ANNUAL REPORT 2018-19

Annual Report

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भाकृअनुप
ICAR

भारतीय गन्ना अनुसंधान संस्थान, लखनऊ
ISO 9001:2015

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Preface

It is my pleasure to present the Annual Report of ICAR–Indian Institute of Sugarcane Research, Lucknow comprising the research, extension and development activities undertaken by the Institute during the year 2018-19. The country witnessed the highest ever record sugar production of 32.95 million tonnes during the current sugar season. Uttar Pradesh also witnessed good production of sugar by producing about 11.82 million tonnes of sugar, during 2018-19. However, the most significant contribution was the increase in sugar recovery. The average sugar recovery during 2018-19 in U.P. was 11.46% against sugar recovery of 10.84% during 2017-18. This could be possible by the concerted efforts of the research Institute and developmental efforts of various State cane development departments. However, the labour scarcity, input cost escalation, surplus sugar production and mammoth cane price arrear on sugar mills due to low sugar prices are major issues which need to be addressed on priority.

The year was very fruitful for the varietal improvement. Two new sugarcane varieties, *viz.*, CoLk 11203 (*Ikshu*-5; Early) and CoLk 11206 (*Ikshu*-4; Mid-late) were released and notified for commercial cultivation in North West Zone. Two other sugarcane varieties, *viz.*, CoLk 12207 (Early) and CoLk 12209 (Mid-late) were also released by CVRC for North Central and North East Zone. A red rot resistant genotype "LG 05817" was registered as a Novel Germplasm at ICAR-NBPGR, New Delhi. Three high sugar genetic stocks (LG 14482, LG 14564, LG 11440) with 19-20% sucrose in juice were submitted to National Hybridization Garden, ICAR-SBI, Coimbatore to use as parent in future breeding programme. The *in vitro* cultures were established for newly released varieties, *viz.*, CoLk 11203, CoLk 11206, CoLk 12207 and CoLk 12209. In DBT-Accredited Test Laboratory (ATL), 3400 mother stock cultures (700 of sugarcane + 2,700 of banana) were tested for virus indexing. One hundred twenty two germplasm lines of sugar beet are being maintained and more than 42,000 q of seed cane of high yielding sugarcane varieties was produced and supplied to the farmers.

The soil organic carbon (SOC) above 0.65% level ensures remunerative cane yield at recommended nutrient supply in sugarcane plant-ratoon system. These SOC levels would help residue recycling and improve soil health leading to input saving and additional cane yield production of ₹ 1,000 crore. These results were obtained in 100% RDF of NPK applied through drip-fertigation over conventional planting methods. There was less weed infestation in drip fertigation treatments in comparison to conventional methods because of limited wetting area. The profitable sugarcane, banana and papaya based intercropping systems were identified. Modules of bee-keeping and mushroom cultivation were developed. Fifteen phosphate solubilising bacterial strains have been allotted with accession numbers by GenBank NCBI.

Insect pests and disease surveys were conducted in command areas of different sugar mills in U.P., Bihar and Maharashtra. In Muzaffarnagar (U.P.), a black Delphacid Plant Hopper, *Eoeurysa flavocapitata* has been observed on sugarcane. Three species of *Odentotermes* were recorded for first time in sugarcane. The artificial diet based on *sheesham* wood powder (15 gm) with agar powder (5 gm) in 250 ml water was found suitable for termites control. Termites could survive up to 45 days. Termite incidence was significantly lower in treatment with *P. lilacinum* and Chlorantraniliprole 18.5% SC at 90 DAP. Serial thermotherapy of two hours through MHAT at 50°C for three consecutive days and standard MHAT were found effective to check infection of YLD in seed cane.

The RNA *Seq* analysis of top portions of cane in both control and GA_3 exposed plants produced 1,65,410 transcripts. Of these, 72,521 transcripts were annotated. Based on drop in sucrose % juice due to delayed crushing, CoLk 94184 was found the most tolerant to post-harvest deterioration followed by CoPk 05191. Genome sequence of a virulent pathotype (*Cf* 08) of *C. falcatum* causing red rot to sugarcane was achieved using Pac Bio (RSII) platform. Almost 97.24% genome was sequenced.

A new machine, two row disc ratoon management device (RMD), was developed for carrying out ratoon initiation operations. The IISR deep furrower was used with multipurpose tool frame for earthing up also in sugarcane crop at Institute farm for its feasibility testing. The attachment for sowing wheat as intercrop in sugarcane ratoon was also tested at Institute farm for sowing wheat as intercrop in ratoon. Prototype of cane node planter was developed for mechanizing cane node planting. The IISR improved jaggery unit was recognized for production of quality jaggery. Muzzafarnagar and Hardoi districts were identified under One District One Product (ODOP) programme.

Seed cane crop of nine selected varieties sown on farmers' fields in different districts of U.P. covering 32.86 ha area achieved yield of 108-120 t/ha. Nearly 3,533 tonne seed cane was produced and more than 30,000 progressive farmers and development workers from states visited farmers' fields where interventions were introduced in PPFP mode and interacted with beneficiary farmers. Several sugarcane based interventions including ratoon management, land leveling, seed programme, variety selection, trench planting, drip irrigation, fertigation *etc.* along with other interventions such as intercropping, dairy farming, poultry farming, Apiculture and microenterprise have been introduced in eight selected villages of two districts of U.P. being undertaken under PPP mode with DSCL Sugar. During 2018-19, three field days were also organized and several residential and off campus training programmes were conducted in which nearly 1,000 participants were groomed to pursue agri-business. Four model seed cane farms were developed to facilitate learning on "more income - per crop" in true sense of Farmer-to- Farmer Extension. A mega event, *Krishi Kumbh* was organized in collaboration with the Government of U.P. It was inaugurated by Hon'able PM Shri Narendra Modi Ji through video conferencing and attended by one lakh farmers and Government Officers from various States.

Our painstaking journey during the year was suitable rewarded by number of awards, showered to the Scientists for their outstanding contributions. The Institute also bagged *Rajarshi Tandon Rajbhasha Puraskar* (First Prize) by ICAR for the outstanding work in official language.

The overall growth and development of the Institute was possible with the able guidance, encouragement and continuous support received from Dr. T. Mohapatra, Secretary, DARE and DG, ICAR; Dr. Anand Kumar Singh, Deputy Director General (Horticulture and Crop Science) and Dr. R.K. Singh, Assistant Director General (CC), ICAR, New Delhi which I acknowledge with sincere gratitude and reverence.

I would like to appreciate all Heads of Divisions *viz.,* Drs. M.R. Singh, Radha Jain, D.R. Malaviya, V.P. Singh and A.K. Singh and Drs. S.K. Shukla, Rajesh Kumar, S.N. Singh, A.K. Sah, A.K. Dubey and A.K. Mall for their sincere efforts in compiling and editing report of their Divisions/Sections. The sincere efforts of Dr. Sangeeta Srivastava, Dr. A.K. Sharma, Dr. L.S. Gangwar, Sh. Brahm Prakash and Dr. Anita Sawnani, in compiling, editing and timely bringing out the report are highly appreciated.

(A.D. Pathak)
Director

Date : June 29, 2019

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Executive Summary

Crop Improvement

- Two sugarcane varieties, *viz*., CoLk 11203 (Ikshu-5; early maturity group) and CoLk 11206 (Ikshu-4; mid-late maturity group) were released and notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for commercial cultivation in the North West Zone of India.
- Two sugarcane varieties, *viz*., CoLk 12207 (early maturity group) and CoLk 12209 (mid-late maturity group) were identified by the Varietal Identification Committee of the AICRP on Sugarcane for their release in the North Central and North East Zone. The Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops released two varieties for commercial cultivation.
- Two early maturity group sugarcane clones, CoLk 18201 (LG 12033) and CoLk 18202 (LG 12038) and two mid-late maturity group clones, CoLk 18203 (LG 11517) and CoLk 18204 (LG 12081) were accepted during the AICRP (S) Workshop held at UAS, Bengaluru during 2018 for multi-location testing in the North West Zone of India.
- A red rot resistant genotype "LG 05817" was registered as a Novel Germplasm at ICAR-NBPGR, New Delhi with Registration No. INGR18035 on June 02, 2018.
- Based on the yield, quality and red rot ratings, the seven clones (LG 12201, LG 13001, LG 13002, LG 13009, LG 15169, LG 15267, LG 16070) were promoted to Station Trial (2019-20).
- Three high sugar genetic stocks (LG 14482, LG 14564, LG 11440) with 19-20% sucrose in juice during January were submitted to National Hybridization Garden, ICAR-SBI, Coimbatore for probable use as parent in hybridization programmes.
- The Institute is maintaining a collection of 350 genotypes consisting of 30 species level genotypes (*Saccharum officinarum*, *S. barberi*, *S. sinense*), 51 ISH and Ikshu ISH clones, 71 LG selections, 173 commercial hybrids, and 25 somaclonal variants. A 'Varietal Cafeteria' comprising of 28 early and mid-late maturing varieties is being maintained to provide an opportunity for farmers to select varieties of their choice.
- Small RNA sequences in response to red rot infection, generated from Illumina NextSeq 500 aligned against the miRBase 21 led to identification of >300 known miRNA. Unannotated sequences were screened using *S. officinarum* genome database to predict 472 novel miRNA, for which 12,566 targets were identified. Most of the target genes of differentially expressed miRNA genes were associated with cellular and metabolic processes, cell and organellar development.
- RNA seq data for sucrose accumulation was generated from parents (MS 68/47 and CoV 92102) and their high and low sucrose F_1 bulks. Differential gene expression, indels and alternate splicing events were identified. A total of 30,137 SNPs were identified of which, 21,511 were present in the coding region of the genes, and among them 9,905 were non-synonymous variants. The individual effect of each SNP on trait expression was quantified.
- The *in vitro* cultures were established for newly released varieties, *viz*., CoLk 11203, CoLk 11206, CoLk 12207 and CoLk 12209. In addition, the genotype *Khakai* was established and multiplied under *in vitro* conditions. Slow growth cultures were developed, and stored cultures were able to regenerate after storage period of 360 days.
- In DBT-Accredited Test Laboratory (ATL), 3,400 mother stock cultures (700 of sugarcane + 2,700 of banana) were tested for virus indexing. In addition, 6,500 samples (950 of sugarcane + 5,500 of banana) were tested for genetic fidelity testing, which equals to quality certification of 65 lakh tissue culture plantlets.
- One hundred twenty two germplasm lines of sugar beet are being maintained. Ethanol recovery in 11 sugar beet varieties was assessed, and the varieties LKC 2010, LK 4 and *Shubhra* recorded the highest ethanol content against checks in normal grown conditions, while under drought condition, LK 7, *Hilma*, LKC LB were at par to check varieties.
- This year, approx. 9,000 q of seed cane of different high yielding sugarcane varieties was produced. For promoting the use of recently notified varieties, an awareness campaign was initiated on the occasion of Institute's Foundation Day on Feb. 16, 2019 by distributing Seed Cane Packets to more than 100 farmers.

Crop Production

- Soil organic carbon (SOC) above 0.65% level ensured remunerative cane yield at recommended nutrient supply in a sugarcane plant-ratoon

system. Achieving said SOC level would help residue recycling and soil health leading to input saving and additional cane yield.

- About 130 soil samples were collected from waterlogged sugarcane growing areas, of which 100, 76, 80 and 30% soil samples were deficient in respect of available N, P, K and S content, respectively. The SOC, soil pH, sand content, FDA, available K and S were identified as quality indicators which accounted for 70.6% soil quality variations. The average contributions towards the SQI development were soil pH (17.7%), SOC (15.3%), sand content (12.1%), FDA (9.09%), K (8.98%) and S (8.04%) in low-lying sugarcane growing areas of eastern region.
- Significantly the highest rate of sprouts (93.4%) was observed under the treatment of only organic matter application along with FYM. The highest number of tillers (180.2 thousand/ha at 120 days after planting), shoot count (175.6 thousand/ha at 180 DAP), number of millable canes (120.5 thousand/ha), cane yield (84.20 t/ha) and sugar yield (10.55 t/ha) were recorded under the treatment where application of FYM @ 20 t/ha was done along with soil test (rating chart) based inorganic fertilizer recommendations. However, it was found comparable to the treatment of FYM @ 10 t/ha along with biofertilizer and soil test based inorganic fertilizers application. The yield attributing characters *viz.*, cane length (220.60 cm), cane girth (2.30 cm) and weight of individual cane (1.10 kg) were recorded significantly higher with the application of FYM @ 20 t/ha along with inorganic fertilizers applied on the basis of soil test rating chart. The quality parameters *viz.*, brix value and pol % were significantly improved with application of FYM and biofertilizers. The soil health indicators *viz.*, bulk density (1.27 M/m^3), infiltration rate (4.64 mm/hr) and soil organic carbon (0.47%) showed positive response with the application of organic manure in the system.
- Based on observations recorded on germination of binding weed *Ipomoea* spp., it was found that February sown pot took 10 days to complete germination while rest of months sown pots germinated after five days of sowing. It was observed that month of sowing significantly affected the plant height, dry matter accumulation, leaf area above ground part and root length below ground part. Initially, plant height, leaf area and dry matter accumulation rate were slow in the February sown pot. After 60 DAS, the rate was increased with successive growth stages. The maximum plant height was recorded in the March sown pot at 60 DAS while April sown pot observed maximum plant height during rest of the growing period which was statistically superior to February, March, June, July and August sown pots but at par with May sowing. Similar trend was also recorded with respect to dry matter accumulation. February sown pot recorded the longest root length during entire growing period. Minimum root length was measured in August sown pot during whole season.
- Number of tillers and NMC under cane node planting were higher to the tune of 4.05% and 6.54%, respectively as against conventional method of planting. On an average, the ratoon cane yield of 80.83 t/ha obtained under cane node planting from three sugar factory zones was higher by 6.95% than that of conventional method of planting (75.21/ha).
- Brown manuring in rice and 125% RDN significantly improved the grain yield and yield attributes in rice and wheat. Among tillage practices, conventional tillage produced little bit more rice and wheat yields over zero-tillage. However, crop residue management enhanced the productivity of wheat by 9.4%. In sugarcane, 6% higher cane yield has been recorded with planting under conventional tillage (65.4 t/ha) over zero tillage (61.7 t/ha). Retention/incorporation of crop residues of rice and wheat enhanced the cane yield by 21.86% over without crop residue
- 100% RDF of NPK under drip fertigation gave significantly higher cane yield over 75% RDF of NPK applied through drip fertigation and conventional methods with 100% RDF of NPK. Reduced doses of NPK *i.e.* 75 and 50% under drip fertigation were found significantly at par. Improvement in brix, sucrose content and purity coefficient were also obtained in 100% RDF of NPK applied through drip-fertigation over conventional methods of planting. There was less weed dry matter in drip fertigation treatments in comparison to conventional methods because of limited wetting area in former one. The 120 cm inter paired row space remained dry leading to the low weed growth and its biomass.
- In the sugarcane-based Integrated Farming System having different components of agriculture *viz.*, horticulture (banana, papaya, and *karounda* planting), bee-keeping and intercropping systems, allocation of farm land was kept to meet minimum essential annual requirements of food and fodder of a household with 7 family members and overall improvement in livelihood. Impact of different treatments on growth, yield and juice quality parameters of sugarcane were observed. The most

profitable sugarcane, banana and papaya based intercropping systems were identified. Modules of bee-keeping and mushroom cultivation were developed.

- Fifteen phosphate solubilising bacterial strains have been allotted Accession No. MG923828, MG923829, MK342558, MH100690, MK342617, MG930046, MG930047, MG923808, MH817418, MH817419, MG924852, MG924853, MH100893, MG924892 and MH100731 by GenBank NCBI. Similarly, twelve endophytic nitrogen fixing bacterial strains were given the accession No. MH810328, MH810320, MH813022, MH813026, MH817413, MH812993, MH810338, MH817416, MH810341, MH810333, MH810330 and MH810327 by GenBank NCBI.
- Genotype CoLk 13204 sown at 90 cm row spacing gave higher NMC, cane yield and CCS (t/ha) over rest of the genotypes and also to the check varieties. Sowing of present genotypes at 120 cm row distance was not beneficial over 90 cm even at elevated doses of fertilizers.
- The new genotype CoS 13231 proved its superiority in cane yield over Co J 64 but it gave significantly lower tonnage over check variety Co 0238. Most of the growth and yield parameters were higher at 90 cm spacing over 120 cm
- Sugarcane yield varied significantly due to different planting methods and trash mulching. Paired-row trench planting (30:120 cm row spacing) with trash mulching (75.19 t/ha) being at par with conventional flat method of planting along with trash mulching (74.22 t/ha) resulted in significantly higher cane yield than that of conventional flat method of planting with no trash mulching (63.42 t/ha). The higher cane yield under paired-row trench planting with trash mulching was attributed to more number of millable cane (95.92 x 000/ha). The irrigation schedules at IW: CPE 0.8 recorded 10% and 6.7% higher cane yield compared to 0.6 and 1.0 IW: CPE ratio, respectively. Water use efficiency was found maximum under paired-row trench planting with trash mulching (0.432 t/ha/cm) followed by conventional flat method of planting with trash mulching (0.427 t/ha/cm). The cane yield and water use efficiency can be increased significantly by trash mulching.

Crop Protection

- Insect pests and disease surveys were conducted in command areas of different sugar mills in Uttar Pradesh, Bihar, and Maharashtra. In U.P., incidence of Pokkah boeng, smut and red rot was observed in variety Co 0238 was 5.0%, 10.0% and 15-20%, respectively. In Bihar, low incidence of top borer, plassey borer, root borer and mealy bug were recorded. *Pyrilla* attack was recorded in variety Co 0238 up to 10% in Harinagar area. In Majhaulia, whitefly incidence was 20-25% in Co 0238 in few fields. In U.P., in few fields, early shoot borer was recorded to the tune of 15-20% in variety Co 0238. In Maharashtra, sporadic incidence of army worm (*Spodoptera* sp.) up to 25-30% was observed in Bahraich. In ratoon crop, top borer was the major problem affecting 20-25% of the shoot. In Pravaranagar area, severe incidence of internode borer (>75%) was observed at one location. Incidences of early shoot borer (5-10%), pink borer, mealy bug, pyrilla and white fly (in traces) were observed in farmer's field.
- A black beetle (*Heteronychus* sp.) was observed gnawing the basal portion of young shoots. In Muzaffarnagar (U.P.), a black Delphacid Plant Hopper, *Eoeurysa flavocapitata* was observed on sugarcane. Sporadic incidence of YLD was observed. High incidence of red rot (20.0%) and Pokkah boeng was noticed in Co 0238 and some old and rejected sugarcane varieties.
- In Maharashtra, infestation of white grubs ranged from 40% to 80% and in some areas, it reached up to 90%. The incidence of FAW was observed in one sugarcane field. Small to large sized caterpillars of FAW were seen on the maize and sugarcane leaves.
- 20-25% incidence of YLD was observed in the command area of PDVVPSSK Ltd., Pravaranagar. Incidence of Pokkah boeng was 10-15%. Incidence of smut was 5-10% on CoM 11081 and CoM 11082.
- Around 2,000 specimens isolated/collected from soil and litter samples were identified up to order/family level and preserved for further identification. Acari were the dominant microarthropods followed by Collembola. Mites were represented by 3 suborders. The cryptostigmata mites were the dominant (75.0%) followed by prostigmata (15.0%) and mesostigmata (10.0%).
- Three species of *Odentotermes viz. O. vaishno, O. bellahunisensis* and *O. horni* were recorded for the first time from sugarcane. The artificial diet supported workers and soldiers of termites for 45 days. Amongst different anti-protozoan, >90% mortality of termites was recorded within 8 days in Tinidazole, while it was 100% in Ornidazole and Tinidazole in 10-11 days.
- Both serial thermotherapy of two hours through MHAT at 50°C for three consecutive days and standard MHAT were found effective for sugarcane plant to overcome the infection of YLD from the seed cane.

- Out of 93 genotypes, 14 genotypes were found resistant (R) to both the pathotypes (Cf 08 and Cf 09).
- Out of 93 genotypes, 24 genotypes were rated as resistant (R) for smut.
- Ten isolates of *Trichoderma* resulted > 20% increase in germination. *Trichoderma* isolates, STr-64, STr-83 and STr-126 were found the most promising resulting in 33.3 to 41.5% increase in yield over control.
- Sugarcane variety, CoLk 94184 was taken for monitoring of insect pests. Incidence of termite was low. Incidence of top borer I, II, III and IV broods was 16.28 to 27.79, 14.25 to 23.11, 5.36 to 30.47 and 5.34 to 18.64 per cent, respectively. Incidence of root borer was 11.76 to 52.94 per cent in September. Incidence of mealy bug was 6.25 to 34.31 per cent. Incidence of stalk borer and internode borer was 10.71 to 56.00 and 7.14 to 40.00 per cent, respectively.
- Paper cone technique for mass multiplication of black bug, *Dimorphopterus gibbus* (Fabricius) and *Cavelerius sweeti* Myamoto has been developed.
- The virulence pattern of Co 0238 isolates did not match with the red rot isolate of CoLk 8102 and also with designated pathotypes namely Cf 07, Cf 08 and Cf 09 of sub-tropical zone.
- In Uttar Pradesh, incidence of red rot was noticed in Co 0238, CoSe 95422, CoJ 64, CoS 8436, CoLk 08102, CoS 88230, CoS 95255, CoSe 01424 and CoS 91269. In Co 0238, it was 10% to 55% in some fields, while in CoSe 95422, CoS 8436 and CoSe 92423, incidence was up to 25 per cent. Incidence of smut was observed in CoSe 92423, CoS 88230, CoS 91269 and Co 0238. Incidence of GSD (2 to 10%) was noticed in most of the field surveyed and in CoS 91269 incidence was 20-30%. The incidence of the minor disease Pokkah boeng was up to the 25% in Co 0238.
- In Bihar, incidence of red rot was noticed in CoSe 95422, Co 0238, CoP 06436 and BO 130 to the tune of 3-12%. Co 0238 received 5% to 20% incidence of red rot. YLD was noticed in CoP 06436, CoLk 94184, Co 0118, Bo 130 and Co 0238. Pokkah boeng was observed in CoP 06436, BO 154, CoP 9301, Co 0238, CoSe 95422, Co 0118, CoLk 94184, BO 130 and CoP 112.
- IISR combo trap has been modified to repel the blue bulls from sugarcane fields in early stage of the crop.
- Genomic DNA of YLD affected 50 sugarcane genotypes was subjected to nested PCR assay using universal phytoplasma primers. First Round PCR showed 1.8 kb size amplicons that were used as a template for the second round PCR. Second round PCR yielded 1.2 kb size amplicons which were gel eluted and stored at –20°C for further studies.
- Two native EPN species isolated from the soil samples collected from white grub endemic areas of sugarcane (cv. CoM 265) were identified as, *Heterorhabditis indica* and *Steinernema carpocapsae*. The partial sequence information was deposited into NCBI GenBank -1. *H. indica* strain IISRBCCH01- (Accession No- MH909057), 2. *S. carpocapsae* strain IISRBCCS01 (Accession No- MK371212). Bio-efficacy studies of EPN species against white grubs were carried out and *H. indica* strain IISRBCCH01 was found to be causing 100% mortality in first and second instars of *Holotrichia serrata* grubs at a dosage of 100 and 250 IJs per grub at 48 hours post inoculation, whereas, *S. carpocapsae* strain IISRBCCS01 was observed to cause 100% mortality in first and second instars grub of *H. serrata* at a dosage of 150 and 250 IJs per grub after 36 and 48 hours of inoculation, respectively. Similarly, Bio-efficacy experiment of *S. carpocapsae* strain IISRBCCS01 was carried out on *Spodoptera frugiperda* at different dosage levels. The 100% mortality was observed at 50 and 100 IJs per larvae from 30 hours to 72 hours post inoculation.

Plant Physiology and Biochemistry

- RNA *Seq* analysis of top portions of cane (CoLk 94184) of both control and GA_3 exposed plants produced a total of 1,65,410 transcripts. Of these, 72,521 transcripts were annotated and analysed to generate a total of 558 differentially expressing transcripts; 513 were found up and rest 45 were found down regulated in source-sink perturbed conditions.
- Increased expression over control of fructose 1, 6-biphosphatase was seen, which later declined to the level of control whereas expression of an uncharacterized protein was found increasing with days of GA_3 exposure, indicating its positive role as far as GA_3 response is concerned. A specific water stress related *myb* transcription factor depicted gradual increase in its expression with cane maturity, possibly helping cane to withstand water deficit during ripening stage of the cane for high sucrose accumulation.
- Four sugarcane varieties (CoLk 94184, CoLk 09204, CoPk 05191 and Co 0238) were used to study the post-harvest sucrose losses and their management

using chemical formulation especially the use of SMS+BKC solution. Most responsive variety to formulation (BKC+SMS) was CoLk 94184. Based on drop in sucrose % juice due to delayed crushing, CoLk 94184 was found most tolerant to post-harvest deterioration followed by CoPk 05191 and then Co 0238 and finally CoLk 09204.

- Genome sequence of a virulent pathotype (Cf 08) of *C. falcatum* causing red rot of sugarcane was achieved using Pac Bio (RSII) platform. Almost 97.24% genome was sequenced. A total of 253 contigs was obtained when all reads were assembled.
- Pot and field experiments were conducted using tolerant (CoS 767) and susceptible (CoJ 64) sugarcane varieties to identify physiological traits conferring tolerance to single/multiple abiotic stresses. The crop was grown under normal and saline soil (6 dS/m) conditions and it was imposed to individual stress of drought (at 75 DAP) and waterlogging (at 120 DAP for 60 days), and to their combinations. A significant variation existed for growth parameters; plant height, single cane weight, internode length, cane girth, fresh leaf weight, root weight and root volume under different single/combined stresses. Compared to control, a threefold decrease in leaf fresh weight was found under treatment drought+ waterlogging+salinity in both varieties. Drought induced an increase in root weight and root volume; increases was about 2.5 times higher than control. The stalk/aerial root ratio was found higher under treatment drought+waterlogging as compared to waterlogging alone and being higher in CoS 767 than CoJ 64.
- CoS 767 showed the highest stress tolerance index in waterlogging followed by drought and salinity while CoJ 64 had the highest stress tolerance index for salinity followed by drought and waterlogging +salinity for both the varieties.
- The RWC, electrolyte leakage, proline, CAT and POX activity varied significantly among different stress treatments and the values for above traits were found higher in CoS 767 than CoJ 64. The different stresses caused leaf chlorosis and necrosis which were the highest in the treatment drought+waterlogging+salinity in both varieties. This was also evident from chlorophyll analysis, indicating that stay green character may be one of the visual screening criteria for single/multiple stress tolerance.
- Drought tended to cause the highest increase in fiber content followed by waterlogging and salinity. Among combined stresses, the highest fiber content was found under treatment drought + salinity while the lowest was found in drought + waterlogging + salinity.
- The juice quality parameters decreased under single/combined stresses. The lowest decrease in sucrose was observed in waterlogging and highest in drought + waterlogging + salinity in both the varieties.

Agricultural Engineering

- For carrying out ratoon initiation operations, a new machine, two row disc ratoon management device, was developed. Main feature of the machine was its off barring discs which perform efficiently even in the field having left over surface trash. Developed prototypes were of two types. First was without stubble shaver- to perform off barring and fertilizer application. The second prototype has stubble shaver attachments also to perform stubble shaving along with off barring and fertilizer application. Prototype without stubble shaver is suitable for piecemeal harvesting. Both types of prototypes were field tested.
- The IISR deep furrower was used with multipurpose tool frame for earthing up also in sugarcane crop at Institute farm for its feasibility. The earthing up operation could be performed with this equipment in sugarcane crop till formation of cane in the plant. The equipment has high ground clearance that made it suitable to operate in the field even up to 600-750 mm height of the sugarcane crop. The field performance testing of the developed prototype was carried out for earthing up mode. The field capacity of the equipment was 0.40 ha/h with field efficiency of 74%.
- Attachment for sowing wheat as intercrop in sugarcane ratoon was tested at the Institute farm for sowing wheat as intercrop in sugarcane ratoon field. The adjustment of tines was done for sowing of two rows of wheat crop in between each sugarcane crop rows. The equipment was able to sow six lines of wheat at a time. The sowing was done in the field after operation of RMD in the field. The trash has to be removed before operation of machine.
- Prototype of tractor operated cane node planter was developed for mechanizing cane node method of planting. The planter was field tested at IISR farm. Machine performs deep furrow opening, metering of pre-soaked cane nodes, fertilizer application and soil covering over planted cane nodes, simultaneously in a single pass of the machine. Metering mechanism, comprising of lugged ground wheel driven belt and mild steel L

shape cells, performed satisfactorily. Effective field capacity of the planter was 0.15-0.16 ha/h.

- Design of the new prototype of sugarcane trash management machinery has been conceptualized.
- A total of 30 prototypes (11 tractor operated and 19 manually operated) were fabricated in the Workshop of Agricultural Engineering. Fifteen prototypes (tractor operated-6 and manually operated-9) were supplied to different locations for multi-location trials.
- The performance of sugarcane cleaner-cum-washer (SC-c-W) was evaluated with three sets of speed of scrapping rollers. In the third set, all the scrapping rollers moved with different speed for better scrubbing action. Single, two and three-cane feeding with single, double and triple pass was used for evaluation. Maximum impurity was removed in case of roller set III and minimum with roller set I. Impurity removal also increased with increase in number of cane feeding due to more resistance provided by canes.
- The scale up model of efficiency boosting device with nipples is in the process of fabrication for installation in IISR 2-pan furnace.
- For the development of integrated drying system for jaggery drying, data on solar radiation, humidity and ambient temperature for drying period have been collected. Three units of heating element having power rating as 1000 W each has been selected for supply of hot air into the drying chamber. 75 mm diameter pipe has been used for supply of hot air received through waste heat recovery system of furnace.
- A wet and dry vacuum cleaner was used together with strainer for scum removal from the pan during juice clarification. Two types of hoods were also tried. A molten jaggery pumping unit was designed based on principle of vacuum suction. It consists of pump, water inlet valve, vacuum valve, vacuum breaker valve, suction valve. A mechanism is being developed so that machine will remain fix and molten jaggery will be transferred to cooling pan through food grade pipes.

Extension and Training

- Seed cane crop of nine selected varieties *viz.*, CoLk 94184, CoLk 09204, Co 98014, CoPk 05191, Co 0118, Co 0238, Co 08272, Co 08279 and CoLk 09709 was sown on farmers' fields in Sitapur, Lakhimpur, Shravasti, Hardoi, Farrukhabad, Mathura and Ballia districts of Uttar Pradesh. A total of 83 seed cane plots in 32.86 ha area were maintained in fields of 61 farmers of 22 villages. The average yield obtained last year for seed cane crop of different varieties were 120, 122, 132, 110, 92, 112, 124, and 108 t/ha, respectively. However, the average seed cane yield for all the varieties was 115 t/ha.
- A total of 3,533 tonne seed cane was produced out of which 62.58% (2,211 t) was utilized as seed material either through sale to other farmers or on own farm to raise seed cane crop in order to multiply the quantity of seed cane of new varieties and rest of the harvested cane was supplied by farmers to sugar mill for crushing. The average net profit recoreded for seed cane crop was ₹ 3,07,725 per ha, however, it varied between ₹ 2,16,720 and ₹ 3,58,500 per ha which is much higher than the average net profit of ₹ 1,27,500 per ha earned under conventional method by cane farmers in the study areas of U.P.
- The decision support for application of sugarcane production technologies in consultation with the stakeholders was invoked. The knowledge and skills of sugarcane growers and sugarcane development officials was enhanced by imparting training on innovative sugarcane production benefiting 28 participants (16 sugarcane development officials and 12 progressive farmers) Ten on-farm trials using 65.30 q cane seed of varieties CoLk 09204, CoLk 11206 and CoLk 14201 were conducted in April. A WhatsApp group was created for sharing information and knowledge on various aspects of sugarcane farming.
- More than 30,000 progressive farmers and development workers from other states visited farmers' fields where interventions were introduced in PPFP mode and they interacted with beneficiary farmers. This way, farmer-to-farmer extension also happened there.
- Complete enumerated data of eight selected villages in Hardoi and Lakhimpur districts of U.P. was collected with the help of extension/cane development personnel of the sugar mills in the first half of the year 2018 by executing survey schedule in personal interview mode. The collected data was compiled, collated and analysed to have deep insight into existing farming conditions and present level of farm income in the villages.
- ICAR-IISR joined hands with DCM Shriram Sugar Ltd., New Delhi to double the farmers' income in eight sugarcane growing villages of Lakhimpur Kheri and Hardoi districts of Uttar Pradesh. These villages are under the command area of four sugarcane mills namely Ajbapur, Rupapur, Hariyawan and Loni. The sugarcane interventions include ratoon management, land leveling, seed programme, variety selection, trench planting, drip

irrigation, fertigation *etc.* Other interventions include, intercropping, dairy farming, poultry farming, Apiculture and microenterprise.

- In the first year, there is overall increase of 10.6 and 70.6 per cent in ratoon-I and ratoon- II. The autumn planting has increased by 25.4% and total cane area to 8.3%. The cane intensity has increased to 3.36 per cent. Trench planting has increased by 208%. The compost pits and green manuring/press mud/FYM have increased to 216%. The area of intercrop has also increased by 44.4%. There is substantial increase in services and technical support. The soil sample and soil health card distribution increased to 14.2 and 13.4 folds. Availability to PSB and azotobacter increased to 97% and 97.5%, respectively. There is 93.5% increase in area for application of *Beauveria*. Similarly, *Trichoderma* application has also increased by 318%. Training camps for dairy, apiculture, insect- pest and disease management were also organized in these adopted villages.
- The intercropping technology was assessed in farmers' fields for its large scale adoption by farmers. The intercrops raised with autumn and spring cane provide opportunity to the farmers to earn intermittent income from sale of crops harvested at 3 to 4.5 months after sowing, depending upon the nature of intercrops. Demonstration on Intercropping with autumn and spring sugarcane under NFSM scheme (2018-19) of Ministry of Agriculture and Farmers Welfare, Govt. of India was conducted in farmers' fields in Sitapur and Lakhimpur districts of U.P. covering 20.0 ha area. The highest net profit of ₹ 4,35,000/ ha was earned in case of garlic grown as intercrop with sugarcane and lowest net profit of ₹ 1,84,750/ ha was earned by the farmers with radish intercropping. The net profit for all intercrops was much higher than the profit recorded with sole cane crop *i.e.* ₹ 1,27,500/ha. This clearly establishes that the intercropping with sugarcane was profitable cropping system in comparison to sole cane crop. In addition to higher profit, the intercrops also provided pulses and vegetables to the farmers for their family consumption and thus help in food and nutritional security for village dwellers.
- As many as 20 demonstrations on ratoon promoter machine were conducted to assess its benefit in enhancing yield and profit from ratoon crop. It was assessed in farmers' fields in command area of Biswan Sugar Mill, Biswan, Sitapur (U.P.) covering 12 villages, 21 cane growers and 12.00 ha area. Under all ratoon plots where ratoon promoter machine was operated, cane yield enhanced by 12-16 t/ha, cost saving was upto ₹ 6,000/ha and profit enhanced by ₹ 42,000-54,000/ha.
- A total of ITKs from the States of Uttar Pradesh and Bihar covering 4 sugar mill reserved zones, 9 villages, 220 farmers, 45 KIs and 40 sugarcane development personnel. A total of 83 ITKs, 20 proverbs and 9 social beliefs were documented. Triangulation for confirmation of ITKs were also carried out.
- Fifty FLDs on seed cane production technology were conducted in farmers' fields in Sitapur, Lakhimpur Kheri, Barabanki, Ballia, Farrukhabad, Hardoi and Shrawasti districts of Uttar Pradesh and Motihari district of Bihar. Seed cane crop of varieties CoLk 94184, CoPk 05191, Co 05011, Co 0118, CoLk 09204, Co 0238, Co 98014, CoS 08272, Co 0232 and Co 0233 was raised in demonstration fields with recommended package of practices. Demonstrations on Ratoon Promoter were conducted at farmers' fields in command area of Biswan Sugar Mill, Biswan, Sitapur (U.P.) covering 12 villages, 21 cane growers and 12 ha area. FLDs on intercropping with sugarcane and bud chip technology were conducted on a total of 194 ha area in Uttar Pradesh, Madhya Pradesh, Bihar and Maharashtra.
- The frontline demonstration of IISR ratoon management device was conducted in Hardoi, Sitapur and Lucknow districts. RMD was operated with a 35 hp tractor. It took nearly three hour per hectare of ratoon field to complete all assigned tasks in one pass of the tractor. Approximately 6.5 ha area was covered by IISR RMD in 12 farmers' fields.
- IISR tractor operated deep furrow sugarcane planter was demonstrated at farmers' field of Ballia, Shravasti, Shahjahanpur and Lucknow districts of Uttar Pradesh in 12 ha area. Ten farmers used the planter. The performance of the planter was satisfactory for planting of sugarcane (including sett cutting) at farmers' field.
- Trench planter was demonstrated at farmers' field in villages of Lakhimpur Kheri, Hardoi & Lucknow. Ten ha area was covered at farmers' field covering ten farmers.
- IISR tractor operated raised bed seeder-cum-sugarcane planter was operated at farmers' field at Biswan Sugar Mill area, Sitapur and Lucknow in 5 ha area.
- IISR tractor operated sugarcane-cum-potato planter was operated at farmers' field at Harsiddhi village of Bihar and Lucknow in 5 ha area.

- On-station demonstration in one ha area was laid out in Technology Park (Field No. E-40). Planting methods, intercropping with sugarcane, IPM, cane node technique, plant growth regulator and cane varieties were demonstrated.
- A ten days training on Sugarcane Management and Development for cane development personnel of sugar mills was organized. Twelve cane managers/officers from different sugar mills of the country participated in this training.
- Twenty six residential skill development trainings for different clientele groups were organized in which 654 farmers, entrepreneurs, students and development personnel participated. They were trained in the latest cane production techniques, seed cane production, advances in sugarcane research and ways and means to enhance income from sugarcane based production systems including jaggery making.
- Sixty seven one day trainings and visit programmes were organized at the Institute in which 1165 farmers, 135 development personnel, 903 students and 35 teachers acquired latest know-how in scientific cane cultivation practices.
- Three field days were organized in Dhaka Pakariya, Paliya, Lakhimpur; Hariyawan Sugar mill, Hardoi and Biswan Sugar mill, Sitapur. More than 1,000 farmers, development officials, and sugar mill personnel participated in the event.
- About 3,500 tonne of healthy seed cane of improved varieties of sugarcane was produced in farmers' fields under extension programme on entrepreneurship in seed cane production.
- Several residential and off campus training programmes were conducted in which more than 1,000 participants were groomed as entrepreneurs to pursue agri-business in their available farming systems.
- Four model farms in Khambapurva, Shankarpur and Bakhariya (Sitapur) and Dhaka Pakariya, Paliya (Lakhimpur Kheri) were developed to facilitate learning on "More income - Per crop" in true sense of 'Farmer-to- Farmer Extension'.
- A farmers' club was formed in Biswan Sugar Mill area. Presently, more than 150 farmers are the members of the club.
- IISR participated in ten exhibitions organized at various places.

Economics, Statistics and ICT

- Technological innovations for cane productivity enhancement in Maharashtra have shown results in terms of higher sugarcane productivity (108 t/ha) and higher sugar recovery (11.24%) during season 2017-18. Farmers adopted improved cane varieties CoM 0265, Co 86032, having 32 and 53% area, respectively, wider row spacing, single/two bud sets and skip furrow and drip irrigation in Ahmednagar and Pune districts. Maharashtra is the second largest sugar producing state next to Uttar Pradesh with 10.7 mt sugar production with 11.19% sugar recovery during crushing season 2018-19.
- Sugarcane farmers face challenges of climate change, water scarcity, incidence of disease, pests (White grub) and high cost of production. The cost of sugarcane production and its processing has been enhanced both for farmers and sugar mills. The cost of sugarcane production in Maharashtra ranged from ₹ 2,445 and ₹ 2,494/tonne. The average cane price paid to the farmers was ₹ 2,844 and ₹ 2,991 per tonne during year 2017-18 and 2018-19, respectively in Maharashtra.
- The average cost of sugar production in Maharashtra state sugar mills varied from ₹ 2,853 to ₹ 4,071/quintal with ex-mill sugar price ₹ 31-35 per kg during year 2017-18 in stand alone, integrated sugar-energy complex owned by cooperative or private sector. The cost of sugarcane and conversion cost account for 79 and 21%, respectively during the year 2017-18.
- The Government has fixed higher price for bioethanol produced from B-heavy molasses and sugarcane juice directly. The average bioethanol recovery from C and B-heavy molasses on per tonne basis was 252 and 350 litre, respectively.
- The average cost of bioethanol production from C and B-heavy molasses was ₹ 32.24 and ₹ 38.81 per litre. The profit from bioethanol production was ₹ 11.22 and ₹ 13.62 per litre.
- The diversion of B-heavy molasses for bioethanol production would reduce sugar recovery by 1.3 to 1.5 per cent. This would help in minimizing sugar production up to some extent. The Govt. of Maharashtra issued an order to add 1.3 per cent to the sugar recovery of sugar mills to decide final FRP paid to the farmers for sugar crushing season 2018-19.

About the Institute

The Indian Institute of Sugarcane Research (IISR), Lucknow was established in 1952 by the Indian Central Sugarcane Committee for conducting research on fundamental and applied aspects of sugarcane culture as well as to co-ordinate research work done on this crop in different states of the country. The Government of India took over the Institute from the Indian Central Sugarcane Committee on January 1, 1954, and thereafter, it was transferred to the Indian Council of Agricultural Research (ICAR), New Delhi on April 1, 1969. The Institute is located in Lucknow, the capital city of Uttar Pradesh and conveniently situated at about 12 km from CCS Airport, Amausi and about 5 km from Lucknow Railway Station. The climate of the area is sub-tropical semi-arid type. Monthly average maximum temperature during April to June ranges from 36°C to 40°C and minimum temperature during November to February ranges from 7°C to 11.5°C. The annual average rainfall is around 880 mm.

Vision

An efficient, globally competitive and vibrant sugarcane agriculture

Mission

Enhancement of sugarcane production, productivity, profitability and sustainability to meet future sugar and energy requirement of India

Mandate

(i) Basic, strategic and adaptive research on production and protection in sugarcane and breeding for sub-tropical region of the country.

(ii) Coordination and monitoring of applied research on national and regional issues to develop improved varieties and technologies.

(iii) Dissemination of technologies and capacity building.

Issues and strategies

To achieve the desired growth in area, productivity and recovery of sugarcane in different agro-ecological zones of the country and to extend appropriate information and technologies to the end users, following issues and strategies have been identified which need to be pursued at:

Issues

- Low levels of cane yield and sugar recovery
- High cost of cane cultivation
- Decline in factor productivity

Strategies

Increasing the level of cane yield and sugar recovery

a. Introgression of untapped genes in the parental gene pool

b. Enhancing selection efficiency through marker aided selection (MAS)

c. Improving sink strength and source efficiency

d. Enhancing productivity of ratoon cane

Reducing the cost of cane cultivation

a. Nutrient use efficiency through rhizospheric engineering and INM technology

b. Water use efficiency through micro- irrigation

c. Land use efficiency though companion cropping

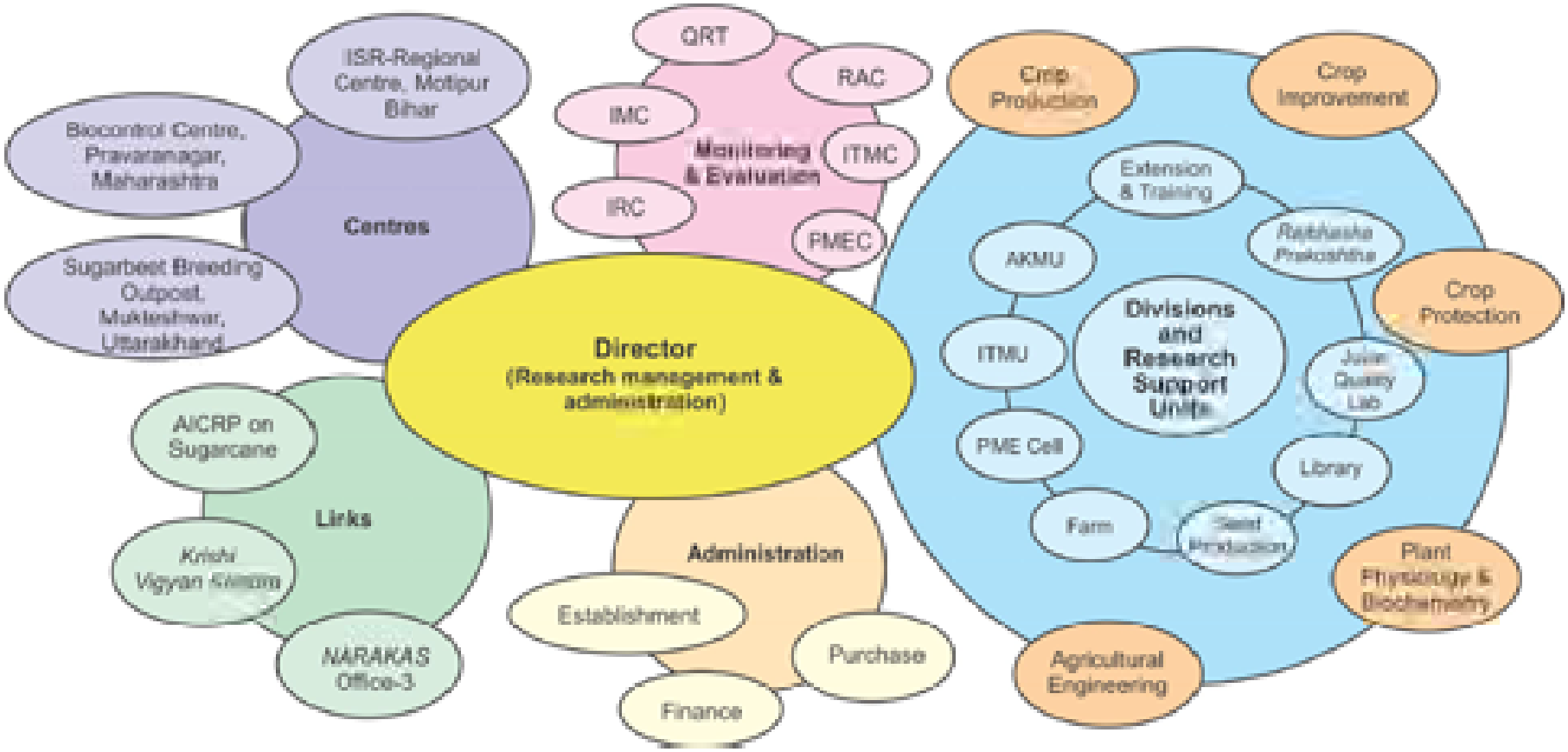
d. Reducing cost of pesticide use in an eco-friendly manner through bio-intensive IPM and IDM

e. Mechanizing sugarcane farming

Arresting decline in factor productivity

a. Soil biological and nutritional dynamism

b. Carbon sequestering through cropping system



Organizational Structure

Financial statement (2018-2019)

Particulars	Plan (₹ in lakh)	
	Revised Estimate	Expenditure
ICAR-Indian Institute of Sugarcane Research	8959.80	8959.80
All India Coordinated Research Project on Sugarcane	1364.00	1364.00

Staff position as on March 31, 2019

Category	Sanctioned	Filled	Vacant
Research Management Position	1	1	0
Scientific			
Principal Scientist	8	5	3
Senior Scientist	15	15	0
Scientist	50	38	12
Total	**73**	**58**	**15**
Technical	134	81	53
Administrative	51	44	7
Skilled Supporting Staff	74	14	60
Total	**333**	**198**	**135**

CHAPTER 1

Genetic Improvement of Sugarcane for Higher Cane and Sugar Productivity

Development of sugarcane varieties for sub-tropics

Sugarcane varieties notified for commercial cultivation

Two sugarcane varieties, *viz*., CoLk 11203 (*Ikshu*-5; early maturity group) and CoLk 11206 (*Ikshu*-4; mid-late maturity group) were released and notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for commercial cultivation in the North West Zone of India comprising of Punjab, Haryana, Uttarakhand, Rajasthan, Central and Western parts of Uttar Pradesh vide The Gazette of India Notification No. S.O. 6318 (E) dated Dec. 26, 2018 (Fig. 1.1 & 1.2). Some key features and attributes of the two varieties are mentioned in Table 1.1.

Fig. 1.1. Field view of the crop and buds of CoLk 11203

Fig. 1.2. Field view of the crop and buds of CoLk 11206

Fig. 1.3. Field view of the crop and buds of CoLk 12207

Fig. 1.4. Field view of the crop and buds of CoLk 12209

Sugarcane varieties identified for release

Two sugarcane varieties, *viz*., CoLk 12207 (early maturity group) and CoLk 12209 (mid-late maturity group) were identified by the Varietal Identification Committee of the All India Coordinated Research Project on Sugarcane (AICRP-S) for their release and notification (Fig. 1.3 & 1.4). The Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops vide its Notification No. MOM No.

Table 1.1. Salient features of newly released and notified sugarcane varieties CoLk 11203 (*Ikshu*-5) and CoLk 11206 (*Ikshu*-4)

Variety	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Pol % cane at harvest
CoLk 11203 (*Ikshu*-5)	CoLk 8102 × Co 1148	Early	81.97	10.52	18.41	13.44
CoLk 11206 (*Ikshu*-4)	CoPant 90223 × Co 62198	Mid-late	91.50	11.20	17.65	13.42

3-70/2018 –SD.IV dated Feb. 19, 2019 released the two varieties for cultivation in the North Central and the North East Zone. The salient features of newly released sugarcane varieties is given in Table 1.2.

Sugarcane clones accepted for multi-location testing

Two early maturity group sugarcane clones, CoLk 18201 (LG 12033) and CoLk 18202 (LG 12038) and two mid-late maturity group clones, CoLk 18203 (LG 11517) and CoLk 18204 (LG 12081) were accepted during the AICRP(S) Workshop held at UAS, Bengaluru during 2018 for multi-location testing in the North West Zone of India. Some key features and attributes of these clones are mentioned in Table 1.3.

Evaluation of sugarcane clones under Station Trial 2018-19 (PZVT): Nine elite sugarcane genotypes, *viz*., LG 10723, LG 10726, LG 11067, LG 11406, LG 12040, LG 12429, LG 13430, LG 13821 and LG 13825 evolved under different projects of the division along with five standards (CoJ 64, Co 0238, CoS 767, Co 05011, CoPant 97222) were evaluated under Station Trial (Table 1.4). The genotype LG 10723 recorded the highest cane yield (102.62 t/ha) which was significantly superior to the best standard and followed by the LG 11406 (90.48 t/ha) and LG 12429 (89.08 t/ha). LG 10723 also recorded the highest CCS yield (13.68 t/ha) followed by LG 12429 (12.03 t/ha) and LG 12040 (11.86 t/ha). The highest sucrose percentage at harvest was recorded in LG 12429 (19.48%) followed by LG 12040 (19.31%) and LG 11067 (19.30%). Among the standards, CoJ 64 for sucrose content and Co 0238 for cane and CCS yield were found to be the best at harvest.

Hybridization and seedling raising: A total of 27 bi-parental sugarcane crosses were attempted at National Hybridization Garden, ICAR-SBI, Coimbatore during the crossing season of 2018. In addition, eight poly-crosses were also effected. The fluff of these crosses along with the 48 GCs was received and will be sown in the glass/poly house for the seedling raising. 10,676 seedlings derived from 16 bi-parental crosses, 03 selfs, and 38 GCs attempted during 2017 crossing season, were raised and transplanted in the field conditions for their evaluation.

Table 1.4. Performance of elite sugarcane genotypes under Station Trial 2018-19

Genotype	CCS yield (t/ha)	Cane yield (t/ha)	Sucrose % in juice at harvest
LG 10723	13.68	102.62	19.05
LG 10726	6.24	58.17	15.73
LG 11067	10.96	81.92	19.30
LG 11406	11.65	90.48	18.47
LG 12040	11.86	88.16	19.31
LG 12429	12.03	89.08	19.48
LG 13430	11.08	84.87	18.77
LG 13821	10.36	81.07	18.32
LG 13825	7.03	68.12	15.15
CoJ 64	8.32	62.42	19.13
CoS 767	8.31	68.63	17.48
Co 0238	10.39	75.52	18.68
Co 05011	8.44	66.06	18.35
CoPant 97222	8.68	70.26	18.04
CD at 5%	1.41	9.85	1.39
CV (%)	8.44	7.55	4.52

Selection in seedling (C_0) population: Based on the Brix and other growth parameters, a total of 995 clones were selected from the seedling populations. These selected clones were planted as C_1 clones along with standard varieties for further evaluation.

Evaluation of advanced clonal generations: Based on juice quality, crop growth and yield parameters, 56 clones were selected in C_1 generation and promoted to C_2 generation for their further evaluation. Similarly, 21 promising sugarcane clones were selected in C_2 generation and promoted to C_3 generation. These clones were planted in replicated trials for their yield and quality evaluation and also given for the red rot testing. Based on the yield, quality and red rot ratings, the best seven clones (LG 12201, LG 13001, LG 13002, LG 13009, LG 15169, LG 15267, LG 16070) were included in the Station Trial (2019-20) for their evaluation.

Table 1.2. Salient features of newly released sugarcane varieties CoLk 12207 (*Ikshu*-6) and CoLk 12209 (*Ikshu*-7)

Variety	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Pol % cane at harvest
CoLk 12207 (*Ikshu*-6)	CoLk 8002 GC	Early	75.42	8.74	16.90	13.17
CoLk 12209 (*Ikshu*-7)	LG 95053 × CoPant 90223	Mid-late	77.50	9.38	17.66	14.33

Table 1.3. Salient features of the sugarcane clones accepted for multi-location testing under AICRP-S

Clone	Parentage	Maturity group	Cane yield (t/ha)	CCS yield (t/ha)	Sucrose % at harvest	Red rot rating
LG 12033 (CoLk 18201)	CoJ 99192 × CoSe 92423	Early	91.64	11.48	18.18	MR
LG 12038 (CoLk 18202)	CoJ 99192 × CoSe 92423	Early	88.68	10.96	18.07	MR
LG 11517 (CoLk 18203)	LG 02100 GC	Mid-late	97.80	13.98	20.46	MR
LG 12081 (CoLk 18204)	CoJ 99192 PC	Mid-late	84.46	10.85	18.48	MR

Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions

A collection of 350 genotypes consisting of *Saccharum officinarum*, *S. barberi*, *S. sinense*, ISH clones, Ikshu ISH clones, LG selections, commercial hybrids, and somaclonal variants (25) was maintained and the required material was supplied to various on-going projects of the Institute. The collection includes 173 commercial hybrids, 51 ISH & Ikshu ISH lines, 71 LG clones and 30 species level genotypes. A 'Varietal Cafeteria' comprising of 28 early and mid-late maturing varieties was planted in March, 2019 to provide an opportunity for farmers to select varieties of their choice. The LG and CoLk clones available to the Breeders under NHG, ICAR-SBI, Coimbatore were multiplied and included in the germplasm collection.

Development of breeding stocks of sugarcane for durable resistance to red rot

Red rot resistant germplasm line "LG 05817" was registered as a Novel Germplasm at ICAR-NBPGR, New Delhi with Registration No. INGR18035 on June 02, 2018 (Fig. 1.5).

Fig. 1.5. Field view of the plants of LG 05817

Evaluation of early sugarcane clones for North West Zone

Initial Varietal Trial: A trial comprising of nine test sugarcane genotypes, *viz*., Co 15023, Co 15024, Co 15027, CoLk 15201, CoLk 15203, CoLk 15204, CoLk 15205, CoPb 15211 and CoPb 15212 and three standards (CoJ 64, Co 0238, Co 05009) was conducted and observations were recorded on various yield and quality parameters. The genotype CoLk 15201 recorded the highest cane yield (83.64 t/ha) closely followed by Co 15205 (82.68 t/ha). Similarly, the genotype CoLk 15201 also showed the highest CCS yield (11.31 t/ha) followed by CoLk 15205 (11.27 t/ha). The highest sucrose content at harvest was recorded in Co 15023 (20.23%) followed by CoLk 15203 (20.04%). Among the standards, Co 0238 was found the best standard for both yield and quality parameters and recorded the highest cane (76.17 t/ha) and CCS (10.10 t/ha) yields.

Advanced Varietal Trial I Plant: Four sugarcane genotypes, *viz*., Co 14034, CoLk 14201, CoPb 14181 and CoPb 14211 along with three standards (CoJ 64, Co 0238, Co 05009) were evaluated for yield and quality parameters. Among the test genotypes, CoLk 14201 recorded the highest cane (87.69 t/ha) and CCS (10.59 t/ha) yield. The genotype Co 14034 showed the highest sucrose content at harvest (19.44%) followed by CoLk 14201 (19.43%). Among the standards, Co 0238 was the best check for cane (79.07 t/ha) and CCS (9.12 t/ha) yields.

Advanced Varietal Trial II Plant: Three sugarcane clones, *viz*., Co 13034, CoPb 13181 and CoS 13231 along with three standards (CoJ 64, Co 0238, Co 05009) were evaluated for yield and quality parameters. None of the test genotypes was found superior to the best standard Co 0238. Among the test genotypes, CoS 13231 recorded the highest cane (65.51 t/ha) and CCS (8.88 t/ha) yield. The genotype CoS 13231 showed the highest sucrose content at harvest (19.54%) followed by Co 13034 (18.56%). Among the standards, Co 0238 was the best check for cane (80.34 t/ha) and CCS (10.90 t/ha) yields.

Advanced Varietal Trial Ratoon: Four sugarcane clones, *viz*., Co 13034, CoPb 13181 and CoS 13231 along with three standards (CoJ 64, Co 0238, Co 05009) were evaluated for their ratooning ability. The genotype CoS 13231 recorded the highest cane (52.46 t/ha) and CCS (6.52 t/ha) yields. Among the standard varieties, Co 0238 was the best for cane (74.15 t/ha) and CCS (8.72 t/ha) yields.

Seed Multiplication: The seed of nine sugarcane genotypes (Co 15025, Co 16029, CoLk 16201, CoLk 16202, CoPb 16211, CoPb 16181, CoPant 16221, CoPant 16222 and CoS 16231) was multiplied for next year's IVT trial.

Evaluation of mid-late sugarcane clones for North West Zone

Initial Varietal Trial: Eleven sugarcane clones, *viz*., Co 15026, CoLk 15206, CoLk 15207, CoLk 15208, CoLk 15209, CoPb 15213, CoPb 15214, CoS 15231, CoS 15232, CoS 15233 and CoS 15234 along with three standards (CoS 767, CoPant 97222, Co 05011) were evaluated for

yield and quality parameters. The genotype CoLk 15206 recorded the highest cane yield (86.09 t/ha) followed by CoLk 15207 (82.41 t/ha) and CoLk 15209 (73.20 t/ha). The genotype CoLk 15207 recorded the highest CCS yield (11.61 t/ha) followed by CoLk 15206 (11.32 t/ha) and CoLk 15209 (9.51 t/ha). Among the test genotypes, CoLk 15207 recorded the highest sucrose content at harvest (20.20%) followed by CoS 15232 (19.09%) and CoLk 15206 (19.06%). Among the standard varieties, CoPant 97222 recorded the highest CCS yield (10.31 t/ha) followed Co 05011 and CoS 767.

Advanced Varietal Trial I Plant: Seven sugarcane genotypes, *viz.*, Co 14035, CoH 14261, CoLk 14203, CoLk 14204, CoPb 14184, Co 14185 and CoS 14233 along with three standards (CoS 767, CoPant 97222, Co 05011) were evaluated for yield and quality parameters. The clone CoLk 14203 recorded the highest cane yield (113.09 t/ha) which was significantly superior to the best check. CoH 14261 exhibited the highest sucrose content at harvest (19.95%) followed by CoS 14233 (19.13%) and CoLk 14203 (19.12%). Among the standard varieties, CoS 767 was found to be the best for cane yield (82.96 t/ha) and CoPant 97222 for CCS yield (10.36 t/ha).

Advanced Varietal Trial II Plant: Five genotypes, *viz.*, Co 13035, CoH 13263, CoLk 13204, CoPant 13224 and CoPb 13182 along with four standard varieties (CoS 767, CoS 8436, CoPant 97222, Co 05011) were evaluated for yield and quality parameters. Genotype CoLk 13204 recorded the highest cane yield (87.94 t/ha) followed by CoPb 13182 (82.36 t/ha) and CoH 13263 (82.20 t/ha). In addition, CoH 13263 also recorded the highest CCS yield (11.34 t/ha) followed by CoLk 13204 (10.99 t/ha) and CoPb 13182 (10.41 t/ha). The genotype CoH 13263 showed the highest sucrose content (19.75%) at harvest followed by Co 13035 (19.22%). Among the standards, CoPant 97222 was the best check for cane (78.55 t/ha) and CCS yields (10.75 t/ha).

Advanced Varietal Trial-Ratoon: Five genotypes, *viz.*, Co 13035, CoH 13263, CoLk 13204, CoPant 13224 and CoPb 13182 along with four standard varieties (CoS 767, CoS 8436, CoPant 97222, Co 05011) were evaluated for their ratooning ability. The genotype CoLk 13204 showed the highest cane (69.78 t/ha) and CCS (7.69 t/ha) yield. Among the standard varieties, CoS 767 and CoPant 97222 were on par for cane as well as CCS yields.

Seed multiplication: The seed of seven genotypes, *viz.*, Co 16030, CoLk 16203, CoLk 16204, CoPb 16212, CoPant 16223, CoS 16232, CoS 16233 was multiplied for next year's IVT trial.

Mapping of loci linked to sugar content in sugarcane

The project aims to identify molecular markers linked to sugar content and to map the loci linked to the trait, making use of segregating populations and high sugar sugarcane genotypes. High sugar genotypes in different clonal generations were evaluated and promising selection were advanced. An advanced trial of 96 promising high sugar genotypes gave 22 genotypes with mean sucrose % in juice values 19 % or more in January (Table 1.5). These clones were from nine matings involving the high sugar genotypes/genetic stocks developed in the initial three cycles of convergent breeding and selection. Nine selections are from the bi-parental cross LG 05433 × LG 97050. The genotype LG 14564 with the highest mean sucrose% in juice (20.1%) was selected from the self-population of LG 05480. Approximately 60% of these genotypes had sucrose % in juice more than 18%, with five genotypes indicating a resistant reaction to the most prevalent races of red rot pathogen. One hundred eighty five genotypes in C_2 generation were evaluated for their juice quality. 88 genotypes with more than 18% mean sucrose % in juice during January 2019 and satisfactory morphological attributes were selected and planted for further evaluation. These selections came from ten general collections (GCs). LG 07408 GC (second cycle of mating), gave the maximum number of selections followed by LG 07482 GC (fourth cycle of mating) and LG 07501 GC (third cycle of mating) (Table 1.6).

The clones from 13 matings were evaluated in the C_1 generation. A total of 149 genotypes exhibited mean HR Brix readings more than 20.0% in January 2019 with

Table 1.5. Performance of promising genotypes in advanced trial

Genotype	Sucrose (%)	CCS (%)	Parentage
LG 14568	19.36	13.49	LG 05480 Self
LG 14503	19.76	13.84	LG 05433 × LG 97022
LG 14452	19.89	13.95	LG 01118 × LG 05460
LG 14497	19.44	13.59	LG 05433 × LG 97022
LG 14482	19.78	13.87	LG 05433 × LG 05460
LG 14564	20.05	14.06	LG 05480 Self
LG 14445	19.12	13.40	LG 01118 × CoLk 97147
LG 14419	19.91	13.87	LG 01118 × CoLk 97147
LG 14480	19.17	13.31	LG 05433 × LG 05460
LG 14402	19.08	13.31	LG 641 Self
LG 14495	19.83	13.87	LG 05433 × LG 97022
LG 14538	19.03	13.25	LG 05433 × LG 97022
LG 14483	19.38	13.48	LG 05433 × LG 05460
LG 14530	19.08	13.31	LG 05433 × LG 97022
LG 14488	19.08	13.27	LG 05433 × LG 05460
LG 13449	19.18	13.41	LG 99164 GC
LG 14504	19.79	13.84	LG 05433 × LG 97022
LG 14420	19.27	13.45	LG 01118 × CoLk 97147
LG 14542	19.54	13.67	LG 05433 × LG 97022
LG 14553	19.10	13.37	LG 05460 Self
LG 14426	19.00	13.28	LG 01118 × CoLk 97147
LG 14470	19.01	13.28	LG 01118 × LG 05460
Mean #	18.40	12.80	
CV#	5.37	5.88	

#Parameters for the 52 genotypes tested in the trial

Table 1.6. GCs with good performance in C_2 stage

Mating	Number of genotypes selected	Mean Sucrose % in juice of the selections (January)
LG 08422 GC	7	18.21
LG 07501 GC	12	18.35
LG 07482 GC	21	18.25
LG 911 GC	1	19.60
LG 07408 GC	30	18.46
LG 02100 GC	5	17.62
LG 05434 GC	3	17.90

satisfactory morphological traits. Based on HR Brix data and the general morphological characters, these genotypes were advanced to C_2 generation.

Three promising clones, LG 11991, LG 14452 and LG 14494 were included in the divisional station trial for evaluation. Three high sugar genetic stocks, *viz.*, LG 14482, LG 14564 and LG 11440 with sucrose % juice values 19-20% during January, were sent to National Hybridization Garden at ICAR-SBI, Coimbatore for probable use as parental clones in hybridization programmes. A promising mid-late maturing clone CoLk 18203 (LG 11517) was accepted for multilocation testing in the AICRP (Sugarcane) trials.

Profiling and prediction of small RNA transcriptome in red-rot challenged sugarcane

The project was initiated to unravel the profile of conserved and novel miRNA in response to red rot disease and their role in order to understand small RNA-guided control of red rot resistance in sugarcane. Total RNA isolated from stalks and leaves of two varieties, *viz.*, BO 91 (red rot resistant) and CoJ 64 (red rot susceptible) inoculated with *C. falcatum* at different time intervals along with control, was used for library preparation. The purified libraries of small RNA were sequenced using the Illumina NextSeq 500. High-quality small RNA reads were extracted from raw reads through filtering. Several non-coding small RNAs were found including Lnc RNA that ranged from 18-463, mature transcript ranging from 71-172, msr RNA from 0-1, non-protein coding transcripts 0-40, piRNA 7-113, pre_miRNA 0-11, self-splicing ribozyme RNA 4-547, snmRNA 3-861, snoRNA 194-1520, snRNA 258-522, SRP_4.5S RNA 0-1 and Y RNA 0-4 in different control and treated samples. Such non-coding RNA sequences were excluded from further analysis. Remaining sequences were aligned against the miRBase 21 to search for known miRNAs that led to identification of >300 known miRNA in each sample. Unannotated sequences were screened using *S. officinarum* genome database to predict 472 novel miRNA in all the samples. Their canonical hairpin structure was predicted by RNAfold. A total of 12566 targets were identified for these 472 new miRNA. Most of the miRNA had approx. 25-30 targets; some had >100 target genes. Most of the target genes of differentially expressed miRNA genes were associated with cellular and metabolic processes, or with cell or organellar development. Some target genes were also identified related to disease resistance mechanism and their validation is in progress.

Production of disease-free and genetically pure seed cane through micropropagation

Micropropagation technique of plant tissue culture assumes significance for rapid multiplication of new varieties with superior traits and production of disease-free genetically uniform seed cane. This year, rapid *in vitro* cultures of new sugarcane varieties CoLk 12207 and CoLk 12209 were established. The previously established sugarcane varieties CoLk 09204, CoLk 11203, CoLk 11206 and Co 0238 were multiplied through enhanced axillary shoot proliferation using apical shoot explants. Shoot initiation was achieved on Murashige and Skoog's medium supplemented with 4.44 µM benzyladenine (BA) and 4.6 µM kinetin (Kin) + 3% sucrose. The maximum shoot proliferation per explant with 100% shoot regeneration frequency was obtained on MS medium supplemented with 2.22 µM BA + 2.3 µM Kin + 26.8 µM NAA + 3% sucrose. Vigorous rooting was obtained on MS medium containing 26.8 µM NAA and 5% sucrose.

Development of *in vitro* conservation protocol using slow-growth tissue culture techniques in sugarcane

A protocol for *in vitro* conservation of sugarcane genotype *Khakai* using slow-growth culture technique has been developed, that involved establishment of shoot-tip cultures, followed by their multiplication on MS medium with 2.22 µM BA, 0.5 µM Kinetin, 0.5 µM GA_3. The slow-growth culture regime included maintenance at 25^{0}C for 365 days of incubation on MS medium supplemented with 2.22 µM BA, 0.5 µM Kinetin, 0.5 µM GA_3, 5% sucrose and 5.0 µM flurprimidol. The cultures stored for 180-365 days without any sub-culture were observed for survival and green parts. The same green parts of the shoots were re-cultured for regeneration on MS medium with 2.22 µM BA, 0.5 µM Kinetin, 0.5 µM GA_3 and 3% sucrose. Successful shoot multiplication was recorded from such stored slow-growing shoots incubated for 180 and 360 day. Re-culture capacity of the slow-growth cultures was tested after one year, and the results have been encouraging. Genetic fidelity assay using ISSR markers revealed no genetic variation in the recovered cultures (Fig. 1.6).

Fig. 1.6. ***In vitro*** **slow-growth cultures of sugarcane genotype** ***Khakai***

Accredited Test Laboratory under National Certification System for Tissue Culture-raised Plants (DBT, New Delhi)

An Accredited Test Laboratory (ATL) for genetic fidelity and virus indexing of tissue culture raised plants is under operation at ICAR-IISR, Lucknow with the financial support from Department of Biotechnology (DBT), New Delhi under National Certification System of Tissue Culture-raised Plants (NCS-TCP). During 2018-19, a total of 9,900 samples were tested, out of which 3,400 samples comprising of 700 samples of sugarcane and 2,700 samples of banana from DBT recognized tissue culture production facilities were tested for mother stock virus indexing. Of the 9,900 samples, a total of 6,500 samples (950 of sugarcane and 5,500 samples of banana) were tested for genetic fidelity testing, which equals to quality certification of 65 lakh tissue culture plantlets. The testing includes virus indexing of sugarcane for Sugarcane mosaic virus (SCMV), Sugarcane yellow leaf virus (SCYLV), Sugarcane bacilliform virus (SCBV) and phytoplasma, and banana samples for Banana bract mosaic virus (BBrMv), Cucumber mosaic virus (CMV), Banana bunchy top virus (BBTV), and Banana streak virus (BSV).

RNAseq-based bulk segregant analysis for SNP mining and linkage mapping for early sucrose accumulation in sugarcane (DBT-BioCARe, and DST-WoS-A Project)

RNA-seq based bulk segregant analysis (BSR-seq) relies on the fact that extreme phenotypes should be having strong differences in genotypes as well. In this study, condition-specific SNPs related to high sucrose accumulation were identified using RNAseq data generated from two sugarcane varieties (CoV 92102 and MS 68/47) contrasting for sucrose content and two extreme bulks derived from their segregating population. The two parental lines exhibited contrasting expressions for sucrose content, cane width, number of millable canes, cane diameter and cane length and these traits segregated in the C_2 generation of the F_1 mapping population as well. The phenotypic performance of 10 promising F_1 clones has been presented in Table 1.7.

Table 1.7. Performance of a few promising F_1 individuals in C_2 generation

Genotype	Corrected Brix	Sucrose % (300 d)	Purity coefficient	Average cane diameter (cm)	Cane density (g/cc)
MSC 170	19.43	16.08	82.8	3.35	2.121
MSC 134	19.17	17.06	89.02	2.55	2.375
MSC 162	18.09	16.11	89.08	3.35	2.124
MSC 236	20.0 5	17.36	86.59	3.18	2.026
MSC 183	17.75	14.27	80.38	3.55	2.089
MSC 201	15.47	12.24	79.10	4.15	1.978
MSC 31	17.43	14.86	85.29	3.05	2.011
MSC 165	14.93	12.38	82.91	3.11	2.128
MSC 186	17.90	15.02	83.92	3.15	2.125
MSC 136	17.36	14.82	85.32	3.45	1.785

The highest sucrose content was recorded in genotype MSC 170 (17.36%) followed by MSC 162 (16.11%), whereas, it was the lowest in MSC 331 (6.79%) followed by MSC 217 (7.4%). In terms of cane diameter, the genotypes MSC 202 and MSC 36 were recorded to be superior among the mapping population. The RNAseq libraries of the two parental lines and two extreme bulks generated 40-50 million raw paired-end reads per sample. The *de novo* assembly generated 1,83,151 transcripts when all isoforms were considered. The transcripts represented 88,939 unigenes, with a mean length of 783.11 base pairs, N50 value of 859 and GC content of 49.57%. A total of 30,137 SNPs were identified of which, 21,511 were present in the coding region of the genes (Fig. 1.7), and among them 9,905 were non-synonymous variants (NSVs). Due to the fact that this model could quantify the individual effect of each SNP on trait expression, following the 9,905 NSVs located in the coding regions of the genes, and visualizing them in different cellular pathways, important allelic variations of genes that were differentially enriched during early sucrose accumulation were identified (Fig. 1.8). The data related to genotyping by sequencing (GBS) of ~148 F_1 progeny is underway. These NSVs can be useful candidate markers that can be used in marker assisted selection for developing high sucrose containing sugarcane varieties in a shorter span of time.

Central Sector Scheme for Protection of Plant Varieties and Farmers' Rights Authority

This year, a total of 153 reference varieties of

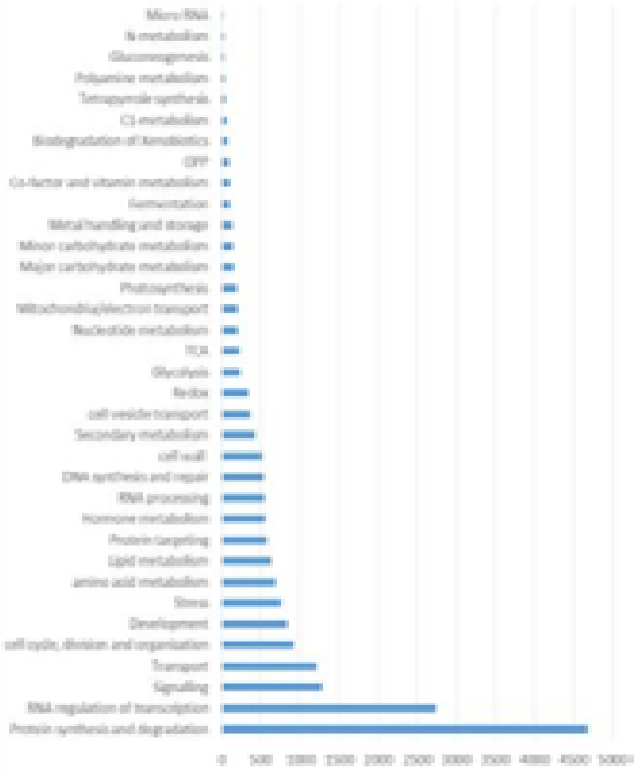


Fig. 1.7. Frequency distribution of differential SNPs linked to early sucrose accumulation in various functional bins

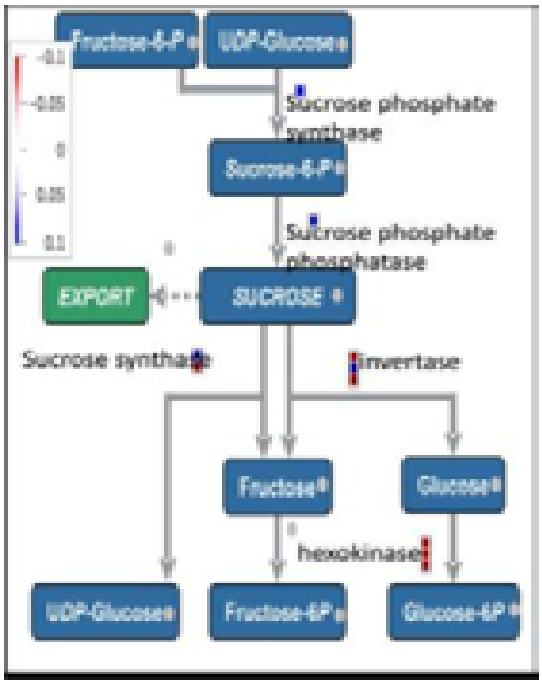


Fig. 1.8. Differential NSVs in sucrose synthesis pathway

sugarcane were maintained in DUS field during autumn and spring seasons. This reference collection includes all the identified, released and notified varieties from CVRC, varieties released from states and clones from Advanced Varietal Trials of AICRP(S) available with different research organization working on sugarcane.

DUS characters were recorded on 90 varieties in reference collection as per the DUS Testing guidelines. In a process to synchronize and harmonize the DUS Reference Collection at ICAR-IISR, Lucknow and ICAR-SBI-RC, Karnal, a set of 43 varieties was sent to ICAR-SBI-RC, Karnal and a set of 15 varieties was received from ICAR-SBI-RC, Karnal. The varieties were planted in field for multiplication.

Seed production in agricultural crops (ICAR Seed Project)

During the year 2018-19, approximately 9,000 quintals of seed cane was produced (Table 1.8). Approximately 75% seed cane of improved varieties of sugarcane was lifted. The rest has been utilized for further multiplication and distribution to farmers. In addition, 12.0 ha area has been planted with newly released varieties for seed cane production during 2019-20. New varieties included in the seed production from the current year are CoLk 11206 and CoLk 11203. Under Seed Cane Awareness, seed of newly released varieties CoLk 09204, CoLk 9709 and CoPk 05191 were distributed to farmers and several sugar industries for making the sugarcane growers aware about the role of new varieties and the quality seed cane in enhancing the yield and production.

Table 1.8. Sugarcane seed production at ICAR-IISR, Lucknow

Variety	Group	Quantity (q)
CoPk 05191	Early	2000
CoLk 94184	Early	700
CoLk 9709	Early	700
Co 0238	Early	800
CoLk 09202	Early	400
Co 0118	Early	600
Co 05011	Mid-late	300
CoH 0128	Mid-late	200
CoPant 05224	Mid-late	200
CoLk 09204	Mid-late	2000
CoLk 11206	Mid-late	600
CoLk 14201	Early	400
CoLk 11203	Early	100
Total		9000

For promoting the use of recently notified varieties, an awareness campaign was initiated on the occasion of Institute's Foundation Day on 16th February 2019 by distributing seed cane packets to more than 100 farmers along with making them aware about the distinguishing characters of the recently notified varieties. Field Days were organized at the Institute to popularize recently notified varieties *viz.*, CoLk 09204, CoLk 11206, CoLk 11203, CoLk 12207 and CoLk 12209. Awareness for morphological identification of varieties with DUS characters under field condition was also taken-up with development staff and farmers.

CHAPTER 2

Natural Resource Management

Soil nutrition and health for higher tonnage and enhanced quality of the cane

Sugarcane productivity in relation to initial soil organic carbon content and nutrient management in sub-tropical inceptisol

A field experiment was initiated in March 2015 to assess the influence of initial soil organic carbon (SOC) content and nutrient management on sugarcane growth and yield in a multi-ratooning system. During the year (2018-19), performance of third ratoon crop as influenced under various treatments was assessed. Ratoon was initiated in February 2018 and harvested in December 2018. The experimental field consisted of plots (8x6 m) with varying initial SOC content as a result of addition of variable rates of different bio-manures continuously for 10 years in a plant-ratoon system followed by a fallow year. Four initial SOC levels (0.45-0.55, 0.56-0.65, 0.66-0.75 and above 0.75 %) and three nutrient management packages (recommended dose of fertilizers (RDF): 150, 60, 60 kg NPK; RDF + farmyard manure 10 t/ha; RDF + zinc sulphate 25 kg/ha + S 20 kg/ha) were evaluated in all combinations (12) following randomized block design with three replications.

Data depicted in Table 2.1 evinced that initial soil organic carbon content and nutrient management practices did not influence the tiller count (120 and 180 days after initiation-DAI) nor was it affected by the different nutrient management practices. However, numerical increase in the number of tillers at 120 and 180 DAI was recorded with increasing levels of initial SOC. The number of millable canes (NMC) increased conspicuously up to 0.66-0.75% SOC as compared to that with SOC 0.45-0.55 and 0.56 – 0.65 %. The highest NMC (85.28 thousand/ha) was recorded in the treatment with >0.76% SOC. Ratoon yield significantly increased with increasing SOC content and the highest cane yield (86.98 t/ha) was attained with 0.66-0.75% that was at par with the yield levels recorded under >0.76% SOC. Higher SOC (0.56-0.65% or above) could not cause significant increase in cane thickness over that at 0.45-0.55% SOC. Different nutrient management practices adopted in ratoon crop did not influence the crop performance as statistically similar growth and yield parameters were recorded. Influence of SOC levels and nutrient management on juice quality attributes was not conspicuous. Effect of interaction between SOC levels and nutrient management practices was not found significant in the third ratoon crop.

Soil quality assessment under different sugarcane growing system

The eastern region of subtropical India is a major sugarcane producing area where water logging, multi-nutrient deficiency and over-exploitation have led to decreased soil quality and sugarcane productivity. A variety of soil samples representing the spatial homogeneity in 131 sugarcane fields were collected from Ramkola, Hatta, Captanganj and Seorahi Sugar mill command areas and analysed for several physical, chemical and biological properties of the soil. The analysed data exhibited that soil reaction of these soils falls under slightly acidic (6.50) to alkaline (8.80) in nature, non-saline and low to high content of organic matter ranged between 2.48 and 10.13 g/kg soils. The soil samples showed 100, 76, 80 and 30% in low categories in respect of available N, P, K and S content,

Table 2.1. Effect of initial soil organic carbon content (SOC) and nutrient management on growth and yield of sugarcane ratoon

Treatment	Tiller no. ('000/ha)		NMC (000/ha)	Cane length (m)	Cane girth (cm)	Cane yield (t/ha)
	120 DAI	180 DAI				
Initial SOC level						
0.45-0.55	81.39	120.84	78.02	2.08	2.36	74.35
0.56-0.65	86.73	128.67	78.11	2.12	2.38	77.31
0.66-0.75	91.46	142.42	84.37	2.15	2.46	86.98
≥ 0.76	91.12	126.81	85.28	2.15	2.47	86.94
CD (*P*=0.05)	NS	NS	5.12	NS	NS	9.38
Nutrient management						
RDF (150, 60, 60 kg NPK/ha)	88.54	125.72	80.46	2.10	2.40	77.32
RDF + FYM (10 t/ha)	87.04	124.46	83.17	2.12	2.49	84.99
RDF + $ZnSO_4$ 25 kg + S 20 kg/ha	92.41	138.85	83.19	2.14	2.36	84.36
CD (P= 0.05)	NS	NS	NS	NS	NS	NS

respectively. However, all the soil samples indicated high to very high content of iron and manganese which affected the soil quality and productivity of sugarcane. A minimum data set (MDS) including soil organic matter, soil pH, sand content, FDA, available K and S accounted for 70.6% of the quality variation among soils. The soil quality index was calculated using the Integrated Quality Index equation, after all indicators had been weighted and scored. Soil quality indices of the 131 sugarcane fields in this study were calculated and varied from 0.539 to 0.992, with a mean of 0.712 and a coefficient of variation of 14.8%. The average contributions of soil quality indicators towards the soil quality development were soil pH (17.7%), SOC (15.3%), sand content (12.1%), FDA (9.09%), available K (8.98%) and S (8.04%) (Fig. 2.1).

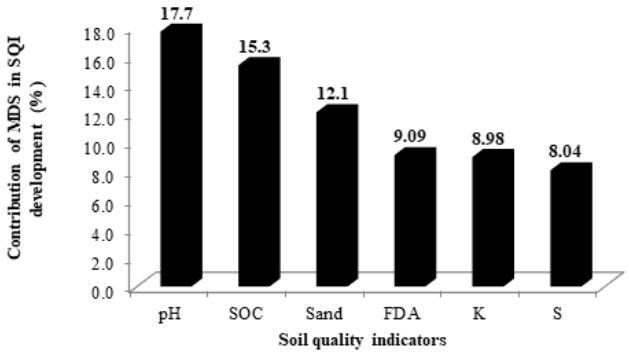


Fig. 2.1. The average contribution of soil quality indicators (MDS) for the development of soil quality index under sugarcane growing areas of water logged conditions in eastern region of Uttar Pradesh

Soil test and resource based integrated plant nutrient supply system for sustainable sugarcane production (STCR)

Targeted yield equations of spring season plant crop and ratoon crop (var. Co 0238) and wheat crop under plant-ratoon-wheat cropping system were developed which are useful for recommendation of mineral fertilizers based on soil test values and getting fixed target in the alluvial soils of sub-tropical condition of India. By using cane yield, initial soil test values, nutrient uptake and fertilizers doses applied, the basic data [*viz.*, nutrient requirement (NR) and contributions of nutrients from soil (Cs), fertilizers (Cf), and farmyard manure (Cfym)] were computed and used to develop fertilizer prescription equations for sugarcane production. The actual nutrient requirement for fixed targeted yield of sugarcane also computed. The targeted yield equation for ratoon crop developed during 2015-16 was verified in second ratoon crop at our research farm during 2018-19 (Table 2.2). The results revealed that tillers count, cane length, cane diameter, cane weight, NMC, ratoon yield and CCS were significantly affected by application of mineral fertilizers based on soil test and targeted yield equations over the recommended doses of fertilizers. However, quality of sugarcane *viz.*, Brix, Pol percentage and purity could not be affected significantly (Table 2.2). Application of mineral fertilizers on the basis of soil test values and targeted yield equations for achieving targeted yield of 100 and 120 t/ha of second ratoon could not achieve with within 10% yield deviations. However, highest yield and yield attributes were recorded within the treatments where application of FYM @ 10 t/ha with mineral fertilizers applied based on soil test and targeted yield equation for getting 120 t/ha targeted yields. Application of FYM with RDF, target of 100 t/ha and targets of 120 t/ha augmented cane yield of 6.54, 7.50 and 6.95% over RDF, targets of 100 and 120 t/ha, respectively (Table 2.3).

Carbon sequestration assessment in sugarcane-based cropping system

The experiment was carried out with aim to improve the total soil organic carbon build-up and sustain crop yields under rice-wheat and sugarcane-ratoon-wheat systems. Soil analysis of experimental field revealed that rice-wheat cropping system recorded average organic carbon 0.36% as compared to sugarcane- based cropping system (0.43%) in 0-30 cm depth of soil. It subsequently decreased in 30-60 cm depth and recorded 0.24 and 0.29% SOC, respectively. Mean available nutrient status in soil decreased as compared to initial status of soil. During second year of

Table 2.2. Basic data and targeted yield equations of plant, ratoon (cv. Co 0238) and wheat crop (var. DBW 16) under sugarcane-ratoon-wheat crop rotations (2017-19)

Basic data	N	P	K	N	P	K	N	P	K
	Plant crop			Ratoon crop			Wheat crop		
Nutrient requirement (kg/t)	2.07	0.75	2.28	1.87	0.70	2.14	1.74	0.41	2.10
Soil efficiency (%)	54.7	82.1	56.4	57.7	81.1	55.8	18.1	44.2	21.8
Fertilizer efficiency (%)	28.0	79.0	67.8	31.6	49.3	89.5	17.9	24.8	36.0
Organic efficiency (%)	5.74	12.6	22.7	11.8	12.1	12.1	9.98	3.04	11.2
Targeted yield equations									
FN=7.37 T –1.95 SN–0.20 ON **FP**=0.96 T –2.21 SP –0.16 OP **FK**=3.36 T–0.83 SK–0.34 OK **Response Yardstick (kg/t) = 8.55**				**FN**=5.91 T–1.83 SN –0.37 ON **FP**=0.64 T–1.85 SP –0.11 OP **FK**=2.33 T–0.60 SK–0.14 OK **Response Yardstick (kg/t) = 11.3**			**FN**=9.74 T –1.01 SN – 0.56 ON **FP**=1.66 T –1.79 SP – 0.12 OP **FK**=5.82 T –0.61 SK – 0.31 OK **Response Yardstick (kg/t) = 5.81**		

Table 2.3. Effect of different treatments on growth, yield and juice quality of second ratoon crop during 2018-19

Treatments	Tillers No. (10^3/ha)	Cane length (m/plant)	Cane girth (cm)	Cane weight (g/plant)	NMC (10^3/ha)	Cane yield (t/ha)	Brix	Pol (%)	Purity coefficient (%)
T_1-RDF	83.2	1.99	1.95	0.807	75.7	69.6	20.0	18.3	87.7
T_2-T1 + FYM (@ 10 t/ha	88.5	2.07	2.03	0.847	80.0	74.2	20.1	18.8	88.0
T_3-TY 100 t/ha	92.0	2.04	2.04	0.876	83.3	77.8	20.1	18.7	87.7
T_4-T_3 + FYM (10 t/ha)	96.6	2.14	2.12	0.911	89.0	83.7	20.6	18.0	88.1
T_5-TY 120 t /ha	99.9	2.12	2.14	0.900	85.0	80.4	20.3	18.5	88.0
T_6-T_5 + FYM (@ 10 t/ha	106.1	2.21	2.17	0.979	88.0	86.0	20.4	18.1	88.0
CD (P=0.05)	6.13	0.10	0.08	0.10	7.09	6.23	NS	NS	NS

experimentation, rice-wheat cropping system recorded grain yield of rice and wheat in tune of 41.6 and 35.9 q/ha, respectively (Table 2.4). Ratoon crop yielded 109.8 t/ha in sugarcane- based cropping system. Higher wheat yield (46.9 q/ha) was recorded in sugarcane-based cropping system just after harvest of ratoon crop as compared to 35.9 q/ha in rice-wheat system. Residue retention with *Trichoderma* in wheat improved the wheat yield by 11.2% in rice-wheat based cropping system. However, trash mulching with *Trichoderma* in ratoon crop improved the cane yield by 9.5% as compared to mulching without *Trichoderma*.

Impact of integrated application of organics and inorganics in improving soil health and sugarcane productivity

Field experiment was conducted to develop nutrient management strategy for sustaining soil health and sugarcane production. The experiment consisted of 10 treatments *viz*. T_1-No organic + 50% RDF (recommended dose of fertilizer): 50% RDF, T_2-No organic + 100% RDF : 100% RDF, T_3-No organic + soil test based recommendation: STBR, T_4-Application of FYM @ 20 tonnes/ha + 50% RDF (inorganic source) : 20 t + 50% RDF, T_5-Application of FYM @ 20 tonnes/ha + 100% RDF (inorganic source) : 20 t + 100% RDF,T_6-Application of FYM @ 20 tonnes/ha + inorganic nutrient application based on soil test (rating chart) : 20 t + STRC, T_7-Application of FYM/Compost @ 10 tonnes/ha + biofertilizer (*Acetobacter* + *PSB*) + 50% RDF : 10 t + B + 50% RDF, T_8-Application of FYM/Compost @ 10 tonnes/ha + biofertilizer (*Acetobacter* + *PSB*) + 50% RDF: 10 t + B + 100% RDF, T_9-Application of FYM/Compost @10 tonnes/ha + biofertilizer (*Acetobacter* + *PSB*) + 50% RDF : 10 t + B + STBR, T_{10}-Only organic. The experiment was laid out in Randomised Block Design with three replications. The cane setts were soaked with bioferilizer cultures by dipping in the containers. FYM was applied in the furrows at the time of planting.

The data on ratoon sugarcane growth, yield and quality (Table 2.5 and 2.6) indicate significant variations among the treatments. Significantly the highest rate of sprouts (93.4%) was observed under the treatment of only organic application. The highest number of tillers (180.2 thousand/ha at 120 days after planting), shoot count (175.6 thousand/ha at 180 DAP), number of millable canes (120.5 thousand/ha), cane yield (84.20 t/ha) and sugar yield (10.55 t/ha) were recorded under the treatment where application of FYM @ 20 t/ha was done along with soil test (rating chart) based inorganic fertilizer recommendations. However, it was found comparable to the treatment of FYM @ 10 t/ha along with biofertilizer and soil test basis inorganic fertilizers

Table 2.4. Crop yield as influenced by different cropping systems

Cropping System	2016-17		2017-18	
	Rice (q/ha)	Wheat (q/ha)	Rice (q/ha)	Wheat (q/ha)
T_1: Rice – Wheat – Rice – Wheat (residue retention without *Trichoderma*)	41.7	44.2	42.4	34.01
T_2: Rice – Wheat – Rice – Wheat (residue retention with *Trichoderma*)	42.8	47.3	40.8	37.8
Mean	**42.3**	**45.8**	**41.6**	**35.9**
Sugarcane-Wheat				
	Plant crop yield (t/ha)		**Ratoon crop yield (t/ha)**	**Wheat yield (q/ha)**
T_3: Sugarcane – Ratoon (Trash mulching without *Trichoderma*) – Wheat	110		110	48.7
T_4: Sugarcane – Ratoon (Trash removal without *Trichoderma*) – Wheat	116		107.5	45.8
T_5: Sugarcane – Ratoon (Trash mulching with *Trichoderma*) – Wheat	107		120.5	49.8
T_6: Sugarcane – Ratoon – Wheat (Trash incorporation through rotavator and *Trichoderma* incorporation before sowing of wheat)	119		103.3	46.7
T_7: Sugarcane – Ratoon – Wheat (Zero tilled) without *Trichoderma*	107		109.1	43.8
T_8: Sugarcane – Ratoon – Wheat (Zero tilled) with *Trichoderma*	113		108.7	46.5
Mean	**112**		**109.8**	**46.9**

Table 2.5. Growth and yield of sugarcane under different treatments

Tr. No.	Treatment	Sprouts (%)	Tiller/Shoot population (000/ha)						NMC (000/ha)	Yield (t/ha)
			May	June	July	August	Sep.	Oct.		
			60 DAP	90 DAP	120 DAP	150 DAP	180 DAP	210 DAP		
1.	50%RDF	84.3	110.7	115.0	120.5	122.8	124.9	112.8	81.6	51.60
2.	100% RDF	83.7	115.8	120.3	140.7	145.6	140.6	125.9	93.4	72.20
3.	STBR	84.5	130.5	125.8	136.8	140.8	139.4	128.6	87.6	73.90
4.	20 t 50%	88.9	132.6	135.0	142.8	145.6	146.8	132.9	89.2	68.90
5.	20 + 100	88.4	160.9	165.7	170.5	173.8	174.3	150.8	108.6	83.70
6.	20 + STRC	90.2	170.8	176.8	180.2	182.8	175.6	160.6	120.5	84.20
7.	10+ B + 50	87.6	140.7	110.9	130.8	135.7	140.8	142.9	107.6	76.90
8.	10 + B + 100	88.8	150.9	155.7	165.5	170.6	168.7	142.6	114.8	82.40
9.	10 + B + STBR	89.2	160.8	165.8	170.6	173.8	174.6	150.8	122.2	84.50
10.	Organic	93.4	120.0	125.8	135.2	138.9	140.8	142.2	104.6	72.60
	SEm ±	0.92	1.59	2.01	2.27	2.68	2.17	2.21	2.48	1.49
	CD (P=0.05)	2.86	4.86	6.28	7.25	8.26	6.89	6.76	8.96	5.26

Table 2.6. Effect of different treatments on juice quality, yield attributes and sugar yield

Tr. No.	Treatment	Brix	Pol % (%)	Purity (%)	Cane length (cm)	Cane girth (cm)	Cane wt. (kg)	CCS (%)	CCS (t/ha)
1.	50% RDF	18.77	16.48	87.77	190.70	2.10	0.60	11.36	5.86
2.	100% RDF	18.68	16.30	87.31	210.80	2.16	0.87	11.20	8.09
3.	STBR	19.57	17.52	89.62	216.80	2.25	0.89	12.19	9.01
4.	20 t 50%	18.91	16.43	86.93	205.20	2.26	0.76	11.27	7.76
5.	20 + 100	19.95	17.35	87.01	215.80	2.27	0.97	11.91	9.97
6.	20 + STRC	20.51	18.12	88.38	220.60	2.30	1.10	12.53	10.55
7.	10 + B + 50	19.78	17.35	87.77	200.60	2.21	0.69	11.96	9.19
8.	10 + B + 100	20.16	17.86	88.62	208.70	2.24	1.10	12.37	10.19
9.	10 + B + STBR	21.10	17.51	87.12	221.70	2.30	1.17	11.73	9.92
10.	Organic	19.44	16.94	87.16	205.00	2.30	0.96	11.64	8.45
	SEm ±	0.31	0.34	0.70	3.70	0.03	0.12	0.42	0.80
	CD (P=0.05)	0.97	1.10	2.10	11.16	0.10	0.35	1.27	2.41

application. The yield attributing characters *viz.*, cane length (220.60 cm), cane girth (2.30 cm) and weight of individual cane (1.10 kg) was recorded the highest with the application of FYM @ 20 t/ha along with inorganic fertilizers applied on the basis of soil test rating chart. The quality parameters *viz.*, brix value and pol % were significantly improved with application of FYM and biofertilizers. The soil health indicators *viz.*, bulk density (1.27 Mg/m^3), infiltration rate (4.64 mm/h) and soil organic carbon (0.47%) showed positive responses with the application of organic manure in the system.

Development of microbial formulations/ microbial inoculants for the sugarcane crop

Fifteen phosphate solubilising bacterial strains were molecularly identified and submitted nucleotide sequences were allotted with Accession No. MG 923828, MG 923829, MK 342558, MH 100690, MK 342617, MG 930046, MG 930047, MG9 23808, MH 817418, MH 817419, MG 924852, MG 924853, MH 100893, MG 924892 and MH 100731 by GenBank NCBI. Field experiments were conducted with potential liquid microbial product (Ikshu PSB) of P solubilizing bacteria strains PSB28 *(Pseudomonas fluorescens)* and PSB29 *(Bacillus cereus)* along with different dosage of recommended phosphatic fertilizers. Soil physical and chemical parameters, P availability, P uptake, plant physiological parameters, plant growth and yield parameters and juice quality parameters were studied. Among different treatment combinations with recommended dose of phosphatic fertilizers, treatments T_3 and T_6 (25% less application of phosphate containing fertilizers) and T_2 and T_5 (50% reduction in application of phosphatic fertilizers) recorded 15-20% and 10% higher cane yield (t/ha) compared to control (T_7), respectively. The 0.3% improvement in sugar recovery was also observed in treatments T_3 and T_6. Moreover, twelve endophytic nitrogen fixing bacterial strains were molecularly identified and submitted nucleotide sequences were allotted with Accession No. MH 810328, MH 810320, MH 813022, MH 813026, MH 817413, MH 812993, MH 810338, MH 817416, MH 810341, MH 810333, MH 810330 and MH 810327 by GenBank NCBI. In another experiment, potential liquid microbial product (IkshuAceto) of endophytic nitrogen fixing bacterial strains *Gluconacetobacter aggris* (NB1) and *Gluconacetobacter sacchari* (NB2) were tested in field conditions with different doses of nitrogenous fertilizers. Soil physical and chemical parameters, N availability,

N uptake, plant physiological, plant growth, crop yield and juice quality parameters were studied. It was observed that reduction upto 50% nitrogenous fertilizers could be managed with application of endophytic nitrogen fixing bacterial strains - *Gluconacetobacter sacchari* (NB2). It was also calculated that besides reduction of nitrogenous fertilizers, it increased 10-15% sugarcane yield compared to 100% application of nitrogenous fertilizers and also reduced the cost of production. The reduction percentage (25 and 50%) of nitrogenous fertilizers had no significant difference on sugarcane yield (t/ha). Besides this, twenty *Trichoderma* isolates were molecularly identified by ITS region sequencing and submitted nucleotide sequences were allotted with Accession No. MH 150937, MH 151122, MH 151158, MH 155303, MH 151203, MH 156051, MH 156054, MH 156055, MH 156058, MH 156141, MH 156143, MH 156193, MH 156197, MH 156203, MH 161377, MH 156214, MH 156225, MH 156422, MH 156423, MH 156424 by GenBank NCBI. Field experiment was conducted with microbial product of *Trichoderma harzianum* (IkshuTricho) for improving soil health and pokkah boeng disease management.

Effect of bio-stimulator on sugarcane

An exploratory trial on the effect of biostimulator on sugarcane was executed on sugarcane cv CoS 08279 at IISR Main Farm during 2017-2019. The major objective of this exploratory trial was to find out the effect of biostimulator on germination and yield of sugarcane. As per the protocol; different concentrations of biostimulator were applied as cane node treatment and as foliar spray also. Results revealed that higher germination (68.75%) in sugarcane was recorded with the cane nodes treated with low molecular weight biostimulator @ 2.5 ml/litre of water as compared to control (46.5%). Cane nodes dipped with low molecular weight derivative of biostimulator @ 2.5 ml/litre of water + foliar spray with biostimulator @ 2.5 ml/litre of water were found the best for cane yield (78.4 t/ha) followed by 72.3 t/ha with cane nodes dipped in medium molecular weight derivative of biostimulator @ 2.5 ml/litre of water + foliar spray with biostimulator @ 2.5 ml/litre of water; whereas in control, 66.5 t/ha cane yield was observed.

Crop management for enhancing cane productivity and profitability

Validation of cane node technology under farmers' field condition

Experimental results presented in Table 2.7 clearly indicated that, on an average, tillers and millable canes obtained under cane node planting were numerically higher as compared to conventional method of 3 bud setts planting at all the farmers' fields of different sugar factory zones of Uttar Pradesh. Number of tillers and millable canes recorded under cane node & conventional methods of planting were 104 & 98 (000/ha); 176 & 158 (000/ha), 183 & 187 (000/ha) and 82 &73 (000/ha); 120 & 105 (000/ha); 118 & 120 (000/ha) in East, Central and Western sugar factory zones, respectively. Mean values of all the above characters for three sugar factory zones clearly showed that number of tillers and population of millable canes under cane node planting were higher to the tune of 4.05% and 8.08%, respectively as against conventional method of planting. Ratoon Cane yield obtained in different farmers' fields of all the three sugar factory zones exhibited almost the same trend as that of number of tillers and millable canes as reported above. On an average, the ratoon cane yield of 80.83 t/ha obtained under cane node planting from all the three sugar factory zones was higher by 7.49% than that of conventional method of planting (75.20 t/ha). The technology of sugarcane planting by cane node method is becoming popular among sugarcane farmers in the state since it gives not only good cane and ratoon yield but also saves precious seed cane planting material and thereby reduces cost of cultivation. Sugarcane farmers are also preferring this technology and using it for rapid multiplication of newly released varieties of sugarcane.

Developing sugarcane based integrated farming system models for small farm holders of sub-tropical India

The field experiment is under progress on Sugarcane based Integrated Farming System including different components of agriculture *viz.*, horticulture (banana, papaya, and *karounda* planting), bee-keeping and intercropping systems with the objective to develop integrated farming system models for small farm holders. Allocation of farm land was kept to meet minimum essential annual requirements of food and fodder of a household with 7 family members and overall improvement in livelihood. Impact of different treatments on growth, yield and juice quality parameters of sugarcane was observed. During the period under report, the most profitable sugarcane, banana and papaya based intercropping systems were identified. Modules of bee-keeping and mushroom cultivation were developed.

Autumn planted sugarcane-based systems

During the autumn season, thirteen cropping systems *viz.*, Sugarcane (Sole) CoPk 05191, Sugarcane + Potato (Kufri Chandramukhi), Sugarcane + Pea (Azad P 3), Sugarcane + Maize (VMH-174), Sugarcane + French bean (Arun), Sugarcane + Broad bean (SWS 1 White), Sugarcane + Fenugreek (Rajendra Kranti), Sugarcane +

Table 2.7. Number of tillers, number of millable canes and cane yield obtained under cane node and conventional planting techniques in different sugar factory zones of Uttar Pradesh (2018-19)

Sugar factory zone/village/ farmer	Tillers (000/ha)		Millable canes (000/ha)		Cane yield (t/ha)	
	Cane node	Conventional	Cane node	Conventional	Cane node	Conventional
(A) Hata (East U.P.)						
(1) Village : Chetawna Patti						
(i) Shri Ram Kripal Rai	116	109	94	70	78.40	62.50
(ii) Shri Bhanu Pratap	85	75	65	63	59.30	52.31
Mean	101	92	80	67	68.85	57.41
(2) Village : Doomari Malav						
(i) Shri Inder Dev	109	106	84	78	74.52	66.95
(ii) Shri Surendra Singh	105	99	81	77	68.61	63.70
Mean	107	103	83	78	71.57	65.33
Mean of Eastern U.P.	104	98	82	73	70.21	61.37
(B) Biswan (Central U.P.)						
(1) Village : Benwaria						
(i) Shri Surya Prasad	181	160	119	104	95.30	85.40
(ii) Shri Hare Ram	184	158	116	103	94.50	88.59
Mean	183	159	118	104	94.90	87.00
(2) Village : Karipur						
(i) Shri Chandra Mohan	170	155	124	109	90.42	85.50
(ii) Shri Khusi Ram	165	158	117	102	88.35	82.30
Mean	168	157	121	106	89.39	83.90
Mean of Central U.P.	176	158	120	105	92.15	85.45
(C) Ramala (West U.P.)						
(1) Village : Kirthal						
(i) Shri Rishi Pal	180	185	119	120	82.30	83.28
(ii) Shri Yash Pal	172	179	108	117	78.61	75.29
Mean	176	182	114	119	80.46	79.29
(2) Village : Loomb						
(i) Shri Nain Pal	190	195	125	121	82.28	80.28
(ii) Shri Daryal	188	188	119	118	77.26	76.26
Mean	189	192	122	120	79.77	78.27
Mean of Western U.P.	183	187	118	120	80.12	78.78
Mean of Uttar Pradesh	154	148	107	99	80.83	75.20

Garlic (Polish White), Sugarcane + Coriander (CO 2), Sugarcane + Lentil (PL 639), Sugarcane + Turnip (Purple Top Sultan), Sugarcane + Radish (Clear White), Sugarcane + Sugar beet (LS 6) were tested and respective yield and economic gain were analysed. From the result, it is evident that intercropping of autumn sugarcane + fenugreek fetched the highest net income of ₹ 6,04,820 (Fig. 2.2). The next best treatment was observed to be Sugarcane + Garlic (net income ₹ 5,93,088/ha). The other intercropping systems found highly remunerative are, Sugarcane + Coriander (net income ₹ 4,90,309/ha), Sugarcane + French bean (net income ₹ 3,11,600/ha) and Sugarcane + Maize (net income ₹ 3,59,206/ha). The net income from sole sugarcane was observed to be ₹ 1,61,461/ha. The results clearly indicate that autumn sugarcane based intercropping systems hold promise in increasing the net income of 2-3 times to the sole sugarcane. The above systems were also recorded for the higher cane equivalent ratio (123.7 to 248.8 t/ha) and B:C ratio (2.47 to 4.89).

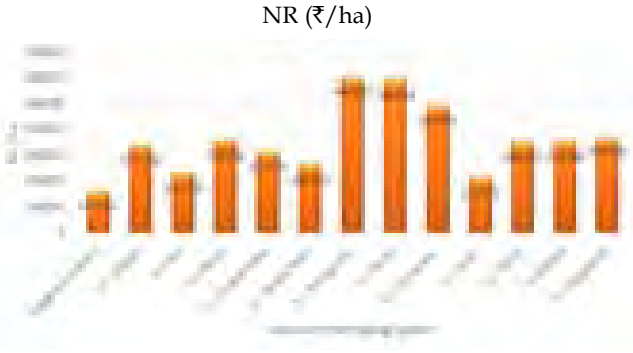


Fig. 2.2. Net return (₹/ha) of autumn sugarcane based intercropping systems (2018-19)

Spring planted sugarcane-based systems

Spring season experimentation also comprised of thirteen cropping systems *viz.*, Sugarcane (Sole)- CoPk 05191, Sugarcane + Bitter gourd (F1 Hybrid), Sugarcane + Bottle gourd (Shakti 201), Sugarcane + Sponge gourd (Shakti 801), Sugarcane + Pumpkin (Chakor), Sugarcane

+ Cucumber (Rohini), Sugarcane + Ladies Finger (Sunanda), Sugarcane + Cowpea (Chitra Lobia), Sugarcane + Green gram (Virat), Sugarcane + Black gram (Urd Black Classic), Sugarcane + Sunflower (Sunlight), Sugarcane + Maize (VMH 150), Sugarcane + Onion (Agri-found Light red) were tested and respective yield and economic gain were analysed. Spring Sugarcane + Onion recorded for the highest net income of ₹ 4,28,005/ ha (Fig. 2.3). The next best treatment was observed to be Sugarcane + Maize (net income ₹ 3,22,446/ha), Sugarcane + Ladies Finger (net income ₹ 2,41,763/ha), Sugarcane + Green gram (net income ₹ 1,93,994/ha). The net income from sole sugarcane was ₹ 1,43,506/ha. Spring sugarcane based intercropping systems also hold promise in increasing the net income as compared to sole sugarcane. The above systems also recorded higher cane equivalent ratio (109.4-187.3 t/ha) and B:C ratio (2.13 to 3.64).

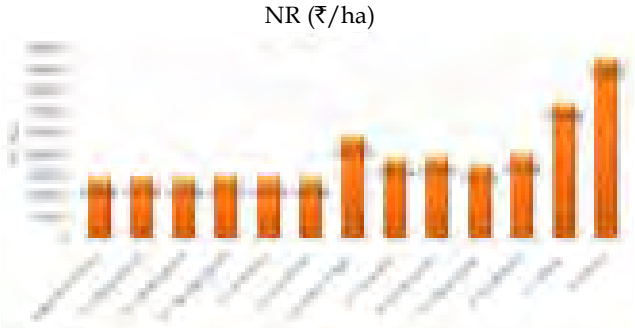


Fig. 2.3. Net return (₹/ha) of spring sugarcane based intercropping systems (2018-19)

Horticultural crop-based systems

Under Banana-first ratoon crop, net profit of ₹ 2,26,124/ha was recorded (Fig. 2.4). The banana based systems also recorded higher B:C ratio (2.28 to 2.34). The papaya crop was intercropped with brinjal, onion, radish, French bean, broad bean, fenugreek and dill (*soa*). The intercropping of fenugreek recorded the highest profit (₹ 4,58,714/ha). The next best treatment was Papaya + Onion (Net return ₹ 4,02,877/ha). Intercropping of Papaya + Dill recorded net return of ₹ 2,89,287/ha (Fig. 2.5). The *Karounda* (*Carrissa carandas*) planted along with the field boundary produced 58 kg of fruit.

Fig. 2.4. Net return (₹/ha) of banana based intercropping system (2018-19)

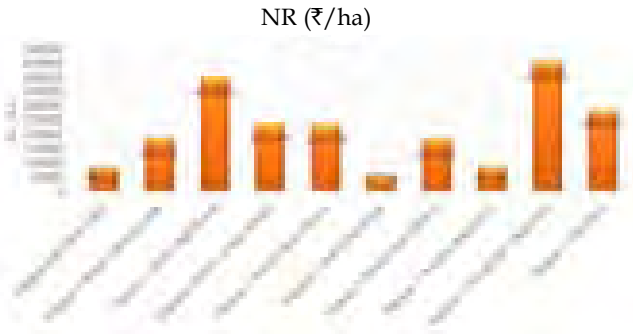


Fig. 2.5. Net return (₹/ha) of papaya based intercropping system (2018-19)

Other farming components

Apiculture (Bee-keeping): Under apiculture farming, two jangistrat type (*Apis Mellifera*) boxes were maintained and 15.5 kg of honey was produced.

Mushroom cultivation: Under mushroom farming, 12 kg oyster mushroom was produced.

Farming systems developed

1. Agri (0.8 ha)- horti (0.2) system (Net income: ₹ 5,63,056)
2. Agri (0.8)-api (0.1) system: (Net income ₹ 4,86,856)
3. Agri (0.8)-mushroom farming (0.1): (Net income ₹ 4,84,856)
4. Agri (0.8)-horti (0.2)- api system: (Net income ₹ 5,66,056)
5. Agri (0.8)- horti (0.1)- mushroom farming (0.05): (Net income ₹ 5,24,456)
6. Agri (0.8)-api- mushroom farming (0.2): (Net income ₹ 4,87,856)

Effect of tillage and management practices on rice-wheat-sugarcane-ratoon-wheat under Conservation Agriculture (CA) system

A field experiment to assess the effect of conservation agriculture practices on the productivity and profitability of sugarcane- based production system and on the soil quality parameters was initiated during June 2017. The experiment comprises of 24 treatments in split-split plot design with three replications. In main plot, four treatments *viz.*, Conventional tillage without crop residue; Conventional tillage with crop residue incorporation; Zero tillage without crop residue; Zero tillage with crop residue retention; in sub plot, two treatments *viz.*, with and without brown manuring and in sub-sub plot, three treatments *viz.*, recommended dose of nitrogen of the crop (RDN), 75% of RDN and 125% of RDN. In "Brown Manuring" practice, *Sesbania* seeds were sown in rice field, and knocked down after 25 days

of sowing with the application of 2, 4-D ester @ 0.50 kg *a.i.*/ha. The experimental soil was sandy loam with pH 7.4, low in organic carbon (0.44%) and available nitrogen (174.36 kg/ha) and medium in available P_2O_5 (10.83 kg/ha) and high in available K_2O (339.68 kg/ha). The observations on soil microbial activity, soil microbial biomass carbon and other biological parameters were recorded before sowing of crop. This is the first year of experimentation, the experiment is progressing well and observations on growth and yield parameters of the crops are being recorded as per schedule.

Brown manuring in rice and different nitrogen doses recorded significant improvement in production of effective tillers and 1000 grain weight in rice and wheat. The highest grain yield of 3.79 and 4.07 t/ha in rice and wheat, respectively was produced with conventional tillage as compared with zero tillage (3.71 and 3.95 t/ha in rice and wheat, respectively). Crop residue (previous crop) management treatment in wheat recorded enhanced grain yield (4.19 t/ha) to the tune of 9.4 per cent over without crop residue management (Table 2.8). Application of 125% recommended dose of nitrogen (RDN) in rice and wheat produced maximum effective tillers (294 and 227) in per meter square area in rice and wheat, respectively, which was significantly superior over 100% RDN and 75% RDN.

Data depicted in Table 2.8 & 2.9 reflect that different tillage practices significantly influenced the tiller number, NMC and yield of sugarcane. However, numerical increase in cane yield was only 2.8% in conventional tillage (65.44 t/ha) over zero tillage (61.67 t/ha) with crop residue management. Crop residue management (retention/incorporation of crop residue of rice and wheat) treatment recorded increase in cane yield to the tune of 21.86% over without crop residue management. Application of different dose of nitrogen and brown manuring in system was statistically at par as far as NMC and yield of sugarcane is concerned. However, production of tillers in sugarcane was statistically significant with application of different dose of nitrogen. The maximum tiller production (88.7 thousand/ha at 120 DAP) was recorded with 125% RDN followed by 100% RDN and 75% RDN.

Table 2.9. Effect of tillage and management practices on yield of rice, wheat and sugarcane

Treatment	Rice	Wheat	Sugarcane
Conventional tillage with crop residue incorporation	3.81	4.31	64.442
Conventional tillage without crop residue	3.77	3.82	52.889
Zero tillage with crop residue retention	3.70	4.06	62.673
Zero tillage without crop residue	3.71	3.84	51.426
CD (P=0.5)	NS	0.0634	7.631
Brown manuring in rice	3.93	4.1	59.897
Without Brown manuring	3.56	3.91	55.819
CD (P=0.5)	0.0670	0.0448	NS
75% of Recommended dose of nitrogen (RDN)	3.48	3.83	54.271
100% RDN	3.80	4.02	58.503
125% of RDN	3.96	4.17	60.799
CD (P=0.5)	0.0821	0.0549	NS

Biology and management of binding weed *Ipomoea* spp. in sugarcane

Weeds adversely impact the sugarcane crop in a number of ways. A significant reduction in yield occurs if weeds are not controlled, as they compete with the sugarcane crop for nutrients, sunlight and moisture. Other weeds, such as vines, climb over and entangle themselves with the sugarcane crop, making harvesting difficult and reducing product quality. Some weeds may

Table 2.8. Effect of tillage and management practices on yield attributes of rice, wheat and sugarcane

Treatments	Rice		Wheat		Sugarcane	
	No. of effective tillers/m²	1000 grain wt. (g)	No. of effective tillers/m²	1000 grain wt. (g)	Number of tillers (120 DAP) (000/ha)	NMC (000/ha)
Conventional tillage with crop residue incorporation	286	23.29	224	36.04	90.4	75.9
Conventional tillage without crop residue	280	23.20	216	35.19	78.6	65.0
Zero tillage with crop residue retention	279	22.74	220	35.23	87.2	71.1
Zero tillage without crop residue	281	22.82	215	35.01	73.1	65.0
CD (P=0.5)	NS	NS	3.95	0.19	0.101	3.069
Brown manuring in rice	287	23.33	222	35.79	83.8	71.8
Without Brown manuring	276	22.69	215	34.96	80.8	66.7
CD (P=0.5)	4.283	0.099	4.08	0.11	NS	NS
75% of Recommended dose of nitrogen (RDN)	264	22.72	207	34.94	75.8	65.0
100% RDN	286	23.07	223	35.44	82.5	68.8
125% of RDN	294	23.24	227	35.73	88.7	73.9
CD (P=0.5)	5.253	.121	3.50	0.16	0.088	NS

also release compounds that are toxic to sugarcane growth. Weed causes reduction in sugarcane yield ranging from 12 to 72%, if not controlled at critical stages. Studies conducted worldwide have shown the yield losses due to binding weeds range from 20-25%. To control these binding weeds, we must understand biology and growth behaviour of these plants. Considering all the facts, one pot experiment entitled growth behaviour of *Ipomoea* as influenced by different dates of sowing has been conducted as given below:

Effect of different dates of sowing on the growth behaviour of *Ipomoea* sp.

On germination : Germination of any plant seed is governed by several factors but among them, temperature, moisture and air play a vital role. The February sown seeds took longer time to germinate than the rest of month sown seeds. The possible reasons could be the low temperature. February sown seeds took 10 days to complete the germination while other treatments took only five days to germinate (Table 2.10).

Table 2.10. Days taken to germination

Sr. No.	Date of sowing	Days taken to germination
1	15/02/2018	10
2	15/03/2018	5
3	15/04/2018	5
4	15/05/2018	5
5	15/06/2018	5
6	15/07/2018	5
7	15/08/2018	5

On plant height: Time of sowing affected the plant height of *Ipomoea spp.* and it was found that at 60 days after sowing (DAS), May sown seeds recorded significantly higher plant height than February, March, April and August sown seeds but it was at par with June and July month sowing. April sown seeds showed maximum plant height during rest of the growing period. It was statistically superior to February, March, June, July and August sown seeds but at par with May sowing 90 DAS, while at 120 DAS, 150 DAS and harvesting stage, it was superior to rest of the treatments. It was also observed that the least plant height was recorded in the August sown seeds (Table 2.11).

Table 2.11. Effect of date of sowing on plant height (cm)

Date of sowing	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
15/02/2018	90.93	178.6	389.56	405.86	424.33
15/03/2018	191.80	192.33	400.10	493.76	495.53
15/04/2018	206.00	377.00	420.56	582.00	588.53
15/05/2018	254.90	339.76	375.10	388.43	411.13
15/06/2018	240.47	304.90	369.56	382.10	403.00
15/07/2018	243.10	269.00	289.10	329.46	365.10
15/08/2018	125.86	236.00	254.00	292.76	292.76
C.D.	41.41	56.81	76.81	69.66	47.39

On dry matter accumulation : Dry matter accumulation shows the production potential of particular plant. In the present pot experiment, it was observed that sowing period significantly affected the dry matter accumulation at 60 and 120 DAS while at rest of growing season, it was non-significant. At 60 DAS, March sown pots observed maximum dry matter accumulation and it was superior to pots sown from April to August but at par with February sown pot. February sown pots accumulated maximum dry matter at 120 DAS, 150 DAS and harvesting stages due to prolonged growing period whereas, it was statistically superior to pots sown from April to August only at 120 DAS. The least dry accumulation was recorded in August sown pots throughout the growing season (Table 2.12).

Table 2.12. Effect of date of sowing on dry matter accumulation (g/pot)

Date of sowing	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
15/02/2018	56.267	178.400	229.333	341.500	255.133
15/03/2018	89.167	165.000	196.467	283.367	238.267
15/04/2018	42.267	137.900	154.433	186.433	181.100
15/05/2018	35.133	108.933	123.133	181.100	174.100
15/06/2018	29.067	107.600	116.233	165.533	152.033
15/07/2018	19.767	71.533	37.800	63.700	62.167
15/08/2018	19.700	60.200	19.867	62.833	62.833
C.D.	41.234	NS	69.057	NS	NS

On root length: Root length was measured using destructive procedure in the present experiment. It was observed that February sown pot recorded the longest root length during entire growing period. It was statistically superior to July and August sown pots at 60 DAS, May, June, July and August sown pots at 90 DAS and 120 DAS, and from April to August sown pot at 150 DAS and harvesting stage. February sown pot remains statistically at par with March sown pot. Minimum root length was measured in August sown pot during whole season (Table 2.13).

Table 2 .13. Effect of date of sowing on root length (cm)

Date of sowing	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
15/02/2018	48.33	76.33	90.77	92.33	114.23
15/03/2018	42.00	63.80	77.23	81.90	97.23
15/04/2018	41.00	56.93	74.23	79.10	86.67
15/05/2018	38.87	49.43	68.90	74.57	84.00
15/06/2018	33.57	45.00	48.53	72.23	80.57
15/07/2018	30.10	24.10	27.63	31.23	31.23
15/08/2018	16.23	21.87	26.67	27.90	27.90
C.D.	14.63	18.78	21.13	38.19	20.12

On leaf area : Leaf area indicates the light absorbing capacity of the plant. It was observed that March sown pots recorded maximum leaf area and was superior to rest of all the treatments at 60 DAS, while at 90 DAS and all growth stages, the maximum leaf area was recorded in February sown pots. Moreover, at 90 DAS February

sown pots were statistically superior to pots sown from June to August but remains at par with March to May sown pots. At other growing stages such as at 120 DAS, February sown pot was at par with March to June sown pots but higher than July and August sown pots and at 150 DAS and harvesting. July and August sown pots were significantly lower than rest of the treatments. Least leaf area was measured in July and August sown pots due to less time for vegetative growth (Table 2.14).

Table 2.14. Effect of date of sowing on leaf area (cm^2)

Date of sowing	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
15/02/2018	185.30	2,907.200	2,817.000	2,831.866	3,111.400
15/03/2018	1,157.00	2,797.267	2,690.267	2,803.333	3,099.566
15/04/2018	833.30	2,337.833	2,505.500	2,461.000	2,997.300
15/05/2018	646.13	2,270.167	2,466.333	2,354.233	2,778.200
15/06/2018	477.97	2,033.867	2,196.233	2,273.167	2,710.400
15/07/2018	374.27	326.000	230.667	270.200	268.800
15/08/2018	176.90	228.500	226.867	184.933	257.867
C.D.	207.95	867.129	753.826	1,006.723	585.437

On seed yield: There are numerous factors responsible in increase or decrease of seed yield of any plant. February sown pot yielded maximum grain yield pot as well as per plant basis followed by March to June sown pot (Table 2.15). The July and August sown pots did not give even any grain yield. The highest grain yield in February sown pot might be due to prolonged growing season, more dry matter accumulation, leaf area *etc.*

Table 2.15. Effect of date of sowing on seed yield (g)

Date of sowing	g/pot	g/plant
15/02/2018	60.23	19.20
15/03/2018	50.50	16.83
15/04/2018	40.73	13.63
15/05/2018	40.33	13.43
15/06/2018	39.10	13.00
15/07/2018	0.00	0.00
15/08/2018	0.00	0.00
C.D.	NS	NS

Sustainable water uses through tillage, planting system, companion cropping, and other profitable crop husbandry practices

Synchronizing nutrient supply with crop demand under drip fertigation for up scaling nutrient use efficiency in sugarcane (plant) - ratoon system

A field experiment was conducted during 2018 - 2019 to assess the effect of split application of NPK under drip fertigation on plant and succeeding ratoon sugarcane cane productivity. The experiment comprising of seven treatments was laid out in RBD with four replications. One additional replication (R_5) was kept exclusively to study the weed dynamics under drip fertigation trial. The soil of the experimental field was low in OC and medium in NPK. Paired planting (120:30 cm) of sugarcane variety CoLk 11206 was done in trenches on February 8, 2018. Results revealed that the most of the growth and yield parameters of sugarcane were influenced significantly by different treatments (Table 2.16). The germination ranged from 25 to 58% in different treatments. Germination % was higher in the treatments where drip fertigation was given over conventional method. Number of tillers were significantly lower in conventional methods of fertilizer application + surface irrigation in comparison to the most of the drip fertigated treatments. T_4 & T_7 where 100% RDF of NPK was given by drip irrigation, gave higher no. of tillers/ha (1.9 lakh/ha). 50% and 75% reduced doses of RDF given through drip were statistically at par with conventional methods (T_7) in number of tillers/ ha. Similarly, higher number of shoots was reported in the T_4 & T_7 where entire recommended doses of NPK was given under drip fertigation. T_1 & T_6 being at par gave significantly lower number of shoots over rest of the treatments. Conventional methods (T_1), 75% & 50% RDF of NPK (T5, T6) gave statistically lower NMC over rest of the treatments. However, the NMC/ha did not

Table 2.16. Effect of different treatments on sugarcane growth, yield attributes, yield and weed biomass

Tr. No.	Treatments details	Germination (%)	Tillers (000/ha)	Shoot (000/ha)	NMC (000/ha)	Yield (t/ha)	Height (cm)	Girth (cm)	Per cane wt (g)	Weed dry wt (kg/ha)
T_1	Conventional*	25.98	148.2	120.3	103.4	70.33	198	2.15	0.715	1108
T_2	N through drip + PK basal	57.43	165.7	138.6	117	85.10	222	2.4	0.788	972
T_3	NP Drip + K basal	57.7	173.8	141.4	117.4	84.77	231	2.29	0.792	866
T_4	100% NPK drip	58.55	187.9	160.5	123.5	96.43	237.5	2.48	0.810	732
T_5	75%NPK drip	58.13	154.1	117.7	101.6	76.35	211	2.32	0.787	864
T_6	50% NPK drip	57.93	146.3	104.6	88.01	68.57	206.3	2.26	0.763	1096
T_7	100% NPK through drip**	58.83	190.3	164.2	122.2	95.92	238.3	2.42	0.793	780
	C.D.	4.46	18.70	9.0	7.77	10.86	22.62	0.22	0.07	-

*1/3 RDF of N & full PK was applied at sowing; rest 2/3 N was applied in two equal splits + surface irrigation

**In ratoon cane, 10% higher RDF of NPK will be provided.

differ significantly due to different timing & way of fertilizer applied under the treatments No. 2, 3 and 4. Cane yield was significantly higher in T_4 & T_7 where all the RDF of NPK was applied in splits under drip irrigation. But the 50 and 75% RDF of NPK (T_5 & T_6) applied through drip were statistically at par with conventional methods (T_1). Although per cane weight was higher in drip fertigated treatments but no significant difference was observed among the treatments. Cane girth ranged from 1.99 to 2.48 cm in different treatments. T_2, T_4 and T_7 gave significantly higher cane girth over conventional method. The highest Brix, sucrose % and purity % was reported in the T_4 & T_7 while it was lower in case of T_6 (Table 2.17). There was 35% less irrigation water was applied in drip treatments over conventional methods.

Wide variation was reported in weed dry weight among the different treatments (Table 2.16). Weed dry weight was the highest in conventional methods of sugarcane cultivation. Higher dry weight of weeds (1108 kg/ha) was recorded in conventional methods of fertilizer application and surface irrigation. It was observed that the T_4 and T_7 treatments where 100% RDF of NPK was given by drip-irrigation, the weed infestation was lower. It appears that small quantity of different spilt doses of fertilizer applied in the root zone of the crop under drip fertigation might have favoured the sugarcane plant to absorb the nutrients more efficiently leaving little amount/or no amount available to the weeds which might have disfavoured the weeds' growth and resulted in lower dry weight. This might be responsible for increase in different growth and yield attributes of sugarcane plant reported in this experiment under different drip fertigated treatments over conventional methods.

Assessment of impact of climate change on sugarcane productivity

Finding of climate change impact on rainfall has been depicted in Fig. 2.6. Under the study, two long-term normal (30 years average) were studied. The first normal was for the period of 1956 to 1985 and second normal for the period of 1986 to 2015. The study revealed

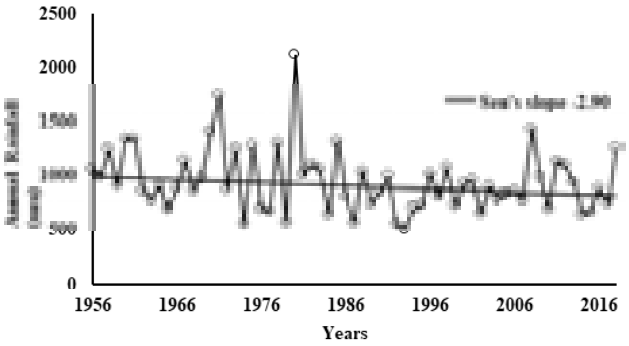


Fig 2.6. Decreasing trend in annual rainfall (From 1956 to 2018)

that 87% of the total annual rainfall was received during the monsoon months (June to September) while 9.4 and 3.6% rainfall was received during the post-monsoon (October to February) and pre monsoon months (March to May), respectively. The rainfall occurrence probabilities revealed that standard meteorological week number 26 to 37 have more that 50% probabilities of going to wet. Rainfall was declined in all the months except four non rainy season months (January, February, April and December) in comparison to the two normal. The maximum rainfall decline was recorded in August (84.2 mm). The decrease in August month rainfall was reflected in increase of minimum and maximum temperature by 0.31 and 0.7 °C as compared to the first normal. The time series data of weather attributes from 1956 to 2018 was studied by Man-Kendall trend test to study the long term trend of weather attributes on monthly, seasonal and annual basis. Study showed the significant increasing trend in minimum temperature in February, March and December. The seasonal minimum temperature showed significantly increasing trend in summer and winter season which was also reflected by average annual minimum temperature with a Sen's slope of 0.01°C. The maximum temperature showed significantly decreasing trend in January and May whereas, August showed significantly increasing trend. Winter season maximum temperature decreased significantly. The minimum temperature during the winter season recorded significantly increasing trend at one side and another side the maximum temperature

Table 2.17. Quality parameters as influenced by different treatments

Treatment	Brix (%)	Sucrose (%)	Purity	O.C. (%)	SMBC (mg CO_2-C/ kg soil/ day)	SMBN (mg NH_4- N/ kg soil/ day)
Conventional	19.51	17.07	87.44	0.32	146	4.10
N through drip + PK basal	19.57	17.12	87.50	0.34	189	4.23
NP Drip+ K basal	19.55	17.25	88.24	0.36	178	4.18
100% NPK drip	20.12	18.23	90.60	0.37	220	4.35
75%NPK drip	19.56	16.95	86.64	0.35	150	4.15
50% NPK drip	19.17	16.54	86.31	0.30	136	3.88
100% NPK through drip	20.10	17.89	89.00	0.36	230	4.36
CD	0.61	0.74	1.61	0.012	6.06	0.21
Initial	-	-	-	0.28	118	3.69

recorded decreasing trend. The morning relative humidity showed significantly increasing trend from January to July and October to November. The increasing trend was also found in the afternoon relative humidity, during January to March, July and October to December. The average annual R.H. of morning and afternoon recorded Sen's slope of 0.12 and 0.10. The significantly decreasing trend was recorded in monsoon and total rainfall. The monthly rainfall of August showed significantly negative trend. Reduction in rainfall during August was resulted by significantly decreasing trend in total number of rainy days. The highest average monthly evaporation was recorded during the month of April (8.36 mm/day) and the lowest was recorded during the month of December (1.61 mm/day). The significant reduction in an average evaporation was recorded during the month of January to May, July and from October to December. However, increasing trend in evaporation was found during August. This trend was also reflected in seasonal and annual trend. The maximum wind speed was found during the month of April (4.86 km/h) and minimum during the month of November (1.47 km/h). Wind speed showed significantly negative trend during January, April to May, July to September and in November. The season and annual study of wind speed also showed significantly negative trend in all the seasons and at annual level. It was found that the highest BSS recorded during the month of May (9.29 hrs/day) and the lowest during August (5.50 hrs/day). Significantly negative trend was recorded during the months from January to March, July and November to December.

Impact of integrated application of organics and inorganics in improving soil health and sugarcane productivity

The significantly highest rate of sprouts (93.4%) was observed under the treatment of only organic matter application along with FYM. The highest number of tillers (180.2 thousand/ha at 120 days after planting), shoot count (175.6 thousand/ha at 180 DAP), number of millable canes (120.5 thousand/ha), cane yield (84.20 t/ha) and sugar yield (10.55 t/ha) were recorded under the treatment where application of FYM @ 20 t/ha was done along with soil test (rating chart) based inorganic fertilizer recommendations. However, it was found comparable to the treatment of FYM @ 10 t/ha along with biofertilizer and soil test based inorganic fertilizers application. The yield attributing characters *viz.*, cane length (220.60 cm), cane girth (2.30 cm) and weight of individual cane (1.10 kg) were recorded significantly highest with the application of FYM @ 20 t/ha along with inorganic fertilizers applied on the basis of soil test rating chart. The quality parameters *viz.*, Brix value and pol % were significantly improved with application of FYM and biofertilizers. The soil health indicators *viz.*, bulk density (1.27 M/m^3), infiltration rate (4.64 mm/hr) and soil organic carbon (0.47%) showed positive responses with the application of organic manure in the system.

Response of elite genotypes of sugarcane (early) at higher fertility level and at wider spacing

The findings revealed that germination % was significantly higher in Co 0238 over CoS 13231 and CoJ 64. The two spacings did not have significant effect on germination %. Similarly, significantly higher (20.48%) number of tillers were obtained in the genotype Co 0238 sown at 90 cm over CoS 13231 sown at same distance. But shoot and NMC count (000/ ha) were significantly higher in the genotype CoS 13231 sown at 90 cm row spacing in comparision to the rest of the two genotypes sown at both the spacing. The shoot and NMC count were significantly lower at 120 cm spacing over 90 cm spacing in all the three genotypes. Significantly higher cane yield (104.0 t/ha) was reported in Co 0238 sown at 90 cm over CoS 13231 and CoJ 64 sown at same spacing. Further, the genotype CoS 13231 and Co 0238 gave significantly lower cane yield at 120 cm row spacing over the 90 cm spacing. Cane length, cane girth and cane weight were higher in Co 0238 than the remaining two genotypes.

In general, higher values of different quality parameters were recorded at 10 months stage over 8 months stage. But corrected brix, sucrose % and purity coefficient measured at 8 and 10 months stage did not differ in any of the genotypes sown at different spacing. CCS % and CCS yield (t/ha) at 8 and 10 months stage also showed the similar pattern as reported for other quality parameters.

Response of elite genotypes of sugarcane (mid-late) at higher fertility level and at wider spacing

Growth and yield of the different genotypes showed wide variations. The germination % ranged from 12.51 to 33.04 in different genotypes. Higher germination % was obtained in the genotype CoLk 13204 (33.04), CoH 13263 (29.39) while lower germination % (12.51) was recorded in genotype CoPant 97222. Similar trend was recorded in number of the tillers/ha. The genotypes CoLk 13204 and CoH 13263 were also superior for number of shoots and NMC count over all the genotypes. The lowest shoot number (88.44 thousand/ha) was recorded in CoPb 13182 at 120 cm spacing. The genotype CoLk 13204 gave the highest yield (84.76 t/ha) at 90 cm spacing followed by the same genotype planted at 120 cm spacing (68.49 t/ha). The higher yield of CoLk 13204 was mainly attributed to its higher number of NMC/ha.

The different quality parameters also showed significant variability among different genotypes. Brix % varied from 17.3 to 21.07% at 10 months stage and 18.87% to 20.72% at 12 months stage in different genotypes. The sucrose content at 10 months stage ranged from 14.13% to 18.48% and higher sucrose containing genotypes were CoH 13263, Co 13035, CoPb 13182 *etc.*, while the genotype CoLk 13204 showed the lowest sucrose content among all genotypes at both the stages. Significant variations in purity coefficient were recorded in different genotypes at 10 months stage but there was no significant variation among genotypes at 12 months stage.

The CCS % and CCS yield (t/ha) at 10 months stage were lower in comparison to these values recorded at 12 months stage in different genotypes. At 12 months stage, higher CCS % containing genotypes were Co 13035, CoH 13263, CoLk 13204, CoPant 97222, CoPb 13182, while lower CCS % was recorded in CoS 767 planted at 90 cm and CoLk 13204 planted at 120 cm spacing.

Almost all the genotypes included in this trial showed significant reduction in different growth, yield attributes and yield at wider (120 cm) spacing in comparison to the 90 cm row spacing. There were 13.66 and 8.33% lower cane and CCS yield, respectively at 120 cm spacing over 90 cm. CCS (t/ha) at 10 and 12 months stage was higher in CoLk 13204 planted at 90 cm row apart than other genotypes tested. At 12 months stage, CoLk 13204 planted at 90 cm row distance gave significantly higher CCS (t/ha) over its 120 cm row distance. CoLk 13204 proved superiority at both the distances over all the genotypes tested in this experiment.

Scheduling irrigation with mulch under different sugarcane planting methods

The field experiment was conducted during second week of February 2018, to enhance crop and water productivity in sugarcane at ICAR-IISR, Lucknow experimental farm. The experiment consisting of twelve treatment combinations, with four planting methods with or without mulch in the main plot treatments *viz.*, 1. Conventional flat planting (75 cm row spacing) with mulch, 2. Conventional flat planting (75 cm row spacing) without mulch, 3. Paired-row trench planting (30:120 cm row spacing) with mulch and 4. Paired-row trench planting (30:120 cm row spacing) without mulch and three irrigation schedules as sub-plot treatments (irrigation 0.60, 0.80 and 1.0. at IW/CPE ratio) was undertaken in split plot design with four replications. The sugarcane variety was CoPk 05191. Two irrigations were applied at the time of planting and 35 days after planting (time of germination) and subsequent irrigations were scheduled on the basis of IW/CPE ratio in the respective plots.

Sugarcane yield varied significantly due to different planting methods and trash mulching. Paired-row trench planting (30:120 cm row spacing) with trash mulching (75.19 t/ha) being at par with conventional flat method of planting along with trash mulching (74.22 t/ha) resulted in significantly higher cane yield than that of conventional flat method of planting with no trash mulching (63.42 t/ha). The higher cane yield under paired-row trench planting with trash mulching was attributed to more number of millable cane (95.92 x 000/ha). The juice quality parameters °Brix, sucrose content and purity per cent, remained statistically at par among all the four methods of planting. The trash application led to higher sugarcane yields, irrespective of irrigation scheduling. The higher cane yield (73.86 t/ha) under irrigation schedule at 0.8 IW: CPE might be attributed to better initial crop growth, higher number of millable cane (92.27 x 000/ha) owing to optimum irrigation frequency with trash mulching at the time of crop establishment. The irrigation schedules at IW: CPE 0.8 recorded 10% and 6.7% higher cane yield compared to 0.6 and 1.0 IW: CPE ratio, respectively. Water use efficiency was found maximum under paired-row trench planting with trash mulching (0.432 t/ha/cm) followed by conventional flat method of planting with trash mulching (0.427 t/ha/cm). The cane yield and water use efficiency can be increased significantly by trash mulching.

ICAR funded agri-consortia research programme on water

Eight sugarcane varieties from early maturing group and eight from mid late maturing group were irrigated with four irrigation treatments. The irrigation treatments were as follows:

M1S1: Irrigation water equal to 100% crop water requirement at 40% depletion of available soil moisture.

M1S2: Irrigation water equal to 100% crop water requirement at 70% depletion of available soil moisture.

M2S1: Irrigation water equal to 75% crop water requirement at 40% depletion of available soil moisture.

M2S2: Irrigation water equal to 75% crop water requirement at 70% depletion of available soil moisture.

Number of millable canes: Number of millable canes (NMC) are significantly influenced by sugarcane varieties. In early maturing group, the highest NMC (103.8 thousand/ha) was recorded for CoPk 05191 followed by CoLk 09202 (79.5 thousand/ha) and CoLk 94184 (63.5 thousand/ha). In mid late maturing variety group, the highest NMC (97.7 thousand/ha) was recorded in CoS 08276 followed by CoS 08279 (93.2 thousand/ha) and CoSe 01434 (92.8 thousand/ha). Different varieties behaved differently under different irrigation treatments (Fig. 2.7 and Fig. 2.8). The highest number of millable canes (55.3 thousand/ha) was

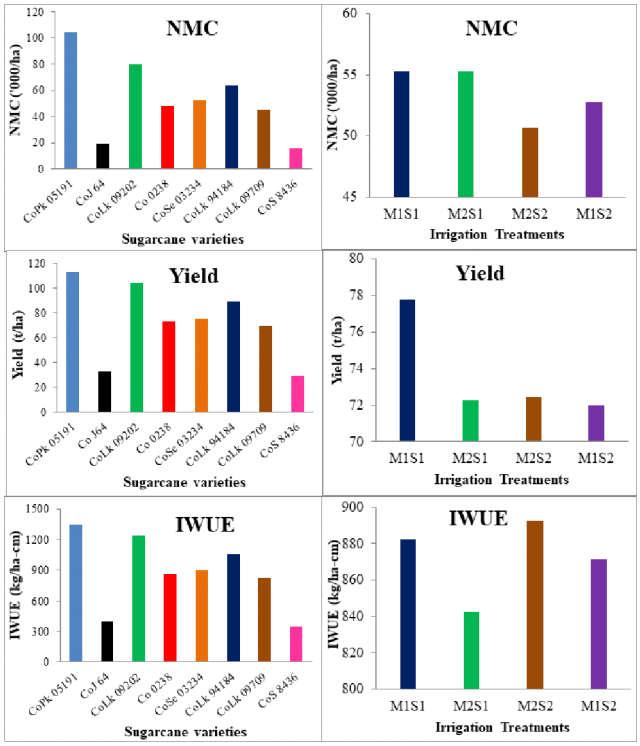


Fig. 2.7. Effect of sugarcane varieties and irrigation treatments on NMC, sugarcane yield and irrigation water use efficiency of early maturing group

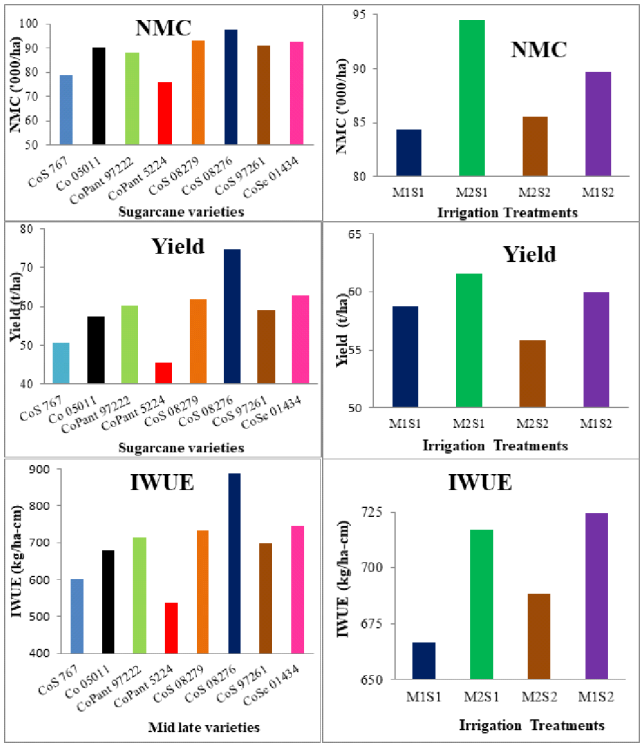


Fig. 2.8. Effect of sugarcane varieties and irrigation treatments on NMC, sugarcane yield and irrigation water use efficiency of mid late maturing group

observed in M1S1 and M2S1 irrigation treatments for early maturing variety group. For mid late maturing variety group, the highest NMC (94.5 thousand/ha) was observed in M2S1 irrigation treatment followed by 89.7 thousand/ha for M1S2 irrigation treatment.

Sugarcane yield: Irrigation treatments and varieties both influenced sugarcane yield. The highest sugarcane yield (113.64 t/ha) was observed for CoPk 05191 in early maturing variety group followed by CoLk 09202 (104.57 t/ha) and CoLk 94184 (89.57 t/ha). In mid late maturing variety group, the highest sugarcane yield (74.85 t/ha) was recorded for CoS 08276 followed by CoSe 01434 (62.86 t/ha) and CoS 08279 (61.76 t/ha). In early maturing variety group, sugarcane yield was the highest (77.76 t/ha) for the M1S1 irrigation treatment whereas for mid late maturing variety group, the sugarcane yield was the highest (61.51 t/ha) for M2S1 irrigation treatment.

Irrigation water use efficiency: Irrigation treatments and varieties both influenced irrigation water use efficiency (IWUE) for sugarcane. In early maturing variety group, the highest irrigation water use efficiency of 1347.75 kg/ha/cm was observed for CoPk 05191 followed by CoLk 09202 (1236.92 kg/ha/cm) and CoLk 94184 (1064.00 kg/ha/cm). In mid late maturing variety group, the highest irrigation water use efficiency (887.50 kg/ha/cm) was recorded for CoS 08276 followed by CoSe 01434 (744.83 kg/ha/cm) and CoS 08279 (732.75 kg/ha/cm). In early maturing variety group, irrigation water use efficiency was the highest (kg/ha/cm) for the M2S2 irrigation treatment whereas for mid late maturing variety group, the irrigation water use efficiency was the highest (724.92 kg/ha/cm) for M1S2 irrigation treatment.

Sustaining sugarcane yield under multiple ratooning through drip irrigation

The experiment was initiated from 4th ratoon. This year 6th ratoon crop was initiated in the first week of February after stubble shaving and interculturing. The crop was being drip irrigated daily and fertigation was done weekly. Recommended dose of fertilizer *i.e.* 200 kg N, 60 kg P_2O_5 and 60 kg K_2O was applied through fertigation in 20 equal doses. Irrigation water was kept equal to pan evaporation. Drip irrigation treatments were provided with irrigation water equal to 0.6 times the pan evaporation, considering 60% surface area of field was wet. Surface treatments were irrigated at IW/CPE ratio equal to 1 and depth of irrigation water was kept at 80 mm. The highest number of millable canes (87.22 thousand/ha) were recorded in surface drip in ring-pit planting method. (105×75 cm) with drip irrigation-fertigation (Table 2.18) followed by surface drip irrigated plots where planting of sugarcane was done in paired

Table 2.18. Cane growth parameters, juice quality parameters, sugarcane yield, irrigation water applied and irrigation water use efficiency

Treatment	Cane stalk diameter at harvest (cm)	Cane stalk length at harvest (cm)	Corrected °Brix	Sucrose (%)	Purity (%)	Juice extraction (%)	NMC ('000/ ha)	Yield (t/ha)	Irrigation water (ha/cm)	IWUE (kg/ha/ cm)
T1 Planting at 75 cm row to row distance with Surface irrigation & recommended fertilizers application in soil	2.41	151.27	20.23	17.29	85.49	55.24	61.10	30.98	112.0	276.61
T2 Planting at 75 cm row to row and at alternate row drip irrigation-fertigation	2.62	171.60	20.38	17.48	85.77	56.57	74.67	56.66	74.7	758.46
T3 Paired row planting under 40×110×40 cm with drip irrigation-fertigation	2.49	176.27	20.04	17.21	85.90	53.66	77.47	60.98	74.7	816.36
T4 Paired row planting under 45×135×45 cm with drip irrigation-fertigation	2.46	164.20	20.16	17.29	85.77	54.10	71.67	61.30	74.7	820.61
T5 Paired row planting under 60×120×60 cm with drip irrigation-fertigation	2.44	186.93	19.62	16.54	84.29	56.06	75.00	63.50	74.7	850.11
T6 Paired row planting under 40×110×40 cm with Sub-surface drip irrigation-fertigation	2.53	181.40	21.00	18.14	86.41	53.34	76.20	61.57	74.7	824.30
T7 Surface drip in Ring- pit planting method (105×75 cm) with drip irrigation-fertigation	2.42	188.33	20.19	17.46	86.50	55.12	87.22	65.08	74.7	871.22
T8 Planting at 90 cm row to row distance with surface irrigation & recommended fertilizers application in soil	2.49	153.93	20.04	16.98	84.74	53.73	59.44	37.49	112.0	334.77
SE±	0.06	3.7	0.21	0.25	0.44	0.89	2.27	1.55		18.57
CD (P=0.05)	NS	6.5	NS	NS	NS	NS	4.00	2.72		32.69

rows spaced at 40×110×40 cm (77.47 thousand). The lowest number of millable canes (59.44 thousand) were recorded in surface irrigated crop planted at 90 cm spacing. The highest sugarcane yield (65.08 t/ha) was recorded in ring-pit planting system. The lowest sugarcane yield (30.98 t/ha) was recorded in surface irrigated crop planted at 75 cm spacing. The highest irrigation water use efficiency (871.22 kg/ha/cm) was recorded in ring-pit planting system. The lowest irrigation water use efficiency (276.61 kg/ha/cm) was recorded in surface irrigated crop planted at 75 cm spacing.

CHAPTER 3

Management of Insect Pests and Diseases

Survey and surveillance of insect pests and diseases of sugarcane in sub tropical India

Insect pests and disease surveys were conducted in command areas of different sugar mills in Uttar Pradesh, Bihar, and Maharashtra.

In Uttar Pradesh: The command area of DSCL Sugar Mill, Loni was surveyed during May and July 2018. Incidence of Pokkah boeng (up to 5%) and smut (up to 10%) was observed in Co 0238. Incidence of red rot (15-20%) in variety Co 0238 was also observed in some fields of village Adampur under Loni Sugar Mills.

The survey was conducted in Command area of Chilwariya Sugar Mill, Bahraich. The sporadic incidence of army worm (*Spodoptera* sp.) (25-30%) was observed in Bahraich. In ratoon crop, top borer was the major problem affecting 20-25% of the shoot. A black beetle (*Heteronychus* sp.) was observed gnawing the basal portion of young shoots and causing dead hearts. Its incidence was wide spread but only around 5-10%.

Chilwariya Sugar Mill, Bahraich; Nanpara Sugar Mill, Bahraich; Hata Sugar Mill, Hata, Bahraich and Hata Sugar Mill, Deoria; four units of DSCL Group (Rupapur, Hariyawan, Loni, Ajbapur), three units of Balrampur Group, Sekseria Sugar Mill, Biswan, Sitapur; Rosa Sugar Works, Rosa; K.M. Sugar Mill, Masodha; Oudha Sugar Mill, Hargaon; Dalmia Chini Mill, Ramgarh; IPL Chini Mill were surveyed.

The incidence of ESB (30.00%), root borer (47.0%), and top borer (33.33%) was observed. A black beetle (*Heteronychus* sp.) was observed gnawing the basal portion of young shoots in Chilwariya Sugar Mill, and Nanpara Sugar Mill area (Fig. 3.1). Sporadic incidence of YLD was observed. High incidence of red rot (20.0%) and Pokkah boeng was noticed in Co 0238, and some old & rejected sugarcane varieties.

A delphacid plant hopper, *Eoeurysa flavocapitata* of sugarcane: During the course of periodic insect pests surveys in sugarcane fields of District, Muzaffarnagar in western Uttar Pradesh, a black Delphacid Plant Hopper, *Eoeurysa flavocapitata* has been observed on sugarcane in *Akheypur* and *Charkheda* villages and UPCSR, Shahjahanpur. The newly emerged nymph is pale green with red eyes (Fig. 3.2) and advanced stage nymphs are black (Fig. 3.3). The general appearance of adults is blackish (Fig. 3.4). Both stages (adult and nymphs) remain concealed in leaf funnel/whorl of sugarcane and suck the plant sap. Some sort of sticky translucent substance honey dew was observed on under surface of newly opened leaves that invited black sooty mould (Fig. 3.5 & 3.6). Under surface of most of the leaves was covered with black sooty mould. Besides the

Fig. 3.1. Sugarcane damage by black beetle

Fig. 3.2. Newly emerged nymph

Fig. 3.3. Nymph with wing pads

Fig. 3.4. Adult Plant hopper

Fig. 3.5. Black sooty mould on under surface of leaf

Fig. 3.6. Cane top affected with black sooty mould

yield loss to the crop, it made the green cane tops unfit for cattle feed.

The incidence of different diseases were monitored by conducting the survey during 2018-19 sugarcane crop season for occurrence of diseases on commercial cultivated varieties in different cane growing areas of Uttar Pradesh (IPL Sugar Chemical, Jarwal, Bahraich; Simbhaoli Sugar Mills, Chilwariya; Balrampur Chini Mill Group; Command area of DSCL group; Dalmia Chini Mill Group; Hargaon Oudha Sugar Mill; Seksaria Biswan Chini Mill, Biswan; Dhuriapar Kisan Sugar Mill Ltd.; Saraya Sugar Mills Ltd., Gorakhpur; Triveni Sugar Mill, Kushinagar and DSCL Sugar Loni, Shahabad, Hardoi).

- Incidence of red rot was noticed in Co 0238, CoSe 95422, CoJ 64, CoS 8436, CoLk 8102, CoS 88230, CoS 95255, CoSe 01424 and CoS 91269.
- In Co 0238, 10% to 55% red rot was noticed in some fields in Uttar Pradesh while in CoSe 95422, CoS 8436, and CoSe 92423, incidence was up to 25 per cent.
- Incidence of smut was observed in CoSe 92423, CoS 88230, CoS 91269 and Co 0238.
- Incidence of GSD (2 to 10 %) was noticed in the most of the field surveyed and in CoS 91269, incidence was 20-30%.
- The incidence of the minor disease Pokkah boeng was higher up to the 25% in the variety Co 0238.

In Bihar: Survey was conducted in command areas of Vishnu Sugar Mills, Gopalganj; Sasa Musa Sugar Mills, Gopalganj; New Swadeshi Sugar Mills, Narkatiaganj, West Champaran; Harinagar Sugar Mills Limited, Harinagar, West Champaran; Majhauliya Sugar Mills, West Champaran; HPCL Biofules Ltd., Suaguli, Bihar and Hasanpur Sugar Mills, Hasanpur, Samastipur. Mainly CoP 06436, BO 91, BO 154 CoP 9301, Co 0238, CoSe 95422, Co 0118, CoLk 94184, Co 0239, BO 130 and CoP 112 are in cultivation.

Trace to low incidence (up to 5%) of top borer, plassey borer, root borer and mealy bug were recorded in different sugar mill areas. *Pyrilla* attack was recorded in variety Co 0238 up to 10% in Harinagar area. In Majhaulia, average whitefly incidence was recorded to the tune of 20-25% in Co 0238 in few fields and up to 80% in CoLK 94184 in one field in Keshavan village. Shoot borer was recorded to the tune of 15-20% in variety Co 0238. Occurrence of top borer, stalk borer, internode borer, pyrilla was in traces. In general crop condition was good in the area surveyed.

Red rot was recorded in varieties namely CoSe 95422, Co 0238, CoP 06436 and BO 130 to the tune of 2-10%, whereas Pokkah boeng was observed in the variety Co 0238 (10-25%) and Yellow Leaf Disease (YLD) was noticed in CoSe 95422, CoP 06436,CoLk 94184, Co 0118, BO 130 and Co 0238

In Maharashtra: During 2018-19, the surveys were conducted at the Biological Control Centre, Pravaranagar, Maharashtra for the seasonal prevalence of major insect-pests and diseases of sugarcane in the command and uncommand area of Dr. Padmashri Vitthalrao Vikhe Patil Sahkari Sakhar Karkhana, Ltd. Pravaranagar. The following major insect-pests and diseases were recorded.

White grub: During the 2018-19, crop growing season, surveys were conducted in different villages including Rajuri, Mamdapur, Tisgaon, Kolhar, Loni, Chinchpur and Durgapur and infestation of white grubs was ranged from 40% to 80% and in some areas, it reached up to 90%. Per clump of sugarcane, an average of about 3-5 grubs were recorded. Grub infestations were recorded from July and it continued up to October. However, maximum cane damage recorded in August to September. Uneven rainfall followed by high temperature in August and September, led to maximum white grub occurrence. The affected sugarcane fields showed severely dried canes which were found easily uprooted.

Early shoot borer: The pest incidence was observed at early stage of sugarcane (3 to 4 months old) crop. Occurrence of dead hearts is characteristic symptoms noticed in the field. On an average, 5% to 15% damage has been seen. Most of the farmers have used green trichocards provided by IISR-Biological Control Centre, Pravaranagar for pest management.

Fall army worm: During survey, the incidence of FAW was observed in one sugarcane field in Village-Fattyabad. Small to large sized caterpillars of FAW was seen on the maize and sugarcane leaves. The infested sugarcane (cv. CoM 265) plot was intercropped with maize (cv. African tall). Newly emerged caterpillars were found to be slightly greenish in colour with black coloured head and as it progress through instars; the body colour was changed to orange and reddish. Mature caterpillar may have marks and spots on its body. The inverted 'Y' sign on head was seen prominently in full grown larva. Four large blackish dots were observed on the dorsal side of second last segment of caterpillars. As a consequence of feeding, the larval excreta were seen on leaves. It was observed that a 10% and 60% infestation has been found in sugarcane and maize crop, respectively. Apart from these major pest incidences, sugarcane was also attacked by other pests such as Internode borer, Pink borer, Woolly aphid, Scale insect, and Pyrilla.

Diseases: 20-25% incidence of YLD was observed in the cultivated sugarcane varieties in the command area of

PDVVPSSK, Ltd. Pravaranagar. Incidence of Pokkah Boeng ranged from 10-15% in the cultivated sugarcane varieties. Incidence of smut ranged from 5-10% on CoM 11081 and CoM 11082.

Developing arthropods based soil health bio-indicators for subtropical sugarcane ecosystem

Community structure of soil arthropods and microflora in sugarcane ecosystem was assessed in relation to nutrient management practices and compared with adjacent non-sugarcane fields at regular intervals. Soil parameters (EC, pH, OC, Available NPK, micronutrients and soil enzyme) were also analyzed in subset of the samples as per standard procedures. Berlese-Tullgren and pitfall methods were used to extract soil arthropods while standard plate culture method was used for microflora assessment.

Around 2,000 specimens isolated/collected from soil and litter samples were identified up to order/family level and preserved for further identification. Acari were the dominant microarthropod followed by Collembola. Mites were represented by three suborders. The cryptostigmata mites were the dominant (75.0%) followed by prostigmata (15.0%) and mesostigmata (10.0%) (Table 3.1).

Among microflora, bacteria were the predominant microbial community in all the samples, with population ranging between 1.6×10^9 and 11.2×10^9 cfu/g soils. The fungal population in the samples was observed to be in the range of 6×10^4 to 36×10^4 cfu/g soil while actinomycetes population varied between 1.2×10^4 cfu/g soil and 8.4×10^4 cfu/g soil. Population of the antagonistic microbes *Trichoderma* and fluorescent *Pseudomonas* was also observed and ranged from 0.8×10^3 to 5.0×10^3 cfu/g soil and 2.2×10^7 to 16.8×10^7 cfu/g soil, respectively.

Development of eco-friendly technologies for the management of termites in sugarcane

Three species of Odentotermes *viz.*, *O. vaishno*, *O. bellahunisensis* and *O. horni* were recorded for the first time from sugarcane.

Artificial diet for termites: Different wood powder, Eucalyptus (*Eucalyptus obliqua*), *Neem* (*Azadirachta indica*), *Sheesham* (*Dalbergia sissoo*), Mango (*Mangifera indica*), *Poplar* (*Populus deltoides*), Teak (*Tectona grandis*), *Jamun* (*Syzygium cumini*), *Kanak Champa* (*Pterospermum acerifolium*), Drumstick (*Moringa oleifera*), *Jungle Jalebi* (*Pithecellobium dulce*) based permutation and combinations have been tried to develop artificial diet for rearing termites in the laboratory. Among these, the diet based on *sheesham* (*D. sissoo*) (15 gm) with agar powder (5 gm) in 250 ml water was found to be better over others for rearing of termites. Termites (workers and soldiers) could survive up to 45 days.

Table 3.1 Arthropod taxa observed during the study

Class	Order	Species/Family
Arachnida	Palpigardi	1 species
	Pseudoscorpiones	1 species
	Araneae	3 species
	Acari	Scheloribetidae, Oppiidae, Epilohmanniidae, Acaronychidae, Ameronothridae, Oribatellidae, Polypterozetidae, Hypochthoniidae, Galumnidae, Hermanniellidae, Oribatulidae, Neoliodidae, Phthiracaridae, Damaeidae, Hermanniidae, Microzetidae, Hypochthoniidae, Tarsenomidae, Erythraeidae, Neophyllobiidae, Bdellidae, Cunaxidae, Stigmaeidae, Rhodacaridae, Cercomegistidae, Uropodidae, Dermanyssidae, Anoetidae
Diplopoda	Polyxena	1 species
	Symphyla	1 species
	Pauropoda	1 species
Insecta	Collembola	Coenaletidae, Acetalidae, Entomobryidae, Orchesellidae, Lepidocyrtidae, Isotomidae, Seiridae, Onychiuridae, Hypogasturidae, Brachystomellidae, Neelidae, Dicyrtomidae, Sminthuridae, Sminthurididae
	Diplura	Campodeidae, Japygidae
	Psocoptera	1 species
	Coleoptera	4 species
	Hymenoptera	Formicoidae (4 species)
	Hemiptera	2 species
	Thysanoptera	1 species
	Lepidoptera	2 species

Evaluation of different anti-protozoan compounds against termites: Different anti-protozoan compounds *viz.*, (Metronidazole; Ornidazole; Tinidazole; Nitazoxanide) were evaluated for their effect on termites under laboratory condition using artificial diet and > 90% mortality of termites was recorded within 8 days by Tinidazole, while 100% mortality was recorded in Ornidazole and Tinidazole in 10-11 days.

Evaluation of different treatments against termites under field condition: In order to evaluate efficacy of different entomopathogens (*Beauveria bassiana* @ 2.5 kg/ha ($1x10^8$ cfu/gm); *Metarhizium anisopliae* @ 2.5 kg/ha ($1x10^8$ cfu/gm); *Purpureocillium lilacinum* @ 2.5 kg/ ha ($1x10^8$ cfu/gm) and *Bacillus subtilis* @ 3 lit/ha ($1x10^9$ cfu/ml) and synthetic insecticides (Chlorantraniliprole 18.5% SC, Imidacloprid 17.8% SC, Bifenthrin 10% EC and Chlorpyrifos 20% EC) against termites, a field experiment was laid out in Randomized Block Design (RBD) with 10 treatments including cultural practice of

weekly irrigation for 4 weeks from planting onwards and untreated control. Each treatment was replicated three times.

Results showed that per cent germination at 30 days after planting (DAP) was 30.33 per cent in Chlorantraniliprole 18.5% SC @ 600 ml/ha followed by Bifenthrin 10% EC @ 1000 ml/ha, while it was only 14% in weekly irrigation and 19.66 per cent in untreated control. Termite infestation was low in insecticide treated plots. Among the insecticidal treatment, *Purpureocillium lilacinum* @ 2.5 kg/ ha ($1x10^8$ cfu/gm) was superior over others and control. Termite incidence was significantly low in all treatments over untreated control. The higher NMC (1,24,070/ha) and yield of 81.47 t/ha were recorded in Chlorantraniliprole 18.5% SC for initial four weeks (Table 3.2).

Management of yellow leaf disease (YLD) of sugarcane through thermotherapy

Yellow leaf disease (YLD) infected canes of sugarcane *cv.* CoLk 94184 were treated with five regimes of heat treatments in MHAT.

T_1 2h first day +2h second day +2h third day of MHAT at 50°C;

T_2 2h first day +1h second day +1h third day of MHAT at 50°C;

T_3 2h first day +2h second day +1h third day of MHAT at 50°C;

T_4 1h first day +1h second day +1h third day and

T_5 Normal MHAT (54°C for 2 h 30 minutes) along with two controls;

T_6 (C_1) Healthy seed cane;

T_7 (C_2) Diseased seed cane.

Out of all five treatments, T_1 (Serial thermotherapy of two hours through MHAT at 50°C for three consecutive days) and standard MHAT both were found effective for crop plant to overcome the infection of YLD from the seed cane.

Evaluation of sugarcane germplasm/ genotypes against red rot and smut

During 2018-19, ninety three germplasm/ genotypes *viz.*, WL 8, STD 12, STD 21, STD 22, STD 56, STD 60, STD 87, STD 92, STD 96, STD 98, STD 99, STD 123, LG 10435, LG 11074, LG 11440, LG 11459, LG 11533, LG 12201, LG 12035, LG 12038, LG 12461, LG 13001, LG 13002, LG 13009, LG 13021, LG 13030, LG 13405, LG 13407, LG 13430, LG 13431, LG 13433, LG 13435, LG 13449, LG 13452, LG 14402, LG 14416, LG 14417, LG 14420, LG 14435, LG 14452, LG 14457, LG 14462, LG 14467, LG 14471, LG 14472, LG 14474, LG 14480, LG 14482, LG 14494, LG 14497, LG 14515, LG 14525, LG 14528, LG 14544, LG 14548, LG 14549, LG 14550, LG 14564, LG 15001, LG 15016, LG 15026, LG 15048, LG 15051, LG 15052, LG 15128, LG 15166, LG 15185, LG 15169, LG 15196, LG 15245, LG 15256, LG 15262, LG 15265, LG 15266, LG 15267, LG 16026, LG 16039, LG 16060, LG 16067, LG 16070, LG 16092, LG 16098, LG 16140, LG 16154, LG 16169, LG 16170, LG 16181, LG 16212, LG 16219, LG 16294, LG 16298, LG 16302 and LG 16308 were screened against red rot (Cf 08 and Cf 09) and smut. Natural incidence of wilt and yellow leaf disease (YLD) were also recorded.

Out of 93 genotypes, 14 genotypes *viz.*, STD 92, STD 99, LG 11074, LG 13009, LG 13405, LG 13407, LG 13431, LG 13435, LG 14420, LG 15001, LG 15265, LG 16067, LG 16092 and LG 16308 were found resistant (R) to both the pathotypes (Cf 08 and Cf 09).

Six genotypes namely LG 12461, LG 14472, LG 14480, LG 14515, LG 14528 and LG 14550 were rated as susceptible (S) to both the pathotypes (Cf 08 and Cf 09).

Seven genotypes namely LG 12038, LG 14435, LG 14457, LG 14471, LG 14482, LG 14564 and LG 15051

Table 3.2. Evaluation of different treatments against termites during 2018-19

Treatment	Dosages	Germination (%) (30DAP)	Termite infestation (%)		NMC*/ha ('000)	Yield (t/ha)
			60 DAP*	90 DAP		
T_1 : *Beauveria bassiana*	@ 2.5 kg/ ha ($1x10^8$ cfu/gm)	26.33	5.66	6.74	101.10	64.55
T_2: *Metarhizium anisopliae*	@ 2.5 kg/ ha ($1x10^8$ cfu/gm)	29.33	5.91	6.03	119.99	69.25
T_3: *Purpureocillium lilacinum*	@ 2.5 kg/ ha ($1x10^8$ cfu/gm)	29.66	4.31	4.78	115.18	68.14
T_4: *Bacillus subtilis*	@ 3 lit /ha ($1x10^9$ cfu/ml)	28.33	6.12	6.86	107.77	67.40
T_5: Chlorantraniliprole 18.5% SC	@ 600 ml/ ha	30.33	0.98	1.98	124.07	81.47
T_6: Imidacloprid 17.8% SC	@ 350 ml/ha	27.66	2.66	3.36	108.14	73.56
T_7: Bifenthrin 10% EC	@ 1.0 litre/ ha	30.33	1.54	2.96	115.18	73.70
T_8: Chlorpyrifos 20% EC	@ 6.25 litre/ha	27.33	2.89	3.44	109.62	69.84
T_9: Weekly irrigation	For 4 weeks from planting	14.00	8.23	8.87	74.81	41.84
T_{10} : Untreated Control	-	19.66	11.17	18.39	87.03	45.18
CD at 5%		**7.90**	**2.15**	**3.20**	**24.33**	**17.91**

*DAP= Days after planting; NMC= Number of millable canes

were rated as highly susceptible (HS) to both the pathotypes (Cf 08 and Cf 09).

Smut: Out of 93 genotypes, 24 genotypes *viz*., WL 8, STD 56, LG 11533, LG 12035, LG 12461, LG 13009, LG 13405, LG 13431, LG 14402, LG 14416, LG 14452, LG 14474, LG 14482, LG 14497, LG 14525, LG 14548, LG 14549, LG 15256, LG 15262, LG 15266, LG 16039, LG 16070, LG 16298 and LG 16308 were rated as resistant (R).

Eight genotypes namely STD 99, LG 13001, LG 14462, LG 15026, LG 15128, LG 16140, LG 16181 and LG 16212 were rated as susceptible (S).

Six genotypes namely STD 12, STD 98, LG 13002, LG 13407, LG 15166 and LG 15265 were rated as highly susceptible (HS).

Wilt: Out of 93 genotypes tested under natural condition, 19 genotypes *viz*., WL 8, STD 12, STD 96, LG 10435, LG 11440, LG 13430, LG 14416, LG 14417, LG 14494, LG 14497, LG 14525, LG 14544, LG 14548, LG 15196, LG 15256, LG 16098, LG 16181, LG 16219 and LG 16298 were rated as susceptible (S) to wilt.

YLD: Out of 93 genotypes tested under natural condition, 18 genotypes *viz*., STD 96, STD 123, LG 11459, LG 12035, LG 13405, LG 13407, LG 13452, LG 14467, LG 14515, LG 15185, LG 15256, LG 15262, LG 15265, LG 16067, LG 16098, LG 16140, LG 16294 and LG 16298 were rated as susceptible (S) against YLD.

Enhancing efficacy of *Trichoderma* based red rot management system

Quantitative assays for phosphate mineralization potential of 103 selected *Trichoderma* isolates were carried out *in vitro*. In phosphate mineralization assay, mineralized phosphate concentration varied considerably across the 103 isolates ranging between 0.54 µg/ml (SER-34) and 16.77 µg/ml (STr-3). The most potent 13 *Trichoderma* isolates exhibiting solubilized phosphate concentration of >10 µg/ml in culture filtrate after 72 h incubation were identified.

Based on the *in vitro* qualitative and quantitative screening of 103 selected isolates for their nutrient solubilizing potential (IAA, ammonia and catalase production as well as phosphate and zinc mineralization), 20 most promising isolates were selected and evaluated in field for their growth promoting potential in sugarcane *var* Co 0238. The selected 20 isolates comprised of eight isolates established from sugarcane rhizosphere (STr-1, 3, 64, 83, 93, 120, 123, 126), and 12 endophytic isolates established from root (SER-1, 10, 18, 20, 25, 35, 39, 43), stalk (SES-10, 11) and leaf tissue (SEL-5 and 6) of sugarcane.

The isolates were applied as sett treatment and soil application through FYM at planting. The results revealed that out of the 20 isolates screened, only 10 isolates resulted in > 20% increase in germination over control, with the most promising three isolates (STr-64, STr-83 and STr-126) exhibited 40 to 57.1% increase in germination relative to control. The yield in different treatments ranged from 52.2 t/ha to 77.7 t/ha with only five isolates exhibiting >20% increase in yield over control. Isolates STr-64, STr-83 and STr-126 were found the most promising resulting in 33.3 to 41.5% increase in yield over control.

AICRP(S)

Evaluation of varieties/genotypes for their reaction against major insect pests

In early maturing group, 5 + 2 sugarcane genotypes *viz*., CoS 13231 (II plant), Co 14034, CoLk 14201, CoPb 14181, CoPb 14211 and two standard (Co 0238 and Co 5009) and in mid late maturing group 12 + 2 genotypes *viz*., Co 13035 (II Plant), CoH 13263 (II Plant), CoPb 13182 (II Plant), CoLk 13204 (II Plant), CoPant 13224 (II Plant), CoPb 14035, CoPb 14184, CoPb 14185, CoH 14261, CoLk 14203, CoLk 14204, CoS 14233, and two standards (CoPant 12226 and CoPant 97222) were planted on March 7-8, 2018 in plots of 3.6×6 m^2 plot size with 90 cm row to row distance and each treatment was replicated three times. Recommended agronomic practices were followed to raise a good crop. No insecticide was applied at any stage of the crop.

In early group, germination ranged from 19.33% in Co 14034 to 54.77% in CoPb 14181. Incidence of top borer (II Brood) was the highest in Co 14034 (15.47%) followed by Co 5009 (12.27%), Co 0238 (11.10%) CoLk 14201 (10.52%), CoPb 14184 (9.90%), CoPb 14211 (7.65%) and CoS 13231 (7.35%). The highest incidence of top borer II brood was 15.47% that comes under MS reaction. Standards received > 10% and < 20% incidence that means standards also fall in MS reaction category. CoLk 14201 showed MS reaction and rest of the genotypes showed LS reaction.

Incidence of top borer III was the highest in Co 5009 (12.18%), followed by Co 0238 (7.99%), CoLk 14201 (7.98%), CoPb 14184 (6.24%), Co 14034 (4.62%), CoPb 14211 (4.58%) and CoS 13231 (2.06%). Only one standard Co 5009 showed MS reaction and rest of the genotypes showed LS reaction.

Incidence of top borer (IV Brood) was the higher in CoPb 14211 (21.16%) followed by Co 0238 (14.70%), Co 5009 (14.39%), CoLk 14201 (14.25%), CoPb 14184 (12.34%), Co 14034 (6.36%), and CoS 13231 (5.48%). CoPb 14211 showed HS reaction and two genotypes *viz*., Co 14034 and CoS 13231 were LS. CoS 13231 consistently showed LS reaction to top borer.

Incidence of stalk borer borer was the higher in CoPb 14211 (19.44%) followed by Co 0238 (19.25%), CoLk 14201 (18.33%), CoS 13231, CoPb 14184 (12.33, Co 5009 (10.37%) and Co 14034 (6.70%). Co 14034 showed MS reaction and others showed HS reaction to stalk borer.

Incidence of internode borer was the higher in Co 0238 (42.80%) followed by CoLk 14201 (34.62%), CoPb 14184 (25.70%), Co 5009 (24.37%), Co 14034 (20.83%). CoPb 14211 (20.55%) and Co 13231 (13.00). CoS 13231 showed LS reaction and Co 0238 showed HS reaction and rest of the genotypes showed MS reaction to internode borer.

Incidence of termites during April-May was the higher in Co 14034 (19.72%) followed by CoPb 14211 (8.86%), Co 0238 (8.12%), Co 5009 (6.32%), CoPb 14184 (4.77%), CoLk 14201 (3.50%) and Co 13231 (3.33).

No incidence of root borer was noticed in two genotypes *viz.*, CoS 13231 and CoLk 14201. It was <1.0% in CoPb 14184, CoPb 14211 and Co 5009. In Co 14034 and Co 0238, incidence of root borer was 15.46 and 3.31 per cent, respectively.

Cane yield was higher in CoLk 14201 (87.31 t/ha) followed by CoPb 14184 (75.57 t/ha), Co 0238 (71.08 t/ha), CoPb 14211 (55.20 t/ha), CoS 13231 (50.48 t/ha), Co 5009 (47.62 t/ha) and Co 14034 (39.55 t/ha).

In mid late group, germination ranged from 44.00% in CoPb 14185 to 72.00% in CoPant 12226.

Incidence of top borer (II brood) was higher in CoLk 14204 (11.24%) followed by CoLk 14203 (10.50%), CoPb 14184 (9.20%), CoPant 97222 (9.20%), CoPant 13226 (8.80%), CoLk 13204 (8.56%), CoPb 14185 (8.48%), CoPb 13182 (7.89%), CoH 14261 (7.49%), CoH 13263 (7.45%), CoPb 14035 (7.19%), Co 13035 (6.84%), CoPant 13224 (6.15%) and CoS 14233 (4.70%). Higher incidence of top borer II brood was recorded in CoLk 14204 and CoLk 14203 and it is >10.0 % and <20.0%, therefore, these two genotypes showed MS reaction and rest of the genotypes are in LS reaction category.

Incidence of top borer III was higher in CoPb 14035 (11.94%), CoPb 13182 (9.78%), CoH 13263 (6.68%), CoPb 14184 (6.45%), CoPant 97222 (6.44%), CoH 14261 (6.14%), CoLk 13204 (5.67%), CoPant 13226 (5.29%), CoLk 13204 (4.95%), CoPb 14185 (4.09%), Co13035 (3.73%), CoPant 13224 (3.73%) and CoLk 14203 (3.44%). Except CoPb14035, all genotypes are LS to top borer (III brood).

Incidence of top borer (IV brood) was higher in CoH 13263 (26.09%), CoPb 14035 (17.33%), CoS 14233 (13.07%), CoLk 14203 (12.74%), CoPb 14185 (12.65%), CoPant 13226 (11.33%), Co 13035 (10.16%), CoPb 13182 (10.00%), CoPant 13224 (8.00%), CoLk 13204 (7.33%), CoPant 97222 (7.12%), CoLk 13204 (6.66%), CoH 14261 (6.00%) and CoPb 14184 (5.04%). CoH 13263 showed HS reaction. CoPb 14035, CoS 14233, CoLk 14203, CoPb 14185, CoPant 13226 and Co 13035 showed MS reaction and rest of the genotypes showed LS reaction to top borer (IV brood).

Incidence of stalk borer borer was >5.00 per cent in all the genotypes that indicates that all genotypes were HS to stalk borer.

Incidence of internode borer was high in CoH 13263 (34.00%) followed by CoS 14233 (33.00%), CoPb 14185 (26.00%), CoPb 14035 (26.00%), Co 13035 (25.33%), CoPb 14184 (23.93%), CoPb 13182 (23.33%), CoPant 97222 (23.17%) and CoLk 14204 (21.33) and all these genotypes showed MS reaction to internode borer and rest of the genotypes showed LS reaction. Incidence of termites and root borer during April-May was low.

Cane yield was higher in CoLk 14204 (94.81 t/ha) followed by Co 13035 (72.59 t/ha), CoLk 13204 (67.40 t/ha), CoPb 14184 (67.03 t/ha), CoPant 12226 (63.33 t/ha), CoLk 14203 (62.22 t/ha), CoPb 13182 (55.55 t/ha), CoPant 13224 (54.06 t/ha), CoPb 14185 (51.85 t/ha), CoS 14233 (50.73 t/ha), CoH 13263 (48.88 t/ha), CoH 14261 (44.81 t/ha), CoPant 97222 (44.06 t/ha) and CoPb 14035 (40.72 t/ha).

Monitoring of insect pests and bio-agents in sugarcane agro-ecosystem

Sugarcane variety, CoLk 94184 was taken for monitoring of insect pests of sugarcane. Incidence of termite was low. Incidence of top borer I, II, III and IV brood was 16.28 to 27.79, 14.25 to 23.11, 5.36 to 30.47 and 5.34 to 18.64 per cent, respectively. Incidence of root borer was 11.76 to 52.94 per cent in September. Incidence of mealy bug was 6.25 to 34.31 per cent. Incidence of stalk borer and internode borer was 10.71 to 56.00 and 7.14 to 40.00 per cent, respectively. Cane yield was 73.5 t/ha.

Standardisation of simple and cost effective techniques for mass multiplication of sugarcane bio-agents

Paper cone technique for mass multiplication of black bug, *Dimorphopterus gibbus* (Fabricius) and *Cavelerius sweeti* Myamoto has been developed. For egg laying, cut tops of sugarcane with some part of leaves are kept in a muslin bag and then 50 pairs of adult (male:female) bugs are released in bag and its open end is closed with the help of rubber band and kept in enameled tray for egg laying. Eggs are collected and kept in glass vials for further development. Freshly laid eggs are used for rearing of its egg parasitoid, *Eumicrosoma* sp.

Mass multiplication of *Eumicrosoma* sp. (Hymenoptera: Sceilionidae), an egg parasitoid of Lygaeid bugs of sugarcane is done on freshly laid black bug eggs. Eggs are released into glass tube containing gravid females of *Eumicrosoma* sp. Prasitised eggs become shiny black in 4-5 days and wasps emerge out in 9-10 days.

Identification of pathotypes in red rot pathogen

During 2018-19, 16 new isolates *i.e.* one isolate from CoLk 8102 (IR-161) and fifteen isolates from Co 0238 (IR-155, IR-156, IR-157, IR-158, IR-159, IR-160, IR-162, IR-163, IR-164, IR-165, IR-166, IR-167, IR-168, IR-169 and IR-170) were evaluated for their virulence and compared with Cf 07, Cf 08 and Cf 09 on 19 designated differentials *viz.*, BO 91, Co 419, Co 975, Co 997, Co 1148, CoS 8436, Co 7717, Co 62399, CoC 671, CoJ 64, CoS 767, Co 7805, Co 86002, Co 86032, CoSe 95422, CoV 92102 , Khakai (*S. sinense*), SES 594 (*S. spontaneum*) and Baragua (*S. officinarum*) by plug method of inoculation. Except Co 0238 isolates, the virulence pattern of other isolates was more or less matched with the existing pathotypes of this zone. It was observed that Co 0238 isolates gave intermediate reaction to BO 91, Co 7717, CoJ 64, Co 419, CoSe 95422 and Baragua; susceptible reaction to Co 975, Co 62399, CoC 671, Co 86002, CoV 92102 and Khakai and resistant reaction to CoS 8436, CoS 767, Co 997, Co 1148, Co 86032 and SES 594 Co 1148, thus indicating the existence of gained virulence for BO 91, Co 975, Co 62399, Co 86002 and CoV 92102 and loss of virulence for CoJ 64 CoS 767, Co 997, CoS 8436, Co 1148 and Co 86032.

The virulence pattern of Co 0238 isolates did not match with the red rot isolate of CoLk 8102 and also with designated pathotypes Cf 07, Cf 08 and Cf 09 of sub-tropical zone, thus, indicating the existence of gained specific virulence of Co 0238 isolates on its host which is different from the existing pathotypes of this zone.

Evaluation of zonal varieties against red rot, smut and wilt

North West Zone (ICAR-IISR, Lucknow)

In North West Zone, ICAR-IISR, Lucknow, 39 genotypes were screened against red rot pathotypes Cf 08 and Cf 09 during 2018-19.

Thirty nine genotypes *i.e.* nine of Initial Varietal Trial (Early) *viz.*, Co 15023, Co 15024, Co 15027, CoLk 15201, CoLk 15203, CoLk 15204, CoLk 15205, CoPb 15212 and CoPb 15211; four of Advanced Varietal Trial (Early)-I Plant *viz.*, Co 14034, CoLk 14201, CoPb 14181 and CoPb 14211; three of Advanced Varietal Trial (Early)-II Plant *viz.*, Co 13034, CoPb 13181 and CoS 13231; eleven of Initial Varietal Trial (Mid late) *viz.*, Co 15026, CoLk 15206, CoLk 15207, CoLk 15208, CoLk 15209, CoPb 15213, CoPb 15214, CoS 15231, CoS 15232, CoS 15233 and CoS 15234; seven of Advanced Varietal Trial (Mid late)-I Plant *viz.*, Co 14035, CoH 14261, CoLk 14203, CoLk 14204, CoPb 14184, CoPb 14185 and CoS 14233; five of Advanced Varietal Trial (Mid late)-II Plant *viz.*, Co 13035, CoH 13263, CoPant 13224, CoPb 13182 and CoLk 13204 were planted for screening against red rot, smut and natural infection of wilt and yellow leaf disease along with susceptible checks *viz.*, CoJ 64 (Cf 07 and Cf 08) and CoS 767(Cf 09) for red rot and CoLk 7701 and Co 1158 for smut.

Red rot: In Initial Varietal Trial (Early), out of nine genotypes tested, one genotype, Co 15027 was found resistant (R) by both the method of inoculation (plug and nodal) against both the pathotypes (Cf 08 and Cf 09). Six genotypes *viz.*, Co 15023, CoLk 15201, CoLk 15203, CoLk 15204, CoLk 15205 and CoPb 15212 were rated as moderately resistant (MR) by plug method and resistant (R) by nodal method of inoculation against Cf 08 and Cf 09. One genotype, Co 15024 was rated as moderately susceptible (MS) by plug method and susceptible (S) by nodal method of inoculation against Cf 08 and Cf 09. One genotype, CoPb 15211 was rated as moderately susceptible (MS) against Cf 08 and susceptible (S) against Cf 09 by plug method whereas resistant (R) against Cf 08 and susceptible (S) against Cf 09 by nodal method of inoculation.

In Advanced Varietal Trial (Early)–I Plant, all the four genotypes *viz.*, Co 14034, CoLk 14201, CoPb 14181 and CoPb 14211 were rated as moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method against Cf 08 and Cf 09.

In Advanced Varietal Trial (Early)-II Plant, out of three genotypes, two genotypes, Co 13034 and CoPb 13181 were rated as moderately resistant (MR) by plug method and resistant (R) by nodal method of inoculation against Cf 08 and Cf 09. One genotype, CoS 13231 was found resistant (R) by both the methods of inoculation against Cf 08 and Cf 09.

In Initial Varietal Trial (Mid late), out of 11 genotypes tested, eight genotypes *viz.*, Co 15026, CoLk 15206, CoLk 15207, CoLk 15208, CoLk 15209, CoPb 15213, CoS 15233 and CoS 15234 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 08 and Cf 09. One genotype, CoS 15232 was rated as moderately resistant (MR) against Cf 08 and moderately susceptible (MS) against Cf 09 by plug method whereas resistant (R) by nodal method of inoculation against Cf08 and Cf 09. Two genotypes CoPb 15214 and CoS 15231 were rated moderately susceptible (MS) by plug method of inoculation and resistant (R) by nodal method of

inoculation against Cf 08 and Cf 09.

In Advanced Varietal Trial (Mid late)-I Plant, out of seven genotypes tested, one genotype (CoLk 14203) was found resistant (R) by both the method of inoculation (plug and nodal) against Cf 08 and Cf 09. Six genotypes, *viz*., Co 14035, CoH 14261, CoLk 14204, CoPb 14184, CoPb 14185 and CoS 14233 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 08 and Cf 09.

In Advanced Varietal Trial (Mid late)-II Plant, all the five genotypes Co 13035, CoH 13263, CoPant 13224, CoPb 13182 and CoLk 13204 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 08 and Cf 09.

Smut: Three bud setts were dipped in *Teliospore* suspension (10^6 spores/ml) for 30 minutes and planted as per technical programme. Smut incidence was recorded at fortnightly intervals up to the harvest of the crop.

Out of 39 genotypes tested, 12 genotypes *viz*., Co 15023, Co 15024, Co 13034, CoPb 13181, CoLk 15206, CoLk 15208, CoPb 15213, CoPb 15214, CoS 15231, CoS 15234, Co 14035 and CoH 13263 were rated as resistant (R) to smut. Six genotypes, CoLk 15203, CoLk 15205, Co 14034, CoH 14261, CoPb 13182 and CoLk 13204 were rated as moderately resistant (MR). Ten genotypes namely CoPb 15211, CoLk 14201, CoPb14211, CoS 13231, CoS 15232, CoS 15233, CoLk 14203, CoPb 14185, Co 13035 and CoPant 13224 were rated as moderately susceptible (MS). Eight genotypes namely Co 15027, CoPb 15212, CoPb 14181, CoLk 15207, CoLk 15209, CoLk 14204, CoPb 14184 and CoS 14233 were rated as susceptible (S). Three genotypes, namely, CoLk 15201, CoLk 15204 and Co 15026 were rated as highly susceptible (HS).

Wilt: Out of thirty nine genotypes tested under natural infection condition, ten genotypes *viz*., Co 15023, CoPb 15211, Co 14034, CoS 13231, Co 15026, CoPb 15213, CoPb 15214, CoS 15231, CoPb 14185 and CoS 14233 were found as susceptible (S) to wilt. Remaining twenty nine genotypes *viz*., Co 15024, Co 15027, CoLk 15201, CoLk 15203, CoLk 15204, CoLk 15205, CoPb 15212, CoLk 14201, CoPb 14181, CoPb14211, Co 13034, CoPb 13181, CoLk 15206, CoLk 15207, CoLk 15208, CoLk 15209, CoS 15232, CoS 15233, CoS 15234, Co 14035, CoH 14261, CoLk 14203, CoLk 14204, CoPb 14184, Co 13035, CoH 13263, CoPant 13224, CoPb 13182 and CoLk 13204 were found resistant (R) to wilt at ICAR-IISR, Lucknow.

Yellow leaf disease (YLD): Out of thirty nine genotypes tested under natural infection condition, four genotypes *viz*., Co 14034, CoPb 15213, CoH 14261 and CoPb 13182 were rated as susceptible (S) against YLD. Remaining thirty five genotypes *viz*., Co 15023, Co 15024, Co 15027, CoLk 15201, CoLk 15203, CoLk 15204, CoLk 15205, CoPb 15212, CoPb 15211, CoLk 14201, CoPb 14181, CoPb14211, Co 13034, CoPb 13181, CoS 13231, Co 15026, CoLk 15206, CoLk 15207, CoLk 15208, CoLk 15209, CoPb 15214, CoS 15231, CoS 15232, CoS 15233, CoS 15234, Co 14035, CoLk 14203, CoLk 14204, CoPb 14184, CoPb 14185, CoS 14233, Co 13035, CoH 13263, CoPant 13224 and CoLk 13204 were found resistant (R) to YLD.

North Central Zone (ICAR-IISR RC, Motipur)

In North Central Zone, 31 genotypes were screened against red rot at ICAR-IISR RC, Motipur. Nine of Initial Varietal Trial (Early) *viz*., CoBln 15501, CoLk 15466, CoLk 15467, CoP 15436, CoP 15437, CoSe 15451, CoSe 15452, CoSe 15455 and CoSe 15456; four of Advanced Varietal Trial (Early)-I Plant *viz*., CoLk 14206, CoP 14437, CoSe 14451 and CoSe 14454; three of Advanced Varietal Trial (Early)-II Plant *viz*., CoP 13437, CoSe 13451 and CoSe 13452; ten of Initial Varietal Trial (Mid late) *viz*., CoBln 15502, CoLk 15468, CoLk 15469, CoP 15438, CoP 15439, CoP 15440, CoP 15441, CoSe 15453, CoSe 15454 and CoSe 15457; five of Advanced Varietal Trial (Mid late)-I Plant *viz*., CoLk 14208, CoLk 14209, CoP 14438, CoP 14439 and CoSe 14455 were screened along with standard checks against Cf 07 and Cf 08 by plug and nodal method of inoculation.

Red rot: In Initial Varietal Trial (Early), out of nine genotypes tested, seven genotypes *viz*., CoLk 15466, CoLk 15467, CoP 15436, CoP 15437, CoSe 15451, CoSe 15455 and CoSe 15456 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 07 and Cf 08. Genotype CoBln 15501 was rated as moderately susceptible (MS) against Cf 07 and moderately resistant (MR) against Cf 08 by plug method whereas resistant (R) by nodal method of inoculation against Cf 07 and Cf 08. Genotype CoSe 15452 was rated as moderately resistant (MR) against Cf 07 and moderately susceptible (MS) against Cf 08 by plug method whereas resistant (R) by nodal method of inoculation against Cf 07 and Cf 08.

In Advanced Varietal Trial (Early)-I Plant, out of four genotypes tested, genotype CoSe 14454 was rated as resistant (R) against Cf 07 and Cf 08 by both the methods (Plug and Nodal). Two genotypes, CoLk 14206 and and CoSe 14451 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 07 and Cf 08. Genotype CoP 14437 was rated as moderately susceptible (MS) against Cf 07 and moderately resistant (MR) against Cf 08 by plug method whereas resistant

(R) by nodal method of inoculation against Cf 07 and Cf 08.

In Advanced Varietal Trial (Early)-II Plant, all the three genotypes CoP 13437, CoSe 13451 and CoSe 13452 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 07 and Cf 08.

In Initial varietal Trial (Mid late), out of ten genotypes tested, seven genotypes *viz*., CoLk 15468, CoLk 15469, CoP 15438, CoP 15439, CoP 15440, CoP 15441 and CoSe 15454 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 07 and Cf 08. CoBln 15502 was rated as susceptible (S) against Cf 07 and Cf 08 by both the methods (Plug and Nodal) of inoculation. CoSe 15453 was rated as moderately susceptible (MS) by plug method and resistant (R) by nodal method of inoculation against Cf 07 and Cf 08. Genotype CoSe 15457was rated as moderately resistant (MR) against Cf 07 and moderately susceptible (MS) against Cf 08 by plug method whereas resistant (R) by nodal method of inoculation against Cf 07 and Cf 08.

In Advanced Varietal Trial (Mid late)-I Plant, all the five genotypes, namely, CoLk 14208, CoLk 14209, CoP 14438, CoP 14439 and CoSe 14455 were rated moderately resistant (MR) by plug method of inoculation and resistant (R) by nodal method of inoculation against Cf 07 and Cf 08.

Among the standard checks, CoSe 95422 was susceptible (S) against both the pathotypes by both the methods. CoJ 64 was highly susceptible (HS) against both the pathotypes by both the methods. BO 130, CoP 06436 and BO 91 were moderately resistant (MR) against both the pathotypes by plug method and resistant (R) against both the pathotypes by nodal method.

Smut: Three bud setts were dipped in *Teliospore* suspension (10^6 spores/ml) for 30 minutes and planted as per technical programme. Smut incidence was recorded at fortnightly intervals up to the harvest of the crop.

Out of 31 genotypes tested, 19 genotypes *viz*., CoLk 15466, CoLk 15467, CoP 15437, CoSe 15451, CoLk 14206, CoP 14437, CoSe 14451, CoBln 15502, CoLk 15468, CoLk 15469, CoP 15438, CoP 15439, CoSe 15454, CoSe 15457, CoLk 14208, CoLk 14209, CoP 14438, CoP 14439 and CoSe 14455 were rated as resistant (R). Nine genotypes *viz*., CoSe 15452, CoSe 15455, CoSe 15456, CoSe14454, CoP 13437, CoSe 13451, CoSe 13452, CoP 15441 and CoSe 15453 were rated as moderately resistant (MR). Two genotypes, CoP 15436 and CoP 15440 were rated as moderately susceptible (MS). One genotype CoBln 15501 was rated as susceptible (S).

Wilt: Natural incidence of wilt was recorded in the experiment conducted at ICAR-IISR, RC, Motipur and results revealed that out of 31 genotypes tested under natural condition, three genotypes, CoSe 15452, CoSe 13451 and CoBln 15502 were rated as susceptible (S) to wilt. Remaining 28 genotypes *viz*., CoBln 15501, CoLk 15466, CoLk 15467, CoP 15436, CoP 15437, CoSe 15451, CoSe 15455, CoSe 15456, CoLk 14206, CoP 14437, CoSe 14451, CoSe14454, CoP 13437, CoSe 13452, CoLk 15468, CoLk 15469, CoP 15438, CoP 15439, CoP 15440, CoP 15441, CoSe 15453, CoSe 15454, CoSe 15457, CoLk 14208, CoLk 14209, CoP 14438, CoP 14439 and CoSe 14455 were found resistant (R) to wilt.

Yellow leaf disease (YLD): Out of 31 genotypes tested under natural condition, five genotypes *viz*., CoP 15437, CoSe 13451, CoP 15438, CoSe 15453 and CoLk 14209 were rated as susceptible (S) against YLD whereas remaining 26 genotypes CoBln 15501, CoLk 15466, CoLk 15467, CoP 15436, CoSe 15451, CoSe15452, CoSe 15455, CoSe 15456, CoLk 14206, CoP 14437, CoSe 14451, CoSe 14454, CoP 13437, CoSe 13452, CoBln 15502, CoLk 15468, CoLk 15469, CoP 15439, CoP 15440, CoP 15441, CoSe 15454, CoSe 15457, CoLk 14208, CoP 14438, CoP 14439 and CoSe 14455 were found resistant (R) to YLD.

Assessment of elite and ISH genotypes for resistance to red rot

During 2018-19, 26 ISH genotypes namely, SA04-472, SA04-454, MA/5/22, MA/5/37, PG 9869137, BM 1009-163, BM1022-173, BA 1003143, SA04-390, SA04-496, CYM-07986, AS04-2097, BM-1009149, AS04-1687, MA5/5, SA98-13, GU07-2276, MA5/51, GU07-3849, SA04-409, BM1010168, MA5/99, AS04-1689, GU073-774, AS04-635 and AS04-245 along with two susceptible checks CoJ 64 (for Cf 08) and CoS 767 (for Cf 09) were planted and evaluated under field condition against red rot pathotypes Cf 08 and Cf 09.

Out of 26 ISH genotypes, seven genotypes namely SA 04-454, BA 1003143, GU 07-3849, GU 07-2276, BM 1010168, SA 98-13 and AS 04-635 were rated as resistant (R) against Cf 08 and Cf 09 by plug and nodal both the method of inoculation.

Two genotypes, BM 1009-163 and PG 9869137 were rated susceptible (S) to Cf 08 and Cf 09 by plug and nodal both the method of inoculation.

Two genotypes, AS04-245 and GU073-774 were rated highly susceptible (HS) against Cf 08 and Cf 09 by plug method of inoculation and susceptible (S) by nodal method of inoculation.

Four genotypes, BM1022-173, AS04-1687, CYM-07986 and MA 5/51 were rated as moderately susceptible (MS) against Cf 08 and Cf 09 by plug method of inoculation whereas resistant (R) by nodal method of inoculation.

The other eleven genotypes *viz*., SA 04-472, MA/5/22, MA/5/37, SA 04-390, SA 04-496, AS 04-2097, BM-1009149, MA 5/5, SA 04-409, MA 5/99 and AS 04-1689 were rated as moderately resistant (MR) to Cf 08 and Cf 09 by plug method of inoculation and resistant (R) by nodal method of inoculation.

Management of Pokkah boeng disease of sugarcane

Rhizospheric soil samples have been collected from diverse agro-ecosystem cultivating sugarcane varieties in the different states of the country (Kerala, Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, Bihar and Uttar Pradesh). Two beneficial bacteria and five beneficial fungi have been isolated and maintained in lab conditions.

Genetic diversity and transmission of pathogens causing Yellow Leaf Disease in sugarcane

Genomic DNA of YLD affected 50 sugarcane genotypes was isolated using DNeasy Plant Mini Kit and these 50 DNA samples were subjected to nested PCR assay using universal phytoplasma primers. First Round PCR products showing 1.8 kb size amplicons were used as a template for the second round PCR. Second round PCR yielded 1.2 kb size amplicons which were gel eluted and stored at –20°C for sequencing and restriction analysis to assess the genetic diversity of the associated phytoplasma.

Bio-prospecting of entomopathogenic bacteria for management of white grubs infesting sugarcane

The endemic area of white grub infestation was identified and the soil samples were collected from different locations in Ahmednagar, Pune, Satara, Sangli and Kolhapur districts of Maharashtra. These soil samples were processed and stored at 4°C for isolation of bacteria. The bacterial strains originating from different locations were isolated and colonies with distinct morphologies were purified. The glycerol stocks of purified colonies were prepared and stored at –20°C.

Utilization of entomopathogenic nematodes (EPNs) against white grubs infesting sugarcane

Two native EPN species were isolated from the soil samples collected from white grub endemic areas of sugarcane (cv. CoM 265) using soil bait-technique. Modified white traps method was used to recover infective juveniles (IJs). Based on morphological and molecular characterization studies, EPN species identified as, *Heterorhabditis indica* and *Steinernema carpocapsae*. The partial sequence information deposited into NCBI GenBank- 1. *H. indica* strain IISRBCCH01- (Accession No- MH909057), 2. *S. carpocapsae* strain IISRBCCS01 (Accession No-MK371212). Bio-efficacy studies of EPN species against white grubs were carried out and *H. indica* strain IISRBCCH01 was found to be causing 100% mortality in first and second instars of *Holotrichia serrata* larvae at a dosage of 100 and 250 IJs per grub, after 48 hours post inoculation whereas, *S. carpocapsae* strain IISRBCCS01 was observed to cause 100% mortality in first and second grub instars of *H. serrata* at a dosage of 150 and 250 IJs per grub after 36 and 48 hours post inoculation. The value for median lethal dose (LD_{50}) of *S. carpocapsae* strain IISRBCCS01 was estimated at different incubation periods (Table 3.3). Similarly, Bio-efficacy experiment of *S. carpocapsae* strain IISRBCCS01 was carried on *Spodoptera frugiperda* at different dosage levels. The 100% mortality was observed at 50 and 100 IJs per larvae from 30 hours to 72 hours post inoculation, respectively. Likewise, larval instars of early shoot borer, *Chilo infuscatellus* also showed 100% mortality with *H. indica* IISBCCH01 strain when a dose of 100 IJs per larvae after 72 hours of EPN inoculation.

Table 3.3. LD_{50} values of *S. carpocapsae* strain IISRBCCS01 against early and late grub instars of *H. serrata*

Exposure period (hr)	Early instar grub		Late instar grub	
	LD_{50}	Fiducial limit	LD_{50}	Fiducial limit
24	70.8	50.7-134. 4	205.7	147.2-30.48
48	49.4	33.4-66.5	172.5	116.5-254.9
72	39.6	26.8-50.1	95. 5	53.9-134.8
96	21.5	7.4-31.4	72.3	34.6-106.1

Mass multiplication and field release of egg parasitoid, *Trichogramma chilonis* against borer complex of sugarcane

An egg parasitoid, *T. chilonis* is employed for efficient management of borer complex in sugarcane (early shoot, internode and top shoot borer). The egg parasitoid was reared on its natural insect host (rice mealworm, *Corcyra cephalonica*) in laboratory and good qualities of green trichocards were distributed to farmers. Total 1289 trichocard strips were prepared and 755 tricho strips were distributed to the farmers.

Technology developed

Multiplication of termites in laboratory: Artificial diets for rearing termites in the laboratory have been developed and both workers and soldiers may survive for about 45 days.

IISR-Combo Insect Trap

Status of technology commercialization

Royalty to the Institute: ₹ 2,32,500/- for sold out traps (3100 nos.) during 2016-17.

₹ 1,05,000/- for sold out traps (1400 nos.) during 2017-18.

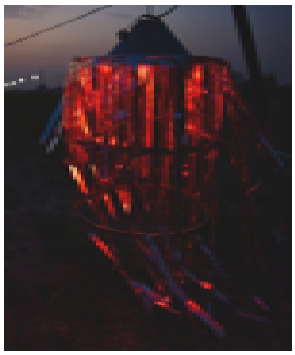
Demonstrations

1. ICAR-IISR, Regional Station, Pravaranagar (MS)- 7 villages (21 traps installed)
2. KVK, Ahmednagar (MS)
3. KVK, Nalgonda (Telangana)
4. KVK, Junagadh (Gujarat)
5. KVK, Yavatmal (MS)
6. PDKV, Akola (MS)

IISR-Combo Insect Trap

Blue bull repellent trap

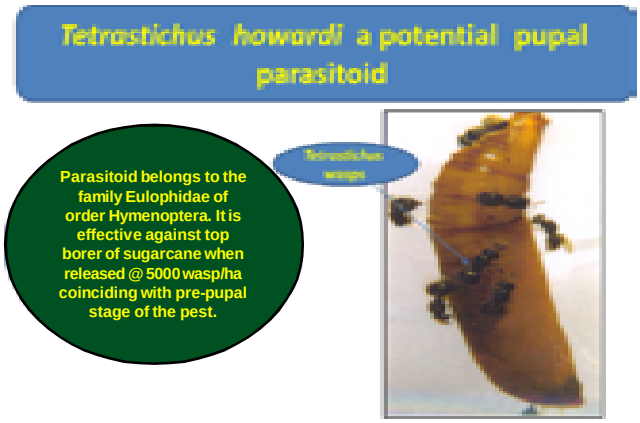
IISR combo trap has been modified to repel the blue bulls from sugarcane fields in early stage of the crop. It gives good results.



Blue bull repellent trap

- Rearing of black bug, *Dimorphopterus gibbus* (Fabricius) and *Cavelerius Sweeti* Myamoto.
- Mass multiplication of *Eumicrosoma* spp. (Hymenoptera: Sceilionidae) an egg parasitoid of Lygaeid bugs of sugarcane.

Mass multiplication of pupal parasitoid, *Tetrastichus howardi*



Mass multiplication of the parasitoid and *Tetrastichus* cards

- Parasitoid can be reared and mass multiplied in the laboratory on the cocoon of a range of Lepidopterous pests like maize borer, pink borer, rice moth, root borer, silk moth etc.
- It completes its life cycle in 2-3 weeks at 27°C and 70% RH.
- On an average, 100-150 parasitoids are obtained from one pupae.
- *Tetrastichus* cards have also been developed for delivery purpose.

CHAPTER 4

Research in Plant Physiology and Biochemistry

Molecular study to reveal transcriptomes and genes associated with sucrose transport and accumulation in sugarcane

In order to identify the differentially expressing transcripts in source-sink perturbed condition achieved through the application of GA_3, tissues of top portion of cane (CoLk 94184) of both GA_3 treated and untreated canes were analyzed through RNA *Seq* analysis. As indicated in Table 4.1, a total of 1,65,410 transcripts were obtained and of these 72,521 transcripts were annotated based on NCBI database and these were grouped into three categories based on their functions namely biological, molecular and cellular processes. Based on bioinformatic analysis and keeping reasonable level of read count of individual reads and then comparative fold change among two sets of samples, a total of 558 differentially expressing transcripts were fished out, of which 513 were found up and rest 45 down regulated transcripts in source-sink perturbed conditions in top portion of canes.

Table 4.1. Annotation summary of total transcripts

Total transcripts	165410
Annotated by NCBI	72521
Annotated by Uniprot	53392
Annotated by KEGG	22007
Annotated GO biological process	17215
Annotated GO molecular process	32602
Annotated GO cellular process	19456

Primer3 software was used to design the primers keeping standard parameters using 558 transcripts. Twenty six primer pairs were synthesized and their functionality was checked with sugarcane samples (Fig. 4.1). Twenty primers showed reactions. Real-time PCR (RT-PCR) was performed to visualize the expression behaviour of some selective transcripts including uncharacterized protein using samples having exposure of GA_3 of different days (Fig. 4.2). Increased expression over control of fructose 1, 6- biphosphatase was seen, which later declined to the level of control whereas expression of uncharacterized protein was found increasing with days of GA_3 exposure, indicating a positive role as far as GA_3 response is concerned (Fig. 4.2).

Present analysis also revealed a specific water stress related *myb* transcription factor which depicted gradual increase in its expression with cane maturity, possibly helping cane to withstand water deficit during

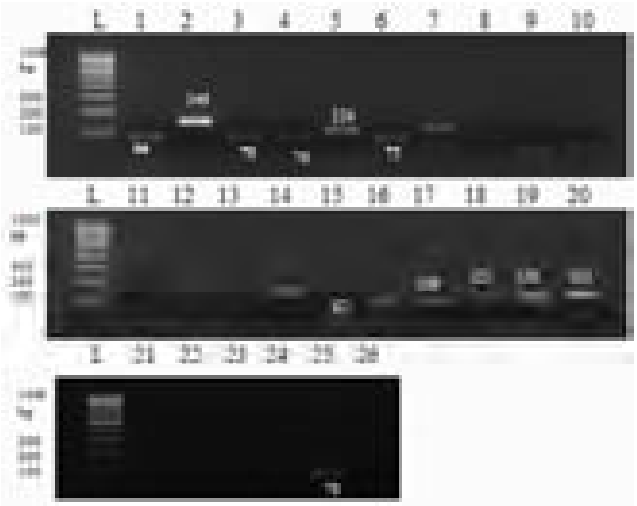
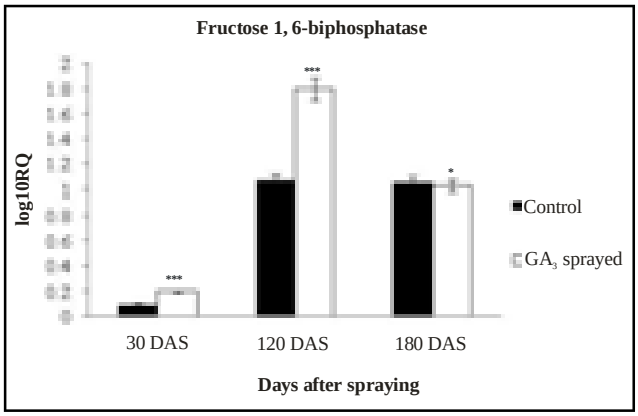


Fig. 4.1. Validation of 26 designed primers based on novel transcripts sequence using total RNA isolated from CoLk 94184 variety of sugarcane



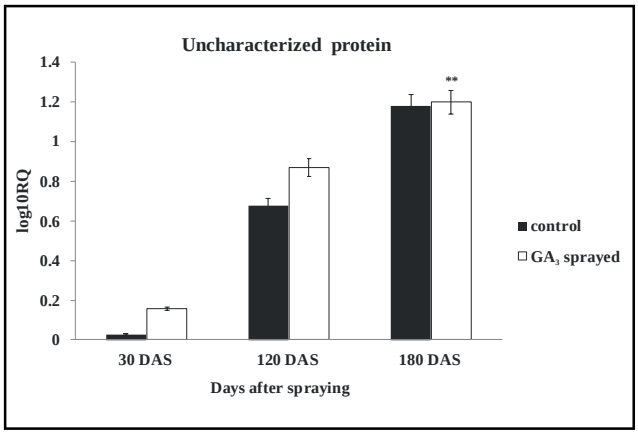


Fig. 4.2. Real-time PCR based expression analysis of selected primers designed based on the novel transcripts fished out from GA_3 influenced source-sink perturbed conditions in CoLk 94184 variety of sugarcane

ripening stage of the cane for high sucrose accumulation. Beside these, some hypothetical and uncharacterized transcripts were also recognized having high expression at immature stage of the crop, presumably enhancing sink strength for high sugar accumulation.

Protein structure of some uncharacterized and hypothetical protein (transcripts having homology after annotation) was predicted using Phyre2 software. For this, amino acid sequences of the proteins were retrieved from NCBI by using accession number. This protein belongs to super family methenyl tetrahydrofolate cyclohydrolase. Its secondary structure contains around 73% of alpha helix with no beta strand while around 30% of the structure was found disordered (Fig. 4.3).

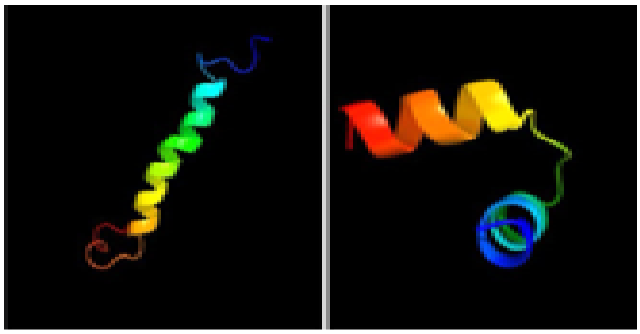


Fig. 4.3. Protein structure obtained by Phyre2 tool (a) uncharacterized protein (b) hypothetical protein

The expression behaviour detected through qRT-PCR analysis was in concurrence with the RNA-seq results for the most transcripts, validating the reliability of the transcriptomic analysis results. The single peaks obtained for all primers in the melt curve analysis, validate the precision of primer designing tool. The data generated in this study has supplemented the existing sugarcane transcriptome resource and may be utilized for further deliberation and exploration of functional genomics of sugarcane. The study sheds light on transcripts which are particularly differentially expressed under conditions of GA_3 perturbed source-sink communication. The results may help elucidate additional factors/genes that bring about better sink strength to facilitate sucrose accumulation, specifically in sugarcane.

Minimizing post-harvest sucrose deterioration and its molecular assessment in sugarcane

Four sugarcane varieties (CoLk 94184, CoLk 09204, CoPk 05191 and Co 0238) were contemplated to study the post-harvest sucrose losses and their management using chemical formulation especially the use of SMS+BKC solution. Experiment was carried out using spring planted cane and juice was analyzed at different days (0, 2, 4, 7, 9 and 11) after harvest of the cane taking samples from both control and BKC+SMS treated canes. At zero days, Brix ranged from 19.83 to 22.13, reducing sugars (RS) from 0.44 to 0.94%, sucrose % juice from 16.76 to 19.84 and purity from 88.13 to 90.71 among these varieties. After 11 days of post-harvest, range of increase in Brix under control condition among varieties were 24.27 to 27.73 and reducing sugars from 10.80 to 20.33, while range of decrease in sucrose % juice was 19.61 to 12.19 and purity from 72.46 to 50.1. In SMS+BKC treated canes, these were 24.03 to 26.50, 8.82 to 13.67, 19.94 to 15.78 and 75.19 to 63.14, respectively (Fig. 4.4 to 4.7). Among these four varieties, due to the treatment (11^{th} day) increase in RS was 35.5% whereas in control, it was 46.9% and in case of Brix, it was 9.3% over 12.5% in control. Decrease in sucrose % juice was less in treated cane (20.9%) than those of control (37.8%) and purity was 16% than those 30.9% in control, indicating impact of formulation in checking the post-harvest quality deterioration. Among these varieties, post-harvest deterioration (after 11 days of cane harvest) in terms of RS and sucrose % juice was observed maximum in CoLk 09204, a increase of RS from 0.94 to 20.33 and decrease of sucrose % juice from 17.59 to 12.19 in control and 0.94 to 13.67 in RS and 17.59 to 15.78 in sucrose % juice in SMS+BKC treated canes. The least increase in RS was observed in Co 0238 (0.44 to 10.80 in control and 0.44 to 9.10 in treated) whereas most responsive variety to formulation was CoLk 94184 where RS reduction from control to treated cane was from 14.86 to 8.82% (6.04%) after 11 days of post-harvest. Very little response was seen in CoPk 05191 variety (only 0.5% difference was observed) (Fig. 4.5). Treatment also checked increase of Brix during post-harvest period and this check was maximum in CoPk 05191. Maximum reduction in sucrose % juice due to delayed crushing in comparison to fresh crushing in control condition was observed in CoLk 09204 (17.59 to 12.06 on seventh day) and minimum reduction was observed in CoLk 94184 (17.59 to 16.84 on eleventh day) (Fig. 4.6). Based on drop in sucrose % juice and purity (Fig. 4.7) due to delayed crushing, CoLk 94184 was found the most tolerant to post-harvest deterioration followed by CoPk 05191 and then Co 0238 and finally CoLk 09204.

If results of all the four varieties are taken together, loss in sucrose % juice in control was almost double (37.8%) over BKC+SMS treated cane (20.9%) when cane was crushed after eleven days of harvest (post-harvest). Treatment was imposed just after the harvest.

Increase in reducing sugar (RS) was almost 13% more in control (46.9%) over treated (34%) measured in 11 days stale cane.

Among the varieties, the highest loss in sucrose % juice in comparison to zero time stale cane was observed in CoLk 09204 and this loss was 5.4% in control and 1.81% in BKC+SMS treated canes at 11^{th} day after crushing.

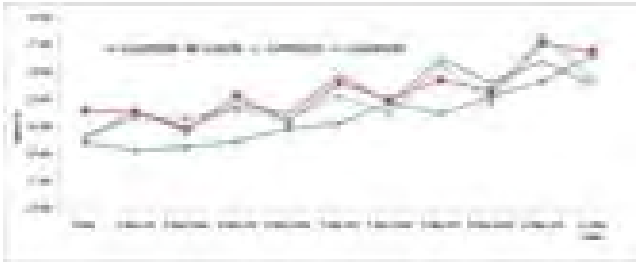


Fig. 4.4 Varietal scenario of post-harvest sucrose losses seen in terms of increase in the level of Brix application of SMS+BKC formulation checked Brix increase

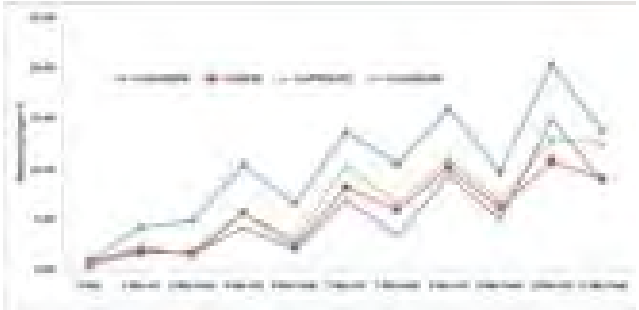


Fig 4.5. Varietal scenario of post-harvest sucrose losses seen in terms of increase in the level of reducing sugar. Application of SMS+BKC formulation checked reducing sugar increase

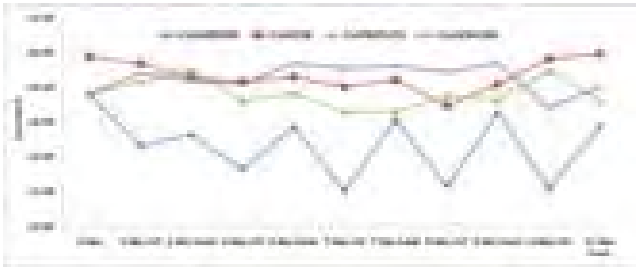


Fig. 4.6. Varietal scenario of post-harvest sucrose losses seen in terms of sucrose % juice. Application of SMS+BKC formulation checked downfall of sucrose % juice

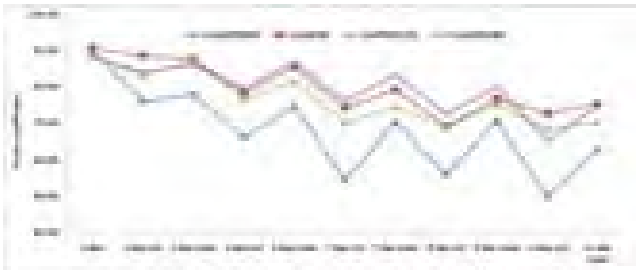


Fig. 4.7. Varietal scenario of post-harvest sucrose losses seen in terms of juice purity coefficient. Application of SMS+BKC formulation checked fall in juice purity coefficient

Genome sequencing of red rot pathogen of sugarcane

A virulent pathotype (Cf 08) of *C. falcatum* causing red rot to sugarcane was first grown on suitable media to get good amount of mycelia. Genomic DNA was isolated from mycelia and its quality was checked on 0.8% agarose gel. Nanodrop spectrophotometer was used to get 260/280 (1.8) and its concentration (380 ng/µl), indicated good quality and quantity of isolated DNA (Fig. 4.8). Before library construction, DNA was further purified using AMPure PB beads. Pac Bio (RSII) platform was used for sequencing (Fig. 4.9). As per flow chart, sequencing was carried out. Almost 97.24% genome was sequenced (Fig. 4.10). A total of 253 contigs was obtained when all reads were assembled, however, the number of contigs might reduce when a different sets of assembly software is executed.

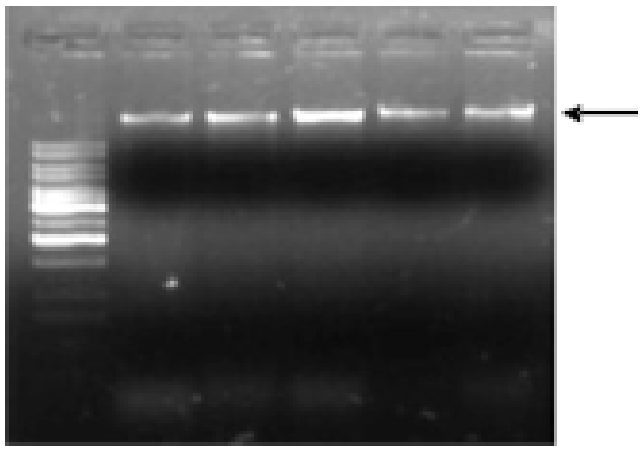


Fig. 4.8. Genomic DNA isolated from Cf 08

PacBio RS II System using P6C4 chemistry
↓
7.24 Gb read data (124.80X coverage)
↓
5.21 Gb filtered data comprised of 2,42,298 raw reads used for generation of draft assembly
↓
Initial draft assembly of genome comprising >200 contigs

Fig. 4.9. Flow chart depicting genome sequence data

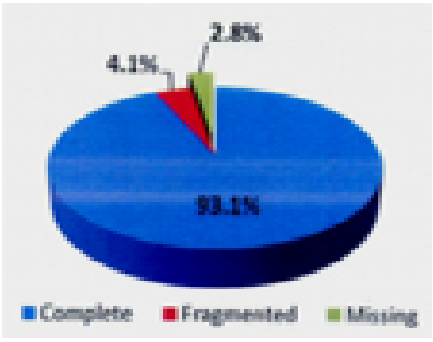


Fig. 4.10. Analysis of genome completeness

Physio-molecular basis of multiple abiotic stress tolerance in sugarcane

- Pot and field experiments were conducted using tolerant (CoS 767) and susceptible (CoJ64) sugarcane varieties to identify physiological traits

conferring tolerance to single/multiple abiotic stresses. The crop was grown under normal and saline soil (6 dSm^{-1}) conditions and it was imposed to individual stress of drought (at 75 DAP) and water logging (at 120 DAP for 60 days), and to their combinations.

- A significant variation existed for growth parameters; plant height, single cane weight, internode length, cane girth, fresh leaf weight, root weight and root volume under different single/ combined stresses. Compared to control, a three fold decrease in leaf fresh weight was found under treatment drought+waterlogging+salinity in both the varieties. Drought induced increase in root weight and root volume; these increases were about 2.5 times higher than control. The stalk/aerial root ratio was found higher under treatment drought+waterlogging as compared to waterlogging alone and being higher in CoS 767 than CoJ 64.
- CoS 767 showed the highest stress tolerance index in waterlogging followed by drought and salinity while CoJ 64 had the highest stress tolerance index for salinity followed by drought and waterlogging +salinity for both the varieties.
- The RWC, electrolyte leakage, proline, CAT and POX activity varied significantly among different stress treatments and the values for above traits were found higher in CoS 767 than CoJ 64. The different stresses caused leaf chlorosis and necrosis which were the highest in the treatment drought+waterlogging+salinity in both varieties. This was also evident from chlorophyll analysis, indicating that stay green character may be one of the visual screening criteria for single/multiple stress tolerance.
- Drought tended to cause the highest increase in fiber content followed by waterlogging and salinity. Among combined stresses, the highest fiber content was found under treatment drought+salinity while the lowest was found in drought +waterlogging +salinity.
- The juice quality parameters decreased under single/combined stresses. The lowest decrease in sucrose was observed in waterlogging and the highest in drought+ waterlogging+ salinity in both the varieties.

Inter-Institutional Research project: Screening and identification of sugarcane lines tolerant to water-logging and their physio-biochemical investigation

- Soil samples of waterlogged plot along with control were analysed for nutrient analysis. Sulphur, potassium, phosphorus and EC of soil showed relatively higher value in waterlogged affected soil as compared to control plot.
- Ratoon crop of 24 sugarcane genotypes including seven commercial varieties (tolerant/susceptible), CoLk 94184, BO 91, CoS 767, CoJ 64, CoS 97264, UP 9530, CoSe 96436 (Jalpari) and 17 germplasm lines, CoLk 12204, CoLk 12202, CoLk 12206, CoLk 07201, CoLk 04238, S 5085/11, S 5087/11, LG 06605, LG 04439, LG 05350, LG 05020, LG 03040, A-46-11, B-44-12, A-27-12, D-12-9, D-6-13 were evaluated for physiological attributes, yield and juice quality parameters under waterlogged condition along with untreated control at Kharika Block, ICAR-IISR, Lucknow. Results obtained indicated higher root dry mass (sum of shoot root and aerial roots) and plant height in waterlogged affected plants. Aerial rooting pattern varied among genotypes; some of the genotypes showed aerial roots up to 9th nodes. A-46-11, UP 9530, LG 06606, D-12-9, CoLk 12206, CoS 767, CoLk 1220, D-6-13, genotypes showed dense aerial root growth. Leaf length, width, area and SPAD index decreased due to waterlogging.
- Cane samples of both the waterlogged and control plot were evaluated for juice quality attributes in the month of November 2018 and January 2019. On average basis, sucrose % juice and Brix were relatively lower (8% decrease over control) in waterlogged condition in most of the genotypes except A-46-11, D-6-13, CoLk 94184, CoSe 96436 and UP 9530 indicating tolerance to waterlogging.
- Based on relative cane weight, genotypes namely D-6-13, D-12-9, A-46-11, CoLk 12202, CoLk 12206, CoLK 12204, LG 06605 and 5085/11, UP 9530, CoS 767, CoSe 96436 may be grouped under tolerant category.

Impact of *Jeevamrutha* on sugarcane growth, yield and juice quality attributes

To study the impact of *Jeevamrutha* on sugarcane growth, yield and juice quality attributes, an exploratory trial was conducted in autumn using CoLk 94184 variety with two treatments *i.e.* control and soil & foliar application of *Jeevamrutha*. Results obtained indicated 50 and 66% increase in germination at 25 and 45 DAP. However, increase in plant population was 51, 18, 12, 10, 35 and 75% at 25, 45, 90, 150, 210 and 270 DAP. Increase in leaf area was 62, 60 and 12%, whereas, LAI increased by 92, 116 and 95% at 45, 210 and 240 DAP. Increase in yield and NMC was 10 and 13 % while °Brix, sucrose and juice purity were 11, 17 and 5%, respectively.

CHAPTER 5

Mechanization of Sugarcane Farming

Development of two row disc type ratoon management device with and without stubble shaving attachments

For raising good ratoon crop in sugarcane, cultural operations such as stubble shaving, off barring and fertilizer application are recommended to be performed after harvesting. These cultural operations are often called as ratoon initiation operations. Earlier ratoon initiation operations were performed in the field free from sugarcane trash. Now-a-days, sugarcane trash is left in the field after harvesting. For carrying out ratoon initiation operations, a new machine, two row disc ratoon management device, was developed. Main feature of the machine was its off barring discs which perform efficiently even in the field having left over surface trash. Developed prototypes were of two types. First was without stubble shaver- to perform off barring and fertilizer application. The second prototype has stubble shaver attachments also to perform stubble shaving along with off barring and fertilizer application. Prototype without stubble shaver is suitable for piecemeal harvesting. Both types of prototypes were field tested at IISR farm as well as at farmers' field in Hardoi district (Fig. 5.1 & 5.2).

Fig. 5.1. Two row disc RMD with stubble shaving attachment

Fig. 5.2. Sugarcane ratoon field after two row disc RMD operation

Development and evaluation of tractor operated multipurpose tool frame with attachments for sugarcane

Testing of earthing up attachment

The field performance testing of the developed prototype was carried out for earthing up mode using IISR deep furrowers. The earthing up operation could be performed with this equipment in sugarcane crop till formation of cane in the plant. The equipment has high ground clearance that made it suitable to operate in the field even up to 600-750 mm height of the sugarcane crop. The field capacity of the equipment was 0.40 ha/h with field efficiency of 74% (Table 5.1 and Fig. 5.3).

Table 5.1. Field performance of the prototype in earthing up operation in sugarcane

Average height of crop at earthing up (mm)	1100
Furrow bottom used (No.)	3
Speed of operation (km/h)	2.4
Draft (kN)	5.4
Effective field capacity (ha/h)	0.40
Field efficiency (%)	74
Cost of operation (₹/ha)	1340
Plant damage (%)	2.8

Fig. 5.3. Multipurpose tool frame with earthing up attachments

Attachment for sowing wheat as intercrop in sugarcane ratoon

The equipment was tested at the Institute farm for sowing wheat as intercrop in sugarcane ratoon field in December 2018. The adjustment of tines was done for sowing of two rows of wheat crop in between each sugarcane crop rows. The equipment was able to sow six lines of wheat at a time. The sowing was done in the field after operation of Ratoon Management Device in

the field (Fig. 5.4). The trash has to be removed before operation of machine. Performance results have been depicted in Table 5.2.

Fig. 5.4. Sowing of wheat as intercrop in sugarcane ratoon field

Table 5.2. Performance results of the machine

Parameter	Value
Speed of operation (km/h)	2.2
Depth of sowing (mm)	90-110
Distance between two rows of wheat (mm)	200
Actual seed rate observed (kg/ha)	116
Effective field capacity (ha/h)	0.35
Field efficiency (%)	70
Clamps uprooted (%)	2.2

Development of cane node planter

Prototype of tractor operated cane node planter was developed for mechanizing cane node method of planting. The planter was field tested at IISR farm. Machine performs deep furrow opening, metering of pre-soaked cane nodes, fertilizer application and soil covering over planted cane nodes, simultaneously in a single pass of the machine (Fig. 5.5). Metering mechanism, comprising of lugged ground wheel driven belt and mild steel L shape cells, performed satisfactorily. Effective field capacity of the planter was 0.15-0.16 ha/h.

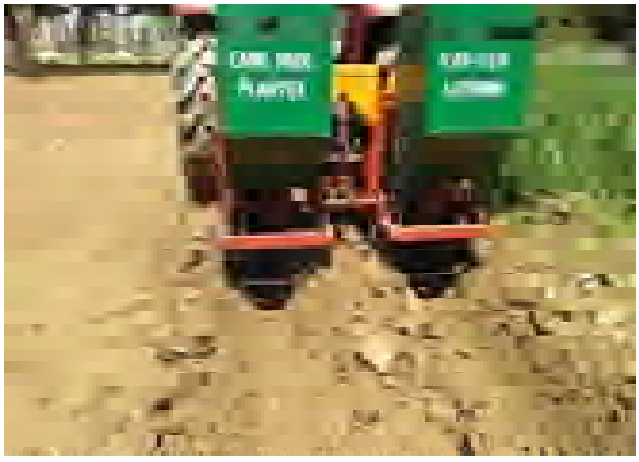


Fig. 5.5. Tractor operated cane node planter in field operation

Development of sugarcane trash management machinery

Review of literature was done. Working functions of existing farm machineries namely IISR Plant Residue Shredder, IISR Disc type Ratoon Management Device, commercially available Shredder and Mulcher were studied for trash management in sugarcane. Literature review revealed the need of a new machine for sugarcane trash management in sugarcane especially in ratoon sugarcane. Design of the new prototype machine has been conceptualized.

AICRP on Farm Implements and Machinery (FIM)

Manufacturing of prototypes for conducting field adaptability trials under varying agro-climatic and soil conditions

Prototypes fabricated

S. No.	Name of the prototype	Achievement (No.)
1.	IISR TO deep furrow adjustable row spacing sugarcane cutter planter (1.0/1.2/1.5 m)	2
2.	IISR TO deep furrow adjustable row spacing sugarcane cutter planter (0.75/0.90 m)	2
3.	IISR TO two row disc RMD with stubble shaver	1
4.	IISR TO single row disc RMD	1
5.	IISR trencher for paired row sugarcane planting	1
6.	IISR TO Sugarcane trench planter	2
7.	IISR TO Zero till sugarcane planter	1
8.	IISR TO multiple pit digger	1
9.	IISR Manual cane node cutter-cum-bud scooper	5
10.	IISR solar operated manual sprayer	1
11.	IISR manual weed wiper	2
12.	IISR manual bud chipper-cum-sett cutter	10
13.	Manual soil sampler/auger	1
Total		**30 (TO 11, Manual 19)**

Prototypes supplied

S. No.	Name of the prototype	Number	Supplied to
1.	IISR Manual cane node cutter-cum-bud scooper	2	TNAU-AECRI, Kumulur, Trichi
2.	IISR Manual cane stripper	2	Shri Vivekanand Srivastava
3.	IISR TO Sugarcane trench planter	1	TNAU-AECRI, Kumulur, Trichi
4.	IISR TO trencher	1	Shri Ram Deen Tyagi, Muraina
5.	IISR TO Deep furrow sugarcane cutter planter	1	UPCSR, Shahjahanpur
6.	IISR TO Deep furrow deep fertilizer sugarcane cutter planter	1	UPCSR, Shahjahanpur (Seorahi)
7.	IISR TO Deep furrow deep fertilizer sugarcane cutter planter (1.0, 1.2 1.5 m)	2	VC Farm, Mandya (Karnataka) (1) TNAU-AECRI, Kumulur, Trichi (1)
8.	IISR Manual bud scooper	3	Shri Satish Kumar Singh, Farrukhabad (1)
			Shri Shailesh, Fatehpur (1)
			Shri Neebulal, Mau (1)
9.	Manual sett cutting machine	1	Shri Nar Singh, Lucknow (1)
10.	Manual innoculator	1	UPCSR, Shahjahanpur (Seorahi)
	Total	**15 (TO 6, Manual 9)**	

Prototype feasibility testing (PFT) of Pant-ICAR sub-soiler cum differential rate fertilizer applicator

Prototype feasibility testing (PFT) of Pant-ICAR sub-soiler cum differential rate fertilizer applicator was conducted at IISR farm in one hectare area. The performance of this equipment was compared with traditional planting system i.e. opening of furrows using ridgers, applying fertilizer, setts and soil covering manually. In the equipment under testing the fertilizer was placed at differential depths whereas, in conventional system setts and fertilizer are placed at same depth. The equipment was operated at 0.5 m/s forward speed. The effective field capacity was 0.20 ha/h at forward speed of 0.5 m/s. Higher germination percentage was recorded after 45 days of planting in case of the equipment than the conventional method.

UPCAR project "Center of excellence in farm machinery"

Testing of developed manual multicrop planter

An experiment was conducted at Institute farm for sowing of wheat and mustard as intercrop in sugarcane in November 2018. Sugarcane was planted with tractor operated deep furrow sugarcane cutter planter (75 cm row spacing) and sugarcane trench planter (30:150 cm spacing) (Fig. 5.6). In each trench, two rows of sugarcane were planted by machines at 30 cm spacing and at 30 cm depth. Then two rows of wheat and mustard were sown with manual multicrop planter on the 80 cm ridges width formed in between two trenches. One row of wheat and one row of mustard were taken on ridges formed (50 cm) with deep furrow sugarcane planter (Fig. 5.7). The performance results have been given in Table 5.3.

Fig. 5.6. Manual multicrop planter in operation for sowing of wheat and mustard as intercrop in sugarcane

Fig. 5.7. Intercropping of wheat and mustard in sugarcane with manual multicrop planter

Table 5.3. Performance of manually operated multicrop planter for sowing of intercrop

Particular	Observed values	
Crop	Wheat	Mustard
Date of sowing	26.11.2018	29.11.2018
Average speed (km/h)	1.8	1.9
Depth of seed placement (mm)	55	42
Actual seed rate observed (kg/ha)	116	4.3
Effective field capacity (ha/h)	0.07	0.10
Field efficiency (%)	64.4	62.8
Cost of operation (₹/ha)	1070	750

Development of sugarcane manual stripper cum detopper

Three models of sugarcane stripper cum detopper were designed and developed. The technical specifications of all the models are given in Table 5.4. The preliminary testing of these tools have been carried out at Institute farm (Fig. 5.8). Two individuals, one male and one female having the experience of sugarcane harvesting for more than five years were selected for operating these tools. After harvesting of cane, data of cane stripping and de-topping with all tools was taken for 20 minutes continuous work by the operator (Fig. 5.9 & Table 5.5).

Table 5.4. Technical specifications of the sugarcane stripper cum detopper

Parameter	Model I	Model II	Model III
Weight (g)	408	398	225
Material of blade	High carbon steel	High carbon steel	High carbon steel
Thickness of blade (mm)	3.0	2.0	2.0
Thickness of cutting edge (mm)	0.5	0.5	0.5
Dia. of hand grip (mm)	35	30	30
Cutting length of the blade (mm)	110	95	85
Material of handle	Wood	Wood	PVC
Overall dimensions (LxB) (mm)	370x60	350x75	310x55

Model I Model II Model III

Fig. 5.8. Developed sugarcane stripper cum de-topper

Fig. 5.9. Operation of sugarcane stripper cum detopper in the field

Table 5.5. Test results of sugarcane stripper cum de-topper (Variety: CoPk 05191)

Parameter	Model I		Model II		Model III	
	Male	Female	Male	Female	Male	Female
Time (min)	20	20	20	20	20	20
Cane stripped & de-topped (No.)	107	65	86	66	116	99
Weight of the clean cane (kg)	48	29	38	31	50	45
Green top weight (kg)	10.5	7	7.5	9	15	10
Dry trash (kg)	5.8	4.2	4.3	5.4	9.1	5.5

Development of weed cleaner for weed management

A manual light weight weed cleaner was developed based on the principle of wiping (or brushing) for weed control in between crop rows by using non-selective herbicide *i.e.* glyphosate (round up) to the targets (weeds) by direct contact without damaging the crop (Fig. 5.10). The technical specifications of the cleaner are given in Table 5.6. The herbicide solution is supplied to an absorbent surface *i.e.* spongy roller in weed cleaner. The weed cleaner was calibrated for herbicide dose and volume of water. Preliminary testing of weed cleaner was carried out at Institute farm.

Fig. 5.10. Developed prototype of manual weed cleaner

Table 5.6. Technical specifications of manual weed cleaner

Particular	Value
Overall size (mm) (LxW)	1780x330
Effective working width (mm)	200
Main pipe length & diameter (mm)	1520 & 60
Roller width & diameter (mm)	210 & 95
Length of pipe and dia (mm) above the roller	210 & 16 (4 small holes of dia. 0.8 mm)
Capacity of the pipe (m^3)	0.005041 (5.0 litre)
Weight of the wiper (kg) (without chemical)	2.0
Tentative cost of the wiper (₹)	2500/-

Preliminary testing

Weed cleaner was tested at the farm in sugarcane field planted at 75 cm row spacing (Fig. 5.11). One person is required to operate the cleaner. The capacity of the cleaner was 0.04 ha/h at operating speed of 2.0 km/h. The discharge rate was observed 470 l/ha.

Sugarcane field before operation

Operation of weed cleaner in the field

Field conditions 10 days after operation

Fig. 5.11. Testing of the weed cleaner at Institute farm

Development of solar powered manual sprayer

A solar powered manual sprayer was developed for spraying herbicide/fungicide in different crops. The height of the spraying can be adjusted from 300 mm to 1000 mm. The technical specifications of the manual sprayer are given in Table 5.7. Preliminary testing of this sprayer has been carried out at Institute farm for spraying pre-emergence herbicide (Table 5.8 and Fig. 5.12 & 5.13).

Fig. 5.12. Manual sprayer in operation in the field for spraying pre-emergence herbicide

Table 5.7. Technical specifications of the solar powered manual sprayer

Overall dimensions (LxWxH) (mm)	1830x2930x1550
Minimum base height (mm)	300
Maximum height (mm)	1000
Type & No. of nozzles	Flat fan nozzles, 7
Nos. of wheels & dia (mm)	3, 670
Nos. of battery & pump used	2 each
Battery voltage & capacity	12 V, 8 Ah
Pump voltage, press., flow rate	12 V, 5.09 kg f/cm^2, 3.1 l/min
Pipe length, dia. & capacity	1900 mm, 200 mm, 65 litre
Power of solar panel used	20 W
Another drum capacity & separate pipe used	220 litre, 30 m

Table 5.8. Performance results of sprayer during preliminary testing

Effective width (mm)	3600
Average speed of operation (km/h)	1.8
Average discharge of nozzle (ml/minute)	614
Average discharge of all nozzles (l/minute)	4.3
Effective field capacity (ha/h)	0.52
Time to cover 1 ha area (h/ha)	1.92
Field efficiency (%)	80
Battery backup after fully charging (self charging by solar also during operation)	> 6 h

Fig. 5.13. Developed prototype of Solar powered manual sprayer

CHAPTER 6

Diversification and Value-addition in Sugarcane

Development of sugarcane juice extractor for household use

The existing centrifugal juicer was modified for the extraction of sugarcane juice. Pusher was developed so that sugarcane stalk could be pushed on the grinding plate. Rind was removed with the help of sugarcane peeler. The peeled cane stalk was cut into pieces and nodes was removed.When the peeled sugarcane stalk was feeded with the help of the developed pusher, the juicer was able to extract 40% of sugarcane juice. The capacity of the juicer (Fig. 6.1) was 350 ml per minute. The feeding chute was suitably blocked to prevent choking.

Fig. 6.1. (a) Cut cane pieces (b) Juicer and (c) Extracted juice

Refinement of sugarcane cleaner cum washer for jaggery

The performance of sugarcane cleaner-cum-washer (SC-c-W) was evaluated with three sets of speed of scrapping rollers. In the third set, all the scrapping rollers moved with different speed for better scrubbing action. Speed and direction of rollers in different roller sets is given in Table 6.1.

Single, two and three-canes feeding with single, double and triple pass were used for evaluation.

Table 6.1. Speed and direction of rollers in different roller sets

Roller set	Position of rollers	Direction of rollers	Speed of feed rollers (rpm)	Speed of 1st set of scrapping rollers (rpm)	Speed of 2nd set of scrapping rollers (rpm)
I	Upper	Forward	15	50	75
	Lower	Backward	15	50	75
II	Upper	Forward	15	60	90
	Lower	Backward	15	60	90
III	Upper	Forward	15	50	75
	Lower	Backward	15	60	90

Effect of roller set on impurity removal

Effect of roller sets on impurity removal for single pass and for single, two and three canes feeding is shown in Fig. 6.2.

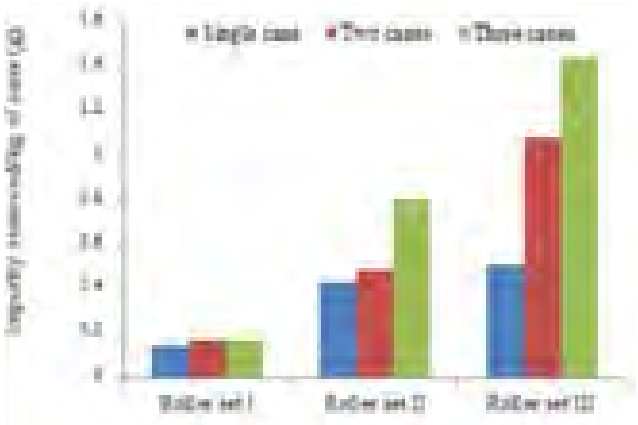


Fig. 6.2. Effect of roller set on impurity removal (Single pass)

It was observed that maximum impurity was removed in case of roller set III and minimum with roller set I. Impurity removal was also increased with increase in number of cane feeding due to more resistance provided by canes.

Effect of number of passes on impurity removal

Effect of number of passes on impurity removal for all the cases of roller sets for single cane feeding is shown in Fig. 6.3.

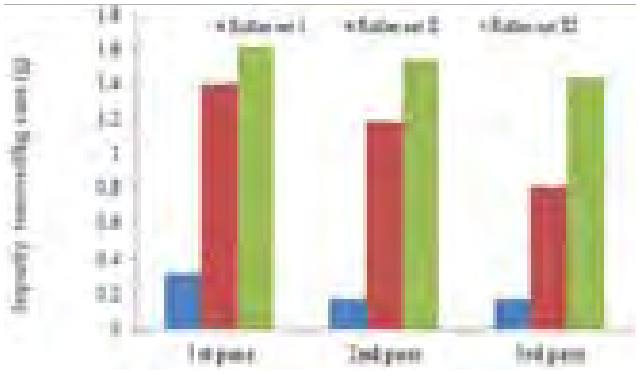


Fig. 6.3. Effect of number of pass on impurity removal (Single cane)

It was observed from above figure that impurity removal decreases with number of passes with all the roller sets. This is due to the fact that available impurities decrease with the consecutive number of passes *i.e.* once impurities are removed in a pass, less impurities are available for subsequent passes for further removal.

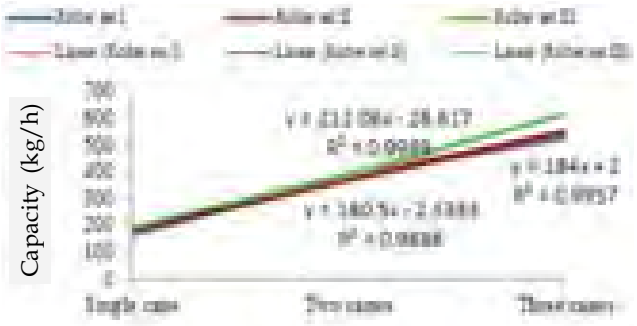


Fig. 6.4. Effect of cane feeding on capacity of SC-c-W (Number of pass 1)

Development of a jaggery furnace with efficiency boosting device

The scale up model of efficiency boosting device with nipples is in the process of fabrication for installation in IISR 2-pan furnace. On installation, furnace performance would be evaluated.

Development of Integrated drying system for jaggery drying

Data on solar radiation, humidity and ambient temperature for drying period have been collected. Three units of heating element having power rating as 1,000 W each have been selected for supply of hot air into the drying chamber. Seventy five mm diameter pipe has been used for supply of hot air received through waste heat recovery system of furnace.

Externally funded project-Development of process technology (protocol) for manufacturing of protein rich jaggery using natural source

Recruitment of Junior Research Assistant has been completed and approval for the same has been received from CSTUP. Literature has been surveyed and a rich and natural source of protein has been identified. Experiments have been conducted. The samples are ready for the analysis.

Development of a semi-automatic jaggery manufacturing plant

A wet and dry vacuum cleaner was used together with strainer for scum removal from the pan during juice clarification. Two types of hoods were also tried. A molten jaggery pumping unit was designed based on principle of vacuum suction. It consists of pump, water inlet valve, vacuum valve, vacuum breaker valve, suction valve. A mechanism is being developed so that machine will remain fix and through food grade pipes, molten jaggery will be transferred to cooling pan.

CHAPTER 7

Developing Sugar Beet Varieties Suitable for Indian Agro-climates

Developing sugar beet varieties suitable for Indian agro-climates

One hundred twenty two germplasm lines were maintained during 2018-19 at Lucknow, out of which 80 germplasm lines were planted at Mukteswar for seed production. Five crosses were attempted for high sucrose and root yielding variety for sub-tropical conditions (Fig. 7.1).

Morphological assessment of sugar beet grown under water limiting conditions: The experiment was laid out in RBD with eleven treatments and two checks, *viz*., LS 6 and IISR Composite 1, in three replications with the aim of identifying sugar beet having good growth and yield under drought conditions in comparison to normal conditions. Morphological results showed that LKC 2007, LK 7 and LKS 10 had maximum leaf weight against check varieties under normal but under drought conditions, Shubhra and LKC 2006 had maximum leaf weight. In root length, LK 4 and LKS 10 recorded the highest root length under normal condition but under drought condition, LK 7 and LK 4 showed superiority over checks. In root width, six varieties, *i.e.*, LKC 2010, Shubhra, LKC LB, Hilma, LK 7 and LKC 2007 recorded root width close to check variety LS 6 in comparison to check varieties under normal conditions while under drought conditions, three varieties, Hilma, LK 7 and LK 4 recorded the highest root width against check varieties (Table 7.1).

Juice quality assessment of sugar beet grown under normal and drought conditions: Quality assessment of the above mentioned eleven varieties against two checks was done for high sucrose content and ethanol recovery under drought conditions. Results revealed that three varieties, *i.e.*, LKC 2010, LKC LB and Shubhra recorded

Fig. 7.1. Flowering and crossing in sugar beet at Mukteswar

Table 7.1. Morphological observation on sugar beet grown under drought conditions

Variety	Leaf weight per crown (kg)		Root length (cm)		Root width (cm)		Single root weight (kg)	
	E_1	E_2	E_1	E_2	E_1	E_2	E_1	E_2
Shubhra	150.27	146.24	23.67	14.25	7.83	7.67	0.96	0.87
LKC 2006	161.81	157.05	25.83	20.83	8.83	6.67	0.92	0.54
LK 4	168.69	75.33	27.83	21.83	9.17	8.33	1.27	0.56
LKC 2000	186.70	148.98	26.50	19.23	9.83	6.93	0.54	0.59
LKC LB	185.43	109.16	17.00	19.67	7.83	6.83	0.67	0.54
LKC 2007	316.71	139.46	16.67	19.17	10.33	6.80	0.69	0.64
LKS 10	341.11	143.98	20.50	20.30	7.33	8.17	0.86	0.54
LK 7	283.65	178.38	26.67	21.00	8.83	7.00	0.97	0.84
Hilma	186.98	171.24	22.83	22.83	7.17	8.23	0.92	0.67
LKC 2010	244.05	99.11	21.00	18.17	7.67	8.50	0.70	0.90
LS 6	246.87	204.16	26.83	18.17	8.50	6.67	1.06	0.66
IISR Composite 1	140.47	120.08	21.67	21.67	8.00	9.20	1.12	0.93

E_1: Irrigated & E_2: Drought

Table 7.2. Juice quality and ethanol recovery of sugar beet grown under drought condition

Variety	Sucrose content (%)		Brix (%)		Ethanol recovery (%)	
	E_1	E_2	E_1	E_2	E_1	E_2
Shubhra	14.48	16.36	16.90	20.30	8.14	7.32
LKC 2006	14.52	17.14	17.97	21.33	7.72	2.14
LK 4	17.88	15.59	18.97	17.80	8.32	5.50
LKC 2000	20.08	18.55	20.73	21.47	8.02	7.00
LKC LB	19.67	19.48	19.87	21.57	7.61	7.60
LKC 2007	21.07	18.91	20.27	21.40	*	*
LKS 10	18.51	15.22	19.43	19.83	2.63	7.38
LK 7	16.53	18.24	19.13	20.10	4.14	5.03
Hilma	18.69	17.05	19.03	21.29	7.44	8.22
LKC 2010	18.68	15.99	18.37	18.90	7.54	7.58
LS 6	19.68	16.88	20.57	19.23	8.52	3.66
IISR Composite 1	17.20	13.01	19.87	18.30	7.16	9.64

E_1: Irrigated & E_2: Drought; *Didn't respond

the highest sucrose content in sugar beet under normal conditions while none of the varieties showed better performance under drought conditions against check in sucrose content (Table 7.2). LKC 2000 and LKC LB showed better brix in normal conditions against check varieties while LKC LB and LKC 2000 were better in drought conditions for this aspect. Assessment of ethanol recovery in drought conditions against normal conditions was performed in collaboration with ICAR-CISH, Lucknow. Results illustrated that LKC 2010, LK 4 and Shubhra recorded highest ethanol content against checks in normal grown conditions while under drought conditions, LK 7, Hilma and LKC LB were close to check varieties.

CHAPTER 8

Economics, Statistics and ICT

Factors contributing economic viability of sugar and energy production complexes

To fulfill objectives of project, primary data was collected from 40 sugar mills from western, central, eastern U.P., Uttarakhand and Maharashtra during sugar season 2015-16, 2016-17, 2017-18 and 2018-19. The selected sugar mills were classified as standalone or integrated complex owned by cooperative or private sector mills. Besides the sugar mills, primary data were also collected from 105 sugarcane farmers to examine comparative economics of sugarcane production in Maharashtra and Uttar Pradesh. Simple tabular analysis and appropriate statistical methods were applied to estimate cost, return and net profit. Ten sugar mills, 5 distilleries and power co-generation each from U.P. and Maharashtra was surveyed during sugar crushing season 2018-19 and data collected on various socio-economic parameters affecting economic viability.

Factors contributing sugarcane profitability and financial viability of sugar sector in India

Indian sugar industry provides livelihoods to 7.5 million sugarcane growers and 1.0 million skilled workers employed in sugar mills and allied industries. This sector faced challenges due to climate change, water scarcity, higher input cost and labour wages which ultimately led to decrease in profitability to sugarcane farmers. In spite of production constraints, sugarcane productivity has increased from 59.6 to 79.2 t/ha and sugar recovery has also improved from 9.52% to 11.50% during year 2013-14 to 2018-19 in U.P. There were wide fluctuations in sugarcane productivity from 60 to 108 t/ha and stagnated sugar recovery 11.30 per cent due to low rainfall and water scarcity in Maharashtra during last five years. The area under early maturing sugarcane varieties has increased from 14.6 per cent to 85.8 per cent during last five years. Major production constraints were sugarcane mono cropping, low soil organic carbon, non-availability of quality seed, indiscriminate plant protection chemicals and fertilizer use, narrow row spacing, crop planting without sett treatment and heavy infestation of white grub in some parts of Maharashtra. The majority of cane farmers do not apply FYM/bio-fertilizers and green manuring regularly. The use of mechanical power in sugarcane cultivation has upward trends in Maharashtra and U.P. as they have adopted mechanization for planting and intercultural operations to address labour paucity. The sugarcane farmers realized higher productivity and reaped better net income with wide-adoption of Co 0238, CoLk 94184 in U.P. and CoM 265, Co 86032 in Maharashtra; intercropping with pulses/oilseeds/vegetables with cane, wider row spacing, single/two bud setts planting, drip or irrigation in trench to improve productivity per unit of water use. Farmers also adopted sugarcane cutter planter/trencher for sowing, multi-purpose power tillers for intercultural operations in both the states. They earned the net income of ₹ 24,920 to ₹ 45,852 per ha from different intercrops grown and market price.

Comparative economics of sugar production in U.P. and Maharashtra

Sugarcane processing includes operational expenses such as sugarcane price, harvesting and transportation cost as well as fixed expenditure incurred by the sugar mills and different conversion cost components, depreciation, interest paid and other expenses for sugarcane processing into value added products to attain goals of sweetener food and energy security. Table 8.1 reveals that the sugar production cost in two major producing states varied from ₹ 3,487 to ₹ 3,550/q in standalone sugar mills having crushing capacity less than 4,000 TCD. The integrated sugar-energy production units of more than 7,000 TCD have sugar production cost ₹ 3,321 to ₹ 3,402/q in Maharashtra and Uttar Pradesh, respectively. Due to surplus sugar production and its supply in domestic market, it led to decline in prevailing ex-mill sugar price to ₹ 2,900 to 3,450/q during year 2017-18 in a standalone, integrated sugar-energy complex owned by cooperative or private sector. The cost of sugarcane has a lion's share of 77 to 81% of total cost of sugar production in standalone sugar mills. The average cane crushing capacity of 20 surveyed sugar mills varied from 1,750 to 10,000 TCD in Uttar Pradesh and Maharashtra. The sugar mills in Maharashtra recorded sugar recovery of 11.9% and 11.95% such as Daund and Pravaranagar Sugar Mill. The sugar mills in U.P. such as Ajbapur, Loni, Rupapur and Haryawan also achieved sugar recoveries of 10.32 to 11.55% during crushing season 2017-18. These sugar mills initiated steps to ensure minimum extraneous material with cane, minimize cane cut to crush duration and reduced post-harvest sucrose losses. The integrated sugar-energy complexes used upgraded technologies and majority of respondent cooperative owned sugar mills had to increase crushing capacity, sugar recovery and made them economically viable, self reliant and competitive with efficient private sector sugar mills in U.P. and Maharashtra.

Table 8.1. Economic analysis of sugar production in major producing states during 2017-18 (in ₹/quintal sugar)

Sl.	Parameter/Cost component	Stand alone < 4000 TCD		Sugar + Co-gen 4000-7000 TCD		Sugar + Distillery + Co-gen > 7000 TCD	
		U.P.	M.S.	U.P.	M.S.	U.P.	M.S.
1	Sugarcane price	2824	2099	2742	1739	2640	2012
2	Harvesting & transport	0	639	0	591	0	631
	Total sugarcane cost	2824	2737	2742	2329	2640	2643
3	Power/electricity price	38	17	38	22	20	36
4	Chemicals expenses	17	38	17	32	29	17
5	Salary and wages	288	307	263	416	277	205
6	Packaging	40	33	41	36	40	57
7	Repair and maintenance	33	110	31	89	46	77
8	Overheads	63	135	68	119	73	69
	Cash conversion cost	479	641	458	715	485	463
9	Depreciation	34	46	43	70	77	36
11	Interest on						
	Working capital	144	122	163	195	149	111
	Term loans	6	4	11	83	33	9
	Deposits	1	0	2	43	19	59
12	Total interest	151	126	176	321	200	179
13	Total conversion cost	663	813	676	1107	762	678
	Cost of sugar production	3487	3550	3419	3436	3402	3321

Sugar recovery and production varied noticeably in sugar mills owned by cooperative or private sector. There are wide fluctuations in sugarcane supply to sugar mills during past four years which affects economic feasibility, profitability, cane price payment and outstanding cane price arrears on sugar mills. The integrated sugar-energy complex with more than 7,000 TCD capacity in Maharashtra have slight comparative cost advantage as compared to similar sugar complex in Uttar Pradesh as indicated in Table 8.1. Hence, these sugar complexes have economic advantage in sugar export to international market. This may not hit them harder due to transport cum freight costs for sugar exports as compared to land-locked state of Uttar Pradesh. The Government of Maharashtra provides financial subsidy of ₹ 5,000/t for sugar export promotion.

Economic analysis of bio-ethanol production from B-heavy molasses and final molasses

In order to balance sugar demand-supply equilibrium and enhance the bio-ethanol production, the Government of India announced differential price policy for bio-ethanol production from different routes such as conventional (C-molasses), B-heavy molasses and directly from sugarcane juice. The surplus sugar production during past seasons has depressed domestic sugar price. Therefore, sugar mills have lost their profitability which led to accumulation of huge cane price arrears due to poor paying capacity to the farmers. To reduce sugar production, the Govt. of India has taken policy decisions and allowed B-heavy molasses and sugarcane juice diversion for ethanol production during season 2018-19.

The Government declared premium of ₹ 52.43 and ₹ 59.13 per litre as bio-ethanol price produced from B-heavy molasses and directly from cane juice, respectively as compared to existing ethanol price ₹ 47.13 per litre produced through conventional route. Besides these incentives, applicable GST and transportation charges would be paid by the OMCs. The OMCs have been instructed to give priority for procurement of bio-ethanol produced from sugarcane juice, B heavy molasses as compared to conventional C molasses. Table 8.2 reveals that the bioethanol production through B-heavy

Table 8.2. Comparative economics of bio-ethanol production using B heavy and C molasses

Particulars/Economic parameter	Final C-molasses	B-Heavy molasses
Sugarcane crushing capacity (TCD)	5,000	5,000
Sugar recovery (%)	12	10.5
Molasses production (% cane crushed)	4.5	6.5
Sugar production (t/day)	600	525
Molasses production (t/day)	225	325
Sugar price (₹/t)	31,000	31,000
Molasses price (₹/t)	5,000	10,000
Ethanol price (₹/litre)	43.46	52.43
Sugar production losses (t)	0	75
Sugar revenue losses (₹ lakh)	0	23.25
Cost of C molasses (₹ lakh)	11.25	11.25
B heavy molasses price (₹ lakh)	0	32.5
Bio-ethanol recovery (l/t)	230	375
Bio-ethanol production (l/day)	51,750	1,21,875
Revenue from bio-ethanol (₹ lakh/day)	22.49	63.90
Raw material cost (₹/litre)	21.74	28.31
Conversion cost (₹/litre)	10.50	10.50
Cost of bio-ethanol production (₹/litre)	32.24	38.81
Net profit to distillery unit (₹/litre)	11.22	13.62

molasses gives per unit net income of ₹ 13.62 to the distillery as compared to ₹ 11.22 per litre by conventional final molasses route. The B heavy molasses utilization for bio-ethanol production may reduce the sugar by about 15-20% and increase bio-ethanol production by about 125-200% as indicated in Table 8.3. The major constraints in adoption of flexi sugar- bio-ethanol production plan are need of huge initial investment on modernization of distillery and storage capacity. If sugar-energy complex of 5,000 TCD is willing to adopt complete flexi plan of diversion of whole sugarcane for ethanol production, it requires a modern distillery 350-400 KLPD capacity along with storage facility as reported in Table 8.3. It needs additional financial outlay of approximately ₹ 500-600 crores.

The diversion of B heavy molasses for ethanol production would reduce steam consumption in sugar leading to bagasse saving, improvement in sugar colour, size and enhance power export from cogeneration unit. The sugar mills would also have some saving in poly packing/gunny bags due to less sugar production. It would reduce interest burden on sugar stock, transport cost and minimize per litre effluent treatment cost to the integrated sugar-energy complex. It is expected that out of total ethanol supply of 750 million litre, 210 million litre would be manufactured from B-heavy molasses/ sugarcane juice.

Policy support measures initiated by the Government of India

The Govt. of India has encouraged sugar export through reduction in export tax. The sugar export is yet to improve as prices in global market is low. To improve economic viability of Indian sugar sector, the Govt. of India decreased GST on ethanol from 18% to 5% and declared higher premium price to encourage diversion of B heavy molasses and partial sugarcane juice for ethanol production.

The Uttar Pradesh Power Corporation Limited (UPPCL) and U.P. Electricity Regulatory Commission (UPERC) has proposed to reduce power tariffs by 35% in the next five years for bagasse-based co-gen power supplied by sugar mills. The prevailing electricity tariffs of ₹ 6.19 to ₹ 6.75 per unit for the purchase of cogenerated power reduced by ₹ 2.00 to 2.25 per unit, beleaguered sugar mills to face economic revenue loss of nearly ₹ 500 crore as annual power supply bill by sugar mills to UPPCL was approximately ₹ 1,500 crore. The new tariffs would be determined for captive and non-conventional energy generating plants (CRE) regulation, applicable on co-generation of power from bagasse, biomass, solar plants *etc.*

The Government has made obligatory Minimum Indicative Export Quota (MIEQ) for sugar export promotion. The sugar millers demands more economic incentives to make sugar exports viable with prevailing international sugar prices, bumper sugar production and demand-supply disequilibrium led to market glut. The Government permitted 2.5 m t raw sugar and 3.5 m t refined sugar export under MIEQ scheme for sugar season 2018-19 to clear surplus stocks and improve cash flow to mill for cane price arrears payment. These policy measures may reverse domestic market sugar price trend.

Impact assessment of IISR developed technologies

A study on impact assessment of Institute developed technologies such as sugarcane cutter planter, varieties developed and other production and protection technologies was carried out. ICAR-IISR developed sugarcane cutter planters are being manufactured by number of manufacturers in many States and are getting very good acceptance amongst all the categories of sugarcane growers. The large farmers who face acute shortage of labour during peak periods are also showing interest to purchase these machines. Preliminary estimates revealed that the number of sugarcane cutter planters in operation in India has increased substantially in almost all the cane growing states of India. The sugarcane cutter planters have been purchased by all types of cane holdings. There are about 2.63 lakh cane growers who are using sugarcane cutter planters. These sugarcane cutter planters are not only popular with the large holdings but are also very popular with the small cane growing holdings. About 62.75% of these categories of farmers are also using these machines, may be by custom hiring the machine. The

Table 8.3. Comparative analysis of sugar production loss and bio-ethanol production gain

Particulars	Sugar recovery (%)	Sugar production decrease (%)	Bio-ethanol production gain	Constraints and added economic advantages
Conventional route	11.6-12.4	-	-	Sugar mills having distillery need no new investment.
B heavy molasses	10.1-11.0	15-20	1.25 to 2.0 time increase in bio-ethanol	Need huge investment to enhance B heavy molasses storage and distillery capacity.
Partial sugarcane juice	6.0-8.0	35-55	3.1 to 3.4 time increase in bio-ethanol	Need huge additional investment to enhance storage and distillery capacity.
Total sugarcane juice	0	0	6.9 to 7.5 time increase	Require 300-400 KLPD distillery with the 5,000 TCD sugar mills.

use of this planting machine eliminates manual seed distribution and planting operation and results in the saving of 35 mandays per ha in the planting of cane. The extent of cost reduction in sugarcane cultivation in India is to the extent of ₹ 182 crore. The machine is also good on equity considerations as about ₹ 103 crore is the saving on the farms of small holders. The returns to research on sugarcane cutter planter were also worked out.

Varietal breeding started at ICAR-IISR, Lucknow after it was taken over by ICAR in 1969. Successful IISR varieties released by CVRC are CoLk 8001, CoLk 8102, CoLk 94184, CoLk 09709 and CoLk 09204. IISR developed CoLk 94184 (Birendra) in 2008. This is an early maturing variety for the sub-tropical agro-climates, particularly the North Central Zone which is prone to water logging. The adoption of sugarcane varieties developed by the Institute has significant economic gain to the sugarcane farmers and sugar mills in subtropical region during last few years. The impact of the cultivation of CoLk 94184 has contributed to high sugar recovery levels during last three years in U.P. The sugar recovery achieved in U.P. was higher by 1.00 percentage point. The annual economic gains due to cultivation of CoLk 94184 were worked out at ₹ 510 crore during 2018-19 out of which 24% accrued to growers by way of higher prices and 76% to sugar mills in terms of higher recovery in sub-tropical region.

Estimation of techno-economic feasibility of sugar beet cultivation for sugar and ethanol production in India

As an alternative sugar crop, sugar beet was introduced into India and IISR took the lead role in developing suitable agro-techniques for its cultivation. Sugar beet is now being grown in sizeable area (around 50,000 ha) in Punjab for ethanol production in contract farming mode. Farmers are reaping a harvest of 87.5 tonnes sugar beet per ha and earning gross returns to the tune of ₹ 1.5 lakh and net return to the tune of ₹ 68,000 to 75,000 from a short-duration crop. Given assured marketing, the crop has the potential to replace wheat crop in the area.

Based on a survey of 40 sugar beet growers in Punjab, the economic feasibility of sugar beet cultivation *vis-a-vis* that of wheat cultivation, its competing crop, was carried out. Net returns from sugar beet cultivation were more than double the returns being obtained from rice or wheat cultivation. The sugar beet cultivation has increased the income levels of the growers. Sugar beet growers are generally having higher holding size, the average size was 19.5 acres.

Analysis of comparative economics of wheat crop and sugar beet crop revealed that though the total cost of sugar beet cultivation (₹ 93,500 per ha) is almost double compared to that of wheat cultivation (₹ 48,000 per ha), the net returns per ha were almost the double compared to wheat crop.

The requirement for labour was 4 times higher compared to just 16 man days required per ha for wheat crop. Around 60% of the total labour in sugar beet was required for manual weeding operations. There is a demand for more female workers in sugar beet growing while no female worker was involved in wheat cultivation.

Eighty per cent farmers perceive that sugar beet gives more returns compared to wheat crop. About 60% farmers were convinced that the crop improved the land quality, while 40% were desirous of shifting away from the wheat crop.

The weakness associated with the crop cultivation is high demand for labour for manual weeding in the wake of non-availability of an efficient weedicides. High labour consumption for hand weeding and harvesting results in increased cost of cultivation.

Online database and mixed model analysis of sugarcane varieties tested/released in India

Mixed model analysis indicated that there is no significant difference in cane yield and sucrose of early and mid-late trials of the country. Early and mid-late trials may be merged together in each zone of the country as it was observed in the long term data analysis. However, there was clear cut significant difference between zones and between plant and ratoon crop of the country. The following benefits are expected to take place with the execution of new project :

- Cost of the experimentation in sugarcane varietal programme will reduce.
- Entries in the combined trials will get better chance of comparison among early and mid-late entries.
- Error of the experiment will be minimized due to large number of entries in the trials and better experimentation.
- Handling of the experiments will be easy for planting, irrigation and other cultural practice.
- Dispute of payment for early varieties to the farmers will not arise and they will get better price.

Efficiency of designs in sugarcane field experiments

As per the recommendation of the proceedings of the 32nd Biennial Workshop-2018 of AICRP on Sugarcane, an experiment on "Efficiency of Designs in

Sugarcane Field Experiments" was undertaken. Two Experiments (Alpha Design and Randomized Block Design) were planted at ICAR-IISR farm with 21 varieties in two replications in both the designs. In Alpha Design, in each replication, three blocks were formed with seven varieties in each block. Separate Randomized Block Design was also planted with two replications. Germination percentages of each plot in both the experiments were recorded at 45 days and 60 days. Combinations of other designs will also be tried and efficiency will be compared.

Development of web based reporting system for the trials of AICRP on Sugarcane

Web site of AICRP on Sugarcane has been developed and launched. AICRP Reporter, a web based application is being developed for online data updation of AICRP trials beng conducted at various centres. A brief information about the modules developed so far is as follows:

Profile management modules deal with a management of AICRP trials data *viz.* Project, Experiment, Centre, Official, Trial, Treatment, Character/Attribute, Treatment Schedule, Attribute Schedule, and Event/Activity, *etc.*

Activity Dashboard will be the platform available to users of the software to access all the tools available in the system. It has buttons/links to perform activities such as addition, updation, search, sort, view and remove profile record.

System enables two modes of observation recording by the centre *viz.* Online through AICRP Reporter portal and Offline through Excel Sheet generation.

Analysis & Knowledge Hub will host modules to carry out data analysis, data mining and knowledge discovery from the system. Till now, modules have been developed to carry out data analysis (RBD) of recorded trials observations.

Security mechanism has been incorporated in the software to deny unauthorized access of the software modules and AICRP data. System incorporates three level of security mechanism *viz.* User Registration and Authentication, Role-based access to Software Modules and Data Filtering Rules.

Further, excel files for observation recording from Varietal Trials of 2017-18 conducted at various centres have been generated and submitted to PC (Sugarcane) for data collection.

Exploratory study on global sugar beet production and growth scenario

Sugar beet is a temperate crop and is mainly cultivated in cold countries where sugarcane cultivation is not feasible. Out of the total sugar production in the world, 20% sugar is produced from sugar beet.

The EU (EU-28) is the world's leading producer of beet sugar, with around 50% of the total beet sugar production. However, beet sugar represents only 20% of the world's sugar production; the other 80% is produced from sugar cane.

The trends in world area coverage, production and yield of both sugarcane and sugar beet crop were analysed. In terms of area coverage, the area under sugar beet crop was 7.65 million ha during seventies and it has declined to 4.60 million ha at present, while the area under sugarcane has increased from 9.75 million ha to 26.50 million ha. The production of sugar beet was 202.4 million tonnes in seventies which increased to just 264.69 million tonnes at present while the production of sugarcane increased from 504.03 million tonnes during seventies to 1864.87 million tonnes at present. The world average yield of sugar beet was quite low at 26.36 tonnes per ha during seventies which increased to 57.66 t/ha at present in sharp contrast to higher yield levels of sugarcane during seventies at 51.57 t/ha which increased to a level of 70.37 t/ha at present.

Advisory on estimates of cost of cultivation of sugarcane in U.P. during 2018-19

The cost of sugarcane cultivation for central U.P. region was estimated by carrying out survey of 20 farmers in Hardoi district of the state. The cost of sugarcane production was estimated to be ₹ 308 per quintal of plant crop and ₹ 298 per quintal of ratoon crop for the year 2018-19 sugar season. Advisory on cost of production of sugarcane in central U.P. was also provided to U.P. State Sugarcane Department in connection with the fixation of sugarcane price.

CHAPTER 9

All India Coordinated Research Project on Sugarcane

Technologies developed

Sugarcane varieties identified

During meeting of Variety Identification Committee, held at the University of Agricultural Sciences, Bengaluru (Karnataka) on 17th October, 2018 during 32nd Biennial Workshop of AICRP on Sugarcane, four sugarcane varieties *viz*., Co 10026 (Upahar), Co 12029 (Karan-13), CoLk 12207 (Ikshu-6) and CoLk 12209 (Ikshu-7) were identified for release and notification.

Co 10026 (*Upahar*): This variety has been developed by ICAR-SBI, Coimbatore in early group for Peninsular region and identified in 2018. The variety exhibited cane yield by 109.06 t/ha, CCS yield by 13.86 t/ha and sucrose by 17.98% in juice. It is tolerant to drought and salinity conditions. It is resistant to red rot and YLD.

Co 12029 (*Karan*-13): This variety has been developed by ICAR-SBI RC, Karnal under mid-late group for North-West zone and identified in 2018. The variety recorded cane yield by 95.57 t/ha, CCS yield 12.07 t/ha and sucrose 18.10% in juice. It is suitable for planting in autumn and spring seasons. It is the least susceptible to shoot borer, top borer and stalk borer.

CoLk 12207 (*Ikshu*-6): This variety has been developed by ICAR-IISR, Lucknow in early group for North Central & North East Zones and identified in 2018. The variety has exhibited cane yield by 75.42 t/ha, CCS yield by 8.74 t/ha and sucrose by 16.90% in juice. It is non-lodging, non-flowering and better ratooning. It is resistant to red rot and waterlogged condition.

CoLk 12209 (*Ikshu*-7): This variety has been developed by ICAR-IISR, Lucknow in mid-late group for North Central & North East zones and identified in 2018. The variety has exhibited cane yield of 77.5 t/ha, CCS yield of 9.38 t/ha and sucrose 17.65% in juice. It is non-lodging, non-flowering and better ratooning.

Events/Meetings organized

32nd Biennial Workshop of AICRP on Sugarcane

The 32nd Biennial Workshop of All India Coordinated Research Project on Sugarcane was hosted by the University of Agricultural Sciences, Bengaluru (Karnataka) during September 17-18, 2018. Dr. S. Rajendra Prasad, Vice Chancellor, UAS, Bengaluru was the Chief Guest. Dr. Y.G. Shadakshari, Director of Research, UAS, Bengaluru welcomed all the delegates and participants. P.C. (Sugarcane) presented the highlights and achievements of AICRP (S).

Recommendations

The plenary session was held on October 18, 2018. The Chairman invited Principal Investigators/ Rapporteurs for presentation of the proceedings of different technical sessions. The following recommendations were made:

- It was observed that some of the centres are testing elite clones in Station/multi-location trials in their respective states with selection numbers and entries

are being released in the name of selection numbers, which is not as per the AICRP(S) norms. Entries which are entering into station trials must have the AICRP(S) allotted slot numbers. Hence, AICRP(S) number may be assigned by the proposing centre for the new entries within the slot number allotted for the centre and proposed for inclusion in the ZVT in the AICRP(S) workshop/ group meeting. This will ensure the maintenance of uniform number for the new entries in both the station trials and ZVT.

- The data submitted by the centre must be carefully scrutinized by the Scientist before sending to Principal Investigator (CI). ADG (Commercial Crops), ICAR viewed it seriously and noncompliance of the recommendations will invite review of budget of the concerned centre.
- An undertaking must be taken from the farmers/ factories when pre-released clones are given to them for Adaptive Research Trial. The elite clones may be characterized with DUS morphological descriptors and if possible, DNA finger printing before giving to them. This will give protection to the centres which developed the clones and to avoid wrong claim made by other parties.
- Determination of optimum spacing for planting under experiment AS 72 of Crop Production was deffered for the next meeting of AICRP on Sugarcane. It was decided that a consensus should be evolved for optimum spacing in different zones.
- Under experiment PP14 of Crop Protection, the occurrence of red rot pathotypes in Co 0238 especially in Lucknow, Shahjahanpur, Karnal and Pusa regions of the subtropical India was discussed in detail. It was consented that a rigorous screening and validation was required prior to reporting about the presence of new red rot pathotype.
- Strict vigil and adequate quarantine measures are required to check the spread of the diseases through seed material . A letter should be written to all the State Govt. Agencies, ISMA, DSTA, SISTA, NISSTA for issuing advisory to all the sugar factories to follow the strict vigil and adequate quarantine measures while importing the seed material from abroad.
- The Chairman suggested that at least one/two recommendations regarding preventive measures should also come from entomology discipline for different regions.
- A meeting of all the researchers working on sugarcane may be convened by the PC (S) to discuss and modify the Technical Programme 2018-19 as per the new policy of the Government.

Varietal Identification Committee Meeting

Varietal Identification Committee Meeting was held under the Chairmanship of Dr. R.K. Singh, ADG (Commercial Crops), ICAR, New Delhi on October 17, 2018 at UAS, Bengaluru during 32nd Biennial Workshop of AICRP(S). Ten varietal proposals were put up before Varietal Identification Committee Meeting for consideration. The four sugarcane clones *viz*., Co 10026 (Upahar), Co 12029 (Karan-13), CoLk 12207 (Ikshu-6) and CoLk 12209 (Ikshu-7) were identified for release.

Zonal Breeders & Plant Pathologists Meet

Zonal Breeders & Plant Pathologists Meet-2019 of AICRP on Sugarcane was organized at ICAR-IISR Regional Centre, Motipur (Bihar) on January 11, 2019 to finalize the sugarcane genotypes for the Advanced Varietal Trials. The breeders and pathologists from various research institutes, universities, centres working under All India Coordinated Research Project on Sugarcane and state cane development officials participated in the meet. The meet was inaugurated by the Chief Guest of the function, Dr. R.K. Singh, ADG (Commercial Crops), ICAR, New Delhi. He congratulated sugarcane researchers for the record sugar production (32 million tonnes) in the country.

Important decisions taken in the meeting are given below:

- In East Coast Zone, four entries were evaluated in IVT (E) and three entries *viz*., CoC 15336, CoC 15338 and CoV 15356 were selected based on juice sucrose % at 10th month, red rot resistance and field stand. These three entries will be evaluated in AVT (E) I Plant during the year 2018-19.
- Based on the juice quality traits, resistant to red rot and cane stand, out of five entries tested in IVT (ML), two entries namely, CoC 15339 and CoOr 15346 were selected. These entries will be multiplied for one year in all the centres during the year 2018-19 for testing in AVT (ML) I Plant during the year 2019-20.
- In North West Zone (NWZ), among the seven entries evaluated in IVT (E), four entries *viz*., Co 14034, CoLk 14201, CoPb 14181 and CoPb 14211 were selected based on juice sucrose % at 10th month, red rot resistance and field stand. These four entries will be evaluated in AVT (E) I Plant during the year 2018-19.
- Among the 13 entries tested in IVT (ML), seven entries namely, Co 14035, CoH 14261, CoLk 14203, CoLk 14204, CoPb 14184, CoPb 14185 and CoS 14233 were selected for conducting AVT (ML) I Plant during the year 2018-19.
- In North Central and North East Zones, eight entries were evaluated in IVT (E) and four entries *viz*., CoLk 14206, CoP 14437, CoSe 14451 and CoSe 14454 were selected for testing in AVT I Plant (Early) during the year 2018-19.
- Nine entries were tested in IVT (ML) and five entries *viz*., CoLk 14208, CoLk 14209, CoP 14438, CoP 14439 and CoSe 14455 were selected for testing in AVT I Plant (Mid-late) during the year 2018-19.
- Red rot incidence on PI 16376 was reported by Nellikuppam centre. Hence, the entry may be removed from evaluation and need not be included in the IVT (ML) during the year 2018-19 in the East Coast Zone.

CHAPTER 10

Outreach Programmes and Technology Management

Entrepreneurship development for sugarcane seed production and multiplication

The problem of unavailability of healthy seed of newly released or recommended sugarcane varieties in a sugarcane growing area is prevalent at large due to which old varieties are not being replaced by new recommended/released varieties. Many factors are responsible for this undesirable situation but few important among them are poor mechanism of seed cane production and multiplication; lack of entrepreneurial ability among farmers to venture out in seed cane production enterprise and Lack of technical know-how in seed cane production and multiplication among farmers. To address these problems, the project is being implemented in sugar mill zone areas of Uttar Pradesh.

Seed cane crop of nine selected varieties *viz.*, CoLk 94184, CoLk 09204, Co 98014, CoPk 05191, Co 0118, Co 0238, Co 08272, Co 08279 and CoLk 09709 was sown on farmers' fields in Sitapur, Lakhimpur, Shravasti, Hardoi, Farrukhabad, Mathura and Ballia districts of Uttar Pradesh. A total of 83 seed cane plots in 32.86 ha area were maintained in fields of 61 farmers of 22 villages (Table 10.1 & Figure 10.1). The average yield obtained for seed cane crop of different varieties raised during last season (2017-18) were 120, 122, 132, 110, 92, 112, 124 and 108 t/ha for varieties, respectively (Table 10.2). However, the average seed cane yield for all the varieties was 115 t/ha.

A total of 3533.20 tonne seed cane was produced out of which 62.58% (2211.18 t) was utilized as seed material either through sale to other farmers or on own

Table 10.1. No. of plots and area under seed cane crop of each variety

Sr. No.	Variety	Area (ha)	No. of seed plots
1	CoLk 94184	8.62	22
2	Co 0118	6.40	15
3	Co 0238	6.00	15
4	CoLk 09204	4.00	10
5	Co 08272	3.50	08
6	Co 98014	2.74	07
7	CoPk 05191	1.00	03
8	Co 08279	0.50	02
9	CoLk 09709	0.10	01
Total		32.86	83
Total number of farmers		61	

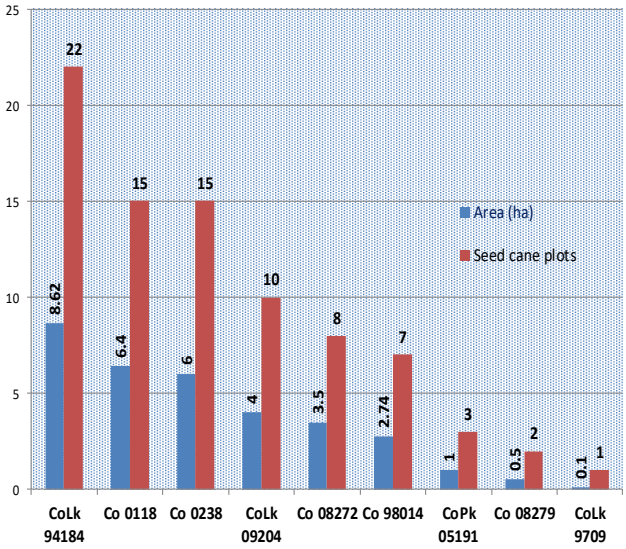


Fig. 10.1. Area and no. of seed cane plots under different varieties

farm to raise seed cane crop in order to multiply the quantity of seed cane of new varieties and the rest of the harvested cane was supplied by farmers to sugar mill for crushing. The average net profit recoreded for seed cane crop was ₹ 3,07,725 per ha, however it varied between ₹ 2,16,720 to ₹ 3,58,500 per ha which is much higher than the average net profit of ₹ 1,27,500 per ha earned under conventional method by cane farmers in the study areas of U.P. (Table 10.2). Cane variety-wise gross and net returns are also presented in Fig. 10.2.

The entrepreneurship training for beneficiary farmers was organised in the months of September, October, December, January, February and March to provide information in seed cane crop raising, motivate the farmers for enterprising in cane seed production and multiplication of new sugarcane varieties. The data on entrepreneurial ability of farmers (40) was collected with the help of interview schedule comprising of 10 parameters/traits of entrepreneurial behaviour (EB) *viz.*, risk taking, innovativeness, hope of success, persuasability, manageability, self confidence, knowledgeability, persistence, use of feedback, achievement motivation. The collected data was compiled and analysed and entrepreneurial behaviour index (EBI) are presented in Table 10.3. Maximum EBI value was reported for knowledgeability trait of entrepreneurial behaviour and minimum was reported for achievement motivation trait.

Table 10.2. Seed cane yield, seed cane production & utilization, economics of seed cane crop of each variety

Variety	Average yield (t/ha)	Total seed cane produced (t)	Seed cane utilization pattern (t)		Gross return (₹/ha)			Net profit (₹/ha)
			For seed multiplication	Crushing	Seed @ ₹ 4,000/t	Crushing @ ₹ 3,250 and ₹ 3,150/t	Total	
CoPk 05191	120	240.0	180 (75%)	60.0 (25%)	360000	97500	457500	337500
Co 0118	122	610.0	457.5 (75%)	152.5 (25%)	366000	99125	465125	345125
Co 0238	132	1584.0	792 (50%)	792 (50%)	264000	214500	478500	358500
CoLk 94184	110	506.0	404.8 (80%)	101.2 (20%)	352000	71500	423500	303500
Co 98014	124	310.0	186.0(60%)	124 (40%)	297600	161200	458800	338800
CoS 08272	108	86.4	60.48 (70%)	25.92 (30%)	302400	105300	407700	287700
Co 05011	92	73.6	44.16 (60%)	29.44 (40%)	220800	115920	336720	216720
CoLk 09204	112	123.2	86.24 (70%)	36.96 (30%)	313600	105840	419440	299440
All varieties	115	3533.20	2211.18 (62.58%)	1322.02 (37.42%)	287868	139857	427725	307725 (B:C 2.56)
Conventional	70	0	0	70 (100%)	0	227500	227500	127500 (B:C 1.27)
Percentage increase in net profit of the farmers								141.35
*Production cost @ ₹ 1,20,000/ha (for seed cane crop) and ₹ 1,00,000/ha (for conventional method)								

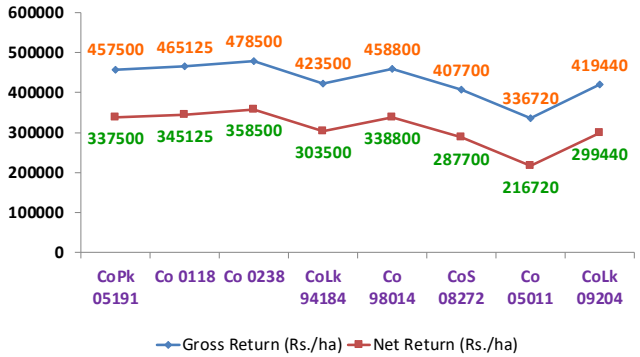


Fig. 10.2. Variety wise gross and net return (₹/ha)

Table 10.3. Entrepreneurial behaviour index of farmers (n=40)

Sl. No.	Attribute	Mean score	Entrepreneurial behaviour index	Rank
1	Risk taking	6.78	56.50	II
2	Hope of success	6.43	53.58	IV
3	Persuasability	6.18	51.50	VII
4	Manageability	6.75	56.25	III
5	Self confidence	6.30	52.50	VI
6	Knowledgeability	6.99	58.25	I
7	Persistency	6.18	51.50	VII
8	Feedback usage	6.42	53.50	V
9	Innovativeness	6.14	51.17	VIII
10	Achievement motivation	5.29	44.08	IX
Entrepreneurial behaviour		63.46	52.88	

Documentation and confirmation of indigenous technical knowledge under sugarcane based cropping systems

ITKs from the States of Uttar Pradesh and Bihar covering four sugar mill reserved zones, nine villages, 220 farmers, 45 KIs and 40 sugarcane development personnel were recorded. A total of 83 ITKs, 20 proverbs and 9 social beliefs were documented. Triangulation for confirmation of ITKs were also carried out.

An analysis of gender perspective in sugarcane cultivation

Review of literature for development of gender analysis framework has been carried out and items for development of Operational Difficulty Index have been collected. The items were edited, responses of judges collected, analysed and an Operational Difficulty Index has been developed to measure the operational difficulty of sugarcane production technologies.

Modulating application of sugarcane production technologies for harnessing production and productivity potential in farmers' field perspective

In order to invoke decision support and make out preferential choices for application of sugarcane production technologies, the stakeholders *i.e.* practising sugarcane growers, sugarcane researchers, sugar mill authorities and sugarcane development personnel were approached and consulted. The researchers recommended newly released varieties *i.e.* CoLk 09204, CoLk 11206 of mid late group and CoLk 14201 and CoLk 09202 of early group for on-farm trials at farmers' field in Kumbhi Chini Mill, Kumbhi, Lakhimpur Kheri district in Central Uttar Pradesh. The authorities of Kumbhi Chini Mill, Kumbhi namely Corporate Head, General Manager (Cane) and Senior Manager (Cane) were contacted. After detailed interaction, they had shown keen interest for conducting on-farm trials at farmers' fields. The critical inputs were met out jointly by ICAR-IISR, Lucknow, farmers and sugar mill. The ICAR-IISR was mainly providing the technological back-up. Before initiation of on-farm trials, soil samples from

the field of participating farmers were collected to know the soil health status. A training programme on innovative sugarcane production technologies like, insects pests and diseases management, methods of planting, nutrient management and ratoon management was conducted by the resource person of ICAR-IISR, Lucknow at Kumbhi Chini Mill, Kumbhi. A total of 28 participants (16 sugarcane development officials and 12 progressive farmers) participated in training. An interaction session was also organised in which queries of farmers and sugarcane development personnel were answered by the experts of ICAR-IISR, Lucknow to their utmost satisfaction. The overwhelming response was noticed and they demanded new varieties in view of emerging threats of red rot in the sugarcane variety Co 0238 which was extensively grown by the growers in the area.

For conducting 10 on-farm trials, 65.30 quintal seed cane of varieties namely, CoLk 09204, CoLk 11206 and CoLk 14201 was provided to sugarcane growers, out of which three trial of CoLk 11206, six of CoLk 09204 and one trial of CoLk 14201 were initiated in the month of April. Further on-farm trials were also proposed to be conducted in autumn season keeping in view of the enthusiasm shown by the growers during visit to their fields. The data would be recorded on germination %, number of tillers per hectare, millable cane per hectare, diseases and pests infestation as well as other growth parameters. A WhatsApp group of stakeholders was created for sharing information and knowledge on various aspects of sugarcane farming.

Model developed: Public-Private-Farmer Partnership (PPFP) model in sugarcane to double farmers' income

In the recent time, the public-private-farmer partnership (PPFP) has emerged as the most crucial and effective extension approach in achieving speedy growth in agriculture. The sugarcane sector in India operates under the public-private-farmer partnership arrangement for cane cultivation and marketing. So, this sector has vast potential to achieve higher productivity and profitability through partnership. To harness this potential, Public-Private-Farmer Partnership (PPFP) model was developed and implemented under outreach programme of the Extension and Training unit of The Institute (Fig. 10.3). The outcome of the programme is not only encouraging but also depicts unparalleled success achieved by the growers and sugar mills of the state. More than 30,000 progressive farmers and development workers from other states visited farmers' fields where interventions were introduced in PPFP mode and interacted with beneficiary farmers, this way farmer-to-farmer extension also happened there.

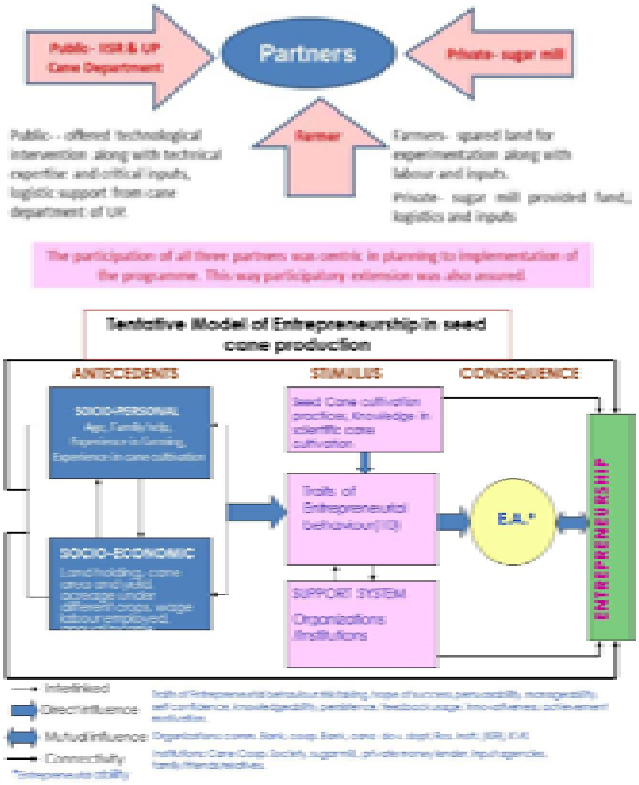


Fig. 10.3. PPFP model of enterpreneurship in seed cane production

Delineating intervention and assessing their contribution in doubling farmers' income

Complete enumerated data of eight selected villages in Hardoi and Lakhimpur districts of U.P. was collected with the help of extension/ cane development personnel of the sugar mills in the first half of the year 2018 by executing survey schedule in personal interview mode. The collected data was compiled, collated and analysed to have deep insight into existing farming conditions and present level of farm income in the villages. On the basis of information generated on actual farming situation and farm income, interventions related to sugarcane based system, other cropping/farming systems were listed, prioritized and their respective tentative contribution in doubling farmers' income was conceptualized and are presented in Fig. 10.4 to 10.6.

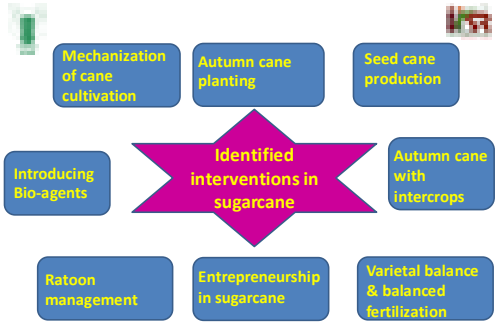


Fig. 10.4. Identified interventions in sugarcane

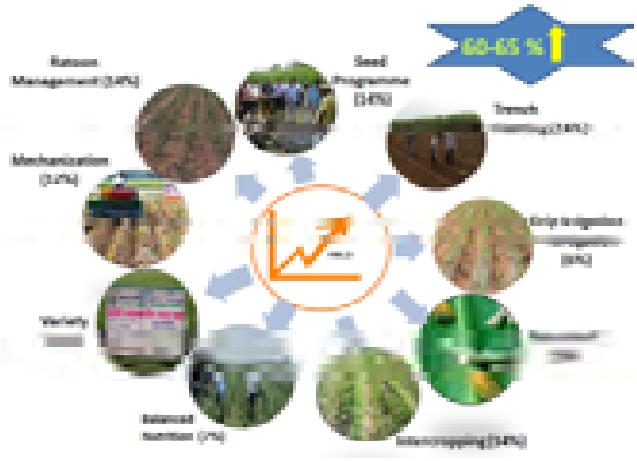


Fig. 10.5. Contributory factors identified for increasing cane yield and income from sugarcane

Fig. 10.6. Promoting entrepreneurship through allied activities to double income

Doubling Farmers' Income: ICAR-IISR initiative

ICAR-IISR joined hands with DCM Shriram Ltd, New Delhi to double the farmers' income in eight sugarcane growing villages of Lakhimpur-Kheri and Hardoi districts of Uttar Pradesh. These villages are under the command area of four sugar mills namely Ajbapur, Rupapur, Hariyawan and Loni. The sugarcane interventions include ratoon management, land leveling, seed programme, variety selection, trench planting, drip irrigation, fertigation etc. Other interventions include, intercropping, dairy farming, poultry farming, Apiculture and microenterprise (Fig. 10.7).

In the first year, there was overall increase of 10.6 and 70.6 per cent area in ratoon-I and ratoon-II. The autumn planting has increased by 25.4% and total cane area to 8.3%. The cane intensity has increased to 3.36 per cent. The compost pits and green manuring/press mud/ FYM use have increased by 216%. The area of intercrop has also increased by 44.4%. There is substantial increase in services and technical support.

Fig. 10.7. Demonstration of apiculture technique in adopted villages

The soil sample collection and soil health card distribution increased to 14.2 and 13.4 folds. Availability to PSB and *Azotobacter* increased to 97% and 97.5%, respectively. There is 93.5% increase in area for application of *Beauveria*. Similarly, *Trichoderma* application has also increased by 318%. Training camps for dairy, apiculture, insect- pest and disease management were also organized in these adopted villages.

Mera Gaon Mera Gaurav

Fourteen multidisciplinary teams of the scientists of ICAR- IISR, Lucknow adopted eight villages under the scheme *"Mera Gaon Mera Gaurav"* in four DSCL sugar mills namely Rupapur, Hariyawan and Loni in Hardoi district and Ajabapur in Lakhimpur Kheri district of Uttar Pradesh while one team of three scientists at Pravaranagar, Maharashtra. Each team of scientists contacted with the farmers by paying personal visits to their home and fields which enabled the rapport building as well as understanding the prospects of the villages after acquiring baseline information from the key informants and resource persons of the villages. The team of scientists have provided technology backstopping to DSCL sugar mills and advisory services through personal visits, group interactions, messaging through SMS feature of mobile and phone calls to farmers.

Awareness for *Swachchhata* was created among school children during celebration of *Swachchhata Pakhwara* (December 16-31, 2018) by ICAR-IISR, Lucknow. The *Swachchhata* day was celebrated at Primary School, Nagala Bhagwan in DSCL Sugar Mill, Loni and Primary School, Kanhari in DSCL Sugar Mill, Rupapur. The awareness among the school children was created by explaining importance of cleanliness, providing tips of maintaining cleanliness of self and society, administering oath for cleanliness. The children were awarded by providing stationary items, hand wash, sanitizers and dust bins, *etc.* In *Swachchhata* day celebrations, more than 100 children, school staff and villagers participated. The procession in the villages

were also carried out by reciting slogan on *Swachchhata* to spread the message among the villagers. The programme was coordinated by Dr. A.K. Sharma, Principal Scientist.

Technology assessed in farmers' fields

Intercropping in sugarcane for enhancing profit and nutritional food security

The intercropping technology was assessed in farmers' fields for its large scale adoption by farmers. The intercrops raised with autumn and spring cane provide opportunity to the farmers to earn intermittent income from sale of crops harvested at 3 to 4.5 months after sowing, depending upon the nature of intercrops. Demonstration on Intercropping with autumn and spring sugarcane under NFSM scheme (2018-19) of Ministry of Agriculture and Farmers Welfare, Govt. of India was conducted in farmers' fields in Sitapur and Lakhimpur districts of U.P. covering 20.0 ha area. The highest net profit of ₹ 4,35,000/ha was earned in case of garlic grown as intercrop with sugarcane and the lowest net profit of ₹ 1,62,300/ha was earned by the farmers with maize intercropping. The net profit for all intercrops was much higher than the profit recorded with sole cane crop *i.e.* ₹ 1,27,500/ha (Table 10.4). This clearly establishes the intercropping with sugarcane as much profitable cropping system in comparison to sole cane crop. In addition to higher profit, the intercrops also provided pulses and vegetables to the farmers for their family consumption and thus helped in food and nutritional security for village dwellers.

Ratoon promoter machine

As many as 20 demonstrations on ratoon promoter machine were conducted to assess its benefit in enhancing yield and profit from ratoon crop. It was assessed in farmers' fields in command area of Biswan Sugar Mill, Biswan, Sitapur (U.P.) covering 12 villages, 21 cane growers and 12.00 ha area. Under all ratoon plots where ratoon promoter machine was operated cane yield was enhanced by 12-16 t/ha, cost saving was upto ₹ 6,000/ha and profit was enhanced by ₹ 42,000-54,000/ha.

PGR in sugarcane

The application of PGR in sugarcane was well experimented and perfected by the Scientists of Plant Physiology and Biochemistry Division in the Institute. As per the recommendation of RAC to assess its impact on growth parameters, yield and economy of the cane crop under farmers' field condition, assessment trial was conducted in the farmers' fields in the mill zone area of Biswan Sugar Mill in May under late planting condition and in October under autumn planting.

Treatments given were :

- Setts soaking in Ethrel @ 100 ppm (25 ml/100 litres) for 24 hrs before its planting
- Foliar spray of 200 ppm Ethrel at 25 DAP
- Foliar spray of GA_3 @ 50 ppm (50 mg/liter) in first week of June
- Foliar spray of GA_3 @ 50 ppm in last week of June
- Cane varieties- CoLk 94184, CoLk 0238 and CoLk 0118

Results are shown in Table 10.5 and 10.6.

Frontline Demonstrations

Frontline demonstratons on seed cane production technology

For fast spread of newly released cane varieties, 50 number of FLDs on seed cane production technology were conducted in farmers' fields in Sitapur, Lakhimpur, Barabanki, Ballia, Farrukhabad, Hardoi and Shrawasti districts of Uttar Pradesh and Motihari district of Bihar.

Table 10.4. Economic analysis of intercropping with sugarcane

Cropping system	Yield (t/ha)		Return (₹/ha)		Gross return (₹/ha)	Net Profit (₹/ha)	B:C Ratio
	Cane	Intercrop	Cane	Intercrop			
Sole sugarcane	70	-	227500	-	227500	127500	1.28
Intervention-Intercropping in sugarcane							
Sugarcane + vegetable pea	83	7.4	269750	133200	402950	282950	2.36
Sugarcane + potato	86	29.0	279500	275500	555000	425000	3.27
Sugarcane + lentil	83	1.5	269750	76500	346250	221250	1.77
Sugarcane + chickpea	84	1.95	273000	81900	354900	229900	1.84
Sugarcane + mustard	80	1.60	260000	60800	320800	195800	1.57
Sugarcane + maize	78	1.6	253500	28800	282300	162300	1.35
Sugarcane + radish	83	2.5	269750	35000	304750	184750	1.54
Sugarcane + pigeonpea	80	2.0	260000	100000	360000	235000	1.88
Sugarcane + cabbage	82	21.0	266000	210000	476500	351500	2.81
Sugarcane + cauliflower	80	20.0	260000	180000	440000	315000	2.52
Sugarcane+ garlic	80	5.0	260000	300000	560000	435000	3.28

Sale price (₹/q): vegetable pea- 1800; potato- 950; lentil- 5100; chickpea- 4200; mustard- 3800; maize- 1800; *arhar*- 5000; cabbage- 1000; cauliflower- 900; radish- 1400; garlic- 6000

Table 10.5. Impact of PGR technology on sugarcane cv. CoLk 94184 (Late planting in the month of May) (in 10 meters row length)

Growth parameter	Control	Treated	% increase
Initial shoot population at 45 DAP	60	80	33.33
Tillers count at 75 DAP	90	125	38.89
Millable canes 180 DAP October	74	105	41.89
Cane length (cm)	182	192	5.49
Cane girth (cm)	7	8	14.29
Pol	16.5	17.2	4.24
Pol (% in cane)	13.00	13.45	3.46
Recovery (%)	10.50	10.75	2.38
Net millable cane (lakh/ha)	1.0	1.38	38
Cane yield (t/ha)	80	118.68	48.35
Gross return (₹/ha)	260000	385710	48.35
Net profit (₹/ha)	150000	273710	82.47
B:C ratio	1.36	2.44	79.41

Table 10.6. Impact of PGR technology on sugarcane cv. Co 0238 & Co 0118 (Date of planting: Autumn planting with two bud setts)

Growth/economic parameter	Control	Treated	% increase
Germination (%)	43	56	30.23
Initial shoot population at 45 DAP/ha	50500	65000	28.71
Tillers count at 180 DAP/ha	150000	205000	36.67
Millable canes at the time of harvesting	100000	145000	45.0
Cane length (cm)	190	205	7.89
Cane girth (cm)	8	9	12.5
Cane yield (t/ha)	116	164	41.38
Pol	16.6	17.4	4.82
Pol (% in cane)	13.50	14.02	3.85
Recovery (%)	10.67	11.05	3.56
Gross return (₹/ha)	377000	533000	41.38
Net profit (₹/ha)	277000	428000	54.51
B:C ratio	2.77	4.08	47.29

Seed cane crop of varieties CoLk 94184, CoPk 05191, Co 05011, Co 0118, CoLk 09204, Co 0238, Co 98014, CoS 08272, Co 0232 and Co 0233 was raised in demonstration fields with recommended package of practices. Demonstrations on Ratoon Promoter were conducted at farmers' fields in command area of Biswan Sugar Mill, Biswan, Sitapur (U.P.) covering 12 villages, 21 cane growers and 12 ha area. FLDs on intercropping with sugarcane and bud chip technology was conducted on total of 194 ha area in Uttar Pradesh, Madhya Pradesh, Bihar and Maharashtra.

Frontline demonstrations of IISR tractor operated disc type ratoon management device

The frontline demonstration of IISR ratoon management device was conducted in Hardoi, Sitapur and Lucknow districts (Fig. 10.8). The equipment, RMD, was operated with a 35 hp tractor. It took nearly three

Fig. 10.8. ICAR-IISR two row disc type RMD in field operation at farmers' fields

hours per hectare of ratoon field to complete all assigned task in one pass of the tractor. Each sub-units were adjustable and, if needed, could be detached from the equipment. It is advised to detach the stubble shaving unit from the main frame of the equipment while operating in fields where harvesting of the preceding crop was done in phases or in fields with healthy tillers. Realistically, farmers in the selected village preferred to get RMD operated without shaving tillers. The crop was managed by the farmers.

It was sandy loam soil with moisture content varying from 14% to 16%. Fields were covered with a thin layer of scattered sugarcane dry leaves and with weed like *Cyprus rotundus*. Preceding sugarcane crop was planted by using sugarcane cutter planter in straight lines at a 75 cm inter-row spacing. Fields were made available two to three weeks after harvesting the preceding sugarcane crop.

Ratoon management device was operated in farmers' fields in accordance with the recommendations. Operations like deep tilling, off barring, basal dose of fertilizers in free-flowing were got executed in the presence of farmers. Adjustments were made as per the requirement of the crop.

Off barring discs could, however, be adjusted to work 20-30 cm sideways from the centre of the stubble-row to prevent such damage. It may be mentioned that sugarcane grows with a dense cluster of roots spreading 30-40 cm sideways and 10-100 cm deep inside the soil. Well-established plant-stubbles provide desirable anchorage for sharp cutting of old roots with minimal damage.

Approximately 6.5 ha area was covered by IISR RMD in 12 farmers' fields. Feedback information from the farmers' field, suggested the necessity of simplifying the metering and power transmission system of the equipment.

Frontline demonstrations of IISR tractor operated deep furrow sugarcane cutter planter

IISR tractor operated deep furrow sugarcane planter was demonstrated at farmers' field of Ballia, Shravasti, Shahjahanpur, Lucknow districts of Uttar Pradesh in 12 ha area (Fig. 10.9). Total 10 farmers used the planter. The performance of the planter was satisfactory for planting of sugarcane (including sett cutting) at farmers' field. Cost of planting operation was ₹ 2,780 per ha using the planter as compared to ₹ 7,380 per ha in conventional method.

Fig. 10.9. ICAR-IISR tractor operated deep furrow sugarcane planter in field operation at farmers' field in Shravasti (U.P.)

Frontline demonstrations of IISR tractor operated sugarcane trench planter

Trench planter was demonstrated at farmers' field in villages of Lakhimpur Kheri, Hardoi and Lucknow districts (Fig. 10.10). A total of 10 ha area was covered at farmers' field covering 10 farmers. The equipment plants one pair of rows at a spacing of 30 cm in the single pass. Tractor rear wheel marking is utilized to maintain inter pair spacing of 120 cm. The effective field capacity of the equipment was 0.20 ha/h with a field efficiency of 65-70%. The performance of the planter was satisfactory in accomplishing the unit operations involved in cane planting such as furrow opening, sett cutting, placement of cut setts into the furrows, application of fertilizer and chemical insecticide, covering of setts with soil and pressing the covered soil; in a single pass of the equipment.

Fig. 10.10. ICAR-IISR sugarcane trench planter in field operation at farmers' field in Hardoi (U.P.)

Frontline demonstrations of IISR tractor operated deep furrow sugarcane cutter planter–cum-multicrop raised bed seeder

IISR tractor operated raised bed seeder-cum-sugarcane planter was operated at farmers' field at Biswan sugar mill area, Sitapur and Lucknow in 5 ha area (Fig. 10.11). The planter makes two furrows at a spacing of 75 cm and two raised beds (one full raised bed + two half raised beds) in a single pass. Two furrows are planted with the cane and seed of companion crop of pulses were sown on the two raised beds. Performance of the planter was satisfactory with effective field capacity of 0.20 ha/h.

Fig. 10.11. ICAR-IISR tractor operated sugarcane-cum-potato planter

Frontline demonstrations of IISR tractor operated sugarcane-cum-potato planter

IISR tractor operated sugarcane-cum-potato planter was operated at farmers' field at Harsiddhi village of Bihar and Lucknow in 5 ha area. The planter makes two furrows at a spacing of 75 cm and two ridges between two successive furrows. Two furrows are planted with the cane and seed of potato is planted on ridges simultaneously in single pass of the planter.

On-station demonstration

To showcase the cane production technology to dignitaries and visitors, on-station demonstration in one ha area was laid out in Technology Park (Field No. E-40). Planting methods, intercropping with sugarcane,

IPM, cane node technique, plant growth regulator and cane varieties were demonstrated.

Organisation of Technology and Machinery Demonstration Mela

Technology & Machinery Demonstration Mela was organized at ICAR-Indian Institute of Sugarcane Research, Lucknow on February 16, 2019. It was jointly organized by IISR, Lucknow Centre of AICRP on Farm Implements & Machinery and Post-Harvest on Engineering and Technology (Fig. 10.12). Total participants were 600, mainly farmers from U.P.

Dr. A.K. Singh, DDG (Horticulture & Crop Science), ICAR, New Delhi was the chief guest and Dr. R.K. Singh, ADG (CC), ICAR, New Delhi was the guest of honour. Dr. A.K. Singh stressed the need of transfer of Technology from Laboratory to the actual users *i.e.* farmers. Director of the Institute Dr. A.D. Pathak elaborated the efforts made by the Institute for popularization of technologies developed at the Institute. Dr. Akhilesh Kumar Singh, Head, Division of Agricultural Engineering welcomed the participants.

Fig. 10.12. Demonstration of IISR sugarcane machinery during Technology and Machinery Demonstration Mela

The exhibition was organized and IISR developed machineries and post-harvest equipments were displayed. The live field demonstration of sugarcane machinery namely Disc Type Sugarcane Ratoon Management Device, Deep Furrow Sugarcane Cutter Planter, Trench Planter-cum-Bed Seeder and Deep Furrow Sugarcane-Cum-potato Planter was conducted. The live demonstration of improved jaggery making technology namely three pan jaggery furnace, moulding frame and storage bin were also conducted. Farmers took keen interest in the machinery and equipment exhibited and demonstrated. It was a successful event in showcasing and live demonstration of latest machinery to the end users.

Field day organized

1. 18th September, 2018 at Dhaka Pakariya, Paliya, Lakhimpur
2. 27th March, 2019 at Hariyawan Sugar Mill, Hardoi (Fig. 10.15)
3. 30th March, 2019 at Biswan Sugar Mill, Sitapur

More than 2000 farmers, development officials, and sugar mill personnel participated in the event. Information on cane production technology was provided to the participants and *Vaigyanik-Krishak*

Fig. 10.15. Field day organized by ICAR-IISR, Lucknow




Paricharcha was also organised to provide on-the-spot solution to the farmers.

Entrepreneurship in seed cane production

About 3500 tonnes of healthy seed cane of improved varieties of sugarcane was produced in farmers' fields under extension programme on entrepreneurship in seed cane production. This helps in making available healthy seed material to farmers as well as motivating farmers and rural youth to venture out in seed cane business in order to generate employment in rural areas and enhancing farmers' income from sugarcane cultivation.

Linkages developed

- Collaboration with Mahindra Agri Solutions Ltd., Mumbai was developed to work for developing advisory package for farmers and officers. Collaborative programme is also planned to promote entrepreneurship in sugarcane based production system.
- Technical collaboration with ITC Limited was initiated and a collaborative programme proposal has been prepared for skill development of progressive farmers and NGO personnel in water saving cane technologies, SSI and seed cane business.

Exhibitions organized

Date	Event	Place
April 05-06, 2018	*Kisan Mela*	NDUA&T, Kumarganj, Faizabad
October 06-08, 2018	*Smrit Mahotsav & Krishi Pradarshan, Sangoshthi*	PDDU Dham, Farah, Mathura
October 26-28, 2018	*Krishi Kumbh*	ICAR-IISR, Lucknow
January 31, 2019	*Kisan Mela*	CSIR-CIMAP, Lucknow
February 16-19, 2019	*Ikshu Mahotsav & SUGARCON*	ICAR-IISR, Lucknow
February 24, 2019	*Kisan Mela*	ICAR-IISR, Lucknow
February 20-23, 2019	XIV ASC-2019	NASC, New Delhi
February 28, 2019	Agricultural Technology Exhibition/Farmers' Fair	ICAR-CISH, Lucknow
March 02-03, 2019	*Purvanchal Kisan Mela*	KVK, Peppeganj, Gorakhpur
March 27, 2019	*Kisan Goshthi*	Hariyawa Sugar Mill, Hardoi

Entrepreneur farmers developed

Four farmers were developed as entrepreneurs and they are doing seed cane business. They are now recognized by state department/AIR/DD and are being invited to share their experiences on success achieved.

Model farm developed

Four model farms in Khamba purva, Shankarpur and Bakhariya (Sitapur) and Dhaka Pakariya, Paliya (Lakhimpur) were developed to facilitate learning on "More income - Per crop" in true sense of farmer-to-farmer extension.

Farmers' club formed

A farmers' club was formed in Biswan sugar mill area. Farmers were motivated to enhance cane yield to more than 100 t/ha to be eligible for member of Farmers' club. Presently, more than 150 farmers are members of the club.

Externally funded project (RKVY, Govt of U.P.) on Establishment of quality jaggery production-cum-training units in selected districts of Uttar Pradesh for income generation and entrepreneurship development

A new project has been sanctioned by the RKVY with a total budget outlay of ₹ 220 lakh. Order has been placed for establishment of Jaggery Unit at KVK, Gorakhpur. Purchase procedure has been initiated at KVK, Deoria and Kushinagar.

A new project entitled "Entrepreneurship Development and Income Enhancement of Sugarcane Farmers in Chakia , Areraj and Kotwa Block of East Champaran, Bihar" was sanctioned by National Seeds Corporation under CSR mode. The cost of the project was ₹ 36.0 lakh. Three IISR model jaggery units have been established at Chakia, Kotwa and Areraj and were made functional. The units are working satisfactory.

Transfer of technology related to jaggery

Sr. No.	Name of technology transferred/ adopted	No. of units	Address of farmers/entrepreneurs/ manufacturers
1.	IISR 3-pan jaggery unit	12	• Department of Agriculture, Mizoram • DIC, Muzaffarpur, U.P. • Morena, M.P. • Sant Kabirnagar, U.P. • Motihari, Bihar • Aarav enterprises, Hardoi • Kanungy rukungiri agro industry Ltd. Uganda (Through KS Projects) • Yamunanagar • Hoshangabad, M.P. • FPO of kotwa, Chakia and Areraj, Motihari, Bihar
2.	Moulding frame	50 set	
3.	Value added jaggery	02	• Mr. Bhupesh Saini, Chandigarh • M/S AKC and Company, Ghaziabad

MoAs signed

Seven MoAs were signed, one each with agricultural machinery manufacturer and jaggery processing equipment and five with entrepreneurs for establishing IISR model jaggery units as per following details;

MoAs with manufacturers

- M/s Mittal Engineers, Bagpat Road, Meerut
- M/s Prabh Enterprises, Subhash Nagar, Alambagh, Lucknow

MoAs with entrepreneurs/ farmers

- Shri Aditya Garg, S/o Shri Ashwani Garg, Yamunanagar, Haryana
- M/S AKC and Company, Shastri Nagar, Ghaziabad , U.P.
- Mr. Bhupesh Saini, 2, NITTTR Campus, Sector 26, Chandigarh
- Shri Hridesh Tyagi, Vill- Syowata, Morena, M.P.
- Shree R.S. Food Products, Vill- Tikulia Haraj, Motihari.

CHAPTER 11

Krishi Vigyan Kendra

On-farm testing/trials (OFTs)

Six OFTs were conducted pertaining to various disciplines as per identified major thrust areas. OFTs are the most important mandatory component of KVK under which evaluation of recently developed technologies or varieties in specific agro climatic condition is done for future recommendations or popularization, which are given below :

Performance of milk production through bypass protein supplementation to lactating cows.

Bypass protein provides extra source of nutrients to lactating animal which increases milk production by 15%. Average milk yield was 7.9 lit/day/animal as compared to farmer practice (6.7 lit/day/ animal) (Fig. 11.1).

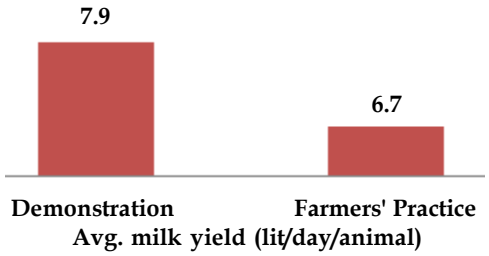


Fig. 11.1. Performance of bypass protein in milk production

Performance of UMMB supplementation to maintain milk yield in cows

Urea molasses mineral mixture block (UMMB) is an extra source of essential nutrients, which fulfills the mineral requirement, increases milk production and improves fertility in lactating animals. Average milk yield was 7.2 lit/day/animal as compared to farmer practice (6.7 lit/day/animal). Experiment was conducted from April to July,2018 on fifteen cows at Village Ismailnagar, Block Mohanlalganj (Fig. 11.2).

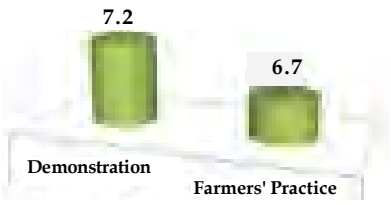


Fig. 11.2. Performance of UMMB in milk production

Site specific nutrient management in potato

Experiment was conducted at Village Shankarkhera of Mohanlalganj Block of Lucknow district. Soil test based recommendation showed that average weight of tuber, number of tubers per plot and yield in demonstrated plot was 335 gm, 9.1, 332.4 q/ha, respectively as compared to 315 gm, 8.4, 305.6 q/ha, respectively in farmers' practice. Keeping quality of potato in demonstrated plot was also good as compared to farmers' practice (Fig. 11.3).

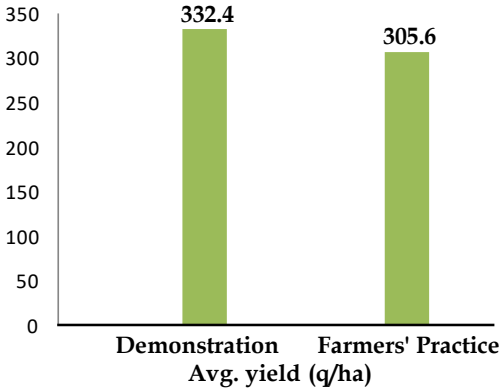


Fig. 11.3. Yield of potato on site specific nutrient management

Impact of intercropping of shed loving crops in mango orchard

Farmers of Lucknow district get mangoes only from orchards but they may get other produce from the same orchard. So keeping this fact in view, an experiment on intercropping of different shed loving crops in mango orchard was conducted at Village Baheliya of Kakori Block of Lucknow district where intercrops were colocasia, yam and turmeric. Results showed that total yield of 308.0 q/ha (Mango+ colocasia), 254.1 q/ha (Mango + yam) and 247.5 q/ha (Mango + Turmeric) were recorded as compared to sole mango crop (160.8 q/ha) (Fig. 11.4).

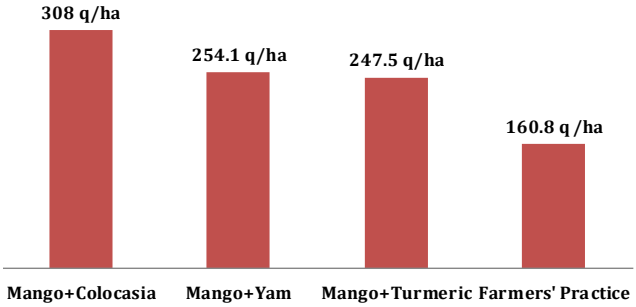


Fig. 11.4. Impact of intercroping in mango orchard

Impact of CSR-Bio in potato crop

Farmers of Lucknow district use fertilizer and pesticides in injudicious manner due to which plants become succulent and crops have more pest complicity. So, keeping this fact in view, an experiment was conducted to study the impact of a microbial consortia *i.e.*, CSR-Bio, which enhances the nutrient availability to plant and its spray checks the insect disease incidence. It reduced the pest incidence upto 17% and yield increased by 13.8% as compared to farmers' practice (305.6 q/ha) (Fig. 11.5).

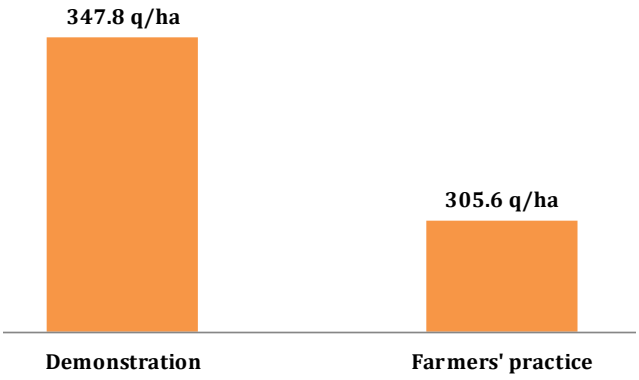


Fig. 11.5. Impact of CSR-Bio on potato crop yield

Use of hand wheel hoe for drudgery reduction in weed management to farm women

Weeding is an important component of crop production. It is specific farm work for farm women and is labour intensive as well as needs more drudgery, due to which farmwomen suffer more pain and discomfort in this activity. So, keeping this fact in view, an experiment was conducted to assess the impact of manual hand wheel hoe as compared to hand hoe. The study showed that farm women feel average pain and discomfort only 21.63% in hand wheel hoe as compared to hand hoe (60.55%). So, it is efficient, time saving and reduces drudgery to farm women (Fig. 11.6).

Fig. 11.6. Pain and discomfort (%)

Frontline demonstrations

Total 926 FLDs were conducted in 140 ha area, where oilseeds and pulses covered 92 ha area under National Food Security Mission (NFSM), 19 ha area for fodder demonstration under National Initiative on Fodder Technology Demonstration (NIFTD), 13 ha covered under horticultural crops and 16 ha area under cereal crops (Fig. 11.7). Animal health management through vaccination and deworming of 1000 animals (Buffaloes and Cows) was carried-out. Other than this, different demonstrations like rug making, spray painting and preparation of value added products of horticultural crops were conducted under women empowerment. Yield increase obtained under various frontline demonstrations conducted on various crops have been shown in Table 11.1.

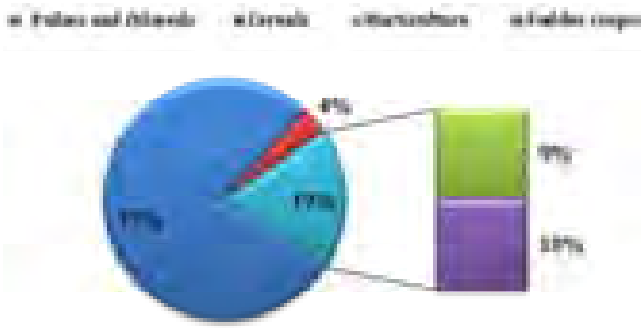


Fig. 11.7. Percentage share of frontline demonstrations conducted on various crops

Other programmes organized

1. Live telecast of Interaction of Hon'ble Prime Minister with farmers: June 20, 2018
2. Live telecast on Hon'ble PM's Address to farm women: July 12, 2018
3. *Kisan Kalyan Abhiyan Goshthi* : July 17, 2018
4. Conference on Organic Farming for Soil Health Management and Enhancing Field Crops Production and Doubling of Farmers Income : August 6, 2018
5. National Seminar on Enhancing Vegetables Production for Food and Nutritional Security and Improvement in Livelihood : October 12-13, 2018
6. *Mahila Kisan Diwas* : October 15, 2018
7. World Soil Health Day: December 5, 2018
8. *Swachhta Pakhwada* : December 16-31, 2018
9. *Kisan Diwas* : December 23, 2018
10. Live telecast of *Pradhan Mantri Kisan Samman Nidhi* and *Kisan Mela* : February 24, 2019

Table 11.1. Yield of different crops obtained under various frontline demonstrations

Crop		Area (ha)	Technology demonstrated	No. of farmers	Average production (q/ha)		% Increase
					Demonstrations	Farmers' practice	
Oilseeds	Sesamum	10	RT 351	67	Demonstration failed due to heavy rains		
	Mustard	20	NRC HB 101	148	13.42	11.45	14.7
Pulses	Black gram	10	PU 40	67	Demonstration failed due to heavy rains		
	Green gram	10	IPM 2-3	67			
	Lentil	10	PL 08	94	18.5	13.8	25.4
	Fieldpea	100	IPFD 10-12	20	22.1	15.5	21.3
	Chickpea	20	GNG 1581	138	15.24	9.8	35.69
Cereals	Wheat	5	HD 2967	10	44.23	36.63	17.2
	Rice	7	R 6451	14	63.8	45.2	20.0
		4	Management of YSB in rice	28	72.5	61.4	15.3
Horticulture crops	*Kharif* onion	1	Agri Found Dark Red	7	206.3	172.6	19.52
	Vegetable pea	1	Kashi Uday	4	73.62	62.5	17.76
	Broccoli	1	Pusa Broccoli (KTS 1)	7	122.83	98.5	24.7
	Red cabbage	1	Super Red 115	8	275.1	229.9	19.7
	Onion	1	Agri Found Light Red	13	263.7	207.4	27.14
	Cucumber	2	Management of fruitfly	10	255.1	208.5	18.3
	Mango	2	Management of fruitfly	18	110.6	96.5	12.7
	Potato	2	IPM in potato	10	310.6	245.8	20.86
Fodder crops	Sweet sorghum	5	SS 84	16	607.4	463.9	30.9
	Barseem	5	JHB 146	39	445.5	335.6	29.8
	Sugar beet	2	LS 06	10	453.0	-	-
	Perennial fodder grass	1	Hybrid Napier	15	850.0	-	-

Cluster frontline demonstration on oilseeds and pulses

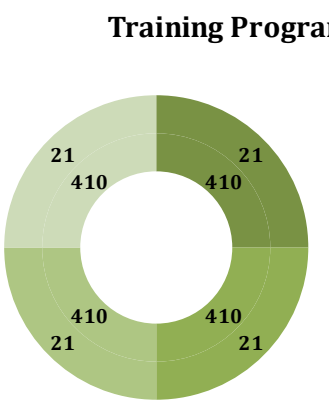
Frontline demonstration on rice


Frontline demonstration on vegetable crops


Frontline demonstration on fodder crops

Training programmes organized

Krishi Vigyan Kendra offered 84 training courses for participating farmers and farm women on various topics with an objective to improve skill and upgrade their knowledge about developed and potent product. All training programmes were fully skill oriented and conducted following the principles of "Learning by doing". Total 1640 participants (1230 male and 410 female) attended the programme.



Training programmes organized by KVK

Other extension activities

Activity	No. of programmes	No. of farmers	No. of extension personnel
Advisory services	57	-	-
Diagnostic visits	13	260	5
Group discussions	6	56	-
Kisan Goshthi	4	768	30
Film show	16	280	
Exhibition	4	450	23
Celerabition of important days	3	215	
Lectures delivered	12		
Method demonstrations	10	125	-
Scientists visit to farmers' field	75	425	-
Farmers visit to KVK	10	250	
Celebration of important days	6	150	-
TV & Radio talks	18		
Total	**234**	**2979**	**58**

KVK, Lucknow in ICAR website

Glimpses of events organized by KVK, Lucknow

CHAPTER- 12

Services to the Industry

Contract Research

ICAR-IISR, Lucknow carried out the evaluation of some new industrial products which have the use in sugarcane cultivation. The evaluation of products such as insecticides, pesticides, weedicides, fungicides, seed material and other chemical formulations has been carried out on sugarcane crop. The evaluation was carried out signing a MoU with the company or agency as per details given in Table 12.1 :

Table 12.1. MoUs for Contract Research

Bayer Crop Science Ltd., Mumbai	Bio-efficacy evaluation of tembotrione 420 SC (laudis (420 SC) in sugarcane (V.P. Singh, K.K. Singh, S.N. Singh and S.K. Shukla; 2016-2018)
Atul Limited	Bio-efficacy and phytotoxicity evaluation of RJKP 1505 (2,4-D Sodium Salt 67.7% + Metribuzin 16.5% WG) in sugarcane (V.P. Singh, K.K. Singh, A.K. Singh and S.K. Shukla; 3/16- 8/18)
Sumitomo Chemical (India)	Bio-efficacy & phyto-toxicity evaluation of 'Flumioxazin 50% SC' against weeds in sugarcane and its effect on succeeding crop (V.P. Singh, K.K. Singh, V.P. Jaiswal and S.K. Shukla; 10/16-8/19)
ISK Biosciences India Pvt. Ltd.	Bio-efficacy evaluation of SL160 10% herbicide against weed control of sugarcane (V.P. Singh, A.P. Dwivedi, V.K. Singh and K.K. Singh; 3/17 - 12/19)
Meghmani Organics	Bioefficacy evaluation of Atrazine 50% WP herbicide against weed complex in sugarcane (K.K. Singh, V.P. Singh, S.K. Shukla and V.P. Jaiswal; 3/17 to 9/19)
Sirius Minerals India Pvt. Ltd., New Delhi	Efficacy of POLY 4 on growth behaviour, yield attributes, yield and soil health of sugarcane (M.K. Tripathi, S.N. Singh, V.P. Singh, S.K. Shukla and A.P. Dwivedi; 10/18-02/21)
Narmada Biochem Limited	Assessing efficacy of Narmada PROM (Phosphorus rich organic manure) as an organic source of P on soil quality and productivity of cane and sugar in Indian sub-tropics (S.N. Singh, A.D. Pathak, V.K. Singh, R.K. Singh and Y.P. Singh; 03/17-07/19)
Coromondal Pvt. Ltd., Hyderabad	Bioefficacy and phytotoxicity evaluation of halosulfuron-methyl 75% WG against weeds in spring planted sugarcane (V.P. Singh, K.K. Singh, V.K. Singh and A.P. Dwivedi; 03/17-12/18)
ADAMA India Pvt. Ltd., Hyderabad	Bio-efficacy evaluation of Ametryn 80% WDG herbicide against weed complex of sugarcane (V.P. Singh, V.K. Singh, K.K. Singh and A.P. Dwivedi, 03/17-12/19)
United Phosphorus Ltd., Mumbai	Bio-efficacy & phyto-toxicity evaluation of UPH 114b against weeds in sugarcane (V.P. Jaiswal, V.P. Singh, Lalan Sharma, S.K. Shukla and Anita Sawnani; 03/19-08/21)
United Phosphorus Ltd., Mumbai	Bio-efficacy evaluation of fungicide "SAAF Gr (Carbendazim 1.92 + Mancozeb 10.08% GR) against the Pokkah Boeng disease of Sugarcane (Lalan Sharma, V.P. Jaiswal, S.K. Shukla and A.D. Pathak; 02/19-03/21)
Bayer Crop Science Ltd., Mumbai	Bio-efficacy of Vayego Superb (Tetraniliprole 0.4% + Fipronil 0.6% Gr against early shoot borer, top shoot borer and white grub in sugarcane (M.R. Singh; 05/18-05/20)
BASF	Evaluation of bio-efficacy and phytotoxicity pre-emergent application of Saflufenacil 68 g/l + Dimethanamid - P 600 g/l EC (Integrity 668 g/l EC) against weeds in sugarcane and its effect on succeeding crop, (S.K. Holkar; D.N. Borase and Y.E. Thorat, 04/18-03/20)

CHAPTER 13

Training and Capacity Building

Training imparted

ICAR sponsored Winter School

The Institute organised 21 days ICAR sponsored Winter School at ICAR-IISR Lucknow on "Physio-biochemical and genomic tools to manage drought and post-harvest sucrose losses in sugarcane". Twenty five participants (including 3 local candidates) covering five states participated in the Winter School. Four guest

lecture including the lecture delivered by Dr. N.K. Singh, Director, ICAR-NIPB, New Delhi was arranged on Plant Genomics. Trainees were taken to CIMAP, NBFGR and one full day for sugar mill (Biswa Sugar Mill, Sitapur) where they were exposed to whole process of crushing to bagging of sugar.

International training on use of pheromones

An International training on "Use of pheromones for the management of sugarcane insect pests" was arranged at ICAR-IISR, Lucknow for one trainee from Sri Lanka during October 1-6, 2018.

Field/exposure visit of Skilled Support Staff of ICAR Headquarters, New Delhi

A field/exposure visit of Skilled Support Staff of ICAR HQs was organised at the ICAR-IISR, Lucknow in two batches (Batch I from March 01-02, 2019 and Batch II from March 15-16, 2019) by Dr. Sangeeta Srivastava, Nodal Officer-HRD and Dr. Sukhbir Singh, Co-Nodal Officer-HRD. There were 22 participants and two Coordinators in first batch and 20 participants and two Coordinators in second batch.The participants were welcomed and briefed about the activities of ICAR-IISR, Lucknow by the Director Dr. A.D. Pathak. They were taken around to visit the well-developed farm area for research experiments of IISR, Lucknow, sugarcane juice extraction and jaggery making procedure, integrated farming system research and programmes and activities of the Krishi Vigyan Kendra of ICAR-IISR, Lucknow. Later, they visited the ICAR-Central Institute for Subtropical Horticulture, Rehmankhera and ICAR-NBFGR, Lucknow.

Training programme on "Motivation, positive thinking, time management and communication skills" for technical (up to T4) and skilled support staff of ICAR-IISR

A three days HRD Training Programme on "*Motivation, Positive Thinking, Time Management and Communication Skills*" was conducted for Technical staff (up to T4) and Skilled Support Staff at ICAR-IISR, Lucknow from March 05-07, 2019. Dr. Sangeeta Srivastava, HRD-Nodal Officer was the Course Director and Dr. Sukhbir Singh, HRD-Co Nodal Officer was the Co-Course Director along with the technical support of Sri Brahm Prakash and Sri Raghwendra Kumar. Thirty technical and SSS participated in the programme. Thirty staff members participated in this training.There were nine lectures and two practical sessions. Lectures were organised on motivation, trust building and interpersonal relationship & conflict management , time and stress management, communication skills, cleanliness issues, acquaintance with administrative and conduct rules, health and nutrition management, and integrated farm management. The two practical sessions were on introduction to MS Word and MS Excel, and ERP followed by a visit of institute research farm. The training proved extremely useful for the staff and their feed-back was very positive.

Training programme on "Enhancing efficiency and behavioural skill" for administrative staff

A three days HRD training programme on "*Enhancing Efficiency and Behavioural Skills*" was successfully conducted at ICAR-IISR, Lucknow for administrative staff from March 11-13, 2019. Dr. Sangeeta Srivastava, HRD-Nodal Officer was the Course Director and Dr. Sukhbir Singh, HRD-Co Nodal Officer was the Co-Course Director along with the technical support of Sri Brahm Prakash and Sri Raghwendra Kumar. A total of 25 staff members participated in this training programme.Lectures were organised on

motivation, trust building and interpersonal relationship, conflict management, time management, acquaintance with office procedure, administrative and conduct rules, official language policy, communication and behavioural skills, enhancement of computer skills and emotional intelligence etc. Participants' feed-back in the end was very encouraging.

Capacity building programme for cane managers of sugar industry

A 10-days training on Sugarcane Management and Development for cane development personnel of sugar mills was organized from July 10-20, 2018 (Fig. 10.13). A total of 12 cane managers/officers from different sugar mills of the country participated in this training. In an ice-breaking session organized at the beginning, the training need of participants and their expectations from this training were assessed and training module was reoriented and implemented in true-spirit of participants' expectation. The major objective of this training was to groom cane development officers of sugar mills in latest cane production and processing technology; update them in marketing and development strategy. Accelerated large-scale adoption of sugarcane technologies in sugar mill zone areas was also targeted by grooming and developing cane managers/officers of sugar mills into "torch-bearer" of IISR technologies.

Residential skill development trainings

Twenty six residential skill development trainings for different clientele groups were organized in which 654 farmers, entrepreneurs, students and development personnel participated (Fig. 10.14). They were trained in latest cane production techniques, seed cane production, advances in sugarcane research and ways and means to enhance income from sugarcane based production systems including jaggery making.

One day training-cum-visit oragnised

During 2018-19, a total of 67 nos. one day training and visit programmes were organized at the Institute in which 1165 farmers, 135 development personnel, 903 students and 35 teachers acquired latest know-how in scientific cane cultivation practices.

Entrepreneurship training for promoting agri-business

The entrepreneurship in agriculture has been identified as significant contributing factor in doubling or enhancing farm income. The Institute has applied concerted efforts under its outreach extension and training programme to impart the knowledge and skills in entrepreneurship to farmers, NGO personnel, development officers, agri-graduates and extension functionaries of different state governments. For these, several residential and off campus training programmes were conducted in which more than 1,000 participants were groomed as entrepreneur to pursue agri-business in their available farming systems.

Students visit under inter-institutional HRD activities

Under inter-institutional HRD activity, visits of students and teachers from SHUATS, Prayagraj; BHU, Varanasi; Amity University, Lucknow; GD Goenka School, Lucknow; NDUA&T, Ayodhya; CSAUA&T, Kanpur and other institutions were conducted. About 800 UGs/PGs students visited IISR. During visit, they were imparted information on IISR research infrastructure, achievements and technologies developed through orientation lecture and visit to labs and fields.

Students training

Several UG/PG students of various Universities attended training in frontier areas of Biotechnology, Microbiology and Agricultural Engineering under the supervision of the Institute Scientists. Among research scholors pursuing for Ph.D. work, two students submitted their thesis for Ph.D.

Capacity building of IISR Researchers and Staff

Name and Designation	Training Programmme	Venue	Date
Scientific staff			
Dr. Sangeeta Srivastava, Principal Scientist	WIPO Day Seminar on "Powering Change : Women in Innovation and Creativity"	UPCST, Lucknow	April 26, 2018
Dr. A.D. Pathak, Director	Senior Executive Development Programme-2018 (Indian Component)	ASCI, Hyderabad	July 10-August, 2018
Dr. A.D. Pathak, Director	Exposure visit under Senior Executive Development Programme on Developing Effective Organizational Leadership for Senior Officers of ICAR (International Component) organized by ASCI, Hyderabad	Singapore, Australia and New Zealand	September 9-23, 2018
Dr. S.S. Hasan, Pr. Scientist, AKMU	Training programme on Advances in Web and Mobile Application Development	ICAR-NAARM, Hyderabad	October 4-11, 2018
Dr. RR Verma Scientist (SS), Soil Science	Model training on Advanced Geospatial Technologies in Natural Resource Management in Changing Climate Scenario	ICAR-NBSS&LUP, Nagpur	October 5-12, 2018
Dr. Pushpa Singh, Principal Scientist (Organic Chemistry)	Training Programme on Leadership and Organization Development for Women Scietists/Technologists	Centre for Organization Development, Hyderabad	October 8-12, 2018
Dr. SN Singh, Principal Scientist, Division of Crop Production	Agri-Startups and Entrepreneurship development programme of ICAR	NASC, New Delhi	October 16-17, 2018
Dr.. Mona Nagargade, Scientist, Division of Crop Production	Three months professional attachment training	ICAR-IARI, New Delhi	November 15, 2018 – February 14, 2019

Name and Designation	Training Programmme	Venue	Date
Dr. A.P. Dwivedi, Principal Scientist (Agronomy) and Mr. Rajeev Kumar, Scientist (Biochemistry)	21 days Winter School on Physio-biochemical and genomic tools to manage drought and post-harvest sucrose losses in sugarcane	ICAR-IISR, Lucknow	November 20 to December 10, 2018
Dr. L.S. Gangwar, Principal Scientist & I/c, PME Cell	MDP on Priority Settings, Monitoring and Evaluation of Agricultural Research Projects	ICAR-NAARM, Hyderabad	December 17-21, 2018
Dr. A.K. Dubey, Head, KVK	Training programme on "Information and communication Technologies for Empowering Farm Women"	ICAR-NAARM, Hyderabad	February 1-6, 2019
Dr Sanjeev Kumar, Principal Scientist (Plant Breeding) and Dr Sanjeev Kumar, Principal Scientist (Biotechnology)	DST, New Delhi sponsored Program on "Emotional Intelligence at Workplaces for Scientists/ Technologists"	Centre for Organization Development, Hyderabad	February 18-22, 2019
Dr. Mona Nagargade, Scientist (Agronomy)	Training on Nanotechnology	ICAR-IISS, Bhopal	March 19-28, 2019
Dr. M.K. Singh, Principal Scientist, Division of Agricultural Engineering	Training programme on Work Ethics for Development Professionals	SIMA, Rahmankhera, Lucknow	March 26-28, 2019
Technical and Administrative Staff			
Sh. Sant Ram, Senior Technical Assistant	Training programme on motivation, positive thinking and communication skills for technical staff	ICAR-CIAE, Bhopal	August 1-7, 2018
Sh. Rajnarayan Prasad Bharti	J-Gate@CeRA Regional Ambassador training programme	PAU, Ludhiana	August 26-30, 2018
Dr Viveka Nand Singh, SMS, Horticulture	Training programme on " Orchard Management Practices in Fruit Crops"	ICAR-IIHR, Bengaluru	August 27-29, 2018
Dr. B.B. Joshi, CTO (Farm Manager)	Training programme on Capacity Building and Skill Upgradation Programme for Technical Staff on "Farm Management	ICAR-IIFSR, Modipuram	September 12-20, 2018
Dr Deepak Rai, SMS (Plant Protection)	Training for trainers under ASCI	BUAT, Banda	October 15-17, 2018
Dr Vineeka Singh, SMS (Home Science) and Dr Deepak Rai, SMS (Plant Protection)	Model training programme on "Food and Nutritional Security of Farmwomen through Horticulture Based Interventions"	ICAR-CISH, Lucknow	November 13-17, 2018
Dr. Anita Sawnani, ACRO, PME Cell	Training on Impact Assessment of Agriculture Research Technology	ICAR-NAARM. Hyderabad	December 5-9, 2018.
Sh. Raghwendra Kumar, STO, Division of Crop Improvement	ICAR sponsored training programmme on Layout and Maintenance of Field Experiments and Recording Observations	ICAR-IARI, New Delhi	January 14-23, 2019
Sh. Ghanshyam Ram and Sh. Rajnarayan Prasad Bharti, Senior Technical Officer (Library)	Training programme on "KOHA for library staff of ICAR"	ICAR-NAARM, Hyderabad	February 21-26, 2019

Name	Training Programmme	Venue	Date
Mr. Chhatrapal, Mr. Munni Lal, Mr. Mahendra Pratap Singh, Mr. Brij Nandan Singh, Mr. Bhullan, Mrs. Shiv Devi, Mr. Dharmendra Singh, Mr. Vijay Kumar, Mr. Anoop Chandra Kol, Mrs. Pallavi, Mr. Dildar Husain, Mr. Shiv Kumar, Mr. Raj Nath Sharma, Mr. Dasha Ram, Mr. Suresh Chandra, Mr. Sudhir Kumar, Mr. Shri Ram, Mr. Sushil Kumar Sharma, Mr. Upendra Kumar, Mr. Ashok Kumar Vishwakarma, Mr. Anil Kumar Maurya, Mr. Ram Lakhan, Mr. Santosh Kumar, Mr. Patandin, Mr. Maikoo Kannojia, Mrs. Santosh Kumari Gautam, Mr. Rajendra Kumar, Mr. Brij Kishore, Mr. Rakesh Kumar Srivastava and Mr. Anuj Kumar	Training Programme on "Motivation, Positive Thinking, Time management and Communication Skills" for Technical (up to T4) and Skilled Support Staff	ICAR-IISR, Lucknow	March 5-7, 2019
Mr. Lalit Prasad Singh, Mr. Vishva Nath, Mr. Adya Prasad, Mrs. Rashmi Sanjay Srivastava, Mr. Subhash Chandra Jaiswal, Mr. Nageshwar Lal, Mrs. Chaman Ara Siddiqui, Mr. Prashant Kamal Srivastava, Mrs. Poonam Manish Mishra, Mr. Sanjay Misra, Mr. Amar Kumar, Mr. Avadhesh Kumar, Mr. Hari Lal, Mr. Arvind Kumar Yadav, Mr. Ganesh Prasad, Mr. Ram Sanwarey, Mrs. Rupam Rani, Mr. Ram Sanjivan, Mr. Arjun, Mr. Ramesh Prasad Verma, Mr. Madan Chandra, Mr. Sundar Lal, Mr. Taruk Nath Saini, Mr. Deepak Kumar, Mr. Dhirendra Pratap Singh	Training Programme on "Enhancing Efficiency and Behavioural Skill" for Administrative Staff	ICAR-IISR, Lucknow	March 11-13, 2019
Sh. Brahm Prakash, CTO, PME Cell	Training programme on Work Ethics for Development Professionals	SIMA, Rahmankhera, Lucknow	March 26-28, 2019

CHAPTER 14

Awards and Recognitions

ICAR Awards

- IISR, Lucknow received *Rajarshi Tandon Rajbhasha Puraskar* 2016-17 (First Prize) from ICAR on July 16, 2018 in New Delhi.

- Dr. A.K. Singh and Dr. Sukhbir Singh received the NASI-ICAR award on Innovation and Research on Farm Implements-2017 on the occasion of 90th Foundation Day & Award Ceremony on July 16, 2018 at NASC, New Delhi from Hon'ble Union Minister of Agriculture and Farmers Welfare, Sh. Radha Mohan Singh Ji and Union State Minister of Agriculture and Farmers Welfare, Sh. Gajendra Singh Shekhawat Ji.

- Dr. S.K. Holkar, received ICAR-Jawaharlal Nehru Award for P.G. Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences -2017 (Crop Protection Sciences) on the occasion of ICAR-Foundation Day on 16th July, 2018 by Hon'ble Minister of Agriculture and Farmers Welfare, Govt. of India, Sh. Radha Mohan Singh Ji.

Professional Society Awards

- Dr. A.D. Pathak was conferred "SSRP Fellow Award 2019" by Society for Sugar Research and Promotion, New Delhi during International Sugar Conference : Sugarcon- 2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. Sangeeta Srivastava was conferred "SSRP Fellow Award 2019" by Society for Sugar Research and Promotion, New Delhi during International Sugar Conference : Sugarcon- 2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. Amaresh Chandra was conferred "SSRP Fellow Award 2019" by Society for Sugar Research and Promotion, New Delhi during International Sugar Conference : Sugarcon- 2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. A.K. Singh, Head (Agril. Engg.) was conferred "SSRP Fellow Award 2019" by Society for Sugar Research and Promotion, New Delhi during International Sugar Conference : Sugarcon- 2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. S.N. Sushil was conferred "SSRP Fellow Award 2019" by Society for Sugar Research and Promotion, New Delhi during International Sugar Conference : Sugarcon- 2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. Rajesh Kumar was conferred "SSRP Fellow Award 2019" by Society for Sugar Research and Promotion, New Delhi during International Sugar Conference : Sugarcon- 2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.

- Dr. S.N. Singh received Indian Society of Agronomy Fellow Award of Indian Society of Agronomy at the XXI Biennial National Symposium on "Doubling Farmers' Income through Agronomic Interventions under Changing Scenario" organized by the Society at the Rajasthan College of Agriculture, MPUAT, Udaipur on 24.10.2018.

- Dr. A.K. Singh, Principal Scientist (Agronomy) was awarded with "Fellow of Indian Society of Agronomy".
- Dr. S.N. Sushil was awarded with 'Fellow of Entomological Society of India'.
- Dr. S.N. Singh received Award of Excellence – 2019 award of Sugar Research and Promotion during International Conference SUGARCON-2019 held at ICAR-IISR, Lucknow during February 16-19, 2019.
- Dr. S.N. Singh received the best KVK Worker Award from the Hon'ble Agriculture Minister, Govt. of Uttar Pradesh on *Kisan Diwas* Celebration organized at the Integral University, Lucknow on 23.12.2018.

- Dr. V.K. Singh received'Fellow Award-2018' by Agricultural Technology Development Society (ATDS), Ghaziabad in 2nd International Conference on'Advances in Agricultural, Biological & Applied Sciences for Sustainable Future (ABAS-2018) held at Swami Vivekanand Subharti University, Meerut, during October 20-22, 2018.
- Dr. V.K. Singh, Principal Scientist was conferred "SEE Fellow Award 2018" by Society of Extension Education, Agra in 9th National Extension Education Congress 2018 on 'Climate Smart Agriculture Technologies: Innovations and Interventions' held at CAEPHT, Ranipool, Sikkim (CAU Campus) during November 15-17, 2018.
- Dr. A.P. Dwivedi received Fellowship Award of Doctor's Agriculture and Horticulture Development Society, Lucknow in the International Conference on Sustainable Organic Agri-Horti System held at *Chhatrapati Maharaj Sahuji Shodh Evam Prashikshan Sanshthan,* Lucknow during November 28-30, 2018.
- Dr. A.P. Dwivedi received Bio Diversity Conservation Award for outstanding contributions in the field of Agronomy on occasion of International Seminar on Climate Resilience of Agricultural Biodiversity, Technology and Marketing Policy at University of Allahabad, Prayagraj on March 9-10, 2019.
- Dr. Radha Jain was awarded Life Membership of National Academy of Sciences, India, (NASI), Allahabad.
- Dr. A.D. Pathak was awarded Noel Deerr Gold Medal by The Sugar Technologists' Association of India, New Delhi at 76th Annual Convention and International Sugar Expo of The Sugar Technologists' Association of India at Brilliant Convention Centre, Indore during September 16-18, 2018.
- Dr. Rajesh Kumar was awarded Noel Deerr Gold Medal by The Sugar Technologists' Association of India, New Delhi at 76th Annual Convention and International Sugar Expo of The Sugar Technologists' Association of India at Brilliant Convention Centre, Indore during September 16-18, 2018.

- Dr. Rajesh Kumar was conferred Science & Technology Award for his contribution in the field Agricultural Statistics by North Indian Sugarcane and Sugar Technologists' Association (NISSTA) during Annual Convention–2018 and Asian Conclave of Sugar Millers - Vision 2022 on May 24 -25, 2018 at National Institute of Technical Teachers Training and Research, Sector - 26, Chandigarh.
- Dr. Rajesh Kumar was conferred Life Time Achievement Award – 2018 by The Society of Tropical Agriculture, New Delhi (India) during 7th International Conference on Agriculture, Horticulture and Plant Sciences on June 28-29, 2018 at Hotel Landmark, The Mall, Shimla (H.P.).
- Dr. D.R. Malaviya was awarded with Sri P.M. Dabadghao Memorial Lecture Award by Range Management Society of India on December 12, 2018.
- Dr. A.K. Sah received Best Extension Professional Award from Society of Extension Education, Agra in 9th SEE National Extension Congress held at CAEPHT, Gangtok, Sikkim on November 15-17, 2018.

- Dr. Sangeeta Srivastava was conferred "Distinguished Scientist Award" in the field of Genetics at GRISAAS-2018 Held at RARI, Jaipur on October 28-30, 2018.
- Dr. Sangeeta Srivastava was conferred "Life Time Achievement Award" at ICAAAS- 2018 held at JNU, New Delhi on April 28-29, 2018.
- Dr. Sangeeta Srivastava received Certificate of Accomplishment at ICAAAS-2018 held at JNU, New Delhi during April 28-29, 2018.
- Dr. T.K. Srivastava received Certificate of Outstanding Contribution in Reviewing by the International Journal Agriculture, Ecosystems and Environment (Elsevier).
- Dr. S.R. Singh received Reviewer Excellence Award, 2019 as Reviewer of Indian Journal of Agricultural Research during 2018-19 by Agricultural Research Communication Centre (ARCC).
- Dr. A.K. Mall received Fellow Award by Agricultural Technology Development Society (ATDS) on October 22, 2018.
- Dr. A.K. Mall received Best Scientist Award by *Ek Nayi Rah* Foundation (ENRF) on April 29, 2018.
- Dr. A.K. Mall received Young Geneticist Award-2018 by Biologix Research and Innovation Center Pvt. Ltd. (BRICPL) on April 28, 2018.

Paper presentation awards

- Dr. P.K. Singh - Outstanding Oral Presentation Award in the 9th National Seed Congress 2018-19 organized by NSRTC, MOA&FW, GOI, Varanasi and I.Ag.Sc., BHU, Varanasi on February 19-21, 2019.
- Dr. A.K. Singh, Principal Scientist (Agronomy) received Best Poster Presentation Award in International Conference on "Sustainability of Smallholder Agriculture in Developing Countries under Changing Climatic Scenario" held at CSAUA&T, Kanpur on February 14-17, 2018.
- Dr. A.K. Singh, Principal Scientist (Agronomy) received Best Paper Award during Annual Convention – 2018 and Asian Conclave of Sugar Millers - Vision 2022 of North Indian Sugarcane and Sugar Technologists' Association (NISSTA) held at National Institute of Technical Teachers Training and Research, Chandigarh on May 24 - 25, 2018.
- Dr. S.N. Sushil received 1st Oral Presentation award during 2nd International Conference on Advances in Agricultural, Biological, and Applied Sciences for Sustainable Future (ABAS – 2018) held at Swami Vivekanand Subharti University, Meerut during October 20-22, 2018.
- Dr. V.P. Jaiswal received Best Oral Presentation Award during 2nd International Conference on Advances in Agricultural, Biological, and Applied Sciences for Sustainable Future (ABAS – 2018) held at Swami Vivekanand Subharti University, Meerut during October 20-22, 2018.
- Dr. S.I. Anwar was conferred upon Best Paper Award in the category, Energy Applications for his paper entitled, " Efficiency enhancement efforts in sugarcane processing for jaggery making" in SOLARIS- 2019, An International Conference on Renewable Energy and Sustainable Climate held at Jamia Millia Islamia, New Delhi on February 07-09, 2019.

- Dr. R.R. Verma received Best Oral Presentation Award in International Conference "Sugarcon-2019" held at ICAR-IISR, Lucknow during February 16-19, 2019.
- Dr. Y.E. Thorat received Best Poster Award in International Conference Sugarcon-2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.

- Sh. Rajeev Kumar, Scientist received Second Prize in oral presentation in International Conference Sugarcon (2019) conducted by SSRP during 16-19 Feb, 2019 held at ICAR-IISR, Lucknow
- Dr. Dilip Kumar, Scientist (Agronomy) received Best Poster Award in International Conference Sugarcon-2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. Anita Sawnani, ACTO received Best Poster Award in International Conference Sugarcon-2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.

IISR (Institute Awards)

- Crop Improvement Division was conferred with the "IISR Team Award" for "Sugarcane Improvement & Development of Varieties on the 68th Foundation Day of ICAR-IISR, Lucknow on February 16, 2019.
- Dr. Amaresh Chandra received Best Scientist Award on the occasion of 68th Foundation Day of ICAR-IISR, Lucknow on February 16, 2019.
- Dr. S.K. Awasthi and Shri Adil Zubair received Best Technical Personnel Award on the occasion of 68th Foundation Day of ICAR-IISR, Lucknow on February 16, 2019.
- Dr. Anita Sawnani received Best Technical Personnel Award on the occasion of 68th Foundation Day of ICAR-IISR, Lucknow on February 16, 2019.

Chairman/Members/Rapporteurs/Experts

- Dr. S.I. Anwar chaired Technical Session V of SOLARIS-2019, An International Conference on Renewable Energy and Sustainable Climate held at Jamia Millia Islamia, New Delhi on Feb. 07-09, 2019.
- Dr. A.K. Sah acted as Chairman in Technical Session in International Conference Sugarcon-2019 on Green Technologies for Sustainable Development of Sugar & Integrated Industries from Feb. 16-19, 2019, jointly organized by SSRP, IISR and IAPSIT at ICAR-IISR, Lucknow.
- Dr. A.K. Singh acted as Co-Chairman of Technical Session on "Mechanization of sugarcane agriculture for improving farm and industry income" during International Conference (SUGARCON-2019) held at IISR, Lucknow during February 16-19, 2019.
- Dr. R.D. Singh acted as Co Chairman in SOLARIS 2019. International Conference on "Renewable Energy and Sustainable Climate" held at Jamia Millia Islamia New Delhi, during February 07-09, 2019.
- Dr. A.K. Singh has been nominated by ICAR as Member of Institute Management Committee (IMC) of ICAR-Central Institute of Agricultural Engineering, Bhopal for a period of three years with effect from July 30, 2018.
- Dr. P.K. Singh acted as Member, Advisory Board and Chairperson in the International Conference on "Sustainable Development: Strategies & Emerging Trends" organized by Netaji Subhash Chandra Bose Govt. Girls PG College, Lucknow on November 16-17, 2018.
- Dr. P.K. Singh acted as Member, National Advisory Board for the International Seminar on Global Partnership in Agricultural Research & Education (GPA-2018) at Institute of Agricultural Sciences, BHU, Varanasi on December 22-24, 2018.

- Dr. Radha Jain and Dr. P.K. Singh acted as Supervisor, Summer Research Fellowship Programme sponsored by Council of Science & Technology, Uttar Pradesh for the year 2018.
- Dr. Radha Jain acted as Session Speaker 4th International Plant Physiology Congress Dec 2-5, 2018 organised by CSIR-NBRI, Lucknow and ISPP New Delhi at Lucknow
- Dr. A. Chandra acted as Course Director and Drs. Radha Jain & S.P. Singh acted as Course Coordinators in 21 days winter school at ICAR-IISR Lucknow in 2018 on "Physio-biochemical and genomic tools to manage drought and post-harvest sucrose losses in sugarcane"
- Dr. T.K. Srivastava acted as Principal Investigator (Crop Production), AICRP on Sugarcane.
- Dr. T.K. Srivastava acted as Member, National Monitoring Team constituted for AICRP on Sugarcane.
- Dr. T.K. Srivastava acted as Member, Varietal Identification Committee of the AICRP on Sugarcane.
- Dr. T.K. Srivastava acted as Member, Expert Panel for evaluation of research work done under projects funded by UPCAR.
- Dr. Sukhbir Singh acted as External Examiner of Ph. D. *Viva Voce* in SHUATS, Prayagraj.
- Dr. Rajesh Kumar was Chairman, Organizing Committee and acted as Convener of Technical Session II : Cane Farming during Annual Convention – 2018 and Asian Conclave of Sugar Millers - Vision 2022 of North Indian Sugarcane and Sugar Technologists' Association (NISSTA) held on May 24 -25, 2018 at National Institute of Technical Teachers Training and Research, Sector-26, Chandigarh.
- Dr. Rajesh Kumar was President, Organizing Committee of Seminar on Soil Health and Recent Advances in Cane Management with Emphasis for Water Logging Areas of Bihar and Eastern UP on September 14, 2018 at Harinagar Sugar Mills, Harinagar, West Champaran, Bihar organized by North Indian Sugarcane and Sugar Technologists' Association (NISSTA).
- Dr. Rajesh Kumar was Chief Editor and Dr. Sangeeta Srivastava was Co-Editor of book published as Souvenir and Research Papers released during one day Seminar on Soil Health and Recent Advances in Cane Management with Emphasis for Water Logging Areas of Bihar and Eastern UP on September 14, 2018 at Harinagar Sugar Mills, Harinagar, West Champaran, Bihar organized by North Indian Sugarcane and Sugar Technologists' Association (NISSTA).
- Dr. Rajesh Kumar was Chief Editor and Dr. Sangeeta Srivastava was Co-Editor of book published as Souvenir and Research Papers released during Annual Convention - 2018 and Asian Conclave of Sugar Millers - Vision 2022 of North Indian Sugarcane and Sugar Technologists' Association (NISSTA) held on May 24 -25, 2018 at National Institute of Technical Teachers Training and Research, Sector - 26, Chandigarh.
- Dr. Rajesh Kumar acted as Rapporteur during the Plenary Session of 32nd Biennial Workshop of ICAR-All India Coordinated Research Project on Sugarcane during October 17-18, 2018 at the University of Agricultural Sciences, Bengaluru, Karnataka.
- Dr. Sangeeta Srivastava acted as Rapporteur of Technical Session-B 1 (Green technologies to enhance sugar productivity) of International Sugar Conference- Sugarcon -2019 held at ICAR-IISR, Lucknow on February 16-19, 2019.
- Dr. Sangeeta Srivastava acted as Rapporteur of Technical Session- III (Agriculture and Allied Sciences (ICAAAS-2018) held at JNU Convention Centre, New Delhi on April 28-29, 2018.
- Dr. Sukhbir Singh acted as Rapporteur in the technical session on "Sugarcane Research- Sugar Industry Interface and Emerging Policies" during International Conference (Sugarcon-2019) held at IISR, Lucknow during February 16-19, 2019.
- Dr. Sukhbir Singh acted as Convener of Technical Session on "Mechanization of sugarcane agriculture for improving farm and industry income" during International Conference (Sugarcon-2019) held at IISR, Lucknow during February 16-19, 2019.
- Dr. Mrityunjai Kumar Singh acted as Rapporteur of Technical Session on "Mechanization of sugarcane agriculture for improving farm and industry income" during International Conference (Sugarcon-2019) held at IISR, Lucknow during February 16-19, 2019.
- Dr. A.K. Sah acted as Rapporteur in Technical Session on "Climate Smart Agricultural Technologies- Innovations and Interventions" in 9th NEEC-2018 at CAEPHT, Ranipool, Sikkim from November 15-17, 2018.
- Dr. Sangeeta Srivastava acted as Nodal Officer of AIEEA UG-PG-Ph.D. 2018 (Online Exam) at DIT Education Centre, Lucknow during June 21-23, 2018.

- Dr. A.K. Singh is acting as Co-Chairman of Indian Society of Agricultural Engineers, Lucknow Chapter.
- Dr. R.D. Singh is acting as Joint Secretary cum Treasurer, Indian Society of Agricultural Engineers, Lucknow Chapter.
- Dr. S.I. Anwar acted as Member, Project Monitoring Committee of Ministry of Environment, Forest and Climate Change, Govt. of India.
- Dr. S.I. Anwar acted as Secretary of Lucknow Chapter of Indian Society of Agricultural Engineers (ISAE).
- Dr. Rajesh Kumar presided over as judge for evaluation of papers presented for consideration of Dr. G.R. Seth Memorial Young Scientist Award of Indian Society of Agricultural Statistics, New Delhi during 72nd Annual Conference of India Society of Agricultural Statistics organized at ICAR-Central Institute of Agricultural Engineering, Nabibagh, Berasia Road, Bhopal-462038, Madhya Pradesh on December 13-15, 2018.
- Dr. Rajesh Kumar presided over as Chairman of Session on IP 05 : Advanced Statistical and Informatics in Agriculture of the 72nd Annual Conference of the Indian Society of Agricultural Statistics organized at ICAR-Central Institute of Agricultural Engineering, Nabibagh, Berasia Road, Bhopal during December 13-15, 2018.
- Dr. Rajesh Kumar was nominated as Supervisor and Centre-in-Charge, Agricultural Research Service (ARS)-2018 (Preliminary) & National Eligibility Test (NET-I)-2018 Examination of Agricultural Scientists Recruitment Board, New Delhi to conduct Examination in the online mode held during April 6-10, 2018 at Lucknow Centre and also coordinated conduct of the examination at 18 locations in Lucknow.
- Dr. Rajesh Kumar was nominated Assistant Supervisor of ASRB on line examination centre at ICAR-Indian Institute of Sugarcane Research, Lucknow to conduct online examination ICAR–National Eligibility Test–II-2018 on December 27-29, 2018.
- Dr. Rajesh Kumar was nominated as Vigilance Officer of ICAR-IISR, Lucknow by ICAR on March 19, 2019.
- Dr. Rajesh Kumar was nominated as DG Nominee for Departmental Promotion Committee of ICAR-Indian Agricultural Statistics Research Institute, New Delhi.
- Dr. Rajesh Kumar was designated to act as ERP / FMS-MIS administrator at ICAR-Indian Institute of Sugarcane Research, Lucknow.
- Dr. Sangeeta Srivastva invited as Guest Speaker in DBT, Govt. of India sponsored Popular Lecture Series in Biotechnology at Institute of Biotechnology and Biosciences, Sri Ramswaroop Memorial University, Lucknow on January 19, 2019.
- Dr. Sangeeta Srivastava served as Nodal Officer-EFC/SFC of all Commercial Crops (Sugarcane, Cotton, Tobacco, Jute and Allied Fibers).
- Dr. Sangeeta Srivastava served as Advisory Board Member of Agrica Journal.
- Dr. Sangeeta Srivastava acted as Co-Major advisor of two M.Sc. (Biotechnology) students of SHUATS, Prayagraj.

CHAPTER 15

Publications

Research Papers

Chandra P, Tripathi P and Chandra A. 2018. Isolation and molecular characterization of plant growth-promoting *Bacillus* spp. and their impact on sugarcane (*Saccharum* spp. hybrids) growth and tolerance towards drought stress. *Acta Physiol Plant*. **40**:199 doi.org/10.1007/s11738-018-2770-0.

Gangwar LS, Singh AK and Pathak AD. 2018. Potential of mechanization in improving productivity, farmers income and reduction of sugarcane production cost in India- An *ex-ante* evaluation. *Agricultural Economics Research Review* **31** (Conf.): 215

Holkar SK, Mandal B, Krishna Reddy M and Jain RK. 2019. Watermelon bud necrosis orthotospovirus - an emerging constraint in Indian subcontinent: An overview. *Crop Protection* **117**: 52-62.

Jain R, Singh A, Singh CP, Kumar R, Singh SP, Chandra A, Srivastava VK and Pathak AD. 2018. Rooting pattern and anatomical alteration in roots of sugarcane genotypes under waterlogged conditions. *Climate Change and Environmental Sustainability* **6**: 139-153.

Jain R, Singh A, Singh SP and Chandra A. 2018. Influence of bud sett soaking with plant growth regulator, ethephon and its foliar application on growth, biochemical attributes and SAI and SPS gene expression in sugarcane. *J Environ. Biology* **39**: 472-480.

Jain R, Singh A and Srivastava S. 2018. Genetic variability and correlation of foliar characters, HR-brix and juice quality attributes of sugarcane genotypes in ratoon. *Indian Journal of Sugarcane Technology* **33**(01): 44-48.

Joshi D, Gupta J, Mishra A, Upadhay M, Holkar SK, Singh P.2018. Distribution, composition and bioactivity of endophytic *Trichoderma* spp. associated with sugarcane. *Proceedings of National Academy of Sciences, India B. Biological Sciences* 1-12. Published online at: https://doi.org/10.1007/s40011-018-1036-3.

Joshi D, Singh P, Holkar SK and Kumar S. 2018. *Trichoderma*-mediated suppression of red rot of sugarcane under field conditions in subtropical India. *Sugar Tech* **21**(3) : 496-504.

Kaushal P, Dwivedi KK, Radhakrishna A, Saxena S, Paul S, Srivastava MK, Baig MJ, Roy AK and Malaviya DR. 2018. Ploidy dependent expression of apomixis and its components in guinea grass (*Panicum maximum* Jacq.). *Euphytica* **214**(9). DOI: 10.1007/s10681-018-2232-1.

Kaushal P, Dwivedi KK, Radhakrishna A, Srivastava MK, Kumar V, Roy AK and Malaviya DR.2018. Partitioning apomixes components to understand and utilize gametophytic apomixis. *Frontiers in Plant Science* **10**:256.doi:10.3389/fpls.2019.00256.

Khan MS, Kumar S, Singh RK, Singh J, Duttamajumder SK and Kapur R. 2018. Characterization of leaf transcriptome, development and utilization of unigenes-derived microsatellite markers in sugarcane (*Saccharum* sp. hybrid). *Physiology and Molecular Biology of Plants* **24**(4): 665-682.

Kharate PS, Pathak AD, Jha Z and Srivastava S. 2018. SSR based characterization of molecular diversity in general cross progeny of sugarcane (*Saccharum* spp. hybrids). *Indian Journal of Sugarcane Technology* **33**(2): 88-93.

Kumar D, Dhar S, Kumar S, Meena DC and Meena RB. 2019. Effect of zinc application on yield attributes and yield of maize and wheat in maize-wheat cropping system. *International Journal of Current Microbiology and Applied Sciences* **8**(1): 1931-1941.

Kumar D, Kumar S, Meena LK, Meena LR and Singh SP. 2018. Stability analysis of sugarcane (*Saccharum* spp) genotypes for metric and quality traits by AMMI Model. *Indian Journal of Agricultural Sciences* **88**(4): 657-64.

Kumar M, Ghorai AK, Kundu DK, Mitra S and Singh SR. 2018. Carbon and nitrogen mineralization kinetics as influenced by diversified cropping systems and residue incorporation in Inceptisols of eastern Indo-Gangetic Plain. *Soil & Tillage Research* **178**: 108–117.

Kumar M, Kumar A, Mandal NP, Kumari C and Singh VK. 2018. Evaluation of drought tolerance indices for rice (*Oryza sativa* L.) under non stress and stress condition. *Research Journal of Agricultural Sciences* **9** (Special): 121-126.

Kumar M, Mishra V, Singh BD, Mall AK and Pathak AD. 2018. Incidence of red rot disease in sugarcane variety, CoS 8436, in Bihar, India. *Plant Archives* **18** (SI): 182-186.

Kumar R, Singh P, Rai RK, Kumari M, Kumar A, Pathak AD and Olekar NS. 2018. Homa organic farming reduces pest and disease infestations in okra and improves its quality and yield. *Journal of Entomology and Zoology Studies* **6**(6): 211-218.

Kumar S, Shiva D, Barthakur S, Kumar S, Mondal B, Kumar D, Kochewad SA, Meena LR, Singh MV, Singh M, Chandrakala M and Ram C. 2018. Integrated K management exhibit a key role in potassium uptake transporter (ZmKUP) expression to improve growth and yield of corn *Int. J. Curr. Microbiol. App. Sci.* **7**(12): 1867-1887.

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Kumar S, Shiva D, Barthakur S, Chandrakala M, Kochewad SA, Meena LR, Meena LK, Kumar S, Singh M and Kumar D. 2018. Effect of integrated potassium management on soil biological properties and yields of corn under corn-wheat cropping system. *International Journal of Current Microbiology and Applied Sciences* **7**(12): 1855-1866.

Kumar N, Nath CP, Hazra KK, Das K, Venkatesh MS, Singh MK, Singh SS, Praharaj CS and Singh NP. 2019. Impact of zero-till residue management and crop diversification with legumes on soil aggregation and carbon sequestration. *Soil & Tillage Research* **189**: 158–167.

Maity AN, Natarajan D, Vijay R, Srinivasan MP and Malaviya DR. 2018. Influence of metal nanoparticles (NPs) on germination and yield of *oat* (*Avena sativa*) and *berseem* (*Trifolium alexandrinum*). *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci.* (Apr–June 2018) **88**(2):595–607. https://doi.org/10.1007/s40011-016-0796-x.

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Malaviya DR, Roy AK, Kaushal P, Yadav A, Pandey DK. 2019. Complementary gene interaction and xenia effect controls the seed coat colour in interspecific cross between *Trifolium alexandrinum* and *T. apertum. Genetica.* https://doi.org/10.1007/s10709-019-00063-5.

Malaviya DR, Roy AK, Kaushal P, Chakraborti M, Yadav A, Khare A, Dhir R, Khairnar D and George GP. 2018. Interspecific compatibility barriers, development of interspecific hybrids through embryo rescue and lineage of *Trifolium alexandrinum* (Egyptian clover) – important tropical forage legume. *Plant Breeding* **137**:655–672.

Mall AK, Misra V, Singh D, Kumar M and Pathak AD. 2018. Methods and procedures for high yielding seed cane production. *International Journal of Agricultural Sciences* **10**(14): 6660-6664.

Misra V, Mall AK, Shrivastava AK, Solomon S, Shukla SP and Ansari MI. 2019. Assessment of *Leuconostoc* spp invasion in standing sugarcane with cracks internodes. *Journal of Environmental Biology* **40**: 316-321.

Misra V, Mall AK, Shrivastava AK, Solomon S, Shukla SP, Prajapati CP and Pathak AD. 2018. Morphological variation in thick and thin canes staling indifferent portions of cane stalk. *Plant Archives* **20** (SI): 157-160.

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Rai D, Singh V, Singh VN and Ram Kewal. 2019. Study of technological gap in adoption of pulse production technologies in Lucknow district of Central Plain zone of Uttar Pradesh. *Journal of Krishi Vigyan* **7**(2): 248-250.

Rai RK, Singh P, Pathak AD and Singh SN. 2018. Optimizing plant population with smart canopy architecture for maximized cane and sugar yield in sub-tropics. *Indian Sugar* **68**(10):16-22.

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Roy MM and Chandra A. 2018. Technological and management options for optimizing sugar recovery in India: A review. *Int. J. Eng. Res. Mgmt.* **5**: 14-22.

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enhancing income of sugarcane farmers in subtropical India. *Agric. Res.*, doi.org/10.1007/s40003-018-0387-6.

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Roy S,Balaji RK and Misra AK. 2018. A pilot study for area-wide management of fruit fly in mango for the central Gangetic plain. *Journal of Eco-friendly Agriculture* **13**(2):68-71.

Sawnani Anita and David Alka. 2018. Socio detrimental status of women and their rural households in Gwalior region of Madhya Pradesh. *International Journal of Research in Engineering, Science and Management* ISSN (Online) 2581-5792 **1**(10): 187-189.

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Shingote PR, Mithra SVA, Sharma P , Devanna NB, Arora K, Holkar SK, Khan MS, Singh J, Kumar S, Sharma TR and Solanke AU. 2019. LTR-Retrotransposons and highly informative ISSRs in combination are potential markers for genetic fidelity testing of tissue culture-raised plants in sugarcane. *Molecular Breeding* **39**(25): 1-12 .

Shukla SK, Soloman S, Sharma L, Jaiswal VP, Pathak AD and Singh Priyanka. 2019. Green technologies for improving cane sugar productivity and sustaining soil fertility in sugarcane-based cropping system. *Sugar Tech* **21**(2):186-196.10.1007/s12355-019-00706-z.

Shukla SK, Yadav RL, Gupta R, Singh AK, Awasthi SK and Gaur A. 2018. Deep tillage, soil moisture regime and optimizing N nutrition for sustaining soil health and sugarcane yield in sub-tropical India. *Communications in Soil Science and Plant Analysis* **49**(4): 444-462.

Singh A, Singh SP, Chandra A and Jain R. 2018. Sett priming with plant growth promoting chemicals affecting germination and physio-biochemical attributes in sugarcane. *Climate Change and Environmental Sustainability* **6**: 35-40.

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CHAPTER 16

Technical Programme (2018-19)

Project code	Title of the project
Division of Crop Improvement	
B 1.7	Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions (P.K. Singh, Sanjeev Kumar and J. Singh (upto April 15, 2018); 01/1995-LT)
B 1.8	Defining ideotypes in sugarcane for moisture deficit conditions (A.K. Mall, D.R. Malaviya and S.P. Singh; 01/17-12/21)
B 2.13	Development of sugarcane varieties for sub-tropics (Sanjeev Kumar, P.K. Singh, D.K. Pandey (upto October 31, 2019), J. Singh ((upto April 15, 2018) and T.K. Srivastava; 10/03-LT)
B 2.14	Development of breeding stocks of sugarcane for durable resistance to red rot (D.K. Pandey, P.K. Singh, Deeksha Joshi, J. Singh (up to April 15, 2018) and Sanjeev Kumar; 10/04-10/18)
B 2.15	Developing sugarbeet varieties for Indian agro-climates (A.D. Pathak, S.K. Duttamajumder, Arun Baitha and A.K. Mall; 09/08- LT)
B 2.16	Development of sugarcane clones/varieties for North Central Zone (A.K. Mall, A.D. Pathak, D. Singh, Arun Baitha, M.K. Tripathi and C.K. Gupta; 10/18-09/28)
B 3.19	Mapping of loci linked to sugar content in sugarcane (M. Swapna and D.K. Pandey (upto October 31, 2019); 12/09-03/20)
B 3.21	Production of disease free and genetically pure seed cane through tissue culture techniques (Sanjeev Kumar, J. Singh (upto April 15, 2018) and S.K. Holkar ; 11/13-LT)
B 3.22	Development of *in vitro* conservation protocol using slow-growth tissue culture techniques in sugarcane (Sanjeev Kumar (Biotech.) and J. Singh (upto April 15, 2018); 03/15-03/20)
B 3.23	Profiling and prediction of small RNA transcriptomes in sugarcane in sugarcane inoculated with red rot pathogen (Sangeeta Srivastava, A.D. Pathak and Dinesh Singh, 10/15-10/20)
AICRP on Sugarcane	
B 1.1	Evaluation of early maturing sugarcane clones of North West Zone (Sanjeev Kumar and P.K. Singh, 02/09-LT)
B 1.2	Evaluation of mid-late sugarcane clones of North West Zone (Sanjeev Kumar and P.K. Singh, 02/09- LT)
B 1.3	Evaluation of sugarcane clones under Zonal Varietal Trials for North Central and Eastern Zone (A.K. Mall and A.D. Pathak; 02/09 to LT)
Externally funded	
DBT BioCARe	RNA seq for SNP mining and linkage mapping in sugarcane (Nandita Banerjee, Sanjeev Kumar; 11/14-06/18; Budget: ₹ 50 lakh)
DBT	Accredited Test Laboratory (ATL) under National Certification System for Tissue Culture Raised Plants (NCS-TCP) [Coordinator: Sanjeev Kumar (Biotech.), PIs: Sanjeev Kumar and Dinesh Singh; 03/15-03/20, Budget : ₹ 103.00 lakh]
DST-SERB	Genomic selection based accelerated breeding in sugarcane (*Saccharum* species complex) with special reference to sugar content and red rot resistance [Sanjeev Kumar (Biotech.), 06/18-06/21; Budget : ₹ 41.00 lakh]

Project code	Title of the project
DST WOS-A	Investigating sucrose accumulation through RNA-seq bulked segregant analysis in sugarcane (PI: Nandita Banerjee, Mentor: Sanjeev Kumar; 06/18-06/21, Budget : ₹ 30.0 lakh)
PPV&FRA	Central Sector Scheme for PPV&FRA (P.K. Singh, 2006-LT)
ICAR	ICAR seed project "Seed production in agricultural crops" (P.K. Singh and Sanjeev Kumar, 2006-LT)
Division of Crop Production	
A 1.1.32	Validation of cane node technology under farmers' field condition (S.N. Singh, A.K. Sah and C. Gupta; 2016 – 2019)
A 1.1.33	Biology and management of binding weed *Ipomoea spp*. in sugarcane (V.P. Singh, K.K. Singh, S.P. Singh, V.P. Jaiswal. T.K. Srivastava and A.P. Dwivedi; 2017 – 2022)
A 1.1.34	Improved agronomic interventions for enhancing productivity of ratoon crop (Dileep Kumar, V.P. Singh, K.K. Singh, Mona Nagargade and S.R. Singh,: 04/19-03/24).
A 1.2.31	Studies on effect of tillage and management practices on rice-wheat-sugarcane-ratoon-wheat in Conservation Agriculture (V.K. Singh, V.P. Singh, A.K. Singh (Engg.), S.K. Shukla, V.P. Jaiswal, Dinesh Singh and S.N. Sushil; 2017 – 2022)
A 2.37	Sugarcane productivity in relation to initial soil organic carbon content and nutrient management in sub-tropical inceptisol (T.K. Srivastava, S.R. Singh, Pushpa Singh and R.R. Verma; 3/15 - 6/19)
A 2.38	Soil quality assessment under different sugarcane growing systems (S.R. Singh, T.K. Srivastava, R.R. Verma, Pushpa Singh, S.N. Singh, A.K. Singh, R.S. Dohare; 2015-2018)
A 2.39	Synchronizing nutrient supply with crop demand under drip fertigation for upscaling nutrient use efficiency in sugarcane (Plant) ratoon system (K.K. Singh, S.R. Singh, V.P. Singh, S.K. Shukla and Rajendra Gupta; 2017-2022)
A 2.40	Effect of silicon nutrition on growth, yield. juice and soil quality of sugarcane in sub-tropics (M.K. Tripathi, S.R. Singh, C. Gupta, S.K. Shukla, S.N. Singh, A.P. Dwivedi and V.K. Singh: 4/19-03/24)
A 2.41	Management of bio-resources for enhancing sugarcane productivity and soil health (A.P. Dwivedi, S.K. Shukla, V.P. Singh, M.K. Tripathi, V.K. Singh, K.K. Singh, S.R. Singh and Lalan Sharma: 10/18-09/23)
A 2.42	Improving soil health and sugarcane ratoon productivity through application of microbial consortia (V.P. Jaiswal, S.K. Shukla, T.K. Srivastava, Lalan Sharma, D.N. Borase and S.K. Yadav: 02/19-01/24)
A 2.43	Developing scientific aids for site specific nutrient management through variable mapping of soil properties in sugarcane growing soils (R.R. Verma, T.K. Srivastava, Pushpa Singh and S.R. Singh: 04/19 - 03/24)
A 3.24	Enhancing system productivity and profitability of wide row planted autumn sugarcane through intercropping of high value crops (C. Gupta, A.K. Singh (Agron.), M.K. Tripathi, S.R. Singh, S.P. Singh, A.K. Singh (AE): 03/19-02/23)
A 3.25	Diversification of sugarcane based cropping system with medicinal and aromatic plants in sub-tropical India (S.K. Yadav, S.K. Shukla, V.P. Jaiswal, Saudan Singh (CSIR-CIMAP, Lucknow) and Arun Baitha: 03/19-02/23)
A ET 1.1	Modulating application of sugarcane production technologies for harnessing production and productivity potential in farmers' field perspective (R.S. Dohare, T.K. Srivastava, Rajesh Kumar and S.N. Singh; 2015 – 2020)
A 4.10	Developing sugarcane based Integrated Farming System Models for small farm holders of sub-tropical India (A.K. Singh, T.K. Srivastava, A.K. Sharma, Akhilesh Kumar Singh, Rakesh Kumar Singh, M.M.Roy (Upto November 30, 2018); 2016-LT)

Project code	Title of the project
Exp Trial	Evaluation of the effect of bio-stimulator on growth, yield and juice quality quality of sugarcane (AP Dwivedi, V.K. Singh and V.P. Singh; 03/17-03/19)
AICRP on Sugarcane	
AS 68	Impact of integrated application of organics and inorganics in improving soil health and sugarcane productivity (A.K. Singh, T.K. Srivastava and S.R. Singh, 2014-2018)
AS 69	Use of plant growth regulators (PGRs) for enhanced yield and quality of sugarcane (R.R. Verma and S.R. Singh, 2015-2018)
AS 70	Scheduling irrigation with mulch under different sugarcane planting method (C. Gupta, S.K. Shukla, V.P. Jaiswal and V.K. Singh, 2016-2019)
AS 71	Carbon sequestration assessment in sugarcane based cropping system (V.P. Jaiswal, S.K. Shukla and V.P. Singh; 2016-2019)
AS 72 (A)	Agronomic performance of elite sugarcane genotype (Early) (V.P. Singh and S.K. Shukla; 2016- LT)
AS 72 (B)	Agronomic performance of elite sugarcane genotype (Midlate) (K.K. Singh and V.P. Singh; 2016-LT)
AS-73	Assessment of climate change impact on sugarcane productivity R.R. Verma and T.K. Srivastava; 2018-LT)
AS-74	Evaluation of sugarcane varieties for drought tolerance (V.K. Singh, K.K. Singh and V.P. Singh; 2018-LT)
AICRP on STCR	
STCR	Soil test and resource based integrated plant nutrient supply system for sustainable sugarcane production (S.R. Singh, T.K. Srivastava, R.R. Verma, S.S. Hasan; 2014-LT)
Contract Research	
FMC	Evaluation of F 8072 and F 9253 herbicides for weed control in sugarcane, (A.K. Singh and T.K. Srivastava, 2014 – 2018)
Bayer	Bio-efficacy evaluation of tembotrione 420 SC (laudis (420 SC) in sugarcane (V.P. Singh, K.K. Singh, S.N. Singh and S.K. Shukla; 2016 – 2018)
Atul Limited	Bio-efficacy and phytotoxicity evaluation of RJKP 1505 (2,4-D Sodium Salt 67.7% +Metribuzin 16.5% WP) in sugarcane (V.P. Singh, K.K. Singh, A.K. Singh and S.K. Shukla; 3/16- 8/18)
Sumitomo Chemical (India)	Bio-efficacy & phyto-toxicity evaluation of 'Flumioxazin 50% SC' against weeds in sugarcane and its effect on succeeding crop (V.P. Singh, K.K. Singh, V.P. Jaiswal and S.K. Shukla; 10/16-8/19)
ISK BioSciences India Pvt. Ltd.	Bio-efficacy evaluation of SL160 10% herbicide against weed control of sugarcane (V.P. Singh, A.P. Dwivedi, V.K. Singh and K.K. Singh; 3/17 -9/19)
Meghmani Organics	Bioefficacy evaluation of Atrazine 50% WDG herbicide against weed complex of sugarcane (K.K. Singh, V.P. Singh, and V.P. Jaiswal; 3/17 to 9/19)
Coromondal Pvt. Ltd., Hyderabad	Bioefficacy and phytotoxicity evaluation of halosulfuron-methyl 75% WG against weeds in spring planted sugarcane (V.P. Singh, K.K. Singh, V.K. Singh and A.P. Dwivedi; 2017-2018)
ADAMA Ind. Pvt. Ltd. Hyderabad	Bio-efficacy evaluation of Ametryn 80% WDG herbicide against weed complex of sugarcane (V.P. Singh, V.K. Singh, K.K. Singh and A.P. Dwivedi, 03/17-9/19)
United Phosphorus Ltd. Mumbai	Bio-efficacy & phyto-toxicity evaluation of UPH 114b against weeds in sugarcane (V.P. Jaiswal, V.P. Singh, Lalan Sharma and S.K. Shukla; 2019-2021)
Division of Crop Protection	
EM 01	Survey and surveillance of insect pests and diseases of sugarcane in sub tropical India (M.R. Singh and all the Scientists of Crop Protection Division and IISR-Biological Control Centre, Pravarangar; Duration: LT)

Project code	Title of the project
M 5.10	Management of Yellow Leaf Disease (YLD) of sugarcane through thermotherapy (Dinesh Singh and S.K. Holkar, 05/15-04/18)
M 17	Evaluation/screening of sugarcane germplasm against red rot and smut (M.R. Singh, Dinesh Singh and S.K. Duttamajumder, 1992-93-LT)
M 15.6	Enhancing efficacy of *Trichoderma* based red rot management system (Deeksha Joshi and Pushpa Singh, 04/12-03/20)
M 15.7	Management of Pokkah boeng disease of sugarcane (Lalan Sharma, S.K. Shukla, V.P. Jaiswal and M.R. Singh: 03/19-02/23)
Ento 15.3	Isolation, identification and synthesis of sex pheromones lures for the management of major borers of sugarcane (M.R. Singh, Pushpa Singh, A Baitha, S.N. Sushil and A.K. Jaiswal: 04/19-03/22)
Ento 15.4	Dispersal, host location, kairomonal effect and recovery of bio-agents *Trichogramma chilonis* and *Tetrastichus howardi* (Arun Baitha, M.R. Singh, A.K. Jaiswal, S. Roy and S.N. Sushil: 10/18-09/22)
Ento 2.1.2	Developing arthropods based soil health indicator for subtropical sugarcane ecosystem (Sharmila Roy, A.K. Jaiswal, D. Joshi and S.R. Singh: 10/18-09/23)
Ento 4.2.1	Development of eco-friendly technologies for the management of termites in sugarcane (S.N. Sushil, A.K. Jaiswal, S. Roy and D. Joshi: 10/18-09/22)
AICRP (S)	**Plant Pathology**
PP 14	Identification of pathotypes in red rot pathogen (Dinesh Singh, S.K. Duttamajumder and Lalan Sharma)
PP 17	Evaluation of zonal varieties against red rot, smut and wilt (Dinesh Singh, S.K. Duttamajumder and Lalan Sharma)
PP 22	Survey of sugarcane diseases naturally occurring in the area on important varieties (Dinesh Singh, S.K. Duttamajumder and Lalan Sharma)
Entomology	
E 4.1	Evaluation of varieties/genotypes for their reaction against major insect pests (M.R. Singh, A. Baitha and S.N. Sushil)
E. 30	Monitoring of insect pests and bio-agents in sugarcane agro-ecosystem (M.R. Singh, A. Baitha and S.N. Sushil)
E. 34	Standardization of simple and cost effective techniques for mass multiplication of sugarcane bio-agents (M.R. Singh, A. Baitha and S.N. Sushil)
E.39	Pilot evaluation of water less pheromone trap and water basin pheromone trap against sugarcane borers (Arun Baitha and M.R. Singh)
Contract Project	
Bayer Crop Science, Ltd	Bio-efficacy of Vayego Superb (Tetraniliprole 0.4% + Fipronil 0.6% Gr against early shoot borer, top shoot borer and white grub in sugarcane sponsored by Bayer Crop Science, Ltd., Mumbai, Budget ₹ 9.0 lakh.
Division of Plant Physiology and Biochemistry	
PB 27	Molecular study to reveal transcriptomes and genes associated with sucrose transport and accumulation in sugarcane (A. Chandra and Radha Jain, 04/12-04/18)
PB 28	Minimizing post- harvest sucrose deterioration and its molecular assessment in sugarcane (A. Chandra, Radha Jain and D.N. Borase; 04/12-03/19).
PB 29	Physiological and molecular bases of multiple abiotic stress tolerance in sugarcane (S.P. Singh, Radha Jain, A. Chandra, A.K. Mall and A.D. Pathak, 04/17-03/22)
PB 30	Genome sequencing of red rot pathogen of sugarcane (A. Chandra, Sanjeev Kumar (Biotech.), D. Singh and Deeksha Joshi, 04/17-03/22)

Project code	Title of the project
PB 31	Understanding mechanisms of sugar accumulation and WUE in sugarcane through physio-bio-chemical studies (C.K. Gupta, S.P. Singh, Rajeev Kumar, A. Chandra, A.K. Mall, Bhupinder Singh, Rajesh Kumar, R Jain and A.D. Pathak; 10/18-09/22)
PB 32	Evaluation of silica application in relation to moisture stress, disease and pest tolerance and productivity in sugarcane (Rajeev Kumar, A.D. Pathak, R. Jain, C.K. Gupta, A. Chandra, Lalan Sharma, R.R. Verma, Pushpa Singh and M.R. Singh: 03/19-02/24)
PB 33	Process development for enhancing ethanol recovery from sugarcane trash and 'B heavy' molasses (Pushpa Singh and Rajeev Kumar: 04/19-03/24)
PB 34	Assessment of scope for invigoration of biomass dynamics during sugarcane growth cycle through plant growth regulators (Pushpa Singh, R. Jain and Rajeev Kumar: 04/19-03/24)
Inter-Institutional Project	Screening and identification of sugarcane lines tolerant to water-logging and their physio-biochemical investigation (Radha Jain, A.D. Pathak, A. Chandra, S.P. Singh, M. Swapna, V.K. Srivastava, M. Ramadurai, 2013-2021)
Externally Funded Projects	
UPCST	Enhancing sugarcane bio-productivity : Physiological and metabolic interventions using nutrient – hormonal carriers (Radha Jain, A.D. Pathak, A. Chandra and S.P. Singh, 08/15-08/18, Budget ₹ 11.0 lakh).
Division of Agricultural Engineering	
AE 1.19B	Development of two row disc type ratoon management device with and without stubble shaving attachments (A.K. Singh and Sukhbir Singh; 09/16 to 08/19)
AE 1.52	Development and evaluation of tractor operated multipurpose tool frame with attachments for sugarcane (Sukhbir Singh and A.K. Singh, 10/15 to 09/20)
AE 1.23	Development of cane node planter (A.K. Singh and S.N. Singh; 09/16 -08/19)
AE 1.81	Development of sugarcane trash management machinery (M.K. Singh, A.K. Singh and R.D. Singh: 09/18-08/21)
AE 6.8	Sustaining sugarcane yield under multiple ratooning through drip irrigation (Rajendra Gupta; 03/16 - 03/22)
AE 7.1.1	Refinement of sugarcane cleaner cum washer for jaggery (S.I. Anwar, Dilip Kumar and R.D. Singh, 11/16-10/20)
AE 7.6.1	Development of integrated drying system for jaggery drying (R.D. Singh, A.K. Singh, S.I. Anwar and Dilip Kumar; 11/16 – 11/19)
AE 7.6.2	Development of a jaggery furnace with efficiency boosting device (S.I. Anwar, 04/12-03/20)
AICRP on Farm Implements and Machinery	
FIM/IISR/PMW/86	Manufacturing of prototypes for conducting field adoptability trials under varying agro-climatic and soil conditions (A.K. Singh; 04/86-LT)
FIM/IISR/PFT/2015/01	Prototype feasibility trial of Pant-ICAR sub-soiler-cum-differential rate fertilizer applicator (R.D. Singh, Sukhbir Singh and A.K. Singh; 04/16 – 03/19)
FIM/IISR/FLD/2017/01	IISR Tractor operated disc type ratoon management device (A.K. Singh, Sukhbir Singh and A.K. Sah; 04/17 – 03/20)
FIM/IISR/FLD/2017/02	IISR Tractor operated deep furrow sugarcane cutter planter (A.K. Singh, Sukhbir Singh and R.D. Singh; 02/17 - 03/20)
FIM/IISR/FLD/2017/03	IISR Tractor operated sugarcane trench planter (A.K. Singh, Sukhbir Singh and R. Gupta; (04/17 – 03/20)
FIM/IISR/FLD/2017/04	IISR Tractor operated deep furrow sugarcane cutter planter/trench planter-cum-multicrop raised bed seeder (A.K. Singh and Sukhbir Singh; 04/17 - 03/20)

Project code	Title of the project
FIM/IISR/FLD/2017/05:	IISR Tractor operated deep furrow sugarcane-cum-potato planter (A.K. Singh; 11/17- 03/20)
AICRP on Post Harvest Engineering Technology (PHET)	
LKO/PHTS/16/01	Development of sugarcane juice extractor for household use (Dilip Kumar and S.I. Anwar; 01/16 – 12/18)
Externally funded projects	
ICAR	Agri-consortia research platform on water (Rajendra Gupta, T.K. Srivastava, Pushpa Singh, S.R. Singh, R.R. Verma and S.N. Singh, 12/15-03/19, Budget : ₹ 31.0 lakh)
UPCAR	Development and dissemination of drudgery reducing farm tools and equipment for sugarcane for small and marginal farmers of UP- Center of Excellence in Farm Machinery (Sukhbir Singh, A.K. Singh and R.K. Singh, 05/17 – 05/22, Budget : ₹ 40.06 lakh)
UPCST	Development of process technology (protocol) for manufacturing of protein rich jaggery using natural source (S.I. Anwar and R.D. Singh; 07/18-07/21; Budget : ₹ 10.84 lakh)
RKVY (U.P. Govt)	Establishment of quality jaggery production-cum-training unit in selected districts of Uttar Pradesh for income generation and entrepreneurship development (Dilip Kumar, A.D. Pathak, A.K. Singh and A.K. Mall, 04/18 – 03/20, Budget : ₹ 220 lakh)
NSC	Entrepreneurship development and income enhancement of sugarcane farmers in Chakia, Kotwa and Arirajpur (Bihar) through establishment of IISR Model jaggery unit (Dilip Kumar, A.D. Pathak, A.K. Singh, S.I. Anwar and S.N. Singh; 04/18-03/19 Budget ₹ 36 lakh)
Extension and Training Unit	
ET 1.12	Documentation and confirmation of indigenous technical knowledge under sugarcane based cropping systems (Kamta Prasad, T.K. Srivastava, Rajendra Gupta and A.K. Sah; 1/12-12/18)
ET 1.14	Entrepreneurship development for sugarcane seed production and multiplication (A.K. Sah, S.N. Singh, Sanjeev Kumar, S.N. Sushil and Kamta Prasad, 10/12 – 10/19)
ET 1.15	An analysis of gender perspective in sugarcane cultivation (Kamta Prasad, R.S. Dohare, A.K. Sah, Rajesh Kumar and A.K. Sharma, 01/17-12/20)
ET 1.16	Technology and information utilization pattern among the sugarcane growers (Barsati Lal, K. Prasad, R.S. Dohare, A.K. Sah, R. Gupta and L.S. Gangwar: 10/18-09/23)
Economics & Statistics/AKMU/PME Cell	
AES 4.15	Development of data mining and presentation tools in sugarcane (S.S. Hasan, Rajesh Kumar and L.S. Gangwar; 04/12-03/21)
AES. 4.16	Factors contributing to economic viability of sugar mills and energy production complexes in India (L.S. Gangwar, S.S. Hasan and A.K. Sah; 03/15 to 03/20)
AES 4.17	Impact of IISR technologies in sustaining sugarcane production in India (A.K. Sharma, T.K. Srivastava, A.K. Singh, S.K. Duttamajumder, A.D. Pathak and M.R. Singh, 04/15 – 03/20)
AES 4.18	Estimation of techno-economic feasibility of sugarbeet cultivation for sugar and ethanol production in India (A.K. Sharma, T.K. Srivastava and A.D. Pathak; 10/15 -06/19)
AES 4.19	Online database and mixed model analysis of sugarcane varieties tested/released in India (Rajesh Kumar, S.S. Hasan, A.D. Pathak and V.K. Gupta; 04/17-03/21)
AES 4.20	Development of web based reporting system for the trials of AICRP on Sugarcane (S.S. Hasan, S.K. Shukla, A.D. Pathak and Rajesh Kumar, 10/16-09/19)
Exploratory study	Global sugarbeet and sugar production growth scenario (A.K. Sharma and A.D. Pathak; 08/17-08/18)

Project code	Title of the project
Exploratory study	Indian perspective of sugarcane research and policies (A.K. Sharma and A.D. Pathak; 08/18-08/19)
IISR Biological Control Centre, Pravaranagar	
EM 01	Survey and surveillance of insect-pests and diseases of sugarcane in sub-tropical area (M.R. Singh, HoD and IISR Biological Control Centre, Pravaranagar; Duration: Long Term)
M 5.9	Genetic diversity and transmission of pathogens causing Yellow Leaf Disease in sugarcane (S.K. Holkar, Arun Baitha and Sanjeev Kumar (Biotech.); Duration: 04/15 – 03/20)
BCC 1.1	Bio-prospecting of entomopathogenic bacteria for management of white grubs infesting sugarcane (D.N. Borase, S.N. Sushil, D. Joshi, S.K. Holkar and Y.E. Thorat: 08/18-07/23)
BCC 1.2	Utilization of entomopathogenic nematodes against white grubs infesting sugarcane (Y.E. Thorat, S.N. Sushil, D.N. Borase and S.K. Holkar: 08/18-07/23)
Externally funded project	
RKVY (Maharashtra)	Establishment of biological control laboratory for mass production of biological agents against sugarcane insect pests and diseases and dissemination of technology for enhanced cane and sugar productivity in Maharashtra (IISR, Lucknow) (S.N. Singh, M.R. Singh, Deeksha Joshi, Arun Baitha, S.K. Holkar, D.N. Borase and Y.E. Thorat; 04/17-04/19; Budget: ₹ 5.0 crore)

CHAPTER 17

Review, Monitoring and Evaluation

Joint Parliamentary Committee Meeting

Parliamentary Standing Committee on Agriculture, Government of India under the chairmanship of Sh. Hukumdev Narayan Yadav, Hon'ble Member of Parliament visited Lucknow on July 10, 2018 and reviewed research collaboration and coordination by ICAR-IISR, Lucknow with international and national agencies. The Committee appreciated the research collaboration and coordination by IISR, Lucknow with international and national agencies. The committee also appreciated the efforts of the Institute in preparing background papers in the presentable form. The Institute level activities for the meeting was coordinated by Dr. A.K. Sharma, Principal Scientist (Agricultural Economics).

RAC Meeting

XIV meeting of Research Advisory Committee of the ICAR-IISR, Lucknow was held on July 20-21, 2018 under the chairmanship of Dr Y.S. Nerkar, former Vice-Chancellor, MPAU, Rahuri. Dr. S.R. Maloo, Ex. Director Research, MPUAT, Udaipur; Dr. S. Sithanantham, Director, Sun Agro Biotech Research Centre, Chennai; Dr. Surendra Singh, Ex. Project Coordinator (FIM); Dr. Rajvir Singh, Ex. Member CACP, Govt. of India & Ex. Head, Division of Social Sciences, ICAR-NDRI, Karnal; Dr. Anoop Kumar, General Manager, Cane, Biswan Sugar Mill, Sitapur; Farmers' representative, Sh. Shivendra Mohan Dubey from Kanpur Dehat besides ; Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow; Dr. A.K. Sharma, Pr. Scientist (Ag. Econ), ICAR-IISR, as Member Secretary, Project Coordinator (Sugarcane), Heads of the Divisions and Scientists from ICAR-IISR were also present.

Dr. A.D. Pathak, Director, IISR made a presentation on sugarcane scenario in the country and efforts of IISR. Dr. L.S. Gangwar, Principal Scientist and I/c PME Cell

presented an overview of the activities of Prioritization, Monitoring and Evaluation (PME) Cell. Dr. D.R. Malaviya, Head, Division of Crop Improvement; Dr. V.P. Singh, Head, Division of Crop Production; Dr. M.R. Singh, Head, Division of Crop Protection; Dr. Radha Jain, Head, Division of Plant Physiology and Biochemistry; Dr. A.K. Singh, Head, Division of Agricultural Engineering; Dr. A.K. Mall, Senior Scientist & In-charge, IISR Regional Centre, Motipur (Bihar); Dr. S.N. Singh, Pr. Scientist (Agron) and Incharge Head, KVK, Lucknow and Nodal Officer, IISR, Biological Control Centre, Pravaranagar; Dr. A.K. Sah, Principal Scientist & Incharge, Training & Extension Unit; Dr. Rajesh Kumar, Principal Scientist and Incharge, AKMU and Dr. A.K. Sharma presented the research highlights. The RAC appreciated the efforts of the Scientists of the Institute and made following major recommendations:

- Focus should be directed towards development of varieties resilient to the climate change and by-products.
- The nutritive value of sugarcane tops of varieties in the pipeline should be determined to address the problem of fodder.
- Research on ratoon management should be strengthened so as to make available quality cane to sugar mills over a prolonged crushing period.

- Protocols for the management of borers including Plassey borer and Gurdaspur borers should be developed for optimization and impact demonstration of pheromone/semio-chemicals based trapping.
- Research on reducing the losses due to deterioration of cane quality on account of delayed crushing be conducted.
- Design, development and testing of sugarcane trash management machine, sugarcane planter, disc type RMD etc., should be taken up in association with institutions like ICAR-SBI and ICAR-CIAE, etc.
- Entrepreneurship development among farmers for IISR Technology including seed cane production should be carried out.
- Impact assessment of improved IISR technologies should be made.
- White grub management research through entomo-pathogenic nematodes should be initiated at Pravaranagar.

IRC Meeting

The Institute Research Council (IRC) meeting was held under the Chairmanship of Dr. A.D. Pathak, Director during August 23-24, 27-28 & 30 and September 10, 12, 18 & 25, 2018. In the meeting, all the Scientists and four technical officers of the Institute participated and discussed the research findings of on-going Institute research projects and the technical programme for the next year (2018-19) was finalized. Following new research projects were approved by the IRC:

- Development of sugarcane clones/varieties for North Central Zone
- Effect of silicon nutrition on growth, yield. juice and soil quality of sugarcane in sub-tropics
- Enhancing system productivity and profitability of wide row planted autumn sugarcane through intercropping of high value crops
- Management of bio-resources for enhancing sugarcane productivity and soil health
- Improving soil health and sugarcane ratoon productivity through application of IISR-microbial consortia

- Developing scientific aids for site specific nutrient management through variable mapping of soil properties in sugarcane growing soils
- Improved agronomic interventions for enhancing productivity of ratoon crop
- Diversification of sugarcane based cropping system with medicinal and aromatic plants in sub-tropical India
- Management of Pokkah boeng disease of sugarcane
- Identification and synthesis of sex pheromones lures for the management of major borers of sugarcane
- Developing arthropods based soil health indicator for sub-tropical sugarcane ecosystem
- Development of eco-friendly technologies for the management of termites in sugarcane
- Dispersal, host location, kairomonal effect and recovery of bio-agents *Trichogramma chilonis* and *Tetrastichus howardi*
- Process development for enhancing ethanol recovery from sugarcane trash and 'B heavy' molasses
- Assessment of scope for invigoration of biomass dynamics during sugarcane growth cycle through plant growth regulators
- Understanding mechanisms of sugar accumulation and WUE in sugarcane through physio-bio-chemical studies
- Evaluation of silica application in relation to moisture stress, disease and pest tolerance and productivity in sugarcane
- Development of sugarcane trash management machinery
- Technology and information utilization pattern among the sugarcane growers
- Bio-prospecting of native *Bacillus* sp. for control of white grubs infesting sugarcane
- Utilization of entomopathogenic nematodes against white grubs infesting sugarcane

IMC Meeting

Forty fifth meeting of Institute Management Committee (IMC) was held under the chairmanship of Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow on September 29, 2018. Progress of R&D efforts was reviewed and various administrative matters were discussed in the meeting.

Technical Audit of DBT-ATL Project

A Technical Audit of DBT sponsored Accredited Test Laboratory (ATL) established under National Certification System of Tissue Culture-raised Plants (NCS-TCP) at IISR was held on Dec. 18, 2018. The Site Visit Committee-cum-Technical Audit Team comprised of Dr. V.K. Baranwal, Professor, ICAR-IARI, New Delhi, Dr. Suchitra Banerjee, Former Chief Scientist, CSIR-CIMAP, Lucknow, Dr. Amol K. Solanke, Scientist, ICAR-NRCPB, New Delhi, and Dr. Shiv Kant Shukla, Deputy General Manager, Biotech Consortium India Limited (BCIL), New Delhi. The Committee held a discussion with the Director, IISR, while the Coordinator of the project Dr. Sanjeev Kumar, P.S.- Biotech., and Dr. Dinesh Singh, PI facilitated the technical audit. The committee scrutinized all the records including job cards, test reports, quality certificates, equipment purchased under the project, etc., and shown satisfaction over the functioning and execution of this project.

NARAKAS Meeting

A joint meeting of *NARAKAS* (Office 1, 2 and 3) was organized on April 19, 2018. Sh. Prabhas Kumar Jha, Secretary, Department of Official Language, Ministry of Home Affairs, Govt. of India was the Chief Guest on the occasion. At the outset, Dr. A.D. Pathak, Director, ICAR-IISR and Chairman (*NARAKAS*-3) welcomed the Chief Guest and all the participants and narrated about the salient achievements of the Institute. Sh. R. Madhvan, Chairman (Office-1) and Sh. Somnath Chandel, Chairman (Office-2) also narrated about the activities undertaken by them. The Secretary (Official Languages) appreciated the achievements of *NARAKAS* (Office-3) and shared his experiences of the problems prevailing in the field of agriculture. He emphasized on the need of making available the study material of high quality on the original subjects in the field of education. About 135 Head of the Offices or their representatives and Hindi Officers from 48 member offices participated in the meeting.

Two meetings of *NARAKAS* (Office 3) were also organized on June 26 and November 29, 2018 at ICAR-IISR, Lucknow. At the outset, Dr. A.K. Sah, Principal Scientist and Member Secretary, *NARAKAS* (Office-3) welcomed all the participants and presented the six monthly report. Dr. A.D. Pathak, Director, ICAR-IISR and Chairman (*NARAKAS*-3) congratulated the best performing offices and awarded various organizations for doing excellent work in Hindi and three organizations were awarded for *Rajbhasha Patrika*.

CHAPTER 18

Participation in Conferences/Seminars/Symyposia/ Workshops/Meetings

Name	Conference/ Seminar/Symposia	Venue	Date
Dr. A.D. Pathak, all the Scientists and Technical Officers	All India Seminar on Sustainable Sugarcane Practices for Viable Sugar Industry organized by The Sugar Technologists' Association of India and National Federation of Cooperative Sugar Factories and ICAR-IISR	ICAR-IISR, Lucknow	April 6, 2018
Dr. A.D. Pathak	First meeting of the ICAR Committee for ranking proforma	Krishi Bhawan, New Delhi	April 18, 2018
Drs. Sangeeta Srivastava and A.K. Mall	International Conference on Agriculture, Allied and Applied Sciences 2018	JNU Convention Centre, New Delhi	April 28-29, 2018
Dr. A.D. Pathak	State level Agricultural Seminar	Manitara, District Betia. Bihar	May 10, 2018
Dr. A.D. Pathak	Meeting of all the Directors of Crop Science Division regarding cadre review proposals of Scientific category	Krishi Bhawan, New Delhi	May 13, 2018
Dr. A.D. Pathak	Meeting on Quality characteristics of crops/commodities and their availability for commercial scale processing and value addition in India	NASC Complex, New Delhi	May 15, 2018
Drs. Rajesh Kumar, L.S. Gangwar, A.K. Singh and S.N. Sushil	NISSTA Annual Convention (2018) and Asian Conclave of Sugar Miller Vision-2022	Chandigarh	May 24-25, 2018
Drs. A.D. Pathak, M.R. Singh, S.K. Shukla, Radha Jain, D.R, Malaviya, V.P. Singh, A.K. Singh, L.S. Gangwar, A.K. Sharma, S.N. Sushil, S.N. Singh and Brahm Prakash	Interactive meeting on sugarcane and sugar production in India : Strength and challenges	ICAR-IISR, Lucknow	June 21, 2018
Dr. S.K. Shukla	Workshop of Contractual Project by ZACL	CSKHPKV, Palampur (HP)	June 26-29, 2018
Dr. Rajesh Kumar	7th International Conference on Agriculture, Horticulture and Plant Science	Shimla (HP)	June 27-30, 2018
Dr. A.D. Pathak	ICAR Foundation Day Function	NASC Complex, New Delhi	July 16, 2018
Dr. A.D. Pathak	Directors' Conference	NASC Complex, New Delhi	July 16-18, 2018
Dr. A.D. Pathak	Meeting under the chairmanship of the Secretary, DARE, Govt. of India & DG, ICAR	Krishi Bhawan, New Delhi	July 22, 2018
Dr. Dilip Kumar	Seminar on Jaggery Industry	Muzaffarnagar	July 26, 2018

Name	Conference/ Seminar/Symposia	Venue	Date
Dr. A.D. Pathak	Meeting under the chairmanship of the Hon'ble Minister of State for Agriculture & Farmers Welfare, Govt of India to review the targets to double the farmers income by 2022	Krishi Bhawan, New Delhi	August 8, 2018
Drs. Rajesh Kumar and A.K. Sah	76th Annual Convention of STAI and Sugar Expo, 2018	BCC, Indore (MP)	August 20-22, 2018
Dr. S.N. Singh	25th KVK Workshop	SVPUA&T, Meerut (UP)	August 22-25, 2018
Dr. A.D. Pathak	Curtain raiser programme of *Krishi Kumbh* to be organized at IISR, Lucknow on Sept. 26-28, 2018	Krishi Bhawan, New Delhi	August 25, 2018
Dr. Sangeeta Srivastava	ISSCT XII Pathology Workshop	Coimbatore	September 5-7, 2018
Drs. Deepak Rai and Viveka Nand Singh	Workshop on Cluster Frontline Demonstration on Oilseeds and Pulses	BUAT, Banda (UP)	September 09, 2018
Dr. A.K. Singh	Regional Workshop on SSAP	New Delhi	September 13-16, 2018
Dr. A.D. Pathak	XXIV Meeting of ICAR Regional Committee No. IV	ICAR-IINRG, Ranchi	September 14-15, 2018
Dr. Rajendra Gupta	48th Annual Convention of SISSTA	Belagavi (Karnataka)	September 19-24, 2018
Dr. S.K. Shukla	28th Conventional Meeting	CSAUA&T, Kanpur (UP)	September 28, 2018
Drs. Sangeeta Srivastava and Radha Jain	Women Scientists and Entrepreneurs Conclave (WSE), 4th India International Science Festival	*Indira Gandhi Pratishthan,* Lucknow	October 7-8, 2018
Dr. A.D. Pathak	National Conference on Food and Nutritional Security and Livelihood through increase in Vegetable Production organized jointly by IISR, Lucknow and KVK, NHRDF, Deoria	ICAR-IISR, Lucknow	October 12-13, 2018
Drs. A.D. Pathak, S.K. Shukla, Maha Ram Singh, V.P. Singh, T.K. Srivastava, Rajesh Kumar, P.K. Singh, A.K. Singh, Rajendra Gupta, Arun Baitha, K.K. Singh, V.K. Gupta, Sanjeev Kumar, Chandra Gupta, S.S. Hasan, Aditiya Prakash Dwivedi, V.P. Jaiswal, Lalan Sharma, Sanjay Kumar Yadav, S.K. Awasthi and S/Sh. Adil Zubair and Avadhesh Kumar Yadav	32nd Biennial Workshop of ICAR-AICRP on Sugarcane	UAS, Bangalore (Karnataka)	October 15-19, 2018

Name	Conference/ Seminar/Symposia	Venue	Date
Drs. S.N. Sushil, V.P. Jaiswal and Lalan Sharma	2nd International Conference on Advances in Agricultural, Biological and Applied Sciences for Sustainable Future (ABAS–2018).	Swami Vivekanand Subharti University, Merrut, U.P.	October 20-22, 2018
Drs. S.K. Shukla, V.P. Singh, T.K. Srivastava, A.K. Singh, S.N. Singh and Chandra Gupta	21st Biennial National Symposium of Indian Society of Agronomy on Doubling Farmers Income through Agronomic Interventions in Changing Scenario	MPUAT, Udaipur (Raj.)	October 24-26, 2018
Dr. V.K. Gupta	International Conference on Rural Livelihood Improvement by Enhancing Farmer's Income through Sustainable Innovative Agri and Allied Enterprise (RLISAA)	ICAR-ATARI, Patna (Bihar)	October 30-November 1, 2018
Dr. A.D. Pathak	245th Meeting of Governing Body of the ICAR	NASC Complex, New Delhi	November 10, 2019
Drs. A.K. Sah, V.K. Singh and Rakesh Kumar Singh	9th National Extension Education Congress- 2018 on Climate Smart Agricultural Technologies Innovations and Interventions	CAEPHT, Ranipool (Sikkim)	November 15-17, 2018
Dr. L.S. Gangwar	26th Annual Conference of AERA	ICAR-NDRI, Karnal (Haryana)	November 15-17, 2018
Dr. V.K. Singh	National Seminar on "Smart Technologies to Boost Farm Profitability and Socio-Economic Status of Rural India"	SKUAS&T, Jammu (J & K)	November 19-20, 2018
Drs. Viveka Nand Singh and Deepak Rai	Half Yearly KVK Workshop	ICAR-ATARI, IIPR, CSAUA&T, Kanpur (UP)	November 20-21, 2018
Drs. A.P. Dwivedi, S.N. Sushil and Deeksha Joshi	International Conference on Sustainable Organic Agric-Horti System	*Chhatrapathi Maharaj Sahuji Shodh Evam Prashikshan Sansthan,* Lucknow	November 28-30, 2018
Drs. Sangeeta Srivastava and Radha Jain	4th International Plant Physiology Congress	CSIR-NBRI, Lucknow	December 2-5, 2018
Dr. A.D. Pathak	General Body Meeting of ISMA	New Delhi	December 6, 2019
Drs. Rajendra Gupta and Rajesh Kumar	72nd Annual Conference of Indian Society of Agricultural Statistics	ICAR-CIAE, Bhopal (MP)	December 11-15, 2018
Dr. A.D. Pathak	155th Meeting of Board of Management of CSAUA&T, Kanpur	Lakhimpur Kheri	December 12, 2019
Dr. P.K. Singh	First National Genetics Congress on Genetics for Sustainable Food, Health and Nutrition Security	ICAR-IARI, New Delhi	December 14-16, 2018

Name	Conference/ Seminar/Symposia	Venue	Date
Drs. P.K. Singh, A.K. Singh and A.K. Sah	International Seminar on Global Partnership in Agriculture Research and Education (GPA-2018)	IAS, BHU, Varanasi (UP)	December 22-24, 2018
Dr. Deepak Rai	Workshop on Finalization VATIKA Project	ICAR-ATARI, Kanpur (UP)	December 27, 2018
Dr. A.K. Singh	Annual Workshop of AICRP on FIM	MPKV, Rahuri (MS)	January 09-11, 2019
Dr. Sangeeta Srivastava	Seminar on Popular Lecture Series in Biotechnology	Institute of Biotechnology and Bio Sciences, SRSMU, Lucknow	January 19, 2019
Dr. Veenika Singh	4th National Convention on Integrated Agriculture Prosperous Bharat	NASC, New Delhi	January 27-30, 2019
Drs. M.K. Singh, A.K. Singh, R.D. Singh, S.I. Anwar and Sukhbir Singh	53rd Annual Convention and International Symposium of Indian Society of Agricultural Engineering on "Engineering Technologies for Precision of Climate Smart Agriculture"	BHU, Varanasi (UP)	January 28-30, 2019
Drs. A.D. Pathak and S.K. Shukla	Directors Conference	NASC Complex, New Delhi	January 31-February 1, 2019
Drs. R.D Singh and S.I. Anwar	International Conference on Renewable Energy and Sustainable Climate	Jamia Millia Islamia, New Delhi	February 07-09, 2019
Dr. A.D. Pathak	Agri Summit-2019	Gandhi Maidan, Motihari, Bihar	February 9-11, 2019
Dr. A.D. Pathak	246th Meeting of Governing Body of the ICAR	NASC Complex, New Delhi	February 12, 2019
Drs. A.D. Pathak, S,K. Shukla, M.R. Singh, Radha Jain, S.K. Duttamajumder, V.P. Singh, D.R. Malaviya, A.K. Jaiswal, A.K. Singh, Sangeeta Srivastava, T.K. Srivastava, M. Swapna, Sanjeev Kumar, A.K. Singh, S.N. Singh, K.K. Singh, R.S. Dohare, S.R. Singh, Arun Baitha, S.N. Sushil, Dinesh Singh, Deeksha Joshi, Rajendra Gupta, S.I. Anwar, M.K. Singh, Dilip Kumar, Amaresh Chandra, Rajesh Kumar, A.K. Sharma, Chandra Gupta, S.S. Hasan, A.K. Sah, Kamta Prasad, L.S. Gangwar, V.K. Singh,	International Conference : Sugarcon-2019 on Green Technologies for Sustainable Development of Sugar & Integrated Industries	ICAR-IISR, Lucknow (UP)	February 16-19, 2019

Name	Conference/ Seminar/Symposia	Venue	Date
M.K. Tripathi, R.D. Singh. Sharmila Roy, Barsati Lal, S.P. Singh, Sukhbir Singh, A.P. Dwivedi, A.K. Mall, V.P. Jaiswal, R.R. Verma, Dileep Kumar, S.K. Yadav, Chandan Kumar Gupta, S.K. Holkar, Yogesh E. Thorat, Lalan Sharma, Rajeev Kumar, Mona Nagargade, Rakesh K. Singh, Deepak Rai, Anita Sawnani, Om Prakash, Prashant Vikram, Ram Kishor, Nandita Banerjee, Varucha Misra, M.S. Khan, S/Sh. Brahm Prakash, Nar Singh, B.B. Joshi, Rajiv Ranjan Rai, Atul Kumar Sachan, Yogesh Mohan Singh, Awadhesh Kumar Yadav, Abhishek Kumar Singh, C.P. Prajapati, Alok Singh, Raghavendra Tiwari, Ms. Mithilesh Tewari and Nitu Goyal			
Drs. A.D. Pathak, Amaresh Chandra, S. Srivastava and M. Swapna	14th Agricultural Science Congress: Innovations for Agricultural Transformation	ICAR-IARI, New Delhi	February 20-23, 2019
Dr. A.D. Pathak	90th Annual General Body Meeting of ICAR	NASC Complex, New Delhi	February 28, 2019
Dr. S.S. Hasan	National Consultation on ICT in Agriculture	NASC, New Delhi	March 05-07, 2019
Dr. A.D. Pathak	Meeting under the chairmanship of the Agriculture Commissioner, Govt. of India	Krishi Bhawan, New Delhi	March 7, 2019
Dr. S.R. Singh	Workshop of AICRP on STCR	BCKV, Kalyani (WB)	March 07-10, 2019
Dr Aditya Prakash Dwivedi	International Seminar on Biodiversity Conservation jointly organized by SUKAST and Allahabad University	Allahabad University, Prayagraj (UP)	March 08-09, 2019
Dr. A.D. Pathak	Meeting with DDG (CS), ICAR and Managing Director, NSC, New Delhi	New Delhi	March 13, 2019
Dr. M.K. Tripathi	National Seminar	Dumraon, Buxar (Bihar)	March 14-16, 2019

CHAPTER 19

Events Organized

Krishi Kumbh 2018 including International Conference and Exhibition organized

A three day Grand *Krishi Kumbh* 2018 including International Conference and Exhibition was organized at the premises of ICAR-IISR, Lucknow on October 26-28, 2018 in collaboration with the Department of

Agriculture, Government of UP and other UP state line departments which was inaugurated by Sh. Narendra Modi Ji, Hon'ble Prime Minister through Video Conferencing. Addressing the large gathering of farmers, officers, Scientists and Development workers in *Krishi Kumbh* 2018, Hon'ble PM expressed confidence that farmers would pave the way for imbibing of new technology and hoped that better opportunities would be created in the agricultural sector. He applauded the efforts of UP Government for the development of agriculture and welfare of the farmers with the aim of enhancing their income. The PM said that the Government is committed to double the income of farmers by 2022, the year when India completes 75 years of independence. He urged the farmers to discuss about

the improved production technology with the Scientists for its adoption which will lead to increased production and improved quality of produce. He asserted that farmers are the ones who take the country forward. He urged the farmers to take advantage of the technologies disseminated by Japan and Israel for optimum use of resources including water and install solar systems in their fields which will help them in running solar pumping sets and they will also be able to sell the surplus electricity to nation. He also asked the farmers to sell their produce after its value addition which will fetch higher prices in the market and informed that to promote the farming of tomato, potato and onion, the Government had started a TOP scheme for which ₹ 5,000 crore had been allocated in the budget. A further ₹ 7,500 crore had been allocated for pisciculture. The PM also informed that country after achieving green, white and blue revolution is progressing well for sweet revolution also. He also urged the Scientists to interact with farmers

to reduce the use of fertilizers and water in crop production, and to create wealth from farm waste. He said that an event like *Krishi Kumbh* would open avenues for improving agriculture in India. The PM informed that more than 16 crore Soil Health Cards have been distributed in the country which will help the farmers for the judicious use of fertilizers and manures. Sh. Modi thanked the Yogi Government for undertaking new initiatives for the welfare of the farmers.

The main attraction of the function was the inauguration of Indo-Israel Centre of Excellence establishment at Basti and Kannauj. Mrs. Maya Kadoesh, H.E. Ambassador of Israel in India congratulated the Govt. of UP and the Govt. of India for establishing the Centre of Excellence where cutting edge technology of water management and irrigation will be disseminated to the farmers which will be helpful in

increasing agricultural production and income. A MoU was signed between Govt. of UP and Govt. of Japan for increasing investment of Japanese Companies in agriculture. Mr. Takami Nakada, Deputy Assistant Minister, Govt. of Japan said that cooperation between Govt. of Japan and Govt. of UP will be strengthened with this MoU.

In this event, improved production technology of food grains *viz.*, paddy, wheat, maize, sorghum, pearl millet, pigeonpea, urdbean, mungbean, chickpea, lentil and oilseed crops *viz.*, sesame, soybean, mustard and linseed *etc.*, apart from improved technology of animal husbandry, fisheries, dairy and poultry *etc.*, was disseminated through agriculture exhibition of International level. The farmers were imparted detailed information about different facets of agriculture like integrated farming system, vegetable and fruits production, fisheries, production of organic manures through live demonstrations. For disseminating technical know-how on various subjects, an interactive meet on farmers-Scientists of national and international repute was also organized. The progressive farmers shared their experiences with other farmers during the *Krishi Kumbh*. All the State Agricultural Universities located in the State and number of ICAR Institutes participated in this Mega Programme. The organization of *Krishi Kumbh* paved the way for Government's ambitious plan to double the income of farmers of the country.

Shri Radha Mohan Singh, the Hon'ble Minister of Agriculture and Farmers Welfare, Govt. of India narrated the major achievements made during last four years of the Modi Government. Sh. Yogi Adityanath, Hon'ble Chief Minister said that UP is number one state in the country in sugarcane, sugar and milk production and the same could be achieved in the field of horticulture also, and added that fertile land of Uttar Pradesh is capable of producing food grains, sufficient enough to feed the whole world. He further added that the permission to prepare ethanol directly from sugarcane will further pave the way for increasing the income of sugarcane farmers. He also thanked the Hon'ble Agriculture Minister for sanctioning 20 new KVKs in the State. He also highlighted the schemes of Soil Health Cards, *Pradhan Mantri Phasal Beema Yojana*, Irrigation Projects, higher MSP and timely payment of the procured produce directly in the farmers account and abolition of intermediaries in the marketing system. Sh. Surya Pratap

Shahi, Hon'ble Minister of Agriculture, Agriculture Education and Agriculture Research, Govt. of Uttar Pradesh also addressed the gathering and highlighted that the adoption of improved farm technologies will be helpful in boosting agricultural production and farm income of the farmers in the state.

Other dignitaries who visited the *Kumbh* include Smt. Krishna Raj, Hon'ble Minister of State for Agriculture and Farmers Welfare, Govt. of India; Sh. Subodh Uniyal, Hon'ble Agriculture Minister, Govt. of Uttarakhand; Sh. Prem Kumar, Hon'ble Agriculture Minister, Govt. of Bihar; number of Hon'ble Ministers of U.P. Government including Sh. Rajesh Agarwal, Finance Minister; Sh. S.P. Singh Baghel, Livestock, Minor Irrigation and Fisheries Minister; Sh. Laxmi Narayan Chaudhary, Dairy Development, Religious Works and Culture, Minority Welfare Minister; Sh. Mukut Bihari Verma, Cooperative Minister; Sh. Suresh Rana, Minister of State for Sugarcane Development and Sugar Mills and Industrial Development; Smt. Swati Singh, Minister of State for Agriculture Import, Agriculture Marketing, Agriculture Foreign Trade, Women Welfare, Family Welfare, Maternity and Child Welfare; Sh. Sanjay

Agarwal, Secretary, Agriculture, Cooperation & Farmers Welfare, GoI; Sh. S.K. Pattanayak, Former Secretary, Agriculture, Cooperation & Farmers Welfare, GoI; Dr. A.D. Pathak, Director, ICAR-IISR; Vice Chancellors of SAUs located in UP and number of the Directors of ICAR Institutes.

The Government Officials who took active part in the event were Dr. Anup Chandra Pandey, Chief Secretary, Government of Uttar Pradesh in welcoming the dignitaries, guests and farmers; and Dr. Prabhat Kumar, APC, GOUP along with the Directors of the State line departments. About 1,00,000 farmers of all the 75 districts of Uttar Pradesh and adjoining States participated in this *Krishi Kumbh*.

Role of Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow in providing the Institute premises and other logistic support to organize the Mega Event and live demonstrations was duly recognised and appreciated in the plenary session.

International Conference Sugarcon-2019

An International Conference Sugarcon-2019 on Green Technologies for Sustainable Development of Sugar and Integrated Industries was organized in collaboration with the Society for Sugar Research & Promotion, & International Association for Professionals in Sugar and Integrated Technologies from February 16-19, 2019. More than 200 Scientists, including 23 delegates from China, Sri Lanka, Thailand, Brazil, Vietnam and Belgium participated to discuss the green technologies to be adopted in sugarcane production to increase the sugar production.

Seminar on Sustainable Sugarcane Practices for Viable Sugar Industry organized

One day Seminar on Sustainable Sugarcane Practices for Viable Sugar Industry was jointly organized by the Sugarcane Technologists' Association of India (STAI), ICAR-Indian Institute of Sugarcane Research (IISR) and National Federation of Cooperative Sugar Factories Limited (NFCSF) at ICAR-IISR, Lucknow. Inaugurating the Seminar, Sh. Suresh Rana, Hon'ble Minister of Sugarcane Development, Sugar Mills and Industrial Development, Govt. of UP congratulated sugar industry, scientists, development officials and farmers for their sincere and concerted efforts leading to record sugar production during the current crushing season. Sh. Rana urged the sugar industry to enhance their crushing capacity to cope up the crushing of increased sugarcane production and dedicate few units for exclusive production of ethanol.

Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow highlighted the need of proper crop planning and crop use. He urged the need to regulate bio-ethanol prices for the sustainability of the sugar industry and explained about the future prospects of sugar beet for bio-ethanol production. Dr. Pathak also informed that the IISR signed MoU with DSCL Sugar for doubling the income of the sugarcane farmers by 2020-21 in an integrated manner in eight villages of two districts of Uttar Pradesh. Sh. Prakash Naiknavare, Managing Director, NFCSF informed that about 192 million tonne of sugar is being produced by 132 countries of the world. Sh. R.L. Tamak, Executive Director, DSCL highlighted the need of fixing Essential Export Quota for sugar. Sh. Tamak advocated for increasing row to row spacing in sugarcane cultivation in Uttar Pradesh for promoting the mechanized harvesting like Maharashtra and Gujarat,

drip irrigation for saving precious water and replacing *parchi*-wise harvesting by field–wise cane crop harvesting.

Conference on "Enhancing Vegetables Production for Food and Nutritional Security and Improvement in Livelihood" organized

A two-day Farmers Conference on "Enhancing Vegetables Production for Food and Nutritional Security and Improvement in Livelihood" under Integrated Mission of Ministry of Agriculture and Farmers Welfare, Govt. of India was organized jointly by KVK, ICAR-IISR, Lucknow and NHRDF, Deoria (UP) at IISR, Lucknow on October 12-13, 2018. Speaking on the occasion as Chief Guest, Dr. B. Singh, Director, ICAR-IIVR, Varanasi highlighted that micronutrient deficiency or "hidden hunger" affects more than 2 billion people worldwide and can exist in populations even where the food supply is adequate in terms of meeting energy requirements. Poor nutrition causes physical stunting and mental impairment in children, leading to reduced potential to succeed in education and the workplace. An increase in the availability, affordability and consumption of nutrients-rich fruits, vegetables and pulses is one way to reverse malnutrition. Dr. A. D. Pathak, Director, ICAR-IISR, Lucknow advocated the need for establishing vegetable home gardens. He also stressed that schools and community gardens be encouraged in this respect. The programme was coordinated by Dr. S. N. Singh, Principal Scientist and Head, KVK, ICAR-IISR, Lucknow. Dr. Shailendra Rajan, Director, ICAR-CISH, Lucknow; Dr. P.K. Gupta, Director, NHRDF, New Delhi; Dr. S.K. Singh, Joint Managing Director, *Usar Bhoomi Sudhar Nigam,* Lucknow; Dr. Shambhoo Kumar, Head, ICAR-CPRS, Patna and Dr. Rajnish Mishra, Dy. Director, NHRDF, Deoria (UP) also expressed their views on this occasion. The programme was attended by more than 400 farmers from different states of the country besides a large number of development workers and scientists.

Mega *Kisan Mela* organized on the occasion of launching of *"Pradhan Mantri Kisan Samman Nidhi"* scheme

A Mega *Kisan Mela* was inaugurated by Sh. Ram Naik Ji, Hon'ble Governor, Uttar Pradesh on the occasion of launching of *"Pradhan Mantri Kisan Samman Nidhi"* scheme. In his address, Sh. Ram Naik Ji highlighted the salient features of the proposed scheme and hoped that all the farmers having 2 hectare land holding will get benefit from this scheme. On this occasion, Shri J.P. Nadda, Hon'ble Health and Family Welfare Minister, Govt. of India and Shri Kaushal Kishore, Hon'ble Member of Parliament, Mohanlalganj Parliamentary Constituency were also present as the Guests of Honour.

At the outset, Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow welcomed the Hon'ble Governor and other Guests of Honour and highlighted the various efforts made by the Institute in the interest of farmers. During this event, "*Man Ki Baat*" telecast of Sh. Narendra Modi, Hon'ble Prime Minister was also viewed by all the participants, and discussed, after telecast, in the event. On this occasion, Indian Institute of Sugarcane Research and *Krishi Vigyan Kendra*, Lucknow along with manufacturers of farm implements, insecticides, weedicides and seed producing agencies exhibited their products to the farmers.

68th Foundation Day of IISR celebrated

ICAR-IISR, Lucknow celebrated its 68th Foundation Day on February 16, 2019 which marked the successful journey of 67th glorious years of sugarcane research since the establishment of the Institute in the year 1952. Inaugurating the function, the Chief Guest, Dr. A.K. Singh, DDG (HS & CS), ICAR urged the need for crop planning in the country in view of bumper production of sugarcane and other crops. Dr. Singh congratulated IISR for its outstanding contributions which has culminated in the highest ever sugarcane and sugar production in the world and urged the Scientists to work for its sustainability without any adverse effect on the environment. Dr. Singh urged the Scientists to develop improved varieties of sugarcane with higher factor productivity and to make farmers aware about various schemes of the Central and State Govt. which may be

beneficial for the farmers. Dr. R.K. Singh, ADG (Commercial Crops), ICAR appreciated the efforts of IISR Scientists for continuously increasing sugarcane and sugar production in the State for the last two years, surpassing Maharashtra.

Dr. A.D. Pathak, Director, ICAR-IISR delivered the welcome address and highlighted the achievements made during the last year. Dr. Pathak informed that the Institute has developed five varieties during last 18 months and contributed immensely in production and protection technology. Dr. Bakshi Ram, Director, ICAR-SBI, Coimbatore also appreciated the development of machinery suitable for sugarcane cultivation which are being tested in the South India also. Dr. Sushil Solomon, VC, CSAUA&T, Kanpur termed the event as *Ikshu Kumbh* as large number of Scientists, Industry representatives and farmers across the globe are celebrating IISR Foundation Day to discuss the green technologies to be adopted for sugarcane cultivation to increase sugar production without harming the environment. Dr. Shivajirao Deshmukh, DG, VSI, Pune congratulated the Institute for scaling new height.

Sixteen employees of the Institute were honoured with the Excellence Award in various categories and the Team of Crop Improvement Division was also honoured for the outstanding contributions. Life Time Achievements Awards, Awards of Excellence, Fellow Awards and Appreciation Awards were also given by Society for Research and Promotion to the persons having immense contribution in various fields. Seeds of two improved varieties were also distributed among more than 100 participating sugarcane farmers. A live demonstration on sugarcane machines was also conducted for the benefit of visiting farmers.

Ikshu-Fest- 2019

To popularize the activities of the Institute among the youth, *Ikshu*-Fest-2019 was also organized from February 16-19, 2019 at ICAR-IISR, Lucknow. In this spectacular event, large number of interesting competitions like Drawing, Collage, Rangoli, Dance, Debate, fancy Dress, Bouquet making, Singing, Cane chewing, Recipe contest, were organized for different segments of the society.

Kisan Kalyan Diwas and Farmers' *Goshthi* organized

Under the "*Gram Swaraj Abhiyaan*" being organized by Ministry of Agriculture and Farmers Welfare, Govt. of India during April 14 to May 5, 2018 in all the blocks of the country, *Kisan Kalyan Diwas and Farmers' Goshthi* was also organized at ICAR-IISR, Lucknow. Presiding the programme, Dr. M.R. Singh, Head, Division of Crop Protection advised farmers to adopt integrated farming, and also suggested to promote use of compost and vermicompost for organic farming and bio-control agents in place of chemical insecticides and pesticides. Speaking on this occasion, Dr. S.N. Singh, Principal Scientist & Head, KVK, Lucknow highlighted the significant achievements of KVK and discussed improved agro-technologies for reducing the cost of cultivation and increasing the income of the farmers. All other Heads of the Divisions of the Institute also addressed the farmers. On this occasion, seven innovative farmers were honoured by KVK, Lucknow for their significant contributions in the field of agriculture.

'*Mahila Kisan Diwas*' celebrated

'*Mahila Kisan Diwas*' was celebrated at KVK, ICAR-IISR, Lucknow on October 15, 2018 with the tagline '*Sashakt Mahila, Sashakt Bharat*' (empowered women,

empowered India). The day was celebrated to recognise the contribution of women involved in agriculture as 80% independent women in India are associated with the farm sector. Speaking on the occasion, Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow emphasized upon the need for women empowerment in agriculture, and highlighted that ICAR-IISR has developed number of women friendly implements to reduce their drudgeries in sugarcane cultivation. Dr. Pathak honoured Mrs. Sangeeta Sharma for forming a Self Help Group to increase the income of women and mushroom and Mrs. Sushila Chhetri for mushroom cultivation and roof top vegetable cultivation. On this occasion, Mr. Sangeeta Sharma and Mrs. Sushila Chhetri also shared their experience with other women to become financially independent.

Independence Day celebrated

Independence day was celebrated at the Institute on August 15, 2018 with great fervour and enthusiasm. The National Flag was hoisted by Dr. A.D. Pathak, the Director of ICAR-IISR, Lucknow. In his speech, Dr. Pathak emphasized the need to take inspiration on this eve from the great sons and the leaders of India to carry out duties with devotion.

Republic Day celebrated

The 70th Republic Day was celebrated at ICAR-IISR, Lucknow on January 26, 2019. The national flag was hoisted by Dr. A.D. Pathak, Director of the Institute. Speaking on the occasion, Dr. Pathak recalled the significance of the day and contributions of freedom fighters for the country. Dr. Pathak also narrated about the significant achievements of the ICAR-IISR, Lucknow for the last year. He expressed satisfaction over the highest sugarcane production in Uttar Pradesh during 2017-18 crop season. Dr. Pathak congratulated the scientists for their outstanding contributions made for the sugar sector of the country.

International Yoga Day organized

International Yoga Day was organized on June 21, 2019 at IISR Residental Ikshupuri Colony. A brief interactive session was done to highlight the importance of yoga in our daily life, and about the type of yoga which a common people should do daily to keep themselves fit. The yoga session started with warm up exercises followed by micro exercises to add flexibility to the joints from top to bottom. Then *Suryanamaskar* was done followed by various asanas like *Tadasana* (Mountain Pose), *Vrikshasana* (Tree Pose), *Adho Mukho Svanasana* (Downward Facing Dog Pose), *Trikonasana* (Triangle Pose), *Kursiasana* (Chair Pose), *Naukasana* (Boat Pose), *Bhujangasana* (Cobra Pose), *Paschimottanasana and Mandookasana.* The importance of each asanas was also explained while performing it. After asanas, pranayama was done. *Sahita Pranayama, Bhramari, Kapalabhati* and *Anulomvilom Pranayama* exercises were done. The session concluded with *Shavaasana.*

Vigilance Awareness Week observed

To encourage all stakeholders to collectively participate in the prevention of, and the fight against corruption and to raise public awareness regarding the existence, causes and gravity of and the threat posed by corruption, the Vigilance Awareness Week was observed at the Institute during October 29-November 3, 2018 with the theme "Eradicate Corruption-Build a New India". On this occasion, an integrity pledge was taken by all the employees of the Institute. Speaking on the occasion, Dr. A.D. Pathak, Director of the Institute urged the Scientists and the staff to abstain from any

dishonest or unethical conduct as corruption in any form affects all strata of society in some way or the other. Dr. Pathak directed to follow transparent system in the official work like E-governance and systemic changes in procedures, minimal discretion, reduced public interface, technology based procurement and automation. He urged the Staff to identify and implement effective preventive measures to fight corruption and to enhance transparency and accountability in their functioning. Number of other programmes like Workshop, Debate and essay writing competitions were also organized during the Vigilance Awareness Week at the Institute. The programme was coordinated by Dr. A.K. Sharma, Principal Scientist (Agricultural Economics).

World Food Day celebrated

'World Food Day' was celebrated at ICAR-IISR, Lucknow on October 16, 2018. The day was celebrated for the furtherance of food security all over the world; to raise public awareness about problems of hunger and malnutrition; encourage attention to increase production and to highlight the crucial need for developing suitable agriculture policies to be implemented by various governments across world to ensure availability of ample food for everyone. Dr. Amaresh Chandra, Principal Scientist (Biochemistry) explained the importance of the day along with its history. Dr. Chandra highlighted number of challenges like population growth, rising temperature, falling water tables, shrinking crop land per hectare, collapsing fisheries, shrinking forest and loss of plant and animal diversity. Dr. Chandra advocated for investment in Agriculture R & D for its highest returns among various sectors. He called upon all the participants to reduce vegetable oil consumption, maintaining balance between saturated, unsaturated and monosaturated fatty acids, bio fortification of food items with high protein, zinc, iron and vitamin A and use of healthy foods. Chairing the programme, Dr. A.D. Pathak, Director, ICAR-IISR highlighted that hunger and malnutrition are the major problems across the globe. He added that challenges of declining cultivable land, limitation of carrying capacity of the soil and increasing population must be dealt with development of appropriate technologies.

World Soil Health Day celebrated

World Soil Health Day was celebrated at ICAR-IISR, Lucknow on December 5, 2018. Mrs. Swati Singh, Hon'ble Minister of State (Independent Charge) for NRI, Flood Control, Agriculture Export, Agriculture Marketing, Agriculture Foreign Trade and State Minister in the Ministry of Women Welfare, Family Welfare, Maternity and Child Welfare, Government of U.P. was the Chief Guest on this occasion. The Minister highlighted the importance of soil health cards for judicious use of chemical fertilizers to reduce cost of production and to avoid risk of various diseases.

Dr. K.N. Tiwari, Ex. Head of the Department, CSAUA&T, Kanpur and Dr. S.K. Dubey, Principal Scientist, ICAR-ATARI, Kanpur also graced the function as the Guests of Honour. Dr. A.K. Dubey, Senior Scientist & Head, KVK highlighted about the purpose of organizing the World Soil Health Day. Dr. S.K. Shukla, Project Coordinator (Sugarcane) informed about the past achievements of KVK, Lucknow. Dr. K.N. Tiwari, Dr. S.K. Dubey and Dr. S.R. Singh highlighted the importance of soil health for sustainable agricultural production and doubling the farmers' income. On this occasion, soil health cards were distributed to the farmers by the Chief Guest.

Kisan Divas celebrated

Kisan Divas Celebration at Karsanda Village was organised by Institute KVK, Lucknow on December 23, 2018. *Kisan Divas* was celebrated to commemorate the birthday of Ch. Charan Singh, Ex. Prime Minister. Awareness about the improved technologies that were beneficial to the farmers was created by the Institute scientists and the KVK staff. Progressive farmers of the area were felicitated on this occasion. Two village panchayats were represented as the Gram Pradhans of

the concerned panchayat and the neighbouring panchayat were present on the occasion. The experiences of the Gram Pradhans in cleanliness drive in respective village panchayats were also shared.

Swachchhta Pakhwada organized

Swachchhta Pakhwada was observed in the Institute during December 16-31, 2018 as per ICAR order no F.No. 7(1)/2018-Cdn.Tech.(Pt.) dated December 5, 2018. Number of activities were undertaken during this fortnight. Banners for creating awareness on *Swachchhta Pakhwada* were displayed at the Institute gates. Cleanliness drives were undertaken by different functional units of the Institutes at the main Institute as well as its research centres at Pravaranagar,

Maharashtra. The main activities include sports activities and *Swachchhta* quiz at IISR residential Ikshupuri colony for creating awareness among school goers and children, stocktaking for whitewashing/ painting wherever required, and weeding out of old records, disposal of old furniture, junk material by following the necessary official procedures. During this fortnight, a sensitization workshop on cleanliness drive was organised on December 20, 2018. *Swachchhta* Pledge was undertaken at the main Institute on Dec 20, 2018. A panel discussion on efficient conversion of agricultural wastes into wealth with specific reference to the management of sugarcane trash was organised in the Institute on December 26, 2018. Dr. A.K. Singh, HoD (Ag. Engineering) highlighted the role of mechanization in efficient sugarcane trash management. Dr. T.K Srivastava, Principal Scientist (Agronomy) presented the role of agro techniques and microbial management of sugarcane trash on farmers fields. Dr. A.K. Sharma, Pr. Scientist (Ag. Economics) provided an account on the quantum of wastes generated in agricultural market yards and the waste management practices being followed in these market yards. Dr. A.D. Pathak, Director, ICAR-IISR highlighted the importance of research in sugarcane trash management, and called upon the Institute scientists to fine tune the existing research efforts in this direction in order to provide better solution to this challenging problem of sugarcane trash burning on the farmers fields in the present context.

Cleanliness drives organised at IISR adopted villages under MGMG Scheme

Swachchhta pledge was undertaken at number of IISR adopted villages during *Swachchhta Pakhwada.* It was taken at village Karsanda in Lucknow District, at Loni Village in Primary School, in Kanhari Village in Rupapur in Hardoi District. The details are as follows:

Nagla Bhagwan Village, Hardoi District

Cleanliness awareness in IISR adopted Nagla Bhagwan village under *Mera Gaon Mera Gaurav* Scheme

was carried out on December 27, 2018. Number of activities were conducted in schools. *Swachchhta* quiz, slogal recital on *Swachchhta* compaign, *Swachchhta* pledge and *Swachchhta* march in the village were the main activities during the event. The *Swachchhta* March was carried out by the children and the Institute Scientists accompanied them in the March. Dr. A.K. Jaiswal, Dr. R.S. Dohare, Dr. Sharmila Roy, Dr. A.K. Sharma, Dr. T.K. Srivastava, Dr. S.N. Sushil, Dr. Barsati Lal, and Dr. A.K. Dwivedi participated from the Institute. The Cane Development staff of Loni Sugar Mill, and the school teachers and other staff also participated actively in the programme. The toiletries and other material was distributed to the school teachers, staff and children in the school. The sweets were distributed to all the children. The programme was coordinated by Dr. A.K. Sharma, Pr. Scientist.

Kanhari Village, Rupapur, Hardoi District

A *Swachchhta* Awareness Programme was organized in the Kanhari village at Rupapur by the scientists of ICAR-IISR, in collaboration with the DSCL Sugar Mills Ltd., Unit, Rupapur, on 28th December 2018. The team of scientists, Dr. S.N. Singh, Dr. Chandra Gupta and Dr. M. Swapna, Principal Scientists, along with the DCSL Sugar Mill officials visited the Primary School at Kanhari village and interacted with the students and teachers of the school. The students and

other staff were apprised about the virtues of maintaining cleanliness at their home, school and surroundings. The students took a *Swachchhta* Pledge to maintain cleanliness in their surroundings and also to make others aware of the necessity of maintaining cleanliness. The students, other staff of the school along with the officials from ICAR-IISR and the sugar mill, took out a march in the village, with the students actively raising slogans on cleanliness, to make the villagers also aware about *Swachchhta*.

Hindi Pakhwada and Workshops organized

Hindi fortnight was organized at the ICAR-IISR, Lucknow during September 14-29, 2018. Various competitions like Hindi Typing in Unicode, *Antakshari*, Hindi translation, noting, writing of office orders/MoU,

Ashubhashan, Hindi Quiz, *Kavi Sammelan etc*. were organized during the fortnight. On September 29, 2019, winners of various competitions were awarded by the Chief Guest, Sh. Jasbeer Singh Sandhu, DIG, Group Kendra, CRPF, Lucknow. Mithas Trophy was awarded to Division of Agricultural Engineering of the Institute. The programme was chaired by Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow.

Four Workshops on Hindi were organized on June 12, September 22, December 29, 2018 and March 11, 2019 wherein almost all the Scientists and staff members of the Institute were sensitized to use Hindi in day-to-day official works.

Tributes paid to late Sh. A.B. Vajpayee

To give fitting tribute on the first monthly death anniversary *of Bharat Ratna Late Sh. Atal Bihari Vajpayee Ji, former Pr*ime Minister of India, a special programme was organized at ICAR-IISR, Lucknow on September 16, 2018. Dr. A.D. Pathak, Director; Scientists and staff members paid tributes to Sh. Vajpayee Ji by recital of the poems composed by him. The programme was attended by the scientists, officers and staff of the Institute.

ASRB Examinations conducted at ICAR-IISR Centre

Agricultural Scientist Recruitment Board (ASRB), New Delhi in search of talent in agricultural research

services regularly conducts various examinations all over India. It has developed a network of Online Examination Centres at 23 places to ease the process of evaluating candidate in various disciplines of agricultural sciences.

- Agricultural Research Service (ARS)-2017 (Preliminary) & National Eligibility Test (NET-I)-2018 Examination of Agricultural Scientists Recruitment Board, New Delhi was conducted in the online mode on April 06-10, 2018 in three slots per day at Lucknow Centre and also coordinated to conduct the examination at 18 locations in Lucknow. Out of 1455 candidates allotted to the centre for fifty seven disciplines, 1140 candidates appeared in the examination at the ICAR-Indian Institute of Sugarcane Research, Lucknow Centre. Overall 78.35% attendance was registered in the examination centre of ICAR-IISR, Lucknow.
- Agricultural Research Service (ARS)-2017 (Preliminary) & National Eligibility Test (NET-I)-2018 Examination in the discipline of Farm Machinery and Power of Agricultural Scientists Recruitment Board, New Delhi was conducted in the online mode on April 22, 2018. Out of 23 candidates allotted to the centre for Farm Machinery and Power disciplines, 20 candidates appeared in the examination at the ICAR-Indian Institute of Sugarcane Research, Lucknow Centre. Overall 86.96% attendance was registered in the examination centre of ICAR-IISR, Lucknow.
- ICAR-National Eligibility Test-II: Online examination of Agricultural Scientists Recruitment Board, New Delhi was conducted at ICAR-Indian Institute of Sugarcane Research, Lucknow during December 27-29, 2018 in three slots per day. Out of 811 candidates allotted to the centre for fifty seven disciplines, 659 candidates appeared in the examination at the ICAR-Indian Institute of Sugarcane Research, Lucknow Centre. Overall 81.26% attendance was registered in the examination centre of ICAR-IISR, Lucknow.

CHAPTER 20

Distinguished Visitors

Name and Designation	Date of visit
Smt. Krishna Raj, Hon'ble Minister of State for Agriculture and Farmers Welfare, Govt. of India	April 17, 2018 and October 26-27, 2018
Shri Surya Pratap Shahi, Hon'ble Minister of Agriculture, Agricultural Education and Agricultural Research, Govt. of Uttar Pradesh	April 17, 2018, October 26-27, 2018 and February 19, 2019
Sh. S.P. Singh Baghel, Hon'ble Minister of Animal Husbandry, Minor Irrigation and Fisheries, Govt. of Uttar Pradesh	April 17, 2018 and October 26, 2018
Sh. Laxmi Narain Chaudhary, Hon'ble Minister of Dairy Development, Religious Affairs, Culture, Minority Welfare, Waqf and Haj, Govt. of Uttar Pradesh	April 17, 2018 and October 26, 2018
Sh. Ranvendra Pratap Singh (Dhunni Singh), Hon'ble Minister of State for Agriculture, Agricultural Education and Agriculture Research, Govt. of Uttar Pradesh	April 17, 2018 and August 6, 2018
Smt. Swati Singh, Hon'ble Minister of State for Agricultural Exports, Agricultural Marketing, Agricultural Foreign Trade, N.R.I., Flood Control, Family Welfare, Mother and Child Welfare, Govt. of Uttar Pradesh	April 17, 2018 and October 26, 2018
Sh. Prabhat Kumar, Secretary (Rajbhasha), Ministry of Home, Govt. of India	April 19, 2018
Dr. S.K. Pattanayak, Secretary, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India	June 28, 2018 and October 26, 2018
Dr. Man Singh, Director, Directorate of Sugarcane Development, Lucknow	June 28, 2018
Sh. Rajan Aggarwal, CVO, ICAR and Director, DARE, New Delhi	June 30, 2018
Dr. C.P. Srivastava, Dy. Director Agriculture, Lucknow	August 6, 2018
Dr. P.L. Gautam, Ex. Chairman, PPV&FRA, New Delhi and Ex-Vice Chancellor, GBPUA&T, Pantnagar	September 05, 2018
Dr. V.P. Chahal, ADG (Ag. Ext.), ICAR, New Delhi	September 22, 2018
Dr. R.K. Singh, Assistant Director General (CC), ICAR, New Delhi	September 29, 2018 and February 16, 2019
Sh. Jasbeer Singh Sandhu, Deputy Inspector General, Group Centre, Central Reserve Police Force, Lucknow	September 29, 2018
Shri Shivajirao Deshmukh, IAS, Director General, Vasantdada Sugar Institute, Pune	September 29, 2018 and February 16, 2019
Dr. Abhishek Kumar Shukla, Consultant and Interventional Cardiologist, Ajanta Hospital, Lucknow	September 29, 2018
Dr. Randhir Singh Gandhi, ADG (Agricultural Extension), ICAR, New Delhi	October 4-5, 2018
Sh. G.S. Shekhawat, Hon'ble Minister of State for Agriculture and Farmers Welfare, Govt. of India	October 5, 2018
Dr. T. Mohapatra, Secretary, DARE and Director General, ICAR, New Delhi	October 5, 2018
Dr. A.K. Srivastava, Chairman, ASRB, New Delhi	October 6, 2018
Dr. Rajesh Singh, VC, Purnea University, Bihar	October 8, 2018
Dr. Sushil Solomon, VC, CSAUA&T, Kanpur	October 12 and 26-27, 2018 and February 16-19, 2019
Dr. B. Singh, Director, ICAR-IIVR, Varanasi	October 12, 2018
Dr. P.K. Gupta, Director, NHRDF, New Delhi	October 12, 2018

Name and Designation	Date of visit
Dr. R.P. Singh, Director (Horticulture), UP, Lucknow	October 12, 2018
Dr. S. Rajan, Director, ICAR-CISH, Lucknow	October 12 and 26, 2018
Dr. S. Kumar, Head, CPRI RS, Patna	October 12, 2018
Shri Radha Mohan Singh, Hon'ble Minister of Agriculture and Farmers Welfare, Govt. of India	October 26, 2018
Sh. Yogi Adityanath, Hon'ble Chief Minister, UP	October 26, 2018
Mrs. Maya Kadoesh, H.E. Ambassador of Israel in India	October 26, 2018
Mr. Takami Nakada, Deputy Assistant Minister, Govt. of Japan	October 26, 2018
Sh. Subodh Uniyal, Hon'ble Agriculture Minister, Govt. of Uttarakhand	October 26, 2018
Sh. Prem Kumar, Hon'ble Agriculture Minister, Govt. of Bihar	October 26, 2018
Sh. Rajesh Agarwal, Finance Minister, Govt. of UP	October 26, 2018
Shri Laxmi Narayan Chaudhary, Dairy Development, Religious Works and Culture, Minority Welfare Minister, Govt. of UP	October 26, 2018
Sh Mukut Bihari Verma, Cooperative Minister, Govt. of UP	October 26, 2018
Shri Suresh Rana, Minister of State for Sugarcane Development and Sugar Mills and Industrial Development, Govt. of UP	October 26, 2018
Sh. Sanjay Agarwal, Secretary, Agriculture, Cooperation & Farmers Welfare, GoI	October 26, 2018
Dr. Anup Chandra Pandey, Chief Secretary, Government of Uttar Pradesh	October 26, 2018
Dr. Prabhat Kumar, APC, UP Govt	October 26, 2018
Dr. J.S. Sandhu, VC, NDUA&T, Kumarganj, Faizabad	October 26, 2018
Dr. U.S. Gautam, VC, Banda University of Agriculture & Technology, Banda	October 26, 2018
Dr. A.K. Singh, DDG (Ag. Extension), ICAR, New Delhi	October 27, 2018
Dr. N.P. Singh, Director, ICAR-IIPR, Lucknow	October 27, 2018
Dr. Sanjeev Gupta, Project Coordinator (MULLaRP), ICAR-IIPR, Kanpur	October 27, 2018
Sh. Ram Naik, Hon'ble Governor, UP, Lucknow	October 28, 2018 and February 24, 2019
Sh. Keshav Prasad Maurya, Deputy Chief Minister, UP, Lucknow	October 28, 2018
Sh. Hriday Narayan Dixit, Speaker, UP Assembly, Lucknow	October 28, 2018
Dr. A.K. Singh, DDG (HS & CS), ICAR, New Delhi	February 16, 2019
Dr. Bakshi Ram. Director, ICAR-SBI, Coimbatore	February 16, 2019
Dr. J. Singh, Director, UPCSR, Shahjahanpur	February 16, 2019
Dr. Yang-Rui Li, Sugarcane Research Institute, Guangxi Academy of Agricultural Sciences, Nanning, China	February 16-19, 2019
Mr. R.L. Tamak, Executive Director, DCM Shriram Ltd, New Delhi	February 16, 2019
Sh. N. Mohan, Director, National Sugar Institute, Kanpur	February 16, 2019
Dr. A.P. Keertipala, Director, Sugarcane Research Institute, Uda Walawe, Sri Lanka	February 16-19, 2019
Shri Ganga Singh Kushwaha, Hon'ble Member of Legislative Assembly, UP Secretariat, Lucknow	February 19, 2019
Shri J.P. Nadda, Hon'ble Minister of Health and Family Welfare, Govt. of India	February 24, 2019

CHAPTER 21

Personnel

(As on March 31, 2018)

Director	:	Dr. A.D. Pathak
Crop Improvement		
Principal Scientist & Head	:	Dr. D.R. Malaviya
Principal Scientist (Plant Breeding)	:	Dr. Jyotsnendra Singh (On Deputation)
	:	Dr. P.K. Singh
	:	Dr. Sanjeev Kumar
Principal Scientist (Genetics & Cytogenetics)	:	Dr. Sangeeta Srivastava
Principal Scientist (Genetics)	:	Dr. M. Swapna
Principal Scientist (Agril. Biotechnology)	:	Dr. Sanjeev Kumar
Senior Scientist (Plant Breeding)	:	Dr. Ashutosh Kumar Mall
Scientist (SS) (Agricultural Biotechnology)	:	Sh. Ranjit Singh Gujjar (On study leave)
Senior Technical Officer	:	Mr. Raghwendra Kumar
Senior Technical Officer	:	Dr. Ram Kishore
Senior Technical Officer	:	Mr. S.N. Srivastava
Crop Production		
Principal Scientist & Head	:	Dr. V.P. Singh
Principal Scientist (Agronomy)	:	Dr. T.K. Srivastava
	:	Dr. S.N. Singh
	:	Dr. A.K. Singh
	:	Dr. K.K. Singh
	:	Dr. Chandra Gupta
	:	Dr. M.K. Tripathi
	:	Dr. V.K. Singh
	:	Dr. A.P. Dwivedi
Principal Scientist (Soil Science)	:	Dr. S. R. Singh
Principal Scientist (Agril. Extension)	:	Dr. R.S. Dohare
Senior Scientist (Agronomy)	:	Dr. V.P. Jaiswal
Scientist SS (Soil Science)	:	Dr. Ram Ratan Verma
Scientist (Agronomy)	:	Dr. Dilip Kumar
	:	Dr. Mona Nagargade
Assistant Chief Technical Officer	:	Dr. R.K. Singh
Technical Officer	:	Mr. Anil Kumar Singh
Technical Officer	:	Mr. Sanjay Gautam
Crop Protection		
Principal Scientist & Head	:	Dr. M.R. Singh
Principal Scientist (Agril. Entomology)	:	Dr. A.K. Jaiswal
	:	Dr. Sharmila Roy
	:	Dr. S.N. Sushil
	:	Dr. Arun Baitha
Principal Scientist (Plant Pathology)	:	Dr. S.K. Duttamajumder
	:	Dr. Dinesh Singh
Sr. Scientist (Plant Pathology)	:	Dr. Deeksha Joshi
Chief Technical Officer	:	Dr. D.C. Rajak (On deputation)
Assistant Chief Technical Officer	:	Mr. I.P. Maurya

Assistant Chief Technical Officer	:	Mr. Devender Singh
Senior Technical Officer	:	Mrs. Pramila Lal
Agricultural Engineering		
Principal Scientist & Head	:	Dr. A.K. Singh
Principal Scientist (FMP)	:	Dr. R.D. Singh
	:	Dr. S.I. Anwar
	:	Dr. M.K. Singh
Principal Scientist (SWCE)	:	Dr. Rajendra Gupta
Principal Scientist (AS &PE)	:	Dr. Dilip Kumar
Senior Scientist (FMP)	:	Dr. Sukhbir Singh
Chief Technical Officer	:	Mrs. Mithilesh Tiwari
Assistant Chief Technical Officer	:	Mr. M.H. Ansari
Assistant Chief Technical Officer	:	Mr. Suresh Kumar Kushwaha
Assistant Chief Technical Officer	:	Mr. Krishna Nand Singh
Assistant Chief Technical Officer	:	Mr. Rajiv Ranjan Rai
Senior Technical Officer	:	Mr. Umesh Kumar
Technical Officer	:	Mr. Chaman Singh
Technical Officer	:	Mr. Surya Dev Singh
Plant Physiology & Biochemistry		
Principal Scientist & Head	:	Dr. Radha Jain
Principal Scientist (Biochemistry)	:	Dr. Amaresh Chandra
Principal Scientist (Organic Chemistry)	:	Dr. Pushpa Singh
Principal Scientist (Plant Physiology)	:	Dr. S.P. Singh
Scientist (Plant Physiology)	:	Dr. Chandan Kumar Gupta
Scientist (Biochemistry)	:	Mr. Rajeev Kumar
Assistant Chief Technical Officer	:	Mr. C.P. Singh
Technical Officer	:	Mr. R.K. Singh
PME Cell & Institute Technology Management Unit		
Nodal Officer & Incharge	:	Dr. L.S. Gangwar
Chief Technical Officer	:	Mr. Brahm Prakash
Assistant Chief Technical Officer	:	Dr. Anita Sawnani
AKMU		
Principal Scientist & Incharge	:	Dr. Rajesh Kumar
Principal Scientist (Agril. Economics)		Dr. A.K. Sharma
Principal Scientist (Computer Application)	:	Dr. S.S. Hasan
Assistant Chief Technical Officer	:	Mr. Atul Kumar Sachan
Extension & Training Unit		
Principal Scientist & In-Charge	:	Dr. A.K. Sah
Principal Scientist (Agril. Extension)	:	Dr. Barsati Lal
Scientist (SG) (Agril. Extension)	:	Dr. Kamta Prasad
Chief Technical Officer	:	Mr. Nar Singh
Assistant Chief Technical Officer	:	Dr. Om Prakash
Assistant Chief Technical Officer	:	Mr. A.K. Singh
Referral Lab		
Incharge	:	Dr. V.P. Jaiswal
Assistant Chief Technical Officer	:	Mrs. Asha Gaur
Assistant Chief Technical Officer	:	Mrs. Meena Nigam
AICRP on Sugarcane		
Project Coordinator	:	Dr. S.K. Shukla

Principal Scientist (Entomology)	:	Dr. Arun Baitha
Scientist (Agronomy)	:	Dr. Sanjai Yadav
Scientist (Plant Pathology)	:	Dr. Lalan Sharma
Chief Technical Officer	:	Dr. S.K. Awasthi
Chief Technical Officer	:	Dr. G.K. Singh
Assistant Chief Technical Officer	:	Mr. Adil Zubair
HRD Cell		
Nodal Officer	:	Dr. Sangeeta Srivastava
Co-Nodal Officer	:	Dr. Sukhbir Singh
Farm Section		
Principal Scientist & In-charge	:	Dr. A.K. Singh
Farm Managar (Chief Tech. Officer)	:	Dr. B.B. Joshi
Technical Officer	:	Mr. J.P. Pandey
Technical Officer	:	Mr. Deep Kumar
Krishi Vigyan Kendra		
Principal Scientist & I/c	:	Dr. Akhilesh Kumar Dubey
SMS (Home Science)	:	Dr. Veenika Singh
SMS (Plant Protection)	:	Dr. Deepak Rai
SMS (Animal Science)	:	Dr. Rakesh Kumar Singh
SMS (Horticulture)	:	Dr. Vivekanand Singh
Rajbhasha Prakoshtha		
Principal Scientist & In-charge	:	Dr. A.K. Sah
Technical Officer	:	Mr. Abhishek Kumar Singh
Art & Photography		
Principal Scientist & In-Charge	:	Dr. L.S. Gangwar
Chief Technical Officer	:	Mr. Vipin Dhawan
Assistant Chief Technical Officer	:	Mr. Y.M. Singh
Senior Technical Officer	:	Mr. Avadhesh Kumar Yadav
Library		
Principal Scientist & In-Charge	:	Dr. Sharmila Roy
Assistant Chief Technical Officer	:	Mr. Ghanshyam Ram
Senior Technical Officer	:	Mr. R.N.P. Bharti
Others		
In-Charge, Seed Production Unit	:	Dr. Sanjeev Kumar
In-Charge, Vehicle	:	Mr. Raj Kumar
In-Charge, Landscaping	:	Mr. Rajiv Ranjan Rai
In-Charge, Guest House	:	Mr. A.K. Sharma
Manager, Guest House	:	Mr. Nag Chand
Security Officer	:	Mr. C.P. Prajapati
IISR Regional Centre, Motipur (Bihar)		
Senior Scientist & In-charge	:	Dr. A.K. Mall
IISR Biological Control Centre, Pravaranagar (Maharashtra)		
Nodal Officer	:	Dr. S.N. Singh
Scientist Sr. Scale (Plant Pathology)	:	Dr. S.K. Holkar
Scientist (Microbiology)	:	Dr. Deepak Borase
Scientist (Nematology)	:	Mr. Y.E. Thorat

Administration		
Administrative Officer	:	Mr. A.K. Sharma
Finance & Account Officer	:	Mr. Raja Ram
Assistant Administrative Officer	:	Mr. R.K. Yadav
	:	Mr. V.P. Tiwari
	:	Mr. Anand Mohan Srivastava
Private Secretary	:	Mr. Rajeev Arora
	:	Mr. Prem Chandra

Appointment

Name of official	Post held	Date of appointment
Dr. Mona Nagargade	Scientist (Agronomy)	October 9, 2018

Promotions

Name	Promoted to	Date of promotion
Scientists		
Sh. Ranjit Singh Gujjar	Scientist (Senior Scale) (Agril. Biotechnology)	April 28, 2016
Dr. S.P. Singh	Principal Scientist (Plant Physiology)	May 6, 2017
Dr. A.P. Dwivedi	Principal Scientist (Agronomy)	July 22, 2017
Technical		
Sh. Makrand Singh	Senior Technician	June 1, 2015
Sh. Deep Kumar	Technical Officer	June 6, 2016
Sh. Dhirendra Kumar	Senior Technician	December 2, 2016
Sh. Somnath Singh	Technical Officer	March 17, 2017
Sh. Dildar Husain	Senior Technician	July 23, 2017
Sh. Kunwar Kailash	Senior Technician	July 23, 2017
Sh. Ashok Kumar Vishwakarma	Senior Technical Assistant	September 3, 2017
Sh. Sant Ram	Senior Technical Assistant	December 8, 2017
Sh. Triloki Prasad	Technician	October 30, 2018
Administration		
Sh. Sanjay Mishra	Upper Division Clerk (MACP)	February 24, 2017
Sh. Sunder Lal	Assistant (MRCP)	August 25, 2017
Smt. Chaman Ara Siddiqui	Assistant (MRCP)	September 3, 2017
Sh. Rajeev Arora	Private Secretary (MACP)	November 18, 2017

Transfers

Name and Post	From	To	With effect from
Scientist			
Dr. M.K. Singh, Principal Scientist (FMP)	ICAR-IARI, New Delhi	ICAR-IISR, Lucknow	June 14, 2018
Dr. Chandan Kumar Gupta, Scientist (Plant Physiology)	ICAR-IGFRI, Jhansi	ICAR-IISR, Lucknow	July 16, 2018
Dr. Akhilesh Kumar Dubey, Head, KVK	KVK, Kushinagar (Under ICAR-IIVR, Varanasi)	ICAR-IISR, Lucknow	November 13, 2018

Name and Post	From	To	With effect from
Technical			
Sh. Abhay Kumar Srivastava, Technical Assistant	ICAR-CIARI, Port Blair	ICAR-IISR, Lucknow	April 9, 2018
Sh. Ram Lakhan, Technical Assistant	KVK, Shikohpur (ICAR-IARI, New Delhi)	ICAR-IISR, Lucknow	August 4, 2018
Sh. Ajay Kumar, Senior Technician	ICAR-CICR Regional Station, Sirsa	ICAR-IISR, Lucknow	August 9, 2018
Sh. Upendra Kumar, Senior Technician	ICAR-CIARI, Port Blair	ICAR-IISR, Lucknow	September 4, 2018
Administration			
Sh. A.K. Sharma, Administrative Officer	ICAR-CIRC, Meerut	ICAR-IISR, Lucknow	February 4, 2019

Superannuation

Name of official	Post held	Date of retirement
Dr. R.K. Rai	Principal Scientist	April 30, 2018
Mr. Ram Murti	Senior Technical Officer	June 30, 2018
Mr. Hans Raj	SSS	June 30, 2018
Mr. Faujdar Singh	Senior Technical Officer	June 30, 2018
Dr. M.R. Verma	Chief Technical Officer	July 31, 2018
Mr. Onkar Nath	Technical Assistant	July 31, 2018
Mr. Mahesh Kumar	SSS	July 31, 2018
Mr. Radhey Lal	LDC	July 31, 2018
Mr. Sridhar Tewari	Technical Officer	August 31, 2018
Dr. S.K. Sethi	Assistant Chief Technical Officer	September 30, 2018
Mr. A.P. Dubey	Technical Officer	September 30, 2018
Mr. Triloki Prasad	SSS	October 31, 2018
Dr. D.K. Pandey	Principal Scientist	October 31, 2018
Mr. B.B. Singh	Senior Technical Officer	October 31, 2018
Dr. M.M. Roy	Principal Scientist	November 30, 2018
Mr. Lakhan Lal Verma	Technical Officer	November 30, 2018
Dr. V.K. Gupta	Principal Scientist	December 31, 2018
Mr. Susheel Kumar	SSS	December 31, 2018
Mr. Ganga Ram	SSS	December 31, 2018
Mr. Mool Chandra	Technician	December 31, 2018
Mr. Raghu Nandan	SSS	December 31, 2018
Mr. Srikishan	SSS	December 31, 2018
Mr. Rishi Ram	Senior Administrative Officer	January 31, 2019
Mr. Vinayak Sawant	Asstt. Chief Technical Officer	January 31, 2019
Mr. Jagjit Singh	Senior Technical Assistant	January 31, 2019
Mr. Surendra Singh	Assistant Chief Technical Officer	February 28, 2019
Mr. S.K. Bagchi	Assistant Administrative Officer	March 31, 2019
Mr. Sunil Kumar Mishra	Assistant Chief Technical Officer	March 31, 2019

CHAPTER 22

Weather

Important weather parameters during April 2018 to March 2019 at ICAR-Indian Institute of Sugarcane Research, Lucknow

Month	Temperature (⁰C)		Relative humidity (%)		Rainfall (mm)	Rainy days (No.)	Bright sun shine Hours (Hrs./day)	Evaporation (mm/day)	Wind speed (km/hr)
	Maximum	Minimum	at 7: 18 am	at 2:18 pm					
April 2018	36.9	19.9	61.2	26.5	9.2	1	9.0	6.9	3.6
May 2018	38.6	24.8	67.2	36.8	16.8	2	9.1	6.8	2.9
June 2018	38.9	27.3	70.4	45.2	123.4	5	7.3	6.7	3.6
July 2018	34.4	26.2	88.5	68.4	318.7	13	5.6	4.2	2.9
August 2018	32.4	25.4	94.5	77.6	564.4	14	3.7	2.4	2.0
September 2018	34.2	23.9	89.9	65.1	227.8	7	6.1	3.8	3.4
October 2018	33.8	17.6	91.8	36.8	0	0	8.7	3.4	1.6
November 2018	28.8	11.6	92.4	39.1	0	0	7.3	2.1	1.4
December 2018	23.7	5.0	95.0	37	0	0	5.5	1.5	1.5
January 2019	22.3	6.4	93.7	46.2	35.4	2	6.1	1.6	2.1
February 2019	24.1	9.9	93.8	50.4	24.2	3	6.2	2.0	2.7
March 2019	29.9	13.2	80.9	33.4	1.8	0	9.3	4.2	4.2
Annual 2018-19	**33.5**	**20.2**	**83.4**	**48.1**	**1260.3**	**42**	**6.9**	**4.2**	**2.5**

NOTES