAD) in jute-rice-lentil/wheat/mustard cropping system was significantly higher in no tillage with residue (NT+R) than conventional tillage (CT). The jute equivalent yield (JEY) among the cropping systems were in the order: jute-rice-lentil (7.32 t/ha) > jute-rice-wheat (7.19 t/ha) > jute-rice-mustard (6.75 t/ha). However, the production efficiency and land use efficiency was highest in jute-rice-wheat cropping system.
- The weed composition under different tillage practices in jute based cropping systems showed higher density of broad leaved weeds in conventional tillage (CT) compared to no tillage (NT) and NT+R with dominance of *Cynodon dactylon*, a perennial grass.
- Maximum jute equivalent yield (JEY) was recorded with jute-kharif rice-potato cropping system while maximum benefit-cost ratio was obtained in jute-rice-ashwagandha cropping system. Among different medicinal and aromatic plants under jute seed crop, jute-stevia-autumn rice cropping system recorded the highest JEY and B:C ratio. Similarly, jute-nigella-boro rice recorded maximum JEY and B:C ratio under jute fibre cum seed production system.
- Field experiment on sisal suckers of different sizes planted with different combinations of fertilizers revealed that the number of leaves per plant was comparatively more either in higher doses of fertilizer (NPK @ 120:60:120 kg/ha) application (14.29 per plant) or in case of larger (50 cm) sucker size (15.87 per plant).
- Considering the total sisal equivalent yield of different spices,

medicinal and aromatic plants grown as intercrops, aloe-vera recorded maximum yield (32.99 q/ha) followed by safed musili (31.73 q/ha) in case of medicinal and aromatic plants. Among spices, fennel registered highest yield (30.39 q/ha).

- Integrated sisal based farming systems could generate adequate income due to integration of various farm enterprises, recycling of crop residue and by-product within the farm itself for which there was increase in profit by 72%.

### Biotic and Abiotic Stresses

- Validation of sex pheromone components of female jute semilooper in wind tunnel indicated that (Z,Z)-6,9 heneicosadiene and (Z,Z,Z)-3,6,9 heneicosatriene are the major components in virgin female sex pheromone of semilooper. The compound (Z,Z)-6,9 heneicosadiene individually and in combination with (Z,Z,Z)-3,6,9 heneicosatriene at 3:1 ratio demonstrated siginicant male moth enticing ability.
- The entomo-pathogenic virus isolated from infected jute hairy caterpillar larvae was identified as NPV. The molecular characterization of polyhedral occlusion bodies ($POB_s$) of the virus also confirmed it to be NPV. As revealed from SEM and TEM studies, the virus particles are triangular to tetrahedral in shape with average size of about 1.60 µm. The median lethal concentration ($LC_{50}$) of Spob NPV was $3.2 \times 10^4$ OBs/ml on second instar larvae of hairy caterpillar.
- Topical spray of 10 ppm nanosilica on third instar larvae of jute hairy caterpillar caused 75% mortality. The $LC_{50}$ of nanosilica was as low as 0.0000097% of a.i. which was lower than most of the commonly used insecticides such as indoxacarb, cypermethrin and emamectin benzoate.
- On the basis of mite population density in jute during the critical stage of infestation, JR0 204 (16.34-26.60 $cm^2$) and JRO 524 (15.87-28.22 $cm^2$) had significantly less mite population. In these varieties the population build up was slower which was significantly less than JBO 1, JROM 1 and JRO 2407 (42.94, 38.76 and 47.14 mite/$cm^2$). Till 50 DAS, JRO 524 recorded significantly less mite days (934 and 893) at par with JRO 204 (1007 and 952) followed by JROG 1 (1159 and 1029). The susceptibility index (SI) of JRO 2407 was 100 compared to 43.06 and 46.49 in JRO 204 and JRO 524 respectively.
- On the basis of persistence and translaminar toxicity against eggs and adults of yellow mite, fenpyroximate 5EC (0.005%) was found to be most effective followed by spiromesifen 22.9EC (0.016%) and diafenthiuron 50WP (0.05%).
- Nano ZnO at very low concentrations ($10^{-1}$ to $10^{-6}$ ppm) completely inhibited the growth of *M. phaseolina in vitro*. However, conventional ZnO at this concentration caused only about 50% growth inhibition.
- In 4-6 months old sisal bulbils foliar sprays with Fosetyl –Al 66.66% @ 2.0g/l provided best control of zebra disease of sisal. The oil-cakes of neem, karanj and mahua @ 10 q/ha were also effective in preventing the zebra disease of sisal.
- Date of sowing has significant effect on flax wilt with lesser incidence of vascular wilt in 30th Nov. sown crop than first date of sowing on 30th Oct. sown crop. Similarly, significant reduction in disease incidence (7.8%) was recorded in seed treatment with carbendazim @ 0.1%.
- IPM module consisting of cultural (sowing in line with 5-6 lakh plants /ha, NPK: 60 (30+15+15):30:30, manual hand weeding once at 21 DAS), chemical (soil application of $Ca(OCl)_2$ @ 30 kg/ha at 7 DBS, seed treatment with (a) carbendazim @ 2g/kg + (b) imidacloprid @ 4g/kg, application of pesticides: spiromecifen @ 1 ml/l, profenophos @ 2 ml/l); biological (*Trichoderma viride* @ 10g/kg, soil application of *Pseudomonas fluorescens* @ 100g/$m^2$ before sowing and spraying of neem oil @ 3-4 ml/l) components were effective against stem rot, yellow mite and other insect pests of jute.
- The pre-emergence herbicide, ipfencarbazone (PE: 68.43 to 114 g ai/ha) has no harmful effect on jute germination and did not registered any phytotoxicity on jute seedlings sown under different moisture regimes. It reduced the weed biomass by 60 to 71%, grass weed population by 80 to 82%, broad-leaved weed population by 65 to 75% and sedge weed population by 15-26% over manual weeding twice. Haloxofop R methyl 10.5 EC (POE) controlled more than 95% grassy weeds in jute when applied at 15 DAS @ 94.5 to 126 g/ha without any phytotoxicity on jute.
- Plants sprayed with ascorbic acid showed increased plant height, leaf number, chlorophyll content, carotenoid content and membrane stability in drought conditions. Moreover, the effect of exogenous ascorbic acid in maintaining the plant height and leaf number was more at 10 DAS.

### Farm Mechanization and Post-Harvest

- Multi-crop seed drill (Manual Operated) has been modified by fabricating conical frustum shaped seed box with transparent, weather resistant and light weight material for enhancing field capacity. Multi-crop seed drill (Power Operated) has been redesigned by fabricating 5 numbers of rows for smooth operation of machine near bund of the field.
- Prototype model flax fibre extractor with higher capacity has been developed for commercial extraction of flax.
- Power operated (single phase 3 hp electric motor) jute ribboner machine has been designed with the objective to extract ribbons from the freshly harvested jute plants without breaking the sticks.
- Liquid formulation of existing microbial consortium has been developed and validated for increasing its shelf-life for improved retting of jute. The fibre strength was very high in case of liquid formulation with endospore (27.8 g/tex) which was 10.75% higher over talc based formulation (25.11 g/tex).

### Jute and Allied Fibre Informatics

- An integrated web-based agro-meteorological database management system-cum-agro-advisory system named as

JuteMet was developed by storing, updating, retrieving and analysing the long-term temporal and spatial climatic data to address the climate related jute production constraints in the form of agricultural advisory services.

- Spatial and temporal trend analysis of rainfall in West Bengal based on 102-year (1901-2002) time scale data base indicated that May-rainfall was in increasing trend in entire northern part (Cooch Behar, Jalpaiguri, Uttar Dinajpur, Dakshin Dinajpur and Malda) and Murshidabad district of West Bengal, whereas it was in decreasing trend in the entire southern part of West Bengal (Birbhum, Burdwan, Hooghly, Howrah, Nadia, North 24-Parganas, South 24-Parganas).
- Drought vulnerability mapping using GIS in West Bengal revealed that highest number total frequency (>16 times) of moderate, severe and extreme drought was observed in the districts of Bankura, Cooch Behar, Howrah and Nadia, and therefore these districts were classified as highly vulnerable to drought. Moderately vulnerable districts are Birbhum, Burdwan, Hooghly, Malda, South Dinajpur, East Medinipur, Jalpaiguri, Murshidabad and West Medinipur.
- An updated version of JuteMarkerdb has been developed as 'JuteMarkerdb v.2.0' to include new and novel molecular markers besides the 2,079 EST-SSR markers. The new set of molecular markers added in the database involve 6,037 Intron-linked polymorphic (ILP) markers and 6,085 candidates polymorphic SSR markers compared among two published *C. olitorius* (O-4 and JRO-524) and one *C. capsularis* (CVL-1) genomes.

**Technology Assessment and Transfer**

- A total of 470 FLDs on improved production technologies of jute were conducted in 225.70 ha area covering Nadia, North 24 Parganas, Hooghly and Purba Bardhaman districts. These demonstrations resulted in 2.27-4.03 q/ha fibre yield gain and saved labour cost by Rs. 8387 to Rs. 14167/ha over farmers' practice. Application of CRIJAF SONA reduced the retting period by 6-9 days and improved (1-2 grade) in fibre colour i.e. yellowish to bright golden to earn an additional income of Rs. 250-400/q by jute growers.
- Livelihood of marginal landholders could be improved by promoting new crop varieties, changing planting dates and bringing necessary changes in other variable inputs for integrated crop management (ICM) in jute. The mean human development index (HDI) value before and after ICM was increased by 38.85% and farm income by 31.5 %.
- Another study conducted on farmers' perception regarding effect of climate change on jute cultivation revealed that hail storm and heavy rainfall are causing soil compaction, leaching of soil nutrients, reducing of soil fertility, water logging, root initiation from lower portion of plant leading to poor fibre production; severe drought condition is hampering seed germination and growth of the plant; insect, disease and weed infestation become higher due to prolonged hot and humid weather.
- Four trainers' trainings and 400 on-farm training-cum-demonstrations in all the jute growing areas were conducted under Jute-ICARE project in collaboration with NJB and JCI.
- Nine national and skill development trainings under NFSM (CC)-Jute, three ASCI sponsored training programmes, two trainings under SCSP and several other trainings, awareness programmes, exposure visits etc. were conducted for capacity building of the different stakeholders.

**AINP on J & AF**

- One variety each of kenaf (JMBP 4, Utkarsh) and sunnhemp (SUIN 3, Kavita) was recommended for release and notification by the Central Sub-Committee on Crop Standard, Notification and Release of Varieties for their commercial cultivation. Besides, two varieties of tossa jute namely, NJ-7005 and JROMU-1 and one variety of kenaf (JRHC-3) have been identified.
- Fifty accessions each of tossa jute, white jute, kenaf and roselle were screened with their respective check varieties for fibre yield and yield components in various locations of jute and allied fibre growing states. Besides, improved entries of JAF crops were also evaluated in IET, AVTs and adaptive trials as multi-location trials.
- Application of quizalofop ethyl 5 EC 60 g + ethoxysulfuron @100 g/ha at 15 days after crop emergence reduced the weed dry weight, recorded highest weed control efficiency, plant height, fibre yield and net return at Kalyani, Kendrapara, Katihar, Coochbehar and Nagaon.
- Pre-emergence application of pendimethalin @ 0.75 – 1.0 kg a.i./ha was found most suitable for weed control in fibre flax at Barrackpore as it recorded highest fibre yield (17.44 – 18.62 q/ha) and highest weed control efficiency (72.2 – 81.4%) and it has been recommended for the region.

**Krishi Vigyan Kendra**

- On farm trials (OFTs) and frontline demonstrations (FLDs) on pulses, cereals, oilseeds, jute, vegetables, food crops and fisheries under different management practices were conducted to improve the production and farm income under farmer's field conditions. Altogether, 5 OFTs and 1278 FLDs were conducted by KVK, Purba Bardhaman. On improved varieties and breeds of jute, paddy, groundnut, sesame, green gram, mustard, lentil, chickpea, onion, brinjal, oat, barseem, *azolla*, fish and mushroom. About 128 trainings were conducted for farmers, rural youth and extension personnel including extension activities and diploma courses for input dealers of the district. About 770 q seeds of paddy were produced under seed village programme including 55200 seedlings of vegetables and fruits. KVK, North 24 Pgs conducted 6 trainings for 220 farmers. FLDs on jute (50) were also conducted on improved varieties and retting. Other extension activities like webcasting of Hon'ble PMs interaction with farmers, World Soil Health Day Celebration, Mahila Kishan Divas and *Swachhta Pakhrada* and *Kishan Divas* were organized.

# 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 has 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 & protection, improved retting, improved machineries for fibre extraction, intercultural operation and seed production. CRIJAF is also leading in jute genomic research, maintenance of related database and germplasm of jute and allied fibre crops.

## Location

Geographically it is located at 88°26'E longitude and 22°45'N 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

- Basic and strategic research on improvement of jute and allied fibre crops for biotic and abiotic stresses, yield and quality.
- Development of economically viable and sustainable production technology, cropping systems and post-harvest technology.
- Co-ordination and monitoring of applied research on national and regional issues to develop improved varieties and technologies.
- Dissemination of technologies and capacity building

## Organizational set up

The main institute has 3 research 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 and plant protection. The regional stations work on specific mandate crops and seed production. The research management is supported by different sections, cells like PME cell, AKMU, ITMU, 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.

## Ramie Research Station, Sorbhog, Assam

Ramie Research Station 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, Ramie Research Station is playing important role in development and promotion of technology, regeneration and distribution of planting materials for area expansion and profitable ramie cultivation.

## Sisal Research Station, Bamra, Odisha

Sisal Research Station was established at Bamra, Odisha in 1962. Sisal germplasm block, model nursery and plantations are maintained in this station. Continuous effort by the station in the production and distribution of planting materials enhanced the area under sisal. This station has 103.60 ha area for conducting research and field trials on sisal crop. Recently sisal based cropping system has been successfully implemented.

## Sunnhemp Research Station, Pratapgarh, U.P

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 in exclusively done at this station. It has a research farm, laboratories, office and staff quarters in 9.18 ha campus.

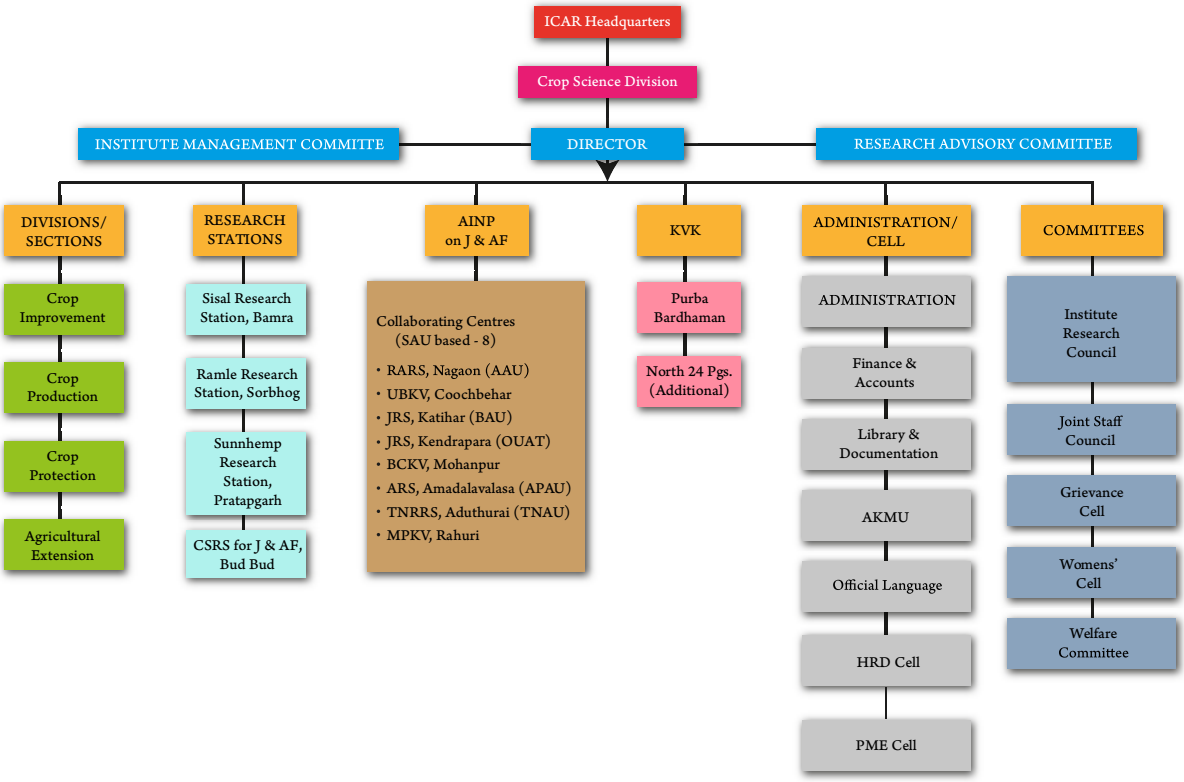
## Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal

Central Seed Research Station for Jute and Allied Fibres (CSRSJAF) previously known as Central Nucleus Jute Seed Multiplication Farm, was established in the year 1956 at Budbud, 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 technology. This regional 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 and TL) of jute and other field crops.

## All India Network Project on Jute and Allied Fibres (AINPJAF)

The coordinating cell of All India Network Projects on Jute and Allied Fibres (AINPJAF) is headquartered in the institute at Barrackpore. At present, this project has 14 centres including 8 SAU-based and 6 ICAR-institute based collaborative centres for multilocational evaluation of the varieties, validation of production and protection technologies and quality evaluation of the fibres.

## Organogram



## Krishi Vigyan Kendra (KVK), Purba Bardhaman, West Bengal

KVK, Purba Bardhaman was established in 2005 in 18 ha area in the campus of Central Seed Research Station for Jute and Allied Fibres, Budbud, Purba Bardhaman under the administrative control of ICAR-CRIJAF. The KVK is actively involved in the transfer of technology through on-farm trials (OFTs), frontline demonstrations (FLDs), 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 trainee's hostel, soil testing laboratory, seed production unit and demonstration units like vermicompost production unit, polyhouse, integrated farming system, well maintained mix-fruit orchard, portable carp hatchery, goatery etc.

## Krishi Vigyan Kendra, North 24 Parganas (Additional), West Bengal

KVK North 24 Parganas (additional) was established in 2016 in 10 ha area in the North Farm campus of ICAR-Central Research Institute for Jute and Allied Fibres, Barrackpore at Nilgunj. The KVK started functioning since December 2016 to take up the programmes related to on-farm trials (OFTs), FLDs, capacity building through hand-on training and other promotional extension activities in jute based farming system in the 11 Southern blocks of the District. Foundation stone of administrative building and the trainee's hostel was laid by Hon'ble Union Minister of Agriculture and Farmers' Welfare Sri Radha Mohan Singh on 13th February 2017. The work for constructions has been initiated. Presently, this KVK is functioning from its temporary office at Extension Section of ICAR-CRIJAF.

## Agricultural Knowledge Management Unit (AKMU)

Agricultural Knowledge Management Unit (AKMU) facilitates the e-governance and manages research information on jute and allied fibres. 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 has 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. ITMC 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.

## Priority setting, Monitoring and Evaluation (PME) Cell

The PME cell of ICAR-CRIJAF was established as per guidelines of the Council. 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. 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 (current and back volumes) especially on jute and other fibre crops such as sisal, ramie, flax, sunnhemp, mesta, etc. It serves the research community with the information at their desks. The activity of the library has been digitized and the services are being provided electronically. 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) system by Consortium for e-Resources in Agriculture (CeRA) to access different journals on line.

## Human Resource Development Cell

The institute has been recognized for research work for M.Sc and Ph.D programmes by the Presidency University, Calcutta University, R.K.M. Vivekananda University and Adamas University. Besides, the cell 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 sectors. HRD cell developed the year wise training schedule for all categories of staffs and monitor the different training programmes.

## Women Cell

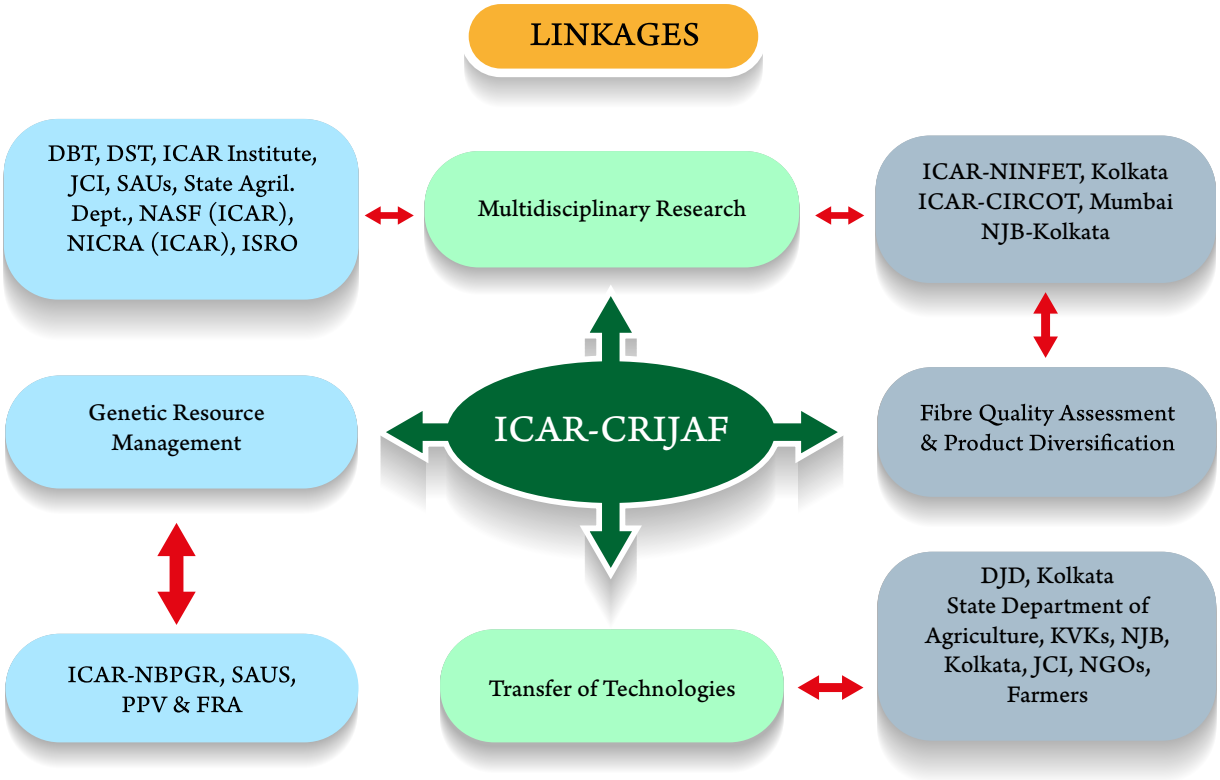
The institute women cell addresses the issues related to grievances of women employees in the HQ and in different regional research stations. This cell also organizes training and awareness programmes for the women on agriculture and other allied activities for enhancing their income and over all involvement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

## Regional Centre of National Agricultural Education Accreditation Board

This institute has been selected as the nodal centre for eastern and north-eastern region for facilitating the submission of self-study reports (SSRs) of the agricultural universities, colleges and other modalities required for accreditation.

## Linkages

The institute has strong linkage with national and international organizations in the field of research, training and policy matters on JAF crops. The institute has R & D collaboration with national funding bodies like DBT, ISRO, NASF, SRD, NICRA, NJB, DST (West Bengal), and RKVY (DAC, MoAC and FW). Besides collaborative programmes are also going on with DJD, NINFET, JCI, NJB, PPV and FRA for research, training and developing effective policies for the sector. The International organization like BJRI, Bangladesh and IJSG, Dhaka are also associated for R & D activities on jute with ICAR-CRIJAF.



# 1. Crop Improvement

## 1.1. Genetic Resource Management

### 1.1.1. Collection of germplasm

An exploration programme was undertaken during December, 2018 in Medak and Nizamabad districts of Telangana and Nanded and Hingoli districts of Maharashtra in collaboration with ICAR-NBPGR, Regional Station, Hyderabad. The surveyed area is located between 17.27° to 19.50° N latitude and 77.08° to 19.01° E longitudes. A total of 108 accessions (Fig. 1.1a and 1.1b) including wild and cultivated species of jute and allied fibres were collected (*Corchorus olitorius* : 36; *C. aestuans* : 23; *C. trilocularis* : 17; *C. fascicularis* : 08; *H. sabdariffa* : 14; *H. cannabinus* : 09; *Crotalaria verrucosa* : 01).


Fig. 1.1a Jute and allied fibre crop species collected from farmer's field. (a) *C. olitorius*, (b) *C. trilocularis*, (c) *C. fascicularis*, (d) *H. cannabinus*, (e) *C. verrucosa*

Fig. 1.1b DIVA-GIS mapping of collection sites of jute and allied fibres germplasm.

### 1.1.2. Acclimatization, conservation and characterization

A total of 238 wild *Corchorus* accessions were characterized for agro-morphological descriptors and evaluated for fibre yield and associated traits. Further, 198 new germplasm accessions collected from Maharashtra and Odisha were also characterized, evaluated and regenerated during this year. In the off-season, 506 wild *Corchorus* accessions and 210 *H. sabdariffa* accessions were successfully regenerated at ICAR-CRIJAF, Barrackpore, West Bengal.

### 1.1.3. Distribution

A total of 712 germplasm accessions (*C. olitorius* : 365, *C. capsularis* : 84, wild *Corchorus* spp: 63, *H. cannabinus* : 100, *H. sabdariffa* : 100) of JAF crops were distributed to different indenters including scientists of CRIJAF, AINP on Jute and Allied Fibres and other institutes (Table 1.1). (*Source: JB 1.1. Contributors: J. Mitra, A. Bera, A. Anil Kumar, R.T. Maruthi and S.K. Sarkar*).

**Table 1.1. Species wise distribution status of JAF germplasm to indenters**

| Crop/species | ICAR-CRIJAF | AINPJAF |
|---|---|---|
| *C. olitorius* | 207 | 160 |
| *C. capsularis* | 24 | 57 |
| Wild *Corchorus* spp. | 63 | -- |
| *H. cannabinus* | -- | 100 |
| *H. sabdariffa* | -- | 100 |
| **Total** | **294** | **417** |
| **Grand total** | **712** | |

## 1.2. Genetic Analysis of Important Traits in Fibre Crops

### 1.2.1. Fixation of a multiparent advanced generation inter-cross (MAGIC) population of *C. olitorius*

A total of 1023 MAGIC lines (MLs) representing 341 ML families were advanced to $ML_4$-$RI_6$ generation. In a preliminary investigation, 341 families of $ML_4$-$RI_5$ together with their 20 parents were phenotyped for bast yield and yield components in an α-lattice design ($19^2$), with two replications. Results on fibre yield revealed significant difference among MAGIC lines ($P<0.001$) with a range of 2.2-27.3 g/plant. The lines also exhibited significant difference in green biomass ($P<0.017$) (Fig. 1.2a, 1.2b). (*Source: JBT 4.6. Contributors: D. Sarkar and P. Satya).*

**Fig. 1.2a** Field view of evaluation plot of MAGIC population at ICAR CRIJAF during kharif-2018

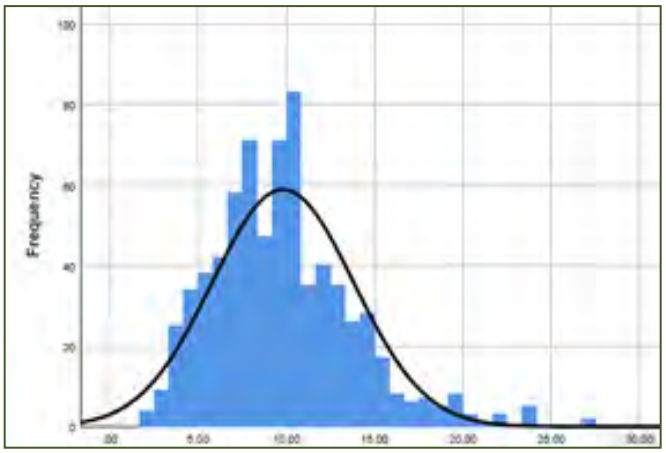



**Fig. 1.2b** Frequency distribution of fibre yield (g/pl) of 341 lines and 20 parents of the MAGIC population

### 1.2.2. Genetic analysis of β-galactosidase activity in jute

For genetic analysis of β-galactosidase activity in jute, a mutant (hypocotyl-defect, *dlpf*) was crossed with wild-type phenotype (cv. JRC 321) that differed for β-galactosidase activity (Fig. 1.3). For segregation analysis, $F_2$ seeds (n=250) from a single representative $F_1$ plant was germinated in controlled condition, and 7-days old $F_2$ population were phenotyped for hypocotyl shape and *in vivo* β-galactosidase activity. Activity staining of β-galactosidase was performed to study trait expression and segregation ratios were tested by $\chi^2$ test for goodness of fit. A 9:7 (undulated/straight hypocotyl) $F_2$ segregation ratio ($\chi^2$=0.71, p=0.40) was observed suggesting complementary action of two genes regulating the undulated phenotype. A 9:7 $F_2$ (high/low β-galactosidase activity) segregation ratio ($\chi^2$=0.20, p=0.65) indicated that cumulative effect of two loci are required for high β-galactosidase activity in the same mutant. The undulated hypocotyl phenotype had a significant ($P < 0.001$) positive correlation ($r_{pb}$=0.65) with in vivo β-galactosidase activity. (*Source: JBT 4.1 and ICAR-NPTC sub-project 3070. Contributors: D. Sarkar, P. Satya and N.K. Singh*)

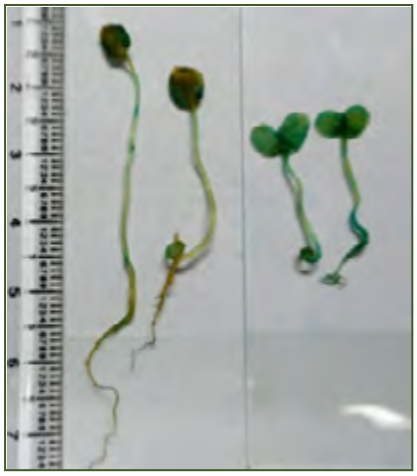


**Fig. 1.3** Difference in β-galactosidase activity in two parental lines, JRC-321 (left) and *dlpf* (right)

### 1.2.3. Screening of advanced breeding lines for stem rot resistance

Selected 167 lines of OIN-154 X JRO 204 derived BCRIL population (advanced breeding lines) were screened for resistance against stem rot disease caused by the infection of necrotrophic fungus *Macrophomina phaseolina* using stem inoculation method in *kharif* 2018. Progress of infection was measured as length of infected stem portion (i.e., lesion length in cm) after 14 days of inoculation. None of the lines were found to be immune (no disease) or highly resistant

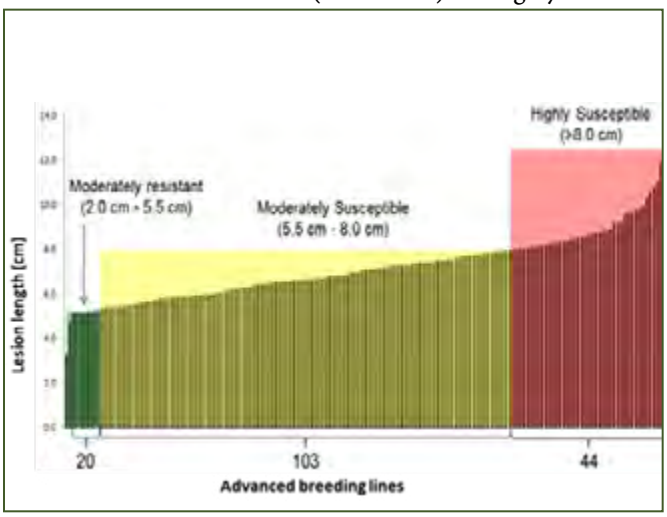



**Fig. 1.4** Disease reaction of advanced breeding lines screened for stem rot resistance

(lesion length <2.0 cm) (Fig. 1.4). Only about 12% of the screened lines were found moderately resistant while the rest were either moderately or highly susceptible against stem rot disease. (*Source: JBT 4.8. Contributers: Soham Ray, Kunal Mondal and P. Satya*)

### 1.2.4. Genetic analysis of functional interference in sunnhemp

Sunnhemp bears terminal raceme inflorescence with bisexual flowers. However, due to late-acting self-incompatibility self-pollinated pistils drop off without seed setting. Male gamete is interfering with the female gamete function. Herkogamy (spatial separation of male and female reproductive functions) is regarded as an adaptation to avoid selfing, to promote outcrossing and, particularly in self-incompatible plants, to reduce sexual interference (Fig. 1.5). Hence, an experiment was designed to know the extent to which this mechanism reduce sexual interference in sunnhemp. The flower buds of variety K-12 yellow were randomly selected and subjected to different pollination treatments using K-12 black as pollen donor: (1) self-pollination, in which flowers were hand pollinated with self-pollen grains; (2) cross-pollination, in which flowers were hand pollinated with cross-pollen grains; (3) mixed-pollination, in which self-pollen was applied once with simultaneous application of cross-pollen; (4) Prior self-pollination, in which self-pollen was applied 24 h before cross-pollen was applied; and (5) Prior cross-pollination, in which cross-pollen was applied 24 h before self-pollen was applied (Table 1.2). Further, stigmatic samples were harvested at different time intervals to compare the pollen tube growth behaviour across the pollination treatments. (*Source: JB 10.2. Contributors: R.T. Maruthi, A. Anil Kumar and S. Datta*).

**Table 1.2. Pollination treatments in sunnhemp during 2018-19**

| Treatments | Crosses attempted | |
|---|---|---|
| | R1 | R2 |
| Self-pollination | 60 | 63 |
| Cross-pollination | 62 | 64 |
| Mixed pollination | 65 | 60 |
| Prior self-pollination | 60 | 63 |
| Prior cross-pollination | 63 | 65 |

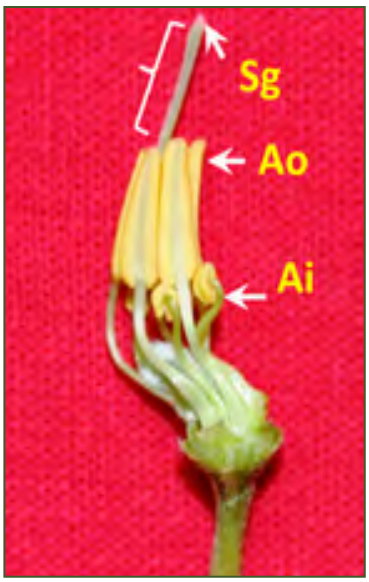



**Fig. 1.5. C.** *juncea* flower exhibiting herkogamy condition
*Legend: Sg stigma, Ao heart shaped anthers, Ai globular anthers*

## 1.3 Breeding of JAF crops for yield and quality improvement

### 1.3.1. Jute (*C. olitorius and C. capsularis*)

#### 1.3.1.1. Hybrization for early flowering resistance

Ten new crosses attempted comprising indigenous × exotic and indigenous × indigenous lines with an objective to impart early flowering resistance gene into adapted lines along with high fibre yield. Crosses are: JRO 128 × Sudan Green, Tarun × Sudan Green, S 19 × Sudan Green, TJ-40 × Sudan Green, CO 58 × Sudan Green, Bidhan Rupali × Tanganyka-1, S 19 × Tanganyka-1, NJ 7010 × Tanganyka-1, S 19 × NJ 7010 and JRO 632 × Tarun.

#### 1.3.1.2. Selection for higher yield

Out of 40 crosses attempted last year, 12 $F_1$s were identified and confirmed with the help of morphological markers; $F_2$ seeds will be advanced to grow $F_2$ generation during kharif 2019. Confirmed $F_1$s are: JRO 524 × JRO 878, JRO 66 × S 19, Co 58 × JRO 524, Co 58 × JRO 878, Co 58 × JRO 7835, Co 58 × JRO 524 (selection), Co 58 × Sudangreen, Co 58 × S 19, S 19 × JRO 878, S 19 × CO 58, S 19 × JRO 524 (Selection), S 19 × Tanganyka-1. In addition, 53 $F_2$ families advanced to $F_3$ generation and 10 best plants based on plant height and base diameter from each families were bulked. In $F_5$, 7 bulks from 10 $F_5$ population were selected and advanced for station trial 2019. Two bulks from previous year have been nominated in AINP JAF trial. (*Source: JB 9.9. Contributor: C.S. Kar*)

### 1.3.1.3. Genetic improvement of jute genotypes against biotic stresses

A total of 152 RIL population of OIJ-248 × WCIN-136-1 in $F_4$ generation were screened against stem rot disease under sick plot conditions as well as in normal condition for fibre yield and yield attributes. Among the $F_4$ RIL's evaluated, RIL-32 showed higher susceptibility than the susceptible parent OIJ-248 and all the susceptible checks showing 100% mortality at 80 DAS (Table 1.3). A marker was identified for hairy caterpillar (HC) resistance by marker trait analysis and tested for its usefulness for marker assisted breeding. Identified marker can clearly differentiate HC susceptible and resistant lines.

**Table 1.3 Performance of selected RIL lines for stem rot and fibre yield traits**

| Line no. | $F_4$ Disease Infection (%) | $F_2$ stem rot lesion length (cm) | FWT (g/pl) | Yield advantage over the best check |
|---|---|---|---|---|
| RIL-174 | 0 | 5.6 | 33.5 | 35.08 |
| RIL-46 | 0 | 2.9 | 30.9 | 24.60 |
| RIL-142 | 0 | 3.2 | 30.8 | 24.19 |
| RIL-25 | 0 | 2.3 | 29.0 | 16.94 |
| RIL-205 | 0 | 5.0 | 28.4 | 14.52 |
| RIL-217 | 0 | 4.4 | 28.0 | 12.90 |
| OIJ-248 | 27.5 | 9.04 | 23.8 | - |
| WCIN-136-1 | 0 | 2.1 | 3.6 | - |
| JRO 524 (c) | - | - | 23.6 | - |
| JRO 204 (c) | - | - | 24.8 | - |

To find out the resistant source against stem rot, selected germplasm lines were screened under sick plot conditions from 2015-2018. Data were recorded as area under disease progressive curve (AUDPC). Among *olitorius* germplasm lines, OIN-456 was recorded as highly susceptible and OIN-154-1 as resistant over the years. In wild *Corchorus* germplasm lines WCIN-136-1 (*C. aestuans*) and WCIJ-150-1 (*C. fascicularis*) were recorded as highly resistant with zero AUDPC values (Table 1.4). (*Source: JB 10.1. Contributors: A. Anil Kumar, R.T. Maruthi, Kunal Mondal and B.S. Gotyal*).

**Table 1.4. Disease reaction in selected germplasm lines expressed as AUDPC values**

| Germplasm line | Species | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| OIN-456 | *C. olitorius* | 748 | 1385 | 609 | 939 |
| OIN-154-1 | *C. olitorius* | 62 | 201 | 44 | 190 |
| WCIN-136-1 | *C. aestuanss* | 0 | 0 | 0 | 0 |
| WCIJ-150-1 | *C. fascicularis* | 0 | 0 | 0 | 0 |

### 1.3.1.4. Evaluation of *C. olitorius* and *C. capsularis* breeding lines for high biomass production

Two station trials have been conducted for identification of high biomass lines of *C. olitorius* and *C. capsularis* during jute growing season of 2018 at ICAR-CRIJAF, Barrackpore. The first trial constituted of 11 *C. olitorius* entries and one check JRO 204. Five lines outperformed cv. JRO 204, producing over 5.7 t/ha green biomass. The second trial consisted of 12 *C. capsularis* entries along with check variety JRC 517. Nine lines outperformed cv. JRC 517 for green biomass trait, producing over 5 t/ha green biomass. Evaluation for fibre yield also revealed that the top four entries have comparable or significantly higher fibre yield than the check varieties (Fig. 1.6 and 1.7). Two lines from each trial have been submitted to All India Network Project on Jute and Allied Fibres for initial evaluation trials. *(Source: JB 10.4. Contributors: P. Satya, S. K. Pandey, S. Roy and S. Ray)*

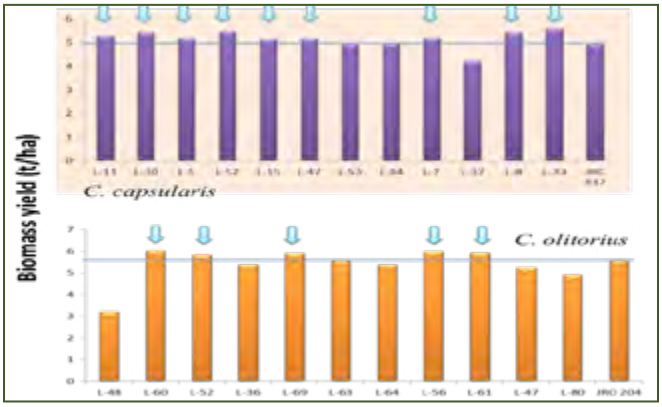



**Fig. 1.6** Evaluation of *C. capsularis and C. olitorius* lines for green biomass

**Fig. 1.7** Superior *C. olitorius* entry (right hand side) along with check JRO 204 (left hand side)

### 1.3.1.5. Protection of jute varieties and DUS testing

Thirty 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, JRO 36 E, Chinsurah Green, Sudan Green, Tanganyika-1, JRO 2345, KOM 62, TJ

40, CO 58, JRO 2407, Tarun, JBO 1, JROG 1, NJ 7010, NJ 7050, NJ 7055, Bidhan Rupali, JROM 1, NJ 7005 and twenty one 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, JRC 532 , JBC 5, JRCM 2, KJC 7 and JRC 9057 were maintained through plant to progeny row method. All essential characters were recorded and database of all reference varieties was sent to PPV&FR authority. *(Source: DA&FW (DUS Testing). Contributors: A. Bera and H.R. Bhandari).*

### 1.3.1.6. Development of DNA finger print for varietal identification in jute

A total of 25 *olitorius* and 21 *capsularis* varieties were used for DNA fingerprinting using 50 Intron linked polymorphic (ILP) markers. There was low variation in *C. capsularis* for ILPs but in *C. olitorius* few variety specific markers were identified. Recently released varieties, i.e, JROG-1, JBO-1 and JRO 128 could be differentiated by using ILP_2, ILP_44_2 and ILP-25 respectively (Fig. 1.8). (*Source: JB 9.5. Contributors: J. Mitra, C.S. Kar and A. Anil Kumar*).

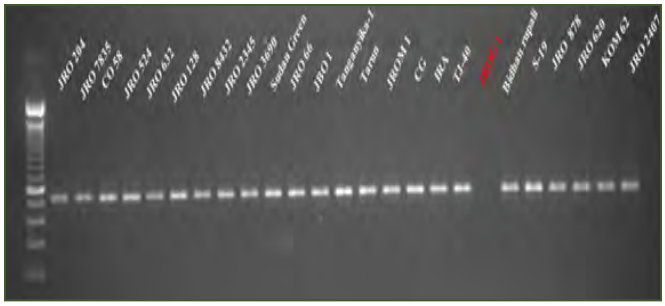



**Fig. 1.8** DNA profiles of 25 *C. olitorius* varieties with ILP_2 marker

## 1.3.2. Mesta (*H. cannabinus* and *H. sabdariffa*)

### 1.3.2.1. Varietal development

A total of 75 kenaf germplam lines with two check (HC 583 and AMC 108) varieties were evaluated for fibre yield and yield related traits (basal diameter, green weight, fibre yield, stick yield) under normal fertility conditions (external fertilizer application was not done). Plant height of kenaf germplasm varied from 241-389 cm with an average of 318.7±40.3 cm (Table 1.5). Average green biomass/plant was recorded to be 221.5±67.7 g. Fibre yield/plant ranged from 3.2-23.5 g with an average of 13.4±4.9 g/plant. Fifteen kenaf accessions performed better than both the check varieties HC 583 and AMC 108 for fibre yield as well as fibre recovery and hence, selected for yield improvement programme. (*Source: JB 9.6. Contributors: R.T. Maruthi, A. Anil Kumar and A.R. Saha*).

**Table 1.5 Descriptive statistics of kenaf accessions**

| Variables | Range | Mean | SD |
|---|---|---|---|
| Plant height (cm) | 240.5-389.0 | 318.7 | 40.3 |
| Basal diameter (mm) | 9.7-19.4 | 14.9 | 2.5 |
| Green biomass (g/plant) | 105.5-407.3 | 221.5 | 67.7 |
| Fibre yield (g/plant) | 3.2-23.5 | 13.4 | 4.9 |
| Stick yield (g/plant) | 5.95-84.5 | 37.3 | 15.2 |

### 1.3.2.2. Evaluation of 45 $F_2$ population of kenaf

A total of 45 $F_2$ populations along with 2 check varieties of kenaf (HC 583 and AMC 108) were evaluated in randomized block design with three replications during 2018. Each plot comprised of 10 rows of 4m length with row to row spacing 30 cm and plants were 5-7 cm apart within the row. Observation on metric traits namely, plant height, basal diameter, mid-diameter, top-diameter, green biomass, dry stick weight, dry fibre yield and fibre % were recorded. The average plant height and basal diameter of $F_2$ population was 285 cm and 1.63 cm, respectively with a range of 185-349 cm and 0.64-2.04 cm. The mean fibre yield/plant was 37g with a range of 19-53g. Average dry fibre recovery of the population was 4.3% with a range of 2.1-6.5%. Out of 45 $F_2$ populations, 13, 07, 12 and 10 showed better performance over the best check for plant height, basal diameter, fibre yield and fibre%, respectively (Table 1.6). A total of 639 individual plants selected from 12 promising $F_2$ population and seeds were collected separately for further evaluation. Selection of plant from the progeny rows will be made on the basis of plant growth parameter i.e. plant height, base diameter, mid-diameter, top diameter, green biomass, dry stick weight, dry fibre yield, fibre quality and reaction to various diseases and pests. (*Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena*).

**Table 1.6 Mean performance and range of kenaf $F_2$ population for metric traits**

| Characters | $F_2$ population | | | No. of superior $F_2$ population |
|---|---|---|---|---|
| | Mean | Range | SD | over best check |
| Plant height (cm) | 285 | 182-349 | 14.72 | 13 |
| Basal diameter (mm) | 16.3 | 09.4-20.4 | 1.26 | 07 |
| Mid-diameter (mm) | 11.9 | 6.1-15.3 | 0.87 | 11 |
| Top-diameter (mm) | 6.1 | 3.8-8.2 | 0.46 | 08 |
| Green Biomass (g/plant) | 864.0 | 533-1525 | 155.0 | 10 |
| Stick yield (g/plant) | 88.0 | 52-179 | 13.90 | 09 |
| Fibre yield (g/plant) | 37.0 | 19-53 | 4.20 | 12 |
| Fibre % | 4.3 | 2.1-6.5 | 0.34 | 10 |

### 1.3.2.3. Mutation breeding: Response of selection for metric traits in kenaf

Gamma (γ) irradiation of kenaf varieties i.e, JBM 2004D, AMC 108 and HC 583 did not show any morphological aberrations except for height and base diameter. However plant to progeny rows selection was made for morphometric traits i.e. plant height and fibre yield (g/plant) for consecutive four years as $M_1$, $M_2$, $M_3$ and $M_4$ generations. After four years of selection for plant height and fibre yield, there was no improvement and response of selection for any traits. It was revealed that varietal differences remained constant even after selection for four consecutive years as depicted in Fig.1.9a and 1.9b. (*Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena*).

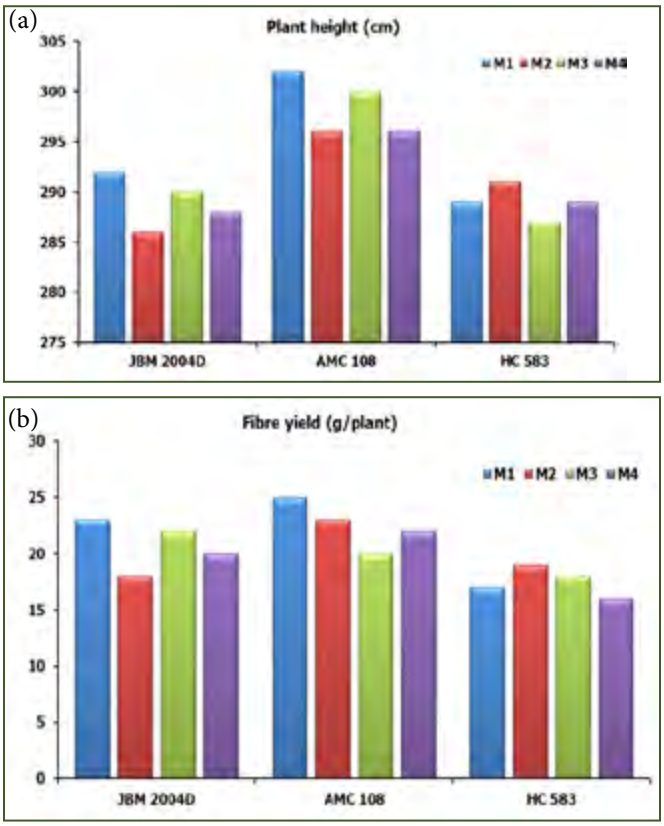



**Fig. 1.9** Response of selection for (a) plant height (cm) (b) fibre yield (g/plant) in γ treated varieties of kenaf.

### 1.3.2.4. Hybridization of promising roselle lines for raising $F_1$ hybrids

Seven promising lines of roselle were selected on the basis of consecutive screening of 50 roselle germplasm for 2 years for fibre yield and its contributing traits. These lines were crossed in a 7 x 7 half diallel mating design and seeds of resulting 21 $F_1$ hybrids were collected for further evaluation and selection of desirable segregates in their successive generations. These hybrids along with their parents will be evaluated in replicated trials with suitable checks for plant growth parameters and other agronomic traits during 2019. (*Source: JB 10.0. Contributors: S.K. Pandey, P. Satya and P.N. Meena*).

### 1.3.2.5. Breeding for diversified uses in roselle

A set of thirty-five calyx type roselle accessions were characterized for 26 descriptors (13 qualitative and 13 quantitative traits). From each accession, 40-50 g of fresh calyx was harvested for drying. The dried calyx samples were preserved for nutrient estimation. Further, 26 new calyx type genotypes were identified from germplasm based on calyx characteristics (Table 1.7, Fig. 1.10). (*Source: JB 9.6. Contributors: R.T. Maruthi, A. Anil Kumar, and A.R. Saha*).

**Table 1.7. Descriptive statistics of twenty-six calyx type roselle accessions**

| Variables | Mean | SD | Min | Max |
|---|---|---|---|---|
| Calyx length (mm) | 37.49 | 6.83 | 26.54 | 47.12 |
| Calyx diameter (mm) | 22.33 | 2.19 | 19.56 | 26.35 |
| Calyx yield (g/fruit) | 1.50 | 0.25 | 1.04 | 1.92 |
| Calyx colour | Green, Light green, Light red, Red, Deep red | | | |

**Fig. 1.10** New calyx type genotypes identified from germplasm

## 1.3.3. Flax (*Linum usitatissimum*)

### 1.3.3.1. Genetic improvement

Nine $F_1$ including 6 parents *viz.*, FT-1001, FT-1017, NFT-1, FT-1001, FT-1017 and HIM-ALSI-2 were evaluated for fibre yield and six $F_1$ population showing heterosis were selected for advancement. The crosses are H-31 x FT-1001, H-43 x FT-1017, NATASJA x NFT-1, H-31 x FT-1001, H-43 x FT-1017 and NATASJA x HIM-ASLI-2.

$F_2$ families of seven crosses were grown for identifying transgressive segregants from crosses VNIIL-17×G-2063-5-10, G-2063-5-10 × VNILL-17, Dolgunetz × JRF-1, JRF-1 × Dolgunetz, Demetcha-1-3-6Viln × Svetoch mutation, Svetoch mutation × Dolgunetz and Demetcha-1-3-6Viln X China2 for superior fibre quality and tall plant height. (*Source: JB 10.3. contributors: J. Mitra and D. Saha*)

### 1.3.4. Sunnhemp (*Crotalaria juncea*)

#### 1.3.4.1. Genetic improvement

A panel of forty sunnhemp (*C. juncea* L.) accessions representing different agro-ecological regions, spreading across the states of India were evaluated for fibre yield and yield attributing traits (basal diameter, green weight, fibre yield, stick yield). Two released cultivars of sunnhemp *viz.*, K 12 Yellow and K 12 Black were included in the study as checks. The study material revealed a wider spectrum of diversity for all the fibre yield and yield attributing traits as CV ranged from 5.42 to 29.82 (Table 1.8). Plant height ranged from 269 to 350 cm with a mean of 312±16.9 cm. Average basal diameter was 14.03±1.88 mm. Average green biomass/plant of the accessions was 277.1±56.2 g and ranged from 172.6-474.2 g/plant. Fibre yield of the accessions ranged from 2.50 to 15.28 g/plant with a mean of 6.68±1.9 g/plant. Ten potential genotypes with high fibre yield/plant and superior values for plant height, basal diameter were selected for breeding programme. (*Source: JB 10.2. Contributors: R.T. Maruthi, A. Anil Kumar and S. Datta*).

**Table 1.8 Descriptive statistics of sunnhemp accessions**

| Variables | Range | Mean | SD | CV |
|---|---|---|---|---|
| Plant height (cm) | 269-350 | 312.12 | 16.93 | 5.42 |
| Basal diameter (mm) | 8.67-18.98 | 14.03 | 1.88 | 13.41 |
| Green biomass (g/plant) | 172.6-474.2 | 276.98 | 56.21 | 20.29 |
| Fibre yield (g/plant) | 2.5-15.28 | 6.68 | 1.99 | 29.82 |
| Stick yield (g/plant) | 27.46-82.64 | 48.02 | 11.72 | 24.41 |

## 1.4. Physiology of Premature Flowering Resistance

### 1.4.1. Flowering behavior of popular jute varieties

In *capsularis* jute (cv. JRC 212, JRC 517) the cumulative number of open flowers per five days follow a normal curve of flowering during the flowering period which varies between 25 to 35 days (Fig.1.11). Whereas the *olitorious* jute (cv. JRO 524, JRO 204, and NJ 7010) does not follow any specific pattern of flowering (Fig. 1.12) throughout the flowering period (21 to 31 days). (*Source: JA 7.5. Contributors: S. Roy, L. Sharma, P. Satya, H. Bhandari and A.K. Jha).*

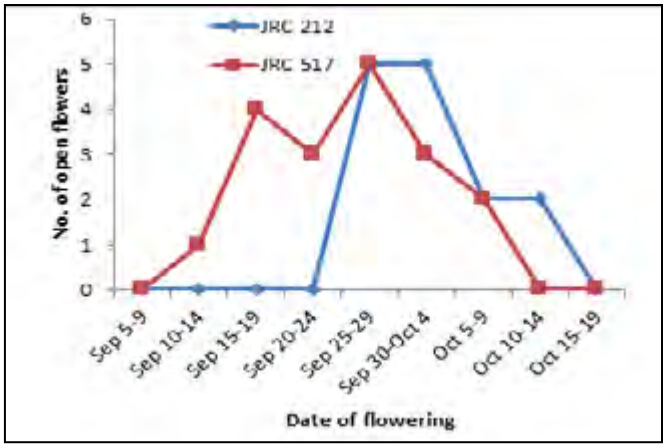



**Fig. 1.11** Flowering pattern of *capsularis* varieties

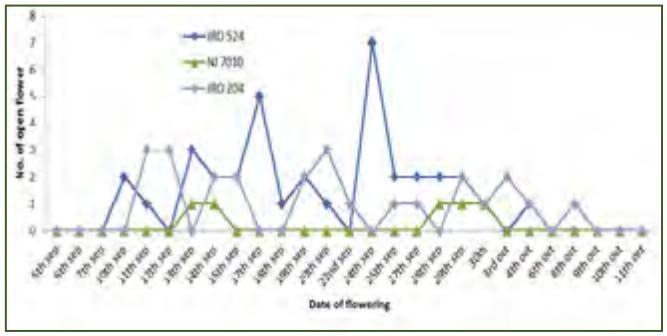



**Fig. 1.12** Flowering pattern of *olitorious* varieties

# 2. Seed Science and Technology

## 2.1. Seed Research

### 2.1.1. Effect of fertilizer dose and method of application on yield and quality of jute seed in southern Bengal condition

To study the effect of method of application and quantity of fertilizer nutrients on yield parameters and seed yield of *olitorius* jute seed (cv. JRO 204), a field experiment was conducted at Nilgunj, Barrackpore with four levels of fertilizers (N 80 kg/ha, N 80 $P_2O_5$ 40 kg/ha, N 80 $P_2O_5$ 40 $K_2O$ 80 kg/ha, no fertilizer) and two levels of N application methods [50% N at 21-28 DAS coinciding with weeding and thinning and 50% N at 42 DAS coinciding with topping of apical bud (NAP1); 50% N at 21-28 DAS coinciding with weeding and thinning; 25 % N at 42 DAS coinciding with topping of apical bud; and 25% N at 56 DAS coinciding with active branching (NAP2)].

***Effect of fertilizer on yield parameters of jute seed:*** Maximum number of pods/plant (19.22) was produced with $T_7$ (N 80 kg, $P_2O_5$ 40 kg, $K_2O$ 80 kg/ha) and the lowest number of pods/plant was recorded with no fertilizer application (11.89). Similarly, the maximum number of seeds/pod (199.67) was recorded with $T_7$ and no fertilizer application produced the lowest number of seeds/pod (150.67).

**Table 2.1. Yield parameters and seed yield of *olitorius* jute seed as influenced by method of application and dose of fertilizer nutrients**

| Treatments | Number of pods/ plant | Number of seeds /pod | Seed yield (kg/ha) |
|---|---|---|---|
| $T_1$: No fertilizer | 11.89 | 150.67 | 561.7 |
| $T_2$: $N_{80}$ (2 splits) | 17.00 | 179.11 | 736.5 |
| $T_3$: $N_{80}$ (3 splits) | 17.22 | 185.33 | 818.7 |
| $T_4$: $N_{80}$ (2 splits) $P_{40}$ | 17.89 | 188.00 | 862.8 |
| $T_5$: $N_{80}$ (3 splits) $P_{40}$ | 18.44 | 187.67 | 887.3 |
| $T_6$: $N_{80}$ (2 splits) $P_{40}$ $K_{80}$ | 18.78 | 197.88 | 894.2 |
| $T_7$: $N_{80}$ (3 splits) $P_{40}$ $K_{80}$ | 19.22 | 199.67 | 974.2 |
| CD (P=0.05) | 1.10 | 13.19 | 90.55 |

***Effect of fertilizer on jute seed yield:*** The jute seed yield followed the same pattern as seed yield parameters with different doses and method of fertilizer application. The highest seed yield of 9.74 q/ha was recorded with $T_7$ (i.e., N 80 kg, $P_2O_5$ 40 kg, $K_2O$ 80 kg/ha) and NAP2. Application of N alone @ 80 kg/ha produced 45.76% more jute seed yield as compared to the seed yield obtained with no fertilizer application (5.61 q/ha). It was also noted that application of 80 kg N along with 40 kg $P_2O_5$ enhanced the jute seed yield by 57.97% and N 80 kg $P_2O_5$ 40 kg $K_2O$ 80 kg produced 73.48% more jute seed yield as compared to no fertilizer application in southern Bengal condition. Instead of two split applications (50 % at 21-28 DAS and 50% at 42 DAS), three split application of N (50% at 21-28 DAS, 25% at 42 DAS and 25% at 56 DAS) produced about 10% more seed yield in *olitiorius* jute.

***Effect of fertilizer on jute seed quality:*** The 1000 seed weight of jute seed varied significantly with different doses of fertilizer and method of fertilizer application (Table 2.2). The highest 1000 seed weight (2.77 g) was obtained with $T_7$ and the lowest 1000 seed weight was with no fertilizer application (2.27 g). There were no significant differences in germination (%) and speed of germination of the jute seeds due to different fertilizer treatments. But the seedling weight and vigour index differed significantly with different fertilizer doses. The maximum seedling weight was recorded with $N_{80}$ $P_{40}$ $K_{80}$ (22.10 mg/20 seedlings) and the minimum seedling weight was observed with no fertilizer treatment (16.87 mg/20 seedlings). Similarly, the highest seedling vigour index was obtained in case of $N_{80}$ $P_{40}$ $K_{80}$ (2210) and the lowest value was recoded in no fertilizer treatment (1653). (*Source: JA 7.9. Contributors: S. Sarkar, M.S. Behera, A. Bera and S.K. Sarkar*).

**Table 2.2. Seed quality of *olitorius* jute seed as influenced by method of application and dose of fertilizer nutrients**

| Treatments | 1000 seed weight (g) | Germination (%) | Speed of germination (%) | Seedling weight (mg/20 seedlings) | Vigour index |
|---|---|---|---|---|---|
| $T_1$: No fertilizer | 2.27 | 98 | 94.67 | 16.87 | 1653 |
| $T_2$: $N_{80}$ (2 splits) | 2.33 | 98 | 93.33 | 18.58 | 1821 |
| $T_3$: $N_{80}$ (3 splits) | 2.64 | 99 | 94.33 | 18.54 | 1835 |
| $T_4$: $N_{80}$ (2 splits) $P_{40}$ | 2.63 | 100 | 95.67 | 20.07 | 2007 |
| $T_5$: $N_{80}$ (3 splits) $P_{40}$ | 2.65 | 99 | 94.83 | 20.11 | 1991 |
| $T_6$: $N_{80}$ (2 splits) $P_{40}$ $K_{80}$ | 2.70 | 100 | 95.83 | 22.10 | 2210 |
| $T_7$: $N_{80}$ (3 splits) $P_{40}$ $K_{80}$ | 2.78 | 100 | 96.33 | 22.09 | 2209 |
| CD (P=0.05) | 0.09 | NS | NS | 1.34 | 152.17 |

### 2.1.2. Effect of seed coating on seed storability and fibre yield in *tossa* jute

Seed coating technique was deployed for delivering fungicide (carbendazim @ 1g a.i./kg seed), insecticide (clothianidin

@ 2g a.i./kg seed and growth regulator ($GA_3$ @ 100 ppm) on jute seed. Polymer was used @16 g/kg of seed. Different treatments were at par with regard to seed germination up to 10 months of storage but seed coating with polymer ($T_2$) showed highest seedling vigour during entire storage duration (Table 2.3). Seed coating with polymer ($T_2$) recorded significantly highest fibre yield (34.9 q/ha) compared to control (31.1 q/ha) and was followed by $T_8$ i.e. seed coating with polymer supplemented with insecticide and fungicide (32.7 q/ha) (Fig. 2.1). (*Source: JST 1.0. Contributors: A. Bera, C.S. Kar, M. Kumar, H.R. Bhandari and B.S. Gotyal*).

**Table 2.3. Effect of seed coating on vigour index during storage**

| Treatments | Ambient Storage | | Storage in moisture proof container | |
|---|---|---|---|---|
| | 6 month | 10 month | 6 month | 10 month |
| Control | 344[b] | 320[b] | 410[ab] | 361[b] |
| Polymer @16g/ kg seed | 378[a] | 367[a] | 450[a] | 397[a] |
| Insecticide @2 g a.i./kg | 337[b] | 311[b] | 425[ab] | 383[ab] |
| Fungicide @1g a.i./ kg | 332[b] | 317[b] | 417[ab] | 360[b] |
| Polymer+ Insecticide | 327[b] | 309[b] | 420[ab] | 366[ab] |
| Polymer+ Fungicide | 325[b] | 300[b] | 410[ab] | 365[ab] |
| Fungicide+ Insecticide | 312[b] | 302[b] | 420[ab] | 362[b] |
| Polymer+ Insecticide + Fungicide | 334[b] | 314[b] | 416[ab] | 368[ab] |
| Polymer+ $GA_3$+Insecticide + Fungicide | 324[b] | 302[b] | 406[b] | 358[b] |

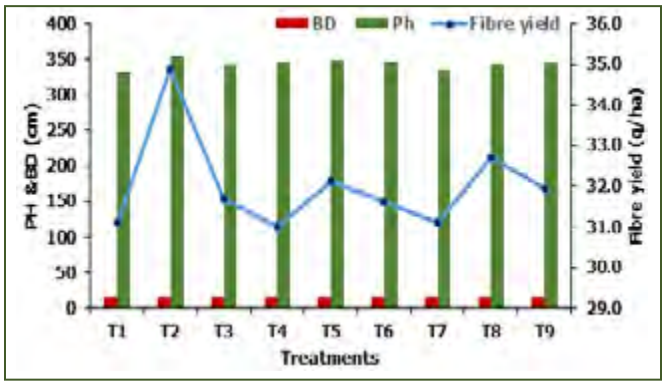



**Fig. 2.1.** Effect of seed coating on fibre yield parameters of jute

### 2.1.3. Standardization of date of sowing of flax seed crop at CSRSJAF, Bud Bud

An experiment was conducted to find the ideal sowing time of flax seed crop at CSRSJAF. The flax variety JRF 2 (Tiara) was sown in randomized block design on four different dates (25th Oct, 6th Nov, 17th Nov and 28th Dec, 2018). The maximum seed yield (10.17 q/ha) was noted on 17th Nov, sowing. The results indicated that mid-November is the best time for sowing of flax seed crop at CSRSJAF, Bud Bud. (*Source: NSP. Contributors: H.R. Bhandari, C.S. Kar and A. Bera*).

## 2.2. Seed Production

### 2.2.1. Breeder seed production under National Seed Project (NSP)

Breeder seed of 15 varieties of jute, and two varieties of sunnhemp were produced as per DAC & FW indent (Fig. 2.2). A total of 14.10 q of breeder seeds of jute and 0.90 q of sunnhemp were produced against the DAC indent of 8.60 q and 0.90 q respectively. The variety wise details are given below in table 2.4. (*Source: NSP. Contributors: C.S. Kar, H.R. Bhandari and A. Bera*).

**Table 2.4. Breeder seed production of jute & allied fibres during 2018-19**

| Variety | DAC/Other indent (q) | Actual production (q) |
|---|---|---|
| **Jute** | | |
| JRC 517 | 0.08 | 0.48 |
| JRC 321 | 0.02 | 0.20 |
| JRC 212 | 0.06 | 0.20 |
| JRC 532 | 0.29 | 0.58 |
| JRO 2407 | 0.36 | 0.48 |
| JROG 1 | 0.04 | 0.10 |
| JRCM 2 | 0.04 | 0.04 |
| JBO-2003-H (IRA) | 1.07 | 1.20 |
| JRO 204 | 2.56 | 3.58 |
| S-19 (Subala) | 0.17 | 0.50 |
| JRO 524 | 2.20 | 3.54 |
| JRO 878 | 0.27 | 0.18 |
| CO 58 | 0.39 | 0.92 |
| JRO 128 | 1.00 | 2.00 |
| JRO 632 | 0.05 | 0.10 |
| Total | 8.60 | 14.10 |
| **Sunnhemp** | | |
| SUIN 053 | 0.50 | 0.50 |
| JRJ 610 | 0.40 | 0.40 |
| Total | 0.90 | 0.90 |

**Fig. 2.2.** Breeder seed production plot of jute variety JRO 204

### 2.2.2. Production and maintenance of nucleus seeds

Seeds from selected true to type individual plants of a variety harvested during *kharif* 2017 were sown to raise progeny rows during kharif 2018 (Fig. 2.3). True to the type, progeny rows without any off type plant were harvested to obtain seed with highest genetic purity and bulked to constitute nucleus seeds of jute, mesta, sunnhemp and flax. About 2.87 q of nucleus seeds of the released varieties of jute (29 varieties), mesta (11 varieties) sunnhemp (4 varieties) and flax (1 variety) were produced for utilization during breeder seed production in *kharif* 2019-20 (Table 2.5).

**Table 2.5. Nucleus seed production of jute, mesta, sunnhemp and flax**

| Variety | Production (kg) | Variety | Production (kg) |
|---|---|---|---|
| **Jute** | | JRC 517 | 9.5 |
| JRO 524 | 15.5 | JRC 532 | 4.5 |
| JRO 8432 | 6.0 | JRC 212 | 13.5 |
| JBO-2003-H | 9.5 | JRC 80 | 9.5 |
| JRO128 | 10.5 | JRC 698 | 7.0 |
| JRO 204 | 9.5 | Monalisa | 3.5 |
| JRO 878 | 6.0 | JRC 9057 | 4.0 |
| JROM 1 | 2.5 | JRC 7447 | 5.5 |
| JROG 1 | 5.5 | Bidhan Pat 1 | 7.5 |
| CO 58 | 6.0 | Bidhan Pat 2 | 2.5 |
| JRO 2407 | 9.0 | UPC 94 | 3.5 |
| S 19 | 9.5 | TJ 40 | 4.0 |
| JRO 7835 | 2.0 | **Total** | **195.5** |
| KOM 62 | 5.5 | **Mesta** | |
| JRO 632 | 6.5 | MT 150 | 7.0 |
| JRO 3690 | 6.0 | HC 583 | 4.5 |
| JRC 321 | 5.5 | AMC 108 | 6.5 |
| JRCM 2 | 6.0 | HS 4288 | 7.5 |
| HC 583 | 4.5 | AMC 108 | 6.5 |
| HS 7910 | 7.0 | Central Kenaf JBMP 2 | 8.0 |
| JRKM 9-1 | 2.5 | CRIJAF R2 | 5.5 |
| CRIJAF R8 | 3.5 | AMV 3 | 5.0 |
| AMV 2 | 1.5 | Total | 58.5 |
| **Sunnhemp** | | | |
| SH 4 | 0.8 | SUIN 053 | 4.5 |
| SUIN 037 | 4.0 | JRJ 610 | 11.5 |
| **Total** | **20.8** | Flax | |
| JRF 2 | 12.0 | **Grand Total** | **286.8** |

**Fig. 2.3.** Nucleus seed plot of jute

### 2.2.3. Monitoring of seed production

A monitoring team comprising representatives from State Seed Certification Agency and National Seed Corporation (NSC) inspected the breeder seed and nucleus seed plots at CSRSJAF, Bud Bud. Central Monitoring Team of AICRP-NSP (Crops) and ICAR Seed Project for East Zone, Group-II visited CRIJAF, Barrackpore and CSRSJAF, Bud Bud on 21st February, 2019 (Fig. 2.4).

**Fig. 2.4.** Monitoring team in front of nucleus seed plot at CSRSJAF, Bud Bud

Fig. 2.5. Monitoring team visiting breeder seed production plot at ARS, Amadalavalasa

A team comprising scientists from CRIJAF, NJB and NSC visited Guntur and Sri Prakasham district, Andhra Pradesh to monitor the certified seed production by NSC using CRIJAF

**Fig. 2.6.** Monitoring team visiting certified jute seed production plot of JRO 204 at Ongole, AP

supplied breeder seed as source foundation seed during 27-28 November, 2018 (Fig. 2.6). It was observed that jute seed production plots of contract farmers at Ongole and Koppolu in Prakasham District were mostly of early sown (July-Aug) crop of variety JRO 204 with wide spacing. Rouging operations were not followed properly at some places. Percentage of off-type plants in some of the plots were slightly more than permissible limits. (*Source: NSP. Contributors: C.S. Kar, H.R. Bhandari and A. Bera*).

## 2.3. AICRP on ICAR Seed Project

Quality seeds of different crops were produced under this project for distribution or sale among the farmers. A total of 512.77 q seeds of different crops were produced. Under this programme 31.77 q TL seeds of jute along with mesta (2.15 q TL and 1.0 q breeder), sunnhemp (20.00 q TL and 0.10 q breeder), dhaincha (6.20 q TL), paddy (347 q certified and 106 q TL), sesame (1.35 q TL), wheat (1.00 q TL), flax (1.00 q BS and 0.65 q TL) and mustard (30.0 q TL) were produced. Planting material of sisal (50,000 bulbils and suckers) and ramie (50 q rhizome) were also produced under this project. (*Source: ICAR Seed Project Contributor: C.S. Kar*).

**Table 2.6. Quality seeds produced under ICAR Seed Project**

| Crop | Production (q) |
|---|---|
| Jute (TL) | 31.77 |
| Dhaincha (TL) | 6.20 |
| Paddy (Certified) var. MTU 7029 | 347.30 |
| Paddy (TL) var. MTU 7029 | 106.30 |
| Mustard (TL) var. B 54 and B9 | 14.90 |
| Wheat (TL) var. UP 262 | 0.25 |
| Mesta (TL) | 2.15 |
| Mesta (Breeder) | 1.00 |
| Sesamum (TL) var. RT 351 | 1.35 |
| Flax (Breeder) var. JRF 2 | 0.65 |
| Flax (TL) var. JRF 2 | 0.80 |
| Sunnhemp (Breeder) var. SUIN 037 | 0.10 |
| **Grand Total** | **512.77** |

## 2.4. Frontline demonstration on mesta seed production

New initiative was taken for FLD on seed production technology of mesta in Bandwan, Purulia, located in drier tract of West Bengal. Farmers were trained on seed production technology of mesta and 50 Kg seed of HS 4288 (roselle variety) were distributed among farmers. A total of 500 kg TL seed of HS 4288 was produced by five farmers (Fig. 2.7 and 2.8).

**Fig. 2.7.** FLD on mesta seed production in Saga village, Bandwan in Purulia district

**Fig. 2.8.** Farmer Biswajit Mahato in seed production plot at Madhupur village, Bandwan

## 2.5 Seed Day

Distribution of jute seed (variety JRO 128 & CO 58) was done on the occasion of Seed Day on 23rd March, 2019 at Kumra village of North 24 Parganas, West Bengal. More than 100 farmers participated in this programme (Fig. 2.9 and 2.10). (*Source: AICRP on ICAR Seed Project. Contributors: C.S. Kar, H.R. Bhandari and A. Bera*).


**Fig. 2.9.** Seed Day on 23rd March, 2019 at Kumra village of North 24 Pargans, West Bengal


**Fig. 2.10.** Distribution of jute seed on the occasion of Seed Day

## 2.6. Seed Production Programme under NFSM Commercial Crops (Jute)

Breeder seed of mesta (1.6 q of AMV 5), TL seed of jute (JRO 204- 5.5 q and JRO 524- 0.5 q) and TL seed of roselle (HS 7910- 0.50 q) were produced at ARS, Amadalavalasa, Gulbarga, Karnataka and Arsha, Purulia, West Bengal (Fig. 2.11). (*Source: NFSM Commercial Crops. Contributors: C.S. Kar, A. Bera and H.R. Bhandari*).

**Fig. 2.11.** Seed production plot of HS 7910 at Arsha, Purulia

# 3. Biotechnology

## 3.1. Population Genetic Analysis of Jute

### 3.1.1. Individual-based restriction site-associated DNA sequencing (RADseq) in dark jute (*C. olitorius*)

A *C. olitorius* association mapping population comprising 225 accessions (fibre-type cultivars, landraces, improved lines and varieties) collected from 15 countries was used in the study. They were grouped into nine geographic populations based on their sampled locations (Table 3.1).

**Table 3.1. Distribution of 225 *C. olitorius* accessions across nine geographic populations**

| Population[a] | Country | Region | Number |
|---|---|---|---|
| AFR1 | Kenya, Sudan | Africa | 12 |
| AFR2 | Tanzania | Africa | 17 |
| CI | India | Asia | 52 |
| EI | India | Asia | 41 |
| NI | India | Asia | 49 |
| SI | India | Asia | 13 |
| NPPK | Nepal, Pakistan | Asia | 17 |
| ESEA | China, Indonesia, Myanmar, Thailand | Asia | 18 |
| Row | Australia, Brazil, Germany, Russia | Rest of the world | 6 |

[a]*AFR1, Africa 1; AFR2, Africa 2; CI, Central India; EI, Eastern India; NI, North India; SI, South India; NPPK, Nepal and Pakistan; ESEA, East and South-East Asia; Row, Rest of the world*

Three 75-plex RAD libraries were constructed, and they were sequenced to 100 bp on a single lane of Illumina HiSeq→ 2000 (Illumina, San Diego, CA) based on Illumina's TrueSeq→ Version 3.0 single-end sequencing chemistry. Non-reference-based universal network-enabled analysis kit (UNEAK) as implemented in TASSEL 3 was used to analyze the RADseq data. RADseq generated 568,217,847 clean reads with 57.98 Gbp of nucleotide sequences from 225 genotypes across three RAD libraries (Fig. 3.1).

Four accessions were excluded from downstream analyses due to >50% missing RAD-SNP genotypes. Finally, a set of 1115 informative loci was retained across 221 accessions, with a call rate of >0.95, MAF of >0.05 and a Ts/Tv ratio of 1.62. Of them, 1110 loci (99.6%) were mapped to the draft genome of *C. olitorius* cv. JRO-524 (Navin), with 798 (72%) present within 563 genes. In contrast, 1062 RAD-SNP loci (95.2%) were mapped to the draft genome of *C. olitorius* cv. O-4, with 766 (69%) present within 552 genes. The Blast2GO mapping of 563 genes supporting 798 loci resulted in 2,292 GO-term annotations, which were summarized into three main GO categories and 42 sub-categories. (*Source: ICAR-NPTC-3070. Contributor: D. Sarkar*).

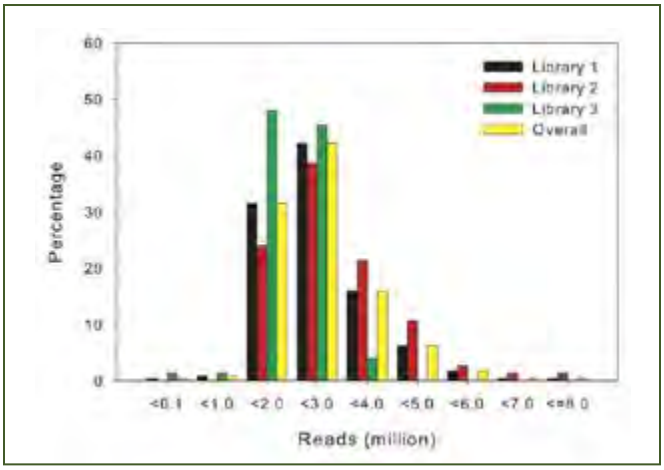



**Fig. 3.1.** Distribution of the number of 100-bp sequence reads (overall and across three libraries) obtained by genotyping 225 *C. olitorius* accessions using single-digest (*ApeKI*) RADseq

### 3.1.2. Population genomic inferences in dark jute (*C. olitorius*)

There were significant ($P < 0.0001$) differences for different genetic diversity parameters across the nine *C. olitorius* geographic populations. The four Indian populations had minimum major allele frequency (P) but maximum minor allele frequency (MAF) and polymorphism information content (PIC) values. The P values in SI and ESEA populations were distributed in agreement with those in AFR1 and AFR2, respectively. However, the NPPK and RoW populations had a skewed distribution of P toward 1.0. The $H_s$ estimates (0.192-0.310), with an average of 0.258, were maximum for Indian and minimum for the RoW and NPPK populations. The four Indian populations were characterized by the highest effective number of alleles ($A_e$), rarified allelic richness ($A_r$) and private allelic richness ($A_p$) (Table 3.2). The four Indian populations were significantly ($P < 0.05$) differentiated ($F_{ST}$) from both the African populations. The EI and SI populations showed minimum and maximum genetic divergence from African populations, respectively. The other two Asian populations were, however, genetically related to both the African populations, but significantly differentiated from all Indian populations. The AMOVA showed that the majority of the genetic variation (85.4%) was partitioned across individuals within populations ($F_{IS}$), whereas only 5.7% and 6.7% of the variations were due to differences among populations nested within ($F_{SC}$) and across ($F_{CT}$) regions, respectively.

**Table 3.2. Summary population genetic statistics[a] for nine geographic populations of *C. olitorius* based on 1115 RAD-SNP loci**

| Pop | MAF | P | PIC | $A_e$ |
|---|---|---|---|---|
| AFR1 | 0.164 | 0.836 | 0.177 | 1.38 |
| AFR2 | 0.156 | 0.844 | 0.183 | 1.36 |
| CI | 0.209 | 0.791 | 0.239 | 1.48 |
| EI | 0.213 | 0.787 | 0.243 | 1.49 |
| NI | 0.224 | 0.776 | 0.245 | 1.51 |
| SI | 0.203 | 0.797 | 0.220 | 1.46 |
| NPPK | 0.124 | 0.876 | 0.152 | 1.29 |
| ESEA | 0.151 | 0.849 | 0.182 | 1.35 |
| RoW | 0.111 | 0.889 | 0.126 | 1.26 |
| Kruskal-Wallis *P* | <0.0001 | <0.0001 | <0.0001 | <0.0001 |

[a]*MAF, minor allele frequency; P, major allele frequency; PIC, polymorphism information content; $A_e$, effective number of alleles*

The overall amount of gene flow among populations was high ($N_m$ = 2.83). Of the nine geographic populations, the average estimates of $N_m$ were much lower in the four Indian populations versus AFR1 (1.37) or AFR2 (1.71), with the minimum and maximum amounts observed in the SI (0.88) and EI (2.47) populations, respectively. This was verified using the principal component analysis (PCA). The first PC that was only significant ($P \leq 0.0001$) explained 62.0% of the total genetic variation and differentiated the four Indian populations from African and the other Asian populations. However, the second PC that accounts for 11.5% of genetic variation was also found to have some explanatory power. (*Source: ICAR-NPTC-3070. Contributor: D. Sarkar*).

### 3.1.3. Population structure of dark jute (*C. olitorius*)

The AMOVA-based *k*-means clustering identified two clusters that best explain the overall population structure of *C. olitorius*. This was based on pseudo-*F* statistic that performs better than BIC when individuals are clustered (Table 3.3). The software STRUCTURE v2.3.4 was used to infer the population structure based on both admixture and non-admixture ancestries and the correlated allele frequencies, with the burn-in and Markov chain Monte Carlo (MCMC) iterations of 20,000 each and 10 replicates for each of several values of *K* that ranged from 1 to 15. Further, population structure was also inferred using sNMF (sparse non-negative matrix factorization) and DAPC (discriminant analysis of principal components).

STRUCTURE inferred that a model with $K = 2$ best fits the complete data for both admixture and non-admixture models. However, this *K* solution was found to be unstable for the non-admixture model because average maximum correlation (i. e. the *K* solution's overall stability) was not significant at $P \leq 0.05$. Incidentally, not a single *K* solution was stable for the non-admixture model (Table 3.4).

**Table 3.3. Summary statistics[a] for the AMOVA-based *k*-means clustering of 221 *C. olitorius* accessions using 1115 RAD-SNP loci**

| *k* | $r^2$ | Pseudo-*F* | BIC |
|---|---|---|---|
| 2 | 0.085 | 20.257 | 2619.670 |
| 3 | 0.107 | 13.028 | 2619.668 |
| 4 | 0.126 | 10.460 | 2620.169 |
| 5 | 0.140 | 8.801 | 2622.048 |
| 6 | 0.153 | 7.765 | 2624.128 |
| 7 | 0.164 | 6.997 | 2626.625 |
| 8 | 0.174 | 6.420 | 2629.305 |
| 9 | 0.184 | 5.959 | 2632.180 |
| 10 | 0.192 | 5.574 | 2635.265 |
| 11 | 0.200 | 5.265 | 2638.367 |
| 12 | 0.208 | 5.004 | 2641.533 |
| 13 | 0.216 | 4.789 | 2644.687 |
| 14 | 0.224 | 4.602 | 2647.896 |
| 15 | 0.231 | 4.431 | 2651.219 |

[a]*k, the number of genotypic groups; $r^2$, the fraction of the total variance explained by the clustering; Pseudo-F, $r^2/(1 - r^2)(n - k)$, where k is the number of clusters and n is the number of populations; BIC, the Bayesian Information Criterion*

This was further confirmed by analyzing the significance of the Q matrix correlations. The STRUCTURE analyses based on coding (798) versus non-coding (317) RAD-SNPs also inferred two genetic groups under admixture. Based on maximum membership probabilities ($q$), 125 and 96 accessions were assigned to Indian and African groups, respectively. Indian populations were characterized by rather high levels of admixture, with an average of 49.7%. More than with 50% of individuals in CI and EI populations were identified as admixed.

**Table 3.4. The *K* solution's overall stability across the two ancestry models of the STRUCTURE analyses as assessed by the significance of the Q matrix correlations based on average maximum correlation criterion**

| *K* | Admixture | | Non-admixture | |
|---|---|---|---|---|
| | *r* | Correlated ($P \leq 0.05$) | *r* | Correlated ($P \leq 0.05$) |
| 1 | NA | ? | NA | ? |
| 2 | 0.999 | Y | 0.976 | N |
| 3 | 0.982 | N | 0.957 | N |
| 4 | 0.969 | N | 0.886 | N |
| 5 | 0.994 | Y | 0.907 | N |
| 6 | 0.980 | N | 0.922 | N |
| 7 | 0.996 | Y | 0.933 | N |
| 8 | 0.994 | Y | NA | ? |
| 9 | 0.994 | Y | NA | ? |
| 10 | 0.991 | Y | NA | ? |
| 11 | 0.993 | Y | NA | ? |
| 12 | 0.985 | N | NA | ? |
| 13 | 0.982 | N | NA | ? |
| 14 | 0.986 | N | NA | ? |
| 15 | 0.976 | N | NA | ? |

The sNMF analysis also inferred that $K = 2$ (cross-entropy value = 0.41 at ⟨= 10) defines the population structure of *C. olitorius* under admixture and clustered 221 of its accessions into two ancestral groups *Q1* (Indian) and *Q2* (African), with mean ancestry coefficients of 0.492 and 0.508, respectively. Using maximum ancestry coefficients, 118 and 103 accessions were assigned to Indian and African groups, respectively, with 96.8% concordance with the STRUCTURE groupings.

The DAPC also inferred two clusters using sequential *k*-means. There was a significant correspondence between the geographic populations and *k*-means-inferred clusters (Fig. 3.2). With $k = 2$, DAPC retained a single discriminant function and assigned 129 and 92 accessions to two clusters (*C1* and *C2*) that correspond to Indian and African groups, with mean coordinate values of -2.333 and 3.272, respectively (Fig. 3.3). About ~95% and ~97% of accessions that were assigned to the STRUCTURE groups *Q1* (Indian) and *Q2* (African), respectively were correctly assigned to corresponding DAPC clusters. There was also high concordance (94.1%) between the sNMF- and DAPC-inferred groupings.

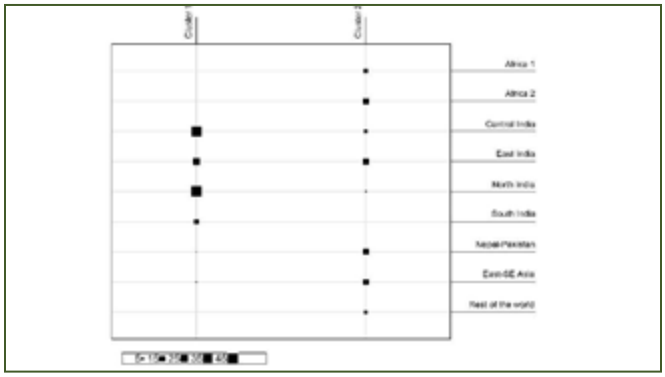


**Fig. 3.2.** Sequential *k*-means-inferred versus original groups correspondence plots. The number of clusters was identified by sequential *k*-means, and the correspondence between the inferred and original groups was assessed. Rows correspond to original geographic populations, whereas columns correspond to inferred Indian (C1) and African (C2) clusters

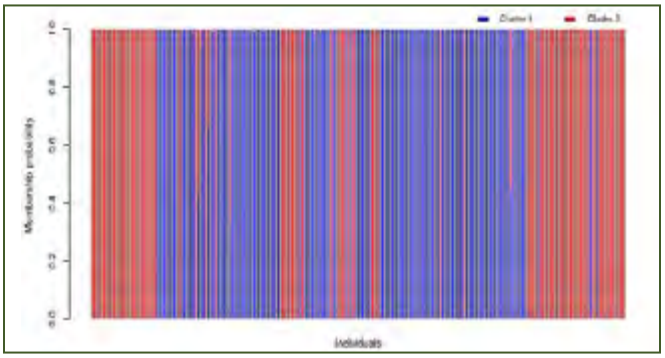


**Fig. 3.3.** Membership probabilities of 221 *C. olitorius* individuals across two clusters (*C1* and *C2* representing Indian and African, respectively) inferred by discriminant analysis of principal components (DAPC)

A total of 39 RAD-SNP loci were identified as the most contributing to DAPC-inferred group differentiation. Based on loading plots (DAPC function *loadingplot*), a total of 39 RAD-SNP loci were identified as the most contributing to group differentiation. All RAD-SNP loci, except for CoRAD33, CoRAD510, CoRAD655 and CoRAD946, contributed both alleles to this group differentiation. (*Source: ICAR-NPTC-3070. Contributor: D. Sarkar*).

### 3.1.4. RAD-SNP loci under selection in dark jute (*C. olitorius*)

Both population- (LOSITAN, BayeScan and HacDivSel) and individual-based (PCAdapt) approaches were used to detect RAD-SNP loci under selection. The distribution of $F_{ST}$ versus $H_e$ values obtained by LOSITAN detected the presence of outliers against neutral expectations outside the 99% CI (Fig. 3.4). Fourteen loci (1.3%) were consistently identified as outliers in African versus Indian (subpopulations) comparison through 10 independent iterations (FDR < 0.05). However, the Bayesian analysis through 10 independent iterations (FDR < 0.05) consistently detected only one (0.09%) outlier (CoRAD959) at $\log_{10}$ BF of 1.5-2.0 that corresponds to very strong evidence of selection based on Jeffreys' scale of evidence.

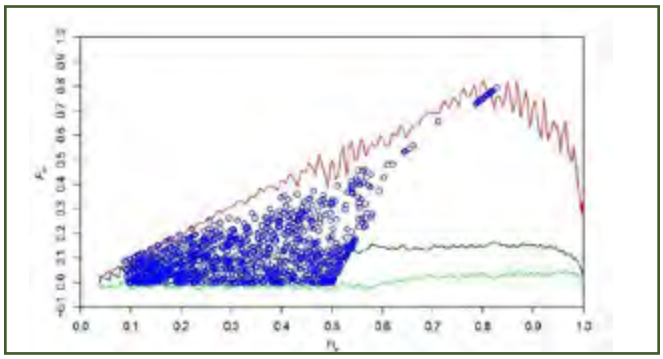


**Fig. 3.4.** Distribution of $F_{ST}$ values as a function of the within-population expected heterozygosity ($H_e$) between the two STRUCTURE subpopulations (Indian and African) in *C. olitorius* obtained by using LOSITAN. The red and green lines represent the 99% and 1% confidence limits (FDR < 0.05), respectively, whereas the black line indicates the median

The HacDivSel extreme outlier-set (EOS) test detected 19 loci (1.7%) as outliers, of which 9 represented the *K*-means extreme positive outliers (EPOs) and 10 were non-EPOs. However, none of these EPOs were found to be significant ($P < 0.05$) when assessed by the LK (Lewontin and Krakauer) test followed by strict Bonferroni correction for multiple testing. The global approach PCAdapt that performs genome scans using PCA without requiring to group individuals into predefined populations detected 63 RAD-SNP loci (FDR < 0.05) involved in biological adaptation. Of these 63 loci, 25 (39.7%) and 38 (60.3%) were assigned to PC1 and PC2, respectively. However, none of these outlier loci detected by PCAdapt were common to those detected by $F_{ST}$-outlier tests, except the one identified by BayeScan.

Taken together, the present study showed that African *C. olitorius* was first introduced in peninsular India to be regarded as its secondary centre of origin (SCO). However, multiple later introductions have occurred in central, eastern and northern India. Two ancestral subpopulations (African and Indian) structure the *C. olitorius* populations, but not in accordance with their geographic origins and patterns of diversity. Based on functional classification of outlier RAD-SNP loci, it is obvious that bast fibre production was an artificial while abiotic and biotic stresses were natural selection pressures in *C. olitorius* adaptation. Reinference of the population structure without outlier loci demonstrates that *C. olitorius* was possibly domesticated as a fibre crop in the Indian subcontinent. (*Source: ICAR-NPTC-3070. Contributor: D. Sarkar*).

## 3.2. Genomic Analysis of Plant *β-galactosidases*

### 3.2.1 Structure and phylogeny of jute *β-galactosidases*

A total of 12 *β-galactosidases* (CcBGALs) from jute were identified through transcriptome analysis. Structural modeling also revealed close structural similarity among all the annotated GH-35 CcBGALs, except CcBGAL11. Secondary structure models of these CcBGALs (10) matched best with tomato β-galactosidase 4 (Fig. 3.5). A different secondary structure was predicted for CcBGAL11, showing best match with human β-galactosidase. *In silico* ligand binding experiments identified a conserved galactose binding site in most of the predicted CcBGAL structures except in CcBGAL9 and CcBGAL12. Plant *β-galactosidases* are classified in nine sub-families based on sequence similarity of *β-galactosidases* of *Arabidopsis* (*AtBGAL*). Based on phylogenetic analysis, we could classify the *CcBGALs* under six of these subfamilies, namely 'a1' (*CcBGAL1*, *CcBGAL4* and *CcBGAL5*), 'a2' (*CcBGAL8* and *CcBGAL10*), 'a4' (*CcBGAL6*), 'a5' (*CcBGAL3* and *CcBGAL7*), 'c2' (*CcBGAL9* and *CcBGAL12*) and 'd' (*CcBGAL11*) (Fig. 3.5). Within subfamily 'a1', *CcBGAL1* and *CcBGAL5* shared 89% and 90% sequence similarity, respectively with *AtBGAL1*, the primary pectin degrading *β-galactosidase* of *Arabidopsis*. In the subfamily 'a2', *CcBGAL10* shared 86% sequence similarity with *AtBGAL9*, while under 'a5', *CcBGAL3* and *CcBGAL7* exhibited 81.9% and 84.3% sequence similarity with *AtBGAL10*, respectively. Phylogenetic analysis also identified the closest homologs of the *CcBGALs* from *Theobroma cacao*, *Gossypium raimondii* and *G. hirsutum*, implying the GH-35 *β-galactosidases* are highly conserved in Malvaceae. (*Source: JBT 4.1 and ICAR-NPTC sub-project 3070. Contributors: D. Sarkar, P. Satya and N.K. Singh*)

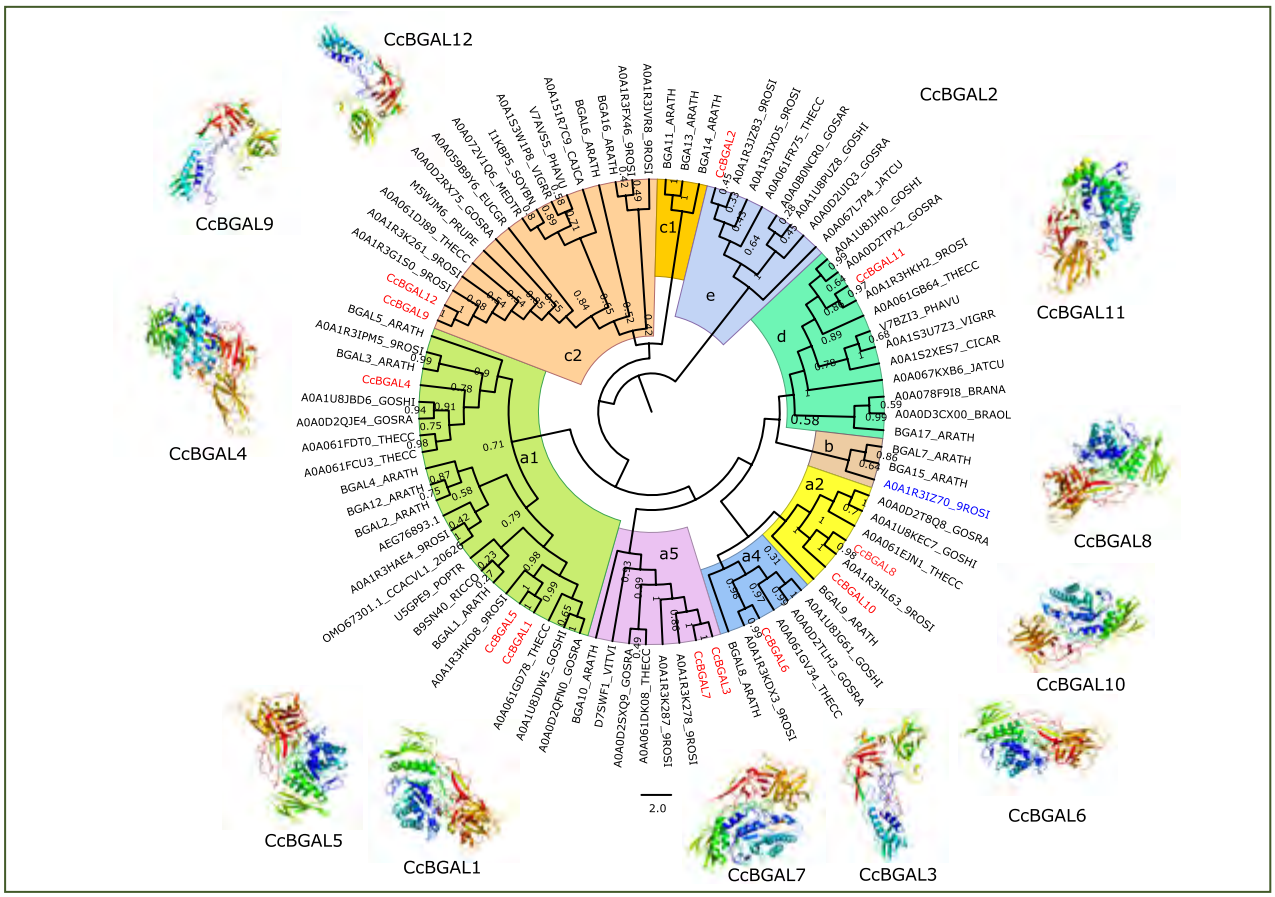



**Fig. 3.5.** Phylogeny and protein structural models of the jute *β-galactosidases*

### 3.2.2. Domain-centric evolutionary model of plant *β-galactosidases*

Four types of domain architecture in plant GH-35 β-galactosidases were identified from domain search in plant species. Based on both the domain architecture and phylogeny of these β-galactosidases, it was proved that the evolution of GH-35 *β-galactosidases* in plant kingdom took place through domain integration along with gene and/or genome duplication (Fig. 3.6). The first group (BGL I), which contains only one N-terminal Glyco_hydro_35 (PF01301) domain, is present in bacteria, fungi, plants and animals. This domain is conserved in both bacteria and eukaryotes, indicating that the members of the BGL I *β-galactosidases* present in higher plants evolved from an ancestral bacterial GH-35 *β-galactosidase*. Moreover, multiple copies of BGL I *β-galactosidases* are present in higher plants, indicating the class has expanded by gene and/or genome duplication. The second group (BGL II) has a domain architecture of Glyco_hydro_35 + Gal_Lectin domain architecture, which has most probably evolved by integration of the C-terminal Gal_Lectin domain to the BGL I type *β-galactosidase*. Presence of this domain architecture in Bryophytes (*Physcomitrella patens*) and Lycophytes (*Selaginella moellendorffii*) but its absence in animals, other lower eukaryotes and prokaryotes suggest that the integration

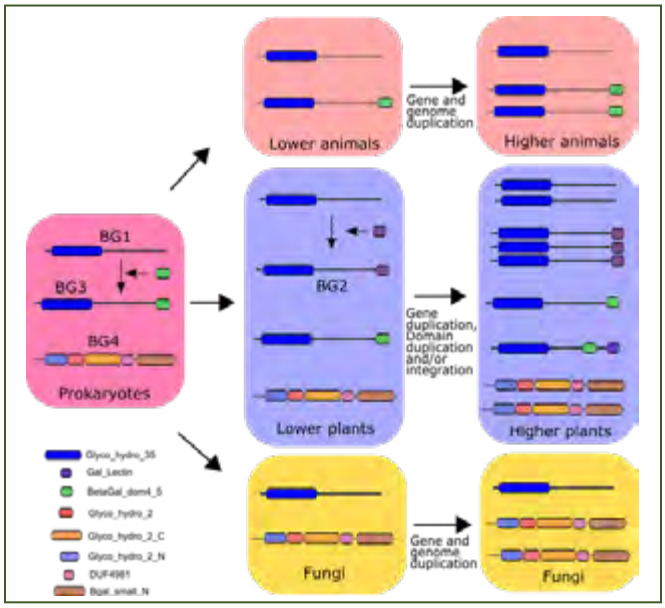



Fig. 3.6. Domen-centric evolutionary model of plant β-*galactosidases*

of these two domains took place after evolution of land plants. The copy number of BGL II also expanded in higher plants probably through gene and/or genome duplication. The third group (BGL III) with Glyco_hydro_35+BetaGal_dom4_5 type domain architecture evolved through integration of BetaGal_dom4_5 to the C-terminal end of BGL I type *β-galactosidase*, which happened before evolution of the eukaryotes. Domain fusion has also led to modification of domain architecture of GH-35 *β-galactosidases* in higher plants. For example, integration of Gal_Lectin domain to the C-terminal end of BGL III *β-galactosidase* resulted in a previously undescribed (BGL IV) domain architecture. The number of *β-galactosidases* in higher plants has increased not only by duplication of ancestral prokaryotic GH-35 *β-galactosidase*, but also through integration and duplication of domains. The five-domain-structure GH-2 *β-galactosidase* (BGL V) was transmitted from bacteria specifically to the fungal and plant kingdoms and expanded by increase in copy number only. The five-domain architecture remained highly conserved in plants without deletion, duplication or integration of domains. (*Source: JBT 4.1 and ICAR-NPTC sub-project 3070. Contributors: D. Sarkar, P. Satya and N.K. Singh*)

### 3.2.3. *CcBGAL11* of jute is a homolog of human *β-galactosidase*

Plant and animal kingdoms diverged from each other about 1500 Million Years ago. But the evolution has preserved the relics of their ancient kinship in the form DNA sequence conservation. Many of such conserved DNA sequences are genic and hence encode functional product. These can serve as classic examples to demonstrate how structural conservation leads to conserved function. A β-galactosidase gene (*CcBGAL11*) form jute (*Corchorus capsularis*) was found to be expressed in plant hypocotyl. Sequence analysis revealed presence of Glyco_hydro_35 domain, which is the main catalytic domain of eukaryotic β-galactosidase and an additional jelly roll domain which might play role in substrate specificity. Secondary structure analysis revealed that *CcBGAL11* possess a structure which is quite different form typical plant β-galactosidases

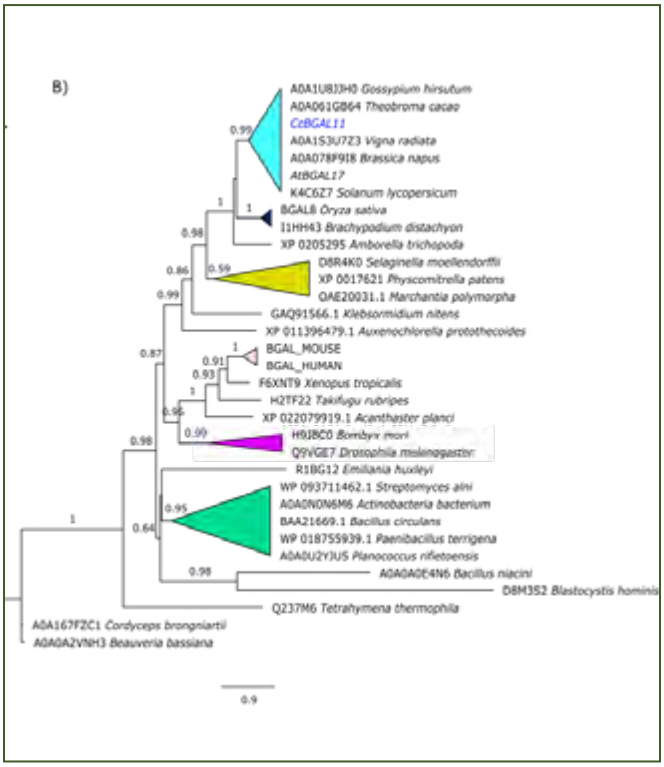



**Fig. 3.7.** Phylogeny of CcBGAL11 along with other plant and animal *β-galactosidases*

but resembles closely with human β-galactosidase, a model for animal-type β-galactosidases. Further investigations using sequence data available in public domain revealed that the presence of such animal-type β-galactosidases in plant is not unique to jute, rather it quite common in many including model plant *Arabidopsis*. It opens up two possibilities – either horizontal gene transfer from animal to plant, or conservation of ancestral gene during evolution. We tested this hypothesis by constructing a phylogenetic tree for CcBGAL11 and its homologous sequences in different organisms (Fig. 3.7). The tree showed that this animal-type β-galactosidase evolved in higher plants from prokaryotes eliminating the possibility of horizontal gene transfer. (*Source: JBT 4.1 and ICAR-NPTC sub-project 3070. Contributors: D. Sarkar, P. Satya and N.K. Singh*).

## 3.3. Mining Novel Alleles for Stress Tolerance in Jute and Allied Fibres

### 3.3.1. Protein characterization and identification of NPA Motifs and Transmembrane Domains in Aquaporin Gene Family in Jute (*Corchorus olitorius* L. and *Corchorus capsularis* L.)

The biochemical properties of identified aquaporin genes in jute were analyzed for molecular weight, protein Isoelectric Point (pI) and subcellular localization. The identified CoAQPs encodes protein ranging from 227 to 318 amino acids with an average of 272 amino acids in length, a molecular weight ranging from 23.4 to 34.2 (average 28.78) kD, pI value ranging from 4.9 to 9.2 (average 7.6), GRAVY value ranging from 0.39 to 1.0 (average 0.57) (Table 3.5). The analysis of the predicted subcellular localization of the CoAQPs showed that all except TIPs, which are localized in tonoplast, are localized in plasma membrane.

Table 3.5. **Physiochemical properties of selected *Corchorus olitorius* aquaporin proteins**

| Gene Name | Mol.Wt (D) | pI | Instability Index | Aliphatic Index | GRAVY |
|---|---|---|---|---|---|
| CcNIP1.1 | 22882.75 | 9.38 | 27.36 | 97.48 | 0.436 |
| CcNIP4.2 | 89938.11 | 7.85 | 39.91 | 104.39 | 0.124 |
| CcNIP5.2 | 31022.92 | 8.55 | 38.12 | 91.07 | 0.388 |
| CcNIP7.2 | 12936.03 | 8.89 | 32.76 | 93.42 | 0.235 |
| CcPIP1.1 | 30665.76 | 8.97 | 26.03 | 98.99 | 0.433 |
| CcPIP2.6 | 30621.5 | 7.03 | 31.69 | 99.3 | 0.442 |
| CcSIP1.2 | 26132.1 | 9.12 | 28.78 | 105.77 | 0.839 |
| CcTIP1.1 | 25855.99 | 5.78 | 24.17 | 111.15 | 0.86 |
| CcTIP1.2 | 26341.59 | 6.57 | 23.06 | 115.61 | 0.812 |

To identify conserved domains within the jute AQP protein sequences, NPA motifs, ar/R filters (H2, H5, LE1, LE2) and Froger's positions (P1–P5) were predicted based on careful visual inspection of multiple sequence alignments of jute AQPs (Fig. 3.8). The second channel construction site known as "ar/R" that consist of tetrad formed by helicase 2 (H2) and 5 (H5) and two LE1 and LE2 residues from loop E were identified. Different combination of ar/R selectivity filter in jute AQP family and a conserved pattern within the subfamilies were also observed. The P2, P3, P4 and P5 Froger's positions in the jute AQPs were highly conserved, whereas the P1-P5 position exhibited variations in amino acid composition.

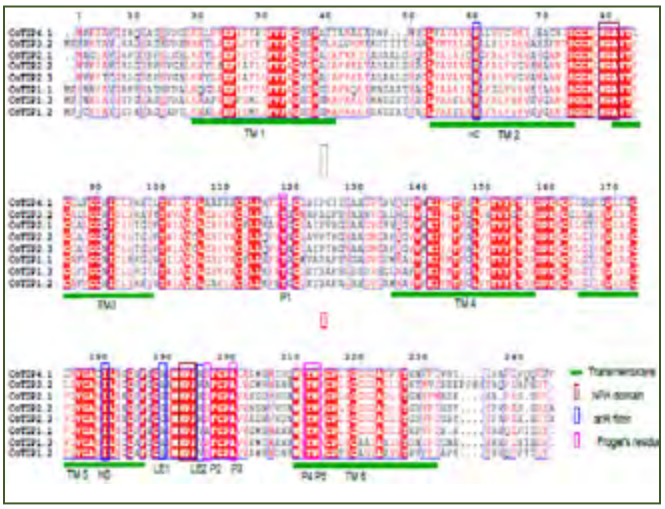


**Fig. 3.8.** Prediction of NPA motifs, selectivity filter residues and position of transmembrane helices in jute aquaporins

The three-dimensional (3D) structure of jute AQPs were generated by intensive protein modeling using Phyre2 server (http://www.sbg.bio.ic.ac.uk/phyre2/html/page.cgi?id=index) using 'Normal' mode modeling based on alignment to experimentally solved protein structures. Transmembrane helix and topology of the CoAQPs and CcAQPs were predicted by MEMSAT-SVM prediction method available in Phyre2 server. Broadly, the Co and Cc AQP 3D protein structure contains the conserved hour-glass model with a pore-forming integral membrane protein containing α-helical bundle forming six TM helices (H1 to H6) and two additional short (half) helices (HE and HB). The loops HE and HB each containing the conserved NPA motifs get close together in the center of the membrane (Fig. 3.9).

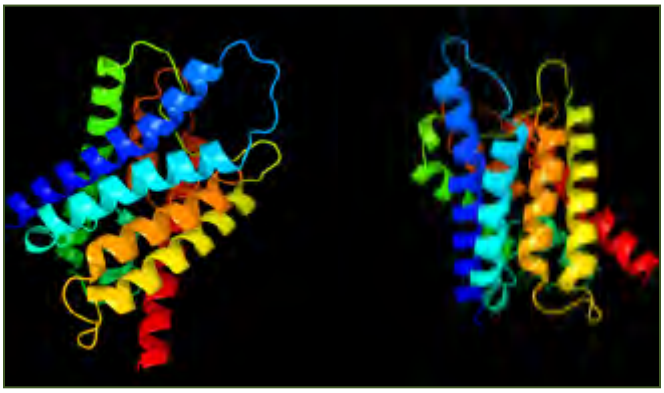


Fig. 3.9. Prediction of three-dimensional structure of two jute Small Intrinsic Proteins

For the detection and characterization of transmembrane protein channels from their 3D structures, PoreWalker was used and four consecutive steps were performed: (1) identification of the protein main axis; (2) identification and optimization of the centre of the pore; (3) detection of the best cavity and optimization of the pore axis; (4) analysis of pore features: size, shape, regularity and straightness of the pore and pore-lining atoms and residues. In Fig. 3.10, the bottom of the pore axis (i.e. the lowest x-coordinate) correspond to the bottom of the stack. The pore diameter profile shows the variation of pore diameters along the pore from the lowest to the highest x-coordinate at 3 Angstrom steps. *(Source: JBT 4.7. Contributors: S. Datta, J. Mitra, D. Saha, P. Satya and A. Anil Kumar).*

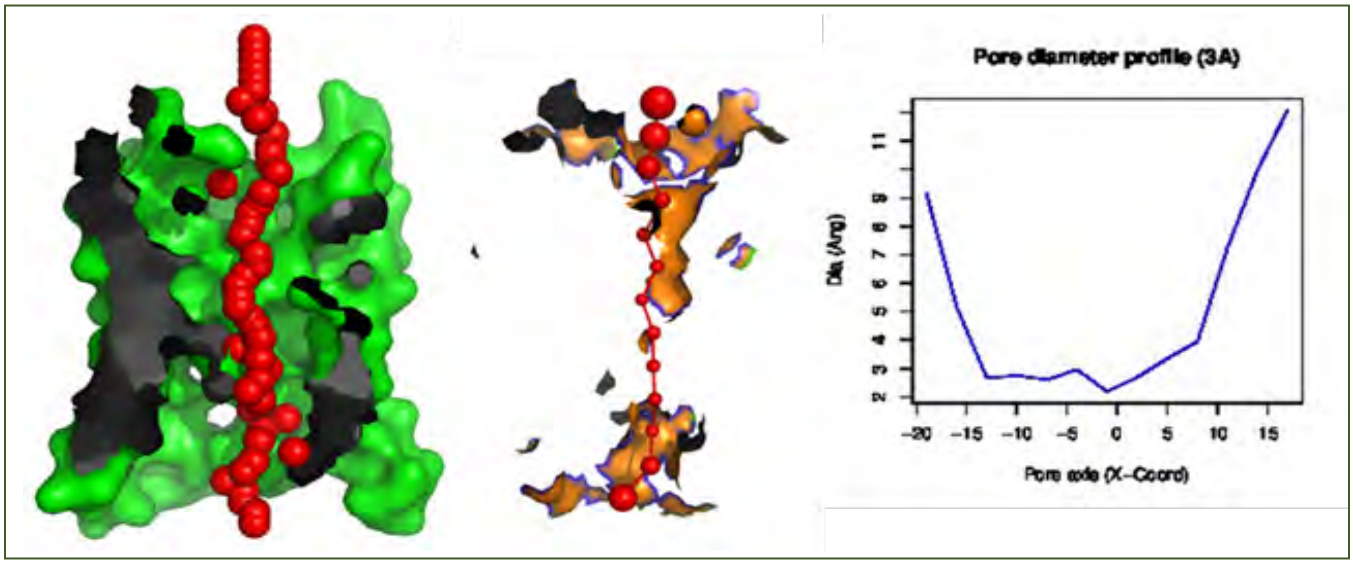



**Fig. 3.10.** Pore visualization of *C. capsularis* TIP 1.2 aquaporin

### 3.3.2 Expression analysis of jute AQPs

Jute RNA-seq data were downloaded from the NCBI Sequence Read Archive (SRA) database (http://www.ncbi.nlm.nih.gov/sra/) and were used to analyze the expression pattern of the CoAQPs under abiotic stresses (salt and drought stress). For the tissue-specific expression, RNA-seq data from various plant tissues and development stages including bast transcriptome of *Corchorus capsularis* cv. JRC-212 (S1; SRX709726), hypocotyl transcriptome of *Corchorus capsularis* cv. JRC-212 (S3; SRX912155), RNA-seq of shoot apex of Corchorus olitorius var. JRO-204 under short-day condition (SRX2828109) were used.

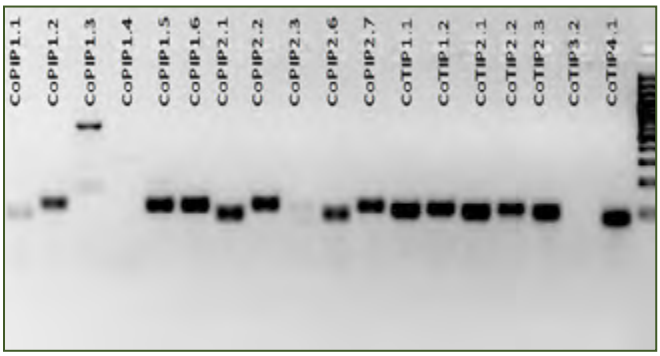



**Fig. 3.11.** Amplification pattern of jute AQP genes in cDNAs

Also RNA from various tissues were isolated and converted to cDNA for qRT PCR using primers designed with IDT PrimerQuest. Primers were first checked for amplification using genomic DNA and cDNA under routine PCR protocol (Fig. 3.11). qRT PCR established tissue specific expression patterns of the jute aquaporin genes. *(Source: JBT 4.7. Contributors: S. Datta, J. Mitra, D. Saha, P. Satya and A. Anil Kumar).*

### 3.3.3 Analysis of the conserved domains (motifs) and the physicochemical characteristics of Heat Shock Factors (HSFs) in Jute (*Corchorus olitorius* L. and *Corchorus capsularis* L.)

Using SMART, NetNES and HEATSTER platform, DBDs, ODs, NLSs and NESs motifs from the amino acid sequences of Hsfs of jute were identified. Position of DNA Binding Domains (DBDs) in jute Heat Shock Factors (HSFs) are listed in table 3.6. Physicochemical indexes related to the characteristic motifs were calculated, including the grand average of hydropathicity (GRAVY), Pi and molecular weight (Table 3.7). Number of residues in jute HSFs ranged from 213 to 535 with a mean of 357 residues per protein. The theoretical isoelectric point (pI) of ColHsfs ranged from 4.79 to 9.03 with an average of 6.21. The corresponding molecular weight of the proteins varied from 23.5 to 58.7 kD with a mean of 40.2 kD. The average GRAVY values (-0.893 to -0.444) of ColHsfs containing were covering wider range than reported in many plant species.

**Table 3.6. Position of DNA Binding Domains (DBDs) in jute Heat Shock Factors (HSFs)**

| HSF | DNA binding domain | |
|---|---|---|
| | Start | End |
| ColHSFA1 | 41 | 137 |
| ColHSFA2 | 1 | 108 |
| ColHSFA3 | 56 | 159 |
| ColHSFA4 | 6 | 119 |
| ColHSFA6.1 | 34 | 136 |
| ColHSFA6.2 | 37 | 139 |
| ColHSFA9 | 137 | 241 |
| ColHSFB1 | 1 | 101 |
| ColHSFB2.1 | 16 | 134 |
| ColHSFB2.2 | 18 | 136 |
| ColHSFB4.1 | 19 | 48 |
| ColHSFB4.2 | 19 | 119 |
| ColHSFB5 | 16 | 142 |

**Table 3.7. Physiochemical properties of *Corchorus olitorius* Heat Shock Factors (HSFs)**

| Gene | Amino acids | Mol. Wt. (D) | pI | GRAVY |
|---|---|---|---|---|
| ColHSFA1 | 535 | 58750.45 | 4.94 | -0.666 |
| ColHSFA2 | 335 | 37931.51 | 4.79 | -0.564 |
| ColHSFA3 | 494 | 55089.69 | 4.95 | -0.65 |
| ColHSFA4 | 456 | 52362.41 | 5.65 | -0.804 |
| ColHSFA6.1 | 376 | 43333.48 | 5.56 | -0.893 |
| ColHSFA6.2 | 380 | 44142.29 | 5.06 | -0.87 |
| ColHSFA9 | 489 | 54613 | 5.11 | -0.681 |
| ColHSFB1 | 219 | 24214.07 | 9.03 | -0.738 |
| ColHSFB2.1 | 323 | 36126.47 | 5.65 | -0.687 |
| ColHSFB2.2 | 255 | 28050.35 | 5.27 | -0.584 |
| ColHSFB4.1 | 213 | 24488.96 | 9.02 | -0.444 |
| ColHSFB4.2 | 364 | 40196.39 | 8.12 | -0.48 |
| ColHSFB5 | 206 | 23543.55 | 7.64 | -0.693 |

Gene Structure Display Server (GSDS version 2.0) was used to predict gene features, such as the composition and position of exons, introns, and conserved elements. The number of introns per gene greatly varied from one to three. The gene ColHSFB2.1 contain maximum three introns; while ColHSFA6 and ColHSFB1 have two introns each. Rest of the ten HSFs contained one intron per gene. Overall jute HSFs showed the complex gene structure with varying intron positions and lengths (Fig. 3.12). *(Source: JBT 4.7. Contributors: S. Datta, J. Mitra, D. Saha, P. Satya and A. Anil Kumar).*

## 3.4 Identification and annotation of Transposable elements from jute genomes

From the published jute genomes, various Transposable elements (TE) were identified for developing transposable element-derived polymorphic markers (Fig. 3.13). Long Terminal Repeats (LTRs) retrotransposons are class I TEs usually known to consist of long terminal repeat sequences flanking an internal coding region. In plant genomes, LTR retrotransposons are the major TE sequence class. Mining of published jute genomes resulted into a total of 875 LTRs from *C. capsularis*, 851 from *C. olitorius* O4 genome and 868 from the JRO524 genome. Further another group of DNA TEs known as miniature inverted–repeat transposable elements (MITEs), which are Class II TEs, were also identified from the above jute genomes. This included, 479 MITE non-redundant families from *C. capsularis* and 379 and 344 MITE non-redundant families from *C. olitorius* O4 and JRO524

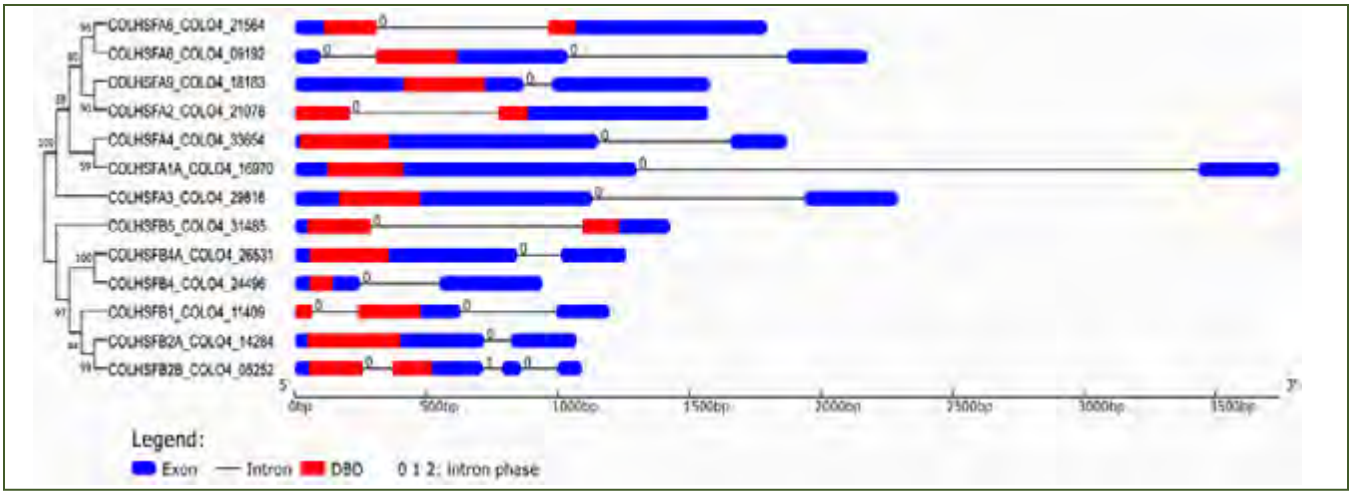



**Fig. 3.12.** Prediction of exons and introns in jute HSF

genomes, respectively. Annotation of these MITE sequences revealed a representative of a number of known MITE classes, like Mariner/Tc1 and PIF/Harbinger types. Majority of these MITE classes are observed to be of unknown types. Among the known MITE classes, Tc1/Mariner elements were found abundant in the jute genomes, followed by the hAT elements. All these TEs from jute will serve as an important resource for TE-derived PCR based molecular markers for characterization of jute germplasm, evolutionary studies and marker-assisted selection of important traits for targeted breeding. (*Source: JBT 4.4. Contributors: D. Saha, S. Datta, A.K.Chakraborty and P. Satya*)

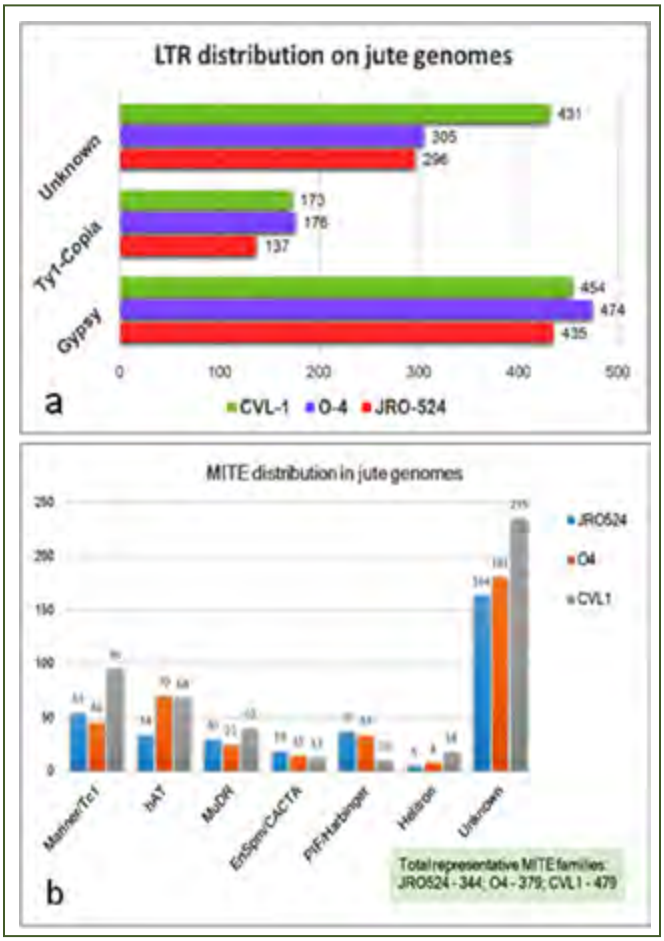



**Fig. 3.13** Distribution of transposable elements on the published jute genomes. (a) long terminal repeat (LTR) elements and (b) miniature inverted repeat transposable elements (MITEs)

## 3.5 Identification and characterization of heat shock factor genes from flax genome

Genome-wide identification and characterization of 34 HSF-coding genes were carried out from the published flax genome. These 34 HSF genes were physically mapped onto 14 of 15 flax chromosomes and were phylogenetically clustered into three broad groups and 15 sub-groups. The RT-qPCR mediated gene expression profiles of 12 selected HSF genes exhibited differences in their response to heat stress in flax (Fig. 3.14). (*Source: JB10.3. Contributors: J. Mitra and D. Saha*)

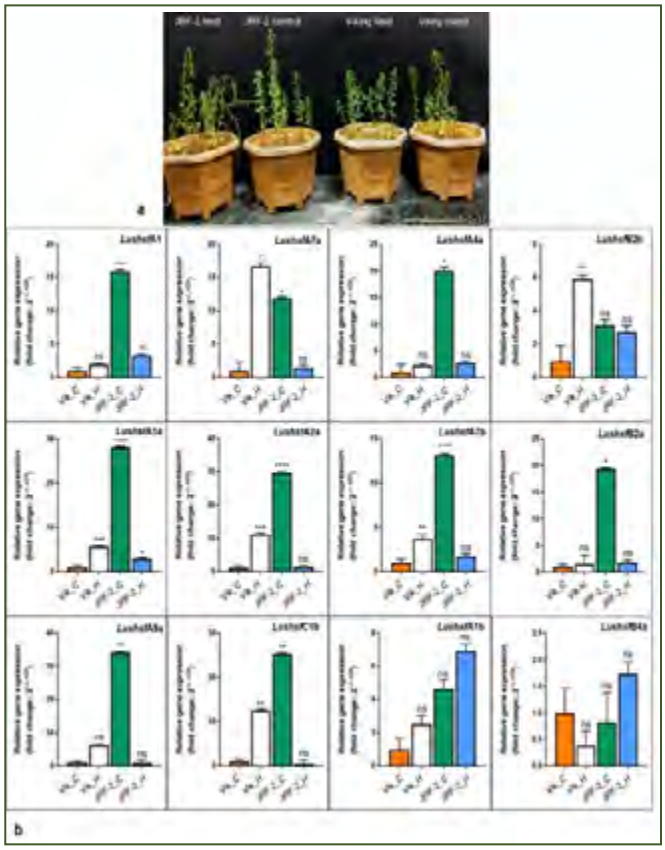



**Fig. 3.14.** (a) Flax plants treated with heat stress at 40±2 °C for 12 hours. (b) Gene expression profiles calculated as relative gene expression fold change of 12 selected HSF genes compared in JRF-2 and viking under controlled and heat stress conditions. In general, majority of the HSF genes were found upregulated in JRF2 under controlled conditions compared to the other condition and in viking

## 3.6 Validation of transcriptome-derived molecular markers in sunnhemp germplasm

From the *C. juncea* (sunnhemp) transcriptome assembly, 1,683 non-redundant EST-SSR markers and 4,759 intron-linked polymorphic (ILP) markers were previously discovered. In the present study, 48 pairs of each EST-SSR and ILP primers were synthesized and evaluated in 24 accessions of *C. juncea* germplasm. These primers were also assessed for their cross-species transferability in other bast fibre crops, like jute, flax, and mesta. Several of these primers showed polymorphic patterns across the sunnhemp accessions. Some of the primers showed promising results in cross-species transferability (Fig. 3.15). (*Source: JBT 4.4. Contributors: D. Saha, S. Datta, A.K.Chakraborty and P. Satya*).

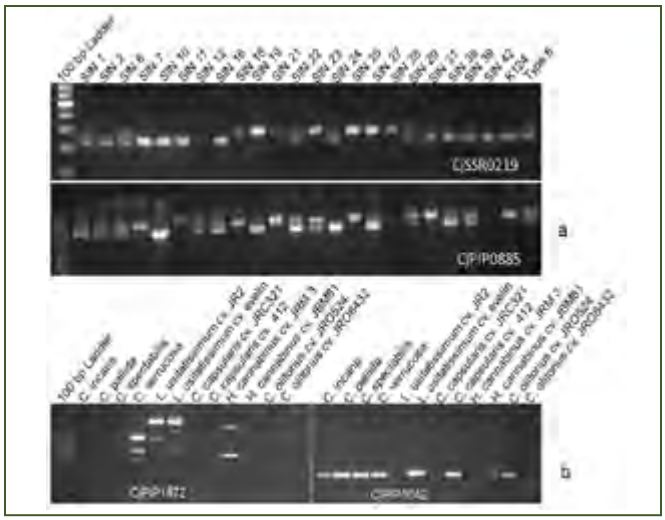



**Fig. 3.15.** Agarose gel images of EST-SSR and ILP marker validations in sunnhemp. (a) Representative polymorphic amplification profiles of one each EST-SSR and ILP marker derived from sunnhemp transcriptome. Amplification was carried out in 24 sunnhemp genotypes. (b) A representative cross-species amplification profile of ILP marker from sunnhemp. Cross-species study was carried out in four *Crotalaria* sp. (lane 2-5), two flax cultivars (lane 6-7), two white cultivars (lane 8-9), two mesta cultivars (lane 10-11), and two dark jute cultivars (lane 12-13)

## 3.7 Genetic purity testing and varietal fingerprinting in mesta using molecular markers

In order to generate DNA fingerprints of different mesta varieties a total of 19 varieties were selected, which involved 10 roselle and 9 kenaf varieties. These varieties were screened with 20 each SCoT and ISSR primers. Out of 20 SCoT only 14 primers amplified and produced reproducible and scorable bands. A single primer couldn't differentiate all or maximum varieties, however unique bands were observed in var. JRM 3 with SCoT-1, AMV 2 and JRKM with SCoT-2, Non-bris with SCoT-3, JBM-G-4 and JRM 5 with SCoT-4, AMV 1 with SCoT-22, JBMP 2 with SCoT-18, CRIJAF 5 with SCoT-29. PCR profile for SCoT 22 is represented (Fig. 3.16). In case of ISSR out of 20 markers used for screening 18 primers amplified with mesta varieties. Primer A835 showed unique bands in variety CRIJAF 8, AMC 108 and JBM 81 (Fig. 3.17), primer U834 showed in JBM-G-4, primer U888 and U889 showed unique band in variety JBM 81 and AMC 108, respectively. Overall it was found that variation among roselle varieties was limited in comparison to kenaf using SCoT and ISSR primers. (*Source: JBT 4.5 Contributors: Kanti Meena, P. Satya and S.K. Pandey*).

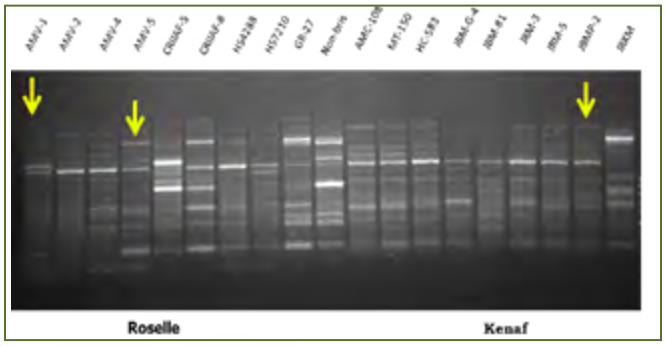



**Fig. 3.16.** Amplification profile of SCoT- 22 among mesta varieties

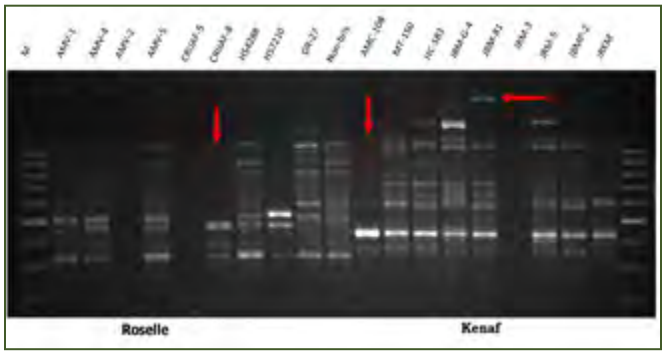



**Fig. 3.17.** ISSR profile of A835 among mesta varieties

## 3.8 Genetic Engineering and Tissue Culture

### 3.8.1 Molecular analysis of putative transgenic plants in flax and jute developed through *Ag*-mediated floral-dip transformation to impart resistance to lepidopteran insect pests

Mature capsules from PCR positive $T_1$ plants developed through floral-dip transformation involving *Agrobacterium* strain LBA 4404 harbouring *cry1A(b)* under the transcription control of ubiquitin promoter and nos terminator in a binary vector pCAMBIA were collected and sown to raise $T_2$ generation plants. Genomic DNA was isolated from tender leaves were subjected to PCR involving *cry1A(b)* compatible primers [(F) 5'-AACATCATCGCAGCCGATAGTATT-3' (R) 5'-ACTCCTGCAGTCCCACTAAAGTTT-3' ] to detect integration of the transgene by amplification of 421bp internal motif of *cry1A(b)* transgene. DNA from 124 plants analysed, of which 19 plants showed distinct 421bp amplicons (Fig. 3.19) indicating stable integration (15.32%) of *cry1A(b)* to the flax genome. Further analyses would be undertaken in this year.

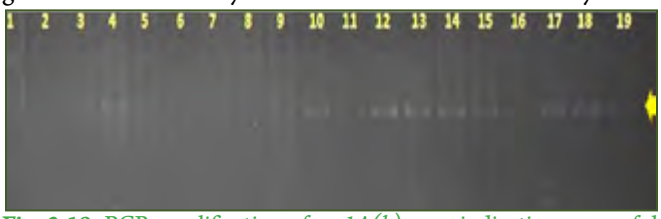



**Fig. 3.19.** PCR amplification of *cry1A(b)* gene indicating successful stable transgene integration in flax at $T_2$ generation
*Legends: Lane1: Molecular ladder, Lanes 2-20: PCR amplicon profiles for* cry1A(b) *gene (421bp) for 19 plants out of total 124 plants*

### 3.8.2 qRT-PCR analysis of the putative flax transgenic plants

Total RNA was isolated from 19 putative transgenic flax plants developed with *cry1A(b)* gene using Trizol method manually. Total RNA was quantified spectrophotometrically and quality of mRNA was found to be appreciably good as evident from

perfect cDNA synthesis profile in respect of 19 flax lines, when the flax gene luEF1α (F:GCTGCCAACTTCACATCTCA R: GATCGCCTGTCAATCTTGGT) was used as internal control. cDNA synthesis was performed by using 1µg of total RNA and cDNA synthesis kit (Invitrogen ,Superscript first strand synthesis kit) was used following manufacturer's instructions. It is to the mentioned that semi quantitative -qRT-PCR was performed just to check the transgene expression pattern using RT-PCR primer (F: ATGACTCCAGAACCTACCCT R: ATGGAGCCTTCGATACCTTG).

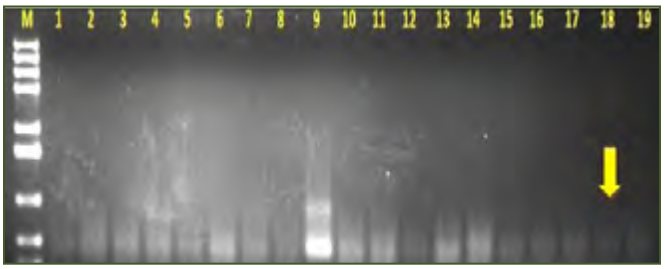



**Fig. 3.20.** Semi-quantitative qRT-PCR expression of *Cry1A(b)* gene in 19 plants

DNA was isolated from young leaves of $T_1$ plants [developed in similar way as adopted for flax with the same gene construct harboring *cry1A(b)*], purified and quantified for PCR using *cry1A(b)* compatible primers as used in flax for detecting transgene introgression. PCR products were successfully amplified from the integrated *cry1A(b)* gene, confirming successful introgression of the transgene. 6 plants showed distinct 421 bp amplicons (Fig. 3.21) indicating stable integration of *cry1A(b)* into the recipient system in a productive *olitorius* var S 19. Many samples are awaiting analysis. Seeds from individual PCR-positive $T_1$ plants collected for raising succeeding generation. Further molecular analyses at $T_2$ involving qRT-PCR, RT-PCR, Southern hybridization & transgene inheritance studies would be done in the current year. (*Source: JB 9.3. Contributors: A.B. Mandal and Kanti Meena*).

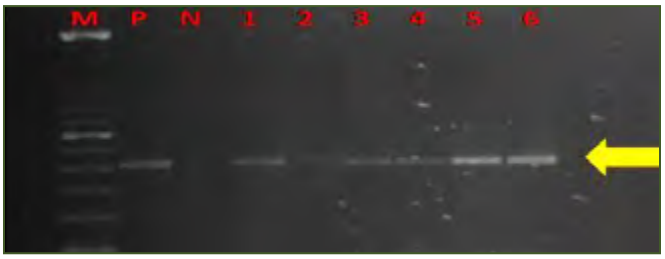



**Fig. 3.21.** PCR amplification of *cry1A(b)* gene (421bp) at $T_1$ generation plants
*Legends: Lane1: Molecular ladder, Lane 2: Positive control, Lanes 3-8: PCR amplicon profiles for* cry1A(b) *in 6 putative transgenic lines in S 19*

### 3.8.3 Field evaluation of stemlets developed from *in vitro* micropropagation derived mericlones of R 67-34

Stemlets developed from individual *in vitro* micropropagated plants of ramie var R 67-34 were grown in cement pots for 6 months and their true-to-parent nature was confirmed through RAPD and ISSR analyses. On an average 15.6 stemlets were found to develop/plant, which were used for field trial. About 18" cut stemlets were planted in replicated trial along with parental check (R67-34) at 1.5 m row to row and 1 m plant to plant spacing under proper management including plant protection measures to ensure good crop stand. The trial is continuing with no cuts of biomass, however, agronomic data have been documented at 6 months interval without any cut, which showed uniform crop stand with no significant variations among the mericlones. This was further substantiated by Clonal fidelity test of randomly selected field grown plants involving RAPD and ISSR (Fig. 3.22) showing true –to-parent nature and near normal heat map of the field grown ramie mericlones generated by using exploration of hierarchical clustering (HCE3.0) software in default setting (not presented). No ectopic expression of any abnormal characters strongly advocates ample prospects of *in vitro* micropropagation in generating safe planting materials in ramie. Annual turnover of planting materials /stemlet would be available after completion of one year of the trail, which will be recorded shortly. (*Source: JB 9.3. Contributors: A.B. Mandal and Kanti Meena*).

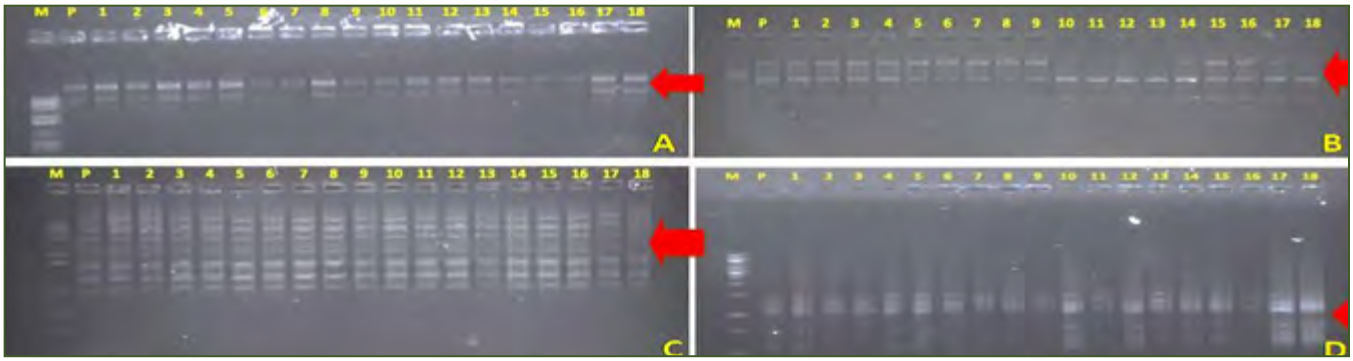



**Fig. 3.22.** PCR amplicon profile of *ex vitro* grown mericlones developed from stemlet cuttings of ramie micropropagated plants (1-18) in comparision to the the parental stock (P) [with: A. & B. RAPD primer (OPA-5 & OPA-8); C &D. ISSR primer (ISSR-U840 & U842)]
*Legends: a. Mother stock of* in vitro *micropropagation derived plants of var. R-67-34 in soil filled cement pots. b. Field establishment of the stemlet cuttings. c. Close-view of the field trial with parental stock.*

# 4. Soil and Nutrient Management

## 4.1. Soil Health

### 4.1.1. Long term fertilizer experiment (LTFE)

Long-term (47 years) effects of continuous application of farmyard manure (FYM) and inorganic fertilizer either alone or in combination on crop yields and soil properties were evaluated in a permanent field trial at Barrackpore, North 24 Parganas district, West Bengal 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:*** Yield of jute, rice and wheat ranged from 9.7 to 25.2 q/ha, 12.1 to 27.3 q/ha and 5.0 to 24.0 q/ha, respectively, under different treatments (Table 4.1). Application of fertilizers, alone or in combination with FYM significantly increased the yield of jute, rice and wheat over control. The highest yield of jute, rice as well as wheat was recorded in 100% NPK+ FYM treatment. The 150% NPK treatment was found to be at par with the application of 100% NPK+FYM. Application of P over N, and K over NP treatments significantly increased yields of jute and rice. On the other hand, application of P and K together over N significantly increased wheat yield. The effect of Zn application on yields of the crops was not significant. Omission of S from the fertilization schedule significantly reduced yields of jute and rice, but not the yield of wheat crop.

***Soil properties:*** In different treatments of LTFE, the soil pH ranged from 7.29 to 7.55 (Table 4.2). Soil pH was the lowest under no fertilizer and no manure control, and the highest under 100% NPK+FYM treatment. Continuous cropping without application of any organic manure and chemical fertilizers resulted in the lowest concentration (0.56%) of organic carbon (OC) in the soil. Regular application of NPK fertilizers significantly increased OC content in the soil. Among different treatments, soils supplied with 100% NPK+FYM had the highest OC concentration (0.89%). There was significant difference among the treatments with respect to N, P and K availability in soil. No fertilizer and no manure control recorded the lowest availability of N, P and K in soil. The highest availability of N, P as well as K in the soil was recorded under the 150% NPK treatment. Availability of N, P and K in the soil under the 100% NPK + FYM treatment was at par with that recoded under 150% NPK treatment. Omission of P and K from fertilization schedule reduced N availability in the soil. Omission of P and K from the fertilization schedule significantly reduced those elements in soil. Integrated use of organic manure and chemical fertilizers resulted in a positive influx of nutrients thereby increased OC, available nitrogen, available phosphorus and available potassium in the soil from 0.56 to 0.89%, 211 to 263 kg/ha, 5.7 to 61.0 kg/ha, and 138 to 200 kg/ha respectively.
*(Source: JC 5.2. Contributors: D. K. Kundu, S. P. Mazumdar, A. R. Saha, B. Majumdar, A. K. Ghorai and M. S. Behera)*

**Table 4.1. Yield of jute, rice and wheat during 2017-18 in LTFE**

| Treatment | Yield (q/ha) | | |
|---|---|---|---|
| | Jute | Rice | Wheat |
| 50% NPK | 16.0$^{e}$ | 19.5$^{e}$ | 14.4$^{d}$ |
| 100% NPK | 21.6$^{b}$ | 24.3$^{b}$ | 21.3$^{ab}$ |
| 150% NPK | 24.9$^{a}$ | 26.9$^{a}$ | 23.6$^{a}$ |
| 150% NPK + HW | 20.9$^{bc}$ | 19.9$^{e}$ | 19.7$^{bc}$ |
| 100% NPK + Zn | 22.3$^{b}$ | 24.8$^{b}$ | 22.0$^{ab}$ |
| 100% NP | 18.2$^{d}$ | 21.6$^{c}$ | 18.2$^{bc}$ |
| 100% N | 16.6$^{e}$ | 21.0$^{d}$ | 17.0$^{cd}$ |
| 100% NPK + FYM | 25.2$^{a}$ | 27.3$^{a}$ | 24.0$^{a}$ |
| 100 % NPK – S | 19.5$^{cd}$ | 21.9$^{c}$ | 19.3$^{bc}$ |
| Control | 9.7$^{f}$ | 12.1$^{f}$ | 5.0$^{e}$ |

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

**Table 4.2. Effect of chemical fertilizer and organic manures on physico-chemical properties and nutrient availability of surface soil**

| Treatment | pH | Organic Carbon (%) | Available Nutrients | | |
|---|---|---|---|---|---|
| | | | N (kg/ha) | P (kg/ha) | K (kg/ha) |
| 50% NPK | 7.32$^{bc}$ | 0.68$^{de}$ | 232$^{cd}$ | 30.9$^{c}$ | 167$^{b}$ |
| 100% NPK | 7.32$^{bc}$ | 0.72$^{bc}$ | 245$^{b}$ | 46.8$^{b}$ | 174$^{b}$ |
| 150% NPK | 7.38$^{bc}$ | 0.73$^{b}$ | 265$^{a}$ | 58.8$^{a}$ | 201$^{a}$ |
| 150% NPK + HW | 7.45$^{ab}$ | 0.71$^{cd}$ | 239$^{bcd}$ | 42.1$^{b}$ | 172$^{b}$ |
| 100% NPK + Zn | 7.35$^{bc}$ | 0.70$^{cd}$ | 245$^{b}$ | 41.1$^{b}$ | 173$^{b}$ |
| 100% NP | 7.39$^{bc}$ | 0.71$^{bc}$ | 232$^{cd}$ | 41.6$^{b}$ | 130$^{c}$ |
| 100% N | 7.33$^{bc}$ | 0.66$^{e}$ | 230$^{d}$ | 7.3$^{d}$ | 126$^{c}$ |
| 100% NPK + FYM | 7.55$^{a}$ | 0.89$^{a}$ | 263$^{a}$ | 61.0$^{a}$ | 200$^{a}$ |
| 100 % NPK - S | 7.35$^{bc}$ | 0.66$^{e}$ | 242$^{bc}$ | 39.9$^{b}$ | 170$^{b}$ |
| Control | 7.29$^{c}$ | 0.56$^{f}$ | 211$^{e}$ | 5.7$^{d}$ | 138$^{c}$ |

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

### 4.1.2. Carbon footprint and energy use in jute and allied fibre production

Carbon footprint and energy use pattern of the four most important natural bast fibres *viz.* jute, kenaf, flax and sunnhemp was studied. Seven general processes which include field operations, seeds, fertilization, pesticides, retting, transportation and fibre processing was considered in the study. The labour, machinery power, diesel fuel, chemical fertilizers, chemical pesticides and irrigation were identified as inputs to assess the amount of energy usage while the fibre and stick in form as output. The amounts of GHG emissions

in jute and allied fibre production were calculated by using $CO_2$, $N_2O$ and $CH_4$ emissions coefficient of inputs. Energy productivity was lowest in flax fibre production as compared to other fibre crops. Flax fibre production consumed more chemical fertilizer, diesels, pesticides and seed energy in comparison to other fibre crops. The carbon footprints of all the fibres crops did not differ significantly and were in the order of 566, 520, 445 and 423 kg $CO_2$-eq/t of fibre for jute, flax, kenaf and sunnhemp, respectively (Fig 4.1). The carbon based sustainability index for jute (2.27) and kenaf (2.07) were highest due to better carbon use efficiency. Sustainability index of flax was found negative (-0.67) due to higher carbon emission. Fertilization and fibre processing contributed most to GHG emissions. Overall, the carbon footprint of bast fibres was found to be 20–50% lower than that of synthetic/artificial fibres. *(Source: JA 6.0. Contributor: A. K. Singh)*

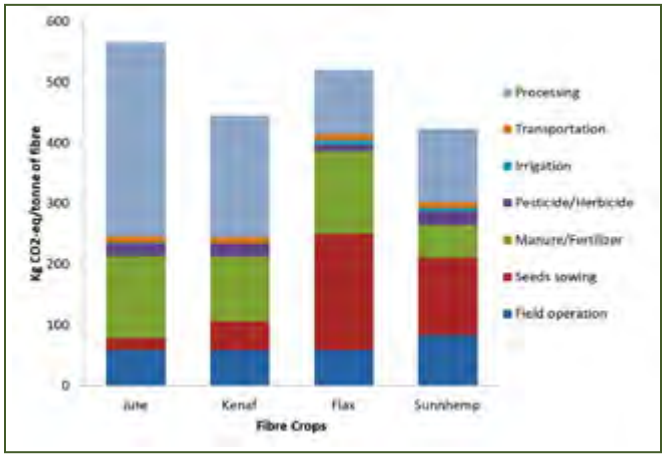



**Fig. 4.1.** Comparison of the greenhouse gas emission per tonne of bast fibres

### 4.1.3. Net ecosystem $CO_2$ exchange in jute agro-ecosystem using Eddy Covariance Technique

The net ecosystem exchange (NEE) of $CO_2$ in high biomass producing jute agro-ecosystem was measured during jute crop season (April to August, 2018) by the open path eddy covariance (EC) technique at Research Farm of ICAR-CRIJAF. The NEE of $CO_2$ was positive at sowing to germination stage, and thereafter it becomes negative up to the maturity stage (harvesting) of jute. The negative values of NEE indicate carbon-intake by jute crop when the rate of photosynthesis is more than the ecosystem respiration, and the positive values indicate its opposite. The highest NEE (-126.86 g C/m$^2$ or -465.15 g $CO_2$/m$^2$) was observed at fibre development stage of jute crop (Table 4.3). The cumulative NEE from the jute agro-ecosystem over the entire jute growing season from 17 April to 5 August (111 days) was -268.49 g C/m$^2$ or -984.46 g $CO_2$ /m$^2$ (-2.68 t C/ha or -9.84 t $CO_2$ /ha). This is the first report of NEE of $CO_2$ flux in jute agro-ecosystem measured by eddy covariance technique in India as well as in the world. *(Source: ISRO-NRSC Collaborative Project, Contributors: D. Barman, A. Chakraborty[1], D. K. Kundu, C. S. Murthy[1], P. K. Das[2], R. Saha, S. Bandyopadhyay[2], A.K. Singh, S. Mitra, S. Roy and S.P. Mazumdar) [1]ISRO-National Remote Sensing Centre, Balanagar, Hyderabad- 500 037, India; [2]ISRO-Regional Remote Sensing Centre-East (NRSC), Kolkata – 700156, India*

**Table 4.3. Net ecosystem exchange (NEE) of $CO_2$ at different jute growth stages**

| Growth stages (2017-18) | Days after sowing (DAS) | Cumulative NEE (g C/m$^2$) | Mean NEE (g C/m$^2$/day) |
|---|---|---|---|
| Sowing to germination | 1-6 | +9.98 | +1.66 |
| Seedling stage | 7-36 | -17.12 | -0.57 |
| Active vegetative stage | 37-66 | -96.87 | -3.23 |
| Fibre development | 67-96 | -126.86 | -4.23 |
| Maturity | 97-111 | -37.63 | -2.51 |
| Total | | -268.49 | |

### 4.1.4. Soil health characterization and carbon sequestration potential for ramie based cropping system in North Eastern India

Impact of ramie based cropping systems on soil organic carbon stocks as well as the long-term sustainability of the cropping systems were evaluated at different soil depths *i.e.*, 0-20, 20-40, 40-60 and 60-100 cm. The present study showed (Fig. 4.2) that ramie based cropping systems influenced the soil organic carbon and its labile pools. Soil organic carbon (SOC), labile carbon, microbial biomass were significantly improved under long term ramie cultivation (15 years). SOC stocks decreased with soil depth, but under sole ramie crop (15 years), it was significantly higher than fallow at 0-20 and 20-40 cm soil profiles. Results showed that long-term ramie cultivation is very important for maintaining soil quality as well as positive

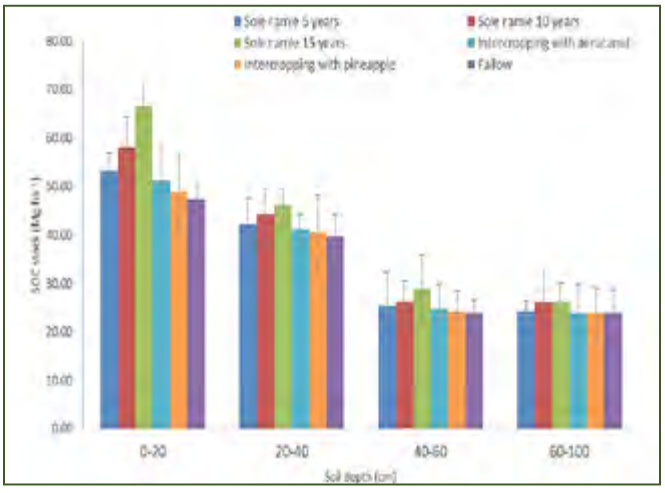



**Fig. 4.2.** Soil organic carbon stock of different ramie based cropping systems

impact on the environment. *(Source: JA 7.2. Contributors: S. P. Mazumdar, B. Majumdar, and S. Mitra)*

## 4.2. Nutrient Management

### 4.2.1. Soil test and integrated plant nutrient management for sustainable agriculture

The relation between soil test values and crop response to fertilizers in order to provide a calibration of fertilizer recommendation based on soil test values was developed in a field experiment having artificially created fertility gradient. Varying fertility level was developed using maize as exhaust crop with the application of different levels of N, P and K and plant population. Soil test targeted yield (ST-TY) equations for jute (*cv.* CO 58) and onion (*cv.* Sukhsagar) have been derived with all the basic data *i.e.*, nutrient requirement (kg/q produce), contribution of soil, fertilizer and organic to total uptake (Table 4.4.).

The field verification trials on onion (*cv.* Sukhsagar) and mustard (*cv.* B9) were undertaken in the farmers' fields at different locations. Application of fertilizers as per ST-TY without and with FYM achieved the target of 15 q/ha mustard seed yield with (+) 3.33 and (+) 13.3 % deviation, respectively. Application of fertilizers as per ST-TY without and with FYM achieved the target of 22 t/ha bulb yield of onion with higher B: C ratio as compared to RDF and farmers' practice. *(Source: JC 5.6, Contributors: A.R. Saha, B. Majumdar, S.P. Mazumdar and Mukesh Kumar)*

**Table 4.4. Basic data and targeted yield equation of jute (*cv.* CO-58) and onion (*cv.* Sukhsagar)**

| Basic data | | | | Targeted Yield Equations |
|---|---|---|---|---|
| Jute (*cv.* CO-58) | | | | |
| | N | P | K | FN= 8.56T- 0.72SN-0.15 OM<br>FP = 2.32T- 0.97SP- 0.29 OM<br>FK = 4.86T- 0.46SK- 0.04 OM |
| NR (kg/q) | 4.17 | 0.92 | 4.27 | |
| CS (%) | 34.98 | 38.84 | 40.34 | |
| CF (%) | 48.77 | 39.92 | 87.75 | |
| CFYM (%) | 7.11 | 11.41 | 3.42 | |
| Onion (*cv.* Sukhsagar) | | | | |
| | N | P | K | FN= 1.70T-0.92SN-0.39 OM<br>FP =0.46T- 0.75SP-0.30 OM<br>FK =0.88T- 0.47SK- 0.11 OM |
| NR (kg/q) | 0.67 | 0.19 | 0.67 | |
| CS (%) | 36.34 | 30.59 | 36.14 | |
| CF (%) | 36.67 | 40.63 | 76.44 | |
| CFYM (%) | 15.54 | 11.99 | 8.42 | |

### 4.2.2. Long term effect of ST-TY equation based INM on nutrient budgeting and quality of soil under jute–rice-lentil sequence

Long term (8 years) effect of ST-TY equation based integrated nutrient management (INM) on yield, value addition, nutrient budgeting and quality of soil under jute-rice-lentil with the same set of varieties *i.e.* jute (*cv.* JRO 8432), rice (*cv.* Kshitish) and lentil (*cv.* B 256) and same targeted yield equations of jute, rice and lentil were considered for determining the quantity of fertilizer to be applied. The source of inorganic fertilizers were urea, SSP and MOP. FYM was applied as organic manure. The treatments were T1- control, T2- ST-TY (5 t/ha), T3- ST-TY (4 t/ha), T4- T3 + FYM (5 t/ha), T5 - T3 + *Azotobacter* + PSB, T6- T4 + *Azotobacter* + PSB, T7-FYM @ 5 t/ha, T8-T7 + *Azotobacter* + PSB, T9-Recommended dose of fertilizer (RDF) and T10-Farmers' practice (FP). *Azotobacter* was used as biofertilizer in jute but in case of rice, *Azospirillum* and in case of lentil *Rhizobium* was used instead of *Azotobacter*. 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 (-) 7.5 % deviation. Integration of ST-TY with FYM achieved the targeted yield of jute fibre (35 q/ha) with (+) 2.8 % yield deviation (Fig. 4.3). Application of fertilizers as per ST-TY could achieve the target of 50 q/ha and 40 q/ha of rice with (-) 4.0% and (+) 7.5 % yield deviation, respectively. Integration of ST-TY with FYM and bio fertilizers achieved the targeted yield of rice (40 q/ha) with (+) 22.5 % yield deviation. Application of inorganic fertilizer as per application of balanced fertilizers based on ST-TY achieved the target yields of lentil. Application of inorganic fertilizers on ST-TY basis with and without organic manure showed positive response in respect to sustainability of crop yield and soil fertility status in comparison to RDF and Farmers practice (FP). Moreover, integrated management practices showed clear advantage in improving the carbon management index (Table 4.5) and incorporation of FYM along with inorganic fertilizer and biofertilizers was found as the best management practice. *(Source: JC 5.6a, Contributors: A. R. Saha, B. Majumdar, S. P. Mazumdar and Mukesh Kumar)*

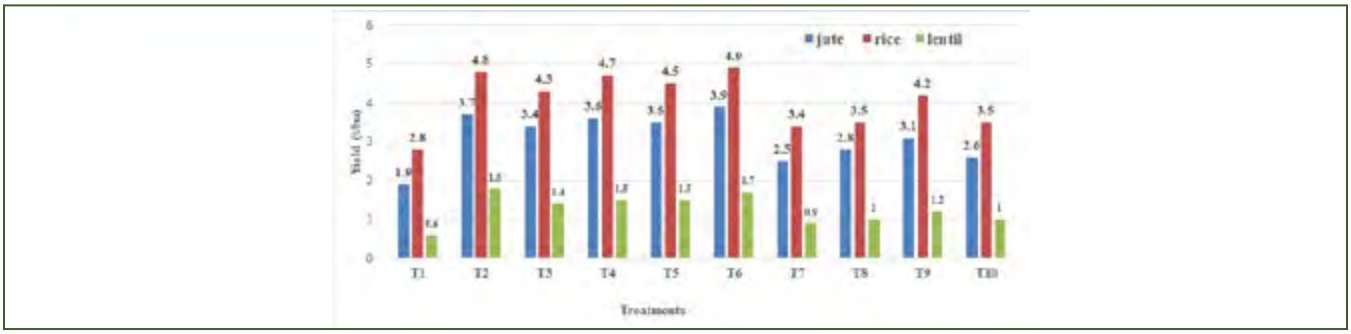



**Fig. 4.3.** Yield of jute, rice and lentil as affected by different nutrient management treatments under jute–rice- lentil sequence

**Table 4.5. Carbon pool index (CPI), liability index (LI) and carbon management index (CMI) under different nutrient management treatments**

| Treatments | CPI | LI | CMI |
|---|---|---|---|
| T1-Control | 1.00 | 1.00 | 100 |
| T2-ST-TY 1 | 1.08 | 1.08 | 117 |
| T3-ST-TY 2 | 1.06 | 1.05 | 111 |
| T4-T3+FYM (5 t/ha) | 1.12 | 1.07 | 120 |
| T5-T3+*Azot/Rhizobium* + PSB | 1.11 | 1.07 | 118 |
| T6-T4+*Azot./Rhizobium* + PSB | 1.15 | 1.12 | 129 |
| T7-FYM @ 5 t/ha | 1.12 | 1.06 | 119 |
| T8-T7+*Azot./Rhizobium* + PSB | 1.14 | 1.12 | 127 |
| T9-RDF | 1.03 | 1.06 | 108 |
| T10-FP | 1.03 | 1.04 | 105 |

### 4.2.3. Nitrogen dynamics under Rice-Flax cropping system

Nitrogen dynamics under rice-flax cropping system was studied in a field with soil characterized as clay-loam in texture (sand 38.04%, silt 33.91% and clay 28.04%), pH 7.2, medium in organic carbon content (0.56%), low available nitrogen, high in available phosphorus and potassium. In a split-plot design, the cropping system in the form of Fallow-flax, Rice-Flax on zero tillage and Rice-Flax on conventional tillage were in main plots and four nitrogen levels were as sub-plots ($N_0$, $N_{40}$, $N_{80}$, $N_{120}$). The fertilizer dose for rice was 40 kg $P_2O_5$ / ha and 40 kg $K_2O$/ha and flax 40 kg $P_2O_5$ /ha and 50 kg $K_2O$/ ha. Before sowing of flax, tillage operation, *i.e.*, zero tillage in the form of no disturbance of the soil and conventional tillage was followed to prepare a seed bed for flax. The results (Fig. 4.4) revealed that there was a significant response of grain and straw yield of rice towards nitrogen application. The highest grain yield was obtained with $N_{120}$ treatment. Rice yield varied from 3.44 t/ha to 5.47 t/ha. *(Source: JC 7.8, Contributors: Mukesh Kumar, S. P. Mazumdar, D. Barman and M. S. Behera)*

**Fig. 4.4.** Rice crop under various nitrogen levels

# 5. Crop Husbandry

## 5.1 Jute

### 5.1.1. Estimation of competition effects in jute-mungbean intercropping system

For estimation of competition effect in jute-mungbean intercropping, an experiment was laid out in a three-way systematic design in 1:1 alternate bands (15 cm wide) of jute and mungbean into 3 segments (each of 6 m breadth) or parallel terraces of 18 x 6 $m^2$ area in two replications. Three levels (11, 14, 17 cm) of inter-band spacing together with varying levels of intra-plant spacing accommodating plant density of jute (3, 4 and 5 lakh plants/ha) and that of mungbean (2, 2.5 and 3 lakh plants/ha) in bands; each varied independently of the other factors. Both jute (*cv*. NJ 7010) and mungbean (*cv*. TMB-37) were simultaneously sown with 27 spacing combinations in 3rd week of March. As spacing variations between adjacent harvest areas were very small and systematic, plants could be considered as almost equally spaced. Therefore, guard rows between harvest areas were obligatory. Pre-emergence herbicide pretilachlor 50 EC @ 0.9 kg/ha was applied after sowing with irrigation and nail weeder at 12 and 20 days after sowing (DAS) was used for weed control. Mungbean pods were picked at 58, 69 and 75 DAS and jute was harvested at 122 DAS. Intercropping system with all of 27 spacing combinations were assessed by land equivalent ratio (LER), relative crowding coefficient (K), aggressivity (A), competitive ratio (CR), jute equivalent yield (JEY) and area × time equivalent ratio (ATER). LER ranged from 1.20 to 1.65 signifying greater land utilization, ATER and K values were greater than 1.0 in all instances. For jute, CR and A values were positive. These findings indicate that jute is the dominant crop, intercropping is advantageous for better utilization of land and environmental resources and profitable in every situation.

**Optimum spatial arrangement**

The regression model given below, with standard errors of coefficients in parentheses.

$$LER1 = 2.238 - 0.103\,D_J - 0.068\,D_M + 0.008\,D_J D_M \ldots\ldots\ldots\ldots \text{(Eqn 1)}$$

(0.353) (0.035) (0.026) (0.003) $[R^2 = 0.82]$

The optimum levels of three spacing factors are obtained by taking partial derivatives of the estimated regression equations with respect to $D_J$, $D_M$ and $D_I$, the intra-jute, intra-mungbean and inter-band spacing respectively. LER model obtained in backward method of regression. Optimum LER.

Hence optimum ($D_J$, $D_M$) values (in cm) from Eqn 1 found to be (8.50, 12.88) with $D_I$ =14 cm. Hence the optimum yield (of component crop) is achieved from an optimum plant density of 4.0 and 2.7 lakh/ha of jute and mungbean respectively. The optimum spatial arrangement of plants to achieve this is to sow crops in 15 cm bands (two lines are formed after nail weeder application during weeding), jute and mungbean being sown in 14 cm apart alternate bands. *(Source: JST 6.1. Contributors: A.K. Chakraborty and A.K. Ghorai)*


**Fig. 5.1.** June-mungbean intercropping in experimental plot

### 5.1.2. Conservation agricultural practices of jute-based cropping systems under climate change scenario

#### 5.1.2.1. System productivity, resource and radiation use efficiency under tillage and jute based cropping systems

The effect of tillage systems *i.e.* Conventional Tillage (CT) and No Tillage (NT) (with or without crop residue retention, (+R/-R) on crop physiology, radiation and water use efficiency and system productivity was evaluated under most predominant jute based cropping systems (jute-rice-wheat, jute-rice-lentil and jute-rice-mustard). Tillage practices and crop residues alter the surface properties of soil affecting both shortwave albedo and long wave emissivity. Radiation use efficiency in terms of photosynthetically active radiation (PAR) was higher in NT+R than CT. Similarly, the relative water contents (RWC; range: 73.9-88.3 %) and chlorophyll contents (SPAD; range: 7.8-16.2) are significantly higher NT+R were comparable to that under CT. The JEY among the cropping systems (Table 5.1) were in the order: jute-rice-lentil (7.32 t/ha) > jute-rice-wheat (7.19 t/ha) > jute-rice mustard (6.75 t/ha). However, the production efficiency and land use efficiency among the cropping systems varied from 0.028 to 0.034 kg/ha/day and from 76.99 to 87.12 %, respectively, the highest being in jute-rice-wheat cropping system. Thus, conservation agricultural practices improved radiation interception, crop growth and yield by modifying soil physical environment. *(Source: JA 5.7. Contributors: R. Saha, M.S. Behera, Laxmi Sharma, Mukesh Kumar, A.R. Saha, B. Majumdar, D. Barman, S.P. Mazumdar, R.K. Naik and D.K. Kundu)*

**Table 5.1. Jute equivalent yield (JEY), production efficiency and land use efficiency under CA**

| Cropping system | Economic yield (t/ha) | | | JEY (t/ha) | Total duration (days) | Production efficiency (kg/ha/day) | LUE (%) |
|---|---|---|---|---|---|---|---|
| | Summer | Rainy | Winter | | | | |
| J-R-W | 3.12 | 3.74 | 3.56 | 7.19 | 303‡ (116#+84$+ 103¥) | 0.034 | 83.01 |
| J-R-L | 3.35 | 3.80 | 1.12 | 7.32 | 292 (116+84+92) | 0.028 | 80.01 |
| J-R-M | 3.05 | 3.70 | 1.20 | 6.75 | 281 (116+84+81) | 0.028 | 76.99 |
| CD (P = 0.05) | 0.08 | 0.06 | 0.98 | 0.38 | - | NS | 2.47 |

*J: Jute; R: Rice; W: Wheat; L: Lentil; M: Mustard, ‡ total duration of cropping sequence in same piece of land,#total time required from sowing to harvest of jute; $ total time required from transplanting to harvest of rice; ¥time required from sowing to harvest of winter season crop (wheat, lentil and mustard) in sequence*

### 5.1.2.2. Weed dynamics under tillage and jute based cropping systems

The weed composition under different tillage practices after three year of experimentation varied in jute. Broad leaved weeds and total weed density varied under different tillage practices (Table 5.2). The higher density of broad leaved weeds was recorded in CT compared to NT, however it was at par with No tillage with additional crop residue (NT+R). *Cynodon dactylon*, a perennial grass density was significantly higher in NT system. *Cyperus rotundus* density did not vary significantly among different tillage systems. Total weeds were also higher in NT. Cropping system did not affect significantly the weed density. Interaction effect of tillage and cropping system was found non-significant. *(Source: JA 5.7. Contributors: R. Saha, Mukesh Kumar, M.S. Behera, Laxmi Sharma, B. Majumdar, A.R. Saha, D. Barman, S.P. Mazumdar, R.K. Naik and D.K. Kundu)*

**Table 5.2. Weed composition (No./m²) in jute under different tillage and jute based cropping system at 30 DAS**

| Tillage | Total grass# | Broad leaved weeds¥ | Perennial weeds | | Total weeds |
|---|---|---|---|---|---|
| | | | *Cynodon dactylon* | *Cyperus rotundus* | |
| Conventional Tillage (CT) | 5.32 (29.8) | 4.28 (18.7) | 1.56 (4.0) | 2.56 (6.7) | 6.8 (58.2) |
| No Tillage (NT) | 5.5 (30.9) | 2.83 (11.1) | 6.78 (50.2) | 2.92 (9.8) | 9.81 (98.8) |
| NT with residue (NT+R) | 5.27 (28.7) | 3.96 (16.2) | 3.63 (13.7) | 2.96 (10.7) | 8.27 (69.3) |
| CD (P =0.05) | NS | 0.66 | 2.47 | NS | 2.1 |
| **Cropping system** | | | | | |
| Jute-rice-lentil | 5.24 (28.2) | 4.13 (17.7) | 4.08 (22.9) | 3.18 (11.1) | 9.14 (80.0) |
| Jute-rice-mustard | 5.16 (28) | 3.15 (12.9) | 4.11 (23.5) | 2.66 (8.0) | 8.30 (72.4) |
| Jute-rice-wheat | 5.7(33.1) | 3.8 (15.3) | 3.79 (21.5) | 2.6 (8.0) | 8.74 (78.0) |
| CD (P =0.05) | NS | NS | NS | NS | NS |

*Data was square root transformed. Original data in parentheses, # grass weed include annual grass Echinochloa colona, Eleusine indica and Digitaria sanguinalis; ¥ Broad leaved weeds includes, Physalis minima, Amaranthus viridis, Portulaca oleracea and Spilanthus spp.*

### 5.1.3. Prospects of medicinal and aromatic plants in jute based croping systems

### 5.1.3.1. Scope of growing MAPs in jute fibre and *kharif* rice based cropping system

Traditional cropping system jute-kharif rice-potato registered maximum yield of 141.82 (q/ha) followed by jute-kharif rice-ashwagandha (91.87 q/ha) and jute-kharif rice-menthol mint (77.81 q/ha). Cropping systems with RDF + 5 t/ha FYM recorded 6.24 % higher yield than cropping sequence with only RDF (Table 5.3). Jute-*kharif* rice-ashwagandha recorded net return of Rs 1,86,831 /ha followed by asalio (Rs 1,48,426/ ha) whereas traditional crop potato registered highest net return of Rs 2,47,204/ ha. Maximum benefit cost ratio of 2.22 was recorded in case of jute-*kharif* rice-ashwagandha cropping sequence as compared to traditional cropping sequence jute-*kharif* rice-potato (1.89). The cropping system jute-kharif rice-ashwagandha holds the highest economic benefit and productivity potential in jute (fibre) cropping sequences. *(Source: JA 6.9, Contributors: M.S. Behera, D.K. Kundu, S. Satpathy, A .K. Jha and R.K. Naik)*

**Table 5.3. Effect of jute (fibre) based cropping system and fertility levels on jute equivalent yield ( JEY) and system economics**

| | Treatments | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | Mean |
|---|---|---|---|---|---|---|---|---|
| JEY (q/ha) | $F_1$ | 74.85 | 89.60 | 73.79 | 75.38 | 70.40 | 136.40 | 86.73 |
| | $F_2$ | 78.3 | 94.15 | 79.65 | 80.25 | 73.35 | 147.25 | 92.15 |
| | Mean | 76.57 | 91.87 | 76.72 | 77.81 | 71.87 | 141.82 | |
| | CD (P=0.05) | C=12.08 F=0.25 C x F =0.61 | | | | | | |
| Net return (Rs/ha) | $F_1$ | 143798 | 179447 | 135151 | 133642 | 130240 | 233347 | 159271 |
| | $F_2$ | 153054 | 194216 | 154369 | 146963 | 139650 | 261062 | 174886 |
| | Mean | 148426 | 186831 | 144760 | 140303 | 134945 | 247204 | |
| | CD (P=0.05) | C= 4295.4 F=211.81 C x F =518.84 | | | | | | |
| B:C ratio | $F_1$ | 2.08 | 2.18 | 1.98 | 1.92 | 2.00 | 1.86 | 2.00 |
| | $F_2$ | 2.12 | 2.26 | 2.10 | 1.98 | 2.06 | 1.92 | 2.07 |
| | Mean | 2.10 | 2.22 | 2.04 | 1.95 | 2.03 | 1.89 | |
| | CD (P=0.05) | C=0.10 F=0.01 C x F =0.03 | | | | | | |

*$C_1$=jute-kharif rice-asalio, $C_2$=jute-kharif rice-ashwagandha, $C_3$=jute-kharif rice-isabgol, $C_4$=jute-kharif rice-menthol mint, $C_5$=jute-kharif rice-senna, $C_6$=jute-kharif rice-potato $F_1$= RDF (Recommended Dose of Fertilizers), $F_2$ = RDF + 5t FYM/ha*

### 5.1.3.2. Performance in jute seed and autumn rice based cropping system

Jute-stevia-autumn rice cropping sequence recorded highest jute equivalent yield of 229.74 q/ ha followed by spices like ajwain (89.80 q/ha) and nagella (82.09 q/ha). Traditional crop jute-tomato-autumn rice cropping sequence recorded 67.58 q/ha which was quite low (Table 5.4). Cropping systems with RDF+ 5 t/ha FYM recorded 5.02 % higher yield than cropping sequence with only RDF. Considering the system economics, jute-stevia-autumn rice cropping system recorded highest net return of Rs 5,24,467/ha which was 306.68 % higher compared to traditional crop tomato (Rs 1,28,961/ha). This was followed by ajwain (Rs 1,88,750/ha) and fennel (Rs 1,68,854/ha). The maximum B:C ratio (2.61) was recorded in jute-stevia-autumn rice cropping sequence. (*Source: JA 6.9, Contributors: M.S. Behera, D.K. Kundu, S. Satpathy, A.K. Jha and R.K. Naik)*

**Table 5.4. Yield and system economics of jute (seed)-MAPs and spices-autumn rice cropping sequence**

| Treatments | Jute Equivalent Yield (q/ha) | Net Return (Rs/ha) | B:C Ratio |
|---|---|---|---|
| Cropping System (C) | | | |
| $C_1$-Jute-fennel-autumn rice | 78.70 | 168854 | 2.38 |
| $C_2$-Jute-isabgol-autumn rice | 61.76 | 120495 | 2.11 |
| $C_3$-Jute-ashwagandha-autumn rice | 66.29 | 136984 | 2.26 |
| $C_4$-Jute-niagella-autumn rice | 82.09 | 162144 | 2.14 |
| $C_5$-Jute-senna-autumn rice | 59.11 | 123218 | 2.29 |
| $C_6$-Jute-dill seed-autumn rice | 70.59 | 151938 | 2.39 |
| $C_7$-Jute-stevia-autumn rice | 229.74 | 524467 | 2.61 |
| $C_8$-Jute-ajwain-autumn rice | 89.80 | 188750 | 2.31 |
| $C_9$-Jute-coriander-autumn rice | 65.94 | 132841 | 2.19 |
| $C_{10}$-Jute-fenugreek-autumn rice | 59.80 | 118601 | 2.15 |
| $C_{11}$-Jute-pepper mint-autumn rice | 69.97 | 148730 | 2.35 |
| $C_{12}$-Jute-tomato-autumn rice | 67.58 | 128961 | 2.06 |
| CD (P=0.05) | 4.24 | 1476.79 | 0.13 |
| Fertility Levels (F) | | | |
| $F_1$- RDF | 81.40 | 169881 | 2.25 |
| $F_2$ - RDF + 5 t/ha FYM | 85.49 | 181116 | 2.29 |
| CD (P=0.05) | 0.14 | 146.82 | 0.01 |
| Interaction (C x F) | | | |
| CD (P=0.05) | 0.50 | 508.62 | 0.03 |

### 5.1.3.3. Performance in jute fibre cum seed and boro rice based cropping system

Jute-nigella-boro rice recorded maximum JEY of 97.06 q/ha followed by coriander (89.02 q/ha). However, traditional cropping sequence jute-garden pea-boro rice recorded JEY of 85.56 q/ha (Table 5.5). Analysing the system economics, jute-nigella-boro rice recorded maximum net return of Rs 2,04,310/ha which is 32.10% higher than that of traditional sequence. Enhancement of net return of 9% was recorded with application of FYM with RDF. Likewise, nigella recorded the maximum B:C ratio of 2.32 followed by coriander (2.16). Thus, jute-nigella-boro rice was most profitable sequence in the system. *(Source: JA 6.9, Contributors: M.S. Behera, D.K. Kundu, S. Satpathy, A.K. Jha and R.K. Naik)*

**Table 5.5. Effect of jute (fibre cum seed) based cropping system and fertility levels on jute equivalent yield (JEY) and system economics**

| | Treatments | $C_1$ | $C_2$ | $C_3$ | $C_4$ | $C_5$ | $C_6$ | Mean |
|---|---|---|---|---|---|---|---|---|
| JEY (q/ha) | $F_1$ | 78.34 | 95.25 | 79.20 | 84.21 | 85.16 | 84.25 | 84.40 |
| | $F_2$ | 84.18 | 98.88 | 83.32 | 86.92 | 92.88 | 88.06 | 89.04 |
| | Mean | 81.26 | 97.06 | 81.26 | 85.56 | 89.02 | 86.15 | |
| | CD (P=0.05) | C= 2.03 F=0.39 C x F = 0.96 | | | | | | |
| Net return (Rs/ha) | $F_1$ | 143465 | 196485 | 145784 | 150970 | 167853 | 144131 | 158115 |
| | $F_2$ | 160269 | 212135 | 161482 | 158353 | 186735 | 155270 | 172374 |
| | Mean | 151867 | 204310 | 153633 | 154662 | 177294 | 149700 | |
| | CD (P=0.05) | C=1705.7 F=232.53 C x F =569.57 | | | | | | |
| B:C ratio | $F_1$ | 1.98 | 2.26 | 1.99 | 1.94 | 2.14 | 1.86 | 2.02 |
| | $F_2$ | 2.06 | 2.38 | 2.10 | 1.97 | 2.19 | 1.91 | 2.10 |
| | Mean | 2.02 | 2.32 | 2.04 | 1.95 | 2.16 | 1.88 | |
| | CD (P=0.05) | C=0.14 F= 0.02 C x F =0.07 | | | | | | |

*$C_1$=jute-asalio-boro rice, $C_2$=jute-nigella-boro rice, $C_3$=jute-methi-boro rice, $C_4$=jute-garden pea-boro rice $C_5$=jute-coriander-boro rice, $C_6$=jute-isabgol-boro rice., $F_1$= RDF, $F_2$ = RDF+ 5t FYM/ha*

## 5.2. Sisal

### 5.2.1. Effect of planting materials and fertilizer levels on growth and yield of sisal and hybrid sisal

In the field experiment, sisal suckers of different sizes [ large (50 cm), medium (35 cm) and small (25 cm)] were planted with different combinations of fertilizers (60:30:60, 90:45:90 and 120:60:120 kg/ha) in 54 plots (9 treatments x 3 replications x 2 crop types) at Sisal Research Station, Bamra, Odisha. In general, it was observed (Fig. 5.2) that the number of leaves per plant was comparatively more either in higher doses of fertilizer (NPK @ 120:60:120 kg/ha) application (14.29 per plant) or in case of larger (50 cm) sucker size (15.87 per plant). However, percentage increase in leaf number was more in medium sized suckers (35 cm) with higher fertilizer (120:60:120 kg/ha) dose (45.1%) followed by medium sized suckers (35 cm) with medium fertilizer (90:45:90 kg/ha) dose (40.2%). *(Source: SLA 1.7, Contributors: S. Sarkar, A.K. Jha, D.K. Kundu, M.S. Behera, B. Majumdar and R.K. Naik)*

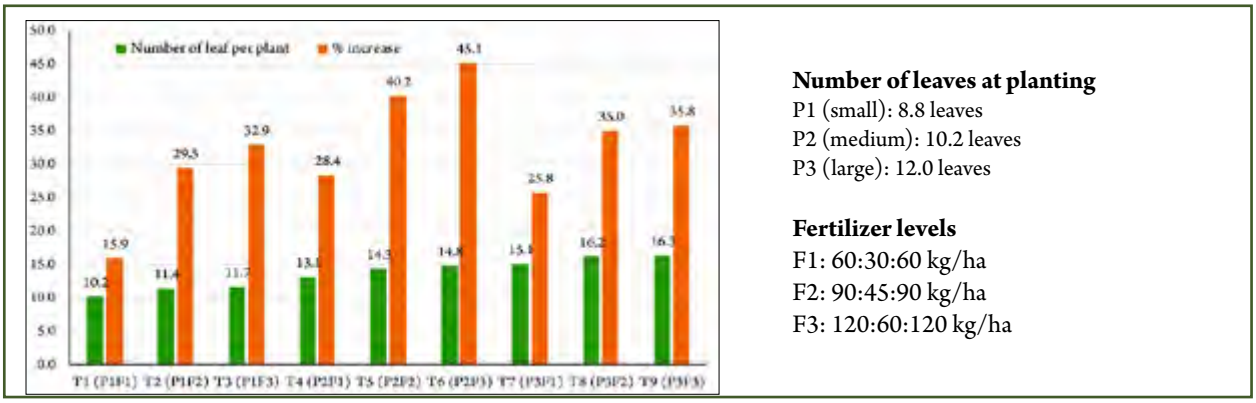



**Fig. 5.2.** Number of leaves in sisal (1st year) as affected by planting materials and fertilizer levels

### 5.2.2. Use of drip irrigation for improving productivity of sisal-based fruit- fibre system

Highest sisal yield of 16.59 q/ha (Table 5.6) was recorded in case of guava followed by custard apple (16.56 q/ha). Irrigating the fruit plants at 80% PE grown in existing 4 years old plantation recorded higher yield in all fruit plants compared to 100% PE and 60% PE. However, in new plantation, where sisal and fruit plants were planted together, the productive period of sisal was advanced by 6 months which resulted in taking up harvesting from 2.5 years of old plantation. The result indicated maximum sisal yield of 11.65 q/ha in case of guava followed by mango (9.67 q/ha). There was significant augmentation of growth and yield in base crop sisal. Yield of 84.00 q/ha in guava and 26.00 q/ha in mango were recorded from the plantation.

**Table 5.6. Effect of different drip irrigation regimes on dry weight of sisal in fruit-fibre system**

| Sisal yield (q/ha) 7 years old sisal plantation | | | | |
|---|---|---|---|---|
| **Treatments** | **$I_1$** | **$I_2$** | **$I_3$** | **Mean** |
| $C_1$ | 17.14 | 18.12 | 14.52 | 16.59 |
| $C_2$ | 15.44 | 16.10 | 13.76 | 15.10 |
| $C_3$ | 16.88 | 17.86 | 14.96 | 16.56 |
| $C_4$ | 14.88 | 16.48 | 14.28 | 15.21 |
| Mean | 16.08 | 17.14 | 14.38 | |
| CD (P=0.05) | C=0.33 I=0.11 C x F=0.12 | | | |
| Sisal yield (q/ha) 2.5 years old sisal plantation | | | | |
| Treatments | $I_1$ | $I_2$ | $I_3$ | Mean |
| $C_1$ | 11.14 | 14.06 | 9.76 | 11.65 |
| $C_2$ | 9.81 | 11.04 | 8.18 | 9.67 |
| $C_3$ | 9.15 | 11.06 | 8.19 | 9.46 |
| $C_4$ | 8.72 | 9.52 | 7.11 | 8.45 |
| Mean | 9.70 | 11.42 | 8.31 | |
| CD (P=0.05) | C=0.34 I=0.13 C x F=0.11 | | | |

*$C_1$= Guava $C_2$= Sapota $C_3$= Custard apple $C_4$= Mango, $I_1$=100% PE $I_2$=80% PE, $I_3$=60% PE*

Four fruit plants *viz*. pomegranate, ber, amla and lemon were grown in interspaces of 4-year-old hybrid sisal plantation (Fig. 5.3). The different annual intercrops were also grown in interspaces of fruit plants from which additional income was obtained. Maximum sisal yield of 14.62 q/ha (Table 5.7) was recorded in ber followed by pomegranate (12.72 q/ha). The growth attributing characters also followed similar trend. Irrigating the crop at 80% PE recorded higher yield compared to 100% PE and 60% PE. (*Source: SLA 1.6, Contributors: M.S. Behera, D.K. Kundu, A.K. Jha)*

**Table 5.7. Effect of drip irrigation regimes on yield of hybrid sisal (q/ha) in fruit fibre system**

| Treatments | $I_1$ | $I_2$ | $I_3$ | Mean |
|---|---|---|---|---|
| $C_1$ | 14.56 | 16.12 | 13.18 | 14.62 |
| $C_2$ | 12.02 | 14.16 | 11.98 | 12.72 |
| $C_3$ | 11.8 | 12.88 | 10.96 | 11.77 |
| $C_4$ | 11.19 | 12.28 | 9.72 | 11.06 |
| Mean | 12.31 | 13.86 | 11.46 | |
| CD (P=0.05) | C=1.07 I=0.40 C x F=0.35 | | | |

*$C_1$= Ber $C_2$= Pomegranate $C_3$= Lemon $C_4$= Amla, $I_1$=100% PE $I_2$=80% PE, $I_3$=60% PE*


**Fig. 5.3.** Fruit fibre system with Hybrid sisal- (a)ber (b)amla (c) pomegranate and sisal (d)guava (e) custard apple (f)mango (g) sapota

### 5.2.3. Production potential and economic benefit of intercropping of medicinal and aromatic plants in sisal plantation

Considering the total sisal equivalent yield of different spices, medicinal and aromatic plants grown as intercrops, aloe-vera recorded maximum yield (32.99 q/ha) followed by safed-musili (31.73 q/ha) in case of medicinal and aromatic plants (Table 5.8). Among spices, fennel registered highest yield (30.39 q/ha). The traditional tuber crop *i.e.* elephant foot-yam recorded 26.04 q/ha yield followed by vegetable crop okra (21.57 q/ha). Safed musili recorded maximum return of Rs 1,58,892 followed by aloe-vera (Rs 1,53,968). Among the spices, fennel (Rs 1,59,903) and in traditional crop, elephant foot-yam (Rs 1,05,457) registered higher net return. Among the MAPs, safed musili recorded highest B:C ratio of 2.67 followed by vetiver (2.61). Among spices fennel and among traditional crops maize registered B:C ratio of 2.92 and 2.31 respectively. (*Source: JA 6.9, Contributors: M.S. Behera, D.K. Kundu, S. Satpathy, A.K. Jha and R.K. Naik)*

**Table 5.8. Yield and economics of MAPs and conventional crops grown in sisal interspaces**

| Treatments | | Sisal Yield (q /ha) | Intercrops Yield (q /ha) | Intercrops SEY(q /ha) | Total SEY (q /ha) | Net Return (Rs/ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| Medicinal and Aromatic Plants | Aloe- vera | 14.69 | 88.65 | 18.30 | 32.99 | 153968 | 2.40 |
| | Asalio | 13.43 | 4.15 | 4.89 | 18.33 | 84918 | 2.37 |
| | Isabgol | 10.93 | 4.45 | 4.14 | 15.07 | 70450 | 2.41 |
| | Vetiver | 13.16 | 9.78 | 16.46 | 29.62 | 146201 | 2.61 |
| | Lemon grass | 14.02 | 263 | 4.84 | 18.86 | 86135 | 2.33 |
| | Palmorosa | 10.85 | 147.5 | 4.08 | 14.93 | 67072 | 2.28 |
| | Citronella | 10.45 | 178 | 4.45 | 14.90 | 69960 | 2.42 |
| | Kalmegh | 15.93 | 20.76 | 5.13 | 21.07 | 88122 | 2.09 |
| | Muskdana | 11.24 | 4.86 | 3.95 | 15.19 | 60349 | 1.98 |
| | Senna | 11.33 | 6.39 | 3.24 | 14.57 | 59459 | 2.04 |
| | Ashwagandha | 13.54 | 4.26 | 4.57 | 18.11 | 79370 | 2.21 |
| | Safed musili | 12.68 | 14.02 | 19.05 | 31.73 | 158992 | 2.67 |
| Spice | Fennel (Seed Spices) | 14.09 | 7.23 | 16.30 | 30.39 | 159903 | 2.92 |
| | Chilli (Spices) | 13.40 | 11.46 | 9.13 | 22.53 | 98153 | 2.19 |
| Traditional Crop | Horse gram (Pulse) | 9.94 | 9.07 | 3.04 | 12.98 | 39146 | 1.60 |
| | Ground Nut (Oilseed) | 11.69 | 6.12 | 3.27 | 14.96 | 62444 | 2.09 |
| | Okra (Vegetable) | 10.30 | 88.26 | 11.2 | 21.57 | 90809 | 2.11 |
| | Elephant foot yam (Tuber) | 11.18 | 74.11 | 14.86 | 26.04 | 105457 | 2.02 |
| | Maize (Cereal) | 10.99 | 13.42 | 6.64 | 17.63 | 80069 | 2.31 |
| | Ragi (Millet) | 10.16 | 7.54 | 3.32 | 13.48 | 56546 | 2.10 |
| | CD (P=0.05) | 0.84 | 16.23 | 0.58 | 1.31 | 1360.87 | 0.11 |
| Fertility Levels | $F_1$ –RDF | 11.52 | 46.60 | 7.89 | 19.41 | 86192 | 2.22 |
| | $F_2$ - RDF + 5t FYM | 12.88 | 49.70 | 8.19 | 21.07 | 95561 | 2.28 |
| | CD (P=0.05) | 0.05 | 0.08 | 0.01 | 0.30 | 12.57 | 0.01 |
| Interaction | CD (P=0.05) | 0.27 | 0.38 | 0.02 | 1.30 | 56.22 | 0.04 |

### 5.2.4. Sisal based integrated farming system under organic management practices

The land-based enterprises such as dairy, poultry, rearing of rabbit, apiary, pisciculture, mushroom cultivation, azolla culture, vermicomposting, growing of field crops, fruits, vegetables, timber including raising of fodder etc. was taken up in the Integrated Sisal Based Farming System (Fig 5.4). The efficient use of available resources helped to generate adequate income due to integration of various farm enterprises, recycling of crop residue and by-product within the farm itself for which there was increase in profit by 72%. The employment generation was also enhanced by 198 man days/ha. (*Source: SLA 1.8, Contributors: M. S. Behera, D.K. Kundu, S. Sarkar and A.K. Jha)*

(a) Dairy

(b) Pisciculture

(c) Goatary

(d) Poultry

(e) Mushroom

**Fig. 5.4.** Various components of Sisal Based Integrated Farming System

# 6. Biotic and Abiotic Stresses

## 6.1. Pest Management

### 6.1.1. Isolation and characterization of sex pheromone

#### 6.1.1.1. Validation of sex pheromone components of female jute semilooper, *Anomis sabulifera* in wind tunnel

Isolation and identification of female sex pheromone of *Anomis sabulifera* using Electroantennogram, Gas Chromatograghy coupled with Electroantennogram Detector (GC-EAD) and Gas Chromatograghy coupled with Mass Spectrometry (GC-MS) revealed the presence of (Z, Z)-6,9 heneicosadiene and (Z,Z,Z)-3,6,9 heneicosatriene as the active compounds in pheromone gland of the virgin female moths for enticing the male moths of *A. sabulifera*.

Wind tunnel experiment with adult male moths of *A. sabulifera* and female pheromone gland and GC-MS detected components individually or in combination thereof revealed that (Z,Z)-6,9 heneicosadiene and (Z,Z,Z)-3,6,9 heneicosatriene are the major components in virgin female sex pheromone gland of *A. sabulifera* and showed male moth enticing ability. Test of significance for difference of multiple proportions by using "N-1" $\chi^2$ test revealed that (Z,Z)-6,9 heneicosadiene individually and (Z,Z)-6,9 heneicosadiene (3) : (Z,Z,Z)-3,6,9 heneicosatriene (1) ratio were significant from other treatments in causing male moth attraction towards the female sex pheromone components (Table 6.1). *(Source: J.E. 1.6; Contributors: V. Ramesh Babu, B. S. Gotyal and S. Satpathy)*

**Table 6.1. Relative response of adult male moths of jute semilooper, *A. sabulifera* to synthetic sex pheromone components in wind tunnel**

| Component | N | (+) ve response | Intermediary | (-) ve response |
|---|---|---|---|---|
| Female pheromone gland extract | 10 | 5*<br>5.29**<br>(0.02) | 0<br>1.32<br>(1.32) | 5<br>3.38<br>(0.77) |
| (Z,Z)-6,9 Heneicosadiene | 18 | 11<br>9.53<br>(0.23) | 2<br>2.38<br>(0.06) | 5<br>6.09<br>(0.19) |
| (Z,Z,Z)-3,6,9 Heneicosatriene | 10 | 3<br>5.29<br>(0.99) | 3<br>1.32<br>(2.12) | 4<br>3.38<br>(0.11) |
| (Z,Z)-6,9 Heneicosadiene + (Z,Z,Z)-3,6,9 Heneicosatriene (3:1) | 20 | 12<br>10.59<br>(0.19) | 3<br>2.65<br>(0.05) | 5<br>6.76<br>(0.46) |
| 8-methyl heptadecane | 10 | 5<br>5.29<br>(0.02) | 1<br>1.32<br>(0.08) | 4<br>3.38<br>(0.11) |

$\chi^2$ – Analysis, two way contingency table [$\chi^2 = 6.73$, df = 8, $\chi^2$/df = 0.84, P ($\chi^2 > 6.73 = 0.56$)]

*Figures in the parentheses are $\chi^2$ values, * Observed frequency, ** Expected frequency*

### 6.1.2. Biological control of insect pests of jute

#### 6.1.2.1. Isolation and extraction of nucleopolyhedrosis virus of jute hairy caterpillar, *Spilosoma obliqua*

Entomopathogenic virus was isolated from dead *S. obliqua* larvae found hanging on jute plants with characteristic viral infection symptoms (Fig. 6.1) at farmer's field (Haringhata, Kalyani,West Bengal) while surveying the jute fields with heavy infestation of hairy caterpillar. The hairy caterpillar larvae in this locality were infected at the scale of epizootics (85-90%) with the suspected entomopathogenic virus which was later identified as NPV.

**Fig. 6.1.** Typical NPV infected *S. obliqua* larva

Crude homogenate of the virus was extracted from single dead larval cadaver, showing the typical symptom of larval infection. The virus was extracted by grinding it in sterile distilled water, centrifuged and stored at -20°C.

#### 6.1.2.2. Characterization of Spob NPV

The molecular characterization of polyhedral occlusion bodies ($POB_s$) from the infected larvae was done after extraction and purification of the viral DNA. The extracted DNA was visualized

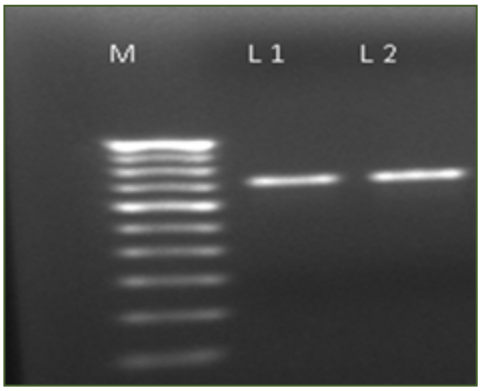



**Fig. 6.2.** PCR detection based on *polh* gene at 700 bp (M = Marker (M):100 bp ladder, lane 1 = *S. obliqua polh* NPV gene (Replication1); Lane 2 = *S. obliqua polh* NPV gene (Replication 2)

in 0.9% agarose gel. Primer set for the amplification of *polh* gene was designed as species-specific primers according to the SpobNPV sequences in the Genbank database of National Centre for Biotechnology Information, and the primer sequence consisted

of forward primer 5'-ATGCCAGACTTCTCGTACCG-3' and reverse primer 5'-TAATACGCGGGACCGGTGAAT-3'. The PCR conditions consisted of an initial denaturation step of 95°C for 3 min and 35 cycles of 95°C for 30 sec, 70°C for 1 min, 55°C for 1 min, and a final extension step 72°C for 10 mins. The PCR product was of 700 bp. (Fig. 6.2). SEM and TEM studies conducted on the OBs revealed that the virus particles are triangular to tetrahedral in shape with average size of about 1.60 µm that ranged from 1.04-1.72 µm.

#### 6.1.2.3. Spob NPV multiplication and larval bioassay

For multiplication of Spob NPV, 5th instar larvae were starved for 2 h and then were fed on jute leaves smeared with 1 ml of viral suspension containing 3.2 × $10^6$ OBs/ml. Larvae were allowed to feed on the virus inoculated leaf for 24 h and later on were transferred to natural diet in a clean container and maintained at 25°C till death.

The number of OBs obtained from single NPV infected dead larvae was adjusted to 3.2 × $10^6$ OBs/ml using a haemocytometer in aqueous solution of 0.05% Tween 20 (v/v). Preliminary mortality studies using leaf dip bioassay with second instar larvae of hairy caterpillar and serial dilution of the OBs revealed the median lethal concentration ($LC_{50}$) of Spob NPV as 3.2 × $10^4$ OBs/ml (F.L. 1.1x$10^5$ - 2.9x$10^4$).

#### 6.1.2.4. Isolation of *Bacillus thuringiensis* Berliner (Bt) from soils of jute growing areas

Native isolates of Bt were isolated from soil samples collected from jute growing areas adjoining ICAR-CRIJAF, Barrackpore. A total of nine isolates of Bt have been isolated using Traver's protocol. Bacterial colonies were identified to be *B. thuringiensis* based on amido black staining and on colony morphology *viz.,* dull whitish, raised mat like, irregular margin (Fig. 6.3). Rod shaped, purple colour bacteria were visualised on Gram staining of the bacterial colonies.

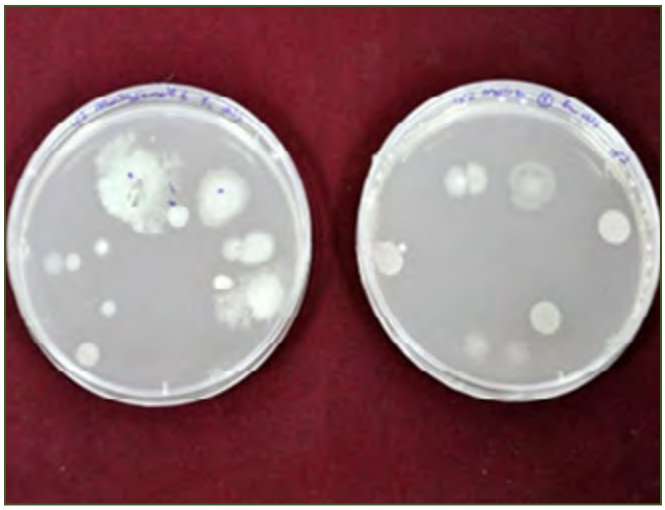


**Fig. 6.3.** Typical isolate of *B. thuringiensis* from native soil

#### 6.1.2.5. Isolation of *Beauveria bassiana* from jute hairy caterpillar, *Spilosoma obliqua*

Entomopathogenic fungus, *B. bassiana* was isolated from the fungal infected 5th instar larvae of hairy caterpillar, *S. obliqua* (Fig. 6.4). The fungus was cultured on Potato Dextrose Agar and Sabaurd Dextrose Agar and maintained at incubation temperature of 28°C. Colony forming units based on serial dilution of the fungal spores was estimated to be 2.2x$10^{10}$ spore/ml. *(Source: J.E: 2.0; Contributors: V. Ramesh Babu, G. Siva Kumar and S. Satpathy).*

**Fig. 6.4.** Larvae engulfed with mycelium of *B. bassiana*

### 6.1.3. Development of nano formulations for pest management

#### 6.1.3.1. Effect of nanosilica on hairy caterpillar, *Spilosoma obliqua*

Six different concentrations of nanosilica *viz.*, 10 ppm, 1 ppm, 0.1 ppm, 0.01 ppm, $10^{-3}$ ppm and $10^{-4}$ ppm were prepared. Uniform third instar larvae of hairy caterpillar (HC) were used for determining the toxicity of nanosilica on hairy caterpillar. Ten larvae were exposed on fresh jute leaves as feed in petriplates that were sprayed with different concentrations of nanosilica @ 5ml/ plate by an atomizer. After 24 h fresh leaves were provided for feeding. After 48 h of spray the weight of nanosilica treated larvae of HC showed considerable reduction as compared to the untreated larvae (Fig. 6.5). The highest body weight reduction of 64.41% was noticed in case of nanosilica spray @10 ppm followed by 1 ppm (62.93%) and 0.1 ppm (37.31%). The lowest body weight reduction (4.55%) was recorded in case of $10^{-4}$ ppm nanosilica. After 72 h of spray, the highest mortality of 75% was recorded in case of 10 ppm followed 73.33% in case of 1 ppm. Even in case of $10^{-4}$ ppm nanosilica spray application there was 16.67% mortality.

The $LC_{50}$ of nanosilica was as low as 0.0000097% of a.i. It was lower than most of the commonly used insecticides such as indoxacarb, cypermethrin, emamectin benzoate etc. (Table 6.2). *(Source: JM 9.3; Contributors: C. Biswas and V. Ramesh Babu)*

**Table 6.2. $LC_{50}$ of nanosilica against hairy caterpillar in comparison to other insecticides**

| Insecticide | $LC_{50}$ (% a.i.) | Fiducial Limit | |
|---|---|---|---|
| | | Lower | Upper |
| Fenpropathrin 30EC | 0.00513 | 0.00442 | 0.00597 |
| Fenvalerate 20EC | 0.00340 | 0.00218 | 0.00525 |
| Indoxacarb 14.5 SC | 0.00053 | 0.0004 | 0.00072 |
| Cypermethrin 10AF | 0.00013 | 0.00011 | 0.00016 |
| Emamectin benzoate 5 SG | 0.00004 | 0.00004 | 0.00007 |
| Nano Silica | 0.0000097 | 0.0000016 | 0.0000521 |

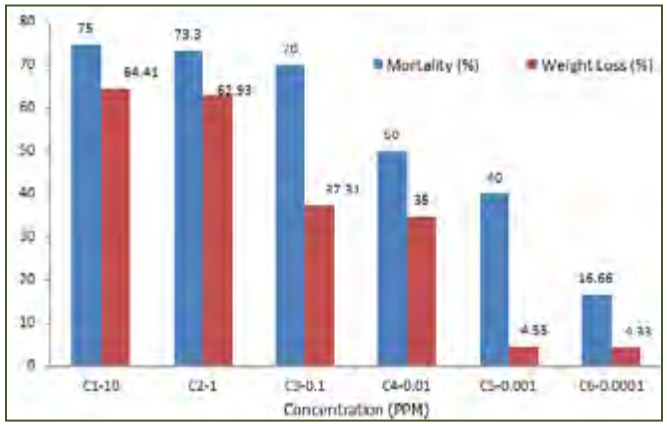



**Fig. 6.5.** Mortality and weight loss due nanosilica application on hairy caterpillar larvae

### 6.1.4. Bio-ecology and management of yellow mite in jute

#### 6.1.4.1. Evaluation of elite jute varieties against yellow mite

Relative susceptibility of elite jute varieties to yellow mite was determined on the basis of population density of adult stages, mite days, tolerance and susceptibility index under field condition.

*Early sown crop:* At 35 DAS, significantly lowest population was recorded in JROG 1 (15.58/cm²) which was at par with JRO 204 (16.00/cm²) (Table 6.3). At this stage, JRO 2407 and JBO 1 had significantly higher mite population (26.42 and 25.60 mite/cm² respectively). Further there was increase in mite infestation. Subsequently, at 45 DAS during the peak period of infestation, JRO 204 and JRO 524, recorded significantly less mite population with 26.19 and 27.16 mites/cm² respectively. These varieties recorded significantly lower mite population than JROM 1, JBO 1 and JRO 2407 (34.91, 37.30 and 41.76 mite/cm² respectively). Consistently least susceptibility of JRO 204 and JRO 524 to yellow mite infestation was still reflected at 65 DAS. The population build up in these two varieties was slower which varied from 14.33 to 27.16/cm² compared to 23.44 to 41.76 mite/cm² in JRO 2407.

*Late sown crop:* The infestation of yellow mite in the late sown crop was higher than the early sown crop**.** Mite population density was observed in the critical stage of infestation i.e., from 35 DAS to 65 DAS (Table 6.3). During all the observation periods significant variation in population density among the varieties was evidenced. JR0 204 (16.34-26.60) and JRO 524 (15.87-28.22) had significantly less mite population. In these varieties the population build up was slower which was significantly less than JBO 1, JROM 1 and JRO 2407 (42.94, 38.76 and 47.14 mite/cm² ). During the peak period of infestation at 45 DAS the mite population density in JRO 524 and JRO 204 was 28.22 mite/cm² and 37.21 mite/cm² respectively compared to 47.14 mite/cm² in JRO 2407 variety indicating it to be most susceptible.

**Table 6.3. Relative infestation of yellow mite (adults) on elite jute varieties**

| Varieties | 35DAS | | 45DAS | | 55DAS | | 65DAS | |
|---|---|---|---|---|---|---|---|---|
| | Early | Late | Early | Late | Early | Late | Early | Late |
| JRO 524 | $18.40^{ab}$ | $21.11^{cd}$ | $27.16^{c}$ | $28.22^{de}$ | $22.55^{bc}$ | $23.14^{cd}$ | $16.11^{c}$ | $15.87^{d}$ |
| JROM 1 | $20.41^{ab}$ | $28.44^{bc}$ | $34.91^{ab}$ | $38.76^{abc}$ | $30.77^{abc}$ | $30.88^{abc}$ | $19.55^{abc}$ | $26.85^{ab}$ |
| JROG 1 | $15.58^{b}$ | $23.18^{cd}$ | $31.13^{bc}$ | $32.98^{cde}$ | $25.05^{bc}$ | $26.8^{bcd}$ | $18.77^{abc}$ | $22.63^{bc}$ |
| JBO 1 | $25.60^{a}$ | $33.45^{ab}$ | $37.3^{ab}$ | $42.94^{ab}$ | $34.11^{ab}$ | $34.65^{ab}$ | $21.33^{ab}$ | $26.72^{ab}$ |
| JRO 2407 | $26.42^{a}$ | $35.77^{a}$ | $41.76^{a}$ | $47.14^{a}$ | $38.77^{a}$ | $37.50^{a}$ | $23.44^{a}$ | $28.82^{a}$ |
| S 19 | $19.66^{ab}$ | $24.21^{cd}$ | $30.33^{bc}$ | $32.9^{cde}$ | $27.33^{abc}$ | $27.38^{bcd}$ | $18.88^{abc}$ | $22.41^{bc}$ |
| JRO 8432 | $21.89^{ab}$ | $27.73^{bc}$ | $32.72^{bc}$ | $37.21^{bcd}$ | $30.44^{abc}$ | $30.7^{abc}$ | $19.77^{abc}$ | $21.86^{c}$ |
| JRO 204 | $16.00^{b}$ | $19.17^{d}$ | $26.19^{c}$ | $26.6^{e}$ | $20.92^{c}$ | $21.1^{d}$ | $14.33^{c}$ | $16.34^{d}$ |
| CD(P=0.05) | 8.59 | 6.75 | 7.00 | 8.68 | 11.34 | 7.76 | 5.48 | 4.18 |

*Relative mite-days on elite jute varieties:* Mite-days gives better estimate of mite infestation which indicates the total duration of mite life stages (days) in the plant. It estimates the cumulative mite duration across the generations. For better estimation of mite causing effective damage to the crop during the critical stages of the crop, mite days at 50 DAS and cumulative mite days were determined. In all the elite varieties, the mite-days in case of early sown crop were less than the late sown crop (Fig. 6.6). The relative susceptibility of the varieties to yellow mite in terms of mite days showed similar trend in case of both the crops. Irrespective of

the sowing time JRO 204 and JRC 524 showed significantly least mite-days (1868.50; 1963.54 and 2009.35; 2095.65 respectively) followed by JROG 1 (2201.10 and 2480.55). Significantly highest mite-days (3164.22 and 3508.50) were recorded in JRO 2407. Till 50 DAS, JRO 204 recorded significantly less mite days (893.10 and 934.63) at par with JRO 204 (952.90 and 1007.00) followed by JROG 1 (1029.10 and1159.40). During the critical period of infestation, JRO 2407 had significantly highest mite days (1487.30 and 1675.17) at par with JBO 1 (1337.20 and 1539.77). On the basis of relative mite infestation and mite days, JRO 524 and JRO 204 were consistently more resistant.


**Fig. 6.6.** Mite-days in elite jute varieties cumulatively during critical period of infestation

***Tolerance and susceptibility index of elite jute varieties:*** Considering the relative population density and damage grade, tolerance and susceptibility index of the elite varieties against yellow mite was determined (Fig. 6.7). The SI of JRO 2407 was 100 compared to 43.06 and 46.49 in JRO 204 and JRO 524 respectively. In terms of TI, JRO 204 and JRO 524 recorded maximum tolerance (64.86 and 61.72). This indicates that considering various parameters JRO 2407 was least tolerant with highest level of susceptibility. On the other hand JRO 524 and JRO 204 were most tolerant and least susceptible to yellow mite.


**Fig. 6.7.** Tolerance and susceptibility index of elite jute varieties against mite

### 6.1.4.2. Effect of acaricides on egg density, mite population and its residual toxicity on yellow mite of jute

***Egg density:*** The toxicity and persistency of acaricides were evaluated under glass house condition against yellow mite till 16 days after treatment (DAT) on 35-day old potted jute plants. The tested acaricides had significant effect on the egg density of yellow mite (Table 6.4). The egg density in different treatments at 3 DAT varied from 0.33-14.33 mite/cm$^2$, significantly least in spiromesifen 22.9EC (0.016%) and fenpyroximate 5EC (0.005%). The plants treated with fenpyroximate 5EC (0.005%) had significantly least egg density (0.33/m$^2$) being at par with spiromesifen 22.9EC (0.016%) with 2.67 eggs/cm$^2$.

The prersistent effect of diafenthiuron, spiromesifen and fenpyroximate continued till 8 DAT and recorded 0.44-5.44 eggs/leaf compared to 17.11 mite/cm$^2$ in control. Relative toxicity of the acaricides in regulating the egg density of yellow mite was similar at 8 DAT. During this period egg density was significantly least in fenpyroximate (0.44/cm$^2$) compared to 17.11 egg/cm$^2$ in control. At 16 DAT significantly least egg density was recorded in fenpyroximate 5EC (3.89 mite/cm$^2$) followed by spiromesifen 22.9 EC (4.22/cm$^2$) and diafenthiuron 50 WP (5.00/cm$^2$). Among the acaricides tested for toxicity and persistency, fenpyroximate 5EC (0.005%) was found to be most effective followed by spiromesifen 22.9EC (0.016%) and diafenthiuron 50WP(0.05%) .

**Table 6.4. Effect of acaricides on egg density of yellow mite in jute**

| Treatments | Egg density/cm$^2$ leaf area | | | |
|---|---|---|---|---|
| | Pre-treat | Post treat-I (3 DAT) | Post treat-II (8 DAT) | Post treat-III (16 DAT) |
| Flonicamid 50 WG (0.025%) | 16.45(4.11)$^a$ | 6.11(2.55)$^{bc}$ | 5.89(2.52)$^{cd}$ | 6.45(2.61)$^{cd}$ |
| Spiromesifen 22.9 EC (0.016%) | 16.22(4.07)$^a$ | 2.67(1.64)$^{cd}$ | 4.22(2.14)$^d$ | 4.22(2.17)$^{de}$ |
| Diafenthiuron 50 WP (0.05%) | 17.11(4.19)$^a$ | 4.45(2.04)$^{bc}$ | 5.44(2.40)$^{cd}$ | 5.00(2.34)$^{de}$ |
| Dinotefuran 20SG (0.025%) | 15.10(3.93)$^a$ | 4.22(2.16)$^{bc}$ | 14.11(3.80)$^a$ | 8.00(2.91)$^{bc}$ |
| Propargite 57EC (0.15%) | 14.78(3.90)$^a$ | 8.89(3.06)$^{ab}$ | 9.00(3.03)$^{bc}$ | 9.89(3.21)$^{ab}$ |
| Fenpyroximate 5EC (0.005%) | 15.16(3.91)$^a$ | 0.33(0.88)$^d$ | 0.44(0.92)$^e$ | 3.89(2.03)$^e$ |
| Wettable S 80% (0.12%) | 14.67(3.88)$^a$ | 6.44(2.63)$^{bc}$ | 11.55(3.47)$^{ab}$ | 11.11(3.40)$^{ab}$ |
| Control | 16.00(4.05)$^a$ | 14.33(3.83)$^a$ | 17.11(4.19)$^a$ | 12.33(3.58)$^a$ |
| CD (P=0.05) | NS | 0.97 | 0.71 | 0.50 |

*Figures in the parentheses are sqr root transformed values*

***Mite population density:*** The tested acaricides had significant effect on suppression of mite population till 16 DAT (Table 6.5). The mite infestation in fenpyroximate 5EC (0.005%) treated jute plants was significantly least (0.33- 8.33 mite/cm²) till 16 DAT. Spiromesifen 22.9 EC was also effective and suppressed the mite population to 2.67. 3.33 and 9.00 mite/cm² at 3,8 and 16 DAT respectively compared to 37.11 mite/cm² during the pre-treatment period. At 16 DAT, the persistent toxicity of fenpyroximate 5EC was quite evidenced with significantly lowest mite population (8.3 mite/cm²) followed by spiromesifen 22.9 EC (9.00 mite/cm²) compared 43.78 mite/cm² in control.

**Table 6.5. Effect of acaricides on population density of yellow mite in jute**

| Treatments | Adult density/cm² leaf area | | | |
|---|---|---|---|---|
| | Pre-treat | Post treat-I (3 DAT) | Post treat-II (8 DAT) | Post treat-III (16 DAT) |
| Flonicamid 50WG (0.025%) | 34.55(5.91)$^{ab}$ | 12.22(3.55)$^{c}$ | 12.44(3.58)$^{c}$ | 14.11(3.80)$^{d}$ |
| Spiromesifen 22.9EC (0.016%) | 37.11(6.13)$^{a}$ | 3.33(1.92)$^{de}$ | 2.44(1.71)$^{e}$ | 9.00(3.07)$^{e}$ |
| Diafenthiuron 50WP (0.05%) | 36.45(6.07)$^{ab}$ | 6.33(2.60)$^{d}$ | 7.44(2.80)$^{d}$ | 9.67(3.18)$^{e}$ |
| Dinotefuran 20SG (0.025%) | 32.11(5.70)$^{ab}$ | 18.89 (4.39)$^{b}$ | 15.11(3.94)$^{c}$ | 23.78(4.92)$^{c}$ |
| Propargite 57EC (0.15%) | 36.67(6.09)$^{ab}$ | 19.00 (4.41)$^{b}$ | 12.00(3.51)$^{c}$ | 20.22(4.55)$^{c}$ |
| Fenpyroximate 5EC (0.005%) | 39.11(6.26)$^{a}$ | 2.67(165)$^{e}$ | 0.33(0.88)$^{f}$ | 8.33(2.97)$^{e}$ |
| Wettable S 80% (0.12%) | 28.67(5.39)$^{b}$ | 20.64 (4.57)$^{b}$ | 23.22(4.84)$^{b}$ | 32.78(5.76)$^{b}$ |
| Control | 37.89(6.19)$^{a}$ | 40.67(6.41)$^{a}$ | 43.33(6.62)$^{a}$ | 43.78(6.64)$^{a}$ |
| CD (P=0.05) | NS | 0.69 | 0.62 | 0.48 |

*Figures in the parentheses are sqr root transformed values*

***Residual and index of persistent toxicity (IPT) of acaricides against yellow mite:*** Among the acaricides, wettable sulphur had least persistent toxicity on yellow mite of jute. Fenpyroximate 5EC (0.005%) showed highest residual toxicity (1478) and IPT (92).

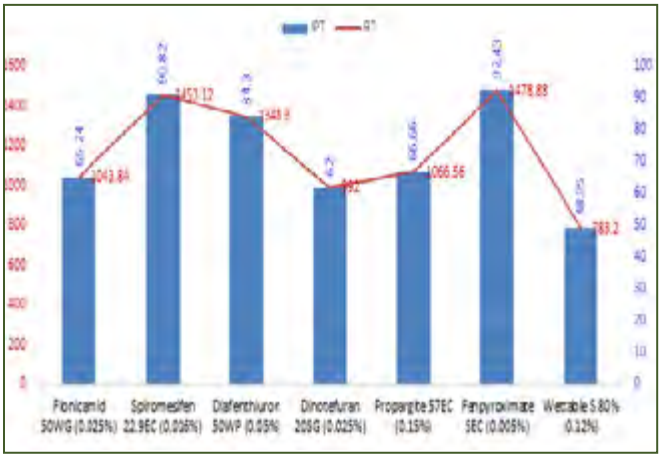



**Fig. 6.8.** Residual and index of persistent toxicity (IPT) of acaricides in jute

Spiromesifen 22.9EC (0.016%) also manifested very good residual toxicity (1453) and IPT (90). These two acaricides were most effective due the persistence toxicity, high translaminar activity and efficacy against both immature and mobile stages (Fig. 6.8).

***Translaminar effect of acaricides on yellow mite in the newly grown young leaves of jute:*** Due to the short and overlapping generations of yellow mite, the bio-efficacy of the acaricides can be better judged by considering the translaminar toxic effect on the mites in the newly grown young leaves. In a glass house experiment translaminar effect of acaricides on mite was judged on the basis of mite population harbouring in the second unfolded leaf which remained folded during spray application (8 days prior to the observation). During the post treatment period, irrespective of treatments there was significant difference in the level of population density between two differentially positioned leaves which were folded and I unfolded leaves during the pre-treatment period (Table 6.6). The mite infestation in the younger leaves was significantly more than the older leaves. This may be due to relatively more preference of the mite for the younger succulent leaves. The main effect of treatments was significantly mainifested in mite population. Fenpyroximate 5EC treatment was free from mite infestation followed by spiromesifen 22.9 EC which recorded 6.61 mite/cm². The interaction effect indicates that except spiromesifen, fenpyroximate and diafenthiuron all the acaricides showed significant difference in mite population between folded (II unfolded during observation) and II unfolded (III unfolded during observation). Eight days after spray application, non-significant population difference in two differentially positioned

**Table 6.6. Translaminar effect of acaricides on yellow mite of jute**

| Treatments | Mite population/ cm² | | |
|---|---|---|---|
| | Leaf position at the time of spray | | Mean |
| | Folded | II Unfolded | |
| Flonicamid 50WG (0.025%) | 15.00(3.94) | 5.67(2.45) | 10.34(3.19) |
| Spiromesifen 22.9EC (0.016%) | 5.55(2.45) | 7.67(2.85) | 6.61(2.65) |
| Diafenthiuron 50WP (0.05%) | 14.33(3.85) | 11.5(3.46) | 12.92(3.65) |
| Dinotefuran 20SG (0.025%) | 14.67(3.82) | 9.00(3.01) | 11.84(3.41) |
| Propargite 57EC (0.15%) | 20.67(4.6) | 6.33(2.61) | 13.50(3.60) |
| Fenpyroximate 5EC (0.005%) | 0.00(0.71) | 0.00(0.71) | 0.00(0.71) |
| Wettable S 80% (0.12%) | 38.00(6.2) | 10.67(3.32) | 24.34(4.76) |
| Control | 57.67(7.63) | 36.67(6.08) | 47.17(8.85) |
| Mean | 20.73(4.61) | 10.93(3.38) | |
| CD (P=0.05) | L=0.23, T=0.47, LXT=0.64 | | |

*Figures in the parentheses are sqr root transformed values*

leaves treated with spiromesifen 22.9EC (0.016%), diafenthiuron 50WP (0.05%) and fenpyroximate 5EC (0.005%) evidenced the retention of toxicity of these acaricides in the folded leaves (during spray). This indicates that these three acaricides had translaminar effect on yellow mite in jute.

#### 6.1.4.3. Field evaluation of acaricides against yellow mite of jute

Seven acaricides were evaluated against yellow mite of jute (cv. JRO 8432) under field condition. The pre-treatment mite population among different treatments varied from 23.33 to 32.33 mite/cm$^2$ with no significant difference among the treatments (Table 6.7). After the first post treatment observation at 38 DAS significantly least mite population (3.11/cm$^2$) was observed in fenpyroximate 5EC (0.005%) treatment at par with the population density recorded in spiromesifen 22.9 EC (6.00/cm$^2$) compared to 66.44/cm$^2$, the highest in case of untreated control. Same trend of efficacy persisted till 45 DAS (10 days after application) and significantly lowest mite density (7.44 mite/cm$^2$) was observed in the plants treated with fenpyroximate 5EC (0.005%). At 53 DAS (3 days after second spray) also fenpyroximate 5EC and spiromesifen 22.9 EC treatments were judged to be superior. These two acaricides reduced the mite infestation significantly to 4.96 and 7.66 mite/cm$^2$ respectively as compared to 51.00 mites/cm$^2$ in control. Further although there was reduction in the population density of mite, same trend of efficacy persisted at 60 days. *(Source: J.E: 1.9; Contributors: S. Satpathy, B. S. Gotyal, and V. Ramesh Babu).*

**Table 6.7. Mite population density in jute treated with different acaricides**

| Treatments | Adult density per cm$^2$ leaf area | | | | | |
|---|---|---|---|---|---|---|
| | Pre-treat | Post treat | | Pre-treat | Post treat | |
| | 35 DAS | 38 DAS | 45 DAS | 50 DAS | 53 DAS | 60 DAS |
| Flonicamid 50WG (0.025%) | 33.33(5.81) | 16.22(4.07)$^{c}$ | 18.00(4.29)$^{d}$ | 12.11(3.54)$^{d}$ | 10.78(3.29)$^{de}$ | 2.15(1.52)$^{c}$ |
| Spiromesifen 22.9EC (0.016%) | 23.33(4.87) | 6.00(2.5)$^{de}$ | 13.11(3.68)$^{e}$ | 7.11(2.73)$^{e}$ | 7.66(2.84)$^{ef}$ | 1.3(1.26)$^{c}$ |
| Diafenthiuron 50WP (0.05%) | 25.33(5.08) | 9.22(3.09)$^{d}$ | 16.88(4.16)$^{de}$ | 17.22(4.18)$^{d}$ | 10.78(3.35)$^{de}$ | 2.11(1.34)$^{c}$ |
| Dinotefuran 20SG (0.025%) | 33.66(5.84) | 23.66(4.91)$^{b}$ | 26.33(5.17)$^{c}$ | 24.52(4.99)$^{c}$ | 13.44(3.73)$^{d}$ | 3.90(2.06)$^{bc}$ |
| Propargite 57EC (0.15%) | 34.34(5.89) | 27.77(5.30)$^{b}$ | 31.33(5.64)$^{bc}$ | 32.56(574)$^{b}$ | 21.67(4.70)$^{c}$ | 4.52(2.19)$^{bc}$ |
| Fenpyroximate 5EC (0.005%) | 31.00(5.60) | 3.11(1.73)$^{e}$ | 7.44(2.80)$^{f}$ | 13.45(3.71)$^{d}$ | 4.96(2.32)$^{f}$ | 0.89(1.06)$^{c}$ |
| Wettable S 80%(0.12%) | 33.00(5.78) | 25.97(5.14)$^{b}$ | 34.66(5.92)$^{b}$ | 36.34(6.05)$^{b}$ | 34.33(5.88)$^{b}$ | 9.85(3.15)$^{b}$ |
| Control | 32.33(5.72) | 66.44(8.17)$^{a}$ | 44.10(6.68)$^{a}$ | 47.77(6.94)$^{a}$ | 51.00(7.17)$^{a}$ | 19.65(4.48)$^{a}$ |
| CD (P=0.05) | NS | 0.83 | 0.49 | 0.73 | 0.75 | 1.22 |

*Figures in the parentheses are sqr root transformed values*

## 6.2. Disease Management

### 6.2.1. Stem rot disease management

#### 6.2.1.1. Progress of jute stem rot in sick plot

In order to increase the disease pressure and soil inoculum of pathogen, the fungus was multiplied on sterilized old jute seeds in polypropylene bags for 10-15 days at 28±1° C in BOD incubator, and incorporated into the soil repeatedly 4-5 times before and during the crop season along with growing of susceptible line, namely, JRC 412 and disease incidence was monitored at fortnightly interval.


**Fig. 6.9.** Comparative disease severity in promising (OIN 04) and susceptible (JRC 412) under sick plot condition

The PDI progressed slowly over the years from 2.8 in 2016, to 16.9 in 2017, 11.70 % in 2017 and finally reached peak of 63.5 during last year (Table 6.8). The sickness level was high enough to differentiate promising entry, OIN 04 from susceptible line, JRC 412 (Fig. 6.9).

**Table 6.8. Progress of jute stem rot as disease incidence in susceptible variety JRC 412 grown in sick plot**

| Year | Root rot | RR score | Stem rot | SR rating | SR score | Total score | PDI |
|---|---|---|---|---|---|---|---|
| 2015-16 | 2.00 | 32.00 | 2.00 | 2.00 | 4.00 | 36.00 | 2.81 |
| 2016-17 | 15.25 | 244.00 | 50.25 | 3.00 | 155.00 | 399.00 | 16.97 |
| 2017-18 | 25.00 | 400.00 | 11.67 | 8.00 | 86.33 | 493.33 | 11.70 |
| 2018-19 | 61.33 | 981.33 | 41.67 | 4.00 | 166.67 | 1148.00 | 63.55 |

#### 6.2.1.2. Evaluation of some new fungicides molecules for management of *Macrophomina phaseolina* in jute

All the fungicide treatments reduced stem rot of jute significantly compared to check with highest root rot of 11.9% and percent disease index (PDI) of 12.7. Pre-sowing seed treatment with

carbendazim + spraying of carbendazim @ 0.1% was the best treatment in managing stem rot of jute with lowest root rot of 3.4% (PDI-4.2). It was followed by hexaconazole with root rot of 3.7% (PDI-5.8) and tebuconazole with root rot of 4% (PDI-5.8) (Table 6.9). *(Source: JM 9.0; Contributors: R.K. De, V. Ramesh Babu and Shamna A.)*

**Table 6.9. Evaluation of some new fungicides molecules @ 0.1 % against *M. phaseolina* in jute**

| Treatment* | Root rot (%) | PDI |
|---|---|---|
| Seed treatment with carbendazim + spraying carbendazim at 45 DAS | 3.44 (18.33) | 4.24 (19.57) |
| Seed treatment with propineb + spraying propineb at 45 DAS | 5.52 (27.01) | 6.32 (29.77) |
| Seed treatment with tebuconazole + spraying tebuconazole at 45 DAS | 4.01 (20.08) | 5.80 (21.66) |
| Seed treatment with difenconazole + spraying difenconazole at 45 DAS | 4.70 (21.16) | 5.83 (25.04) |
| Seed treatment with hexaconazole + spraying hexaconazole at 45 DAS | 3.78 (24.72) | 5.80 (26.37) |
| Seed treatment with tricyclazole+propiconazole + spraying tricyclazole+propiconazole at 45 DAS | 4.69 (23.55) | 5.96 (24.26) |
| Seed treatment with azoxystrobin + difenconazole + spraying azoxystrobin + difenconazole at 45 DAS | 4.19 (22.71) | 5.89 (23.53) |
| Check | 11.91 (31.59) | 12.78 (33.15) |
| CD (P=0.05) | 4.13 | 5.05 |

*Figures in the parenthesis are arc sine transformed values, * All the fungicides were applied @ 0.1% as foliar spray and 1 g/kg as seed treatment.*

### 6.2.1.3. *In vitro* growth inhibition of jute stem rot pathogen, *M. phaseolina* by different nanoparticles

Efficacy of different nanoparticles *viz.*, nano ZnO, nano CuO and nano silver against the jute stem rot pathogen, *M. phaseolina* was tested *in vitro* through poison food technique. Average size of the nanoparticles of ZnO, CuO and Silver were 10 nm, 45 nm and 6.5 nm respectively. Nano ZnO at very low concentrations ($10^{-1}$ to $10^{-6}$ ppm) completely inhibited the growth of *M. phaseolina in vitro* (Fig. 6.10). However, conventional ZnO at this concentration caused only about 50% growth inhibition. Nano CuO was not effective at $10^{-1}$ to $10^{-6}$ ppm, however at 1-2 ppm it inhibited the growth of *M. phaseolina*. Nano silver particles (AgNp) proved to be ineffective in restricting the growth of *M. phaseolina*. *(Source: JM 9.3; Contributors: C. Biswas and V. Ramesh Babu).*

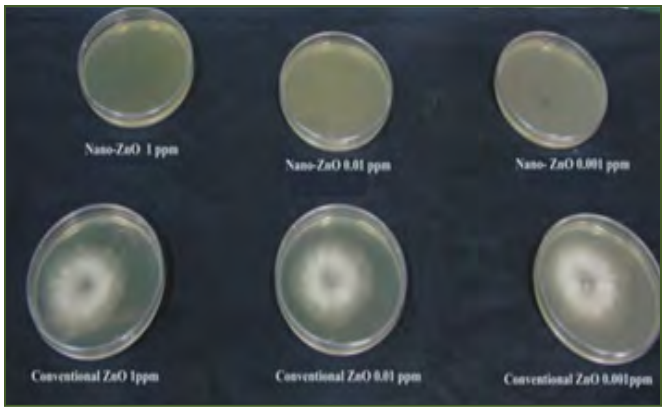



**Fig. 6.10.** *In vitro* growth inhibition of *M. phaseolina* by ZnO nanoparticles

### 6.2.1.4. Isolation of *Trichoderma* for biocontrol of diseases of jute

With the objective of isolation of virulent *Trichoderma* isolate having potential biocontrol efficiency, twenty-three soil samples were collected from 11 locations belonging to Nadia and North 24 Paraganas. Standard protocol was followed for isolation of *Trichoderma* from the soil samples. However, successful isolation could be made from three samples. These isolates were characterised along with one reference strain and two commercially available strains. Isolate 4 and two commercial strains showed significantly higher growth rate on artificial medium (Fig. 6.11). (*Source: JM 9.2; Contributors: K. Mandal, S.K. Sarkar and R. Saha*)

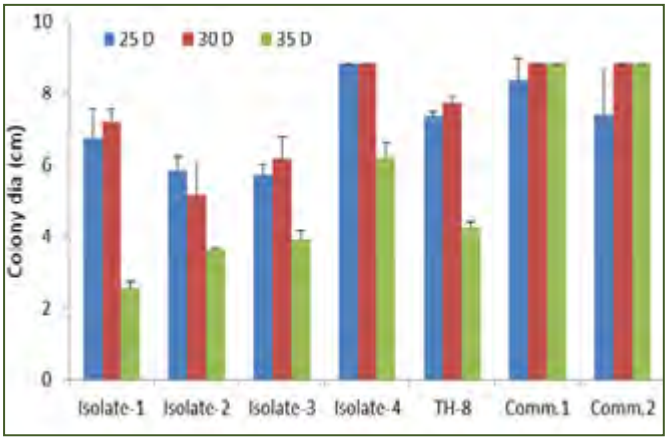



**Fig. 6.11.** Colony diameter of different *Trichoderma* isolates

### 6.2.2. Bio-ecology and management of zebra disease of sisal

### 6.2.2.1. Survey of zebra disease incidence

Twenty-four villages of Jharsugura, Sambalpur and Sundargarh district of Odisha were selected for the study of distribution of the disease. The disease incidence in 5-6 years old sisal plantations in different villages in an around SRS, Bamra recorded 12.8 to 37.6% in *Agave sisalana* and 14.6 to 58.6 % in Bamra Hybrid-1.

### 6.2.2.2. Seasonal incidence of zebra disease in sisal nursery

In nursery stage, disease severity ranged from 3.2 to 41.5% in *Agave sisalana* and 3.8 to 47.4% in Bamra Hybrid-1. In case of 2-3 years old suckers, disease severity ranged from 3.5 to 44.7% in *Agave sisalana* and 5.6 to 51.8% in Bamra Hybrid-1 (Table 6.10).

**Table 6.10. Extent of disease severity in sisal nursery**

| Date | Disease severity in nursery stage (4-5 months old) | | Disease severity in 2-3 years old suckers | |
|---|---|---|---|---|
| | *Agave sisalana* | Bamra Hybrid-1 | *Agave sisalana* | Bamra Hybrid-1 |
| 15th June | 3.2(10.2) | 3.8(11.2) | 3.5(10.8) | 5.6(13.6) |
| 30th June | 5.4(13.3) | 7.0(15.3) | 5.1(13.0) | 9.1(17.4) |
| 16th July | 16.6(23.9) | 20.0(26.5) | 12.7(20.8) | 21.0(27.2) |
| 31st July | 21.8(27.8 ) | 22.5(28.3) | 20.8(27.1) | 27.5(31.6) |
| 16th Aug | 32.1(34.4) | 38.7(38.4) | 28.4(32.3) | 37.0(37.5) |
| 31st Aug | 35.9(36.8) | 40.5(39.5) | 31.2(33.9) | 38.6(38.4) |
| 15th Sept | 39.4( 38.9) | 42.4(40.6) | 38.5(38.3) | 44.5(41.8) |
| 30th Sept | 41.1(39.9) | 43.2(41.1) | 42.4(40.6) | 47.6(43.6) |
| 15th Oct | 41.5(40.1) | 47.4(43.5) | 44.7(41.9) | 51.8(46.0) |
| CD (P=0.05) | 4.7 | 3.8 | 3.3 | 3.0 |

*Figures in parentheses are arc sine transformed value*

### 6.2.2.3. Zebra disease (*Phytophthora nicotiana*) reaction in different sisal types and germplasm

Under natural epiphytotic condition, among 11 *Agave* species none was found to be resistant to zebra disease. One spp. (*A. miradorensis)* showed moderately resistant reaction and three spp. (*A. angustifolia*, *A. cantala* and *A. amaniensis*) showed moderately susceptible reaction and rest 7 species showed susceptible and highly susceptible reaction (Table 6.11).

Out of 61 germplasm, 10 germplasm showed resistant reaction, 12 germplasm showed moderately resistant reaction and 39 germplasm showed susceptible to highly susceptible reaction to zebra disease.

**Table 6.11. Reaction of germplasm against zebra disease**

| PDI | Reaction | Germplasm |
|---|---|---|
| 0-5.0% | R (10) | APR-67, APR-66, APR-60, APR-57, APR-54, APR-52, APR-36, APR-33, APR-31, RST/PK/05/03 |
| 5.1-10.0% | MR (12) | APR-79, APR-78, APR-74, APR-73, APR-70, APR-53, APR-34, APR-18, APR-17, APR-14, APR-13, APR-11, |
| 10.1-25.0% | MS (8) | APR-69, APR-59, RST/PK/05/02, AMDJ-04/48, NA-03/65, YMG-307,YMG-335, NA-03/53 |
| 25.1-50.0% | S (13) | APR-58, AMDJ-04/35, AMDJ-04/32, AMDJ-04/30, AMDJ-04/29, AMDJ-04/21, NA-03/63, NA-03/52, NA-03/44,RST/PK/05/05, AD-03/32, SBC -01/102, KBA-207 |
| >50.0% | HS (18) | NM/02-106, NM/02-71, NM/02-68, NM/02-39, NM/02-34, AMDJ-04/56, AMDJ-04/15, YMG-347, AD-03/11, AD-03/06, NA-03/43, NA-03/42, NLA-03/28, NLA-03/27, RST/PK/05/04, RST/PK/05/01, SBC-01/24, APR-56 |

### 6.2.2.4. Efficacy of fungicides against zebra disease

In 4-6 months old bulbils foliar sprays with fosetyl –Al recorded least PDI (16.8 and 19.2) which was at par with azostrobulin (18.1 and 18.6) and fenamidon 10% + mancozeb 50% WG (20.1 and 20.6) in both the varieties i.e., *A. sisalana* and Bamra hybrid-1 (Table 6.12).

**Table 6.12. Efficacy of fungicides against zebra disease**

| Fungicide | PDI | | | |
|---|---|---|---|---|
| | 4-6 months old bulbil | | One year old sucker | |
| | *A. sisalana* | Bamra hybrid-1 | *A. sisalana* | Bamra hybrid-1 |
| Metalaxyl 8% + Mancozeb 64% @2.5g/l | 25.3 (30.2 ) | 24.6 (29.7) | 26.7 (31.0) | 27.7 (31.8 ) |
| Carbendazim 12% + Mancozeb 63% WP @2.5g/l | 36.5 (37.2) | 39.0 (38.6) | 41.1 (39.8) | 41.6 (40.2) |
| Copper oxychloride @3.0g/l | 26.0 (31.0) | 26.0 (30.6) | 29.9 (33.1) | 30.2 (33.4) |
| Tebuconazole 50% +Trifloxystrobin 25% @3.0g/l | 28.3 (32.1) | 27.0 (31.3) | 29.7 ( 33.0) | 32.9 (35.0) |
| Azostrobulin@1.0g/lt | 18.1 (25.1) | 18.6 ( 25.5) | 19.7 (26.3) | 22.4 (28.2) |
| Cymoxanil 8%WW + Mancozeb 64% WW@2.5g/l | 23.6 (28.9) | 22.6 (28.4) | 26.3 (30.9) | 26.0 (30.7) |
| Fenamidon 10% + Mancozeb 50% WG@2.0g/l | 20.1 (26.6) | 20.6 (26.9) | 20.7 (27.0) | 23.4 (28.9) |
| Fosetyl –Al 66.66% @2.0g/l | 16.8 (24.2) | 19.2 (25.9) | 18.7 (25.5) | 21.0 (27.3) |
| Control | 46.3 (42.9) | 51.9 (46.1) | 49.6 (44.8) | 53.3 (46.9 ) |
| CD (P= 0.05) | 4.5 | 3.0 | 3.9 | 2.7 |

*Figure in parenthesis are arc sine transformed values*

All the 8 fungicides tested were also effective in reducing the zebra disease of sisal on one year old suckers in both the varieties. However, fosetyl –Al @ 2.0g/ l performed best followed by

azostrobulin and fenamidon 10% + mancozeb 50% WG. Among other cymoxanil 8% ww + mancozeb 64% ww, metalaxyl 8% + mancozeb 64% @ 2.5g/l, copper oxychloride @ 3.0g/l and tebuconazole 50% + trifloxystrobin 25% were also effective in reducing the disease to considerable extent.

#### 6.2.2.5. Efficacy of oil cakes against zebra disease

All the 5 oil-cakes tested suppressed the zebra disease of sisal in both nursery and sucker stage (Table 6.13). However, neem cake @10.0q/ha was most effective followed by karanj and mahua cake as compared to check (*Source: SLM 1.0; Contributors: A.K. Jha, R.K. De and S. Sarkar*).

**Table 6.13. Efficacy of oil-cakes (@ 10 q/ha) against zebra disease at nursery stage and one year suckers (*A. sisalana*) in field condition**

| Oil-cakes | PDI | |
|---|---|---|
| | Nursery Stage | Sucker Stage |
| Neem | 20.7 (26.9) | 21.3 (27.4) |
| Karanj | 23.3 (28.8) | 24.5 (29.6) |
| Mahua | 30.3 (33.4) | 30.9 (33.7) |
| Linseed | 38.4 (38.3) | 36.2 (36.9) |
| Mustard | 45.6 (42.5) | 41.0 (39.8) |
| Check | 46.6 (43.1) | 44.3 (41.7) |
| CD (P=0.05) | 3.2 | 3.9 |

*Figure in parenthesis are arc sine transformed values*

### 6.2.3. Vascular wilt management in flax

#### 6.2.3.1. Progress of vascular wilt of flax in different dates of sowing

Flax crop was sown in three different dates i.e. 30th Oct. ($D_1$), 15th Nov. ($D_2$) and 30th Nov. ($D_3$) at CRIJAF Research Farm, Barrackpore. The progress of vascular wilt was recorded at 10 days interval starting from 30 days after sowing (DAS) till 70 DAS. The disease incidence was significantly higher in the earliest sown crop ($D_1$-30th Oct.). The progress of the disease gradually increased with crop age (Table 6.14) in all dates of sowing.

**Table 6.14. Progress of vascular wilt of flax in different dates of sowing**

| Date of sowing | Incidence of vascular wilt of flax (%) | | | | |
|---|---|---|---|---|---|
| | 30 DAS | 40 DAS | 50 DAS | 60 DAS | 70 DAS |
| 30 Oct ($D_1$) | 2.4 | 3.6 | 4.8 | 5.9 | 7.7 |
| 15 Nov ($D_2$) | 1.5 | 2.7 | 3.6 | 4.3 | 5.2 |
| 30 Nov ($D_3$) | 0.0 | 1.1 | 2.0 | 2.8 | 3.7 |
| CD (P= 0.05) | 0.53 | 0.52 | 0.62 | 0.59 | 0.63 |

#### 6.2.3.2. Effect of sowing time, fertilizer and fungicides on wilt incidence and seed yield of flax

Date of sowing has significant effect on flax wilt with least incidence of vascular wilt (3.7%) in third date of sowing i.e. 30th Nov. than first date of sowing on 30th Oct. Similarly, significant reduction in disease incidence (7.8%) was recorded in seed treatment with carbendazim @ 0.1% than the control plot. Application of fertilizer registered no significant effect on vascular wilt. The interaction between date of sowing and seed treatment was significant with least incidence of vascular wilt (2.47%) in 30th Nov. sown crop with seed treatment of carbendazim (Table 6.15).

Seed yield of flax showed significant effect of sowing dates. Third date of sowing on 30 November recorded higher seed yield of 5.6 q/ha than $D_1$ (3.2 q/ha) and $D_2$ (3.6 q/ha). Fertilizer application and seed treatment had effect on seed yield (Table 6.16). *(Source: JM 9.1. Contributors: S.K. Sarkar and K. Mandal)*

**Table 6.15. Effect of date of sowing, fertilizer and seed treatment on vascular wilt incidence (%) in flax**

| Treat. | 30 October ($D_1$) | | | | 15 November ($D_2$) | | | | 30 November ($D_3$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPK 40:40:40 | NPK 60:40:60 | NPK 60:40:80 | Mean | NPK 40:40:40 | NPK 60:40:60 | NPK 60:40:80 | Mean | NPK 40:40:40 | NPK 60:40:60 | NPK 60:40:80 | Mean |
| Carbendazim | 5.10 | 5.23 | 5.27 | 5.20 | 3.40 | 3.27 | 3.50 | 3.39 | 2.47 | 2.90 | 2.87 | 2.74 |
| Trichoderma | 6.30 | 6.63 | 6.17 | 6.37 | 4.60 | 4.77 | 4.83 | 4.73 | 3.27 | 3.27 | 3.60 | 3.38 |
| Control | 11.37 | 11.67 | 11.67 | 11.57 | 7.47 | 7.33 | 7.47 | 7.42 | 4.70 | 4.90 | 5.27 | 4.96 |
| Mean | 7.59 | 7.84 | 7.70 | 7.71 | 5.16 | 5.12 | 5.27 | 5.18 | 3.48 | 3.69 | 3.91 | 3.69 |
| Mean | D1 | D2 | D3 | F1 | F2 | F3 | S1 | S2 | S3 | | | |
| | 7.7 | 5.2 | 3.7 | 5.4 | 5.5 | 5.6 | 3.8 | 4.8 | 8.0 | | | |
| CD (P= 0.05) | Main plot effect=0.63 | | | Sub plot effect= NS | | | Sub-sub plot effect= 0.28 | | DxS = 0.74 Other Interactions=NS | | | |

*$F_1$=NPK:: 40: 40:40, $F_2$= NPK:: 60:40: 60, $F_3$= NPK:: 60:40: 80; $S_1$=Carbendazim, $S_2$= Trichoderma, $S_3$= Control*

**Table 6.16. Effect of date of sowing, fertilizer application and seed treatment on seed yield (q/ha) of flax**

| Treat | 30 October ($D_1$) | | | | 15 November ($D_2$) | | | | 30 November ($D_3$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NPK 40:40:40 | NPK 60:40:60 | NPK 60:40:80 | Mean | NPK 40:40:40 | NPK 60:40:60 | NPK 60:40:80 | Mean | NPK 40:40:40 | NPK 60:40:60 | NPK 60:40:80 | Mean |
| Carbendazim | 3.67 | 3.14 | 3.42 | 3.41 | 3.51 | 3.48 | 3.67 | 3.55 | 6.07 | 5.44 | 5.37 | 5.63 |
| Trichoderma | 3.31 | 3.49 | 3.32 | 3.37 | 3.74 | 3.61 | 3.67 | 3.67 | 5.15 | 5.22 | 6.39 | 5.59 |
| Control | 2.80 | 2.82 | 2.86 | 2.83 | 3.74 | 3.59 | 3.41 | 3.58 | 5.63 | 5.85 | 5.56 | 5.68 |
| Mean | 3.26 | 3.15 | 3.20 | 3.20 | 3.66 | 3.56 | 3.58 | 3.60 | 5.62 | 5.51 | 5.77 | 5.63 |
| Mean | D1 | D2 | D3 | F1 | F2 | F3 | S1 | S2 | S3 | | | |
| | 3.2 | 3.6 | 5.6 | 4.2 | 4.1 | 4.2 | 4.2 | 4.2 | 4.0 | | | |
| CD (P= 0.05) | Main plot effect=0.53 | | | Sub plot effect= NS | | | Sub-sub plot effect= NS | | Interactions =NS | | | |

*$F_1$=NPK:: 40: 40:40, $F_2$= NPK:: 60:40: 60, $F_3$= NPK:: 60:40: 80; $S_1$=Carbendazim, $S_2$= Trichoderma, $S_3$= Control*

### 6.2.4. Integrated pest and disease management

#### 6.2.4.1. Development of IPM module for jute in CRIJAF farm

The IPM module based on the components of pest management effective against jute pests and diseases were evaluated in the Institute Farm and farmer's field. IPM module consisting of cultural (sowing in line with 5-6 lakh plants /ha, NPK: 60 (30+15+15):30:30, manual hand weeding once at 21 DAS), chemical (soil application of $Ca(OCl)_2$ @ 30 kg/ha at 7 DBS, seed treatment with (a) carbendazim @ 2g/kg + (b) imidacloprid @ 4g/kg, application of pesticides: spiromecifen @ 1 ml/litre, profenophos @ 2 ml/litre); biological (*Trichoderma viride* @ 10g/kg, soil application of *Pseudomonas fluorescens* @ 100g/m$^2$ before sowing and spraying of neem oil @ 3-4 ml/litre) components were effective against stem rot, yellow mite and other insect pests of jute in the institute farm.

**Table 6.17. Effect of IPM module on major insect pests and diseases of jute**

| | Incidence/infestation (%) | | | | | |
|---|---|---|---|---|---|---|
| Treatments | Stem rot | Mite | Semilooper | HC | Fibre yield (q/ha) | B:C ratio |
| T1-Complete IPM Module | 2.80 (9.63) | 0.87 (5.32) | 0.50 (4.04) | 0.63 (4.54) | 32.93 | 1.77 |
| T2 - T1 without CC | 3.17 (10.24) | 1.90 (7.92) | 0.71 (4.83) | 0.74 (4.88) | 27.84 | 1.58 |
| T3 - T1 without ChC | 3.44 (10.67) | 2.23 (8.58) | 0.89 (5.40) | 0.74 (4.90) | 25.10 | 1.45 |
| T4 - T1 without BC | 4.62 (12.40) | 2.42 (8.94) | 1.29 (6.42) | 0.92 (5.47) | 23.47 | 1.45 |
| T5 - T1 without C&ChC | 5.17 (13.13) | 2.55 (9.12) | 1.66 (7.35) | 1.10 (5.92) | 21.75 | 1.41 |
| T6- T1 without C&BC | 6.33 (14.56) | 3.40 (10.57) | 2.13 (8.32) | 1.36 (6.64) | 20.34 | 1.38 |
| T7 - T1 without Ch&BC | 7.28 (15.63) | 3.70 (11.08) | 2.68 (9.40) | 1.57 (7.16) | 19.18 | 1.34 |
| T8 - Farmers' practice | 21.55 (27.61) | 6.36 (14.60) | 5.19 (13.15) | 5.55 (13.56) | 14.76 | 1.29 |
| CD (P= 0.05) | 1.94 | 1.10 | 1.72 | 1.06 | 1.99 | |

*Figures in the parenthesis are arc sine transformed values, CC- Cultural Components, ChC- Chemical Components, BC- Biological Components.*

Stem rot was reduced to 2.8% in complete IPM module (with cultural, chemical and biological components) compared to 21.55% in farmers' practice. Yellow mite infestation was 0.87% in IPM module (with cultural, chemical and biological components) compared to 6.36% in farmers' practice. Similarly, semilooper and hairy caterpillar (HC) infested plant was 0.50 and 0.63% in complete IPM module compared to 5.19 and 5.55%, respectively, in farmers' practice. Higher fibre yield and benefit cost ratio of 32.9 q/ha and 1.77 respectively were observed in IPM module as compared to 14.7 q/ha and 1.29, respectively, in farmers' practice (Table 6.17). *(Source: JM 9.0; Contributors: R.K. De, V. Ramesh Babu and Shamna A.).*

#### 6.2.4.2. IPM module in farmers' fields

IPM module consisting of cultural (sowing in line with 5-6 lakh plants /ha, NPK: 60 (30+15+15):30:30, manual hand weeding once at 21 DAS); chemical (soil application of $Ca(OCl)_2$ @ 30 kg/ha at 7 DBS, seed treatment with (a) carbendazim @ 2g/kg + (b) imidacloprid @ 4g/kg, application of pesticides: spiromecifen @ 1 ml/litre, profenophos @ 2 ml/litre); biological (*Trichoderma viride* @ 10g/kg, soil application of *Pseudomonas fluorescens* @ 100g/m$^2$ before sowing and spraying of neem oil @ 3 - 4 ml/litre) components were tested in farmers' fields in two different villages, namely, Malikapur and Borgachhia in North 24 Parganas of West Bengal (Table 6.18).

Higher damage of stem rot and insect pests in broadcast crop showed that IPM module was effective. Stem rot was reduced from 29-30% in broadcast crop to 4% in IPM module. Insect pests infestation declined from 15-23% in broadcast crop to 2-8% in IPM module. Farmers got more fibre yield (30-31 q/ha) adopting IPM module compared to 16-17 q/ha in farmers practice. B:C ratio was also more (1.7) in IPM module than farmers practice (1.1). *(Source: JM 9.0; Contributors: R.K. De, V. Ramesh Babu and Shamna A.)*

**Table 6.18. Pest incidence, fibre yield and B:C ratio in broadcast and line sown jute crop in farmers field**

| Pests | Location: Village Malikapur | | Location: Village Borgachhia | |
|---|---|---|---|---|
| | Line sown | Broadcast | Line sown | Broadcast |
| Apion (%) | 8.60 | 19.80 | 6.80 | 15.60 |
| HC (%) | 8.20 | 17.60 | 7.40 | 16.80 |
| Yellow mite (%) | 5.80 | 24.00 | 4.80 | 18.40 |
| Semilooper (%) | 3.40 | 17.60 | 2.40 | 23.80 |
| Stem rot (%) | 4.80 | 30.20 | 4.60 | 29.20 |
| Fibre yield (q/ha) | 30.49 | 17.10 | 31.16 | 16.34 |
| B:C ratio | 1.71 | 1.14 | 1.74 | 1.11 |

### 6.2.4.3. Effect of seed treatment on jute seedlings

In pot experiment, tebuconazole and propiconazole seed treatment affected the germination process adversely and reduced seedling stand. Both seedling stand and vigour increased by seed treatment with carbendazim + imidacloprid more than tebuconazole + imidacloprid. Insect damage and stem rot also decreased by combined seed treatment with carbendazim + imidaclorprid followed by tebuconazole + imidacloprid compared to both check or sole seed treatment with either fungicide or insecticides.

## 6.3. Weed Management

### 6.3.1. Development of low cost and eco-friendly Integrated Weed Management technology for Jute

A field experiment was conducted at ICAR-CRIJAF with 11 different weed management treatments. Jute (cv. NJ 7010) and green gram (cv. TMB 37 and cv. Sukumar) was intercropped at 1: 1 ratio. Jute and green gram was also sown as mixed crop (green gram plant population- 60,000/ha). Jute seedlings around green gram plants (20 cm diameter) were uprooted for its proper growth. Fertilizer dose for jute as sole crop was N:P:K:: 60:30:30 kg/ha and for intercropping it was N:P:K:: 80:70:70 kg/ha.

***New pre- and post-emergence herbicides for jute:*** Ipfencarbazone (PE: 68.43 to 114 g ai/ha) has no harmful effect on jute germination and did not registered any phytotoxicity on jute seedlings sown under different moisture regimes i.e., rainfed, field capacity and irrigated condition. It did not hamper jute germination when sown by semi-mechanized (CRIJAF Multi Row Seed Drill) or by broadcast method followed by irrigation. It reduced the weed biomass by 60 to 71%, grass weed population by 80 to 82%, broadleaved weed population by 65 to 75% and sedge weed population by 15-26% over manual weeding twice. Using ipfencarbazone, the jute fibre yield varied from 24-28 q/ha and these were at par with manual weeding twice (23.69 q/ha). Haloxofop R methyl 10.5 EC (POE) controlled more than 95% grassy weeds in jute field when applied at 15 DAS @ 94.5 to 126 g/ha without any phytotoxicity on jute (Table 6.19).

**Table 6.19. Jute fibre yield under weed management practices in jute-rice-pulse/oilseeds sequences**

| Treatments | Fibre yield and intercrop yield (q/ ha) | Rice yield (q/ha) | Paira crop yield in sequence (q/ha) |
|---|---|---|---|
| **T1**: Jute + Green gram (TMB 37) Intercropping + Pretilachlor 50EC @ 0.9 l/ha+1HW -Rice- Bottle gourd (gunny bag columns) + Spinach (Zero till paira) | 23.58 (9.39) | 61.99 | 37.5 |
| **T2**: Jute + Green gram (TMB 37) Mixed cropping + Pretilachlor 50EC @ 0.9 l/ha +1HW –Rice-Rajmah | 29.37 (5.6) | 63.42 | 5.47 |
| **T3**: Jute+ Green gram (Sukumar) + Pretilachlor 50EC @ 0.9 l/ha+1HW-Rice | 24.92 (8.2) | 62.01 | -- |
| **T4** : Ipfencarbazone@ 68.43 g/ ha+1HW-Rice – lentil ( zero till paira crop) | 24.17 | 62.18 | 14.85 |
| **T5:** Jute + Spinach (mixed) Ipfencarbazone @ 91.24 g/ha +1HW- mustard (zero till paira crop) | 28.57(14.3) | 59.58 | 10.62 |
| T6:Ipfencarbazone@ 114g/ ha+1HW- Rice | 26.46 | 58.88 | -- |
| **T7**: CRIJAF Nail Weeder (7DAS) + Scrapper (15DAS) +1HW –Rice- Pea (Zero till) | 28.01 | 60.51 | 27.12 |
| **T8:** Two manual weeding-Rice-Lathyrus (zero till paira crop) | 23.69 | 61.17 | 15.60 |
| **T9:** High density broadcast jute sowing (6.75 kg/ha) for weed smothering (no weeding and thinning) | 25.3 | 60.96 | -- |
| **T10 :** Haloxofop R methyl 10.5 % W/W EC @ 94.5 g +1HW+ Rice – Lathyrus (ploughed) | 28.99 | 53.64 | 12.5 |
| **T11:** Control – rice - fallow | 20.67 | 61.98 | -- |
| CD (P=0.05) | 5.65 | 10.76 | |

*Figures in the parentheses are inter-crop yield*

***Microbial population as affected by different doses of Ipfencarbazone after jute harvest:*** The data on FDHA (Fluroscein diacetate hydrolyzing activity), total bacteria, *Azospirillum*, Phosphorus Solubilizing Bacteria and Azotobactor population of jute soil after its harvest indicated that microbial activity was not affected adversely due to application of pre-emergence herbicide, Ipfencarbazone at different doses i.e. 68.43 to 114 g ai/ha in jute plot over control.

***Weed smothering in jute by intercropping green gram:*** Incident solar radiation at the base of green gram + jute canopies were reduced by more than 90% at 55 DAS (12$^{th}$ March). Weed biomass was 76% lower than manual weeding (25 DAS). Due to additional pre-monsoon rainfall during April and May (281 mm), green gram

yield (TMB-37, matured at 60 DAS) as intercrop was 9.35 q /ha and as mixed crop it was 5.6 q/ha and jute yields were 23.58 and 29.4 q, respectively. The green gram yield of cv. Sukumar (small grain variety) was 8.20 q/ha and the fibre yield was 24.90 q/ha.

***Weed smothering in jute by its high density sowing:*** High density broadcast jute (6.75 kg/ha, usual farmers dose) reduced the incident light at base up to 94% (41 DAS) and also reduced the grass, broadleaf, sedges weed population, and weed biomass by 98, 98.5, 64.5, 91.65%, respectively over manual weeding. Out of 20.7 lakh jute plants/ha (41 DAS), only 3.3 lakhs/ha i.e., 16% of the total population (rest jute plants were self thinned) could be harvested at 135 DAS with total yield of 25.3 q/ha (Fig. 6.12).

**Fig. 6.12.** High density jute sowing for weeds smothering (41 DAS)

***Crop yield in sequences:*** In paira crop, weed management was successful using Pretilachlor 50EC @ 0.9 kg/ha (10 DAS) after harvest of rice. In jute-rice-vegetables/pulses/oilseeds sequence, rice yield varied from 55 to 63 q/ha, zero till paira mustard produced 10.62 q mustard/ha, 15.6 q Lathyrus/ha, field pea 27 q/ha and 14.85 q lentil yield/ha. Yield of rajmah in minimum till situation was 5.7 q/ha.

### 6.3.2. Field level demonstration on jute and green gram intercropping

Jute and green gram intercropping was also done in Farmer's field in collaboration with Department of Agriculture, Govt. of West Bengal in different districts like, North 24 Pgs, Nadia, Murshidabad, Dakhsin Dinajpur and West Midnapur. Under high rainfall (near 500 mm including hail storm) during April and May, the jute fibre yield was in between 22 and 32 q/ha, whereas green gram yield varied from 2.6 to 4.5q/ha as intercrop. In mixed cropping system, maximum green gram yield was up to 6.6 q/ha along with jute fibre yield of 30 q/ha. *(Source: CPDN1 JA-7.3 Contributors: A.K. Ghorai, Mukesh Kumar, Suman Roy and Bijan Majumdar)*

## 6.4. Drought Management

### 6.4.1. Physiological response of jute plants under drought conditions

Jute plants were subjected to drought stress at 10 DAS, 20 DAS and 30 DAS by withholding irrigation. The critical drought period for jute seedlings at 10 DAS, 20 DAS and 30 DAS were observed to be 7, 8 and 9 days, respectively from the day of withholding irrigation. The soil moisture content (SMC) for drought was maintained at 7.6%-9.6% (average 8.6%). At this SMC, the relative water content of young leaves ranged from 53.6%-60.9% (average 57.25%). Plant height, leaf number, chlorophyll content, carotenoid and membrane stability of the plants were severely reduced under stress. However, plants sprayed with ascorbic acid showed increased plant height, leaf number, chlorophyll content, carotenoid content and membrane stability. Leaf number and plant height seemed to be more affected at 10 DAS of drought imposition whereas the membrane stability, chlorophyll and carotenoid content were affected equally at all the stages. The loss in leaf number may be attributed to both leaf shedding as well as non-emergence of new leaves under drought. Moreover, the effect of exogenous ascorbic acid in maintaining the plant height and leaf number was more at 10 DAS (Fig. 6.13 and 6.14). Early onset of drought especially at 10 DAS reduces the plant height and leaf number which may be an important cause of yield loss. *(Source: JA 7.4; Contributors: L. Sharma, J. Mitra, S. Mitra, P. Satya, D. Barman and S. Roy)*

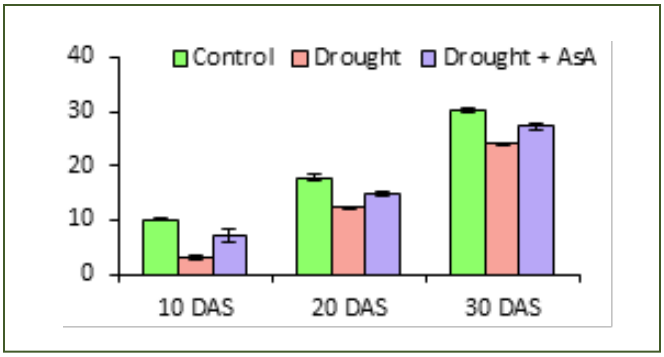



**Fig. 6.13.** Plant height of jute seedlings under drought with exogenous ascorbic acid

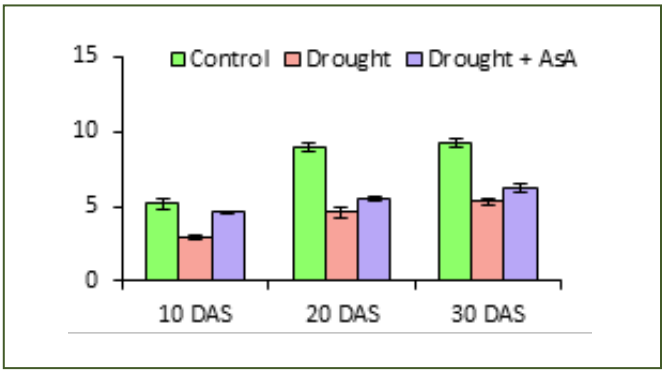



**Fig. 6.14.** Leaf number of jute seedlings under drought with exogenous ascorbic acid

# 7. Farm Mechanization and Post-Harvest Technology

## 7.1. Farm Mechanization

### 7.1.1. Modification of multi-crop seed drill (Manual Operated) for enhancing field capacity

To facilitate the visibility of seed inside the seed box, the conical frustum shaped seed box was fabricated with transparent, weather resistant and light weight material (Fig. 7.1). Seed dispensing holes (12 nos.) are present on the larger diameter of conical seed box. Seed from the box drops directly on the furrow through seed dispensing holes during movement of the machine. The hoe type furrow openers made of m.s. rod are fixed on a bar just ahead of seed box shaft. The machine consists of two ground wheels of 304.8 mm diameter fabricated with m.s. flat. To avoid slippage of machine on the tilled soil 12 nos. of pegs are fixed on the periphery of the ground wheel. For reducing drudgery of the operator, the handle of machine is made compacted and adjustable according to the height of operator. The overall dimension of the machine is 1046 mm x 1000 mm x 1000 mm (L x W x H) and weight is 14 kg. The evaluation of machine in field condition showed field capacity of 0.2 ha/h with depth of seed placement of 10 to 25 mm (Fig. 7.1). The draft requirement of machine during the operation was found to be 12.6 kgf. *(Source: JAE-3.4, Contributors: R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha)*

**Fig.7.1.** Manual operated multi-crop seeder

### 7.1.2 Redesign of multi-crop seed drill (Power Operated) for higher field capacity

Based on the findings of field testing of 6-row power operated seed drill, the machine was re-designed. The main parts of the machine are frame/tool bar, seed hopper, depth control wheel, ground wheel, metering mechanism, furrow openers, seed covering device. For smooth operation of machine near bund of the field, the machine has been fabricated with 5 numbers of rows. The width of the machine is same as power tiller width. The furrow openers are fitted in two bars of the machine frame i.e. two on the front bar and 3 on rear bar for better stability. The trapezoidal shaped seed hopper is made of steel sheet and fixed on the frame. The ground wheel fitted on front side of machine transmits power to the metering shaft through chain and sprocket drive. Chains attached behind the furrow opener acts as ladder. Two rubber wheels is provided for controlling depth of operation and easy transportation. *(Source: JAE-3.4, Contributors: R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha)*

### 7.1.3 Modification of scraper unit of CRIJAF single wheel jute weeder

For improving the efficiency of CRIJAF single wheel jute weeder in different soil conditions, the scraper unit of manually operated push and pull type "CRIJAF Single Wheel Jute Weeder" has been modified (Fig. 7.2). The soil working unit of scraper has been designed as semi-arc shaped for better coverage and easy movement in the soil during weeding operation. The scraping unit is made of hardened m.s. flat of 2.5 cm width with sharpened edge in the front for smooth cutting of grasses. The beam of scraper is made of m.s. square bar and having length of 16 cm. Two holes are engraved on the upper part of the beam for fixing tightly on the tool frame of weeder. *(Source: JAE-3.4, Contributors: R.K. Naik, A.K. Ghorai, S. Sarkar and S.K. Jha)*

**Fig.7.2.** CRIJAF Single Wheel Jute Weeder with modified scraper unit

### 7.1.4 Development of prototype model flax fibre extractor with higher capacity

The capacity of the previously designed flax fibre extractor was very low (5-6 kg fibre/h) to cater more quantity of flax straw in a short period of time for commercial production of flax fibre. Hence, design drawing has been evolved to develop a high capacity flax fibre extractor (Fig. 7.3). The flax straw movement in the machine will be horizontal with provision of straw feeding and fibre outlet platform. The machine will consists of six numbers of scutching points with provision of feeding roller and fibre guiding roller. There will be fourteen nylon rollers having longitudinal grooves and to be driven with the help of spring loaded pinions. The upper and lower scutching roller will move in opposite direction for forward movement of straw. The machine will be powered by 3 hp electric motor. Two operators will operate the machine, one for feeding the straw and other for collection of scutched fibre. *(Source: JAE-3.5; Contributors: R.K. Naik and S. Mitra)*

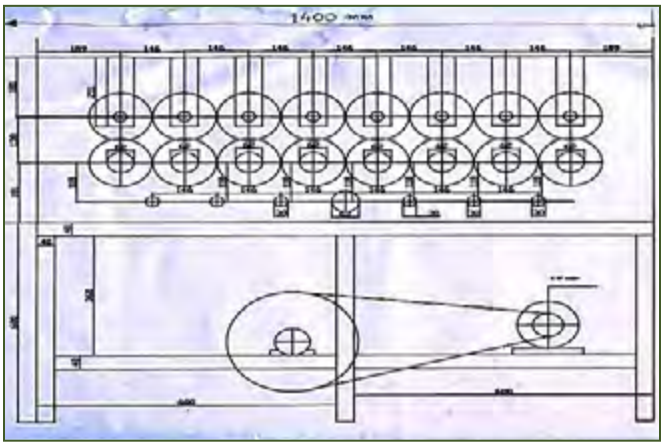


**Fig.7.3.** Design drawing of machine

## 7.2. Post-Harvest Technologies

### 7.2.1. Studies on ribbon retting methods for quality fibre production in jute and mesta

An experimental model of power operated jute ribboner machine has been developed (Fig. 7.4). The machine extracts ribbons from the freshly harvested jute plants without breaking the sticks. The machine is powered by single phase 3 hp electric motor. The machine consists of two sets of stick breaker-cum-ribbon pulling units placed one above the other and consists of 8 numbers of toothed nylon rollers revolving opposite to each other at high speed through toothed pinions. Two operators can work simultaneously at a time for extraction of ribbon. Five to six jute plants can be fed in one set of breaker unit, there by 10-12 plants can be extracted at a time by two operators. The principle involves feeding of jute plants by butt end in between the upper breaking rollers, which crush the stick (about 5 cm) and then pulling of ribbon by the lower rollers at high speed and placing the ribbon on conveyor belt for delivery in front of the machine. The sticks of the extracted plants are ejected intact from the upper tray of the machine. *(Source: JA-5.8. Contributors: R.K. Naik, B. Majumdar, S.P. Mazumdar and M.S. Behera)*

**Fig. 7.4.** Experimental model of power operated jute ribboner machine

### 7.2.2. Development and validation of liquid formulation of microbial consortium for jute retting

With the objective to develop and validate liquid formulation of existing microbial consortium for increasing its shelf-life and improved retting of jute, endospores of the three different strains of *Bacillus pumilus* were produced by using sporulation broth (pH 7.6) medium. Bacterial growth was monitored by optical density measurements at 600 nm, using UV-visible spectrophotometer and sporulation was checked by a phase contrast microscope. Endospores were harvested on accounting for at least 90% of total population (generally on the 4$^{th}$ day), and stored at 4°C in sterile distilled water. The viability of endospores and vegetative cells of *B. pumilus* were tested at different temperature, pH, UV radiation and antibiotics. Endospores of *B. pumilus* recorded very high colony forming unit ($10^9$ to $10^8$ /ml) compared to their vegetative cells ($10^6$ to $10^4$ /ml) after 6 to 18 months of their preservation. Endospores also showed higher resistance to temperature, pH, UV radiation and antibiotic than their vegetative forms (Table 7.1.). In laboratory scale study, with 6-month-old endospores and talc based formulation, the retting of jute was completed in 10 days with endospores, whereas the retting of jute was accomplished in 15 days with talc based formulation. The fibre recovery was also higher in case of endospores than talc based formulation. The fibre strength was very high in case of endospore (27.8 g/tex) which was 10.75% higher over talc based formulation (25.11 g/tex). *(Source: JA 7.7; Contributors: B. Majumdar, S. P. Mazumdar, D. Saha, S. Datta, S. Sarkar and S. K. Jha)*

**Table 7.1. Effect of pH, temperature, UV radiation and antibiotics on endospores and vegetative cells of *B. pumilus***

| Treatment | Samples | | | | | |
|---|---|---|---|---|---|---|
| | MTCC 5573 | MTCC 5574 | MTCC 5575 | MTCC 5573 spore | MTCC 5574 spore | MTCC 5575 spore |
| **pH** | | | | | | |
| pH 3 | 0 | 0 | 0 | >300 | >300 | >300 |
| pH 8 | >300 | >300 | >300 | Lawn | Lawn | Lawn |
| pH 10 | 147 ± 6 | 152 ± 5 | 159 ± 8 | Lawn | Lawn | Lawn |
| pH 12 | 0 | 0 | 0 | >300 | >300 | >300 |
| **Temperature** | | | | | | |
| $60^0$ C | TNTC* | TNTC | TNTC | Lawn | Lawn | Lawn |
| $80^0$ C | 145 ± 6.06 | 152 ± 2.58 | 137 ± 4.69 | Lawn | Lawn | Lawn |
| $100^0$ C | 25 ± 1.83 | 21 ± 1.41 | 18 ± 2.58 | >300 | >300 | >300 |
| **Time of exposure** | | | | | | |
| 10 min | 247 ± 5.35 | 238 ± 6.22 | 256 ± 5.48 | TNTC | TNTC | TNTC |
| 15 min | 192 ± 7.83 | 173 ± 5.83 | 212 ± 6.98 | >300 | >300 | >300 |
| 20 min | 18 ± 6.48 | 17 ± 5.6 | 15 ± 4.69 | 272 ± 11.22 | 259 ±10.49 | 282 ± 7.61 |
| **Antibiotics (MIC µg/ml)** | | | | | | |
| Ampicillin | 2 | 2 | 8 | Growth was up to 240 µg/ml | | |
| Amoxycillin | 0.01 | 30 | 0.01 | | | |
| Tetracycline | 0.01 | 0.1 | 10 | | | |
| Streptomycin | 10 | 60 | 30 | | | |

*Values are mean of replicate ± SD; TNTC= Too numerous to count, MIC = Minimum inhibitory concentration*

# 8. Jute and Allied Fibre Informatics

## 8.1. JuteMet - A Web-based Agro-meteorological Database Management System-cum-Agroadvisory System for Jute Production

An integrated web-based agro-meteorological database management system-cum-agro-advisory system named as JuteMet was developed to address the climate related jute production

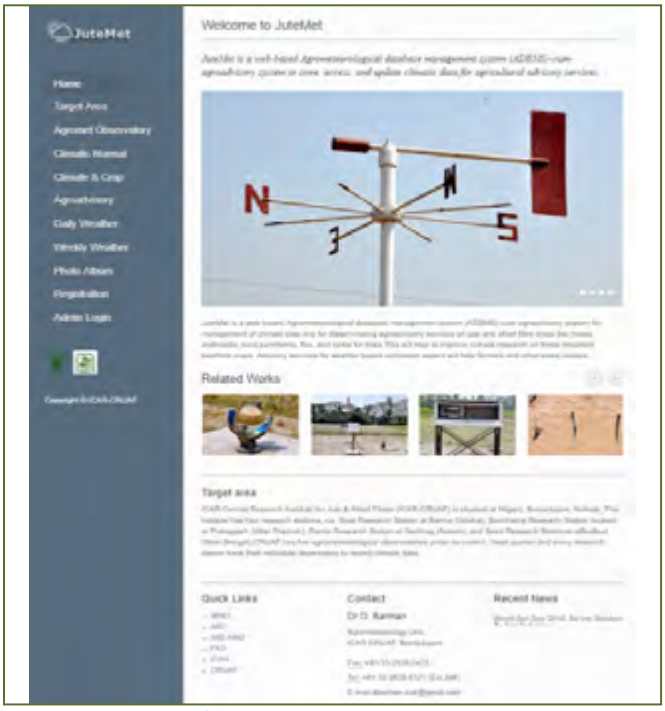



**Fig. 8.1.** Homepage of the JuteMet

constraints. The agro-advisory module embedded in JuteMet (Fig. 8.1) is operated in client-server web-based interactive mode for site specific climate related advisories. JuteMet is developed using ASP.NET(C#) and SQL Server 12.0 for database management. The web pages are designed and configured with texts, figures, maps, and images to make it user-friendly and easily understandable to its end users including farmers. This DBMS-cum-agro advisory system has been developed in .NET environment scripting in C++/Java/html language. This increases the virtual proximity between the scientists and farmers as well as the interaction between them to meet the timely climatic needs in jute production. *(Source: JA 7.1, Contributors: D. Barman, A. K. Chakraborty, A. K. Singh, and R. Saha)*

## 8.2. Assessment of Vulnerability of Jute Production to Climate Change in West Bengal

### 8.2.1. Spatial and temporal trend analysis of rainfall in West Bengal

Rainfall trend in major jute growing districts of West Bengal were evaluated through Mann-Kendall test based on 102-year (1901 -2002) monthly, seasonal (pre-*kharif* and *kharif*) and annual time scale data base. March-rainfall (Fig. 8.2) was in decreasing trend but April rainfall was in increasing trend in all the jute growing districts of West Bengal. May-rainfall (Fig. 8.3) was in increasing trend in

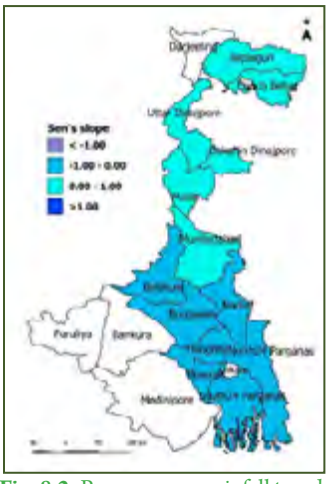



**Fig. 8.2.** Pre-monsoon rainfall trend

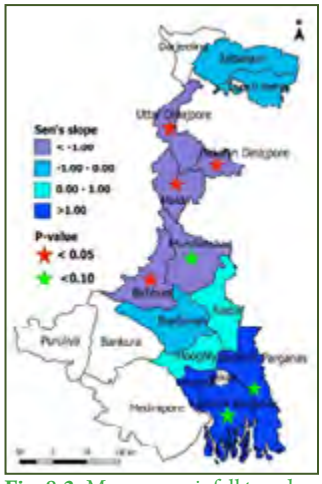



**Fig. 8.3.** Monsoon rainfall trend

entire northern part (Cooch Behar, Jalpaiguri, Uttar Dinajpur, Dakshin Dinajpur and Malda and Murshidabad) district of West Bengal, whereas it was in decreasing trend in the entire southern part of West Bengal (Birbhum, Burdwan, Hooghly, Howrah, Nadia, North 24-Parganas, South 24-Parganas). *Kharif*-rainfall was in decreasing trend in Birbhum (-1.61 mm/yr), Dakshin Dinajpur (-1.63 mm/yr), Malda (-2.04 mm/yr) and Uttar Dinajpur (-1.74 mm/yr). In Murshidabad, the rate of decrease in rainfall trend was -1.14 mm/yr and was significant. Whereas, annual rainfall has significantly increased in North 24-Parganas and South 24-Parganas and the Sen's slope values were about 2 mm /yr. *(Source: DST-West Bengal sponsored Project; Contributors: D. Barman, A.K. Chakraborty, A.K. Singh and R. Saha)*

### 8.2.2. Drought vulnerability mapping using GIS

Jute is prone to drought in its early growth period. In the present study, the simple drought index, standardized precipitation index (SPI) was used in detection and estimation of drought severity. Time series district wise monthly rainfall data of 100 years (1901-2000) collected from IMD, Pune, were used to derive SPI in 3 monthly (March to May) and 6 monthly (March to August) time scales to estimate the severity of drought in spatio-temporal scale in the jute growing districts of West Bengal. The drought severity classifications of FAO based on SPI, *viz.* moderately drought (SPI: -1.00 to -1.49), severely drought (-1.50 to -1.99), and extremely drought (<-2.0) was followed, and its frequency of occurrence was used in vulnerability mapping. Higher the frequency of drought means the higher vulnerability, and the reverse is also true. The frequency of the sum of all three-drought severity was used in classification as highly vulnerable (frequency >16), moderately vulnerable (14-16) and less vulnerable (<14).

Frequency distribution of 100-year SPI-3 of May and SPI-6 of August months revealed that highest number total frequency (>16

times) of moderate, severe and extreme drought was observed in the districts of Bankura, Cooch Behar, Howrah and Nadia, and therefore these districts were classified as highly vulnerable to drought (Fig. 8.4. & Fig. 8.5.). Moderately vulnerable districts

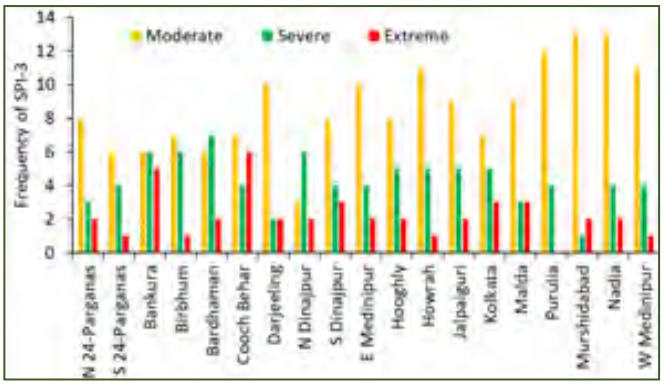



**Fig. 8.4.** Distribution of frequency of SPI-3 (May) in the districts of West Bengal

are Birbhum, Burdwan, Hooghly, Malda, South Dinajpur, East Medinipur, Jalpaiguri, Murshidabad and West Medinipur, and less

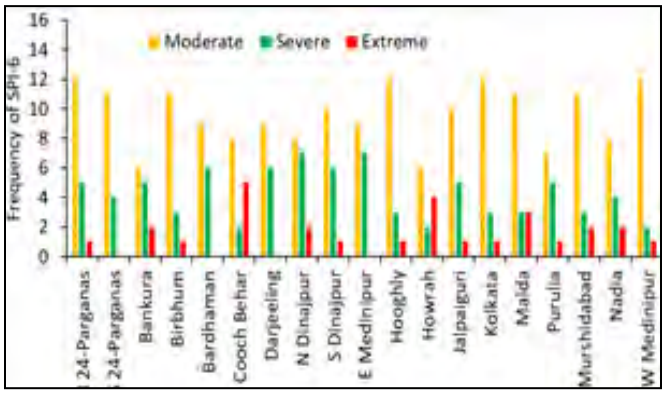



**Fig. 8.5.** Distribution of frequency SPI-6 (August) in the districts of West Bengal

vulnerable districts are Cooch Behar, Hooghly, Nadia and Bankura. Scrutiny of long-term climatic data showed that rainfall has reduced to the tune of 40-50% in the time of jute sowing. Therefore, jute in its early growth period is exposed to drought. *(Source: DST-West Bengal sponsored Project. Contributors: D. Barman and R. Saha)*

## 8.3. Forecasting Area and Production of Jute in India using Stochastic Model

In India, area under jute and fibre yield had moved up and down in alternate years till late 90's. This has been possible mainly due to technological advancement. Using different forecasting models (ANN, ARIMA etc), an attempt is made to understand the dynamics of area and production of jute in India and its future trend till the year 2030 (Fig. 8.6). ARIMA is found to be the best model fulfilling both model fitting and validation criteria. ARIMA model is one of the most widely used stochastic time series model. A stationary ARIMA $(p, d, q)$ is defined by the equation:

$$y_t=\phi_1 y_{t-1}+\phi_2 y_{t-2}+\ldots+\phi_p y_{t-p}-\theta_1 \varepsilon_{t-1}+\theta_2 \varepsilon_{t-2}+\ldots+\theta_q \varepsilon_{t-q}+\varepsilon_t$$

Where, $\varepsilon_t$ is error associated with $t^{th}$ year observation $(y_t)$, $t = 1, 2, \ldots, n$, $\phi_i$ is $i^{th}$ auto-regressive co-efficient, $\theta_j$ is $j^{th}$ moving average coefficient, $p$ is the order of the autoregressive model, $d$ is the degree of differencing, and $q$ is the order of the moving-average model. A model with low Akaike Information Criteria (AIC), Schwarz-Bayesian Information Criteria (SBC) and mean absolute percentage error (MAPE) is considered the best-fit ARIMA model. For jute area and production, ARIMA (1, 1, 2) and ARIMA (0, 1, 2) came out to be the best model, respectively (Table 8.1).

**Table 8.1.:** Best selected ARIMA model based on minimum AIC and SBC criteria

| SPI Series | Model | AIC | SBC | MAPE |
|---|---|---|---|---|
| Jute area | ARIMA (1,1,2) | 1096.41 | 1102.93 | 12.92 |
| Jute production | ARIMA (0, 1, 2) | 793.99 | 802.69 | 10.45 |

ARIMA model predicted that by the year 2030, national area and production will be around 6.8 lac ha and 125 lac bale, respectively. Thereby, with 3% reduction in area, 20% increase in jute fibre production needs to be achieved with productivity of 32.94 q/ha. *(Contributors: N.M. Alam and A.K. Chakbraborty)*

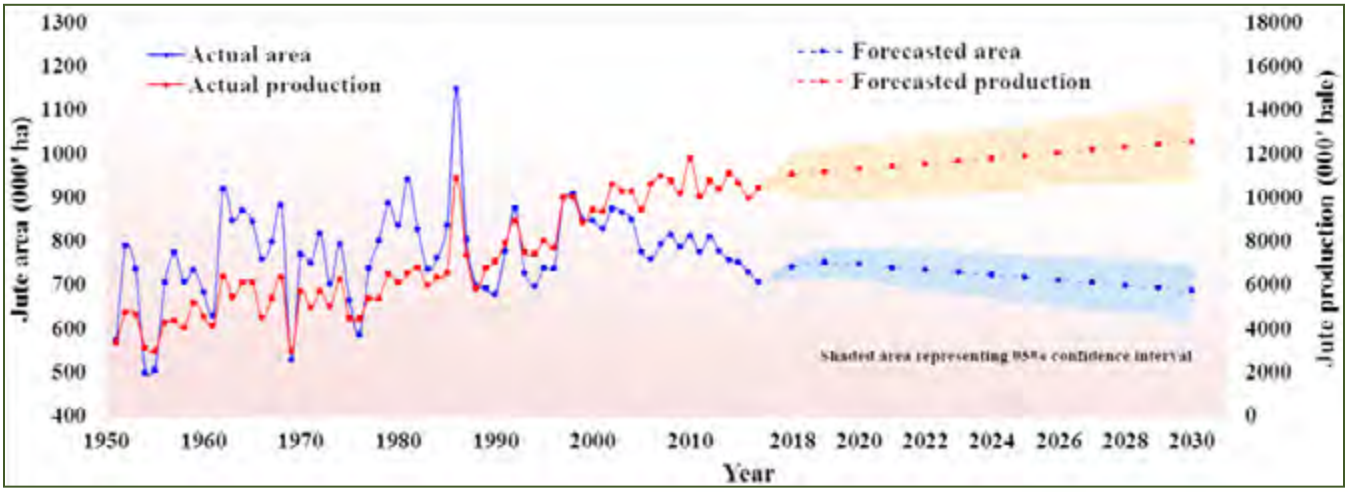



**Fig. 8.6.** Actual and forecasted area and production of jute in India

### 8.4. Updated version of JuteMarkerdb

Previously published 'JuteMarkerdb' was updated as 'JuteMarkerdb v.2.0' to include new and novel molecular markers besides the 2,079 EST-SSR markers (Fig. 8.7). The new set of molecular markers added in the database involve 6,037 Intron-linked polymorphic (ILP) markers and 6,085 candidate polymorphic SSR markers compared among two published *C. olitorius* (O-4 and JRO-524) and one *C. capsularis* (CVL-1) genomes. Transposable elements (TE), such as Long Terminal Repeats (LTRs) elements (e.g. gypsy, copia) and Miniature Inverted-repeat Transposable Elements (MITE) (e.g. Mutator, Harbinger, hAT, Tc1/Mariner etc.) constitute a large proportion of the plant genomes and also serve as important resource for TE-derived molecular markers. From each of the three published jute genomes, more than 850 LTRs and >340 MITEs were identified. These TE sequences and TE-derived molecular markers like repeat junction marker (RJM), repeat junction junction marker (RJJM), insertion site-based polymorphism (ISBP), retrotransposon-based insertion polymorphism (RBIP), and inter retrotransposon amplified polymorphism (IRAP) primers were included. The jute genomes were also mined to identify the 4,147 long non-coding RNA sequences, which have been included in the updated database. In order to perform database users a homology search of jute sequences, a local BLAST tool is being integrated to perform search against the jute and *T. cacao* nucleotide databases. (*Source: JBT 4.4, Contributors: D. N. Saha, S. Datta and A. K. Chakraborty)*

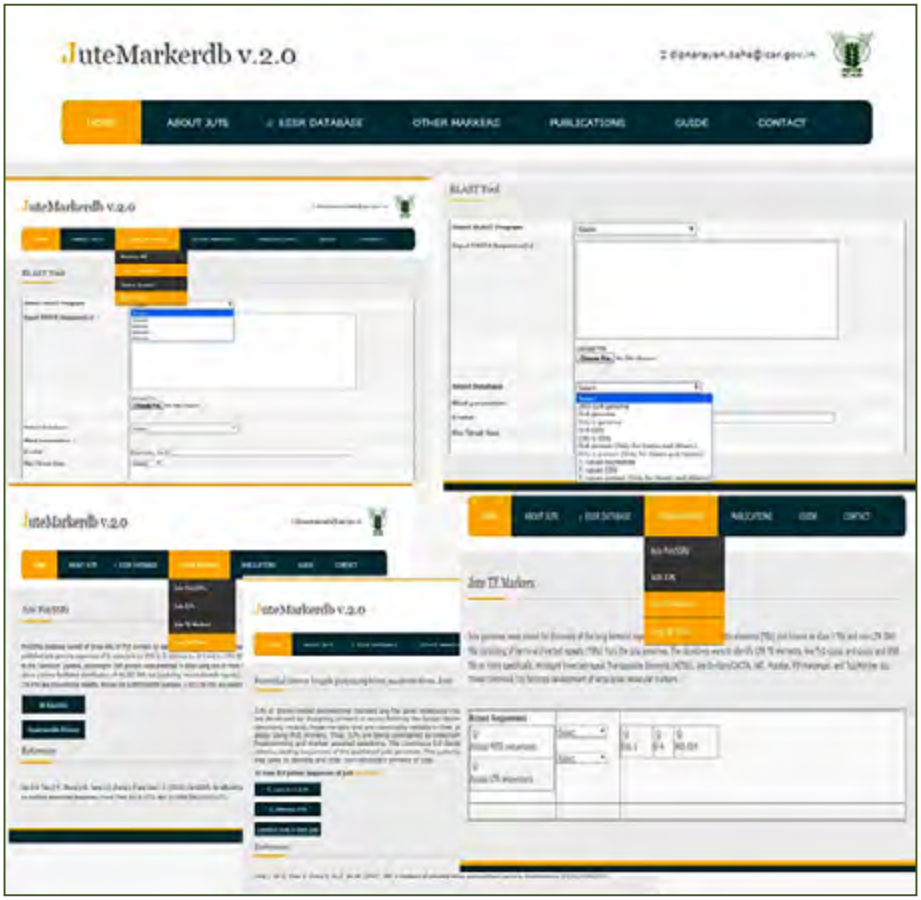



**Fig. 8.7.** Different screenshots of updated JuteMarkerdb

# 9. Technology Assessment and Transfer

## 9.1. Research

### 9.1.1. Improving resource use efficiency in jute to ensure better productivity and economic benefits to the farmers

A study was conducted in jute growing areas of West Bengal to explore the resource use efficiency for economic benefits of selected climate smart practices to marginal landholder, SC farmers. Integrated crop management (ICM) practices as part of climate smart jute farming (CSJF) were followed by 170 randomly selected farmers in six villages. An estimation of cost of adoption, change in fibre yields, net returns and human development index (HDI) before and after ICM interventions was done. The mean HDI value was increased by 38.85% and farm income by 31.5 %. The net benefits of adaptation to climate smart jute technologies were estimated based on specific adaptation actions. Empirical scientific evidence of the study indicates that the livelihoods of marginal landholders can be improved using new crop varieties, changing planting dates and bringing necessary changes in other variable inputs for line sowing, intercropping, weeding, nutrients, irrigation and retting. *(Source: DST-NRDMS Project; Contributors: A.K. Singh, S.K. Jha, B. Majumdar and A.K. Ghorai)*

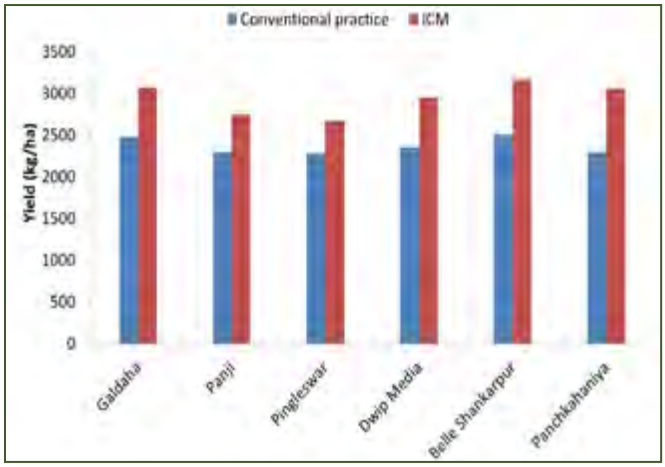



**Fig 9.1.** Production of jute fibre in conventional and ICM practices in different villages of West Bengal

### 9.1.2. Farmers' perception about effect of climate change on jute cultivation

A study was conducted on farmers' perception on effect of climate change on jute cultivation in North 24 Parganas and Hooghly districts of West Bengal. The mean age of the respondents was 43 years and educational qualifications ranged from primary to post-graduate. The average area under jute cultivation was 0.4 ha with farming experience of 17 years. The average no. of trainings they attended in ICAR-CRIJAF was 6. The following observations (Table 9.1) were indicated by farmers (N=50) on effect of climate change on jute cultivation. *(Source: JEXA 5.8; Contributors: M.L. Roy, S.K. Jha, S. Sarkar, A.K. Ghorai, A.K. Singh, S. Satpathy and A. Chakraborty)*

**Table 9.1: Farmers' perception on effect of climate change on jute cultivation (N=50)**

| Effect of climate change on jute cultivation | Frequency | Rank |
|---|---|---|
| Hail storm and heavy rainfall after sowing and before harvesting are causing soil compaction, leaching of soil nutrients, reducing of soil fertility, water logging, root initiation from lower portion causing poor fibre production. | 43 | I |
| Severe drought condition before and after sowing is hampering seed germination and growth of the plant. The plant dries up and its stem becomes thin. | 37 | II |
| Insect-disease and weed infestation become higher due to prolonged hot and humid weather. | 27 | III |
| Uncertainty of rain, absence of suitable temperature and drying of natural water bodies delaying the sowing, harvesting and harvesting of jute. | 25 | IV |
| The cost of cultivation of jute is being increased due to more investment of farm input, labour and time to manage the crop against adverse effect of climate change. | 22 | V |
| Bad colour and quality of fibre is being produced due to forced retting of jute in limited water availability in existing water bodies. | 17 | VI |
| Incidences of pre-flowering are being occurred in jute plants due to prevalent low temperature after sowing. | 18 | VII |
| Death of beneficial insects due to extreme high temperature | 14 | VIII |

## 9.2. Frontline Demonstrations (FLDs)

Frontline demonstration on latest high yielding varieties and other improved production technologies of jute was conducted in villages of Nadia, North 24 Parganas, Hooghly and Purba Bardhaman districts of West Bengal through the extension centres of the institute and Krishi Vigyan Kendra, Purba Bardhaman under National Food Security Mission (NFSM) for Commercial Crops (Jute) sponsored by Ministry of Agril. & Farmers' Welfare, Govt. of India. Altogether, 470 demonstrations on improved production technologies of jute were conducted in 225.70 ha covering four districts (Table 9.2).

**Table 9.2. Area ('ha) under FLDs on improved production technologies of jute**

| Name of village | No. of farmers | Area (ha) | | | |
|---|---|---|---|---|---|
| | | Improved varieties | Multi-row seed drill | Mechanical weed control | Total |
| Brahmapur (Nadia) | 91 | 25.80 | 15.50 | 10.30 | 51.60 |
| Kumra (North 24 Parganas) | 71 | 34.00 | 20.53 | 13.47 | 68.00 |
| Madhusudanpur (Hooghly) | 90 | 23.70 | 14.35 | 9.35 | 47.40 |
| Dhobapara, Balagarh (Hooghly) | 100 | 20.00 | - | - | 20.00 |
| Gopalpur, Hanskhali (Nadia) | 33 | 14.00 | - | - | 14.00 |
| Purbasthali-I & Kalna-I (Purba Bardhaman) | 85 | 20.90 | 1.70 | 2.10 | 24.70 |
| **Total** | 470 | 138.4 | 52.08 | 35.22 | 225.70 |

** All the farmers followed CRIJAF Sona – mediated retting*

### 9.2.1. Weed management through mechanical method

In order to reduce the cost of weeding and increase profitability of jute cultivation, the demonstrations on mechanical weeding by nail weeder were conducted in the farmer's field (33.12 ha) in three districts of West Bengal (Table 9.3). Demonstration on weed management through nail weeder resulted in 3.15-4.03 q/ha fibre yield gain over farmers' practice (30.23-30.60 q/ha). Saving on cost of labour was Rs.12, 914 to 14,167/ha. Net return by the farmers of North 24 Parganas was Rs. 36,735/ha followed by Hooghly (Rs. 32, 294/ha) and Nadia (Rs. 32,163/ha).

**Table 9.3. Economics of jute cultivation through mechanical method of weeding**

| Location/ Particulars | IC (Rs./ha) | LC (Rs./ha) | CC (Rs./ha) | Yield (q/ha) | GR (Rs./ha) | NR (Rs./ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| Brahmapur (Nadia) | | | | | | | |
| NW | 9385 | 64599 | 73985 | 33.75 | 164710 | 90725 | 2.23 |
| FP | 12200 | 77513 | 89713 | 30.60 | 148275 | 58562 | 1.65 |
| Kumra (North 24 Parganas) | | | | | | | |
| NW | 8774 | 57815 | 66589 | 34.46 | 168302 | 101713 | 2.53 |
| FP | 11660 | 71982 | 83642 | 30.43 | 148620 | 64978 | 1.78 |
| Madhusudanpur (Hooghly) | | | | | | | |
| NW | 7379 | 64437 | 71817 | 33.43 | 163261 | 91444 | 2.27 |
| FP | 10660 | 77833 | 88493 | 30.23 | 147643 | 59150 | 1.66 |

*IC- Input Cost, LC- Labour Cost, CC- Cost of Cultivation, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmers' Practice, NW- Nail Weeder, Prices of jute fibre and jute stick were ₹ 4,000/q and ₹ 400/q, respectively.*

### 9.2.2. Line sowing

Demonstrations on manual 4 row seed drill were conducted in an area of 20.53 ha in three districts of West Bengal (Table 9.4). It helped in increasing the fibre yield by 2.27-2.51 q/ha. It also saved the cost of human labour in jute cultivation by Rs. 8387-9839/ha over farmers' practice. The net return was maximum in Nadia district (Rs. 25,129/ha) followed by North 24 Parganas (Rs. 23,609/ha) and Hooghly districts (Rs. 23,387/ha).

**Table 9.4. Economics of jute cultivation under line sowing using multi row seed drill**

| Location/ Particulars | IC (Rs. /ha) | LC (Rs. /ha) | CC (Rs. /ha) | Yield (q/ha) | GR (Rs. /ha) | NR (Rs. /ha) | B:C ratio |
|---|---|---|---|---|---|---|---|
| Kumra (North 24 Parganas) | | | | | | | |
| Multi-row Seed drill | 9003 | 62143 | 71146 | 32.70 | 159733 | 88587 | 2.25 |
| FP | 11660 | 71982 | 83642 | 30.43 | 148620 | 64978 | 1.78 |
| Brahmapur (Nadia) | | | | | | | |
| Multi-row Seed drill | 9066 | 67680 | 76746 | 33.11 | 161612 | 84866 | 2.11 |
| FP | 12200 | 77513 | 89713 | 30.60 | 149450 | 59737 | 1.67 |
| Madhusudanpur (Hooghly) | | | | | | | |
| Multi-row Seed drill | 7470 | 69446 | 76916 | 32.64 | 159453 | 82537 | 2.07 |
| FP | 10660 | 77833 | 88493 | 30.23 | 147643 | 59150 | 1.66 |

*IC- Input Cost, LC- Labour Cost, CC- Cost of Cultivation, GR-Gross Return, NR-Net Return, B:C-Benefit Cost Ratio, FP-Farmers' Practice, Prices of jute fibre and jute stick were ₹4,000/q and ₹400/q, respectively.*

**Fig 9.2.** CRIJAF Nail Weeder demonstration field

**Fig 9.3.** CRIJAF Multi-row Seed Drill demonstration field

### 9.2.3. Improved retting through CRIJAF SONA

Alternate retting demonstrations were conducted at Satyapol, Bhawanipur and Brahmapur villages of Nadia district and at Kumra village of North 24 Parganas district in West Bengal. Alternate retting demonstrations were also conducted at Dhamdaha and Rampur villages of Forbesganj and Parsha Virbal village of Supaul District, Bihar. Scientist-farmer interaction meetings were also conducted during the demonstrations.

Fig 9.4. Alternate retting demonstration at Satyapol

**Fig 9.5** Alternate retting demonstration at Bhawanipur

**Fig 9.6** Alternate retting demonstration at Brahmapur

**Fig 9.7** Alternate retting demonstration at Dhamdaha

In comparison to conventional method of jute retting, application of CRIJAF SONA (@23 kg/ha) reduced the retting period by 6-9 days at all the centres. At all places, there was improvement (1-2 grade) in fibre colour *i.e.* yellowish to bright golden and jute growers could earn additional income Rs. 450-500/q (Table 5). This method also reduced the fibre: water ratio (v/v) to only 1: 5 which is four times less than the conventional method of retting (1: 20).

**Table 9.5. Fibre qualitative evaluation of improved retting**

| Extension Centre | Fibre Quality | | Retting Duration ( days) | | Additional Income (₹/q) |
|---|---|---|---|---|---|
| | Improved retting | Conventional retting | Improved retting | Conventional retting | |
| Bramhapur (Nadia) | TDN-3 | TDN-5 | 11 - 13 | 18 -20 | ₹ 450 / q |
| Kumra (North 24 Parganas) | TDN-3 | TDN-5 | 10 - 12 | 15-18 | ₹500 / q |
| Madhusudanpur (Hooghly) | TDN-3 | TDN-5 | 11 -15 | 16 -19 | ₹450 / q |

### 9.2.4. Monitoring Activities

Monitoring of jute crop was done at Baksaghari and Dhobipara villages of Balagarh, Hooghly and Mirzapur village of Kalna, Purba Bardhaman on 7th June 2018. Next day it was done at Shakdah village of Hanskhali, Nadia. Scientist-farmer interaction meeting was also conducted during the monitoring.

**Fig 9.8** Monitoring at Dhobipara, Balagarh

### 9.2.5. Feedback from the farmers

Improved varieties of jute produced more fibre in comparison to local varieties. Line sowing through multi row seed drill required less seed, less human labour and facilitated in carrying out other agricultural operations in the field. Weed management through nail weeder reduced the labour requirement and effective in soil mulching, reducing the composite weeds without application of chemical herbicides. Application of CRIJAF SONA found beneficial and compatible to low volume water retting system. All these methods helped in reducing the cost of cultivation, increasing fibre yield, fibre grade (quality) and net return in comparison to the traditional practice. *(Source: NFSM and NFSM-Sub Project; Contributors: C.S. Kar, S.K. Jha , M.S. Behera, Amit Bera, S. Kumar, Shamna A., M.L. Roy and R.K. Naik)*

## 9.3. Jute-Improved Cultivation and Advanced Retting Exercise (Jute-ICARE)

Jute-ICARE project initiated in the year 2015 by National Jute Board (NJB) in collaboration with ICAR-CRIJAF and Jute Corporation of India (JCI) with an objective to strengthen the small and marginal jute growers with advanced technologies of jute cultivation. The four main components of the project are a) use of certified seed (var. JRO 204 & JBO 2003H), b) line sowing using CRIJAF Multi-Row Seed Drill, c) mechanical weeding by using CRIJAF Nail Weeder and CRIJAF Single Wheel Jute Weeder and d) improved retting by using microbial consortium (CRIJAF SONA).

**Fig 9.11.** Demonstration of CRIJAF Multi-Row Seed Drill under Jute-ICARE programme

**Fig 9.12.** Impressive growth of jute crop under Jute-ICARE programme

**Fig 9.10.** Demonstration of CRIJAF Single Wheel Jute Weeder under Jute-ICARE programme

**Fig 9.13.** CRIJAF SONA mediated retting demonstration under Jute-ICARE programme

During 2018-19, i.e. fourth year of the project, the ICARE project was extended in 69 blocks of jute growing states (West Bengal, Assam, Bihar, Odisha, Meghalaya and Andhra Pradesh) covering 1,00,834 ha area. About 755 t of certified seed of jute, 750 each of CRIJAF Multi-Row Seed Drill and CRIJAF Single Wheel Jute Weeder and 610 t of CRIJAF SONA was provided to the jute growers during 2018-19. ICAR-CRIJAF extended technical support to the stakeholders through trainings and demonstrations of CRIJAF technologies in the project area. ICAR-CRIJAF conducted four trainings for master trainers of all the jute growing states at Barrackpore. Scientists and technical personnel of ICAR-CRIJAF conducted 400 on-farm training-cum-demonstrations in all the jute growing areas in collaboration with NJB and JCI. Leaflets and printed materials about the technologies were also distributed among the farmers at ICAR-CRIJAF, Barrackpore also provided technical inputs for maintaining the quality of CRIJAF SONA produced by the firms.

As per evaluation report of National Productivity Council (NPC), New Delhi about 90% of the registered farmers under Jute ICARE have adopted new variety of jute seeds. Further, 62.37% of the farmers used CRIJAF SONA for retting. With regards to seed drill and nail weeder, the adoption has been confirmed by 36.59% and 34.64% farmers, respectively. The average increase in yield due to implementation of the project in all the five states was 14.68%. Adoption of improved production technologies of ICAR-CRIJAF increased the net income of farmers from jute cultivation by 15%. (*Source: Jute-ICARE; Contributors: B. Majumdar, S. Sarkar, S.K. Jha, R.K. Naik, A.R. Saha, R. Saha and S. Satpathy*)

**Table 9.6. List of trainings cum demonstrations conducted under Jute-ICARE during 2018-19**

| Place | Date | No of Trainings | Farmers |
|---|---|---|---|
| **Jute production technology, use of seed drill and single wheel jute weeder** | | | |
| Jalpaiguri and Cooch Behar (West Bengal) | 4-7 April, 2018 | 04 | 180 |
| Dhubri (Assam) | 4-7 April, 2018 | 04 | 208 |
| Balagarh, Chapadanga, Hooghly (West Bengal) | 5-6 April, 2018 | 04 | 240 |
| Malda and South Dinajpur (West Bengal) | 11-13 April, 2018 | 03 | 186 |
| Nagaon, Morigaon, Barpeta (Assam) | 11-14 April, 2018 | 06 | 288 |
| Bagdah, North 24 Parganas (West Bengal) | 13 April, 2018 | 02 | 110 |
| Krishnanagar, Nadia (West Bengal) | 20-21 April, 2018 | 04 | 212 |
| Bethudahari, Nadia (West Bengal) | 20-21 April, 2018 | 04 | 228 |
| Berhampore, Murshidabad (West Bengal) | 22-24 April, 2018 | 04 | 232 |
| Supaul, Araria (Bihar) | 4-6 May, 2018 | 02 | 110 |
| Jajpur, Cuttack (Odisha) | 25-27 May, 2018 | 06 | 318 |
| **Improved retting of jute with CRIJAF SONA** | | | |
| Dinhata, Mathabhanga, Coochbehar, Mynaguri, Dhupguri, Jalpaiguri (West Bengal) | 9-11 July, 2018 | 05 | 270 |
| Dhubri (Assam) | 10-11 July, 2018 | 03 | 165 |
| Balagarh, Chapadanga, Hooghly (West Bengal) | 16-17 July, 2018 | 02 | 116 |
| Swarupnagar, Bagda, North 24 Parganas (West Bengal) | 17-18 July, 2018 | 04 | 220 |
| Morigaon, Nagaon (Assam) | 19-20 July, 2018 | 06 | 315 |
| Bongaigaon, Darang (Assam) | 19-20 July, 2018 | 06 | 288 |
| Ratua, Malda, Kaliaganj, North Dinajpur, Tapan and Gangarampur, South Dinajpur (West Bengal) | 19-21 July, 2018 | 06 | 324 |
| Baduria, North 24 Parganas (West Bengal) | 24 July, 2018 | 02 | 124 |
| Chapra, Ranaghat, Shantipur, Nadia, Katwa, Purbasthali-II, Burdwan (West Bengal) | 30 July-1 August, 2018 | 06 | 330 |
| Jalangi, Domkal, Hariharpara, Murshidabad (West Bengal) | 31 July-1 August, 2018 | 04 | 215 |
| Katihar (Bihar) | 7-8 August, 2018 | 04 | 240 |
| Patpatikabari, Patharjhona, Gopal Karimpur, Nadia, Kalitala, Sanayasi danga, Murshidabad (West Bengal) | 8-10 August, 2018 | 07 | 378 |
| Matkuria, Madhabpur, Goria, Supaul (Bihar) | 10-11 August, 2018 | 03 | 161 |
| Cuttack, Jajpur, Dharmsala (Odisha) | 6-7 September, 2018 | 03 | 159 |
| Balajipeta, Bobbili (Andhra Pradesh) | 15 November, 2018 | 02 | 120 |
| **Total** | | **106** | **5737** |


**Fig. 9.14:** Trainers' Training Programme on improved production technology of jute under Jute-ICARE at ICAR-CRIJAF, Barrackpore

## 9.4. Mera Gaon Mera Gaurav (MGMG) Programme

During 2018-19, about 120 field activities were conducted at MGMG villages involving around 5270 farmers. The scientists of the Institute visited the villages for monitoring of jute crop for pre-mature flowering and advisory services for improved retting of jute after harvesting. Interface meetings/*Goshthies* were organized at villages on soil health management, post-harvest activities and feedback regarding CRIJAF technologies. Farmers of MGMG villages were invited to attend on-campus training programmes organized at ICAR-CRIJAF, Barrackpore. Demonstrations were conducted on improved production technologies of jute and vegetable cultivation in jute bag reinforced soil column in paddy fields. Extension literatures were also provided to the farmers. Awareness was created among farmers on use of soil health cards, PMFBY, vigilance, *Swachh Bharat Abhiyan* etc.

**Fig 9.15.** Demonstration on vegetable cultivation in jute bag reinforced soil column in paddy field at MGMG village

## 9.5. Training programmes organized by ICAR-CRIJAF, Barrackpore

| Name of the programme/ training | Place and Date | No. of participants |
|---|---|---|
| Training on 'Improved production technologies of Mesta' under NFSM (CC) Jute | Joypur, Purulia 22 June, 2018 | 50 |
| Trainers' trainings on 'Improved Retting and Production Technology of Jute under Jute-ICARE' | ICAR-CRIJAF, Barrackpore 26-27 June, 2018<br>26 February, 2019 | 91 |
| Skill Development training for 'Seed Quality Maintenance of New Varieties of Jute, Mesta and Sunnhemp' under NFSM (CC) Jute | Bankura, WB 20 July, 2018 | 68 |
| | Guntur, AP 30 July, 2018 | 60 |
| | Kendrapara, Odisha 26 September, 2018 | 70 |
| | Mangaldoi, Assam 5 November, 2018 | 65 |
| | Purulia, WB 12 January, 2019 | 62 |
| | Amadalavalasa, AP 25 January, 2019 | 60 |
| Training-cum-exposure visit on 'Demonstration of 'CRIJAF SONA' sponsored by ATMA | ICAR-CRIJAF, Barrackpore 6 August, 2018 | 80 |
| National Level Trainings on 'Improved Retting, Seed Production and Production Technology of Jute and Allied Fibres' under NFSM ( CC ) Jute | ICAR-CRIJAF, Barrackpore 7-9 August, 2018<br>4-6 October, 2018<br>5-7 March, 2019<br>14 March, 2019 | 53 |
| 'Hands-on training for 'Agrometeorological data recording, storing, and climate change analysis with special reference to jute and allied fibre crops' | ICAR-CRIJAF, Barrackpore 27 August-01 September, 2018 | 17 |
| Farmers' training on 'Quality Seed Production of Mesta' under NFSM (CC)-Jute | Joypur, Purulia 14 September, 2018 | 50 |
| 'National Training Programme on 'Improved Seed Production Technologies of Jute and Allied Fibres' | ICAR-CRIJAF, Barrackpore 4-6 October, 2018. | 20 |
| ASCI Training on 'Agricultural extension service provider' | ICAR-CRIJAF, Barrackpore 30 November, 2018-5 January, 2019 | 20 |

| Name of the programme/ training | Place and Date | No. of participants |
|---|---|---|
| ASCI training on 'Quality Seed Grower' | ICAR-CRIJAF, Barrackpore 03 January-07 February, 2019 | 20 |
| Training on 'Judicious Fertilizer Application based on Soil Test for Higher Crop Productivity and Profitability' | ICAR-CRIJAF, Barrackpore 07-09 January, 2019 | 30 |
| ASCI training on 'Agriculture machinery operator' | ICAR-CRIJAF, Barrackpore 23 January-27 February, 2019 | 20 |
| Training on 'Scientific mushroom cultivation for SC farmers' | 5-7 March, 2019 | 10 |
| Training on 'Improved production technology of jute for Farmers and Extension functionaries' under NFSM (CC ) Jute | 14 March, 2019 | 80 |
| Training on 'Popularization of soil test based fertilizer application for increased crop productivity' | Shimulia, Dikhari Bongaon 16 March, 2019 | 50 |
| Training on 'Improved production technology of jute for SC farmers' under SCSP programme | 28 March, 2019 | 80 |

**Fig 9.16.** National Level Training on Improved Seed Production Technology of Jute and Allied Fibres

**Fig 9.17.** National Level Training on Improved Retting Technology of Jute And Allied Fibres

**Fig 9.18.** Skill development training under NFSM held at Guntur, AP

**Fig 9.19.** Skill development training under NFSM held at Kendrapara, Odisha

**Fig 9.20.** Skill development training held at Purulia

## 9.6. Farmer Field Schools

Three farmer field schools on 'Vegetable cultivation in jute bag reinforced soil column in paddy field' were organized at Vijaynagar and Babpur villages of North 24 Parganas and Khagragachi village of Hooghly district on 24th, 25th and 29th August, 2018, respectively.

**Fig 9.21.** FFS organized at Vijaynagar

## 9.7. Other Extension Activities

### Table 9.8: Exposure visits organized at ICAR-CRIJAF, Barrackpore

| Particulars | Date | No. of participants |
|---|---|---|
| M.Sc. (Ag. and Rural Development) students of West Bengal State University, Barasat | 13 June, 2018 | 16 |
| Farmers of Tehatta Block, Nadia | 22 June, 2018 | 48 |
| Farmers of Barrackpore-I&II Block, North 24 Parganas | 6 August, 2018 | 82 |
| Farmers of Nakashipara Block, Nadia | 14 August, 2018 | 52 |
| Farmers of Polba-Dadpur Block, Hooghly | 24 August, 2018 | 42 |
| Farmers of Polba-Dadpur Block, Hooghly | 28 August, 2018 | 48 |
| Farmers of Hariharpara, Murshidabad | 13 September, 2018 | 28 |
| Farmers of Dhenkanal, Odisha | 09 January, 2019 | 40 |
| Farmers of Dhenkanal, Odisha | 14 February, 2019 | 85 |
| High School Students of NCP Manmath Nath Girls' School, Barrackpore, North 24 Parganas | 18 February, 2019 | 121 |

### Table 9.9: Technological backstopping through inputs distribution

| Particulars | Place | Quantity (kg) |
|---|---|---|
| Seed distribution of jute under NFSM (CC)-Jute | Madhusudanpur, Kumra, Bramhapur | 279.40 |
| Seed distribution of jute mung under DST-NRDMS project | Galdaha, Panji, Dwip Media, Pingleswar, Belleshankarpur (North 24 Parganas) and Bhabanipur (Nadia) | 110.00 |
| Seed distribution of paddy, cucurbits, mustard, lentil under DST-NRDMS project | Galdaha, Panji, Dwip Media, Belleshankarpur (North 24 Parganas) and Bhabanipur (Nadia) | 29.00 |
| Distribution of CRIJAF SONA | Madhusudanpur, Khagragachi and Singhal Pathan (Hooghly) | 350.00 |
| | Brahmapur, Alaipur (Nadia) | 200.00 |
| | Makaltala, Kumra (North 24 Parganas) | 450.00 |


**Fig. 9.22** Shri G.S. Sekhawat, Hon'ble MoS, A&FW along with Dr. T. Mohapatra, Secretary, DARE & DG, ICAR visiting ICAR-CRIJAF exhibition stall in UPAYA-2018 held at NASC, New Delhi.

**Table 9.10. Awareness/sensitization programmes, community mobilization, campaigns etc.**

| Particulars | Place | Date |
|---|---|---|
| Campaigning for better sanitation under Swachh Bharat Programme | Gheedah village, North 24 Pgs | 25 September, 2018 |
| Swachhta related awareness programmes among school children | Sewli Boys High School, North 24 Pgs | 27 September, 2018 |
| | Sewli Girls High School, North 24 Pgs | 29 September, 2018 |
| Mobilizing community to build compost pits for waste management under *Swachh* Bharat Programme | Babpur village, North 24 Pgs | 01 October, 2018 |
| Mobilizing school children for participation in *Swachhta* campaign | Mohanpur village, Nadia | 01 October, 2018 |
| Sensitizing villagers about eradication of corruption under Vigilance Awareness Week | Geedha Village, North 24 Pgs | 8 November, 2018 |
| Quiz competition on Vigilance Awareness | Barasat MGM High School | 14 November, 2018 |
| Village sanitation drive under *Swachhta Pakhwara* | Babpur village North 24 Pgs | 21 December, 2018 |
| Waste management under *Swachhta Pakhwara* | Bodai village, North 24 Pgs | 29 December, 2018 |

**Table 9.11. Participation in agri-fairs, exhibition**

| Particulars | Place | Date |
|---|---|---|
| Start-up and Entrepreneurship Conclave on "Unleashing Potentials in Agriculture for Young Agripreneures (UPAYA)" | NASC, New Delhi | 16-17 October, 2018 |
| ISEE National Seminar on Integrated Farming systems for Enhancing Farmer's income and Nutritional Security | WBUAFS, Kolkata | 5-7 December, 2018 |
| 34$^{th}$ Monomohan Mela-o-Lokosanskriti Utsav | Chhotojagulia, North 24 Parganas | 16-23 December, 2018 |
| Sundarban Kristi Mela-o-Lokosanskriti Utsav | Kultali, South 24 Parganas | 20-29 December, 2018 |
| Krishi Samridhi Mela cum National Workshop on IFS | Ram Krishna Mission, Sargachhi, Murshidabad | 28-30 December, 2018 |
| Bajarpore Gramin Pradarshani-o-Mela-18$^{th}$ year | Alukaranbarh, Purba Medinipur, W.B | 15-18 January, 2019 |
| Tribal Fair | Makaltala, North 24 Parganas | 16 January, 2019 |
| Krishi Kumbh | Motihari, Bihar | 7 -12 February, 2019 |

# 10. AINP on Jute and Allied Fibres (AINPJAF)

All India Network Project on Jute and Allied Fibres functions through 8 SAUs and 4 ICAR Institute based centres across 7 JAF growing states with its headquarter at ICAR-CRIJAF, Barrackpore, Kolkata. A total of 64 projects comprising 258 trials were conducted on jute, mesta, sunnhemp, ramie, flax and sisal during 2018-19 under crop improvement, crop production and crop protection programme.

## 10.1 Crop Improvement

Under crop improvement programme, thirty-three projects comprising 149 trials were conducted on jute and allied fibre crops in different centres.

### 10.1.1 Release and notification of JAF varieties

One variety each of kenaf *i.e.* JMBP 4 (Utkarsh) and sunnhemp *i.e.* SUIN 3 (Kavita) was recommended for release and notification by the Central Sub-Committee on Crop Standard, Notification and Release of Varieties vide Gazette notification no. S.O. 1498(E) dated 2nd April, 2019.

### 10.1.2 Identification of JAF varieties for release

Two varieties of tossa jute namely, NJ-7005 and JROMU-1 and one variety of kenaf (JRHC-3) have been identified for central release during the 30th Annual Workshop of AINPJAF held at Bihar Agriculture University, Sabour during 14-15th February, 2019.

### 10.1.3 Evaluation of jute germplasm

Fifty accessions of *C. capsularis* were screened for fibre yield and yield components in five locations. An overall mean of 14.0±1.6 g/plant was recorded for fibre yield over five locations with a range of 10.8 (CIN-113) to 17.5 g/plant (CIN-93). Eleven genotypes outperformed better check JRC 517 (15.1 g/plant) for fibre yield. Among five locations, Coochbehar centre recorded highest mean fibre yield (19.5±4.5 g/plant) and the entry CIN-89 recorded highest fibre yield of 27.1 g/plant in this location.

Fifty accessions of *C. olitorius* were screened for fibre yield, plant height, basal diameter and green weight in six locations. Average fibre yield over locations was recorded to be 13.3±1.5 g/plant with a range of 10.4-16.5 g/plant. Accession OIN-109 was at par with best check JRO 204 (16.5 g/plant) for fibre yield. Among the six centres, Kendrapara recorded highest mean fibre yield (21.4±4.9 g/plant) and accession OIN-109 and OIN-115 recorded highest yield (32.0 g/plant) in this centre.

### 10.1.4 Evaluation of mesta germplasm

Fifty accessions of *Hibiscus sabdariffa* were evaluated for fibre yield and yield related traits at four locations. An overall mean of 12.8±2.1 g/plant was recorded for fibre yield over four locations with a range of 9.1 g/plant (RIN-60) to 18.3 g/plant (RIN-06). Accession RIN-06 (18.3 g/plant) outperformed better check AMV 5 (17.8 g/plant) for fibre yield. Among the four locations, Barrackpore centre recorded highest mean fibre yield (18.1±4.3 g/plant) and the accession RIN-13 recorded highest fibre yield of 32.8 g/plant in this location.

Fifty accessions of *Hibiscus cannabinus* were evaluated for fibre yield and yield related traits at three locations. An overall mean of 16.5±2.4 g/plant was recorded for fibre yield over two locations with a range of 11.5 g/plant (KIN-163) to 22.9 g/plant (KIN-102). Three genotypes outperformed better check AMC 108 (19.6 g/plant) for fibre yield. Among the three locations, Barrackpore centre recorded highest mean fibre yield (26.5±4.0 g/plant) and the accession KIN-101 recorded highest fibre yield of 35.3 g/plant in this location.

### 10.1.5 National Hybridization Programme (NHP)

In tossa jute, $F_7$, $F_5$, $F_4$ and $F_3$ progenies of different cross combinations were evaluated at Kalyani, Kendrapara, Katihar, Coochbehar, Rahuri and Nagaon centre and promising line have been identified and selected for further evaluation.

In white jute, $F_3$ and $F_2$ progenies of different cross combinations were evaluated at Kalyani, Katihar, Nagaon and Kendrapara. Promising cross combinations at different centres have been identified for further evaluation.

A total of 15 $F_8$ progenies of roselle were evaluated at Amadalavalasa and Aduthurai centres. A new crossing program was initiated at Amadalavalasa and Barrackpore centres using superior performing roselle germplasm lines.

### 10.1.6 Yield evaluation trials

**Tossa jute (*C. olitorius*)**

**IET:** Test entry JROP-4 turned out to be the best performing entry and recorded 33.57 q/ha fibre yield followed by best check JRO 204 (32.58 q/ha).

**AVT-I:** Test entry JROBA-4 was found to be the best performer with 33.28 q/ha, statistically significant over best check variety JRO 204 (31.94 q/ha).

**AVT-II:** Analysis on mean over locations and years (grand mean) suggested that check variety JRO 204 (29.65 q/ha) was the best performer followed by JROCS-6 (29.40 q/ha), NOJ-27-26 (29.35 q/ha).

**White jute (*C. capsularis*)**

**IET:** Test entry JRCP-5 turned out to be the best performing entry and recorded 32.28 q/ha fibre yield followed by NCJ-16-53 (32.09 q/ha), NCJ-33-9 (31.58 q/ha), BRCJ-1 (31.42 q/ha) and BCCC-9 (31.21 q/ha).

**AVT-II:** Test entry JRCJ-11 (30.72 q/ha) recorded highest fibre yield followed by JRCJ-10 (30.40 q/ha), best check JRC 517 (29.85 q/ha) and JRCPS-2 (29.25 q/ha).

**Kenaf (*H. cannabinus*)**

**IET:** Test entry JRK-2017-5 (30.08 q/ha) out - yielded the best check AMC 108 (29.34 q/ha) followed by test entry JRHC-11 (28.54 q/ha) and JRK-2017-2 (27.61 q/ha).

**AVT-I:** Check variety AMC 108 was best performer with 27.96 q/ha fibre yield closely followed by JRK-2016-2 (27.06 q/ha) and JRK-2016-5 (26.58 q/ha).

**AVT-II:** Check variety AMC 108 (27.32 q/ha) recorded highest fibre yield followed by test entry JRK-2015-1 (26.64 q/ha).

**Roselle (*H. sabdariffa*)**

**IET:** Test entry JRHS-12 (34.18 q/ha) turned out to be the best performing entry for fibre yield followed by AHS-319 (30.14 q/ha), AHS-321 (29.84 q/ha) and JRR-2017-1 (29.77 q/ha).

**AVT-I:** Test entry AHS-307 was the best performer with 23.53 q/ha fibre yield followed AHS-309 (22.97 q/ha) and check variety HS 4288 (22.96 q/ha).

**AVT-II:** Test entries AHS-286 (26.22 q/ha) and AHS-298 (25.55 q/ha) significantly out- yielded the best check variety HS 4288 (24.12 q/ha) for fibre yield.

**Sunnhemp (*C. juncea*)**

**IET:** Check variety SUIN 53 turned out to be the best performer with 10.02 q/ha of fibre yield followed by test entry JRS-2017 (10.00 q/ha).

**Ramie (*B. nivea*)**

**IET:** Check varieties R-67-34 (11.84 q/ha/yr) and R-46 (10.39 q/ha/yr) were significantly out yielder than test entries for dry fibre yield.

**Flax (*L. usitatissimum*)**

**AVT-I:** For dry fibre yield test entry JRF-16 (15.17 q/ha) was the best performer followed by JRF-17 (14.87 q/ha) and check variety JRF 2 (14.11 q/ha) which were statistically at par.

### 10.1.7 Special trait trials

***C. olitorius* for leaf yield**

**IET:** Test entry JROV-5 recorded highest leaf yield of 159.30 q/ha followed by best check JRO 204 (150.94 q/ha), JROAL-1 (149.91 q/ha) and JROV-3 (149.10 q/ha).

***C. olitorius* for biomass yield**

**AVT-II:** Analysis of mean over locations and years suggested that test entry JROB-2 (557.09 q/ha) recorded significantly high biomass yield followed by best check JRO 204 (520.56 q/ha).

***C. olitorius* for pre-mature flowering resistance**

This trial was conducted by sowing in two different dates (03rd March and 15th March). In first sowing, test entry NJ-7005 recorded significantly low flowering (0.75% and 1.46%) than the check varieties JRO 524 (12.18% and 26.94%) and JRO 204 (22.80% and 47.81%) at 60 and 90 DAS.

***H. sabdariffa* for calyx yield**

**IET:** Test entry HSLC-1 (43.86 q/ha) recorded highest calyx yield followed by check variety AMV 5 (41.59 q/ha) which was statistically at par with best check.

***H. sabdariffa* for leaf yield**

**IET:** None of the test entries performed better than the best check variety AMV 5 (456.79 q/ha) for fresh leaf yield.

## 10.2 Crop Production

The jute genotypes responded significantly to fertilizer application up to 80:17.5:33.3 kg NPK/ha at Barrackpore, Nagaon and Kendrapara, up to maximum dose of 80:17.5:33.3 kg NPK/ha. At Coochbehar, the effect of fertilizer on fibre yield of jute was non-significant. The fibre yield of test entry JROMU 1 (24.41 q/ha) was significantly lower than that of the check variety JRO 524 (25.96 q/ha) but was at par with yield of JRO 8432 (24.01 q/ha) at Barrackpore, while at Katihar, fibre yield of JROMU-1 (34.7 q/ha) was significantly superior to JRO 8432 only. At Kendrapara, fibre yield of JROMU 1 (24.45 q/ha) was significantly higher than both the checks. At Nagaon, JROMU-1 recorded significantly lower fibre yield (35.28 q/ha) compared to check varieties.

Fibre yield of roselle genotypes increased significantly with fertilizer application up to 60: 13.2: 25 kg NPK/ha only at Rahuri, Maharashtra (21.56 q/ha) and Amadalavalasa, Andhra Pradesh (26.63 q/ha) while at Aduthurai, Tamilnadu the increase in fibre yield was significant up to 80: 17.5: 33.3 kg NPK/ha. Test entry JRHS 4 recorded significantly higher fibre yield over both the checks AMV 5 and HS 4288 at Rahuri, Maharashtra (20.27 q/ha) and Amadalavalasa, Andhra Pradesh while at Aduthurai, Tamilnadu the increase in yield of JRHS 4 was significant over check variety AMV 5 only.

Fibre yield of kenaf genotypes increased significantly with fertilizer application up to fertilizer dose of 60:13.2:25 kg NPK/ha; up to highest fertilizer dose of 80:17.5:33.3 kg NPK/ha at Kendrapara, Odisha (28.47 q/ha); Rahuri, Maharashtra (24.00 q/ha) and at Aduthurai, Tamilnadu (29.03 q/ha). Fibre yield of test entry JRHC-3 (29.03 q/ha) was significantly higher than both the check varieties at Aduthurai, Tamilnadu and at Rahuri, Maharashtra (24.00

q/ha) while at Kendrapara, Odisha, fibre yield of JRHC-3 (26.72 q/ha) was significantly higher over check variety HC 583 only.

During the period 2016 to 2018, the targeted yield of jute fibre (3.2 t/ha) was achieved with ST-TY and IPNS based fertilizer application at Katihar, Bihar and is recommended for the region. In the acid soils of Nagaon, Assam also, targeted fibre yield of jute (3.5 t/ha) could be achieved (with +37% deviation) through soil test based fertilizer application in combination with lime (@ 25% LR) and organic manure (@ 5 t/ha) and is recommended for the state. Targeted yield of rice was not achieved at Nagaon. In mesta, the targeted yield of 2.8 t/ha could be achieved at Aduthurai, Tamilnadu only when inorganic fertilizer (100% NPK on ST-TY) was integrated with FYM. Targeted yield of mesta fibre (2.8 t/ha) was achieved with combined application of inorganic fertilizer (100% NPK ST-TY), lime (@ 25% LR) and organic manure @ 5 t/ha FYM at Amadalavalasa, Andhra Pradesh.

In Kendrapara region, *Echinochloa colonum* was the dominant weed species (density-83.7-99/$m^2$ and IVI 73.0-91.1%) among all the weeds in farmers' fields. In Katihar, *Cyperus rotundus* was the dominant weed species (density-11-28/$m^2$ and IVI- 16-40%) among all the weeds in farmers' fields of Manihari and Katihar blocks. In Nagaon, *Cynodon dactylon* among the grass weeds was the dominant, *Mimosa pudica* was the dominated among broad leaved weed and *Cyperus rotundus* was the dominant weed among the sedges in the experimental farm and farmers' field in different blocks of Nagaon.

In mesta growing blocks of Srikakulam, *Cynodon dactylon* was the dominant weed in Amadalavalasa block, while *Digitaria sangunalis* in Jalumuru and *Echinochloa* in Buraj. Among the broad leaved weeds, *Celosia argentia* was dominant in farmers' field of Srikakulam, Andhra Pradesh. In Aduthurai, *Cyperus iria* was the dominant weed in farmers' field of Srikakulam, Andhra Pradesh. In Adutharai, *Cyperus iria* was the dominant weed in farmers' field of all surveyed blocks of Tamilnadu. *Amaranthus viridis* was dominant broad leaved weeds in all blocks of Adutharai.

Application of quizalofop ethyl 5 EC 60 g + ethoxysulfuron @100 g/ha at 15 days after crop emergence reduced the weed dry weight, recorded highest weed control efficiency, plant height, fibre yield and net return at Kalyani and Nagaon. Application of quizalofop ethyl 5 EC 60 g + ethoxysulfuron @50 g/ha at 15 DAE with one hand weeding at 30 DAE recorded the highest plant height, fibre yield and net return at Kendrapara, Katihar and Coochbehar. Application of pretilachlor 50 EC @ 900 g/ha with one hand weeding recorded the highest mesta fibre yield (25.48 q/ha and 22 q/ha) and weed control (90.47 and 85%) at Amadalavalasa and Aduthurai, respectively. Application of quizalofop ethyl 5 EC 60 g + ethoxysulfuron@ 50 g/ha at 15 DAE + one hand weeding at 30 DAE recoded the higher jute seed yield (16.13 q/ha), weed control efficiency (60.46%) and B:C ratio (3.26) at Rahuri.

The feasibility of growing vegetables on jute gunny bag packed with soil and organic matter (in alternate layers) in transplanted paddy fields had been demonstrated at Kalyani, Coochbehar and Nagaon. Additional net return Rs. 57415/ha, Rs. 93833/ha and Rs. 21300/ha were recorded by growing ridge gourd, brinjal and okra in this system at Kalyani, Coochbehar and Nagaon, respectively.

The study on carbon dynamics and hydro-physical characterization of soils of jute and mesta growing areas (Nagaon - 07 locations, Coochbehar -06 locations, Kendrapara - 05 locations, Amadalavalasa - 06 locations, Rahuri - 07 locations & Aduthurai - 09 locations) revealed that the organic carbon contents were significantly higher in soil of Nagaon (0.91-1.22%) followed by Rahuri (0.60-0.87%), Coochbehar (0.66-0.79% except in Dhupguri Block), Aduthurai (0.54-0.78%), Kendrapara (0.47-0.65%), and Amadalavasa (0.47-0.63%). The soils were mostly acidic in reaction in all the locations except Rahuri and Aduthurai. The soils of Ariyalur district under AINP centre Aduthurai, Tamil Nadu had more very labile C pools status than that of other C pools.

At Amadalavalasa, Andhra Pradesh, mesta – maize cropping sequence recorded significantly higher fibre equivalent yield (79.71 q/ha), gross return (Rs. 231825/ha) and B:C ratio (2.26) followed by mesta – groundnut sequence while among the intercropping systems, mesta + maize intercropping (2:1 row ratio) recorded higher net return of Rs. 190858/ha.

Application of 150% recommended dose of N (RDN) with 25% N from FYM recorded highest fibre yield of ramie (9.66 q/ha) which was statistically at par with that of 150% RDN (9.29 q/ha) treatment while both the treatments recorded significantly higher fibre yield over 100% RDN treatment (8.03 q/ha) at Coochbehar, West Bengal.

At Barrackpore, increase in nitrogen dose increased annual fibre yield of ramie (20.31 q/ha) significantly up to 120 kg N/ha/cut. Application of potassium also increased annual fibre yield significantly up to highest dose of 50 kg K/ha/cut (18.31 q/ha). At Sorbhog, Assam also maximum annual fibre yield of ramie (8.41 q/ha) was recorded with highest potassium dose of 50 kg/ha.

Application of NPK @ 90:30:60 kg/ha along with sisal waste @ 20 t/ha recorded maximum leaf length (114.7 cm), leaf width (9.2 cm), number of harvested leaves (132.5 x $10^3$ / ha) and fibre yield (25.4 q/ha) of sisal and also saved fertilizer N by 30 kg/ha at Bamra, Odisha.

Intercropping of sisal with pulses and oilseed crops significantly increased system sisal equivalent yield by 224.7 – 509.3 kg/ha compared to sole sisal crop (621.7 kg/ha) and legumes (black gram, green gram, cowpea & horse gram).

At Coochbehar, fibre yield of flax (14.38 q/ha) increased significantly with application of 40 kg/ha Nitrogen. Irrigation scheduling at 0.8 IW/CPE ratio with nitrogen dose of 80 kg/ha was recommended for south Bengal as it recorded higher fibre yield (18.69 q/ha).

Pre-emergence application of pendimethalin @ 0.75 – 1.0 kg a.i./ha was found most suitable for weed control in fibre flax at Barrackpore as it recorded highest fibre yield (17.44 – 18.62 q/ha) and highest weed control efficiency (72.2 – 81.4%) and was recommended for the region.

At Coochbehar, West Bengal spacing of 60 cm x 15 cm alongwith topping at 45 DAS recorded significantly higher seed yield of jute (6.06 q/ha). Combined application of quizalofop ethyl (10 EC @ 38 g) and ethoxysulfuron (135 g a.i/ha) at 15 DAE recorded higher seed yield (7.69 q/ha) along with lowest weed biomass both at Kalyani, West Bengal. At Rahuri, Maharashtra, application of FYM @ 5 t/ha recorded significantly higher jute seed yield and net return in *olitorius* jute (13.20 q/ha & Rs. 80406/ha). Similarly, application of fertilizer dose @ 80: 17.5: 33.3 kg NPK/ha recorded maximum seed yield (14.83 q/ha) while net return was highest with 80: 26: 50 kg NPK/ha dose (Rs. 97753/ha).

Maximum seed yield (12.48 q/ha) of kenaf was recorded when topping was done at 45 DAS in 15$^{th}$ June sown crop at Rahuri. Growing of seed crop of sunnhemp at closer spacing of 30 cm x 10 cm with fertilizer dose of 20:40:40 kg NPK/ha recorded highest seed yield of 18.49 q/ha at Rahuri and was recommended for the region.

### 10.3 Crop Protection

During 2018-19, ten experiments comprising of 37 trials were conducted at different AINPJAF centers.

Survey and surveillance of insect pests and diseases of jute were conducted in all the AINPJAF centers. In jute, yellow mite, semilooper, Bihar hairy caterpillar (BHC) and stem weevil were the most common insect pests. The yellow mite infestation was more consistent across the centers with maximum infestation of 51.26, 15.17, 3.90, 28.84 and 1.84 mite population/cm$^2$ leaf area on 2$^{nd}$ unfolded leaf at Barrackpore, Coochbehar, Nagaon, Katihar and Kendrapara respectively coinciding at 50 DAS to 75 DAS during last week of May to first week of July. Maximum infestation of Bihar hairy caterpillar was noticed at Barrackpore where 93.33 % infestation occurred during first week of August at 120 DAS. The BHC damage at Nagaon was 32.34% followed by Katihar (40.42%) and Coochbehar (14.66%) occurred between 55 to 95 DAS, respectively. Grey weevil infestation (66.66%) was specific to Barrackpore at 40 DAS.

Jute semilooper infestation was observed at Katihar, Coochbehar, and Kendrapara with maximum of 30.59%, 12.11% and 22.54% plant damage respectively from 45 DAS to 105 DAS. In Barrackpore and Nagaon centers the crop was free from semilooper infestation throughout the season. The period of semilooper infestation was from second fortnight of June to last week of August. Stem weevil infestation was noticed in all the centers except Coochbehar. At Barrackpore, Nagaon, Katihar and Kendrapara, maximum stem weevil infestation was found from 25 to 65 DAS with 25.00%, 3.64 %, 10.48% and 9.22% plant damage respectively. In general yellow mite, grey weevil and stem weevil were more prevalent during the early crop growth period whereas BHC and semilooper were active during the latter part of the crop period. During July, peak activity of the larval parasite (Tachinid fly) was recorded to be 12.00-38.00% on BHC at Nagaon.

Among diseases stem rot, anthracnose and mosaic diseases were common in jute. The infestation of leaf mosaic in white jute was very specific to Katihar and Kendrapara centers with incidence of 6.70% and 22.10% respectively during 65 DAS and 105 DAS respectively. Seedling blight incidence was observed only at Nagaon with 3.84% plant damage at 45 DAS. Incidence of anthracnose was observed at Nagaon, Katihar and Kendrapara centers during 105 DAS with maximum incidence of 15.36%, 2.00% and 10.97% respectively. Maximum incidence of stem rot 17.81%, 14.38 (PDI), 3.01 (PDI) 23.63 (PDI), 6.58 (PDI) was observed at Barrackpore, Nagaon, Coochbehar, Kendrapara and Katihar respectively. The incidence of root rot disease was maximum 3.91%, 14.58%, 8.47 %, and 3.72% at Barrackpore, Nagaon, Katihar and Coochbehar, respectively. In mesta, at Amadalavalasa infestation of aphids, whiteflies and leaf hoppers were insignificant with <1.00/plants. The infestation of semilooper and mealybug at 45 DAS was 36.00% and 58.00%, respectively.

The promising germplasm lines of *tossa* jute free from mite infestation were OIN-90, OIN-99, OIN-104 and OIN-111 at Coochbehar. Other lines with least infestation were OIN-97, OIN-103, OIN-111, OIN-114, OIN-118, OIN-119, OIN-122, OIN-135 and OIN-134 (1.56 -3.44 mite/cm$^2$) at Kendrapara. Lines OIN-92, OIN-104, OIN-108, OIN-109, OIN-110, and OIN-1181 were found to be moderately resistant to stem rot incidence at Kendrapara.

Among the white jute germplasms, CIN-94, CIN-110 and CIN-125 were resistant to semilooper at Coochbehar, Katihar and Kendrapara, respectively. The lines, CIN-101, CIN-103, CIN-104, CIN-106, and CIN-107 were found to be resistant to yellow mite with <2 mite/cm$^2$ of leaf at Coochbehar. The white jute accessions, CIN-87, CIN-91, CIN-94, CIN-102, CIN-104, CIN-112, and CIN-113 were least susceptible to stem rot at Kendrapara.

Intensive screening against jute stem rot indicated that the lines OIN-92, OIN-104, OIN-108, OIN-109, OIN-111 and OIN- 118 were found to be highly resistant at Kendrapara. The PDI of tossa jute varied from 0 to 11.17 at Kendrapara and germplasm free from stem rot disease were OIN-101, OIN-104, OIN-108, OIN-109 and OIN-110. The lowest PDI (0.56) was recorded in germplasm OIN-123, whereas the highest PDI (11.75) was recorded in OIN-89 which indicated that germplasm OIN-123 is resistant to stem rot. At Nagaon, among the sixteen germplasms, OIN-02, OIN-125, and OIN-651 were found to be resistant to stem rot with PDI of < 5.0. Similarly, at Katihar and Coochbehar all the entries were resistant with PDI of < 5.00.

At Barrackpore, seed treatment and spraying of carbendazim @0.1%at 45 DAS was the best treatment against stem rot of jute

with lowest root rot of 3.44% and PDI of 4.24. Seed treatment and spraying with tricyclozole + propiconazole (@ 1 ml/kg and 0.1%) at 40-45 DAS was most effective with significantly highest fibre yield (30.83 q/ ha) and least disease incidence at par with the treatment of azoxystrobin and difenconazole at Nagaon Centre. In Kendrapara, the fibre yield and B: C ratio in seed treatment with tebuconazole @ 1.5 ml/ kg followed by foliar spray @ 0.15% at 40-45 days was found to be superior. Similar trend was observed at Katihar where the seed treatment (tebuconazole @ 1.5ml/ kg seed) and foliar spray (0.15%) at 40-45 DAS, besides reducing the diseases also recorded highest fibre yield (29.13q/ ha) being at par with the treatment of azoxystrobin + difenconazole combination treatment. In Coochbehar, seed treatment with azoxystrobin + difenoconazole @ 1.0 ml/kg seed + spraying of azoxystrobin + difenoconazole @ 0.075% at 40-45 days of crop age showed promising result with maximum yield of 25.00 q/ha.

In Nagaon, neither sowing method nor seed treatment showed any significant effect on yellow mite population. Seed treatment with carbendazim 50 WP @ 2g/kg seed + spraying of spiromesifen 240 SC @ 0.7 ml/L water at 35 DAS + spraying of tebucanazole @ 0.15% at 45 DAS + spraying of λ-cyhalothrin 5 EC @ 0.6 ml/L at 55 DAS was found to be superior with highest yield of 30.32 q/ ha. At Kendrapara, similar result was observed in which overall combination of $T_1$ with $P_1$ *i.e.* line sowing followed by seed treatment with carbendazim 50 WP @ 2g/kg seed + Spraying of spiromesifen 240 SC@ 0.7 ml/L water at 35 DAS + spraying of tebucanazole @ 0.15% at 45 DAS + spraying of λ-cyhalothrin 5 EC @ 0.6 ml/L at 55 DAS was best for management of stem rot disease in jute. At Katihar, the treatments with integration of carbendazim as seed treatment followed by spray of spiromesifen @ 0.7 ml/L. (35 DAS) and lamda cyhalothin @ 0.6 ml/L recorded low incidence of mites (7.48 and 4.56 mite/$cm^2$) at 40 DAS and 50 DAS followed by the treatments with bio agents and botanicals (8.12 and 5.24 mite/$cm^2$). Similar trend was observed at Coochbehar where seed treatment with carbendazim 50WP @ 2g/kg seed + spraying of spiromesifen 240 SC @ 0.7 ml/L at 35 DAS + spraying of tebuconazole @ 0.15% at 45 DAS + spraying of λ-cyhalothrin 5 EC @0.6 ml/L at 55 DAS proved to be the best.

At Amadalavalasa, mesta germplasms, KIN-102 (5.28), KIN-117 (3.89), KIN-118 (3.64), KIN- 158 (3.67) and KIN-172 (3.48) were comparatively less susceptible to leafhopper and KIN-100, KIN-102 were promising with least whitefly infestation (2.46 to 3.78/plant). At Katihar MVYM resistant germplasms were KIN-111, KIN-117, KIN-152, KIN-165, KIN-166, KIN-172 and KIN-178 while high infestation was observed in KIN-122 and KIN-128. The germplasms *viz.* KIN-101, KIN-106, KIN-122, KIN-129 and KIN-130 were found to be completely immune against whitefly infestation. The lines resistance against phoma blight were KIN-102, KIN-161, KIN-117 and KIN-104.

At Coochbehar, out of 16 *olitorius* germplasm none were found immune or highly resistant against root knot nematode (*M. incognita)*. One genotype (OIN-154) was found as resistant with few galls but no eggs in the root system.

At Nagaon, in AVT-I the Bihar hairy caterpillar damage of entry JROBA 3 was at par with the two check varieties viz. JRO 524 and JRO 204 while the other three entries showed significantly higher infestation than the check varieties. Similarly in AVT-II the entry JRO CS-6 revealed significantly higher Bihar hairy caterpillar damage than both the check varieties, JRO 524 and JRO 204. Infestation by jute stem weevil did not differ significantly.

### 10.4 Tribal Sub Plan

The Tribal Sub Plan programme had been taken up by AINPJAF units of BCKV, UBKV, JRS Kendrapara and RARS, Nagaon. Seven villages belonging to four districts of West Bengal, Assam and Odisha covering 14.77 ha area and 95 tribal farmers participated in the programme. In South Bengal, the activities were carried out at Srikrishnapur and Matiagacha villages of North 24 Paragana district whereas in North Bengal, activities were carried out in Badalgir, Atialdanga, Jaigirbalabari villages of Dinhata II block

Dignitaries during the inaugural session of 30th Annual Workshop of AINPJAF at BAU, Sabour

of Coochbehar district. In Odisha, the TSP activities had been taken up in Dihasahi village of Anandapur block of Keonjhar district while in Assam; the TSP programme was taken up in Itapara village in Nagaon district. The objective of the programme

Dr. R.K. Singh ADG (CC), ICAR lightening the lamp in 30 th Annual Workshop of AINPJAF

was to improve the socio-economic status of the tribal farmers through introduction of improved agriculture and allied activities in the tribal areas. Demonstration of new variety JRO 204, line sowing, integrated weed management (IWM), IPM and jute-

Scientists and participants of 30th Annual Workshop

mung intercropping recorded 1.68 – 4.44 q/ha more fibre yield additional income of Rs. . 7,133 – 18,460/ha over farmers' practices at Matiagacha and Srikrishnapur villages of North 24 Parganas district of West Bengal. Demonstration of improved varieties (JRO 204 and JBO 2003H), line sowing in jute using CRIJAF Multi Row Seed Drill and weed management resulted in additional fibre yield of 2-6 q/ha and increased the profitability of jute farming by Rs. . 7,400/ha to Rs. 26,200/ha in farmers' fields in Coochbehar district, West Bengal. The demonstration of new jute variety (Tarun) and improved package of practices in jute recorded 7.81–12.92 q/ha of additional fibre yield of jute with additional return of Rs. . 12,100/ha to. 13,295/ha over farmers' practice at Itapara village of Nagaon district of Assam.

Dr. S. Maitra, Network Coordinator, AINPJAF presenting the annual report

# 11. Krishi Vigyan Kendra

Two KVKs, Purba Bardhaman and North 24 Parganas (additional) working under the administrative control of ICAR-CRIJAF implemented various On Farm Trials (OFTs), Front Line Demonstrations (FLDs), and trainings/vocational trainings for disseminating new agricultural technologies for farmers, farm women, rural youths and extension workers.

## 11.1. KVK, Purba Bardhaman

### 11.1.1. On Farm Trials (OFTs):

Salient findings of OFTs are given below:

- Assessment of different management practices of lentil in rice-fallow system under medium upland situation revealed that seed priming can increase productivity significantly over farmers' practice (broadcasting dry untreated seed @ 30 kg/ha). Seed priming of lentil + seed treatment with *Trichoderma viride* + Rhizobium + micronutrient foliar spray with seed rate of 30 kg/ha was most profitable followed by the treatment with seed priming + foliar spray of 2% urea at pre-flowering and pod development stage with seed rate of 30 kg/ha.
- Combined application of Zn and B nutrition under rice-mustard cropping system in medium upland situation performed better as regard to productivity of rice and mustard in comparison to sole application. Increase in productivity over FP in TO1, TO2 and TO3 were 6%, 18% and 28%, respectively.
- Two hybrid varieties of tomato, *i.e.* Arka Samrat and Arka Rakshak were tested against Abhilash. Both the hybrids failed to surpass the yield of existing variety namely, Abhilash (305q/ha). Due to hardness and pericarp thickness; Arka varieties, particularly Arka Samrat may be recommended for long distance market.
- Under pond ecosystem application of 5 ppm urea along with bleaching powder showed significantly higher yield (25.5 q/ha) of Indian major crop (IMC) as compared to bleaching powder alone @ 7 ppm (20 q/ha). B:C ratio (BCR) was also higher in case of urea+bleaching powder application (BCR 2.50) as compared to farmers practice (BCR 1.51) and application of bleaching powder alone (BCR 1.91).
- Among different extension methods lecture followed by demonstration was the best teaching method in terms of knowledge gain for promotion of nursery management and propagation of fruit crops.

(*Source: Sk. Md. Azizur Rahman, D. Ghorai, S. Sarkar, G. Ziauddin and M.S. Singh*)

**Fig 11.1.** On farm trial on lentil

**Fig 11.2.** On farm trial on mustard

### 11.1.2. Front Line Demonstrations (FLDs):

Altogether 1278 FLDs were conducted on different agriculture crops including mushroom and fisheries. The salient findings of the FLDs are given below.

**Table 11.1: Details of FLDs conducted by KVK, Purba Bardhaman during 2018-19**

| Crop/ Enterprise (No. of FLD) | Technology demonstrated | Salient Findings |
|---|---|---|
| Jute (85) | Improved production technology in JRO 204 | Improved cultivar (29.45 q/ha) of jute increased productivity by 14.9% over farmer's practice of JRO 524 (25.64 q/ha). |
| Paddy (62) | Integrated crop management | Integrated management of paddy (56.25 q/ha) resulted in productivity increase of 16% over conventional practice (48.48 q/ha). |
| Groundnut (133) | Improved variety (TG-51) +20:50:75:60 N:P:K:S + Boron (20%) foliar spray | Improved variety of TG 51 (18.20 q/ha) resulted in increase of 16.7% over local check, AK 12-24 (15.60 q/ha). |
| Sesame (270) | Improved variety (RT 351) + NPKS@8:40:40:30 kg/ha | Improved variety of RT 351 (9.61 q/ha) resulted in increase of 23% over local check, IS 5 (7.82 q/ha). |

| Crop/ Enterprise (No. of FLD) | Technology demonstrated | Salient Findings |
|---|---|---|
| Green gram (212) | Improved variety (IPM 02-14) +seed priming + seed treatment with carbendazim and imidacloprid+ 2% urea | Introduction of improved variety of IPM 2-14 along with technology resulted in increase of 20.47% yield (10.65 q/ha) over local check (Sonali) (8.84 q/ha). |
| Mustard (47) | Improved variety (Keshari) + soil test based NPK + 30 kg S/ha+ two foliar sprays of boron along with micronutrient mixture | Introduction of improved cultivar of JD 6 with sulfur and boron nutrition resulted in yield increase of 12% (15.25 q/ha) over local check (B 9) (13.61 q/ha). |
| Lentil (181) | Integrated crop management | Improved cultivar of WBL 77 (Moitree) resulted in yield increase of 26.2% (10.41 q/ha) over local check (Ranjan) (8.25 q/ha). |
| Chickpea (117) | Integrated crop management | Improved chickpea cultivar of JAKI 9218 resulted in about 12.1% increase in productivity (10.34 q/ ha) over local check of Mahamaya (9.22 q/ha). |
| Onion (20) | Introduction in kharif season | The variety Agrifound Dark Red produced yield of 220 q/ha during kharif season. |
| Brinjal (15) | Improved variety | Improved variety of Bhangar Selection resulted in 17.8% increase in yield (265 q/ha) over Muktokeshi (225 q/ha). |
| Oat (5) | Improved variety and method of sowing (cv. Kent) | Yield of oat increased by 17.61% from 346 q/ha to 420 q/ha due to improved sowing method. |
| Barseem (5) | Improved variety Wardhan | High yield was recorded in Wardhan variety (458 q/ha) as compared to local variety (388 q/ha). |
| Azolla (16) | Introduction of Azolla as feed | Uses of Azolla as supplementary feed increases 0.7% of fat percentage in cow milk. |
| Monosex culture of tilapia (5) | Monosex culture of tilapia | Monosex GIFT Tilapia (*Oreaochromis niloticus*) recorded 35.6 q/ha production as against 17.5 q/ha in local check. |
| Culture of Singi (5) | Culture of Singhi | Production of 14.5 q/ha was recorded in Singi (*Heteropneustes fossilis*) as against 9.4 q/ha in local check. |
| Culture of Amur carp in composite fish culture (5) | Culture of Amur carp in composite fish culture | Production of 25.0 q/ha was recorded in demonstration of Amur as against 15.0 q/ha in local check. |
| Jayanti Rohu (5) | Jayanti Rohu | Jayanti Rohu recorded 32.0 q/ha production as against 19.0 q/ha in local check. |
| Mushroom (60) | Oyster Mushroom | Production of 1250 g/bed was recorded as against 850 g/bed in local check. |
| Mushroom (30) | Milky White Mushroom | Production of 750 g/bed was recorded against 600g/bed in local check. |

(*Source: Sk. Md. Azizur Rahman, D. Ghorai, S. Sarkar, G. Ziauddin and M.S. Singh*)

**Fig 11.3.** FLD on groundnut

**Fig 11.4.** FLD on mustard


**Fig 11.5.** FLD on Azolla

**Fig 11.6.** FLD on chickpea

**11.1.3. Trainings:** During 2018-19, altogether 128 training programmes were conducted by the KVK, Purba Bardhaman.

**Table 11.2: Training programmes conducted by KVK, Purba Bardhaman during 2018-19**

| Target group | No. of Training | No. of Participants | | | | | |
|---|---|---|---|---|---|---|---|
| | | General | | | SC/ST | | |
| | | Male | Female | Total | Male | Female | Total |
| Farmers | 43 | 1030 | 57 | 1087 | 377 | 83 | 460 |
| Rural Youth | 79 | 50 | 20 | 70 | 17 | 5 | 22 |
| Extension Personal | 5 | 119 | 12 | 131 | 8 | 0 | 8 |
| Vocational training | 1 | 0 | 20 | 20 | 0 | 3 | 3 |
| Total | 128 | 1199 | 109 | 1308 | 402 | 91 | 493 |

**11.1.4. Diploma in Agriculture Extension Service for Input Dealers (DAESI):** In Purba Bardhaman district, there are about 2500 practicing agri-input dealers, who are the prime source of farm information to the farming community. With the objective to train these input dealers as para-extension professionals by providing latest information on agriculture technology, a long-term diploma course (August 2018 to March 2019) was conducted for 40 input dealers of the district. The programme was sponsored by SAMETI.


**Fig 11.7.** Training of DASEI

**Fig 11.8.** Training on mushroom production

**Fig 11.9.** Training on plant propagation techniques

**11.1.5. Production of seed and planting materials:** Through Seed Village Scheme the KVK produced 460 q TL seeds of MTU 7029, 220 q Foundation seeds of MTU 7029 and 14 q Foundation seeds of MTU 1010, 12 q Foundation seeds of Rajendra Masuri and 4 q TL seeds of Pusa 1612 paddy. Paddy seeds of MTU 7029 was distributed to about 238 farmers under the Village Seed Programme. In addition, about 55000 seedlings of tomato and brinjal and 200 planting materials of guava and citrus were also produced at KVK Farm and distributed among the farmers. Vermicompost unit generated about Rs. 30000 by producing 4 tons of vermicompost.

**Fig 11.10.** Production of planting materials

**11.1.6. Other Extension Activities**

KVK, Purba Bardhaman organized many other extension activities to create awareness about the flagship programmes of the Government for the benefit of farmers, farm women and extension functionaries.

**Table 11.3: Details of other extension activities organized by KVK, Purba Bardhaman during 2018-19**

| Extension Activity | Venue | Date | Participants |
|---|---|---|---|
| Mahila Kisan Diwas | KVK Campus | 15 October, 2018 | 56 |
| World Soil Day | KVK Campus | 05 December, 2018 | 65 |
| World Food Day | KVK Campus | 16 October, 2018 | 62 |
| Webcast of PM Interaction with Farmers | KVK Campus | 20 June, 2018 | 300 |
| Telecast of PM Interaction with Women SHG | KVK Campus | 12 July, 2018 | 51 |
| Soil Test Awareness | Gopalpur Colony | 28 November, 2018 | 52 |

| Extension Activity | Venue | Date | Participants |
|---|---|---|---|
| District Kisan Mela (02) | KVK Campus & Raniganj | 24-25 February, 2019 | 912 |
| Pre-Rabi Kisan Sammelan | KVK Campus | 26 February, 2019 | 80 |
| Swachhta Hi Seva | KVK and adopted villages (Bud Bud, Gopalpur Colony, Kasba, Sukdal) | 15 September-2 October, 2018 | 696 |
| Swachhta Pakwada | KVK and adopted villages (Bud Bud, Gopalpur Colony, Kasba, Sukdal) | 16-29 December, 2018 | 352 |
| Vigilance Awareness Week | KVK and adopted villages (Kasba, Gopalpur Colony) | 29 October-03 November, 2018 | 134 |
| Farmer's Day | KVK Campus | 23 December, 2018 | 56 |
| STRY Training ( 02) | KVK Campus | 11-18 December, 2018 01-08 January, 2019 | 30 |
| ASCI Training Programme (02) | KVK Campus | 22-26 February, 2019 | 40 |
| Refresher course for ATM/BTM (02) | KVK Campus | 06-08 June, 2018 11-13 June, 2018 | 74 |

**Fig. 11.11.** Inaugural programme of District Kishan Mela


**Fig. 11.12.** Celebration of Mahila Kishan Divas

**Fig. 11.13.** Webtelecasting of Prime Minister's interaction with SHG

**11.14.** World Soil Day celebration

### 11.1.7. Advisory services

KVK, Purba Bardhaman has provided advisory services to large number of farmers of Purba Bardhaman district on crops, livestocks, weather advisory, market information etc. The KVK has made good use of the Farmers' Portal developed by DAC&FW in sending 63 such advisories benefiting a total of 76,20,995 farmers. Apart from this, farmers regularly visited KVK to sort out problems

faced of various kinds like crop pest/disease, soil testing and other. A total of 320 soil samples have been analysed by the KVK during 2018-19 and soil health cards have been provided.

### 11.1.8. Collaborative programme with ATMA

KVK mobilized Rs. 6,80,000/- from ATMA, Purba Bardhaman for various technology transfer activities. Two refresher courses for ATMA functionaries (Block Technology Managers and Assistant Technology Managers were conducted apart from other pertinent trainings. Apart from that on farm trials and frontline demonstrations on established technologies were also conducted.

(*Source: D. Ghorai, S. Sarkar, G. Ziauddin and M.S. Singh*)

## 11.2. KVK, North 24 Parganas (additional)

**11.2.1. Front Line Demonstrations (FLDs):** About 50 FLDs were conducted on improved jute varieties and retting.

**Table 11.4: Details of FLDs conducted by KVK, North 24 Pgs during 2018-19**

| Crop/ Enterprises (FLDs) | Technology | Results |
|---|---|---|
| Jute (50) | Improved variety of jute (*cv.* JRO 204), 25 FLDs | JRO 204 variety of jute yielded about 33.50 q/ha which was 19.64% higher than Farmer's practice |
| | Improved retting of jute by 'CRIJAF SONA', 25 FLDs | Retting with CRIJAF SONA reduced the retting period (5-6 days) and also improved the jute fibre quality |

**11.2.2. Training:** During 2018-19, six training programmes were conducted by the KVK.

**Table 11.5: Details of trainings conducted by KVK, North 24 Pgs during 2018-19**

| Target group | No. of Train-ing | No. of participants | | | | | |
|---|---|---|---|---|---|---|---|
| | | General | | | SC/ST | | |
| | | Male | Female | Total | Male | Female | Total |
| Farmers and Farm Women | 6 | 152 | 160 | 312 | 120 | 100 | 220 |

### 11.2.3. Other extension activities

***Webcasting of Hon'ble PM's Interactions with Farmers:*** Webcasting of Hon'ble PM's interactions with farmers and SHG members of different states of India through video conferencing was organised at KVK on 20th June and 12th July, 2018. Hon'ble Governor Sri Keshari Nath Tripathi graced the programme of webcasting of PM- KISAN Samman Nidhi launching programme on 24th Feb 2019 as Chief Guest. A Farmer-Scientist interaction meeting was held after the webcasting. More than 700 farmers of different villages of North 24 Parganas district participated along with scientists and staffs of the Institute. Local media personnel were also present to cover the entire programme.

**Fig 11.11.** Webcasting of Hon'ble PM's interaction with farmers

***World Soil Day celebration:*** World Soil Day was observed on 5th December, 2018 through farmer-scientist interaction on soil health issues. About 40 farmers of North 24 Parganas district participated in this programme. They were made aware about soil health management practices, importance of soil testing, scientific method of soil sampling, utility of Soil Health Card Scheme of Ministry of Agriculture and Farmers Welfare. Farmers were also given hands-on training for collecting soil samples from the field. A total of 146 soil health cards were distributed amongst the farmers.

**Fig 11.12.** Hands-on training for collection of soil samples

**Fig 11.13.** Soil Health Card distribution during World Soil Day-2018

***Organization of MAHILA KISAN DIWAS:*** Sixty-five women members from different villages of Nadia and North 24 Parganas District have participated in the programme. The programme included exhibition, essay and drawing competition, on the theme - role of women in agriculture and women empowerment. Five women from different villages of Nadia and North 24 Parganas were given Best Women Farmer Award.

**Fig 11.14.** Exhibition cum sale by SHG members

**Fig 11.15.** The winners of the competitions receiving the prizes

**Celebration of Swachhta Pakhwada and Kisan Diwas:** During Swachhta Pakhwada (16-31 December, 2018), a farmers' meet was organized at Gheedah village of North 24 Parganas to create awareness about cleanliness among farming community. Around 50 farmers and farm women participated in the programme. They pledged to keep their surrounding clean and keep free from filth. Kisan Diwas was also celebrated as a part of action plan for Swachhta Pakhwada. *(Source: M.L. Roy)*

# 12. Training and Capacity Building

## 12.1. Training and Capacity Building of Staff Members

### 12.1.1. Annual training plan

An annual training plan for 54 employees of ICAR-CRIJAF was developed for the year 2018-19 after discussion with their reporting officers and considering their skilled knowledge in specific areas the training plan was submitted to HRM section, ICAR, New Delhi. Accordingly, skill and behaviour of 53 employees (Scientific-10, Technical-18, Administrative-15 and Skilled Supporting Staffs-10) of ICAR- CRIJAF were improved through different human resource management programmes.

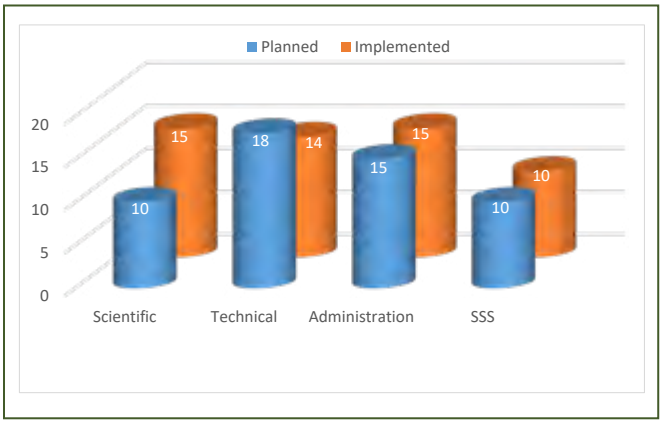



**Fig. 12.1**. Summary of ATP planned and ATP implemented during 2018-19 (Foreground- ATP planned, Background – ATP implemented).

### 12.1.2. Training undergone

The scientists were trained on various frontier aspects including experimental designs and statistical data analysis, ergonomic interventions for designing women friendly agricultural technologies, extension approaches for integrating technological options and institutional arrangements for doubling farmers' income, genomics assisted crop breeding techniques as well as stress management for better performance.

The technical personnel were trained on various areas including automobile maintenance, road safety and behavioural skills, farm management, soft skills and personality development, agrometeorological data recording, storing and climate change analysis, KOHA for library staff of ICAR and on motivation, positive thinking and communication skills.

A total of seven newly recruited administrative staffs were trained on OSP for Assistants of ICAR Institutes. Other training areas included pension and retirement benefits, administration and finance management, e-office for ICAR Institutes and efficiency and behavioural skills. The trainees received their trainings from premier institutes including ICAR-NAARM, ICAR-IARI, NIPHM and ISTM. Besides, two trainings were conducted at ICAR-CRIJAF.

### 12.1.3. Training conducted at ICAR-CRIJAF

The institute organized a training programme for Health Management and Good Office Practice of the skilled supporting staffs, which included free medical check-up and motivational

Director, ICAR-CRIJAF addressing the trainees

Inuagural session of Agrometeorology training

Trainees observing the agromet equipments in IMD, Kolkata

Demonstartion on use of fire extingushier to the trainees

talks for increasing efficiency in performance of these staffs. Besides, another six days training programme (27 Aug to 1 Sep, 2018) was organised for the employees of ICAR-CRIJAF H.Q. and its sub-stations with the objective of hands on training on "Agrometeorological data recording, storing, and climate change analysis with special reference to jute and allied fibres" covering both the theoretical and practical aspects. Total 11 employees of the institute participated in the training programme.

### 12.1.4. Impact and feedback

The institute also reviewed the impact of previous year's training as per guidelines and submitted the feedback to ICAR. Performance of 46 employees who were trained during 2017-18 were monitored through self-evaluation as well as by the evaluation of the reporting officers of the trainees. The average response of the trainees and their reporting officers varied between 3 to 4, in a scale of 1 to 5 (5 indicating highest improvement) indicating considerable improvement in performance of the trainees. The institute spent a total of Rs. 8.03 lakh for training of its staff during 2018-19, exhibiting over 99% fund utilization.

### 12.1.5. Collaboration on HRD

The institute strengthened collaborative research and student training programmes by signing a memorandum of understanding with Adamas University, Barasat, West Bengal, which will allow the students of the University to undergo trainings on cutting-edge technologies and tools of Agricultural Research as well as pave ways for collaborative research between ICAR-CRIJAF and Adamas University. In addition, the HRD section of the institute took initiatives for organizing two on-campus visit programmes for students of schools and colleges for encouraging students to opt agriculture as a career.

**Table 12.1. Training undergone by the Scientists/ Staff Members**

| Name of the Programme/training | Place and Date | Name of the Participants |
|---|---|---|
| **Scientists** | | |
| DBT State Level Biosafety Workshop | BCKV, Kalyani<br>03 April, 2018 | Dr. S. Datta |
| Handling of CAT Cases | ISTM, New Delhi<br>23-25 July, 2018 | Dr. M.S. Behera |
| Stress Management | ICAR-NAARM, Hyderabad<br>17-20 September, 2018 | Dr. S. Satpathy |
| Trainers' Training for Job Role of Quality Seed Grower | BCKV, Kalyani<br>18-20 September, 2018. | Dr. A. Bera |
| Experimental Designs and Statistical Data Analysis | ICAR-IASRI, New Delhi<br>28 September-8 October, 2018 | Dr. H.R. Bhandari |
| Training Workshop of Vigilance officers of ICAR Institutes | ICAR-NAARM, Hyderabad<br>31 October-01 November, 2018 | Dr. S. Satpathy |
| Skill Development Training on Microbial Community Analysis | IARI, New Delhi<br>12 November-12 December, 2018 | Dr. S.P. Mazumdar |
| Trainers' Training for Job Role of Agriculture Machine Operator | BCKV, Kalyani<br>18-20 November, 2018 | Dr. R.K. Naik<br>Dr. A. Bera |
| Basic Hindi Training in Computer | NIT, Durgapur<br>10-14 December, 2018 | Dr. H.R. Bhandari |
| Ergonomic Interventions for Designing Women Friendly Agricultural Technologies for Reduction of Occupational Health Hazards | CEAT, OUAT, Bhubaneswar, Odisha<br>11-20 December, 2018 | Dr. R.K. Naik |
| Management Development Program (MDP) on Priority setting, Monitoring and Evaluation (PME) of Agricultural Research Projects | ICAR-NAARM, Hyderabad<br>17-22 December, 2018 | Dr. S.K. Sarkar |
| Identification and Mass Multiplication of Entomopathogens for the Management of Insect Pests | ICAR-IIOR, Rajendranagar, Hyderabad<br>21-26 January, 2019 | Dr. V. Ramesh Babu |
| CAFT on Genomics Assisted Crop Breeding Techniques | PAU, Ludhiana<br>22 January-11 February, 2019 | Dr. H.R. Bhandari |
| 30th Annual Workshop of AINP on Jute and Allied Fibres | BAU, Bihar<br>14-15 February 2019 | 18 scientists of ICAR-CRIJAF |
| Clinic on Intellectual Property Rights (IPR) | ICAR-NINFET, Kolkata<br>02 March, 2019 | Dr. S.K. Sarkar<br>Dr. R. Saha |

| Name of the Programme/training | Place and Date | Name of the Participants |
|---|---|---|
| **Administrative Staffs** | | |
| Training Programme on Good Governance | ISTM, New Delhi<br>23-27 April, 2018 | Mr. P.K. Jain |
| OSP for Newly Recruited Assistants of ICAR Institutes | ISTM, New Delhi<br>14 May-08 June, 2018 | Mrs. S. Kumari<br>Shri. A. Das<br>Shri. S. Barman |
| OSP for Newly Recruited Assistants of ICAR Institutes | ISTM, New Delhi<br>11 June-06 July, 2018 | Ms. S. Roy Chowdhury<br>Mr. R. Kumar<br>Mr. N. Ray<br>Mr. S. Kumar Suman |
| Refresher Course on Administration & Finance Management for Section Officers, AAOs, AFAOs and Assistants of ICAR Hqs & Institutes | ICAR-CCRI, Goa<br>05-10 July, 2018 | Mr. T. Ghosh |
| Workshop cum Awareness Programme on Pension & Retirement Benefits | ICAR-CIFRI, Barrackpore<br>03-04 September, 2018 | Ms. S. Bhattacharya<br>Mr. A.K. Mondal |
| Enhancing Efficiency and Behavioural Skills of Stenographer Grade-III, PA, PS and PPS Officer of ICAR Hqs/Institutes | ICAR-NBSSLUP (RS), Kolkata<br>07-12 January, 2019 | Mrs. N. Mandal |
| **Technical Staffs** | | |
| Automobile Maintenance, Road Safety and Behavioural Skills | ICAR-CIAE, Bhopal<br>17-23 July, 2018 | Mr. S. Ghosh<br>Mr. A. Singh |
| Agro- Meteorological Data Recording, Storing and Climate Change Analysis with Special Reference to Jute and Allied Fibre Crops | ICAR-CRIJAF, Barrackpore<br>27 August-1 September, 2018 | Mr. M. K. Pradhan<br>Mr. H.K. Das<br>Mr. M. Haque<br>Mr. M.K. Kumbhakar |
| Farm Management for the Technical Staff Associated with Farm Management/ Farm Manager of ICAR Institutes | ICAR-IIFSR, Modipuram<br>14-20 September, 2018 | Mr. D.K. Patra<br>Mr. B. Das |
| Competence Enhancement Programme on Soft Skills and Personality Development for Technical Staff | ICAR- NAARM, Hyderabad<br>18-27 September, 2018 | Mr. B.L. Prasad |
| Basic Hindi Training in Computer | NIT, Durgapur<br>10-14 December, 2018 | Dr. M. Suresh Singh<br>Mr. B.L. Prasad |
| Training cum Workshop on Plant Protection | ICAR-ATARI, Kolkata<br>13-15 December, 2018 | Mr. S. Garai<br>Mr. S.S. Kundu |
| Sensitization / Training Programme for e-office for ICAR institutes | ICAR-IASRI, New Delhi<br>23-24 January, 2019 | Mr. G. Ghosh<br>Mr. P. Singh |
| KOHA for Library Staff of ICAR | ICAR-NAARM, Hyderabad<br>21-26 February, 2019 | Mr. R. Mitra |
| Motivation, Positive Thinking and Communication Skills for Technical Officers (T-5 and above) of ICAR Institutes | ICAR-IISWC, Dehradun<br>13-19 March, 2019 | Mr. S. Biswas |
| **Skilled Support Staff** | | |
| Health Management and Good Office Practice | ICAR-CRIJAF, Barrackpore<br>15-17 November, 2018 | 10 Skilled Supporting Staffs of ICAR-CRIJAF |

**Table 2. Seminar/ Symposium/ Conference/Meeting/ Workshop attended by the scientists**

| Programme | Institute and Date | Name of the Participant |
|---|---|---|
| NICRA Expert Committee Meeting | NASC, New Delhi<br>03-04 July, 2018 | Dr. A.K. Singh |
| Workshop on "Application of Biosensor Technology in Inland Fisheries" | ICAR-CIFRI, Barrackpore<br>01 August, 2018 | Dr. D. Barman |
| 2nd National Conference on "Doubling Farmer's Income for Sustainable & Harmonious Agriculture (DISHA-2018)" | ICAR- IINRG,<br>11-12 August, 2018 | Dr A.K. Jha |

| Programme | Institute and Date | Name of the Participant |
|---|---|---|
| International Conference on "Agriculture & Allied Sciences: The Productivity, Food Security and Ecology". | BCKV, Kalyani<br>13-14 August, 2018 | Dr. A. Bera<br>Dr. Maruthi, R.T.<br>Dr. L. Sharma |
| National Conference on "Advances in Clay Science towards Agriculture, Environment & Industry and the 21st Annual Convention of Clay Mineral Society of India" | NBSSLUP (RC), Kolkata<br>14-15 September, 2018. | Dr. D.K. Kundu<br>Dr. S.P. Mazumdar |
| 1st International Conference on "Biological Control: Approaches and Applications" | Le Meridian, Bengaluru<br>27-29 September, 2018 | Dr. B.S. Gotyal<br>Dr. S. Satpathy |
| DST-NRDMS Project Review Workshop Meeting | JNT University, Hyderabad<br>10-11 November, 2018 | Dr. A.K. Singh |
| 4th International Plant Physiology Congress (IPPC-2018) | CSIR-NBRI, Lucknow<br>02-05 December, 2018 | Dr. L. Sharma<br>Dr. S. Roy |
| International Conference on "Livelihood Promotion, Bio-diversity Conservation and Social Security in Indian Sundarbans" | Eco-Tourism Hub, South 24-Pgs, WB<br>07-09 December, 2018 | Dr. D. Barman |
| 1st National Genetics Congress | IARI, New Delhi<br>13-16 December, 2018 | Dr. S. Datta<br>Dr. P. Satya |
| National Symposium on "Role of Resource Management in Agriculture in the Context of Food Security, Nutrition and Economy" | University of Calcutta, Kolkata<br>15-17 December, 2018 | Dr. R. Saha<br>Dr. S. Sarkar |
| International Conference on "Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Landscape" | ICAR-NRCSS, Ajmer<br>20-22 December, 2018 | Dr. S. Satpathy |
| 4th National Conference on "Diversified Farming System: Sustainable Livelihood and Doubling Farmer's Income" | UBKV, Dinajpur<br>17-18 January, 2019 | Dr. S. Sarkar<br>Dr. B. Majumdar<br>Dr. A.R. Saha<br>Dr. R. Saha |
| National Seminar on "Sustainable Resource Management for Enhancing Farm Income, Nutritional Security and Livelihood Improvement" | Visva-Bharati, Sriniketan<br>01-03 February, 2019 | Dr. S.P. Mazumdar |
| National Seminar on "Natural Fibre Resource Management for Sustainable Developments" | ICAR-NINFET, Kolkata<br>02-03 February, 2019 | Dr. M.S. Behera<br>Dr. D. Barman<br>Dr. R.K. Naik |
| International Symposium on "Advances in Agrometeorology for Managing Climatic Risks of Farmers", | JNU, New Delhi<br>11-13 February, 2019 | Dr. D. Barman |
| National Conference of XIV Agriculture Science Congress on "Innovations for Agricultural Transformation" | ICAR-IARI, New Delhi<br>20-23 February, 2019 | Dr. A.R. Saha<br>Dr. R.K. De<br>Dr. R. Saha<br>Dr. M.S. Behara<br>Dr. R.K. Naik |
| National Symposium on "Recent Challenges and Opportunities in Sustainable Plant Health Management" | BHU, Varanasi<br>26-28 February, 2019 | Dr. K. Mandal |
| West Bengal State Science Congress | Science City, Kolkata<br>28 February - 1 March, 2019 | Dr. S. Datta |
| The 6th Dr. S.K. Mukherjee and Dr. K.K. Rohatgi-Mukherjee Annual Endowment Lecture of Raman Centre for Applied & Interdisciplinary Sciences | NBSSLUP (RS), Kolkata<br>01 March, 2019 | Dr. D.K. Kundu |
| National Conference of Stakeholders on "Conservation, Cultivation, Resource Development and Sustainable Utilization of Medicinal Plants of North-Eastern India" | NU, Lumami<br>06-07 March, 2019 | Dr. M.S. Behera |
| DBT NECAB Symposium | AAU, Jorhat<br>25-26 March, 2019 | Dr. S. Datta |
| National Seminar on "Use of Agrochemicals for a Sustainable Agriculture and Environment and the 6th Annual Convention of the Society for Fertilizers & Environment" | BCKV, Kalyani<br>27 March, 2019 | Dr. S. Sarkar<br>Dr. D.K. Kundu<br>Dr. A.R. Saha |

# 13. Meetings and Events

## 13.1. Brain Storming Meeting on 'Promising Future of Jute'

A brainstorming meeting was organized at ICAR-CRIJAF, Barrackpore on 10th April, 2018. RAC members from Kolkata, Director, ICAR-NINFET, representatives from NJB, JCI, Jute Industries, seed growers (Nuzivedu Seed and Bharat Nursery), farmers' representatives and other stakeholders participated in the meeting. Exploring the world market for jute and allied fibres, product diversification, scientific and simple robust methods for "quality" assessment of fibres and 'products', development of cost effective low-water and quick retting methods were salient recommendations (*Source: S. Datta*).

Participants of Brain Storming Meeting on jute

## 13.2. QRT Meeting

The first meeting of QRT was held at CRIJAF HQ and CSRSJAF, Budbud from 17-19th April, 2018. Director, ICAR-CRIJAF welcomed the members and briefed about Institutional achievements. In the opening remarks Dr. C.D. Mayee, Chairman QRT expressed concerns about the jute sector, particularly the productivity plateau. Dr. N. Gopalakrishnan viewed that the institutional output is to be made stronger for practical problem

QRT meeting Chaired by Dr. C.D. Mayee

solving through proper SWOT analysis. Dr. L.K. Hazarika emphasized to concentrate more on HPR research to combat pest outbreak. Dr. S.R. Das stressed upon development of gene pool, creating greater genetic variability, more multiple evaluation for wider adaptability and breeding methods for targeting mega variety. Dr. D. Nag emphasized for the importance to allied fibre crops with special focus on quality. Dr. S. Satpathy, Member-Secretary, QRT presented the ATR and the background information of the

Field visit of QRT at CSRSJAF, BudBud

Institute, jute and allied fibre sector. Division-wise and regional station-wise and AINPJAF (HQ) presentations were done by respective I/Cs. The CAO and FAO of ICAR-CRIJAF deliberated about the manpower, financial and administrative issues. The QRT team visited CSRSJAF, Budbud on 18th April, 2018. Dr. C.S. Kar, Nodal Officer Seeds and Dr. H.R. Bhandari, I/C, CSRSJAF made brief presentation on the jute seed scenario and achievements of the station. On the third day of QRT meeting on 19th April, 2018 the team had a detail interaction with the scientists of different divisions followed by the representatives of Jute Industry, State Department of Agriculture, JCI, NJB, DJD, NGOs and farmer's representatives.

Quinquennial Review Team (2012-17) of CRIJAF

The final QRT meeting was held on 3rd July, 2018 at ICAR-CRIJAF. The agenda of this meeting was to finalize the future road map of research in jute and allied fibre crops after brief presentations on advances made in research on major disciplines. The Chairman asked the scientists to focus on the cutting edge research agenda primarily on jute first. The committee thoroughly discussed the content of the final report and crystalized the overall recommendations after considering administrative and financial issues with respect to budget, infrastructure, scientific and technical personnel. The Chairman thanked the Director and the Committee members for their full co-operation in successful completion of the review process. (*Source: S. Satpathy.)*

### 13.3. IRC Meeting

The Institute Research Council (IRC) meeting (2018-19) was conducted under the chairmanship of the Director, ICAR-CRIJAF to review the proposal of new research projects as well as progress of the on-going in-house projects and achievements of externally funded research projects during 21st-22nd May, 2018. The chairman complimented Dr. D. Buman, Sr. Scienitst and his team for getting one externally funded project from ISRO and requested

Presentation and discussion on various project report during IRC, 2018

all the scientists to pursue for externally funded projects. He also appreciated the scientists for their commendable achievements and transfer of technologies especially in Jute-ICARE programme. Dr. S.K. Sarkar, Pr. Scientist and In-Charge, PME Cell coordinated the meeting (*Source: S.K. Sarkar*).

### 13.4. Webcasting of Farmers' Interaction with PM

As per the directives of the Council, the Institute organized the live webcasting of farmers' interaction with Hon'ble Prime Minister of India in various Krishi Vigyan Kendras on 20th June, 2018. On this occasion, a farmers-scientist interaction meeting was also organized in the Institute. Various issues related to jute agriculture like weed management, IPM, INM, jute based cropping system

Webcasting of farmers interaction with PM

were deliberated by the scientists and queries raised by the farmers were adequately addressed. About 150 farmers participated in this programmes (*Source: M.L. Roy*).

Farmers-Scientist interaction meeting

### 13.5. International Day of Yoga-2018

The Institute celebrated fourth International Day of Yoga on 21st June, 2018 at its HQs. The programme started with the opening remarks of Dr. R.K. Naik, Senior Scientist & Chairman, E&MC (CRIJAF) in presence of Director, HoDs, Scientists and other staff

Celebration of International Day of Yoga-2018

members. On this occasion Dr. Pranab Roy, District President, *Patanjali Yoga Samiti*, North 24 Parganas, Barasat delivered a talk on Yoga and its relevance to the mental and physical health. He also demonstrated some of the yoga positions and Asanas including Pranayams. About 70 staff of the Institute comprising Scientists, Administrative, Technical and Supporting staff attended the programme and practiced different asanas *(Source: R.K. Naik)*.


Facilitation of Dr. P. Roy, Chief Guest of International Day of Yoga

### 13.6. Training Programme on Improved Seed Production Technology of Mesta

A training programme on foundation seed production of mesta was organized with registered seed growers of Jaypur and adjacent blocks of Purulia district on 22nd June, 2018 In this occasion, 50 kg breeder seed of improved mesta (both roselle-HS 7910, HS 4288 and kenaf-HC 583) varieties were distributed among farmers. The farmers were sensitized to create awareness about mesta seed production. Fifty farmers participated in this training programme. Dr. C.S. Kar, Principal Scientist, Dr. Amit Bera, Senior Scientist

Farmers attending the training on Improved Seed Production of Mesta

and Mr. U.S. Roy, Assistant Botanist, WBAS were present in this meeting. The scientists deliberated in detail on soil, climate and seed production methodology of mesta. (*Source: C.S. Kar*).

### 13.7. Hindi Workshop

One day Hindi workshop was organized at ICAR-CRIJAF on 29th June, 2018 with the objective to reduce the inertness among the employees to use Hindi in day to day official work. Director, Dr. J. Mitra chaired the inaugural session of the workshop. Dr. Chandra Gopal Sharma, Deputy Chief Rajbhasha Adhikari (JAG) Eastern Railway, Kolkata deliberated on Rajbhasha policies, rules, grammer etc. Dr. S.K. Pandey, Scientist In-Charge, Hindi Cell and Mr. Manoj Kumar, Assistant co-ordinated the programme *(Source: S.K. Pandey)*

Resource person is interacting with participants in Hindi Workshop

### 13.8. Live Telecasting of Hon'ble PM's Interaction with Members of SHGs and Women Groups

A programme was organised by KVK North 24 Parganas (additional) at ICAR-CRIJAF, Barrackpore on 12th July, 2018 for live telecasting of the Hon'ble PM's direct interaction with the members of different SHGs and women groups working in various states of India. About 51 women farmers/entrepreneur belonging

Live telecasting of Hon'ble PM's interaction with SHG and women group members

to 15 SHGs working in Barrackpore-I, Barrackpore-II and Barasat-I blocks of North 24 Parganas district participated in this programme to experience this event. The response of the women was very good to this motivating and inspiring programme. After the end of the programme, the Director, In-charge of the KVK congratulated the women farmers for being audience of this interesting live programme and motivated them to be part of women-friendly and employment generating programmes of the Govt. of India in a large scale for their socio-economic development. *(Source: M.L. Roy)*

Director, ICAR-CRIJAF with the SHG and women group members

### 13.9. RAC Meeting

The Research Advisory Committee (RAC) meeting of ICAR-CRIJAF was held during 26-27th July, 2018 under the Chairmanship of Dr. S.A. Patil, Ex-Director, IARI, New Delhi. The RAC discussed in detail the research activities of the scientists of ICAR-CRIJAF for the period of November 2017 to July 2018.The committee was satisfied with the research achievements of the scientists under the broad mandate of the Institute. The RAC made nine specific recommendations for further strengthening of the research

activities of the Institute. These recommendations are being incorporated while formulating research projects. *(Source: S.Datta)*


Chairman and other members of RAC interacting with scientists

### 13.10. National Sanitation Campaign under *Swachha Bharat* Mission activities

Under the banner of *Swachha Bharat* Mission, the Institute organized awareness programmes and cleanliness drive inside the premises and outside the campus. Besides the cleaning activities emphasis was given to create awareness among public towards cleanliness. *(Source: R.K.Naik)*

Cleaning activities in CRIJAF campus

Staff members of ICAR-CRIJAF participated in Swachha Bharat Mission activities

### 13.11. Celebration of Farmers' Day-2018

Farmers' Day-2018 was organized by ICAR- CRIJAF, Barrackpore on 4th August, 2018 at its campus. Around 200 delegates including about 150 progressive farmers from major jute growing districts of West Bengal like Nadia, Hooghly and North 24 Parganas, scientists, small entrepreneurs dealing with jute fabric, press and media personnel participated in this programme. Mr. Arvind Kumar, Secretary, National Jute Board, Kolkata was present as the Chief Guest in this programme. Representative of State Agril. Deptt., bank and other deptt. participated in this programme. Director, Heads and In-charges of different divisions and sections of the


Address of the Director during Farmers' Day-2018

Institute were also present. The meeting started with an exposure visit followed by tree plantation, deliberation of guests and farmer-scientist interaction, quiz competition and valedictory function. *(Source: S.K. Jha)*

Progressive farmers attending the Farmers' Day-2018

### 13.12. National level Training on "Improved Retting Technology of Jute & Allied Fibres" under NFSM (CC)-Jute

A national level training on "Improved Retting Technology of Jute and Allied Fibres" under NFSM (CC)-Jute was organized at ICAR-CRIJAF, Barrackpore during 7-9th August, 2018. A total of 14 agriculture officials from state department of agriculture of West Bengal, Bihar and Uttar Pradesh participated in this training

Dr. C. S. Kar, Nodal Officer, NFSM (CC)-Jute addressing the trainees

programme. The training covered important aspects of retting with respect to microbial retting, fibre extraction and retting of JAF crops, fibre quality and other post-harvest technology for better fibre quality. There was also field visit to the retting facilities and retting demonstration. Ribbon extraction technique by manual/ power operated jute fibre extractor, sisal and ramie fibre extractor and the retting of ribbon with microbial formulation were also demonstrated before the trainees. *(Source: C.S. Kar)*

Demonstration of ribbon extraction in workshop

### 13.13. Independence Day Celebration

Independence day, 2018 was celebrated on 15th August, 2018 at ICAR-CRIJAF in presence of CRIJAF staff and their family members. Dr. Jiban Mitra, Director hoisted the National Flag followed by recitation of National Anthem. The ex-service security personnel of the institute paid Guard of Honour to the Tricolour. Director, Head of the Divisions, In-charges of the sections, Administrative officer, FAO and other senior officers conveyed the message of Independence Day in this occasion.

Dr. Jiban Mitra, Director, ICAR-CRIJAF hoisting the National Flag on Independence Day

### 13.14. *Swachhta hi Seva* campaign

"*Swachhta hi Seva*" was celebrated during 15th September to 2nd October, 2018. In the beginning all the staffs were administered pledge by Director. Various programmes like *Seva Divas, Samagra Swachhta Divas, Swachhta* at nearby households, villages, schools, tourist spot, making wall paintings and constructions of low cost toilet making were performed during this period. On the eve of 150th birth Anniversary of Mahatma Gandhi branding of logo in the form of banner was displayed near main gate of the institute. A rally was conducted in the office campus. Officials and school children of nearby schools including teachers actively participated in the rally. Cleanliness drive was conducted in and around the lawn of guest house through *Shramdaan* by officials. A pictorial exhibition reflecting the life of Mahatma Gandhi was organized. *(Source: R.K. Naik )*

*Swachhta* pledge administered by Director

*Swachhta* awareness nearby households and village

Cleanliness drive in ICAR-CRIJAF campus

Rally on the eve of 150th birth Anniversary of Mahatma Gandhi

### 13.15. Interaction Meeting with Officials from NEHU, Shilong on Ramie Cultivation in NE States

Prof. S.R. Joshi, Professor, Biotechnology and Bio-informatics Department, North Eastern Hill University and Mr. B.K. Sohliya, Director Meghalaya Institute of Entrepreneurship, Shilong visited the institute on 27th September, 2018 to discuss about various issue of ramie cultivation in Meghalaya for improvement of livelihood of farmers. The Director appraised the visitors about prospects of ramie cultivation in NE states and improved technologies available with the Institute. *(Source: S. K. Sarkar)*

NEHU delegates being appraised on microbial retting formulation

### 13.16. Visit of French Delegation

Five member French delegation headed by Mr. Aurelin Sostaponti visited ICAR-CRIJAF on 28th September, 2018 to know about the various activities of CRIJAF. Director, CRIJAF welcomed the delegates and Dr. C.S. Kar, Principal Scientist presented a brief account of various activities and achievements of ICAR-

French delegates on farm visit

CRIJAF. After presentation, issues like production and processing and diversified uses of jute and allied fibres were discussed. The delegation also visited the CRIJAF field for acquaintance with the crops. *(Source: S. K. Sarkar)*

Interaction meeting with French delegates

### 13.17. *Mahila Kisan Diwas*-2018

ICAR-CRIJAF organized the *Mahila Kisan Diwas* on 15th October, 2018. Sixty-five women from different villages of Nadia and North 24 Parganas District participated in the programme. The programme included exhibition, essay and drawing competition, on the themes like role of women in agriculture and women empowerment. In addition to this women of various Self Help Groups from different villages shared their success stories with other farm women. Dr. Jiban Mitra, Director, ICAR-CRIJAF addressed the participants. Five best women entrepreneurs from different villages of Nadia and North 24 Parganas were also awarded Best Women Farmer Award during the concluding session. Prizes for the essay and drawing competitions were also distributed to successful participants during the concluding session. *(Source: Shamna, A)*

The participants of the Mahila Kisan Diwas-2018

### 13.18. Celebration of Vigilance Awareness Week – 2018

ICAR-CRIJAF conducted awareness programmes within and outside the institute during the observance of Vigilance Awareness Week (VAW) -2018 (29th October to 3rd November, 2018). On the inaugural day, Director, ICAR-CRIJAF administered the Integrity Pledge to all the staffs of the institute followed by formation of human chain. Debate competition on the theme topic "Eradicate Corruption – Build a new India" and written quiz competition were organised to create interest and awareness about vigilance, corruption among the employees of the Institute. The winners of all the competitions of the Institute were felicitated with prizes in the concluding session. All the regional stations also observed vigilance awareness week. ICAR-CRIJAF, Barrackpore also organized a village awareness programme on vigilance and corruption at Gheedah village of Barrackpore-II block in North 24 Parganas


CRIJAF staffs being administered pledge during Vigilance Awareness Week

district participated by 52 villagers, mostly women members of the farm families. Apart from various activities at the institute, vigilance awareness programme was extended to several schools and universities. Quiz Competition cum sensitization programme was

organized in Assembly of Angels Secondary School, Barrackpore, ADAMAS University, West Bengal State University, Barasat and Barasat MGM High School. *(Source: S.Satpathy)*


Vigilance Awareness camp at Assembly of Angels Secondary School, Barrackpore


Celebration of Vigilance Awareness Week at RRS, Bamra

### 13.19. Visit of Sri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare, Govt. of India

Hon'ble Union Minister of Agriculture and Farmers' Welfare, Sri Radha Mohan Singh visited ICAR-CRIJAF, Barrackpore on 14th November, 2018. He greeted the gathering and encouraged to the newly joined scientists and staffs of the institute. He also appealed to actively involved in all development programmes like Soil Health Mission, Pradhan Mantri Fasal Beema Yojana and E-NAM. He reiterated that ICAR schemes like Mera Gaon Mera Gaurav (MGMG), Farmers' First, Oilseeds and Pulses Demonstration launched by Govt. of India will benefit the farmers. The minister emphasized to develop and demonstrate jute based farming system model for the farmers and to focus on higher revenue generation. *(Source: S. K. Sarkar)*

Hon'ble Union Minister of Agriculture and Farmers' Welfare, Sri Radha Mohan Singh on discussion with Director, ICAR-CRIJAF

Hon'ble Union Minister of Agriculture and Farmers' Welfare, Sh. Radha Mohan Singh interacting with scientists and staffs of ICAR-CRIJAF

### 13.20. Field Day cum Demonstration on Seed Production Technique

A 'Field day cum demonstration on Seed production technique' was organized at CSRSJAF, BudBud on 20th November 2018. Nearly 75 farmers from different villages of Burdwan district participated in the programme. Mr. Milon Mondal, ADA (Admn.), WBSSA delivered a speech on quality seed production followed by a speech on seed production technologies of paddy crop. The farmers were exposed to seed chain system followed in India, nucleus seed plots of jute, mesta and sunnhemp, other on-farm activities in breeder seed production and germination test. They were also trained on post-harvest operation and seed processing. *(Source: H.Bhandari)*


Field day cum demonstration on seed production technique organized at CSRSJAF, BudBud

### 13.21. ASCI Training Programme on Agriculture Extension Service Provider

An ASCI training programme on Agriculture Extension Service Provider started from 30th November, 2018 at ICAR-CRIJAF, Barrackpore. Twenty rural youths participated in this training programme. The training programme continued till 5th January, 2019. All the subjects essential to perform the job roles of an agriculture extension service provider were covered during this training programme. Resource persons from KVKs, Government Departments and Input Agencies were invited to train the trainees. Exposure visits were also conducted for better understanding of

the trainees about the subject. Experiential learning methodology was applied to train the participants by which the trainees could learn by doing. *(Source: S. K. Jha)*

Dr. Jiban Mitra, Director of the Institute addressing the trainees

Participants of ASCI training programme

### 13.22. Celebration of World Soil Day and distribution of Soil Health Card

World Soil Day was observed by KVK-II, North 24 Parganas on 5th December, 2018 at ICAR-CRIJAF, Barrackpore. A farmer-scientist interaction meeting regarding different soil health issues and a farmers' awareness programme was also organized on this occasion. About 40 farmers of North 24 Parganas district participated in this programme. They were made aware about soil health management practices, importance of soil testing, scientific method of soil sampling, utility of Soil Health Card Scheme of MoA & FW, GoI and soil test-based fertilizer application. Farmers were also given hands-on training for collecting soil samples from the field. A total of 146 soil health cards were distributed amongst the farmers.


Farmer-Scientist interaction during World Soil Day-2018

On the occasion of World Soil Day, ICAR-CRIJAF, Barrackpore distributed 618 soil health cards to the farmers. Dr. Jiban Mitra, Director, ICAR-CRIJAF, Dr. S. Satpathy, HoD (Crop Protection), Dr. D.K. Kundu, HoD (I/c), Crop Production and Dr. A.R. Saha,


Dr. J. Mitra, Director, ICAR-CRIJAF distributing soil health card

Principal Scientist (Soil Science) were present in the occasion. 252 soil health cards were distributed to the farmers of Bansbona village of Haringhata Block, Nadia District. 366 soil health cards were distributed to the farmers of Bhabanipur Village of Haringhata Block of Nadia District. In both the villages resource persons interacted with the farmers. Besides this, farmers were made aware regarding soil pollution. *(Source: A. R. Saha & A. K. Singh)*

Dr. A.R. Saha distributing soil health card

### 13.23. Visit of Dr. A.K. Singh, DDG (Crop Science), ICAR, New Delhi

Dr. A.K. Singh, DDG (Crop Science) visited ICAR-CRIJAF on 15th December, 2018. He addressed the scientists of the institute and underlined the issues like wider popularization of institute technologies, large scale production of microbial consortium CRIJAF SONA, resource generation etc. Various farm machineries developed by this institute were demonstrated in front of him. DDG expressed satisfaction on the technologies developed by the Institute and asked for promotion of these technologies for benefit of the farmers. *(Source: S. K. Sarkar)*

Dr. A.K. Singh, DDG (Crop Science), ICAR interacting with the scientists

### 13.24. *Swachhta Pakhwada* Campaign

The campaign entitled "*Swachhta Pakhwada*" was celebrated during 16-31st December, 2018. The the staffs were administered pledge by the Director. Various programmes like Cleanliness drive, Kisan diwas, Swachhta awareness at nearby households, villages, schools, and tourist spot were performed during this period. *(Source: R. K. Naik)*


Staffs being administered the *Swachhta* pledge

Cleanliness drive at nearby household

### 13.25. Kishan Diwas at SRS, Bamra

Sisal Research Station, Bamra organized Kishan Diwas at SRS, Bamra on 23rd December, 2018. The objective of the programme was to inform the farmers about the latest technologies and the ways to solve the problems faced by the sisal growers. The programme was attended by 40 farmers from nearby villages. There was an interaction session also to know the expectation of the farmers from SRS, Bamra. (*Source: A.K. Jha*).


Kishan Diwas at RRS, Bamra

### 13.26. ASCI Training Programme for the Job Role of Qulaity Seed Grower

ICAR-CRIJAF, Barrackpore organized skill development training for unemployed rural youths for the job role of "Quality Seed Grower" during 3rd January-7th February,2019. Under RKVY with the objective of capacity building by bridging gaps and upgrading skills of farmers, self-employed workers engaged in agriculture regarding quality seed production. Twenty participants attended this training. Both theoretical and practical classes were arranged to provide hands on training in seed production as per National Occupational Standard (NOS) set by National Skill Development Corporation (NSDC). Principle of seed production in various field crops, Rules and regulations, Acts and Orders related to seed quality control were discussed to upgrade their knowledge. Trainees were assessed through an external assessment agency appointed by ASCI. (*Source: A. Bera*)


Inaugural session of ASCI training of Seed Production

### 13.27. ASCI Training Programme for the Job Role of Agriculture Machinery Operator

A training programme for the job role of "Agriculture Machinery Operator" was organized from 23rd January to 27th February, 2019, 2019 at ICAR-CRIJAF, Barrackpore. Twenty rural youths participated in this training programme. The course curriculum covered all the subjects essential to perform the job roles of an agriculture machinery operator through theoretical as well as practical classes. Resource persons from other ICAR Institutes, SAUs and Government departments and Input agencies were invited to train the trainees. Exposure visits were also conducted

for the trainees for better understanding of the subject. Experiential learning methodology was applied to train the participants by which the trainees could learn by doing. (*Source: R.K. Naik*)

### 13.28. Republic Day Celebration

The Republic Day was celebrated in ICAR-CRIJAF with full enthusiasm. Dr. S. Satpathy, Head, Crop Protection Division hoisted the National Flag followed by National Anthem. He appreciated the efforts of the staffs in development of the Institute.


Dr. R.K. Naik, Course Director addressing the trainees

Exposure visit of trainees

On the other hand, he appealed the scientists to work with fresh enthusiasm to face new challenges in research in jute agriculture. Other senior officials, staff members along with children, family members attended the celebration.

Dr. S. Satpathy addressing the gathering on Republic Day

### 13.29. Foundation Day

The ICAR-CRIJAF celebrated 66th Foundation Day at its Headquarters in Barrackpore on 9th February, 2019. The Chief Guest, Dr. N.C. Pan, Director, ICAR-NINFET, Kolkata stressed on the need to have motivation and unity for doing work together. Dr. Jiban Mitra, Director, ICAR-CRIJAF appreciated the efforts of the staffs for the achievements of the Institute and motivated them


Director is addressing the staffs during Foundation Day

for its further overall improvement. Dr. S. Satpathy, Head, Crop Protection Division briefed the audience about the history of the institute and achievements of the division. Shri P.K. Jain, Chief Administrative Officer and Shri G. Ghosh, Finance and Accounts Officer highlighted Institute's major achievements during the last five years. On the occasion different sports activities among the staff wards and staff members of the Institute was organized. Foundation Day Awards instituted for the first time was given to meritorious staffs in different categories. The winners of the different categories viz., scientific, technical, administrative and supporting were also conferred with the "Best Worker Award". The dignitaries also conferred prizes to the winners of sports event. *(Source: P. K. Jain)*

### 13.30. Webcast of PM Kisan Samman Nidhi Programme

ICAR-CRIJAF webcast of the PM Kisan Samman Nidhi launcing programme on 24th February, 2019. Shri Keshari Nath Tripathi, Hon'ble Governor of West Bengal graced the occasion as chief guest. Dr. Jiban Mitra, Director, ICAR-CRIJAF welcomed the chief guest and briefed about the significant achievement of the institute. In his address Hon'ble Governor highlighted about the PM Kisan Samman Nidhi Programme. A number of publications of the institute were released by Hon'ble Governor. Different technologies developed by ICAR-CRIJAF were displayed in a stall. About 350 farmers along with all the staff members of the institute participated in the programme. *(Source: S. K. Jha & T. Samajdar )*

Hon'ble Governor of W.B. in the occasion of launching PM Kisan Samman Nidhi at ICAR-CRIJAF

# 14. Awards and Recognitions

## 14.1. Awards

1. Dr. S Satpathy, Head, Crop Protection Division was conferred with "PP Singhal Memorial Award-2018" instituted by Society for Plant Protection Sciences, New Delhi for outstanding contribution to research in Entomology, in the International Conference on 'Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Landscape'. 20-22 December, 2018, ICAR-NRCSS, Ajmer.

Dr S. Satpathy receiving the P.P. Singhal Memorial Award

- Dr. S. Satpathy, Head, Crop Protection Division was conferred with "ISVS Fellowship-2017" of Indian Society of Vegetable Science–2017, Varanasi for significant contribution in the field of Vegetable Research during the Vegetable Science Congress- VEGCON-2019, 01-03 February, 2019, RAU, Jodhpur.
- Dr. B.S. Gotyal, Senior Scientist was awarded with the NAAS Associateship for the year 2019.

Dr. B.S. Gotyal receiving NAAS Associateship for the year 2019

- Dr. Ritesh Saha, Principal Scientist was conferred with "Distinguished Scientist Award" in Soil Science by Venus International Foundation, Chennai for outstanding contribution, research excellence and accomplishments in the field of Soil Science during Venus International Research Awards Ceremony on 11 August, 2018, Chennai.
- Dr Ajit Kumar Jha, Sr. Scientist received Distinguished Scientist Award for outstanding contribution in the field of Plant Pathology on the Occasion of 2nd National Conference on Doubling Farmers Income for Sustainable & Harmonious Agriculture (DISHA-2018) during 11-12 August, 2018 at ICAR- IINRG, Ranchi, Jharkhand.
- Dr. Shamna, A., Senior Scientist received the Young Scientist Award 2018 in ISEE National Seminar on "Integrated Farming System for Enhancing Farmer's Income and Nutritional Security", 5-7 December, 2018, WBUAFS, Kolkata.

Dr A. Shamna, receiving the ISEE Young Scientist Award, 2018

- Dr. Ritesh Saha, Principal Scientist awarded with Best Oral presentation award for the research paper "System productivity, Resource and Radiation use efficiency under Conservation Agriculture in jute based Cropping Systems" in COBACAS 4th National Conference on "Diversified Farming System: Sustainable Livelihood and Doubling Farmer's Income" on 17-18 January, 2019, Majhian Campus, UBKV, Balurghat.
- Dr. M.S. Behera, Principal Scientist received the Best Paper Award conferred by The Indian Natural Fibre Society, Kolkata during National Seminar on Natural Fibre Resource Management for Sustainable Development, 2-3 February, 2019 held at ICAR-NINFET, Kolkata.
- Dr. Dhananjay Barman, Senior Scientist awarded with Best Paper Presentation Award conferred by Association of Agrometeorologists, Anand for the research paper 'Spatial and temporal variability analysis of rainfall for major jute growing districts of West Bengal' during International Symposium on "Advances in Agrometeorology for Managing Climatic Risks of Farmers", 11-13 February, 2019, JNU, New Delhi.

- Dr. B.S. Gotyal, Senior Scientist received the Best Poster Award for research paper "Biological Control of key Pest of jute, *Spilosoma obliqua*- A case study" authored by B.S. Gotyal, V. Ramesh Babu, S. Satpathy and K. Selvaraj during International Conference on Biological Control (ICBC-2018) Approaches and Applications, 27-29 September, 2018, Le Meridian, Bangaluru.

Dr. B. S. Gotyal receiving the Best Poster Award

- Dr. M.L. Roy, Scientist received the Best Oral Presentation Award under Theme "Challenges and opportunities in enhancing farmers' income" in International Conference on Rural Livelihood Improvement for Enhancing Farmers' Income through Sustainable Innovative Agri and Allied Enterprises (RLISAAe), 30 October-1 November, 2018, BIT, Patna.
- Dr. A. Anil Kumar, Scientist was awarded 'Best Oral Presentation Award' in International Conference on "Agriculture and Allied Sciences: The productivity, Food Security and Ecology", 13-14 August 2018, BCKV, Mohanpur.
- Institute Annual Award presentation during Foundation Day: The Institute conferred awards for various categories of staff members during the Foundation Day ceremony of the Institute on 9th February, 2019. Dr. A. Anil Kumar, Scientist was awarded with 'Best Young Scientist Award 2018'. Under technical category Mr. M.K. Pradhan, Technical Officer was awarded with 'Best Technical Personnel Award-2018'. Under administrative categories Mr. Rajkumar Ghosh, Assistant was conferred with 'Best Administrative Personnel Award-2018'. Similarly, Mr. Ratna Bahadur, Skilled Support Staff was awarded with 'Best Skilled Support Staff Award-2018'.

Sh. M.K. Pradhan receiving the Best Technical Personnel Award

Sh. Rajkumar Ghosh receiving the Best Administrative Personnel Award

Sh. Ratna Bahadur receiving the Best Skilled Support Staff Award

## 14.2. Recognitions

- Dr. S. Satpathy, Head, Crop Protection Division was invited for lead talk on the International Conference on Climate Change and Adaptive Crop Protection for Sustainable Agri-horticulture Landscape organized by Society for Plant Protection Sciences at ICAR-NRCSS, Ajmer during 20-22 Dec, 2018.
- Dr. S.K. Sarkar, Principal Scientist was nominated as a Member of Peer Review Team (PRT) constituted by Director General, ICAR for on spot assessment of accreditation from NAEAB, ICAR, New Delhi.
- Dr. Bijan Majumdar, Principal Scientist was invited to deliver a lead paper on "Production of quality jute (*Corchorus olitorius*) fibre through deployment of improved microbial retting method by the farmers of Dakshin Dinajpur" in COBACAS 4th National Conference on "Diversified Farming System: Sustainable Livelihood and Doubling Farmer's Income". 17-18 January, 2019, UBKV, Balurghat, and Co-Chaired a session on "Climate change resilient smart farming for doubling farmer's income and environmental impact with socio-economic issues".

- Dr. M.S. Behera, Principal Scientist was invited to deliver a lecture on 'Scope and opportunity of growing medicinal and aromatic plants in jute based cropping system' in National Conference of Stakeholders on "Conservation, Cultivation, Resource Development and Sustainable Utilization of Medicinal Plants of North-Eastern India", 6-7 March 2019, Nagaland University, Lumami.

- Dr. S. Datta, Principal Scientist delivered an invited lecture on "Scope of Herbicide Resistant Crops: Tools for Integrated Weed Management" in International symposium on "Biotechnology for Food-Nutritional Security and Organic Agriculture", 25-26 March, 2019, DBT-NECAB, AAU, Jorhat.

- Dr. R.K. Naik was selected as Member of Executive Body of the Indian Natural Fibre Society (TIFNS) at ICAR-NINFET, Kolkata, 21 July, 2018.

- The ICAR-CRIJAF sports contingent participated in ICAR Zonal Sports Tournaments-2018 (Eastern Zone) held at ICAR-IINGR, Ranchi from 5th to 8th October, 2018. Total 8 medals (4 gold + 2 silver + 2 bronze) were won by the contingents. Volley ball team (smashing) won the Gold Medal in team event. Among individual events Sh. Uma Sankar Das won Gold medal in long jump and high jump. Sh. Ritesh Kumar won Gold Medal in 1500 m and 800 m races, bronze medal in 400 m race and silver medal in high jump. Sh Vinay Kumar won silver medal in discuss throw. Smt. Laxmi Bansfore won the bronze medal in javellin throw.

**ICAR-CRIJAF contingent at ICAR Zonal Sports Tournament**

**Sh. Ritesh Kumar receiving the Champions Trophy for 1500, 800 and 400 m races**

# 15. Research Projects

## 15.1 In-house Research Projects

| Project no. | Project title and investigator(s) | Duration | Results cited in page no. |
|---|---|---|---|
| **Crop Improvement** | | | |
| **CI-1: Genetic resource management and utilization of jute and allied fibre crops** | | | |
| JB 1.1 | Introduction, maintenance, characterization and conservation of jute, mesta and flax germplasm: *J. Mitra* (w.e.f. 04.07.2017), *A. Bera* (w.e.f. 04.07.2017), *A. Anil Kumar* (w.e.f. 22.11.2012), *S.K. Sarkar* (01.04.2018), *Maruthi R.T.* (01.04.2015) | 1997-Long term | 01 |
| **CI-2: Breeding jute for higher fibre productivity and quality** | | | |
| JB 9.5 | Development of DNA fingerprint for varietal identification in jute: *J. Mitra, C.S. Kar* and *A. Anil Kumar* | 2014-19 | 05 |
| JB10.1 | Genetic improvement of jute genotypes against biotic stresses: *A. Anil Kumar, K. Mondal* and *B.S. Gotyal* | 2015-20 | 04 |
| JB 10.4 | JB 10.4 Genetic improvement of jute and mesta for diversified end use: *P. Satya, S. K. Pandey, S. Roy* and *S. Roy* | 2017-21 | 04 |
| **CI-3: Breeding mesta for higher fibre productivity and quality** | | | |
| JB 9.6 | Evaluation and selection for high fibre yield and other diversified uses in roselle (*H. sabdariffa*): *Maruthi R.T., A. Anil Kumar* and *A.R. Saha* | 2014-19 | 05, 06 |
| JB10.0 | Genetic enhancement of mesta using conventional and molecular approaches for fibre yield and quality improvement: *S.K. Pandey, P. Satya* and *K. Meena* | 2015-20 | 05, 06 |
| **CI-4: Breeding allied fibre crops for higher fibre productivity and quality** | | | |
| JB10.2 | Genetics of self-incompatibility and development of improved fibre yielding populations in sunnhemp (*Crotalaria juncea* L.): *Maruthi, R.T.* and *S. Datta* | 2015-20 | 03, 07 |
| JB10.3 | Genetic improvement of flax (*Linum usitatissimum*) for higher fibre productivity and fibre quality: *J. Mitra, D.N. Saha, Monu Kumar* and *Kunal Mandal* | 2016-22 | 06, 07, 21 |
| **CI-5: Genetic improvement of jute and allied fibre crops through biotechnology** | | | |
| JB 9.3 | Towards harnessing cell technological approaches for the enhancement of jute and allied fibre: *A.B. Mandal and Kanti Meena* | 2013-19 | 23 |
| JBT 4.5 | Genetic purity testing and varietal fingerprinting in mesta using molecular markers: *Kanti Meena, P. Satya and S.K. Pandey* | 2016-19 | 22 |
| JBT 4.6 | Fixation of a Multiparent Advanced Generation Inter-Cross (MAGIC) population of *Corchorus olitorius*): *D. Sarkar* and *P. Satya* | 2017-20 | 01 |
| JBT 4.7 | Mining novel alleles for genome engineering applications for herbicide and stress tolerance in jute and allied fibers: *S. Datta, J. Mitra, D.N. Saha, P. Satya* and *A. Anil Kumar* | 2017-20 | 18, 19, 20 |
| JBT 4.8 | Identification of host genes related to stem rot disease resistance in jute and development of segregating population for resistance gene mapping: *S. Ray, P. Satya and K. Mandal* | 2018-21 | 03 |
| **CI-6: Bio-informatics of jute and allied fibre crops** | | | |
| JBT 4.4 | Development and utilization of resources for bioinformatics and database in jute and allied fibres: *D.N. Saha, S. Datta, A. K. Chakraborty and P. Satya* | 2015-19 | 20, 21, 50 |
| JST 6.1 | Estimation of competition effects in jute-mungbean intercropping system: *A.K. Chakraborty* and *A.K. Ghorai* | 2016-19 | 28 |
| **CI-7: Production of quality seed of jute and allied fibres** | | | |
| JST 1.0: | Effect of seed coating on seed storability and fibre yield in jute (*Corchorus olitorius*): *A. Bera, C.S. Kar, M. Kumar and B.S. Gotyal* | 2018-21 | 09 |

| Project no. | Project title and investigator(s) | Duration | Results cited in page no. |
|---|---|---|---|
| **Crop Production** | | | |
| **CPDN-1: Studies on integrated management of weeds and ecofriendly agro-chemicals for JAF crops** | | | |
| JA 7.3 | Development of low-cost and eco-friendly integrated weed management technologies for jute: *A.K. Ghorai, M. Kumar* and *S. Roy* | 2017-20 | 45, 46 |
| **CPDN-2: Development of sustainable JAF-based cropping systems for increased farm income** | | | |
| 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* and *R.K. Naik* | 2014-19 | 29, 30, 31, 33 |
| SLA 1.6 | Use of drip irrigation for improving productivity of sisal based fruit-fibre system in central plateau region of India : *M.S. Behera, D.K. Kundu* and *A.K. Jha* | 2015-19 | 32, 34 |
| JA 5.7 | Conservation agricultural practices of jute based cropping systems under climate change scenario: *R. Saha, M.S. Behera, Mukesh Kumar, A.R. Saha, B. Majumdar, S. Paul Mazumdar, D. Barman, D.K. Kundu, R.K. Naik* and *L. Sharma* (w.e.f. 01.04.2017) | 2015-20 | 28, 29 |
| JA 7.4 | Physiological basis of drought tolerance at early growth stage in jute (*C. olitorius*): *L. Sharma, J. Mitra, S. Mitra, P. Satya, D.Barman* and *S. Roy* | 2017-20 | 46 |
| JA 7.5 | Physiology of flowering behaviour of jute under different photoperiod regimes: *S. Roy, D. Sarkar, P.Satya, L. Sharma, H.R.Bhandari* and *A. K. Jha* | 2017-20 | 07 |
| JA 7.6 | Improvement of Soil Carbon Stocks and Farm Productivity through Integrated Cropland Management Practices in Jute Cultivation Areas (A Farmer's Participatory Research): *A.K. Singh, A.K. Ghorai, R. Saha, M. Saha, M. L. Roy* | 2018-23 | - |
| JC 7.8 | Studies on nitrogen dynamics under rice- flax cropping system: *Mukesh Kumar, S.P. Mazumdar, D. Barman and M. S. Behera* | 2018-21 | 27 |
| JA 7.9 | Yield and quality of jute seed as influenced by method of application and dose of fertilizer nutrients in southern Bengal condition: *S. Sarkar, M.S. Behera, A. Bera and S.K. Sarkar* | 2018-20 | 08 |
| **CPDN-3: Studies on soil-water-plant relationships in JAF crops** | | | |
| JA 7.2 | Soil health characterization and carbon sequestration potential in ramie based cropping system in Eastern India: *S.P. Mazumdar, S. Mitra and B. Majumdar* | 2016-19 | 25, 26 |
| **CPDN-5: Farm mechanization and by-product utilization in JAF agriculture** | | | |
| 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* | 2014-19 | 47 |
| JA 7.1 (DSS) | Climate change risk assessment in jute production and related advisory services through Decision Support System: *D. Barman, P. Satya, B.S. Gotyal, A.K. Singh, A.K. Chakraborty, R. Saha, S. P. Mazumdar, Shamna A., S. Mitra and L. Sharma (01.04.2017)* | 2016-21 | 50 |
| JAE 3.5 | Development of prototype model flax fibre extractor with higher capacity: *R.K. Naik and S. Mitra* | 2018-21 | 48 |
| **CPDN-6: Development of improved water-saving methods for retting jute and mesta** | | | |
| JA 5.8 | Studies on ribbon retting methods for quality fibre production in jute and mesta: *R.K. Naik, B. Majumdar, S.P. Mazumdar, M.S. Behera* | 2015-19 | 48 |
| JA 7.7 | Environment friendly low cost retting technology for jute and metagenomics of retting microbiome: *B. Majumdar, S.P. Mazumdar, D. Saha, S. Datta, S. Sarkar, S.K. Jha* | 2018-21 | 48, 49 |
| **Crop Protection** | | | |
| **CPTN-1: Insect pests-plant interaction and the pathogen system in JAF crops** | | | |
| JE 1.9 | Bio-ecology and management of sucking pests in jute: *S. Satpathy, B.S. Gotyal* and *V. Ramesh Babu* | 2016-21 | 37-40 |
| JM 9.3 | Use of nanoparticles for managing pests and diseases in jute: *C. Biswas and V. Ramesh Babu* | 2018-23 | 36 |

| Project no. | Project title and investigator(s) | Duration | Results cited in page no. |
|---|---|---|---|
| **CPTN-2: Investigation on PGPR and bio-control for pest and disease management in JAF crops** | | | |
| JE 2.0 | Identification of microbial entomopathogens for management of major lepidopteran pests of jute: *V. Ramesh Babu, G. Siva Kumar, S. Satpathy* | 2018-23 | 35-36 |
| JM 9.2 | Isolation, Characteristion and Application of *Trichoderma* for Disease Management: *K. Mandal, S. K. Sarkar, R. Saha* | 2018-21 | 41 |
| **CPTN-3: Ecological, behavioural and epidemiological studies on pests and diseases of JAF crops** | | | |
| 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* | 2014-19 | 35 |
| JM 9.1 | Investigation on diseases of flax and their management: *S.K. Sarkar* and *K. Mandal* | 2017-20 | 43, 44 |
| **CPTN-4: Standardization and validation of IPM technologies in JAF crops** | | | |
| JM 9.0 | Development of IPM module for jute: *R.K. De, V. Ramesh Babu* and *Shamna A.* | 2015-20 | 40, 41, 44, 45 |
| **Agricultural Extension** | | | |
| **EXTN-1:Impact assessment of various technology transfer programme of CRIJAF** | | | |
| JEXA 5.8 | Climate variability vis-à-vis jute-based cropping system in West Bengal-an appraisal based on farmers' perspective: *M.L. Roy, S.K. Jha, S. Sarkar, A.K. Ghorai, A.K. Singh and A.K. Chakraborty* | 2017-20 | 53 |
| **Sisal Research Station, Bamra, Odisha** | | | |
| **Sisal-1: Development of improved production and protection technologies of sisal** | | | |
| SLM 1.0 | Studies on disease distribution, intensity and identification of sources of resistance against *Phytophthora* spp. causing zebra disease of sisal (*Agave sisalana*): *A.K. Jha, S. Sarkar and R.K. De* | 2012-19 | 41, 42, 43 |
| SLA 1.7 | Effect of planting materials and fertilizer levels on growth and yield of sisal (*Agave sisalana*) and hybrid sisal: *S. Sarkar, A.K. Jha, D.K. Kundu, M.S. Behera, B. Majumdar and R.K. Naik.* | 2018-23 | 31 |
| SLA 1.8 | Integrated farming system in sisal plantation under organic management package: *M.S. Behera, D.K. Kundu, S. Sarkar and A.K. Jha* | 2018-23 | 34 |
| **Central Seed Research Station for JAF** | | | |
| CSRSJAF 1.0 | Investigations on crossing barriers in inter-specific crosses in the genus *Crotalaria*: *H.R. Bhandari* and *Maruthi R.T.* | 2017-20 | - |

## 15.2 Externally Funded Projects

| Sponsor | Project Title and Investigator(PI) | Duration | Results cited in page no. |
|---|---|---|---|
| ICAR Seed Project | Seed production in agricultural crops and fisheries: *C.S. Kar* | Long-term | 11 |
| DAC | Protection of jute varieties and DUS testing: *Amit Bera* | Long-term | 04, 05 |
| AICRP, LTFE (JC 5.2) | To study changes in soil quality, crop productivity and sustainability under jute-rice-wheat cropping system (LTFE): *D.K. Kundu* | Long-term | 24 |
| AICRP-STCR (JC 5.6) | Soil test and resource based integrated plant nutrient supply system for sustainable agriculture: *A.R. Saha* | Long-term | 26 |
| 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* | Long-term | 26 |
| NFSM | Commercial crop-jute: *C.S. Kar* | 2014-18 | 12, 53-56 |
| NFSM-Sub-project | Front Line Demonstration (FLD) on jute: S.K. Jha | Long-term | 53-56 |
| National Seed Projects (NSP) | Breeder seed production of JAF: *C.S.Kar* | Long-term | 09, 10, 11 |

| Sponsor | Project Title and Investigator(PI) | Duration | Results cited in page no. |
|---|---|---|---|
| ICAR-NPTC Subproject 3070 | Genome sequencing and functional genomics of bast fibre quality: *D. Sarkar* | 2015-18 | 02, 13, 14, 15, 16, 17, 18 |
| DST- NRDMS | Natural Resource Management for Climate Smart Jute Farming through Capacity Building of Scheduled Caste Farmers in West Bengal: *A.K. Singh* | 2016-19 | 53 |
| DST (WB) | Development of an efficient in vitro micro-propagation protocol for production of healthy propagules in ramie (*Boehmeria nivea* L. Gaud) as planting material for enhanced productivity in sustainable scale: *A.B. Mandal* | 2016-19 | 23 |
| NRSC, ISRO | Quantitative assessment of carbon and moisture fluxes over Jute based agro-ecosystem: Integrating ground observations, satellite data and modelling: *D. Barman* | 2017-20 | 25 |
| NICRA | Impact of tropospheric ozone on crop production under jute-rice cropping system: *A.K. Singh* | 2018-20 | - |
| Higher Education, Science & technology and Biotechnology | Assessment of vulnerability of jute production to climate change and its mitigation strategies development using remote sensing GIS in West Bengal: *D. Barman* | 2018-21 | 50-51 |
| SERB | The impact of Heat Shock Factors in regulating heat stress-induced epigenomic changes: a case study in flax (*Linus spp.*): *D. Saha* | 2019-22 | - |
| Science & Technology and Biotechnology | Utilizing the potential of jute biomass for bioethanol production: *L. Sharma* | 2019-22 | - |

# 16. Publications

## 16.1. Research Papers


Alam, N.M., Jana, C., Barman, D., Sharma, B., Singh, D., Mishra, P.K., Sharma, N.K., (2018). Twentieth century rainfall trends of Uttarakhand, India: A spatio-temporal analysis. *Climate Change and Environmental Sustainability*, 6(2): 104-113.

Bhandari, H.R., Bera, A., Kar, C.S. and Biswas, S. (2018). Stability assessment of jute seed production system in lower Gangetic plains of India. *Industrial Crops and Products,* 125(1): 505-510.

Bhattacharyya, N., Selvaraj, K., Satpathy, S. and Gotyal, B.S. (2018). Biology and life table study of *Spilarctia obliqua* Walker (Arctiidae: Lepidoptera) on different host bast fibre. *Journal of Entomological Research,* 42(1): 97-102.

Bhowmik, R., Chowdhury, S., Subbanna, A.R.N.S., Roy, S. and Sharma, L. (2019). Genome wide identification of genic and non-genic Microsatellites in *Nilaparvata lugens* Stål. *International Journal of Chemical Studies*, 7(1): 194-196.

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## 16.9. Radio Talks

B. Majumdar, Principal Scientist Participated as an expert in the "*Khet khamarer Katha*" programme for farming community of India and Bangladesh and delivered a talk on a topic "*Unnata paddhatite pater pachan*" (in Bengali), broadcasted by the Akashvani Maitree Channel of All India Radio, Kolkata on 30.07.2018.

M.L. Roy, Scientist delivered a radio talk on '*Jaibo Krishi*' (in Bengali), broadcasted by Akashvani Maitree Channel of All India Radio, Kolkata in "*Khet Khamarer Katha*" programme on 25.07.2018.

M.L. Roy, Scientist delivered a radio talk on '*Paater Unnata Chash Paddhati*' (in Bengali), broadcasted by Akashvani Maitree Channel of All India Radio, Kolkata in "*Khet Khamarer Katha*" programme on 20.03.2018.

# 17. Library, AKMU, ITMU and PME Cell

## 17.1 Library, Information and Documentation Unit

The library facility of the ICAR-Central Research Institute for Jute and Allied Fibres functions as a repository of all kinds of scientific and technical information on jute and allied fibres like mesta, ramie, sisal, sunhemp and flax. The library is full-fledged with resources from National and International publishers. Presently, it holds about 9537 books under various themes of agriculture and allied sectors like Agronomy, Soil Science, Genetics and Plant Breeding, Plant Pathology, Agricultural Entomology, Agricultural Extension, Plant Physiology, Bio-technology, Agricultural Engineering, etc. The library is enriched with 39 International and 102 Indian journals and digital version of International Bibliographic Information System for the Agricultural Sciences and Technology (AGRIS). The library has about 9,230 bound volumes of journals and scientific literatures since 1947. Library also maintains the annual reports/newsletters/technical bulletins of various ICAR Institutes and SAU's, Commission/Committee reports, Research reports, and other general books in Hindi, English and Bengali languages. To keep abreast of the activities of the Institute, the library sends the Annual Reports, Newsletters (JAF news) and Technical bulletins of ICAR-CRIJAF to various research organizations including other ICAR institutes, SAUs, organizations involved in research and policy related to jute. (*Source: Library; Contributor: A.K. Singh*).

## 17.2 Agricultural Knowledge Management Unit (AKMU)

The main activities of ICAR-CRIJAF Agricultural Knowledge Management Unit (AKMU) are maintenance and provision of Internet and Email facilities, designing, developing and maintenance of Institute Website and Video Conferencing Systems and other IT related works including LAN and systems management in the institute. The online applications of ICAR *viz*., Personnel Management Information System Network (PERMISNET), Project Information and Management System of ICAR (PIMS-ICAR), Half Yearly Progress Monitoring System of Scientists (HYPM), ICAR KRISHI portal are also updated in consultation with PME cell. All the conventional cyber security norms are strictly followed. Use of only genuine softwares, installation of latest operating system, antivirus, use of firewall etc. are being followed by AKMU of the Institute.

AKMU has redesigned and developed Institute Website (http://www.crijaf.org.in/) as per the ICAR guidelines. The Institute website reflects overall research, training and extension activities and achievements of the institute and its research centres. The contents of the Institute Website are periodically being updated.
The institute has a 100 Mbps leased line internet connectivity under National Knowledge Network (NKN). The internet services are spread over more than 100 users of all categories of staff of the Institute.

LAN is distributed through a SONICWALL firewall installed at AKMU with fibre optic backbone connectivity to all buildings. Server centric Antivirus and Antispam, Web and Application filter and Intrusion Detection and Prevention (IDP) are in place to support the virus protection for the end users.

The IP based video conferencing system is available at ICAR-CRIJAF-AKMU to conduct video conference between two locations. AKMU also facilitates the multimedia presentations for various lectures, trainings, workshops, seminars, symposium etc. (*Source: AKMU; Contributors: N.M. Alam and N. Paul*)

## 17.3 Institute Technology Management Unit (ITMU)

### 17.3.1. Germplasm registration

A germplasm of jute (*Corchorus aestuans* L.), WCIN 179 having the unique trait "Resistance to jute hairy caterpillar, *Spilosoma obliqua"* has been registered and its national identity is IC558459.

### 17.3.2. Commercialization of the technologies and revision of selling price

#### Extension of license

Non-exclusive license of M/s Bengal Biotech and Research, West Bengal for large scale production and sale of CRIJAF SONA has been extended for next 2 years w.e.f. 12th April, 2019, based on the report of the committee for inspection of the production site for recommendation of ITMC.

**Fig. 17.1 MoU signed with M/s Bengal Biotech and Research**

#### Rate revision

The institute continued the commercialization contract with the following manufacturers for different institute technologies with the revised rates mentioned below:

**Table 17.1. Revised rate of Institute technologies**

| Technology | Name of the manufacturer | Existing ex-factory rate (Rs.) | Revised ex-factory rate (Rs.) | w.e.f. |
|---|---|---|---|---|
| CRIJAF SONA | M/s West Bengal Pharmaceutical & Phytochemical Development Corporation Limited (WBPPDCL) | 44 per Kg | 48 per Kg | 01.04.2018 |
| CRIJAF Nail Weeder | M/s Creative Displayer | 1700 per unit | 1850 per unit | 01.10.2018 |
| CRIJAF Single Wheel Jute Weeder | M/s Creative Displayer | 1850 per unit | 2000 per unit | 01.10.2018 |
| CRIJAF SONA | M/s Bengal Biotech & Research | 48 per Kg | 50 per Kg | 01.04.2019 |
| | M/s Next 2 Nature | 55 per Kg | 60 per Kg | |
| Multi Row Seed Drill | M/s Joy Maa Tara Enterprise<br>M/s Krishi Udyog | 3850 per unit (4-row)<br>4200 per unit (5-row) | 4100 per unit (4-row)<br>4500 per unit (5-row) | 01.04.2019 |

(*Source: ITMU; Contributor: R. Saha*)

### Royalty

During 2018-19, total Rs. 22.54 lakhs was received as royalty payment of various commercialized technologies (CRIJAF-Nail Weeder, CRIJAF Multi-Row Seed Drill and CRIJAF SONA, CRIJAF Flax Fibre Extractor, CRIJAF Single Wheel Jute Weeder and CRIJAF Herbicide Applicator).

### 17.3. 3. Outreach programme

Technologies like JRO 204, Multi-Row Seed Drill, CRIJAF SONA, CRIJAF Nail Weeder and Single Wheel Jute Weeder through Jute - ICARE have been disseminated in large area (98,898 ha) among 1.93 lakhs farmers in jute growing areas of West Bengal, Assam, Odisha, Bihar during 2018-19 under the programme Jute-ICARE sponsored by National Jute Board and Jute Corporation of India . (*Source: Jute-ICARE; Contributor: S. Satpathy*)

### 17.3.4. Facilitation of Patent Application

To give fresh impetus on patenting, a new firm M/s Anjan Sen and Associates has been engaged w.e.f. 30.03.19 to act as IPR attorney on behalf of ICAR-CRIJAF. (*Source: ITMU; Contributor: R. Saha*).

### 17.3.5. Participation in IPR training

Dr. S. K. Sarkar, I/c PME Cell and Dr. R. Saha I/c ITMU, ICAR-CRIJAF attended the training programme on 'Clinic on Intellectual Property Rights (IPR)' at ICAR-NINFET, Kolkata on 02.03.2019. The IPR Clinic covered various aspects of IPR like Patents, Copyrights, Trademarks, and biodiversity laws and their application in scientific research and commercialization. Another target of this Clinic was to identify and settle the problems faced by the researchers to file the patent and their quarries about the delay of their patent applications at Patent Office. (*Source: ITMU; Contributor: R. Saha*)

## 17.4. Priority setting, 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 four scientists headed by a Principal Scientist. The PME Cell of the Institute is working as "Single Window" system for priority setting, research monitoring and evaluation, maintenance of database related to projects, achievements, technologies developed, publication etc. Important activities performed by the Cell are conducting Departmental Research Council (DRC), Institute Research Council (IRC) meeting, maintaining Research Project Proforma (RPP), processing of files for CAS of scientists, co-ordinating orientation programme and attachment training of fresh ARS scientists, co-ordinating online submission of Half Yearly Progress Monitoring (HYPM) report of all the Scientists of the Institute, updating online programme–PERMISNET and PIMS-ICAR, co-ordinating the reply of Parliamentary question, Annul Plan, DARE report, preparation of EFC, ATR of Directors' meet and Regional Committee Meetings and co-ordination of research audit of the institute. The PME cell also facilitates in providing the research information of the institute to other departments and stakeholders. During the year 2018-19, PME Cell conducted IRC meeting on May 21-22, 2018, interim IRC meeting on February 28, 2019 where the ongoing projects were reviewed and new research proposals were considered. Prior to IRC meeting all the division/ section conducted the DRC to review the progress of the projects and discuss the concept note of new research proposal. (*Source: PME Cell; Contributor: S.K. Sarkar*)

### 17.4.1. Collaborative research programme with national institutes/ Govt. bodies/ other organizations

ICAR-CRIJAF has initiated a number of collaborative research programmes with several prestigious institutes and organizations to improve the quality of research programmes on jute and allied fibres and to strengthen linkages among the stakeholders to disseminate knowledge and technologies for benefitting jute farming community. In 2018-19 following collaborative activities were undertaken.

Table 17.2 Collaborative research programmes of the Institute

| S. No | Collaborative organization | Type of activity undertaken |
|---|---|---|
| 1 | National Remote Sensing Centre, ISRO, Hyderabad | Assessment of carbon and moisture flux in jute based cropping system |
| 2 | ICAR-National Research Centre on Plant Biotechnology, New Delhi | Genome sequencing and development of genomic resources in jute |
| 3 | ICAR-National Institute of Natural Fibre Engineering and Technology, Kolkata | Fibre quality testing, training and technology dissemination |
| 4 | NJB and JCI, Ministry of Textiles, Govt. of India, Kolkata | Dissemination of CRIJAF varieties and technologies, training, survey and knowledge exchange through Jute-ICARE |
| 5 | Agriculture Department, Govt. of W. Bengal | Dissemination of CRIJAF varieties and technologies, training, survey and knowledge exchange |
| 6 | Directorate of Jute Development, Govt. of India, Kolkata | Sharing of expertise for transfer of technologies as well as implementation of NFSM programme |
| 7 | Science and Engineering Research Board, Govt. of India | The impact of Heat Shock Factors in regulating heat stress-induced epigenomic changes: a case study in flax. |
| 8 | Science & Technology and Biotechnology, Govt. of W. Bengal | Utilizing the potential of jute biomass for bio-ethanol production. |
| 9 | National Innovations on Climate Resilient Agriculture (NICRA), ICAR | Impact of tropospheric ozone on crop production under jute-rice cropping system |
| 10 | Higher Education, Science & Technology and Biotechnology, Govt. of W. Bengal | Assessment of vulnerability of jute production to climate change and its mitigation strategies development using remote sensing GIS in West Bengal |
| 11 | Adamas University, Barasat | Strengthening mutual support for education and research |

(*Source: PME Cell; Contributor: S.K. Sarkar*)

# 18. राजभाषा कार्यान्वयन (Official Language Implementation)

## भाकृअनुप-केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान के लक्ष्य, कार्यक्षेत्र तथा राजभाषा गतिविधियाँ

भाकृअनुप-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 पहुंचाने 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 सुधार ; (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 प्रयोगशालाएं व क्षेत्रीय सुविधायें 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 हैं, जो निम्नवत है:-

1. रेमी अनुसंधान केन्द्र, सरभोग, असम (वर्ष 1959 में स्थापित), कुल क्षेत्र 60 हेक्टेयर।
2. सीसल अनुसंधान केन्द्र, बामरा, ओडिशा (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, वर्दवान, 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 विश्वविद्यालय में 8 तथा भारतीय कृषि अनुसंधान परिषद के संस्थानों में 4 केन्द्र स्थापित हैं तथा इन केन्द्रों का नोडल एकक बैरकपुर मुख्यालय है।

### राजभाषा गतिविधियाँ

भाकृअनुप-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 प्रधान वैज्ञानिक हिन्दी प्रभारी के रूप में तथा एक सहायक कार्यरत हैं।

इस संस्थान के वैज्ञानिकों द्वारा कृषकों के जीवन यापन में गुणात्मक सुधार हेतु पटसन एवं समवर्गीय रेशे वाली फसलों के महत्वपूर्ण कृषि तथ्यों से अवगत कराया जाता है। कृषि के क्षेत्र में इस संस्थान की साकारात्मक भूमिका रही है। विकासात्मक गतिविधियों एवं जानकारियों को अन्य भाषाओं के साथ-साथ हिन्दी में भी किसानों तक पहुंचाने में यह संस्थान प्रयासरत है। के.प.स.रे.अ.सं. एक वैज्ञानिक संस्थान होते हुए भी यहाँ राजभाषा हिन्दी को काफी बढ़ावा दिया जाता है। संस्थान के राजभाषा अनुभाग ने हिन्दी पदों के अभाव के बावजूद संस्थान में कार्यरत वैज्ञानिक/अधिकारियों के बलबूते राजभाषा के प्रचार-प्रसार हेतु अनेक 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-

- अधिकांश विहित फार्मों एवं सभी मानक मसौदे द्विभाषी हैं।
- अधिकांश रजिस्टरों के शीर्षक द्विभाषी हैं। बाकी रजिस्टरों के शीर्षक द्विभाषी रूप में जल्द से जल्द कर लिए जाएंगे।
- संस्थान में सभी रबर 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 चर्चायें सिर्फ और सिर्फ हिन्दी में होती हैं तथा उसे अमल में लाया जाता है।
- अन्य भाषा-भाषी लोगों के हिन्दी शब्द ज्ञान हेतु प्रतिदिन हिन्दी का एक शब्द 'आज का शब्द' लिखा जाता है।
- हिन्दी अनुभाग में प्रविष्ठियां, टिप्पणी एवं मसौदा लेखन व अन्य कार्य हिन्दी में ही होते हैं तथा अन्य अनुभाग में भी अधिकांश प्रविष्ठियां, टिप्पणी एवं मसौदा लेखन हिन्दी में किए जा रहे हैं।

- संस्थान के सभी कम्प्यूटरों में द्विभाषी रूप में काम करने के लिए यूनीकोड की सुविधा उपलब्ध है तथा कुछ कम्प्यूटरों पर कृतिदेव पर भी काम किए जा रहें हैं।
- संस्थान के अन्य भाषा-भाषी अधिकारियों/कर्मचारियों को हिन्दी में प्रषिक्षण देने के लिए हिन्दी शिक्षण योजना के अन्तर्गत राजभाषा कक्ष द्वारा संस्थान में ही हिन्दी कक्षायें चलायी जाती हैं । संस्थान में नवम्बर, 2018 के दौरान 08 अधिकारियों एवं कर्मचारियों ने प्राज्ञ परिक्षायें उत्तीर्ण किये तथा मई, 2019 के दौरान इस संस्थान के क्षेत्रीय केन्द्र के.प.स.रे.बी.अ.के., बुदबुद, बर्द्धवान एवं केवीके, बर्द्धवान के 13 अधिकारियों एवं कर्मचारियों ने प्राज्ञ परीक्षा में भाग लिया ।
- हिन्दी अनुभाग में प्रविष्टियां, 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, शब्द कोश, 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 परिषद के दिनांक 31.03.1991 के परिपत्र के अनुसार संस्थान की राजभाषा कार्यान्वयन समिति की बैठकें आयोजित की जाती हैं।

## संस्थान में दिनांक 29 जून, 2018 को एक दिवसीय हिंदी कार्यशाला का आयोजन

भाकृअनुप-केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता में दिनांक 29 जून, 2018 को राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने तथा राजभाषा संबंधी अधिनियमों एवं आदेशों के अनुपालन हेतु एक दिवसीय हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में बड़ी संख्या में सभी वर्ग के अधिकारियों एवं कर्मचारियों (वैज्ञानिक, प्रशासनिक एवं तकनीकी) ने भाग लिया। इस अवसर पर डॉ. चन्द्र गोपाल शर्मा , पूर्व उप महा प्रबंधक (राजभाषा), पूर्व रेलवे, कोलकाता अतिथि वक्ता के रूप में आमंत्रित थे। उन्होंने अपने संबोधन में कहा कि राजभाषा में कार्य करना हमारा संवैधानिक दायित्व

हिन्दी कार्यशाला में भाग लेते हुए संस्थान के अधिकारी एवं कर्मचारीगण।

है तथा अपना अधिकाधिक कार्य राजभाषा हिंदी में करना हमारा संवैधानिक दायित्व है तथा अपना अधिक से अधिक कार्य राजभाषा हिंदी के माध्यम से करने पर जोर देते हुए ऐसे कार्यक्रमों की उपयोगिता पर बल दिया। अतिथि वक्ता ने निदेशक महोदय तथा सभी प्रतिभागियों को

प्रतिभागियों को संबोधित करते हुए डॉ. चन्द्र गोपाल शर्मा, पूर्व उपमहाप्रबंधक (राजभाषा), पूर्व रेलवे, कोलकाता।

सम्बोधित करते हुए राजभाषा अधिनियम-नियम, राजभाषा नीति तथा व्यावहारिक व्याकरणिक समस्याओं व उनका समाधान तथा राजभाषा नीति के प्रमुख बिन्दुओं पर विस्तृत जानकारी एवं चर्चा की।

प्रतिभागियों को प्रषिक्षण प्रदान करते हुए डॉ. चन्द गोपाल शर्मा, पूर्व उप महाप्रबंधक (राजभाषा ), पूर्व रेलवे, कोलकाता।

संस्थान के निदेशक, डॉ. जीबन मित्र अधिकारियों एवं कर्मचारियों को संबोधित करते हुए।

## संस्थान में दिनांक 29 दिसम्बर, 2018 को एक दिवसीय हिन्दी कार्यशाला का आयोजन

भाकृअनुप-केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता की राजभाषा कार्यान्वयन समिति के तत्वावधान में दिनांक 29 दिसम्बर, 2018 को संस्थान के अधिकारियों/कर्मचारियों के दैनिक कार्यालयीन कार्यों में हिंदी के प्रयोग विषय पर एक दिवसीय हिंदी कार्यशाला का आयोजन किया गया। कार्यशाला का मुख्य उद्देश्य संस्थान के अधिकारियों एवं कर्मचारियों को दैनिक कार्यालयीन कार्यों में राजभाषा हिंदी के सुगमतापूर्वक अधिकाधिक प्रयोग हेतु प्रशिक्षित करना था। कार्यशाला की अध्यक्षता संस्थान के निदेशक, डॉ. जीबन मित्र जी ने की। इस अवसर पर उन्होंने सभी उपस्थित अधिकारियों एवं कर्मचारियों से अपना दैनिक कार्यालयीन कार्य हिंदी में करने की अपील

हिन्दी कार्यशाला में प्रतिभागियों का स्वागत करते हुए प्रभारी हिन्दी कक्ष, डॉ. एस.के. पाण्डेय।

किया। श्री पी.के. जैन, मुख्य प्रशासनिक अधिकारी ने राजभाषा हिंदी के महत्व पर प्रकाश डालते हुए इसके अधिकतम प्रयोग पर बल दिया। साथ ही दैनिक कार्यालयीन कार्यों में हिन्दी के प्रयोग को आवश्यक बताते हुए इसकी उपयोगिता पर प्रकाश डाला तथा कार्यशालाओं का आयोजन प्रत्येक तिमाही के नियत तिथि पर आयोजित करने पर भी बल दिया।

कार्यशाला में श्री अदालत प्रसाद, हिन्दी प्राध्यापक, हिंदी शिक्षण योजना, राजभाषा विभाग, गृह मंत्रालय, भारत सरकार, निजाम पैलेस, कोलकाता को आमंत्रित किया गया था। उन्होंने उक्त कार्यशाला का आरम्भ पत्राचार के विभिन्न रूपों जैसे कार्यालय टिप्पणी, परिपत्र, कार्यालय ज्ञापन, कार्यालय आदेश आदि तथा राजभाषा नीति के प्रमुख बिन्दुओं पर विस्तार पूर्वक जानकारी दी तथा अभ्यास भी कराया। अतएव यह कार्यशाला संस्थान के समस्त प्रतिभागियों के लिए बहुत ही उपयोगी एवं उद्देश्यपूर्ण रहा।

इन हिन्दी कार्यशालाओं का सफल आयोजन एवं संचालन डॉ. सुरेन्द्र कुमार पाण्डेय, प्रधान वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने श्री मनोज कुमार राय, सहायक के सहायोग से किया।


हिन्दी कार्यशाला में प्रतिभागियों को प्रषिक्षण प्रदान करते हुए श्री अदालत प्रसाद, हि.षि. यो., गृ.मं., भा.स., निजाम पैलेस, कोलकाता

## संस्थान में दिनांक 29 मार्च, 2019 को एक दिवसीय हिन्दी कार्यशाला का आयोजन

भाकृअनुप-केंद्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता में दिनांक 20 मार्च, 2019 को राजभाषा हिंदी के प्रगामी प्रयोग को बढ़ावा देने तथा राजभाषा संबंधी अधिनियमों, नियमों एवं आदेशों के अनुपालन हेतु एक दिवसीय हिंदी कार्यशाला का आयोजन माननीय निदेशक, डॉ. जीबन मित्र जी की अध्यक्षता में संस्थान के समिति कक्ष में किया गया। कार्यशाला का शुभारंभ डॉ. सुरेन्द्र कुमार पाण्डेय, प्रधान वैज्ञानिक एवं प्रभारी, राजभाषा कक्ष ने श्री आर.डी. शर्मा, सहायक निदेशक (राजभाषा) तथा प्रतिभागियों का हार्दिक अभिनंदन एवं स्वागत करते हुए कार्यक्रम का संचालन किया। इस कार्यशाला में बड़ी संख्या में संस्थान के अधिकारियों एवं कर्मचारियों (कर्मचारी/तकनीकी/वैज्ञानिक वर्ग) ने उत्साह पूर्वक भाग लिया। इस अवसर पर संस्थान के फसल उत्पादन प्रभाग के प्रभागाध्यक्ष, डॉ. दिलीप कुमार कुंडू, कार्यशाला के आयोजन की रूपरेखा और उद्देश्य के बारे में बताया तथा हिन्दी की विशेषता की चर्चा करते हुये कहा कि विश्व के कई देशों में अन्य भाषाओं के साथ-साथ हिन्दी भी बोली जाती है। डॉ. चन्दन सौरव कर, प्रधान वैज्ञानिक, फसल सुधार ने अपने संबोधन में कहा कि हम सभी हिन्दी भली-भांति पढ़ व लिख सकते हैं परंतु कार्य करने में संकोच होता है, इस संकोच को कार्यशालाओं के माध्यम से ही दूर

किया जा सकता है तथा यह कार्यालयीन कार्यों में हिन्दी का प्रयोग करने से ही दूर होगा। अखिल भारतीय पटसन एवं समवर्गीय रेशा नेटवर्क परियोजना के प्रभारी, डॉ. सब्यसाची मित्रा ने अपने उद्बोधन में कहा कि हिन्दी हमारी राजभाषा है तथा इसका प्रयोग कार्यालयीन कार्यों में यथा सम्भव करना चाहिए। डॉ. सुनीति कुमार झा ने अपने अभिभाषण में कहा कि हिन्दी हमारी अपनी भाषा है और इसका यथा संभव प्रयोग करें। प्रशासनिक अधिकारी, श्री प्रहलाद सिंह ने अपने संबोधन में कहा कि कार्यालयीन कार्यों में राजभाषा में कार्य करना हमारा संवैधानिक

हिन्दी कार्यशाला में प्रतिभागियों का स्वागत करते हुए प्रभारी, हिन्दी कक्ष, डॉ. एस.के. पाण्डेय।

दायित्व है तथा अपना अधिकाधिक कार्यालयीन कार्य हिंदी के माध्यम से करने पर जोर देते हुए ऐसे कार्यशाला की उपयोगिता पर बल दिया। माननीय निदेशक, डॉ. जीबन मित्र जी ने सरल, सुबोध एवं आसान शब्दों का प्रयोग करने पर जोर देते हुए यह उद्घोष किया कि राजभाषा संबंधी आदेशों का शत प्रतिशत अनुपालन किया जाए। निदेशक महोदय ने इस बात पर खुशी जाहिर किया कि प्रशासनिक अनुभागों तथा लेखा परीक्षा व लेखा अनुभाग में हिन्दी में टिप्पण एवं मसौदा, कार्यालय आदेश, परिपत्र आदि हिन्दी में जारी हो रहे हैं। कार्यशाला में वैज्ञानिक, तकनीकी एवं प्रशासनिक वर्ग के कुल 57 प्रतिभागियों (29 अधिकारी और 28 कर्मचारी) ने भाग लिया।

तत्पश्चात कार्यशाला का तकनीकी सत्र श्री आर.डी. शर्मा, सहायक निदेशक (राजभाषा) ने निदेशक महोदय एवं सभी प्रतिभागियों का धन्यवाद करते हुए राजभाषा नियम, राजभाषा अधिनियम एवं राजभाषा नीति के प्रमुख बिन्दुओं पर चर्चा की, साथ ही पावर प्वाइंट के माध्यम से यूनीकोड के बारे में विस्तार पूर्वक जानकारी दी। आगे इन्होंने कम्प्यूटर पर हिन्दी में काम करते समय आने वाली समस्या के विषय में भी बताया तथा हिन्दी में टंकण करने हेतु विभिन्न प्रकार के की-बोर्ड के बारे में जानकारी दी। कार्यशाला बहुत ही उपयोगी एवं उद्देश्यपूर्ण रही। इस कार्यशाला का संचालन डॉ. सुरेन्द्र कुमार पाण्डेय, प्रधान वैज्ञानिक एवं प्रभारी, राजभाषा कक्ष ने श्री मनोज कुमार राय के सहयोग से किया।

अंत में डॉ. सुनीति कुमार झा के द्वारा कार्यशाला का समापन निदेशक महोदय, श्री आर.डी. शर्मा, सहायक निदेशक (राजभाषा), एवं समस्त प्रतिभागियों को धन्यवाद ज्ञापित कर किया गया।

हिन्दी कार्यशाला में प्रतिभागियों को प्रषिक्षण प्रदान करते हुए श्री आर.डी. शर्मा , सहायक निदेशक (राभा)

## संस्थान में हिन्दी पख़वाड़ा का आयोजन

कार्यालय में राजभाषा हिन्दी के प्रति जागरूकता पैदा करने तथा उसके प्रभावों में गति लाने हेतु संस्थान में दिनांक 14 से 28 सितम्बर, 2018 के दौरान हिन्दी पखवाड़ा का आयोजन किया गया जिसका उद्घाटन संस्थान के निदेशक, डॉ. जीबन मित्र द्वारा किया गया तथा मुख्य वक्ता के रूप में डॉ. चन्द्र गोपाल शर्मा , पूर्व उप महा प्रबंधक (राजभाषा), पूर्व रेलवे, कोलकाता को आमंत्रित किया गया था। उद्घाटन समारोह में संस्थान के समस्त अधिकारियों/कर्मचारियों ने उत्साहपूर्वक भाग लिया। कार्यक्रम की अध्यक्षता कर रहे संस्थान के निदेशक, डॉ. जीबन मित्र ने समस्त अधिकारियों एवं कर्मचारियों को संबोधित करते हुए राजभाषा हिन्दी के सरल शब्दों के प्रयोग पर बल दिया तथा साथ ही इस कार्यक्रम को सफल बनाने में उनकी सहभागिता दर्ज कराने का आग्रह किया। डॉ. सुब्रत सतपथी, प्रभागाध्यक्ष, फसल सुरक्षा ने अपने उद्घाटन अभिभाषण में संस्थान के समस्त अधिकारियों/कर्मचारियों से कार्यालयीन कार्य हिन्दी में करने का आह्वान किया साथ ही रेशा किरण, भाग-2 का प्रकाशन शीघ्र करने की अपील की। मुख्य अतिथि ने राजभाषा के सुगम प्रयोग के बारे में विस्तार पूर्वक प्रकाश डाला। डॉ. सुरेन्द्र कुमार पाण्डेय, प्रधान वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने राजभाषा को अधिक कारगर ढंग से संस्थान में लागू करने के लिए सुझाव दिया।

इस सुअवसर पर उपस्थित अधिकारियों एवं कर्मचारियों का संस्थान की राजभाषा कार्यान्वयन समिति की ओर से हार्दिक स्वागत करते हुए राजभाषा प्रभारी, डॉ. सुरेन्द्र कुमार पाण्डेय ने हिन्दी पखवाड़ा के अतंर्गत आयोजित किए जानेवाली विभिन्न हिन्दी प्रतियोगितायें तत्कालिक भाषण (एक्सटेम्पोर) (हिन्दीत्तर तथा हिन्दी भाषियों के लिए), हिंदी टंकण (सभी वर्गों के लिए), हिन्दी निबंध लेखन (हिन्दीत्तर भाषियों के

लिए), हिन्दी अनुवाद (हिन्दीत्तर तथा हिन्दी भाषियों के लिए), वाद-विवाद, (हिन्दीत्तर भाषियों के लिए), हिन्दी टिप्पण, मसौद/प्रारूप लेखन (हिन्दीत्तर भाषियों के लिए) आदि प्रतियोगिताओं की जानकारी अधिकारियों एवं कर्मचारियों को देते हुए उनसे यह आग्रह किया कि वे इन प्रतियोगिताओं में अधिकाधिक संख्या में भाग लेकर इस आयोजन को सफल बनाएं।


हिन्दी पखवाड़ा के उपलक्ष्य में स्वागत भाषण देते हुए प्रभारी, हिन्दी कक्ष, डॉ. एस. के. पाण्डेय।

हिन्दी पखवाड़ा के दौरान संस्थान के हिन्दीत्तर भाषी तथा हिन्दी भाषी अधिकारियों/कर्मचारियों के लिए तत्कालिक भाषण (एक्सटेम्पोर), हिंदी टंकण, हिन्दी निबंध, हिन्दी अनुवाद, वाद-विवाद तथा हिन्दी टिप्पण, मसौद/प्रारूप लेखन आदि विभिन्न प्रतियोगितायें आयोजित की गईं जिसमें संस्थान के अधिकारियों/कर्मचारियों ने बढ़-चढ़कर भाग लिया। कार्यक्रम का संचालन डॉ. सुरेन्द्र कुमार पाण्डेय, प्रधान वैज्ञानिक एवं प्रभारी, हिन्दी कक्ष ने श्री मनोज कुमार राय, सहायक के सहयोग से किया।

हिन्दी पखवाड़ा समापन समारोह का अयोजन दिनांक 28 सितम्बर, 2018 को किया गया। इस अवसर पर श्रीमती सुधा मिश्रा, पूर्व राजभाषा अधिकारी, दक्षिण पूर्व रेलवे, गार्डनरीच कोलकाता संस्थान की ओर से मुख्य वक्ता के रूप में सादर आमंत्रित थीं। इस कार्यक्रम की अध्यक्षता संस्थान के निदेशक, डॉ. जीबन मित्र, अध्यक्ष, राजभाषा कार्यान्वयन समिति, भाकृअनुप-केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर ने संभाला और साथ ही इस अवसर पर डॉ. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन, डॉ. एस. मित्र, प्रभारी, ए.आई.एन.पी., डॉ. सुनीति कुमार झा, प्रभारी, कृषि प्रसार, श्री पी.के. जैन, मुख्य प्रशासनिक अधिकारी एवं श्री गौरांग घोष, वित्त एवं लेखा अधिकारी मंचासीन थे। अपने अध्यक्षीय संबोधन में निदेशक महोदय में डॉ. जीबन मित्र ने कहा कि भारत विविध संस्कृति वाला देश है। जिसमें अनेकों भाषाएं बोली जाती हैं मगर राजभाषा हिन्दी का अपना अलग ही स्थान है। राजभाषा कार्यान्वयन की दिशा में इस संस्थान ने अच्छी प्रगति की है। इस अवसर पर उन्होंने अपने अभिभाषण में कहा कि हिन्दी राजभाषा होने के साथ ही अत्यंत सरलतम भाषा भी है। इसके प्रसार एवं व्यवहार में तीव्रतम विकास अति आवश्यक है। इसके प्रचार-प्रसार के लिए उन्होंने संस्थान के समस्त अधिकारियों एवं कर्मचारियों से कार्यालयीन कार्य हिन्दी में करने पर बल दिया तथा संतोष व्यक्त किया कि प्रशासननिक खण्ड से हिन्दी में काफी हद तक हिन्दी टिप्पण/मसौदा लेखन/पत्र लेखन का कार्य किया जा रहा जो सराहनीय है। श्रीमती सुधा मिश्रा, पूर्व राजभाषा अधिकारी, दक्षिण पूर्व रेलवे, गार्डनरीच, कोलकाता ने अपने व्याख्यान में भारत सरकार की राजभाषा नीति को ध्यान में रखते हुए सरकारी कार्यालयो में अधिकाधिक कार्य हिन्दी में करने की अपील की। डॉ. दिलीप कुमार कुण्डु, प्रभागाध्यक्ष, फसल उत्पादन प्रभाग ने अपने सम्बोधन में कहा कि हमारे संस्थान में हिन्दी में काफी कार्य हो रहा है तथा इसे आगे भी जारी रखना चाहिए। डॉ. एस. मित्रा, प्रभारी, ए.आई.एन.पी. ने अपने संबोधन में कहा कि हिंदी में काम करना आसान है, हमें हर क्षेत्र में अधिक से अधिक कार्य हिंदी में करना चाहिए। श्री पी.के. जैन, मुख्य प्रशासनिक अधिकारी ने कहा कि राजभाषा हिंदी ही एक मात्र ऐसी भाषा है जो भारत के एक राज्य को दूसरे राज्यों से जोड़ती है। उन्होंने कहा कि संविधान में हिंदी को पूर्ण रूप से राजभाषा का दर्जा प्राप्त है, हमें निष्ठा भाव से इसे मजबूती प्रदान करनी चाहिए। श्री गौरांग घोष, वित्त एवं लेखा अधिकारी ने कहा कि भारत की सभी भाषाएं एक दूसरे की परिपूरक हैं अतएव हम भारत के किसी भी कोने में जाएं तो हमें सभी भाषाओं में सामंजस्य नजर आती है। उन्होंने लेखा परीक्षा एवं लेखा अनुभाग में हो रहे हिन्दी के प्रयोग पर संतोष व्यक्त करते हुए इसे और व्यापक बनाने का अनुरोध किया।


संस्थान के निदेशक, डॉ. जीबन मित्र अधिकारियों/ कर्मचारियों को संबोधित करते हुए।

समापन समारोह के दौरान विभिन्न प्रतियोगिताओं में सफल सभी विजेता प्रतियोगियों को (क्रमश: प्रथम, द्वितीय एवं तृतीय) डॉ. जीबन मित्र, निदेशक महोदय तथा अन्य उपस्थित गणमान्य पदाधिकारियों के कर कमलों द्वारा पुरस्कार प्रदान कर सम्मानित किया गया। निदेशक महोदय ने संस्थान में हिन्दी पखवाड़ा तथा इस दौरान आयोजित विभिन्न हिन्दी प्रतियोगिताओं के सफल आयोजन पर अपनी खुशी जाहिर की तथा आशा व्यक्त की कि इस संस्थान में हिन्दी के प्रयोग में उत्तरोत्तर प्रगति होगी। कार्यक्रम का समापन डॉ. सुनीति कुमार झा, प्रधान वैज्ञानिक एवं प्रभारी, कृषि प्रसार अनुभाग के धन्यवाद ज्ञापन के साथ सम्पन्न हुआ।

## संसदीय राजभाषा समिति की दूसरी उप समिति द्वारा संस्थान का निरीक्षण

संसदीय राजभाषा समिति की दूसरी उप समिति द्वारा दिनांक 02.11.2018 को भाकृअनुप-केन्द्रीय पटसन एवं समवर्गीय रेशा अनुसंधान संस्थान, बैरकपुर, कोलकाता में राजभाषा नीति से संबंधित आदेशों के कार्यान्वयन आदि के अमल हेतु निरीक्षण किया गया। उप

संसदीय राजभाषा समिति के सदस्यों द्वारा संस्थान के प्रदर्शनी का निरीक्षण करते हुए।

समिति के द्वारा निरीक्षण कार्य बहुत ही सौहार्दपूर्ण वातावरण में सम्पण हुई तथा निरीक्षण संतोषप्रद रही। इस संस्थान की ओर से डॉ. आर. के. सिंह, सहायक महानिदेशक (वा.फ.), भाकृअनुप, नई दिल्ली, श्रीमती

संसदीय राजभाषा समिति के सदस्यगण तथा संस्थान के अधिकारीगण बैठक में भाग लेते हुए।

सीमा चोपड़ा, निदेशक (राजभाषा), भाकृअनुप, नई दिल्ली, डॉ. जीबन मित्र, निदेशक, डॉ. एस. सत्पथी, प्रभागाध्यक्ष, फसल सुरक्षा, डॉ. एस. के. पाण्डेय, प्रधान वैज्ञानिक एवं प्रभारी राजभाषा , श्री पी. के. जैन, मुख्य प्रशासनिक अधिकारी, श्री गौरांग घोष, वित्त एवं लेखा अधिकारी, मो. कासिम, सहायक मुख्य तकनीकी अधिकारी, के.अं.मा.अ.सं. बैरकपुर, श्री मनोज कुमार राय, सहायक एवं श्री सुरजीत बर्मन, सहायक इस निरीक्षण प्रक्रिया में मौजूद थे। निरीक्षण ग्रांड ओबेराय होटल, कोलकाता में संम्पन हुआ। उक्त निरीक्षण कार्य के दौरान संस्थान के द्वारा सम्पादित राजभाषा हिन्दी से संबंधित कार्यालयीन कार्यों तथा प्रकाशनों की प्रदर्शनी भी प्रस्तुत की गयी जिसे इस समिति के सभी सदस्यों के द्वारा सराहा गया।

संसदीय राजभाषा समिति की दूसरी उप समिति के माननीय सदस्य एवं संस्थान के अधिकारीगण।

संसदीय राजभाषा समिति द्वारा सहायक महानिदेशक (वा.फ.) एवं संस्थान के निदेशक प्रमाण पत्र ग्रहण करते हुये।

## सीसल अनुसंधान केन्द्र, बामरा, ओडिशा में "हिन्दी सप्ताह" का आयोजन

सीसल अनुसंधान केन्द्र, बामरा में दिनांक 14-20 सितम्बर, 2018 तक हिन्दी सप्ताह का आयोजन किया गया। इस कार्यक्रम का उद्घाटन डॉ. अजित कुमार झा, केन्द्र प्रभारी, सीसल अनुसंधान केन्द्र, बामरा के द्वारा दीप प्रज्जवलित करके किया गया। केन्द्र प्रभारी ने कार्यक्रम में उपस्थित सभी श्रोताओं का अभिनन्दन किया एवं अपने संबोधन में उन्होंने हिन्दी भाषा के विकास एवं महत्व के बारे में विस्तार पूर्वक बताया। उन्होंने केन्द्र


प्रमाण पत्र वितरित करते हुए केन्द्र प्रभारी, डॉ. ए. के. झा

के सभी अधिकारियों, कर्मचारियों से अपने दैनिक काम-काज राजभाषा हिन्दी में करने के लिए अपील की इस अवसर पर केन्द्र के टी.एस. सी.एल. कार्मिक भी उपस्थित थे। इस अवसर पर विभिन्न प्रतियोगिताओं का आयोजन किया गया, जिसमें इस केन्द्र के कर्मियों ने बढ़-चढ़ कर


प्रमाण पत्र वितरित करते हुए केन्द्र प्रभारी, डॉ. ए. के. झा

हिस्सा लिया। इस अवसर पर केन्द्र के टी.एस.सी.एल. कर्मियों के लिए 'सीसल की खेती' विषय पर भाषण प्रतियोगिता का आयोजन किया गया जिसमें श्री फकीर को प्रथम, श्री लोचेन्द्र को द्वितीय एवं श्रीमती खीरा को तृतीय स्थान प्राप्त हुआ। इसी प्रकार अधिकारियों एवं कर्मचारियों के लिए 'राष्ट्रभाषा हिन्दी का महत्व' विषय पर भाषण प्रतियोगिता का आयोजन किया गया जिसमें श्री मनोज कुमार प्रधान को प्रथम, श्री सोनू कुमार सुमन को द्वितीय एवं श्री हरेकृष्ण दास को तृतीय स्थान प्राप्त हुआ। इसी क्रम में केन्द्र के कर्मचारियों हेतु 'हमारा संस्थान' विषय पर निबंध लेखन प्रतियोगिता का आयोजन किया गया जिसमें, श्री सोनू कुमार सुमन ने प्रथम, श्री मनोज कुमार प्रधान ने द्वितीय एवं श्री हरेकृष्ण दास ने तृतीय स्थान प्राप्त किया।

## केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र, बुदबुद, वर्दवान में 'हिन्दी दिवस' का आयोजन

केन्द्रीय पटसन एवं समवर्गीय रेशा बीज अनुसंधान केन्द्र में दिनांक 14.09.2018 को हिंदी दिवस बड़े उत्साह और उल्लास के साथ मनाया गया जिसका उद्घाटन केन्द्र के प्रभारी, डॉ. हेमराज भण्डारी ने किया। अपने


हिन्दी दिवस का आयोजन

संबोधन में उन्होंने केन्द्र के अधिकारियों एवं कर्मचारियों से कार्यालय के कार्यालयीन कार्य हिन्दी में करने की अपील की तथा उन्होंने आगे कहा कि यद्यपि हमारे देश में विभिन्न भाषाएं बोली जाती हैं किन्तु हिन्दी संपर्क भाषा का कार्य निभा रही है। इस उपलक्ष्य पर हिंदी निबंध प्रतियोगिता का आयोजन किया गया। जिसमें केन्द्र के अधिकारियों/कर्मचारियों ने उत्साहपूर्वक भाग लिया। इसमें अच्छे करने वाले अधिकारियों एवं कर्मचारियों को पुरस्कार भी प्रदान किए गये।

अंत में केन्द्र प्रभारी, डॉ. हेमराज भण्डारी के धन्यवाद ज्ञापन के साथ हिन्दी दिवस समारोह का समापन हुआ।

हिन्दी दिवस के उपलक्ष्य पर मुख्य अतिथि द्वारा पुरस्कार वितरण

## सनई अनुसंधान केन्द्र, प्रतापगढ़, उत्तर प्रदेश में "हिन्दी पखवाड़ा'' का आयोजन

सरकारी काम-काज में राजभाषा के रुप में हिन्दी के प्रति जागरूकता पैदा करने तथा उसके प्रभावों में गति लाने के लिए सनई अनुसंधान केन्द्र में हिन्दी पखवाड़ा का आयोजन दिनांक 14 से 28 सितम्बर, 2018 के दौरान किया गया। इस अवसर पर केन्द्र के श्री सुरेन्द्र प्रताप प्रजापति ने हिंदी के अधिकाधिक प्रयोग पर बल दिया। श्री संदीप प्रकाश, सहायक ने हिन्दी के योगदान और इसके विकास पर प्रकाश डाला, श्री पारस नाथ पाल, प्रवर श्रेणी लिपिक ने हिन्दी कार्यालयीन कार्य हिन्दी में करने पर


सनई अनुसंधान केन्द्र, प्रतापगढ़ में हिन्दी पखवाड़ा का आयोजन।

बल दिया। पखवाड़ा के दौरान विभिन्न प्रतियोगिताएं आयोजित की गईं जिसमें केन्द्र के कर्मचारियों ने बढ़-चढ़कर हिस्सा लिया। सभी विजेता प्रतियोगियों को पुरस्कार भी प्रदान किए गए। श्री देशराज मीणा, केन्द्र प्रभारी के धन्यवाद ज्ञापन के साथ हिन्दी पखवाड़ा का समापन हुआ।

## कृषि विज्ञान केन्द्र, बुदबुद, वर्दवान में 'हिन्दी दिवस' का आयोजन

''हिन्दी दिवस समारोह'' का अयोजन दिनांक 14 सितम्बर, 2018 को कृषि विज्ञान केन्द्र, बुदबुद, वर्दवान में किया गया। इस अवसर पर मुख्य अतिथि के रूप में श्री विश्वजीत मजुमदार, प्राध्यापक, हिन्दी शिक्षण योजना, राजभाषा विभाग, भारत सरकार, दुर्गापुर उपस्थित थे। अपने संबोधन में उन्होंने राजभाषा के बारे में विस्तृत जानकारी तथा हिन्दी के इतिहास पर प्रकाश डाला तथा उन्होंने कहा कि विश्व के कई ऐसे उन्नत देश हैं जहाँ समस्त कार्य उस देश की भाषा में होता है; जैसे कि रूस, चीन, जापान एवं इंगलैण्ड आदि में अपनी-अपनी भाषा में कार्यालयीन कार्य होता है। इस अवसर पर डी. आई. सी., पानागढ़ के हिंदी आधिकारी, श्री संजय माझी भी उपस्थित थे। इस अवसर पर के.वी.के., बुद बुद, बर्दवान के समस्त अधिकारियों एवं कर्मचारियों ने भाग लिया, जिसमें हिंदी एवं मसौदा लेखन प्रतियोगिता का भी आयोजन किया गया। प्रतियोगिता में डॉ. दीपांकर घोराई, विषय वस्तु विशेषज्ञ, श्री निलेश राय, सहायक, एवं डॉ. सुब्रत सरकार, विषय वस्तु विशेषज्ञ ने क्रमश: प्रथम, द्वितीय और तृतीय स्थान प्राप्त किए। पुरस्कार विजेताओं को मुख्य अतिथि के द्वारा पुरस्कार से सम्मानित किया गया। अन्त में डॉ. दीपांकर घोराई के धन्यवाद ज्ञापन के साथ कार्यक्रम का समापन हुआ।

कृषि विज्ञान केन्द्र, बुद बुद में हिन्दी दिवस का आयोजन।

हिन्दी दिवस के उपलक्ष्य पर मुख्य अतिथि द्वारा पुरस्कार वितरण।

# 19. Distinguished Visitors

| Name of the Visitor | Affiliation | Date |
|---|---|---|
| Sh. Radha Mohan Singh | Hon'ble Union Minister of Agriculture and Farmers Welfare, New Delhi | 14 Nov, 2018 |
| Sh. Keshari Nath Tripathi | Hon'ble Governor of West Bengal | 24 Feb, 2019 |
| Dr. C. D. Mayee | Chairman, QRT, ICAR-CRIJAF & Former Chairman, ASRB, New Delhi | 03 July, 2018 |
| Dr. S.A. Patil | Chairman, RAC, ICAR-CRIJAF & Former Director, ICAR- IARI, New Delhi | 26 July, 2018 |
| Dr. A. K. Singh | Deputy Director General (Crop Sciences), ICAR, New Delhi | 15 Dec, 2018 |
| Dr. R.K. Singh | Assistant Director General (Commercial Crops), ICAR, New Delhi | 02 Nov, 2018 |
| Sh. Arvind Kumar | Secretary, National Jute Board, Kolkata | 04 Aug, 2018 |
| Dr. S.S. Singh | Director, ICAR-ATARI, Kolkata | 03 Jan, 2019 |
| Dr. N.C. Pan | Director, ICAR-NINFET, Kolkata | 09 Feb, 2019 |
| Dr. Chandra Gopal Sharma | Former Deputy General Manager (Official Language), Eastern Railway, Kolkata | 14 Sept, 2018 |

Sh. Radha Mohan SinghJi, Hon'ble Union Minister of Agriculture and Farmers Welfare visiting ICAR-CRIJAF

Sh. Keshari Nath Tripathi, Hon'ble Governor, W.B. releasing CRIJAF Bulletin during launching of PMK-Samman Nidhi


Dr. C. D. Mayee, Chairman, QRT, ICAR-CRIJAF is interacting with scientists


Dr. A.K. Singh, DDG (Crop Science), ICAR being appraised with ICAR-CRIJAF technologies

# 20. Staff Position

**Table 20.1. Staff position of ICAR-CRIJAF along with the sub-stations as on 31.03.2019**

| Category | Sanctioned strength | Staff in position | | | | | |
|---|---|---|---|---|---|---|---|
| | | CRIJAF (HQ) Barrackpore | CSRSJAF Budbud | RRS Sorbhog | SRS Bamra | ShRS Pratapgrah | Total |
| Scientist | 74+1 (RMP) | 44 | 01 | 02 | 01 | 01 | 49 |
| Technical | 108 | 34 | 08 | 02 | 03 | 03 | 50 |
| Administrative | 62 | 33 | 01 | 03 | 01 | 02 | 40 |
| SSS | 92 | 05 | 02 | 00 | 01 | 00 | 08 |

**Table 20.2. Staff position at Krishi Vigyan Kendra, Purba Bardhaman as on 31.03.2019**

| Designation | Sanctioned Strength | Men in position | Vacancy |
|---|---|---|---|
| Sr. Scientist-cum-Head | 01 | 01 | 00 |
| Subject Matter Specialist | 06 | 03<br>(T-9 – 02)<br>(T-7/8 – 01) | 03 |
| Farm Manager | 01 | 01 (T-6) | 00 |
| Prog. Asstt. | 01 | 01 (T-6) | 00 |
| Prog. Asstt. (Computer) | 01 | 01 (T-5) | 00 |
| Assistant | 01 | 01 | 00 |
| Stenographer, Gr.III | 01 | 00 | 01 |
| Driver | 02 | 02 (T-3) | 00 |
| Skilled Support Staff | 02 | 02 | 00 |
| **TOTAL** | **16** | **12** | **04** |

**Table 20.3. Staff position at Krishi Vigyan Kendra, North 24 Pgs (additional) as on 31.03.2019**

| Designation | Sanctioned Strength | Men in position | Vacancy |
|---|---|---|---|
| Sr. Scientist-cum-Head | 01 | 01 | 00 |
| Subject Matter Specialist | 06 | 00 | 06 |
| Farm Manager | 01 | 00 | 01 |
| Prog. Asstt. | 01 | 00 | 01 |
| Prog. Asstt. (Computer) | 01 | 00 | 01 |
| Assistant | 01 | 01 | 00 |
| Stenographer, Gr.III | 01 | 00 | 01 |
| Driver | 02 | 00 | 02 |
| Skilled Support Staff | 02 | 00 | 02 |
| **TOTAL** | **16** | **02** | **14** |

# 21. Personnel

## 21.1 Staff in Position

| Name | Designation | E-mail id |
|---|---|---|
| **ICAR-CRIJAF, HQ** | | |
| Dr. J. Mitra | Director (Actg.) | Jiban.Mitra@icar.gov.in |
| **Division of Crop Improvement** | | |
| Dr. J. Mitra | Pr. Scientist (Plant Breeding) and HoD | Jiban.Mitra@icar.gov.in |
| Dr. A.B. Mandal | Pr. Scientist (Plant Breeding) | Asit.Mandal@icar.gov.in |
| Dr. D. Sarkar | Pr. Scientist (Biotechnology) | Debabrata.Sarkar@icar.gov.in |
| Dr. C.S. Kar | Pr. Scientist (Plant Breeding) | Chandan.Kar@icar.gov.in |
| Dr. S. Datta | Pr. Scientist (Biotechnology) | Subhojit.Datta@icar.gov.in |
| Dr. D. Saha | Pr. Scientist (Biotechnology) | Dipnarayan.Saha@icar.gov.in |
| Dr. P. Satya | Pr. Scientist (Plant Breeding) | Pratik.Satya@icar.gov.in |
| Dr. A.K. Chakraborty | Scientist (Agril. Statistics) | Asim.Chakraborty@icar.gov.in |
| Dr. A. Bera | Sr. Scientist (Seed Technology) | Amit.Bera@icar.gov.in |
| Mrs. K. Meena | Scientist (Biotechnology) | Kanti.Meena@icar.gov.in |
| Dr. A. Anil Kumar | Scientist (Plant Breeding) | anil.kumar8@icar.gov.in |
| Dr. Maruthi R.T. | Scientist (Genetics) | Maruthi.RT@icar.gov.in |
| Dr. S. Ray | Scientist (Biotechnology) | Soham.Ray@icar.gov.in |
| Mr. B. Ghosh | Technical Officer | Basudeb.Ghosh@icar.gov.in |
| Mr. O.P. Choudhury | Technical Officer | Omprakash.Choudhury@icar.gov.in |
| Mr. A. Mukhopadhyay | Technical Officer | Ashim.Mukhopadhyay@icar.gov.in |
| Mr. S. Mukhtar | Technical Officer | Shahid.Mukhtar@icar.gov.in |
| **Division of Crop Production** | | |
| Dr. D.K. Kundu | Pr. Scientist (Soil Science) & I/c, HoD | Dilip.Kundu@icar.gov.in |
| Dr. A.K. Ghorai | Pr. Scientist (Agronomy) | Asesh.Ghorai@icar.gov.in |
| Dr. A.R. Saha | Pr. Scientist (Soil Science) | Amit.Saha@icar.gov.in |
| Dr. B. Majumdar | Pr. Scientist (Soil Science) | Bijan.Majumdar@icar.gov.in |
| Dr. S. Sarkar | Pr. Scientist (Agronomy) | Sitangshu.Sarkar@icar.gov.in |
| Dr. R. Saha | Pr. Scientist (Soil Physics) | Ritesh.Saha@icar.gov.in |
| Dr. M.S. Behera | Pr. Scientist (Agronomy) | Madhusudan.Behera@icar.gov.in |
| Dr. A.K. Singh | Pr. Scientist (Soil Science) | Arvind.Singh3@icar.gov.in |
| Dr. D. Barman | Sr. Scientist (Soil Physics) | Dhananjay.Barman@icar.gov.in |
| Dr. S.P. Mazumdar | Scientist (Soil Science) | Sonali.Majumdar@icar.gov.in |
| Dr. M. Kumar | Scientist (Agronomy) (up to 28.03.2019)<br>(Joined Dr. Rajendra Prasad CAU, Samastipur) | Mukesh.Kumar2@icar.gov.in |
| Dr. R.K. Naik | Sr. Scientist (Farm Machinery & Power) | Ranjan.Naik@icar.gov.in |
| Mr. M. Ramesh Naik | Scientist (Agronomy)<br>(On study leave from 08.08.2016) | M.Naik@icar.gov.in |
| Dr. S. Roy | Scientist (Plant Physiology) | Suman.Roy@icar.gov.in |
| Dr. L. Sharma | Scientist (Plant Physiology) | Laxmi.Sharma@icar.gov.in |
| Mrs. M. Saha | Scientist (Soil Science) (up to 27.06.2018, transferred to ICAR-IISS, Bhopal, M.P.) | Madhumonti.Saha@icar.gov.in |

| Name | Designation | E-mail id |
|---|---|---|
| Mr. Sk. Phirose | Technical Officer | Sk.Phirose@icar.gov.in |
| Mr. D. K. Patra | Technical Officer | Dilip.Patra@icar.gov.in |
| Mr. K. B. Roy | Technical Officer | Kalyan.Roy@icar.gov.in |
| Mr. S. Biswas | Technical Officer | Saurav.Biswas@icar.gov.in |
| Dr. S. K. Bhattacharyya | Technical Officer | Saurindra.Bhattacharyya@icar.gov.in |
| **Division of Crop Protection** | | |
| Dr. S. Satpathy | Pr. Scientist (Agril. Entomology) & HoD | Subrata.Satpathy@icar.gov.in |
| Dr. R.K. De | Pr. Scientist (Plant Pathology) | Rajib.De@icar.gov.in |
| Dr. S. Biswas | Pr. Scientist (Plant Pathology) (up to 28.02.2019) | Subrata.Biswas@icar.gov.in |
| Dr. K. Mandal | Pr. Scientist (Plant Pathology) | Kunal.Mandal@icar.gov.in |
| Dr. S.K. Sarkar | Pr. Scientist (Plant Pathology) | Surja.Sarkar@icar.gov.in |
| Dr. C. Biswas | Pr. Scientist (Plant Pathology) | Chinmay.Biswas@icar.gov.in |
| Dr. B.S. Gotyal | Sr. Scientist (Agril. Entomology) | Bheemanna.Gotyal@icar.gov.in |
| Dr. V. Ramesh Babu | Scientist (Agril. Entomology) | Veegala.Babu@icar.gov.in |
| Mr. P.N. Meena | Scientist (Plant Pathology) (On study leave from 01.01.2017) | Prabhu.Meena@icar.gov.in |
| Mr. K.P. Debnath | Technical Officer | Kalipada.Debnath@icar.gov.in |
| Mr. P.K. Biswas | Technical Officer (up to 28.02.2019) | Pabitra.Biswas@icar.gov.in |
| **Agricultural Extension Section** | | |
| Dr. S.K. Jha | Pr. Scientist (Agril. Extension) & I/c | Suniti.Jha@icar.gov.in |
| Dr. S. Kumar | Pr. Scientist (Agril. Extension) | Shailesh.Kumar@icar.gov.in |
| Dr. Shamna A. | Sr. Scientist (Agril. Extension) | Shamna.A@icar.gov.in |
| Dr. M.L. Roy | Scientist (Agril. Extension) | Manik.Roy@icar.gov.in |
| Mr. B. Sarkar | Technical Officer | Baul.Sarkar @icar.gov.in |
| Mr. R.K. Roshan | Technical Officer | Rakesh.Roshan@icar.gov.in |
| **All India Network Project on Jute and Allied Fibres** | | |
| Dr. S. Mitra | Pr. Scientist (Agronomy) & I/c | Sabyasachi.Mitra@icar.gov.in |
| Dr. S.K. Pandey | Pr. Scientist (Plant Breeding) | Surendra.Pandey@icar.gov.in |
| Dr. N.M. Alam | Scientist (Agril. Statistics) (*w.e.f.* 09.07.2018) | Nurnabi.Alam@icar.gov.in |
| Mr. A. Mondal | Technical Officer | Akshaya.Mondal@icar.gov.in |
| Mr. S. Islam | Technical Officer (on study leave) | Sirajul.Islam@icar.gov.in |
| **Administration, Finance & Accounts** | | |
| Mr. P.K. Jain | Chief Administrative Officer | Pradyumna.Jain@icar.gov.in |
| Mr. P. Singh | Administrative Officer (*w.e.f.* 06.08.2018) | Prahlad.Singh2@icar.gov.in |
| Mr. G. Ghosh | Finance & Accounts Officer | Gauranga.Ghosh@icar.gov.in |
| Mr. S. Ghosh | DDO | Samar.Ghosh@icar.gov.in |
| Mr. R. Mishra | AAO (Purchase & Store) | Ravi.Mishra@icar.gov.in |
| Mr. S. Bhattacharyya | AAO (Administration-I) | Subrata.Bhattacharyya@icar.gov.in |
| Mr. S.K. Bala | AAO (Administration-II) | Subrata.Bala@icar.gov.in |
| Mr. S.K. Pal | AAO (Store) | Subrata.Pal@icar.gov.in |
| **Library** | | |
| Dr. M. Kumar | Scientist & I/c (up to 27.03.2019) | Mukesh.Kumar2@icar.gov.in |
| Dr. A.K. Singh | Pr. Scientist & I/c (*w.e.f.* 28.03.2019) | Arvind.Singh3@icar.gov.in |

| Name | Designation | E-mail id |
|---|---|---|
| **Agricultural Meteorology Unit** | | |
| Dr. D. Barman | Sr. Scientist & I/c | Dhananjay.Barman@icar.gov.in |
| Mr. S. Sarkar | Technical Officer (up to 31.10.2018) | Sudhir.Sarkar@icar.gov.in |
| Mr. A. Mondal | Technical Officer (*w.e.f.* 01.11.2018) | Akshaya.Mondal@icar.gov.in |
| **Agricultural Knowledge Management Unit** | | |
| Dr. C.S. Kar | Pr. Scientist & I/c (up to 19.12.2018) | Chandan.Kar@icar.gov.in |
| Dr. N.M. Alam | Scientist & I/c (*w.e.f.* 20.12.2018) | Nurnabi.Alam@icar.gov.in |
| Mr. N. Paul | Chief Technical Officer | Nilanjan.Paul@icar.gov.in |
| **Priority setting, Monitoring and Evaluation Cell** | | |
| Dr. S.K. Sarkar | Pr. Scientist & I/c | Surja.Sarkar@icar.gov.in |
| Dr. B. Majumdar | Pr. Scientist | Bijan.Majumdar@icar.gov.in |
| Dr. R. Saha | Pr. Scientist | Ritesh.Saha@icar.gov.in |
| Dr. S. Datta | Pr. Scientist | Subhojit.Datta@icar.gov.in |
| Mr. N. Paul | Chief Technical Officer | Nilanjan.Paul@icar.gov.in |
| **IPR & Institute Technology Management Unit** | | |
| Dr. S.K. Sarkar | Pr. Scientist & I/c (up to 23.01.2019) | Surja.Sarkar@icar.gov.in |
| Dr. R. Saha | Pr. Scientist & I/c (*w.e.f.* 24.01.2019) | Ritesh.Saha@icar.gov.in |
| **Official Language Cell** | | |
| Dr. S.K. Pandey | Pr. Scientist & I/c | Surendra.Pandey@icar.gov.in |
| **Farm Management Committee** | | |
| Dr. D.K. Kundu | I/c, Head (Crop Production) & Chairman | Dilip.Kundu@icar.gov.in |
| Dr. A.K. Ghorai | Pr. Scientist & Member | Asesh.Ghorai@icar.gov.in |
| Dr. S. Sarkar | Pr. Scientist & Member (*w.e.f.* 29.03.2019) | |
| Dr. M.S. Behera | Pr. Scientist & Member | Madhusudan.Behera@icar.gov.in |
| Dr. R.K. Naik | Sr. Scientist & Member | Ranjan.Naik@icar.gov.in |
| Dr. A. Bera | Sr. Scientist & Member | Amit.Bera@icar.gov.in |
| Dr. M. Kumar | Scientist & Member (up to 28.03.2019) | Mukesh.Kumar2@icar.gov.in |
| **Estate and Maintenance Committee** | | |
| Dr. R.K. Naik | Sr. Scientist & Chairman | Ranjan.Naik@icar.gov.in |
| Mr. A. Dutta | Sr. Tech. Astt. | Avijit.Dutta@icar.gov.in |
| Mr. S. Biswas | Technical Officer | Saurav.Biswas@icar.gov.in |
| Mr. K.B. Roy | Technical Officer | Kalyan.Roy@icar.gov.in |
| Mr. S. Sarkar | Technical officer (up to 31.10.2018) | Sudhir.Sarkar@icar.gov.in |
| **HRD Cell** | | |
| Dr. P. Satya | Pr. Scientist & Nodal officer | Pratik.Satya@icar.gov.in |
| Dr. R. Saha | Pr. Scientist & Member | Ritesh.Saha@icar.gov.in |
| Dr. Suman Roy | Scientist & Member | Suman.Roy@icar.gov.in |
| **Women Complaint Committee/Women Cell** | | |
| Dr. Shamna A. | Sr. Scientist & Chairperson | Shamna.A@icar.gov.in |
| Dr. S.P. Mazumdar | Scientist & Member | Sonali.Mazumdar@icar.gov.in |
| Dr. K. Meena | Scientist & Member | Kanti.Meena@icar.gov.in |
| Mr. P. Singh | Administrative Officer & Member | Prahlad.Singh2@icar.gov.in |

| Name | Designation | E-mail id |
|---|---|---|
| Mrs. N. Mandal | PA to CAO & Member | Neena.Mandal@icar.gov.in |
| **Ramie Research Station, Sorbhog, Assam** | | |
| Mr. K. Das | Scientist & I/c (*w.e.f.* 09.10.2018) | kajal.das@icar.gov.in |
| Mr. Monu Kumar | Scientist (On study leave from 14.11.2016) | Monu.Kumar@icar.gov.in |
| Mr. B. Ramchiary | Technical Officer | Birbal.Ramchiary@icar.gov.in |
| Mr. M.K. Das | Technical Officer | Munindra.Das@icar.gov.in |
| Mr. A. Basumatary | Technical Officer (up to 30.11.2018) | Ananda.Basaumatary@icar.gov.in |
| **Sisal Research Station, Bamra, Odisha** | | |
| Dr. A.K. Jha | Sr. Scientist (Plant Pathology) & I/c | Ajit.Jha@icar.gov.in |
| Mr. M.K. Pradhan | Technical Officer | Manoja.Pradhan@icar.gov.in |
| **Sunnhemp Research Station, Pratapgarh, Uttar Pradesh** | | |
| Mr. Shivakumar K.V. | Scientist (Plant Pathology) & I/C (*w.e.f.* 09.10.2018) | shivakumar.kv@icar.gov.in |
| Mr. D. Meena | Technical Officer | Deshraj.Meena@icar.gov.in |
| **Central Seed Research Station for Jute and Allied Fibres, Budbud, West Bengal** | | |
| Mr. H.R. Bhandari | Scientist (Plant Breeding) & I/c | Hem.Bhandari@icar.gov.in |
| Mr. L.N. Ghosh | Technical Officer | Lakshmi.Ghosh@icar.gov.in |
| Mr. M. Haque | Technical Officer | Mohidul.Haque@icar.gov.in |
| **Krishi Vigyan Kendra (KVK), Purba Bardhaman** | | |
| Dr. Sk. Md. Azizur Rahman | Sr. Scientist-cum-Head (Agril. Entomology) (*w.e.f.* 27.12.2018) | Azizur.Rahman1@icar.gov.in |
| Dr. D. Ghorai | SMS, T 9 (Agriculture) & I/c PC (up to 26.12.2018) | Dipankar.Ghorai@icar.gov.in |
| Dr. G. Ziauddin | SMS T 7-8 (Fishery Science) | Golam.Ziauddin@icar.gov.in |
| Dr. S. Sarkar | SMS T 9 (Horticulture) | Subrata.Sarkar@icar.gov.in |
| Dr. (Mrs.) M.S. Singh | SMS, T 7-8 (Agricultural Extension) | Monica.Singh@icar.gov.in |
| Mr. S.S. Kundu | Technical Officer | Soumya.Kundu@icar.gov.in |
| Mr. S. Garai | Senior Technical Officer | Sandipan.Garai@icar.gov.in |
| **Krishi Vigyan Kendra (KVK), North 24 Parganas (Additional)** | | |
| Dr. M.L. Roy | Scientist & I/c (up to 16.12.2018) | Manik.Roy@icar.gov.in |
| Dr. T. Samajdar | Sr. Scientist-cum-Head (Veterinary Extn. Education) (*w.e.f.* 17.12.2018) | tanmay.samajdar@icar.gov.in |

## 21.2 Promotion

| Name | Designation | Promoted to | w. e. f. |
|---|---|---|---|
| **Scientist** | | | |
| Dr. S. Kumar | Sr. Scientist (RGP 9000/-) | Pr. Scientist (RGP 10,000/-) | 27. 07. 2017 |
| Dr. R.K. Naik | Sr. Scientist (RGP 8000/-) | Sr. Scientist (RGP 9000/-) | 27.06.2018 |
| Dr. B.S. Gotyal | Scientist (RGP 7000/-) | Sr. Scientist (RGP 8000/-) | 10.02.2018 |
| Dr. Shamna A. | Scientist (RGP 7000/-) | Sr. Scientist (RGP 8000/-) | 23.06.2018 |
| Dr. A.K. Jha | Sr. Scientist (RGP 8000/-) | Sr. Scientist (RGP 9000/-) | 20.10.2014 |
| Mr. P.N. Meena | Scientist (RGP 6000/-) | Scientist (RGP 7000/-) | 01.01.2018 |
| Mr. M. Ramesh Naik | Scientist (RGP 6000/-) | Scientist (RGP 7000/-) | 01.01.2018 |

| Name | Designation | Promoted to | w. e. f. |
|---|---|---|---|
| **Technical staff** | | | |
| Mr. L. Pradhan | Sr. Technician (T-2) | Tech. Asstt. (T-3) | 17.01.2018 |
| Mr. B.L. Prasad | Sr. Technician (T-2) | Tech. Asstt. (T-3) | 17.01.2018 |
| Dr. D. Ghorai | Asstt. Chief Technical Officer /T-7-8 | Chief Technical Officer / T-9 | 26.04.2018 |
| Mr. S. Mukhtar | Sr. Technical Assistant/T-4 | Technical Officer/ T-5 | 28.04.2018 |
| Mr. M.K. Pradhan | Sr. Technical Assistant/T-4 | Technical Officer/ T-5 | 19.04.2018 |
| Mr. S. Islam | Sr. Technical Assistant/T-4 | Technical Officer/ T-5 | 25.04.2018 |
| Dr. S. Sarkar | Asstt. Chief Technical Officer /T-7-8 | Chief Technical Officer / T-9 | 04.05.2018 |
| Mr. N. Paul | Asstt. Chief Technical Officer | Chief Technical Officer | 15.05.2017 |
| Mr. M. Haque | Sr. Technical Assistant/T-4 | Technical Officer/ T-5 | 02.06.2018 |
| Mr. D. Meena | Sr. Technical Assistant/T-4 | Technical Officer/ T-5 | 20.06.2018 |
| Dr. M.S. Singh | Sr. Technical Officer (SMS) | Asstt. Chief Technical Officer | 09.07.2017 |
| Dr. S.K. Bhattacharyya | Sr. Technical Assistant/T-4 | Technical Officer/ T-5 | 17.07.2018 |
| **Administrative Staff** | | | |
| Mr. G.C. Dey | Assistant | MACP Scheme to next higher grade (Level -7) | 01.01.2018 |
| Mr. A. Barua | Lower Division Clerk | Upper Division Clerk | 14.01.2019 |

## 21.3 Superannuation

| Name | Designation | Date of Retirement | Place of Posting |
|---|---|---|---|
| Mr. S.P. Dutta | T-4 | 30.04.2018 | CRIJAF, Barrackpore |
| Mr. D.D. Pingh | SSS | 31.08.2018 | SRS, Bamra |
| Mr. P. Dey Chowdhury | T-4 | 31.10.2018 | CSRSJAF, BudBud |
| Mr. S.Sarkar | T-5 | 31.10.2018 | CRIJAF, Barrackpore |
| Mr. S.K. Sen | Assistant | 30.11.2018 | CRIJAF,Barrackpore |
| Mr. A. Basumatary | T-5 | 30.11.2018 | RRS, Sorbhog |
| Mr. S.S. Halder | SSS | 31.12.2018 | CRIJAF, Barrackpore |
| Mr. D.P. Dutta | SSS | 31.12.2018 | CRIJAF, Barrackpore |
| Dr. S. Biswas | Pr. Scientist | 28.02.2019 | CRIJAF, Barrackpore |
| Mr. P.K. Biswas | T-5 | 28.02.2019 | CRIJAF, Barrackpore |

*TO= Technical Officer, SSS= Skilled Support Staff*

## 21.4 New Colleagues

| Name | Designation | Date of Joining | Place of Posting |
|---|---|---|---|
| **Scientist** | | | |
| Dr. N.M. Alam | Scientist | 09.07.2018 | CRIJAF, Barrackpore |
| Mr. Shivakumar K.V. | Scientist | 09.10.2018 | ShRS, Pratapgrah |
| Mr. K. Das | Scientist | 09.10.2018 | RRS, Sorbhog |
| Dr. T. Samajdar | Sr. Scientist-cum-Head | 17.12.2018 | KVK, North 24 Parganas (Additional) |
| Dr. Sk. Md. Azizur Rahman | Sr. Scientist-cum-Head | 27.12.2018 | KVK, Budbud, Purba Bardhaman |

| Name | Designation | Date of Joining | Place of Posting |
|---|---|---|---|
| **Administrative** | | | |
| Ms. F. Banu | Lower Division Clerk | 24.12.2018 | CRIJAF, Barrackpore |
| Mr. P. Singh | Administrative Officer | 06.08.2018 | CRIJAF, Barrackpore |
| Mr. R. Patra | Lower Division Clerk | 24.12.2018 | SRS, Bamra |
| **Technical** | | | |
| Mr. S. Roy | Technical Assistant (T-3) | 10.12.2018 | ShRS, Pratapgrah |
| Ms. P. Mandal | Technical Assistant (T-3) | 18.12.2018 | CRIJAF, Barrackpore |
| Mr. R. Mitra | Technical Assistant (T-3) | 22.12.2018 | CRIJAF, Barrackpore |
| Mr. B. Biswas | Technical Trainee (T-1) | 22.12.2018 | CRIJAF, Barrackpore |
| Ms. S. Sarkar | Technical Trainee (T-1) | 24.12.2018 | CRIJAF, Barrackpore |
| Mr. S. Kumar | Technical Trainee (T-1) | 26.12.2018 | RRS, Sorbhog |
| Mr. P. Roy | Technical Trainee (T-1) | 29.12.2018 | CRIJAF, Barrackpore |
| Mr. K. Sarkar | Technical Assistant (T-3) | 29.12.2018 | CRIJAF, Barrackpore |
| Mr. A.M. Pitre | Technical Assistant (T-3) | 31.12.2018 | CRIJAF, Barrackpore |
| Mr. R.N. Kumar | Technician Trainee (T-1) | 03.01.2019 | SRS, Bamra |
| Mr. A. Banerjee | Technician Trainee (T-1) | 11.01.2019 | CRIJAF, Barrackpore |
| Mr. S. Nandy | Technical Assistant (T-3) | 11.02.2019 | CRIJAF, Barrackpore |
| Mr. A. Singha Roy | Technician Trainee (T-1) | 13.02.2019 | CSRSJAF, BudBud |
| Kazi Md. Azharuddin | Technician Trainee (T-1) | 26.03.2019 | KVK, North 24 Pgs (Additional) |

# 22. Financial Statement

**Table 22.1. Financial Statement of ICAR-CRIJAF, Barrackpore for the year 2018-19**

(Rs. in lakhs)

| Sub-Head | Grants B.E. (2018-19) | Grants R.E. (2018-19) | Grants Expenditure (2018-19) |
|---|---|---|---|
| Establishment Charges | 1700.00 | 2056.24 | 2054.73 |
| **Wages** | 407.00 | 358.50 | 358.38 |
| **OTA** | 0.25 | 0.15 | 0.00 |
| **Retirement Benefit** | 430.00 | 440.00 | 438.13 |
| **T.A.** | 28.00 | 28.80 | 28.69 |
| **Other Charges** | 448.00 | 419.60 | 417.69 |
| Works-Maintenance | | | |
| a) Residential | 60.00 | 7.00 | 6.93 |
| b) Non Residential | 70.00 | 238.00 | 237.47 |
| c) Equipment & others | 20.00 | 24.50 | 24.21 |
| d) Minor Works | 30.00 | 24.00 | 23.43 |
| Major Works | 0.00 | 0.00 | 0.00 |
| **HRD** | 9.00 | 8.10 | 8.03 |
| **Equipments** | 23.00 | 31.10 | 30.55 |
| **Vehicle** | 0.00 | 0.00 | 0.00 |
| **Information Technology** | 8.00 | 8.00 | 7.97 |
| **Furniture** | 0.00 | 0.00 | 0.00 |
| **Library Books & Journals** | 0.00 | 0.00 | 0.00 |
| **Total** | **3233.25** | **3643.99** | **3636.21** |
| Loans & Advance | 35.00 | 35.00 | 14.80 |

**Table 22.2. Financial Statement for AINP on Jute & Allied Fibres, and KVKs [Purba Bardhaman & 24 Parganas (N) (additional)] for the year 2018-19**

(Rs. in lakhs)

| Head | Target | Achievement |
|---|---|---|
| A.I.C.R.P on J & AF | 327.00 | 325.99 |
| K.V.K – Purba Bardhaman | 128.00 | 124.55 |
| K.V.K- 24 Parganas(N) (additional) | 102.00 | 101.41 |

**Table 22.3. Actual Realization of Revenue Receipts 2018-19**

(Rs. in lakhs)

| Target | Achievement |
|---|---|
| 58.11 | 43.20 |

**Table 22.4. Revenue generated at CRIJAF and its sub-stations**

(Rs. in lakhs)

| Institute/ Sub-stations | Total Revenue |
|---|---|
| CRIJAF (H.Q.) | 22.44 |
| CSRSJAF, Budbud | 8.63 |
| RRS, Sorbhog | 3.10 |
| SRS, Bamra | 6.64 |
| ShRS, Pratapgarh | 2.39 |
| **Total** | **43.20** |

# 23. Meteorology

**Table 23.1. Meteorological data of ICAR-CRIJAF, Barrackpore, West Bengal**

| Months | Air temperature (°C) | | RH (%) | | Rainfall (mm) | Rainy days | Bright sunshine (hrs) | Pan evapo-ration (mm/day) | Wind Speed (km/hr) | Soil temperature (°C) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0636 IST | | | 1336 IST | | |
| | Max | Min | Max | Min | | | | | | 5 cm | 15 cm | 30 cm | 5 cm | 15 cm | 30 cm |
| Apr-18 | 33.9 | 22.9 | 90.2 | 55.9 | 187.4 | 7 | 6.9 | 4.5 | 3.4 | 25.9 | 27.3 | 28.4 | 37.6 | 32.9 | 28.5 |
| May-18 | 34.2 | 25.7 | 88.4 | 63.8 | 177.2 | 11 | 6.5 | 4.5 | 4.3 | 28.1 | 29.0 | 29.0 | 38.0 | 33.9 | 29.1 |
| Jun-18 | 34.4 | 26.4 | 88.7 | 71.2 | 203.5 | 11 | 4.1 | 3.4 | 2.1 | 29.8 | 29.6 | 29.2 | 37.2 | 33.8 | 30.5 |
| Jul-18 | 32.5 | 26.0 | 92.9 | 78.0 | 403.8 | 20 | 3.3 | 3.1 | 2.3 | 28.2 | 28.7 | 29.1 | 33.9 | 31.8 | 29.4 |
| Aug-18 | 32.6 | 25.8 | 94.3 | 76.6 | 288.6 | 15 | 4.0 | 2.6 | 1.8 | 28.0 | 28.6 | 6.3 | 35.1 | 32.1 | 6.3 |
| Sep-18 | 32.9 | 25.3 | 92.6 | 71.3 | 130.8 | 9 | 4.7 | 2.8 | 1.6 | 27.6 | 28.1 | 0.0 | 34.8 | 32.2 | 0.0 |
| Oct-18 | 32.2 | 21.7 | 91.6 | 56.5 | 20.0 | 2 | 6.9 | 2.8 | 1.8 | 23.6 | 25.2 | 18.8 | 32.7 | 30.0 | 19.3 |
| Nov-18 | 30.2 | 17.2 | 93.5 | 46.2 | 0.0 | 0 | 6.9 | 2.4 | 1.6 | 20.0 | 23.1 | 24.5 | 32.6 | 26.7 | 24.9 |
| Dec-18 | 24.8 | 11.4 | 95.2 | 46.4 | 11.8 | 3 | 5.9 | 1.9 | 2.2 | 14.1 | 18.0 | 20.0 | 26.1 | 21.0 | 20.3 |
| Jan-19 | 25.3 | 10.0 | 94.3 | 42.4 | 0.0 | 0 | 6.6 | 2.0 | 1.8 | 12.1 | 16.7 | 18.4 | 27.2 | 19.6 | 18.8 |
| Feb-19 | 28.4 | 14.4 | 91.3 | 45.5 | 129.6 | 3 | 7.2 | 2.9 | 1.7 | 16.6 | 20.3 | 21.7 | 30.8 | 23.6 | 21.9 |
| Mar-19 | 31.4 | 21.1 | 92.7 | 46.8 | 40.4 | 3 | 6.6 | 3.0 | 1.3 | 21.5 | 24.8 | 25.0 | 35.3 | 27.2 | 25.4 |

*(Source: Agril. Meteorology Unit, ICAR-CRIJAF; Contributor: D. Barman)*

**Table 23.2. Meteorological data of Sunnhemp Research Station, Pratapgarh, U.P.**

| Months | Air temperature (°C) | | RH (%) | | Rainfall (mm) | Rainy days |
|---|---|---|---|---|---|---|
| | Max | Min | Max | Min | | |
| Apr-18 | 37.09 | 21.45 | 63.53 | 29.83 | 42.0 | 02 |
| May-18 | 39.64 | 25.92 | 71.71 | 34.13 | 10.4 | 02 |
| Jun-18 | 39.80 | 27.75 | 66.16 | 38.66 | 43.2 | 05 |
| Jul-18 | 33.38 | 25.97 | 87.16 | 70.70 | 329.4 | 16 |
| Aug-18 | 31.32 | 25.57 | 92.35 | 80.51 | 340.0 | 14 |
| Sep-18 | 32.27 | 24.12 | 88.86 | 78.10 | 161.6 | 10 |
| Oct-18 | 33.48 | 19.40 | 90.67 | 66.83 | 0.0 | 0 |
| Nov-18 | 28.68 | 13.60 | 85.53 | 72.88 | 0.0 | 0 |
| Dec-18 | 23.62 | 7.39 | 85.83 | 60.74 | 0.0 | 0 |
| Jan-19 | 21.98 | 7.84 | 83.70 | 62.74 | 12.0 | 03 |
| Feb-19 | 23.70 | 11.33 | 75.60 | 54.21 | 8.6 | 03 |
| Mar-19 | 30.04 | 14.79 | 83.06 | 49.12 | 21.0 | 02 |

*(Source: Agril. Meteorology Unit; ShRS, Pratapgrah; Contributor: K.V. Shivkumar)*

# NOTES

# NOTES

VEXIL BUSINESS PROCESS SERVICES

# Certificate

This Certificate is issued to

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**(Indian Council of Agricultural Research)**
**Saheb Bagan, Nilganj, Barrackpore**
**Kolkata 700 120**
**West Bengal**
**INDIA**

who have implemented a Quality Management System, which meets the requirements laid down in ISO 9001:2015, with the following scope:

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Latest Issue : 29 June 2018
Valid Till : 28 June 2021

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***Surveillance 1 due before : 06 June 2019***
***Surveillance 2 due on : 06 June 2020***

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150 YEARS OF CELEBRATING THE MAHATMA


**ICAR - Central Research Institute for Jute and Allied Fibres**

*(An ISO 9001:2015 Certified Institute)*

**Barrackpore, Kolkata - 700120, West Bengal**

**Phone: 033-2535-6121/6122 Fax: 033-25350415**

Mail: crijaf-wb@nic.in, director.crijaf@icar.gov.in