



Annual Report 2012~13



भारतीय गन्ना अनुसंधान संस्थान, लखनऊ
Indian Institute of Sugarcane Research, Lucknow





वार्षिक प्रतिवेदन Annual Report

2012-13



भारतीय गन्ना अनुसंधान संस्थान
लखनऊ - 226 002, उत्तर प्रदेश, भारत
Indian Institute of Sugarcane Research
Lucknow - 226 002, Uttar Pradesh, India

Published by

Dr. S. Solomon
Director
Indian Institute of Sugarcane Research
Lucknow-226 002

Compiled and Edited by

J. Singh

P.K. Singh

T.K. Srivastava

A.K. Sharma

Pushpa Singh

Deeksha Joshi

Sanjeev Kumar

Correct Citation

Annual Report 2012-13
Indian Institute of Sugarcane Research, Lucknow

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Preface

India's sugar production is characterized by a cyclic production pattern with typical sugar cycles lasting 2-3 years, as production adjusts to fall in price which in turn leads to lower supplies, price increase and higher production. During 2012-13 season, sugar production in India registered a fall of 2 MT; from 26 MT in 2011-12 to 24 MT in 2012-13, primarily due to a drop in output from the major sugarcane growing states of Maharashtra and Karnataka. This fall in production has been attributed to the drought-like situations which persisted in many parts of these two states during the 2012 monsoon season. Despite the frequent fluctuations in sugar production, domestic sugar consumption has increased. Moreover, with an increasing demand for ethanol, sugarcane has transformed into an important renewable energy crop as well and it is estimated that by 2025, almost 495 MT of sugarcane will be required to meet the growing sugar and energy demands of the country.

The Indian Institute of Sugarcane Research has carried out focussed research and development activities during the year to address the various challenges posed before sugarcane agriculture in the country. With the institute completing sixty years of dedicated service to the nation in 2012-13, the year was celebrated as 'Diamond Jubilee Year' and 'Year of Excellence' with renewed research efforts in the areas of varietal development, high density cane farming, natural resource management, integrated disease and pest management, mechanization of sugarcane cultivation, climate change, biotechnology and cane juice preservation and packaging. The institute's varietal development efforts culminated in the release of an early maturing high yielding and good ratooner sugarcane variety CoLk 9709 for cultivation in Uttar Pradesh. Development of a tractor operated sugarcane harvester with improved features for small farms and a tractor operated trencher and trench planter for paired row sugarcane planting form an integral part of the institute's ongoing efforts towards increasing mechanization of sugarcane cultivation to reduce labour requirement and ultimately reducing the cost of cultivation in sugarcane. Special emphasis has also been given to farmer's oriented research with the development of a Decision Support System (DSS) for disorder diagnosis in sugarcane crop, which is freely accessible to farmers using a web browser.

During the past year the institute has initiated its outreach activities through conducting demonstrations of various improved technologies at farmer's fields and mill areas, imparting training to farmers and organization of kisan melas/ awareness programmes for famers and cane development officials and signing MoUs with other organizations/ stakeholders. These multi-dimensional and persistent efforts of the institute were recognized when the institute was awarded a mega seed project by the Bihar state government. Institute has created facilities like modern canteen, improved Guest House, Sports ground where Zonal ICAR Sports-2013 was organized and Ikshu-Hub to serve common people and improve the visibility of the institute. At the international front, the institute played host to various high level delegations during the year from China, Sri Lanka and Bangladesh, thus opening up opportunities for future collaborations and linkages.

The present Annual Report documents in-depth research and development activities carried out at the institute during 2012-13 under 21 themes. The efforts made by the editors namely Dr. J. Singh, Dr. P.K. Singh, Dr. Pushpa Singh, Dr. Deeksha Joshi, Dr. A. K. Sharma, Dr. T.K. Srivastava, Dr. Sanjeev Kumar and all Heads of Divisions in bringing out this report in a timely and effective manner deserve appreciation.



(S. Solomon)
Director

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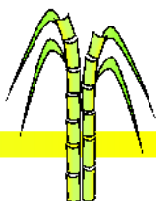
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Executive Summary

Crop Improvement

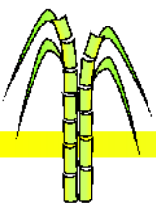
- CoLk 9709, an early maturing sugarcane variety, was released in October 2012 for commercial cultivation in Uttar Pradesh.
- Four early (CoLk 12201, CoLk 12202, CoLk 12203 and CoLk 12204) and 02 mid-late sugarcane genotypes (CoLk 12205 and CoLk 12206) were accepted for multi-location testing in North West Zone, while 02 early (CoLk 12207 and CoLk 12208) and 02 mid-late sugarcane genotypes (CoLk 09204 and CoLk 12209) were accepted for North Central Zone during AICRP(S) Workshop held on 19-20 October, 2012 at TNAU, Coimbatore.
- Eight early high sugar genetic stocks (LG 07408, LG 07482, LG 07501, LG 07560, LG 08422, LG 02005, LG 05302 and LG 05403), 02 genetic stocks tolerant to top borer (LG 06618 and LG 07615) and 02 genetic stocks (somaclones of CoS 767) for red rot resistance (LG 767-1 and LG 767-2) were sent to the National Hybridization Garden, Coimbatore.
- A MoU was signed on February 5, 2013 between IISR and Sugarcane Industries Department, Government of Bihar for execution of a project with an outlay of Rs. 639 lakhs for 5 years to produce and promote quality seed cane in Bihar.
- A collection of 284 genotypes consisting of *Saccharum officinarum*, *Saccharum barberi*, *Saccharum sinense*, ISH clones, Ikshu ISH clones, LG selections, commercial hybrids etc., was maintained and thirty new genotypes were added to the collection, thus increasing the total collection to 314.
- A total of 6400 quintals of sugarcane seed of newly released varieties was produced at the Institute main farm at Lucknow. In addition to this, 1850 quintals seed was produced at IISR Regional Centre, Motipur. For the crop season 2013-14, newly released varieties such as CoH 128 and CoPant 05224 have been included in the seed production chain.
- One hundred twenty seven varieties are under maintenance for the Reference Collection. Three candidate varieties (New category) are under DUS Testing.
- Fifty-two germplasm lines, comprising 4 inbreds, 7 composites, 5 varieties, 27 exotic breeding lines, 5 elite selections and 4 new introductions were maintained at Sugarbeet Breeding Outpost, Mukteshwar. Over fifty kg seed of sugarbeet varieties and breeding lines was produced.
- Genotyping of a population of CoLk 7901 x HR-83-65 was initiated with forty primer pair sequences from sugarcane unigenes.
- Five QTLs and four associated markers were identified linked with red rot resistance using linkage analysis and association mapping approaches, respectively.
- One putative EST_SSR (IISR_132_900) marker was identified associated with stalk borer. The genotypic data generated by gSSRs and EST-SSRs of 87 varieties of sub-tropical India released from 1933 - 2008 were analyzed for genetic structure and diversity.
- Chromosomal variability studies carried out in sugarcane genotypes CoLk 8102, BO 91 and Co 1158, and in two cross populations involving these as parents revealed that the modal chromosome numbers/cell in parents ranged from 108-118 and in progeny population from 92-120 in Co 1158 x BO 91 and 90-112 in BO 91 x CoLk 8102.
- Genomic DNA of red rot resistant and susceptible sugarcane genotypes was amplified with thirty combinations of degenerate primers from known *R*-genes, sequenced and analysed using bioinformatics tools. Based on matching with the proteins related to disease



resistance mechanism, ten putative RGAs have been identified.

Crop Production

- Significantly highest cane yield (75.6 t/ha) was observed at 120:30 cm row spacing. The quality parameters were not affected by plant geometry but significantly highest sugar yield was obtained at 120:30 cm spacing.
- Placement of three pre-sprouted cane nodes at one place at 25 cm spacing recorded significantly higher shoot count (162.3 thousand/ha at 150 DAP), number of millable canes (132.7 thousand/ha) and cane yield (76.1 t/ha). Significantly highest sugar yield (9.09 t/ha) was recorded at 60 cm spacing closely followed with that at 75 cm spacing. The highest cane yield (76.0 t/ha) was recorded for sugarcane planting with three setts (three budded) together keeping intra row spacing of 30 cm (end to end) that was significantly higher than conventional (62.3 t/ha) and other planting methods.
- “Cane node technology of sugarcane planting” was found to be useful in reducing the seed cane quantity in sugarcane cultivation in addition to rapid germination of cane buds. The highest germination of 80.94% was recorded under single node cane segments as against 42.50% under 3-bud setts at 40 days after planting. The cane yield obtained under cane node technology was higher by 10.90% over that of 3-bud setts planted crop. Only 17-18 q/ha seed cane is required in cane node method as against 60-80 q/ha under conventional method of planting.
- Results of experiment on cane node priming techniques for accelerating germination indicated that the priming of cane nodes with hot water (50°C) + 3% urea solution for 02 hrs. or with cattle dung, cattle urine and water in 1:2:5 ratio planted either directly in the field or after incubation (4 days) gave maximum germination (78.21%) at 40 days after planting (DAP) as compared to un-primed cane nodes or treating them with hot water (50°C for 2 hrs.) only (52.76%). Cane yield was also higher wherever cane nodes were primed and incubated before planting in the field.
- Incorporation of rice straw with *Trichoderma viride* improved the bulk density of soil (1.24 Mg m⁻³) and soil organic carbon content (0.69% in September- at grand growth stage). It also improved *in situ* soil respiration rate (206.3 mg CO₂/ g soil/ day). Soil enzymes (such as dehydrogenase, phosphatase and amylase and urease) activity increased with incorporation of crop residues with *Trichoderma* application. Incorporation of residues with *Trichoderma viride* significantly improved growth and yield of succeeding wheat crop besides improving soil fertility. Higher nutrient levels were analyzed after harvesting of sugarcane crop as compared to wheat crop in the experiment which showed that despite greater removal of nutrients by sugarcane, it acts as soil fertility restorer.
- The highest cane yield of 9th ratoon (54.00 t/ha) was recorded with SPMC + *Gluconacetobacter* against the plant cane yield of 77.5 t/ha and 1st ratoon yield of 80.8 t/ha. Soil organic carbon ranged between 0.66 to 0.72 % under different treatment of bio-manuring over its initial value of 0.32%. A strong negative correlation occurred between total lignin, acid insoluble lignin, acid soluble lignin, phenols, anilides and soil enzymes (dehydrogenase, alkaline and acid phosphatase and aryl sulphatase) in control and NPK treated plots during the grand growth phase. In bio-manuring treatments, 1.6-2.3 fold increase in dehydrogenase, 1.2-1.9 fold increase in aryl sulphatase and 1.4 fold increase in acid phosphates activities led to about 65 and 79 % decline in phenol and anilide contents during the grand growth phase.
- Soil samples from different sugar mill command areas located in the states of Punjab and Uttarakhand were collected for

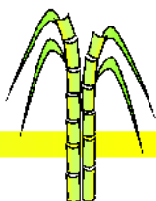


determination of soil physico-chemical properties and soil fertility status. Soil pH and electrical conductivity in sugar mill command areas of both the states were found normal; however, sub-soil layer reflected higher pH in Punjab. Soils in Punjab analysed low in organic carbon and available nitrogen, whereas P and K contents were found high and medium, respectively. Uttarakhand sugarcane soils analysed low for organic carbon, available N, P and K. Micro-nutrients Zn, Cu, Fe and Mn were found above critical values in the soils of both the states except Zn for Uttarakhand.

- Sea weeds, *Kappaphycus* and *Gracilaria* sap spray on sugarcane crop enhanced cane yield significantly over control (water spray). *Kappaphycus* spray @ 5.0% sap solution increased the cane yield by 12.6% over control (59.9 t/ha) due to high cane weight, cane length and number of millable canes. However, *Gracilaria* spray @ 2.5% sap solution augmented the cane yield to the tune of 8.7% over control.
- Significantly higher rate of germination (55.3%), shoot count (204.2 thousand/ha at 180 DAP), NMCs (139.8 thousand/ha), cane yield (89.3 t/ha) and sugar yield (10.17 t/ha) were recorded under trench planting system in which irrigation was applied in deep trenches. The irrigation water use efficiency (IWUE) was also observed to be significantly higher (3541.6 kg cane/ha-cm) under this treatment followed by alternate skip furrow irrigation system.
- Deep tillage and sub-soiling before sugarcane planting increased the NMCs (116.5 thousands/ha), cane length (242.1 cm), cane diameter (2.22 cm) and single cane weight (927 g) over control. Optimum moisture regime (0.75 IW/CPE) significantly increased cane growth and yield attributes over sub-optimal regime (0.5 IW/CPE). The highest cane yield (98.85 t/ha) was obtained with deep tillage and sub-soiling with optimal moisture regime.
- Deep tillage and sub-soiling followed by harrowing before sugarcane planting increased NMCs (117.2 thousands /ha), cane length (240 cm), cane diameter (2.27 cm) and single cane weight (1163 g) over other treatments. There was 12% mean increase in sugarcane (87.85t/ha) and sugar yields (11.25 t/ha) each with deep tillage and sub soiling over the farmer's practice.
- Modified layout involving additional row arrangement in existing RBD enabled covariance analysis for weed number and their dry weight resulting in improvement of the efficiency of existing design with respect to Root MSE, CV and R² values.
- Data from farmers of 4 villages of Biswan Sugar Mill Zone revealed 13 proverbs, 4 social beliefs and 41 ITKs related to sugarcane cultivation. After careful scrutiny only relevant ITKs were retained for further study.

Crop Protection

- No significant effect of fresh press-mud enriched with *T. harzianum* was found on performance of four red rot susceptible varieties. *In vitro* evaluation of different sugarcane waste/residue and other materials like cereal grains, groundnut shell, fallen tree leaves, wheat bran and farm yard manure etc were carried out for multiplication of *Trichoderma harzianum*. Sugarcane bagasse, sorghum grains and molasses were found promising substrates for multiplication of *T. harzianum*.
- A laboratory rearing technique using sugarcane stalk pieces with field collected top borer larvae was developed. The parasitisation of top borer larvae by *Isotima javensis* and *Rhaconotus scirpophagae* was 22 and 29%, respectively, as compared to *Corcyra* larvae (no parasitisation). The female biased sex ratio was observed in *Rhaconotus*, whereas male biased ratio was observed in *Isotima*.
- Incidence of top borer (I and II brood) ranging from 5.65-15.11% and 4.34-7.09% along with various trap crops was

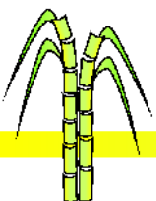


observed whereas it ranged from 10.79 to 19.24% in control. In I-brood, minimum incidence was along with marigold (6.88%), coriander (8.96%), brinjal (12.77%) and tomato (15.11%), whereas in II-brood minimum incidence was only in marigold (4.34%). Similarly, in III-brood, an incidence of 8.02% was observed in plots along with brinjal (in control, 12.29%). The incidence of top borer (IV brood) ranged from 12.34 to 13.39% in plots with jowar, brinjal, bajra and tomato as compared to 18.75% in control.

- Studies were carried out to isolate, enumerate and characterize *Trichoderma* isolates from sugarcane agro-ecosystem of sub-tropical India. Seventy-two *Trichoderma* isolates were established from sugarcane rhizosphere, purified and characterized for colony characters including growth rates at different temperatures (25°C, 30°C, 35°C & 40°C). Isolates exhibited considerable variability in colony characters. Optimum temperature for majority of the isolates ranged from 25°C to 30°C. Ten selected isolates were further screened for their antagonistic activity against *Colletotrichum falcatum* *in vitro* and *in vivo*. Culture filtrates were found promising in reducing *C. falcatum* growth *in vitro* with up to 67% inhibition recorded in isolate STr-52.
- Out of sixty-one elite selections evaluated, 33 selections were resistant and 28 selections were susceptible to red rot. For evaluation against smut, sett dip inoculation was carried out at planting. Out of sixty-one genotypes, 34 were resistant and 27 were susceptible. Natural incidence of wilt was observed in three genotypes.
- In insects, attraction to food is governed by kairomones. The chemical cues released by the host insects are sensed by the parasites and predators. To increase the chemical cues, top borer larvae were crushed in water and sprayed on the sugarcane crop in June. Parasitisation of top borer was increased in plots received foliar spray of crushed larvae (1000 larvae/

ha). Incidence of top borer IV-brood was low in treated plots as compared to untreated ones. Incidence of V-brood was low in all the plots.

- There was no difference in the effects of four macronutrients (N, P₂O₅, K₂O and S) and four micronutrients (Mn, Zn, Fe and Cu) on red rot development. Higher contents of total phenols, PPO and peroxidase activity was noticed in resistant genotypes as compared to susceptible ones. Data indicated that there is a possible role of chitinase and α 1,3-glucanase genes in conferring red rot resistance in sugarcane as the banding pattern confirmed differential expression of these PR proteins after induction of disease and the intensity of these proteins increased with time. Eleven new isolates of *Colletotrichum falcatum*, collected this year and three known pathotypes of North West Zone (Cf 01, Cf 08 and Cf 09) and a pathotype (CoS 8436) received from Shahjahanpur were evaluated for their virulence pattern on 14 sugarcane differentials using standard plug method of inoculation. All the test pathotypes and eleven new isolates resulted in similar disease reaction. This year, no new virulent pathotype was observed in this zone.
- During August, Cf 01 was inoculated on the differentials and after three weeks, reisolation was done. Reisolates were again inoculated in the respective host differentials. Six sporulating variant cultures of Cf 01 were established after next round of isolation. These cultures were multiplied on liquid medium and were used for molecular analysis. It was observed that host did influence the virulence behaviour of the reisolates. Host acted as a selective medium to select out any virulence that is capable of breaching the resistance. It was observed that in the reisolates variations were also occurred at DNA level.
- Fungal endophytes from different portions of sugarcane plant were isolated in different seasons. The distribution of



endophytes was higher in leaves and roots. The most dominant endophytes were species of *Trichoderma*, *Aspergillus* and *Fusarium*. *Trichoderma* isolated from roots showed less inhibition (60%) of *C. falcatum* as compared to leaves (68.84%) in dual culture assay. Selected strains of *Trichoderma* and *Aspergillus* were further evaluated for antifungal volatile substances/metabolites against *C. falcatum*. Mycelial growth of *C. falcatum* was inhibited by *Trichoderma* isolates by 30.0 - 62.2%, whereas the inhibition was 40.3 -56.3% for *Aspergillus* isolates.

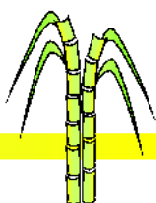
- Morphological character, leaf breadth showed a significant positive correlation, while midrib thickness and plant height had negative correlation with the top borer incidence in different genotypes. Amongst biochemical parameters, Poly Phenol Oxidase (PPO) activity and phenol content was high and reducing sugar content was low in less susceptible varieties.
- The newly developed insect trap was further modified by addition of top borer pheromone dispenser along with the white grub pheromone. The modified trap was found to attract top borer moths also in addition to white grub beetles. White grub beetle management through IISR-combo insect trap and grub management through timely application of selective insecticides were found effective. The technology was demonstrated in 8 sugar mills of UP and 3 sugar mills of Maharashtra.
- A new structure of knowledge base and inference mechanism for disorder diagnosis has been laid, in which symptoms used for disorder diagnosis has been classified into three different categories viz. Symptom Location (Crop Part), Symptom Attributes and Crop Stage, to ease selection of appropriate symptom for disorder diagnosis.

Agriculture Engineering

- Prototype of tractor operated paired row planter was developed. It was field tested at large scale at IISR farm and at farmer's fields of Sitapur district. Prototype of

interculturing equipment with sweep shovels was also developed and field tested at IISR farm for paired row planted cane crop. IISR front mounted sugarcane harvester, with certain modifications in cutting mechanism, was field tested for harvesting of wide spaced paired rows of cane.

- A machine has been designed and developed for chopping of dry sugarcane trash in between two rows of sugarcane spaced at 75, 90 cm. The machine covers two inter-row spaces at a time.
- Two models of tractor operated 'Sugarcane Manager' have been developed. The first model has been developed to carry out intercultural operations by using blade shovels to conserve soil moisture, band placement of fertilizer on both side of rows and earthing-up by using furrowers. These furrowers can also be used for opening of furrows for cane planting. The second model is low cost, simple equipment for carrying out intercultural operation by using sweep shovels and earthing-up operation by using furrowers.
- A paired row planter was developed for planting of single pairs of cane at 30 cm spacing.
- A folding type combo trap was fabricated by using aluminium sheet of 16 g. Its components can be dismantled and assembled in half an hour.
- A tractor operated trench making equipment was developed for making two rows of 25-30 cm deep furrows at a spacing of 30 cm, to facilitate planting of cane in paired rows at a recommended depth for trench method of planting. The prototype is being tested in the field.
- A tractor drawn trencher based on m.b. principle is being developed to open 'W' shaped trench upto 25-30 cm from ground level with 40 hp tractor, in light medium soil.
- The batch type mechanical screw press rectangular system for jaggery moulding



was redesigned with provision of two vertical shafts for smooth vertical movement of rotor pistons into static moulding frame. A sliding plate, which works as platform for setting of jaggery has also been provided at bottom of these base moulds.

Physiology and Biochemistry

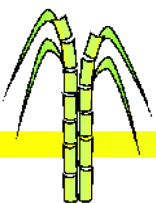
- Soluble acid invertase (SAI) gene expression analysis using total RNA isolated from fresh and, 3, 6, 7 and 8 days stale canes both untreated and treated with electrolyzed water and chemical formulations was performed and results indicated a significant and higher expression of SAI in all untreated stale canes whereas significant reduction in SAI expression in both electrolyzed and chemical formulation treated setts were observed.
- Sett priming with mixture of phosphates improved cane yield by 27 %. Optimum plant population was found to be 50,000/ha. GA3 and cytokinin improved NMC by 7 and 8%, respectively in variety CoSe 92423.
- Bud chip after fungicide treatment (0.2% Bavistin) was encapsulated using a membrane and stored at room temperature for 8 days, seed moisture was about 65 per cent as compared to control (30 per cent). Germination was comparatively higher (70%) than control (30%) under field conditions.
- Foliar application of enzyme effectors viz. Mg, Mn, B, Mg+Mn, Mg+Mn (soil application), a mixture of Mg+ Mn and ethrel and ethrel was performed along with water treated as control. Sucrose increase was highest with chemical formulation containing a mixture of Mg, Mn, and ethrel. In contrast to sucrose, SAI activity decreased in cane stalk due to chemical application.
- Preservation of juice and its packaging was assessed by adding potassium meta-

bisulphite within permissible limits followed by heat treatment, filtration, pasteurization and immediate filling in autoclaved bottles under aseptic condition. Storability of juice under cold condition was satisfactory up to two weeks with sugarcane juice characteristics such as colour, taste and flavour.

- A total of 367 CISP primer-pairs were tested in diverse panel of samples. The data indicate amplification of 41% polymorphic bands leading to 0.52 PIC and 3.50 MI with a set of sugarcane varieties and *Saccharum* species. In addition, a moderate technical functionality of a set of such markers with orphan tropical grasses (22%) and fodder cum cereal oat (33%) is observed.
- Utilizing primer pairs developed based on known sequences of SAI gene, nucleotide sequence for *Saccharum spontaneum* SES34 (Gene accession no.: KC570328) was deduced.

ICT in Sugarcane

- Decision Support System (DSS) for Disorder Diagnosis in Sugarcane Crop has been developed using Client-Server architecture in which, knowledge base and inference engine resides on server and accessible to client using web browser.
- In a study aimed to classify districts according to levels of productivity, spread of sugarcane crop and on some other typologies into homogeneous groups for analysing the impact of sugarcane in relation to net sown area of the districts, it was found that forty three medium to very high spread index districts contribute nearly 75% cane area and 75% cane production of the country.
- An effort has been made to develop efficient statistical design for conducting weed control experiments in sugarcane.
- A continuous analysis of sugar production and trade scenario in South Asia Region is being done at the institute.



About the Institute

The Indian Institute of Sugarcane Research (IISR), Lucknow was established in 1952 by the erstwhile Indian Central Sugarcane Committee for conducting research on fundamental and applied aspects of sugarcane culture as well as to co-ordinate the 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. 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 kms from CCS Airport, Amausi and about 5 kms each from Lucknow Railway Station and Alambagh Bus 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

The mandate of the Institute approved by the ICAR in 2001 is:

- i) To conduct basic and applied research on all aspects of production and protection techniques of sugarcane and other sugar crops particularly sugarbeet for different agro-climatic zones of the country
- ii) To work on the breeding of varieties for sub-tropical region in close collaboration with Sugarcane Breeding Institute, Coimbatore
- iii) To carry out research for diversification and value addition in sugarcane
- iv) To develop linkages with State Agricultural Universities, Research Centres and other organizations for collaborative research, exchange of information and material, and
- v) To provide training, and consultancy to end users at regional, national and international levels.

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

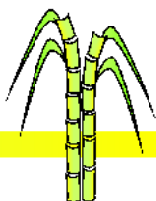
Strategies

Increasing the levels 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 through 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 (2012-13)

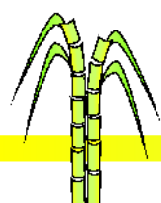
(Rs in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Indian Institute of Sugarcane	2598.50	2499.44	355.00	354.80
AICRP(S)	-	-	1300.00	1300.00

- Revenue Generated: Rs. 124.00 lacs

Staff Position as on March 31, 2013

Category	Sanctioned	Filled	Vacant
Scientific (including RMP)	74	54	20
Technical	129	119	10
Administrative	48	46	02
Supporting	74	51	23
Total	325	270	55





Breeding sugarcane varieties for sub-tropics

Variety is the pivot around which entire production system revolves. Therefore, success of any sugarcane production system largely depends in selection of an appropriate variety for the particular agro-climatic zone. New sugarcane varieties are continuously evolved for different growing conditions. Proper balance of early and midlate sugarcane varieties is very important for better cane productivity, longer crushing period and sugar recovery. Replacement of old and deteriorated sugarcane varieties with new improved ones through the quality seed cane production programme is the need of the hour. Sugarcane is now considered as 'Energy Cane'. Accordingly, the objectives of the sugarcane improvement need to be modified as to develop sugarcane varieties with high fibre and high biomass yield. The Institute employs both conventional and non conventional approaches for sugarcane improvement. Conventional approaches encompass pre-breeding, breeding and post breeding activities. Advance techniques like tissue culture, molecular breeding, molecular diagnostics, genomics, proteomic analysis etc. are being used to resolve the various problems related with sugarcane improvement.

Sugarcane variety released for cultivation

CoLk 9709, an early maturing sugarcane variety, has been identified by the State Varietal Release Committee during October 2012 for commercial cultivation in central and western Uttar Pradesh. The breeders and scientists who contributed for the development of this variety were Dr(s) J. Singh, D.K. Pandey, P.K. Singh, Sanjeev Kumar, M. Swapna, A.D. Pathak, Raman Kapur, Ram Ji Lal, N. Kulshreshtha and H. M. Srivastava. Some characteristic features of CoLk 9709 are given in table 1.1.

Table 1.1 Characteristic features of CoLk 9709

Parentage	Yield (t/ha)	CCS (t/ha)	Sucrose (%) 10 months	Pol (%) cane at 10 months	Fibre (%)
LG 7230 GC	72.35	8.92	18.04	13.26	13.06



Fig 1.1 Canes of variety CoLk 9709

Sugarcane clones accepted for evaluation under AICRP(S)

Four early sugarcane genotypes (CoLk 12201, CoLk 12202, CoLk 12203 and CoLk 12204) and 02 midlate sugarcane genotypes (CoLk 12205 and CoLk 12206) were accepted for multi-location testing in North West Zone, two early sugarcane genotypes (CoLk 12207 and CoLk 12208) and 02 midlate sugarcane genotypes (CoLk 09204 and CoLk 12209) were accepted for multilocation testing in North Central Zone during AICRP(S) Workshop, 19-20 October, 2012 at TNAU, Coimbatore. The characteristics of accepted entries are given in table 1.2.

Evaluation of sugarcane genotypes under Station Trial

A trial comprising of 20 genotypes including 04 controls (CoJ 64, CoPant 84211, CoPant 97222 and CoS 767) was conducted in CRBD with three replications to assess the performance of these genotypes which were drawn from various breeding projects. Three early sugarcane genotypes (LG 07094, LG 05377 and LG 07771) and three mid-late sugarcane genotypes (LG 07785, LG 07584 and LG 07601) were found to be promising based on the cane and sugar yields as well as sucrose (%) and other characters. These genotypes will be proposed for multi-location testing under AICRP(S).

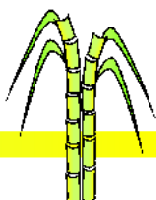


Table 1.2 List of sugarcane clones accepted for evaluation (2012-13) in Zonal Varietal Trials under AICRP(S)

Genotype	Parentage	AICRP (S) Zone	CCS (t/ha)	Cane Yield (t/ha)	Sucrose % (10M) Nov	Sucrose % (12M) Jan
CoLk 12201 (LG 05003)	CoLk 8002 x BO 91	North West	11.71	85.72	19.68	
CoLk 12202 (LG 06599)	LG 94112 GC	North West	11.13	86.78	18.63	
CoLk 12203 (LG 06839)	CoSnk 03-44 GC	North West	10.49	82.93	18.41	
CoLk 12204 (LG 06361)	LG 97009 GC	North West	9.55	74.91	18.50	
CoLk 12205 (LG 06810)	CoS 96268 GC	North West	10.64	89.32	-	17.45
CoLk 12206 (LG 05306)	CoLk 8102 x Co 1148	North West	10.27	78.00	-	19.20
CoLk 12207 (LG 04006)	CoLk 8002 GC	North Central	9.34	81.6	16.67	
CoLk 12208 (LG 02039)	LG 095053 Self	North Central	9.10	80.3	16.62	
CoLk 09204 (LG 04043)	CoLk 8102 x CoJ 64	North Central	9.71	84.9	-	16.7
CoLk 12209 (LG 02039)	LG 95053 x CoPant 90223	North Central	9.67	81.7	-	17.6

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

A collection of 284 genotypes consisting of *Saccharum officinarum*, *Saccharum barberi*, *Saccharum sinense*, ISH clones, IkshuISH clones, LG selections, Commercial Hybrids etc., was maintained and the required material was supplied to various on-going projects of the Institute. For the maintenance year 2012-13 (Autumn Planting completed in October, 2012) thirty new genotypes were added in the collection, thus increasing the total collection to 314. It includes 162 Commercial Hybrids, 51 ISH & IkshuISH lines, 71 LG clones and 30 species level genotypes.

Developing breeding stocks for high sugar in sugarcane

A good number of seedlings were obtained from the fluff of 2010 and transferred to the field for progeny evaluation. Field evaluation of selections in different clonal generations in plant and ratoon crop led to 179 clones to be advanced in autumn for further evaluation. Twenty-four selections were advanced for further evaluation in a replicated trial. A set of five high sugar selections with predominantly LG pedigree, namely II-26-5, V-29-9, IV-8-3, V-4-7 and V-25-6 having high sugar comparing with CoJ 64 have been ear-marked for inclusion to the National Hybridization Garden. The field evaluation of 24 advance selections resulted in selection of eight clones possessing varietal attributes. Four of these, LG 07443, LG 07444, LG 07451 and LG 08422 were significantly superior in cane and sugar yield (Table 1.3) and were included in the Station Trial for 2013-14.

Table 1.3 Performance of selected clones included in Station Trial (2013-14)

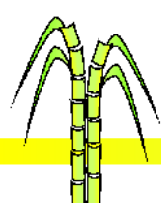
Clone	CCS (t/ha)	Cane yield (t/ha)	Pol % (Nov)	Pol % (Jan)	Pol % (Feb)
LG 07444	11.98	96.6	17.04	17.87	19.21
LG 07443	10.80	81.4	17.29	19.22	19.70
LG 08422	10.66	80.9	18.44	19.01	21.00
LG 07451	10.61	87.9	16.04	17.42	17.54
CoJ 64	8.32	61.7	18.19	19.32	20.41
CoS 767	10.51	87.5	15.75	16.62	17.30
CD (5%)	1.75	12.0	1.08	0.83	1.15
CV (%)	12.7	11.1	3.94	2.80	3.71

This trial also helped ear-mark four high sugar genotypes with LG parentage. These were comparable with the high sugar control CoJ 64 (Table 1.4).

Table 1.4 High sugar selections in advance evaluation trial

Selection	Parentage	CCS %			Remarks
		Nov	Jan	Feb	
LG 07503	LG 01118 GC	12.01	13.80	14.01	Breeding Stock (BS)
LG 08478	LG 99112 GC	12.61	13.13	14.65	BS, S to Red rot & Smut
LG 07595	LG 95053 GC	12.74	13.92	14.50	BS
LG 07528	LG 01118 GC	12.86	14.21	14.58	BS
LG 08422	LG 99001 GC	13.46	13.56	14.71	MR
CoJ 64		12.65	13.46	14.26	
CD (5%)		0.98	0.64	0.87	

Based on early brix in the PVT genotypes, a replicated trial of 26 clones was planted. Similarly, 48 genotypes from C₁ population were advanced for further evaluation. The seedling population (C₀), comprising of 26 GCs, 9 biparental crosses and 10 selfs, was subjected to selection for early sugar,



resulting in 633 being advanced at a selection rate of 22%. At the National Hybridization Garden, Coimbatore, matings were effected among LG clones to further bring together genes for sugar accumulation into desirable recombinants. Fluff has been received for 7 crosses, 3 selfs and 17 GCs. This endeavour at prebreeding for sugar has resulted in inclusion of nearly 50 high sugar selections in NHG. Five more such clones were sent this year, namely LG 07408, LG 07482, LG 07501, LG 07560 and LG 08422.

Development of top borer tolerant genetic stocks of sugarcane

Six inter-generic crosses and four inter varietal crosses were made at SBIRC, Agali and SBI, Coimbatore. Out of 4500 seedlings derived from three inter-varietal, seven inter-generic hybrids and two general collections of inter-generic hybrids raised, 3428 seedlings survived in field condition and evaluated for top borer tolerance and yield and quality attributes. 481 clones with 18 or above HR brix during November 2012 and less than 5% top borer infestation were advanced to C₂ stage. Four selections viz., LG 07620, LG 07630, LG 07652 and LG 07672 were advanced to station trial of the Division. Two genetic stocks tolerant to top borer (LG 06618 and LG 07615) were sent to National Hybridization Garden at Sugarcane Breeding Institute, Coimbatore for further utilization in breeding programme.

Six inter-generic crosses and four inter varietal crosses were made at SBIRC, Agali and SBI, Coimbatore. Out of three thousand four hundred twenty four seedlings evaluated for top borer tolerance, HR Brix, and vigour, 571 genotypes were advanced to C₁ stage for further evaluation.

One hundred ninety seven C₂ clones derived from fourteen biparental crosses involving 4 inter-generic hybrids with *Erianthus* spp. as male parent, 10 GCs and 4 selfs were evaluated for initial vigour, cane forming ability and HR Brix. 15 genotypes free from natural infestation of top borer and other diseases and pests and above 21% brix during January, 2012 advanced to C₃ clonal stage were evaluated for yield, quality and top borer tolerance. Four genotypes were advanced to station trial. Out of 19 genotypes evaluated in C₄ stage, four with superior economic attributes and top borer tolerance were advanced to station trial. Four genetic stocks tolerant to top borer were sent to National Hybridization Garden, Coimbatore.

CoLk 12202, an early maturing genotype, was accepted for AICRP(S) varietal testing in North-West Zone.

Development of sugarcane varieties for subtropics

CoLk 9709, an early maturing, high sugar and good ratooning variety was released for cultivation in Uttar Pradesh. CoLk 12201 (early) was accepted for testing under Zonal Varietal Trial (North-West Zone) of AICRP(S) and also for UP State Varietal Trial. CoLk 12207 (early) and CoLk 09204 (mid-late) were accepted for AICRP(S) testing for North-Central & Eastern Zone. Out of 7230 seedlings from 30 crosses transplanted during August 2011, 500 clones (C₁) selected on the basis of HR Brix% and visual performance in the field. Finally, 453 clones were planted in the field and remaining were rejected owing to pithiness and other problems. On the basis of juice quality parameters and other yield related attributes 63 C₁, 14 C₂ and 15 C₃ clones were advanced to subsequent generations for further evaluation. An experiment was conducted comprising of 16 sugarcane genotypes along with two standards (CoS 767 and CoJ 64). Significant differences were observed for yield and quality attributes. LG 07023, LG 09119, LG 09120 and LG 09028 were significantly superior over both the standards. Another replicated trial was conducted comprising of 10 sugarcane clones, in which LG 09062, LG 09071, LG 09067 and LG 09076 were found to be superior over other clones under study. Four sugarcane clones were included in Station Trial for 2013-14.

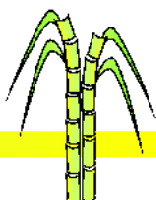
Development of breeding stocks of sugarcane for durable resistance to red rot

One early maturing genotype CoLk 12203 and one mid-late genotype CoLk 12205 were accepted for multi-location testing under AICRP (S).

Four elite clones namely LG 08849 (CoS 96268 x CoLk 8002), LG 08862 (CoSe 95422 GC), LG 08865 (CoSe 95422 GC) and LG 08866 (CoSe 95422 GC) having moderately resistant reaction to both patho types viz., Cf 08 and Cf 09 of red rot were included in Station Trial for 2013-14.

Hybridization programme

Five bi-parental crosses viz., CoLk 8102 x Co 86002, CoLk 8102 x BO 91, BO 91 x Co 62198, Co



86002 x ISH 147 and BO 91 x CoS 8436, one self of LG 05823 and four general crosses of BO 91, LG 05810, LG 05823 and LG 05828 were attempted at National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore during 2012.

Evaluation of seedlings

A total of 2235 seedlings of twelve crosses viz., four selfs of Co 1148, ISH 150, LG 05828, BO 91 and six bi-parental crosses CoS 767 x ISH 150, Co 1148 x ISH 150, Co 62198 x ISH 150, Co 1148 x BO 91, Co 1158 x BO 91, BO 91 x CoLk 8102 and two General Crosses of BO 91 and LG 05828 were transplanted and evaluated for their performance on per clump basis. Observations on number of tillers and shoots per clump, visual performance (score very good = 1, good = 3, poor = 5 and very poor = 7) and growth were recorded and seedlings were ratooned for further evaluation and selection.

Evaluation and selection of clones from seedling ratoon crop

A total of 97 clones from six crosses namely, BO 91 x Co 62198 (33 selections), CoSe 95422 x LG 05817 (2), Co1158 x BO 91 (12), Co 86011 x ISH 147 (18), CoS 767 x BO 91 (6) and LG 05828 self (26) were promoted to first clonal generation to test these clones for red rot reaction based on the performance of individual clump in plant as well as ratoon crops. Highest range for number of shoots/clump (6-13) and millable canes/clump (3-11) were recorded in clones of cross BO 91 x Co 62198 and range of HR Brix(%) (13.6-21.4) in Co 86011 x ISH 147 while variability for NMC (4-9) and for HR Brix(%) (18.6-22.53) was recorded in self of LG 05828.

Evaluation and selection of resistant clones to red rot in first and second clonal generations

Out of 907 C₁ clones, a total of 94 clones, from nine different crosses namely BO 91 x Co 62198 (28), CoS 96268 x BO 91 (2), Co 1148 x ISH 150 (12), Co 7201 x ISH 150 (1), Co 62198 x ISH 150 (2), Co 85002 x ISH 147 (20), CoC 671 x ISH 147 (8) and two self of Co1148 (4) and ISH 150 (17) were selected based on the reaction to red rot pathotypes Cf09 and HR Brix(%). These clones exhibited moderately resistant (41)/ moderately susceptible (53) reaction to red rot pathotype Cf09.

In second clonal generation, out of 20

progenies, five clones namely LG 09802 (CoLk 8102 x Co 86002), LG 09803 (CoLk 8102 x Co 86002), LG 09810 (BO 91 GC), LG 09818 (BO 91 x Co 62198), and LG 09820 (BO 91 x Co 62198) exhibited moderately resistant reaction to red rot pathotypes Cf 08 and Cf 09. All the five clones gave > 17 % sucrose with good phenotypic performance and were advanced to third clonal generation for further evaluation and selection for yield and quality attributes.

Evaluation of advanced clones in second plant crop

A trial comprising of eight advanced clones were evaluated along with two checks namely CoJ 64 and CoS 767 in CRBD with three replications to validate for disease reaction to red rot and to assess their yield and quality performance. Six clones LG 08826, LG 08849, LG 08862, LG 08865, LG 08866 and LG 08868 showed moderately resistant (MR) reaction to two virulent patho types viz, Cf 08 and Cf 09. LG 08849 showed highest cane yield (87.3 t/ha) followed by LG 08866 (86.9 t/ha) over best check CoS 767. All the resistant clones except LG 08868 recorded > 17.5 % sucrose.

Development of sugarcane varieties for moisture deficit environment

Hybridization and seedling raising

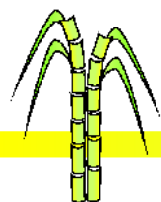
A total of 10 biparental crosses viz., CoLk 94184 x BO 91, CoLk 8102 x Co 86002, CoJ 83 x BO 91, CoJ 88 x BO 91, CoJ 83 x Co 62198, CoJ 83 x CoPant 97222, BO 91 x CoS 8436, Co 0238 x Co 62198 and CoLk 8102 x NCo 310 were attempted at National Hybridization Garden, Coimbatore during the crossing season 2012. The fluff received for all the crosses along with 10 GCs was sown in the glass house to raise the seedling.

Seedling evaluation

About 3950 seedlings raised from fluff of previous year crosses were transplanted in field condition. Observations were recorded on survival and general growth vigour at early stage. The final selection will be carried out on the basis of HR brix and general growth performance of the individual clones.

Clonal selection

Based on the HR brix and general growth



performance, about 337 C₁ clones were selected from seedling population. Out of 132 C₁ clones of previous year, about 37 clones were promoted to the second clonal generation (C₂) for further evaluation. Out 90 C₂ clones, 22 clones were selected on the basis of sucrose content and general growth performance. These clones were promoted to the C₃ generation for their evaluation under normal as well as moisture deficit conditions.

Evaluation of elite clones

Fourteen elite clones along with two standards were evaluated under both normal as well moisture deficit conditions. Observations were recorded on cane growth, yield and quality parameters. Based on the yield and quality performance, four genotypes viz. LG 07727, LG 07782, LG 08702 and LG 08709 were promoted to Station Trial.

Evaluation of early maturing sugarcane clones of North West Zone

Four trials (AVT-II Plant, AVT- I Plant, IVT and Ratoon of AVT-I Plant) in early group were conducted during 2012-13 as per technical programme of AICRP(S). In AVT-II Plant and in Ratoon of AVT-I Plant sugarcane clones CoLk 07201, Co 07025 and Co 07023 were significantly superior over standards for CCS (t/ha). In IVT, 12 sugarcane genotypes along with two standards were evaluated. Sugarcane Clones CoLk 09202 and CoPb 09181 performed significantly better over standards. Five clones were advanced from IVT to AVT-I plant. In AVT-I Plant trial sugarcane clone CoPb 08211 found to be superior over other clones.

Evaluation of mid-late sugarcane clones for North West Zone

Initial Varietal Trial

A trial comprising of eight test genotypes viz., Co 09021, Co 09022, CoH 09264, CoLk 09204, CoPb 09214, CoS 09231, CoS 09232, CoS 09240 along with three standard varieties viz., CoS 767, CoS 8436 and CoPant 97222 was conducted. Observations on yield and quality parameters were recorded as per the technical programme.

Advanced Varietal Trial - I Plant

Six genotypes viz., CoH 08262, CoH 08263, Co 08264, CoPb 08217, CoS 08234 and CoS 08235

along with three standards, CoS 767, CoS 8436 and CoPant 97222 were evaluated for yield and quality parameters. Observations on yield and quality parameters were recorded as per the technical programme.

Advanced Varietal Trial - II Plant

Nine genotype Co 07028, CoH 07263, CoH 07264, CoLk 07202, CoLk 07203, CoPb 07212, CoPb 07213, CoS 07232, CoS 07234 along with three standards, CoS 767, CoS 8436 and CoPant 97222 were evaluated and observations on yield and quality parameters were recorded as per the technical programme.

Advanced Varietal Trial - Ratoon

Nine genotype viz., Co 07028, CoH 07263, CoH 07264, CoLk 07202, CoLk 07203, CoPb 07212, CoPb 07213, CoS 07232, CoS 07234 along with three standards, CoS 767, CoS 8436 and CoPant 97222 were also evaluated for their ratooning ability. Observations on yield and quality parameters were recorded as per the technical programme.

Seed multiplication

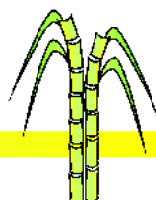
Seed of 10 genotypes viz., Co 10036, Co 10037, Co 10039, CoH 10262, CoH 10263, CoPant 10221, CoPb 10181, CoPb 10182, CoPb 10183 and CoPb 10211 was multiplied for the next year's Initial Varietal Trial.

ICAR Seed Project: Seed Production in Agricultural Crops

A total of 6400 quintals of sugarcane seed of newly released varieties was produced at Lucknow and 1850 quintals seed was produced at IISR Regional Centre, Motipur. For the crop season 2013-14, newly released varieties such as CoH 128 and CoPant 05224 have been included in the seed production chain.

Central Sector Scheme for PPV&FR Authority

One hundred twenty seven sub-tropical varieties of sugarcane were maintained in the Reference collection. DUS Testing of three candidate varieties (New category) viz. Co 0238, Co 0239 and Co 0118 was conducted for the first year. The second year testing has been initiated.





High density cane farming

Sugarcane although considered to be an efficient plant as far as tapping of solar radiation is considered and for that matter huge potential to accumulate biomass exists with the crop, initial establishment phase of the crop growth is marked with slow germination that takes around 30-45 days leading to inefficient utilization of numerous growth resources. Besides, initial high density of tillers and their survival till the stage of millable cane, greatly influenced by the way natural resources are managed, is the key for harvesting profitable sugarcane and sugar yield. During the year various approaches to hasten the germination process and to ensure early canopy development for efficient harnessing of solar energy were tried with encouraging results. Planting geometry in combination with different planting materials to ensure initial high plant population resulted in indication of future research directions to be adopted.

Optimization of plant population for improving physiological efficiency of sugarcane

Early germination in sugarcane

Experiments with sett-priming treatments using extract of Gilloy (*Tinospora cordifolia*) solution of manganese salt and a phenolic compound took 35-42 days for attaining 1/3rd germination. In the sett priming treatments, where mixture of co-enzymes and mixture of phosphates were used it took 45-50 days to attain 1/3rd germination. Sett priming treatments also improved cane yield. Priming with the botanical extract improved cane yield by 48%, with mixture of phosphates by 27% and with mixture of co-enzymes by 24%, respectively.

Enhancing germination, growth, yield and juice quality

Germination of setts soaked in zinc sulphate (50 ppm) was found to be 36.8% in comparison to water soaking (33.4%), salt mixture soaked (25.9%), water soaked (overnight) followed by heat treatment (45°C for 2 hours) 29.7% and control (without soaking) 23.5%.

Observations on optimum plant population

Initial population of 50000/ha led to T_{max} of 305278/ha and NMC 150556/ha with cane yield of 132 t/ha and was found to be the optimum plant population in autumn planted sugarcane. Similarly in spring raised crop with Spaced Transplanting technique this was again true, however NMC was

110000/ha with cane yield of 93 t/ha. This was concluded after raising 70, 60, 50, 40, 30 and 20 thousand initial plant population in autumn (from three bud setts) and spring (from STP) planted cane. The optimum yield at 50 thousand was due to optimum LAI (4-5) compared with >7 at 70, >5 at 60 thousand/ha plant population. At 40, 30 and 20 thousand/ha plant population the LAI were <4 at 8 months of plant growth.

Improvement in NMC and cane weight

Improvement in NMC and cane weight was attained with the spray of cytokinin and GA₃ by 8 and 7%, respectively compared with control (no treatment of hormones) in the cane planted with initial plant population of 50,000/ha.

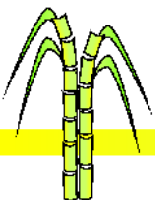
Differences in average cane weight and NMC from single settling

Number of millable canes obtained from one settling in STP was 4 at initial population of 20000 plants/ha, whereas it was only 2 at 70000 plants/ha. Average cane weight (1.1 kg) was highest at 20000; and at 50000/ha plant population it was 800 g.

Physio-biochemical studies concerning survival and establishment of bud-chip

Bud-chip encapsulation for direct planting

Bud-chip planting material has relatively low food reserves (1.2-1.8 g sugars/bud) compared to conventional 3-bud setts (6.0-8.0 g sugars/bud). The food reserves and moisture in the bud-chip



depletes at a faster rate compared to 2 or 3-bud setts which is reflected in their poor sprouting and early growth. Therefore, to maintain moisture and viability of seed material, physical and chemical methods of bud chip encapsulation were performed to raise sugarcane crop by direct planting using bud chip seed material.

Physical method

For improving water retention capacity and shelf life of bud-chip planting material, bud chips after fungicide treatment (0.2% bavistin solution) were encapsulated using a membrane. By this method, bud chip if stored at room temperature for 8 days, seed moisture was about 65 per cent as compared to 30 per cent recorded with control. Similarly bud germination was comparatively higher (70%) than control (30%) under field conditions.

Bud-chip settlings

Bud-chip settlings raised autumn and spring planted sugarcane crops were evaluated for yield attributes and juice quality parameters. The findings revealed substantial saving of seed cane as very low requirement (<1.0 t/ha) was there with bud-chip planting material as against conventional system of cane planting using 3-bud setts where 6-8 t/ha seed cane was needed. With the use of bud-chips germination/ establishment was very early (within 7 days) and rate was also higher (85-90 %) over that of 30-35 % with conventional 3-bud setts obtained after 45-60 days. Synchronized tillering and higher T_{max} was recorded with bud-chip planting as compared to that with conventional three bud setts under both autumn and spring

planting conditions. This helped improving number of millable canes and finally cane yield. Sucrose content in cane juice was almost at par to three-bud setts method.

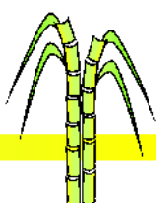
Planting geometry in relation to mechanization in sugarcane

Field experiment was conducted to work out optimum plant geometry of different varieties for use of farm machinery. The experiment consisted of 12 treatment combinations with 3 planting geometries viz., 120, 150 and 120:30 cm row spacing and 4 varieties (CoS 96275, CoSe 92423, CoS 94257 and CoLk 94184). The experiment was laid out in split plot design allocating plant geometry in main plot and varieties in sub plots. The treatments were replicated thrice in the experiment.

The data on sugarcane growth, yield attributes and yield indicate that significant highest shoot population (155.8 thousand/ha), number of millable canes (133.4 thousand/ha) and cane yield (75.6 t/ha) was observed at 120:30 cm row spacing. Variety CoSe 92423 recorded significantly higher cane yield (68.3 t/ha) over CoS 96275 and CoS 94257, however it was found similar to CoLk 94184 (67.0 t/ha). The quality parameters were not affected by plant geometry but significantly highest sugar yield was obtained at 120:30 cm spacing. Different genotypes showed significant variation for different quality parameters. Significantly highest brix (21.69), pol % (18.33) with purity of 84.53% and CCS (12.4%) was harnessed by CoLk 94184. This genotype also fetched highest sugar yield (8.30 t/ha), which was closely followed by CoSe 92423 (Table 2.1).

Table 2.1 Effect of plant geometry and varieties on growth, yield attributes and yield of sugarcane

Treatment	Germination (%) 45 DAS	Shoot count ('000/ha) 180 DAP	NMC ('000/ha)	Cane length (cm)	Cane girth (cm)	Cane weight (kg)	Cane yield (t/ha)
Planting geometry							
Row spacing							
120 cm	40.6	129.7	101.2	186.7	2.50	0.83	64.0
150 cm	40.1	108.7	85.0	186.9	2.63	0.98	55.4
120:30 cm	41.1	155.8	133.4	186.3	2.53	0.85	75.6
CD (P = 0.05)	NS	14.28	11.26	NS	NS	NS	7.38
Genotype							
CoS 96275	40.2	124.0	99.0	177.0	2.45	0.74	61.7
CoSe 92423	44.4	135.0	112.8	193.0	2.75	0.97	68.3
CoS 94257	40.9	135.3	98.3	182.9	2.75	0.96	63.0
CoLk 94184	36.8	131.2	116.3	193.7	2.26	0.88	67.0
CD (P = 0.05)	3.67	7.60	6.26	8.26	0.11	0.20	4.29



Agronomic evaluation of promising genotypes of sugarcane

An experiment was conducted to evaluate three sugarcane genotypes (CoH 06265, CoS 06247 and CoH 06266) under three NPK levels (112.5, 45, 45; 150, 60, 60 and 187.5, 75, 75 kg/ha) with a view to identifying suitable genotype under various fertilizer schedules in spring season. Sugarcane genotype, CoH 06265 produced the highest number of millable canes (97700/ha) followed by CoS 06247 (90200/ha) and CoH 06266 (86100/ha). The highest cane length (235.6 cm) was recorded with genotype CoS 06247 but thicker canes (2.62 cm diameter) were harvested with the genotype CoH 06265. Although, significantly highest sucrose content (17.98%) was analysed in CoH 06266 the higher cane yield (76.37 t/ha) and sugar yields (9.36 t/ha) were obtained with CoH 06265. It was followed by CoS 06247 (71.10 and 8.68 t cane and sugar yields/ha, respectively).

Mean number of millable canes, individual cane length, diameter, weight and cane and sugar yields significantly increased up to application of recommended levels of NPK i.e., 150, 60 and 60 kg/ha (Table 2.2). This fetched significantly higher cane (72.69 t/ha) and sugar yields (8.89 t/ha) which was at par with 125% NPK levels. Different fertility levels could not influence the juice quality parameters significantly. Significant interaction of sugarcane varieties with fertility levels was observed on sucrose % juice. Sucrose content in juice in CoH 06265 decreased with increasing levels of fertility. However, other two varieties CoS 06247 and CoH 06266 maintained juice quality up to the application of 187.5, 75, 75 kg NPK/ha.

Table 2.2 Interaction effect between sugarcane varieties and fertility levels on sucrose content

Variety/ Fertility level	F1 (112.5, 45, 45)	F2 (150, 60, 60)	F3 (187.5, 75, 75)	Mean
CoH 06265	18.06	17.80	17.26	17.71
CoS 06247	17.70	17.47	17.80	17.66
CoH 06266	17.93	18.31	17.71	17.98
Mean	17.80	17.80	17.50	
	S E m±	CD		
Variety (V)	0.09	0.27		
Fertility level (F)	0.09	0.27		
V x F	0.16	0.48		

Regulating shoot population dynamics for high cane productivity

Field experiment was conducted to conceptualize tillering dynamics for enhanced productivity of sugarcane in spring planting season. The experiment consisted of 16 treatment combinations of row spacing (120, 90, 75 and 60 cm) and techniques of planting including different materials (seed cane) and/or placement (conventional three bud setts, parallel sett placement with 30 cm sett to sett spacing, pre sprouted single cane node planting at 25 cm spacing and planting of three pre-sprouted cane nodes at intra-row spacing of 25 cm). The experiment was laid out in Randomized Block Design (Factorial) with three replications. Data on sugarcane growth, yield attributes and yield indicate that significantly highest shoot population (165.1 thousand/ha at 150 DAP), number of millable canes (129.3 thousand/ha) and cane yield (81.2 t/ha) were recorded at closer row spacing of 60 cm. which was however, closely followed by 75 cm spacing (76.4 t/ha). The yield attributing characters viz. cane length, girth and average cane weight were significantly reduced at 60 cm spacing.

Placement of three pre-sprouted cane nodes at one place at 25 cm spacing recorded significantly higher shoot count (162.3 thousand/ha at 150 DAP), number of millable canes (132.7 thousand/ha) and cane yield (76.1 t/ha). The juice quality parameters viz. brix, pol (%), purity (%) and CCS (%) were not affected by row spacing however, significantly highest sugar yield (9.09 t/ha) was recorded at 60 cm spacing which was comparable to 75 cm spacing. Pol (%) in juice was found significantly higher (16.6) when three pre-sprouted cane nodes were placed at 25 cm distance. The CCS % and CCS (t/ha) were also observed to be higher under this treatment (Table 2.3). Observations on combined effect of row spacing and seed material placement treatments clearly indicated that placement of three pre-sprouted cane node bunch placed at 25 cm distance in 60 cm row spacing recorded highest number of millable canes (149.7 thousand/ha) and cane yield (84.2 t/ha).

Modified planting geometry using conventional setts with intra-row spacing

The experiment comprising 16 treatment combinations including planting materials (three and two-bud setts); planting geometry (intra row

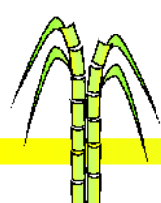


Table 2.3 Effect of row spacing and seed placement techniques on growth, yield attributes and yield of sugarcane

Treatment	Germination (%) 30 DAP	Shoot population ('000/ha)			(a) NMC ('000/ha)	Cane length (cm)	Cane girth (cm)	Cane weight (kg)	Yield (t/ha)
		90 DAP	120 DAP	150 DAP					
Row spacing (cm)									
S ₁ -120	45.6	49.2	78.4	91.3	77.6	237.0	2.54	0.88	64.1
S ₂ - 90	45.1	61.4	114.7	137.3	107.8	235.6	2.49	0.88	69.4
S ₃ - 75	45.4	73.1	125.1	153.7	113.2	237.4	2.49	0.86	76.4
S ₄ - 60	45.1	75.9	143.2	165.1	129.3	227.8	2.33	0.77	81.2
CD (P=0.05)	NS	11.63	12.57	11.39	14.62	6.31	0.18	0.10	4.38
Sett placement									
P ₁ - Conventional	31.7	50.5	91.6	120.4	95.7	224.0	2.33	0.83	71.6
P ₂ - Parallel sett placement	28.5	57.1	91.3	116.6	84.2	225.6	2.39	0.79	70.3
P ₃ - Cane node at 25cm	66.9	74.3	129.7	153.3	115.3	242.6	2.54	0.87	73.2
P ₄ - 3 cane node bunch at 25 cm	54.1	77.7	148.9	162.2	132.7	245.5	2.58	0.90	76.1
CD (P=0.05)	10.34	11.63	12.57	11.39	14.62	6.31	0.18	0.10	4.38

DAP: Days after planting

spacing viz., end to end planting of setts in pair at 20 and 30 cm, planting three setts together at end to end intra row spacing of 30 cm and conventional placement) and sett treatment with resorcinol and control (conventional) was conducted to achieve higher shoot density and cane yield. Sugarcane planting with three budded setts produced significantly higher cane yield over sugarcane planting with two budded setts. The highest cane yield (76.0 t/ha) was recorded in the treatment of sugarcane planting with three setts (three budded) together keeping intra row spacing of 30 cm (end to end) that was significantly higher than conventional (62.3 t/ha) and other planting methods due to heavier canes higher in number. The growth indices recorded in the treatment were also significantly higher over conventional planting. The sett treatment (over- night soaking) with resorcinol @ 0.1 % significantly enhanced germination and cane yield to the tune of 18.1 % and 11.3 %, respectively over control (conventional).

Optimization and standardization of cane node technology for sugarcane planting

Experiment on enhancing the extent and speed of germination through the use of cane nodes indicated that germination as recorded 10, 20, 30

and 40 days after planting under cane node planting treatments (T₁, T₂, T₃ and T₄) was on an average 25.77, 71.47, 76.39 and 80.30% as against 7.64, 22.50, 29.76 and 42.50% observed with conventional planting of 3-bud setts., respectively (Table 2.4). Higher germination in cane node planting produced significantly more number of tillers and millable canes than that of conventional planting methods (T₅, T₆ and T₇). Cane yield and number of millable canes were significantly higher under cane node planting producing 10.90% more cane yield than that obtained under conventional 3-bud planting method (76.74 t/ha).

Priming cane node for accelerating germination

Priming of cane nodes with hot water (50°C)+ 3% urea solution for 2 hrs (T₃) or cattle dung, cattle urine and water in 1:2:5 ratio and planted directly in the field (T₄) or after incubation (4 days) (T₆) recorded the highest germination of cane buds (78.2%) at 40 days after planting (DAP) as compared to un-primed cane nodes (56.90%) or treating them with hot water at 50°C for 2 hrs (48.6%). Conventionally planted crop with 3-bud setts produced the lowest germination (40.9%). Number of tillers and millable canes and yield of cane also exhibited the same trend as the germination of cane

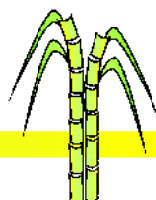


Table 2.4 Effect of cane node planting on the growth, yield and quality of sugarcane

Treatment	Germination (%)				Number of tillers ('000/ha)	NMC ('000/ha)	Cane yield (t/ha)	CCS (%)
	10 DAP	20 DAP	30 DAP	40 DAP				
T ₁ : Cane node (a stem cutting having a bud and root band)	27.6	70.7	75.3	80.4	224	140	84.69	11.2
T ₂ : Cane node + 2 cm internode (both side of cane)	24.1	73.1	74.7	79.1	230	142	85.55	11.1
T ₃ : Cane node + 2 cm internode (upper side of cane)	24.5	69.1	77.7	80.6	232	151	87.71	11.2
T ₄ : Cane node + 2 cm internode (lower side of the cane)	26.66	72.63	77.77	80.9	228	138	83.85	11.0
T ₅ : Conventional planting by 1-bud setts	1.52	22.69	33.61	42.2	109	85	47.33	11.1
T ₆ : Conventional planting by 2-bud setts	2.77	21.18	30.95	41.1	181	102	66.82	11.2
T ₇ : Conventional planting by 3-bud setts	7.64	22.50	29.76	42.5	208	121	76.74	11.2
CD (P=0.05)	--	--	--	--	13.62	14.51	6.42	NS

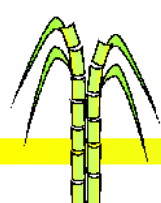
buds obtained in different treatments. Accordingly, cane yield obtained under T₃, T₄, T₅ and T₆ treatments was significantly higher to the tune of 9.79 and 8.17% than that of T₁ and T₂ treatments (un-primed cane nodes or treated with hot water only). Conventional planting with 3-bud setts produced cane yield at par with primed cane node treatments (Table 2.5), however seed rate required under cane node planting was just 17.5 q/ha against that of 72 q/ha needed for conventional planting.

Enhancing sugarcane productivity and profitability under wheat - sugarcane system

An experiment to enhance productivity of sugarcane under wheat - sugarcane cropping system comprising 9 treatments viz.; T₁: Autumn planted sugarcane, T₂: T₁+ wheat (1:2), T₃: T₁+ wheat (1:3), T₄: wheat sown on 15th November - late sugarcane, T₅: wheat sown on 15th December -

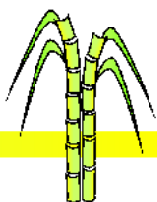
Table 2.5 Effect of cane node priming techniques on the growth, yield and quality of sugarcane

Treatment	Germination (%)				Number of tillers ('000/ha)	NMC ('000/ha)	Cane yield (t/ha)	CCS (%)
	10 DAP	20 DAP	30 DAP	40 DAP				
T ₁ : Un-primed cane node	22.0	31.6	41.0	56.9	174	102	69.49	11.2
T ₂ : Treating cane node in hot water at 50°C for 2 hours	26.6	33.2	39.8	48.6	176	104	70.74	11.0
T ₃ : Treating cane node in hot water (50°C) and 3% urea solution for 2 hours	36.8	56.6	62.5	78.3	204	117	76.81	11.1
T ₄ : Priming cane node with cattle dung, cattle urine and water in 1:2:5 ratio	38.55	48.96	67.80	78.98	208	119	78.80	11.26
T ₅ : Conventional 3-bud setts planting	9.05	18.75	30.99	40.98	190	110	75.33	11.20
Primed and sprouted cane node (incubated for 4 days after priming)	32.96	52.08	70.67	77.31	207	116	77.19	11.08
CD (P=0.05)	--	--	--	--	14.92	10.44	4.37	NS



late sugarcane, T₆; wheat sown (three rows) on 15th November under FIRB + sugarcane in furrows at 75 cm in 3rd week of February, T₇; wheat sown (three rows) on 15th November under FIRB + sugarcane in furrows at 75 cm in 3rd week of March, T₈; T₆ with sowing of wheat on 15th December and T₉; T₇ with sowing of wheat on 15th December was laid out in Randomized Block Design with three replications. The experiment started in the month of October with planting/sowing of sugarcane and wheat on their respective dates as per treatments. The observations on initial fertility status of soil, germination percentage of sugarcane, tiller count of wheat at different stages, number of ear heads per running meter, number of grains per ear head,

test weight and grain yield of wheat has been recorded. The findings reveal that wheat grain yield was the highest (46.6 q/ha) in November sown wheat in the treatment T4. Wheat yielded almost the same in flat as well as FIRB method. However, wheat sown in the month of November yielded higher than wheat sown in December due to higher number of ear heads per running meter, number of grains per ear head and test weight. Wheat (Nov.) + sugarcane (Feb/March) under FIRB method produced higher wheat yield (44.1 q/ha) over wheat (Nov) + sugarcane (Oct) in 3:1 row ratio (40.2 q/ha) as well as 2:1 row ratio (33.5 q/ha)). The sugarcane crop is standing in the field.





Natural Resource Management

Efficient management of natural and other resources hold the key for remunerative sugarcane production. Soil health being an important determinant of soil and crop productivity garnered ample attention and fortification of crop residues with cellulolytic fungi resulted good dividends in terms of soil organic carbon enrichment and cane yield. Highest water use efficiency was obtained with trench planting and application water in deep trenches. Deep ploughing and sub-soiling were found to greatly influence the soil physical properties leading to higher cane yield. It could be further enhanced through drip irrigation and fertigation that brought about similar yield response at almost 80% waving of irrigation water.

Carbon sequestration potential of sugarcane based cropping system

A field experiment was initiated to evaluate long term effect of sugarcane cultivation on soil health. Two cropping systems (rice –wheat and sugarcane–ratoon-wheat), residue incorporation (no residue and residue incorporation) and microbial inoculation (inoculation with *Trichoderma viride* and no inoculation) combinations were evaluated. Initial soil fertility levels indicated that soil had 0.42% organic carbon, 258.5 kg available N; 42.0 kg available P₂O₅ and 274 kg K₂O/ha. Incorporation of residues with *Trichoderma viride* significantly improved growth and yield of succeeding wheat crop besides improving soil fertility. Higher nutrient levels were analyzed after harvesting of sugarcane crop as compared to wheat crop in the experiment which showed that despite greater removal of nutrients by sugarcane, it acts as soil fertility restorer.

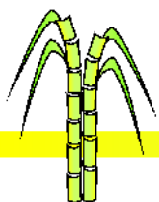
Assessment of soil fertility status of sugar mill command areas of sub-tropical India

Soil fertility maps of sugar mill command areas of Punjab and Uttarakhand states have been prepared. In Sugar mill command areas of Uttarakhand soil pH and electrical conductivity was assessed to be normal. Soil fertility status varied from mill to mill, however, as a trend organic carbon and available NPK analysed low. Among micronutrients Cu, Fe and Mn were found above critical values whereas Zn was determined to be low in these soils. Sugarcane growing soils of Punjab were assessed normal as far as soil reaction (pH) and electrical conductivity is concerned.

Organic carbon content was low to medium in majority of the samples. Soil in command area of Morinda Coop. Sugar Mill, Ropper analysed high in soil organic carbon. Available N was determined to be low in all the mill areas, however, P and K were analysed to be medium in availability. These soils were found to contain sufficient contents of micro-nutrients Zn, Cu, Fe and Mn.

Evaluation of crop nutrition potential of seaweed saps on sugarcane

Sugarcane growth enhancement potential of seaweed saps (*Kappaphycus* sap and *Gracilaria* sap) was evaluated under addition of recommended dosed of fertilizers (150, 60 and 60 kg NPK/ha). The soil of the experimental site was silty loam in texture, low in organic carbon (0.45%), available nitrogen (220 kg/ha), medium in phosphorus (48.3 kg P₂O₅/ha) and potassium (253 kg K₂O/ha) and slightly alkaline in reaction (pH 8.6). Cane setts were treated in 1.0 % sap solution (5-10 minutes soaking) before planting and crop was sprayed with different concentrations of sap at tillering stage (60 DAP), late tillering stage (90 DAP) and grand growth stage (120 DAP). *Kappaphycus* and *Gracilaria* sap spray on sugarcane crop enhanced cane yield significantly over control (water spray). *Kappaphycus* spray (5.0% sap solution) increased the cane yield to the tune of 12.6% over control (59.9 t/ha) owing to high cane weight, cane length and number of millable canes. However, *Gracilaria* spray (2.5% sap solution) augmented the cane yield to the tune of 8.7% over control (water spray). Nitrogen content in leaf and cane was also improved with application of seaweed sap in sugarcane.



Developing efficient water application techniques in sugarcane

Field experiment conducted to find out the most water use efficient planting method of sugarcane recorded the highest rate of germination (55.3%), shoot count (204.2 thousand/ha at 180 DAP), number of millable canes (139.8 thousand/ha), cane yield (89.3 t/ha) and sugar yield (10.17 t/ha) under trench planting system in which irrigation was applied in deep trenches. The irrigation water use efficiency (IWUE) was also observed to be significantly highest (3541.6 kg cane/ha-cm) under this treatment followed by alternate skip furrow irrigation system. Paired row planting (120:30 cm) with irrigation applied in furrows parallel to single row system accrued 3149.2 kg cane/ha-cm. Tallest cane (240.3 cm) were observed in trench planting system, however thicker canes (2.78 cm) were produced under alternate skip furrow system. This system was closely followed by trench system of planting. The quality parameters were not affected by different planting methods (Table 3.1).

Deep tillage under different moisture regimes and N levels for modifying rhizospheric environment and improving sugarcane yield in plantation system

A field experiment conducted with three

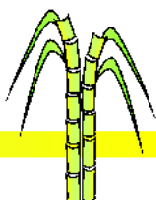
tillage practices (T_1 : Control- recommended harrowing and cultivator for field preparation, T_2 : Deep tillage through disc plough (depth 25-30 cm) before planting and T_3 : Deep tillage through disc plough (depth 25-30 cm) before planting and sub-soiling at 45-50 cm depth; two moisture regimes (M_1 : 0.5 and M_2 : 0.75 IW/CPE ratio) at 7.5 cm depth of irrigation water; and four N levels (0, 75, 150, 225 kg/ha) at initial soil fertility parameters like 0.30% organic carbon, 43.9 kg available N; 52.1 kg available P_2O_5 and 301.4 kg K_2O /ha revealed that deep tillage and sub-soiling before sugarcane planting increased number of millable canes (116500/ha), individual cane length (242.1 cm), cane diameter (2.22 cm) and individual cane weight (927 g) over the control. There was 11% increase in mean cane yield (96.4 t/ha) with deep tillage and sub-soiling over the conventional tillage practices. Optimum moisture regime (0.75 IW/CPE) significantly increased cane growth and yield attributes over suboptimal regime (0.5 IW/CPE). Application of nitrogen up to 150 kg/ha significantly increased growth, cane and sugar yields.

Effect of tillage and moisture interaction on cane yield showed that deep tillage (T_2) under suboptimal moisture level (M_1) increased cane yield (90.3 t/ha) significantly over T_1M_1 (76.57 t/ha-conventional tillage and suboptimal soil moisture regime). The highest cane yield (98.85 t/ha) was

Table 3.1 Growth and yield of sugarcane under different planting methods

Treatment	Germination (%)		Shoot count (000/ha)						Cane yield (t/ha)	CCS (t/ha)
	30 DAP	45 DAP	120 DAP	150 DAP	180 DAP	210 DAP	NMC			
PP-FID	32.7	41.2	140.32	153.2	160.2	140.2	112.8	73.25	8.22	
PP-FIS	33.2	42.3	146.21	153.2	155.6	120.3	106.2	74.32	8.50	
FP-FI	36.1	46.3	172.14	189.3	193.4	170.3	115.9	78.51	8.76	
FP-MFI	30.2	35.2	149.31	165.4	169.3	135.4	110.3	76.29	8.56	
FP-SFI	29.5	40.2	147.30	158.2	167.3	130.2	109.5	75.29	8.65	
FP-ASFI	29.2	39.2	150.31	158.2	163.1	132.1	110.3	72.20	8.26	
TP-TI	55.2	65.2	189.21	200.2	204.2	170.2	139.8	89.25	10.1	
FIRB-FI	49.0	58.2	160.30	172.3	181.3	132.1	113.2	76.37	8.93	
FP-FI	30.2	41.3	132.18	145.7	152.1	122.2	107.2	71.59	8.15	
PP-FI	30.1	42.1	135.30	146.2	150.3	126.3	106.5	72.14	8.29	
CD (5%)	7.52	8.54	11.29	14.28	16.24	15.34	10.28	4.62	0.41	

PP-FID: Paired row planting (120:30 cm) and irrigation in furrows parallel to both the cane rows (15 cm apart from sugarcane row); PP- FIS: Paired row planting (120:30 cm) and irrigation in furrows parallel to single row (15 cm apart from sugarcane row) of paired rows; FP-FI: Furrow planting at 75 cm row spacing and irrigation in furrows of the cane rows; FP-MFI: Furrow planting at 75 cm row spacing and irrigation in furrows opened in the middle of two cane rows; FP- SFI: Furrow planting at 75 cm row spacing and irrigation in skip furrows opened in the middle of two cane rows (skip furrow irrigation method); FP-ASFI: Furrow planting at 75 cm row spacing and irrigation in alternate skip furrows opened in the middle of two cane rows (alternate skip furrow irrigation method); TP - TI: Irrigation in deep trench- sugarcane planted at 120-30 cm; FIRB -FI: Irrigation in furrows - sugarcane planted under FIRB system; FP-F: Flood irrigation(conventional)-furrow planting (75 cm); PP-F: Flood irrigation (conventional)-paired row planting(120-30 cm)



obtained with deep tillage and sub-soiling under optimal moisture regime. Tillage and moisture interaction on water use efficiency (WUE) showed that deep tillage and sub-soiling operation conserved soil moisture for better crop growth. The highest WUE (250.53 kg cane/ha-mm) was obtained with deep tillage and sub-soiling under suboptimal moisture regime (0.5 IW/CPE).

Tillage techniques for improving soil health and increasing sugarcane yield in plant ratoon system

The experiment was initiated to assess the effect of primary tillage treatments before planting of sugarcane followed by sub-soiling up to depth

integrated weed management practices (atrazine 2 kg ai/ha (PE) followed by 2,4-D @1 kg ai/ha (post emergence) and one hoeing). Interaction between primary and secondary tillage (weed control measures) was found significant on cane yield. The highest cane yield (91.76 t/ha) was obtained with sub-soiling, disc ploughing and harrowing before planting and three manual hoeing as inter-cultural operations. There was mean increase of soil organic carbon and available nitrogen at harvest stage (0.36% SOC and 245.7 kg N/ha) as compared to initial contents. The highest SOC at the harvest was recorded where sugarcane planting was done through Sugarcane Cutter Planter due to minimum tillage which reduced oxidation of carbon.

Table 3.2 Interaction effect of tillage and weed management practices on sugarcane yield

Tillage/WM	Deep ploughing	Sub-soiling (45-50 cm), disc ploughing and harrowing	Direct planting through Sugarcane Cutter Planter	Farmers practice (control)	Mean
Three manual hoeing	83.86	91.76	77.40	81.40	83.61
*Integrated weed management	79.50	83.93	72.17	75.33	77.73
Mean	81.68	87.85	74.78	78.37	
CD (P=0.05)	T x WM: 5.10	T: 3.70	WM: 2.61		

*(Atrazine 2 kg ai/ha (pre- emergence) followed by 2,4, D 1 kg ai/ha (post-emergence) and one hoeing (90 DAP)

of 45-50 cm in combination with post planting tillage treatments/ hoeing and integrated weed management practices on input use efficiency and soil health in sugarcane (plant)-ratoon system. Initial level of soil fertility indicated that soil had 0.30% OC, 243.9 kg available N; 52.1 kg available P₂O₅ and 301.4 kg K₂O/ha. First year results on sugarcane plant crop revealed that deep tillage and sub-soiling followed by harrowing before sugarcane planting increased the number of millable canes (117200/ha), individual cane length (240 cm), cane diameter (2.27 cm) and individual cane weight (1163 g) over other treatments. There was 12% mean increase in sugarcane (87.85 t/ha) and sugar yields (11.25 t/ha) each with deep tillage and sub soiling over the farmers practice (Table 3.2). Sugarcane quality parameters did not show tangible differences. Direct planting through Sugarcane Cutter Planter yielded statistically at par with farmers practice and indicated the scope of cost reduction in initial field preparation.

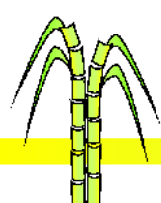
Weed management practices indicated that there were no significant differences among almost all the growth attributes of sugarcane and sugar yields between three manual hoeings and

Optimization of fertigation schedule in drip irrigated sugarcane

Sugarcane ratoon crop was irrigated as per the following treatments:

- (i) I₁: Drip fertigation at 2 days interval with irrigation water equal to 0.6 E_{pan}
- (ii) I₂: Drip fertigation at 2 days interval with irrigation water equal to 0.8 E_{pan}
- (iii) I₃: Drip fertigation at 2 days interval with irrigation water equal to 1.0 E_{pan}
- (iv) I₄: Drip fertigation at 2 days interval with irrigation water equal to 1.2 E_{pan}
- (v) I₅: Conventional flood irrigation with 8 cm irrigation water at 1.00 IW/CPE ratio

It was observed that fertigation and irrigation treatments significantly influenced crop yield and irrigation water use efficiency. Cane yield and IWUE were significantly influenced by irrigation treatments (Fig. 3.1). The highest cane yield of 68.39 t/ha was recorded when fertigation was scheduled at 1.00 E_{pan}. At this fertigation scheduling, irrigation



water use efficiency (IWUE) was 777.16 kg/ha-cm. The lowest cane yield (58.25 t/ha) was obtained in surface irrigation treatment with 661.93 kg/ha-cm IWUE. The highest IWUE of 1126.33 kg/ha-cm was recorded when fertigation was scheduled at 0.6 E_{pan} . At this IWUE, cane yield was 59.47 t/ha.

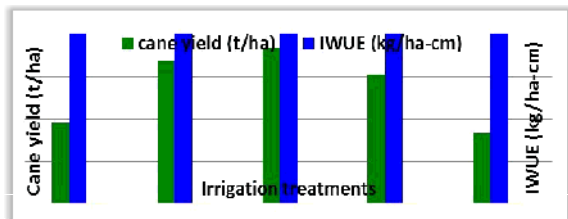


Fig 3.1 Effect of irrigation treatments on cane yield and irrigation water use efficiency of ratoon crop

Optimization of fertigation schedule for sugarcane through sub-surface micro-irrigation technique under different agro-climatic conditions

Highest sugarcane yield of 80.57 t/ha and irrigation water use efficiency of 1526.02 kg/ha-cm was observed when fertigation was done and the amount of irrigation water was kept as 100 per cent of pan evaporation. The sugarcane yield and IWUE was not influenced significantly by doses of nitrogen in fertigation treatments. With surface irrigation, the mean sugarcane yield and IWUE were 66.35 t/ha and 754 kg/ha-cm, respectively. However sugarcane yield (63.06 t/ha) and IWUE (716.54 kg/ha-cm) were significantly lower when nitrogen dose was reduced to 50 per cent of recommended dose (Table 3.3 and 3.4)

Table 3.3 Effect of irrigation treatments and nitrogen doses on sugarcane yield (t/ha)

Irrigation treatment	100% recommended dose of N	75% recommended dose of N	50% recommended dose of N	Average
SSD at 75% PE	76.43	75.31	73.76	75.17
SSD at 100% PE	80.89	79.75	81.08	80.57
SSD at 125% PE	76.47	73.67	74.18	74.78
Average for drip	77.93	76.24	76.34	
Surface irrigation	69.08	66.92	63.06	66.35

Table 3.4 Effect of irrigation treatments and nitrogen doses on irrigation water use efficiency (kg/ha-cm)

Irrigation treatment	100% recommended dose of N	75% recommended dose of N	50% recommended dose of N	Average
SSD at 75% PE	1447.60	1426.24	1396.99	1423.61
SSD at 100% PE	1531.99	1510.42	1535.67	1526.02
SSD at 125% PE	1448.34	1395.31	1404.99	1416.21
Average for drip	1475.98	1443.99	1445.88	
Surface irrigation	785.04	760.42	716.54	754.00

Enhancing water and nutrients use efficiency through drip irrigation and fertigation in spring planted sugarcane

The highest sugarcane yield of 88.78 t/ha was observed in ring-pit planting with drip fertigation. The irrigation water use efficiency was also highest (1321.15 kg/ha-cm) for this treatment. Sugarcane yield and irrigation water use efficiency was also higher and comparable with ring-pit planting in those treatments in which planting was done in paired rows in pairs of 60 x 120 cm and 40 x 110 cm.

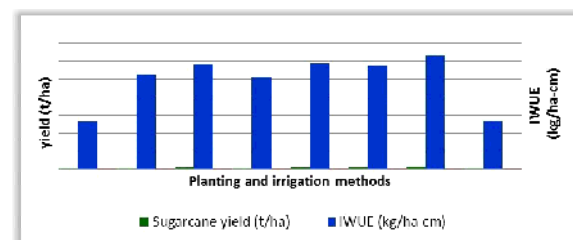
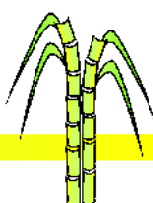


Fig 3.2 Effect of irrigation treatments on cane yield and irrigation water use efficiency

Response of sugarcane crop to different plant nutrients in varied agro-ecological situations

Field experiment was initiated during April 2012, to study the response of sugarcane to different nutrients. Twelve nutrient treatments in RBD having three replications with sugarcane (cv. CoSe 92423) was planted. The recommended fertilizer dose was 150 kg N, 60 kg P₂O₅ and 60 kg K₂O/ha. The other nutrient 40 kg S, 25 kg ZnSO₄, 10 kg FeSO₄ and 5 kg



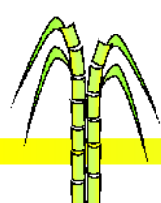
MnSO₄ /ha were applied as per the treatment.

Initially soil was low in organic carbon (0.44%), available nitrogen (236.8 kg/ha), phosphorus (18.39 kg P₂O₅/ha) and medium in potassium (285.91 kg K₂O/ha) contents. Germination, shoot population and number of millable canes (NMC) were not affected by various nutrients applied. Cane yield was influenced significantly by various nutrient management treatments. Highest cane yield (75.56 t/ha) was recorded with treatment T₁₀ (NPK+S+Zn+Fe) followed by the treatment T₆ (NPK+Zn) with cane yield (72.77 t/ha) and T₉ (NPK+S+Zn), cane yield (70.35 t/ha). Lowest cane yield was recorded with control plot (52.69 t/ha). The initial lower soil organic carbon content and available nitrogen, phosphorus and medium potassium nutrients affected cane yield in treatments, where nutrient were applied alone (N or NP or NPK) as compared to in combination of NPK with other nutrient like S, Zn, Fe and Mn. Cane quality parameters were not affected by any of the nutrients applied.

Table 3.5 Growth and cane yield parameters of sugarcane

Treatment	Germination (%)	Shoot count ('000/ha)		NMC ('000 /ha)	Cane yield (t/ha)
		90 DAP	120 DAP		
T ₁ Control	44.9	139.9	110.9	77.4	52.69
T ₂ N	39.9	128.3	113.2	80.3	61.16
T ₃ NP	33.7	108.7	105.3	73.8	58.39
T ₄ NPK	40.4	119.1	107.0	83.9	58.40
T ₅ NPKS	33.5	107.8	103.3	78.1	65.33
T ₆ NPKZn	37.6	107.8	97.9	76.7	72.77
T ₇ NPKFe	37.7	131.2	107.5	76.8	62.19
T ₈ NPKMn	32.6	108.2	102.0	81.2	60.99
T ₉ NPKSZn	35.4	117.9	103.3	78.3	70.35
T ₁₀ NPKSZnFe	28.8	100.2	92.6	72.2	75.56
T ₁₁ NPKSZnFeMn	35.9	108.3	98.3	69.9	63.62
T ₁₂ FYM 20 t/ha	36.9	110.9	99.8	78.6	67.36
CD (5%)	NS	NS	NS	NS	12.51

DAP: Days after planting





Ratoon management

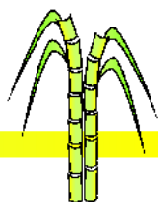
An integral component of sugarcane farming, ratooning ensures the overall profitability of sugarcane production system. Research to devise integrated nutrient management module for raising of multi-ratoons led to the identification of combined use of bio-manures and bio-fertilizers for sustainable multi-ratooning. The practice also accrued positive effects on soil microbial enrichment and nutrient availability.

Effect of bio-manuring on sugarcane productivity and soil properties under plant and subsequent ratoons

Field experiment was started in spring 2003 with the objectives to evaluate the efficacy of different bio-manures on yield and quality of sugarcane under plant and subsequent ratoons and to study the changes in physical, chemical and biological properties of soil on long term basis. Ratooning induced effects in rhizospheric environment were assessed at monthly intervals under 12 treatments in the ninth ratoon crop. The amount of total carbohydrates varied at different stages of growth in all treatments however the magnitude of carbohydrate fractions were about twofold greater in the control and NPK treated plots during the grand growth phase. Decomposition of roots were substantially higher with treatments T₅ (sulphitaion press mud 10 t/ha), T₆ (sugarcane trash compost (10 t/ha) + *Gluconoacetobacter diazotrophicus* Gd) and T₉ (sulphitaion press mud 10 t/ha + *Gluconoacetobacter diazotrophicus*) as indicated by root biomass cellulosic, hemi-cellulosic, total lignin, acid insoluble and acid soluble lignin contents. The root biomass carbohydrate composition turned increasingly more recalcitrant in control and NPK treated plots. A strong negative correlation occurred between total lignin, acid insoluble lignin, acid soluble lignin, phenols, anilides and soil enzymes (dehydrogenase, alkaline and acid phosphatase and aryl sulphatase) in control and NPK treated plots during the grand growth phase. However in plots with treatments T₅, T₆ and T₉, 1.6-2.3 fold increase in dehydrogenase, 1.2-1.9 fold increase in aryl sulphatase and 1.4 fold increase in acid phosphates activities led to about 65 and 79 % decline in phenol and anilide contents during the grand growth phase. A strong positive correlation

existed in root cation exchange capacity and the mentioned soil enzymatic activities. A decline in range of 65-73 % was observed in the root cation exchange capacities of control and NPK treated plots in comparison to T₅, T₆ and T₉ treatments. Overall, the bio-manuring led to improvement in the root cation exchange capacities and increase in the root biomass compositional decomposition. The compositional decomposition was also found to be in high order with treatment T₁₁ (*Dhaicha* + Gd) where cellulosic, hemi-cellulose, total lignin, phenol and anilide contents were about 1.8, 1.6, 1.9, 1.7 and 1.5 folds lesser than control plots, respectively. The rhizospheric alterations involving breakdown of chemical recalcitrance in the bio-manured plots as compared to control and NPK plots during the grand growth phase might thus be responsible for hastening the root decomposition and influencing the available nutrient pool positively rendering their greater availability to the plants.

The highest cane yield of 9th ratoon (54.00 t/ha) was recorded with SPMC + *Gluconoacetobacter* against the planted cane yield of 77.5 t/ha and 1st ratoon yield of 80.8 t/ha. This was followed by SPMC (53.20 t/ha) and FYM + *Gluconoacetobacter* (51.30 t/ha). The growth and yield attributing characters viz., dry matter production, and number of millable canes, cane length, cane thickness and weight also exhibited similar trend. Juice quality including brix and sucrose (%) did not differ significantly. Soil organic carbon ranged from 0.66 to 0.72 under different biomanuring treatments over its initial value of 0.32%. Soil microbial activities enhanced due to different bio-manurial treatments. The highest value of soil microbial biomass carbon (SMB-C) of 235.50 mg CO₂-C/kg soil/day was recorded under plots receiving trash compost + *Gluconoacetobacter* against initial value of 47.60 mg CO₂-C/kg soil/day.





Mechanization of sugarcane farming

Machines play an important role in agrarian life. Availability of labourers has become a costly affair in each and every sector but its impact is significant in agriculture and more precisely in sugarcane cultivation, where the requirement of labourers is distributed through-out the year. Since its establishment 60 years back, Institute has led the development of sugarcane based machinery and implements in India. Sugarcane machinery such as Wide spaced paired row planter, Residue mulcher-cum-bioapplicator, Sugarcane manager, Trencher and Trench planter were developed and demonstrated at the Farm and Farmers' fields.

Development of a wide spaced paired row sugarcane cutter planter

Prototype of tractor operated paired row planter was developed during 2008-09 and 2009-10 for planting of single pair of sugarcane at a row spacing of 30 cm. The spacing between the subsequent pairs could be adjusted by maintaining the spacing for tractor tyre. The large scale field testing was conducted at IISR farm and at farmer's fields of Sitapur district (Fig 5.1) during 2012-13. The effective field capacity of the planter was 0.2 ha/h. Prototype of interculturing equipment with sweep shovels was also developed and field tested at IISR farm for paired row planted cane crop (Fig 5.2). The effective field capacity of the equipment was 0.35-0.40 ha/h. Prototype of IISR front mounted sugarcane harvester, with certain modification in cutting mechanism was field tested at IISR farm for harvesting of wide spaced paired rows of cane.

Development of tractor operated sugarcane harvester for small farms

The power transmission, cutting blades and crop gathering units of IISR tractor operated front



Fig 5.1 IISR tractor operated paired row sugarcane planter in field operation at Sitapur



Fig 5.2 Tractor operated interculturing equipment in field operation in wide spaced paired row (30:120 cm) cane crop

mounted sugarcane harvester were modified (Fig 5.3). The double sprockets were replaced with triple sprockets for strengthening the power transmission from tractor power take off (PTO) shaft to the mild steel shaft. Cutting blades were replaced with serrated disc blades and diameter was increased to facilitate harvesting of wide spaced paired row crop as well as 75/90 cm spaced crop. The height of crop gathering unit was increased and rotary augers were redesigned to handle taller cane stalks effectively. The limited field trials at IISR farm revealed improved basal cutting of cane stalks with the serrated disc blades. The problem of dynamic instability under actual field operations needed to be addressed before taking up the larger trials.

Design refinement of tractor operated sugarcane-cum-potato planter

The prototype of IISR sugarcane-cum-potato planter was tested. The potato seed metering

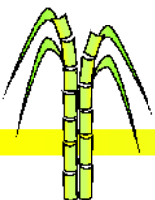




Fig 5.3 Modified tractor operated front mounted sugarcane harvester

mechanism of this prototype worked satisfactorily for whole potato seeds but metering of cut potato seeds were not proper and bridging of cut potato seeds was observed in the seed hopper. Cell type metering mechanism both in direct and vertical were designed, fabricated and tested. This metering mechanism also resulted in gaps. Seed hopper and metering mechanisms are again being re-designed to meter the cut potato seed.

Design and development of residue mulcher-cum-bio applicator

The machine has been designed and developed basically for chopping of dry sugarcane trash in between two rows of sugarcane spaced at 75/90 cm. A PVC pipe for storage of liquid solution and spraying over chopped trash to hasten decomposition process has been provided. Spraying is done through holes on tube, provided over each chopping gangs, through gravitational pressure. The developed machine has two rotary gangs to operate in two inter-row spaces of sugarcane. These operating paths are staggered (one row missing in between) due to operational requirement of tractor. This machine can be used for chopping of dry trash of sugarcane and spraying liquid solution over the chopped trash. Width of each chopping gang is 35 cm. By replacing the 'T' shaped blades with 'L' shaped blades, it can be used for inter-cultural operation in between two rows of sugarcane and strip tilling for sugarcane planting. Trials at Institute farm were satisfactory.

Development of tractor operated sugarcane manager

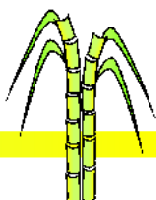
Two models of tractor operated sugarcane manager have been developed. The first model has

been developed to carry out inter-cultural operation by using blade shovels to conserve soil moisture, band placement of fertilizer on both side of rows and earthing-up operation by using furrowers. These furrowers can be used for opening of furrows for cane planting as well. The second model is simple equipment for carrying out inter-cultural operation by using sweep shovels and earthing-up operation by using furrowers. The first model was tested at IISR farm for inter-culture purpose and applying fertilizer on both sides of cane rows at a depth of 12-15 cm. The blade shovels (2 each in inter-row spacing) cut the soil along with weeds about 10 cm deep without disturbing much the top soil. This works as soil mulch. Inter row spacing of blade shovels can be adjusted depending on the row spacing of crop. This equipment covers three rows at a time. Presently, it is under trial in Shamli and Unn Sugar Mill areas. The second model was also tested at IISR farm and worked satisfactorily. Two tynes with sweep shovel are placed in each inter row spacings. This equipment also covers three rows at a time. This model was under farmers' field trial in Barabanki district.

Exploratory trials

Development of tractor operated trencher and trench planter for paired row sugarcane planting

The trench planting of sugarcane is becoming popular particularly in Tarai region and Central UP. This method facilitates furrow irrigation and has potential to save irrigation water. Due to deep planting and subsequent earthing up, the problem of lodging of cane is minimized in this method. Problem with commercially available trenchers is that they do not penetrate deeper than 15 cm as their design is based on the opening of furrows by removing the tilled soil and depth of ploughing generally is not more than 15 cm. They can not



penetrate beyond the depth of ploughing. Now cane growers are preferring the paired row planting (two row parallel to each other at a spacing of 30 cm) rather than the ladder arrangement of seed setts (placement of seed setts transversely to the direction of furrow at 30 cm spacing). In view of the above, a tractor operated trencher and a trench planter (two separate prototypes) have been developed. The trencher could be used for making two rows of 25-30 cm deep furrows at a spacing of 30 cm, to facilitate planting of cane in paired rows at a recommended depth for trench method of planting. The furrow opening unit is equipped with two mould board ploughs (width of cut of share is 10 cm) spaced at 30 cm and curvature of mould board is specially designed and extended to prevent fall back of cut loose soil in the furrows. The spacing between the paired row could be increased to 45 cm by increasing the spacing between the two mould board plough shares. Mould board plough share penetrates up to 30 cm depth for opening of furrows irrespective of the depth of ploughing. The prototype has been tested in the field. The performance was satisfactory. The other prototype i.e. Trench Planter perform the complete paired row sugarcane planting in trench furrow in a single pass of the tractor. The planter was tested at IISR farm as well as at farmers' field.

Development of tractor operated (PTO driven as well as ground wheel driven) customized sugarcane planter for tropical region

With the adoption of self propelled mechanical harvesters in southern and western parts of the country particularly Tamil Nadu, Karnataka, Andhra Pradesh and Maharashtra, the demand of sugarcane planters for planting of sugarcane at 120 and 150 cm spacing is increasing. For planting of cane at uniform spacing of 120 and 150 cm, IISR sugarcane planters (PTO shaft as well as lugged ground wheel driven) were redesigned and fabricated. All the sub-units of planters namely power transmission, furrow opening, sett cutting, fertilizer & chemical dispensing, and soil covering, was rigidly attached with the frame. The frame has been designed to adjust the row spacing by sliding in and out the shaft. For adjusting the row spacing different units of the planters need not to be adjusted, only by adjusting the frame through sliding in and out the shaft, the desired spacing is achieved. Furrow opening and power transmission sub-units have been developed and standardized, so that multiplication of prototypes and replacement of components could be done in case

of breakdown and wear and tear. The power transmission system has also been redesigned. In place of bevel gears (in earlier models of IISR sugarcane planters), worm and pinion has been used. This has simplified the power transmission and is cost effective.

Development of folding type Combo Light Trap

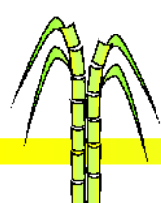
A light trap was available with the Division of Corp Protection. It is made of G.I. sheet. This trap consists of (i) top cone having 38 and 13 cm dia and length, respectively (ii) bottom reverse cone having 40 cm dia, (iii) water container cylinder (dia 16 cm and length 20 cm), (iv) 'Y' shaped baffle rigidly riveted with top cone and inverted bottom cone and (v) light bulb and hanging arrangements are part of top cone structure. The water container is flexibly attached with bottom cone. The diameter of trap is 40 cm and length is 54 cm excluding water container. A folding type combo trap has been developed by using aluminium sheet of 16 g. It has been developed in such a way that all the above mentioned components can be dismantled and assembled in half an hour. Templates, jig and fixtures and dies for pressing top cover and pressing baffle wings have been developed for mass production and true type prototypes. This 'Y' shaped baffle is also folding type. Ten units were fabricated and supplied to Division of Crop Protection.

AICRP on FIM

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

Prototypes fabricated

Particular	Nos.
T.O. ratoon management device	03
T.O. PTO driven sugarcane planter for 1, 1.2 and 1.5 m row spacing	02
T.O. ground wheel driven sugarcane planter for 1.2 and 1.5 m row spacing	01
B.D. three tyne cultivator	01
Modification of 1 st model of ground wheel driven two row sugarcane planter	01
Modification of 1 st model of raised bed seeder cane planter	01
Light Trap	10
Light Trap Stand	08
Manual grass cutter (Jhabau)	10
Total	37



Prototypes supplied

Name of Equipment	Qty
T.O. sugarcane planter (three row)	2 Nos.
Gur moulding frame	1 Nos.
T.O. two row stubble shaver	1 No.
T.O. sugarcane planter for 1, 1.2 and 1.5 meter row spacing	1 No.
T.O. sugarcane planter	1 No.
T.O. raised bed seeder-cum-cane Planter	1 No.
BD three tyne cultivator	1 No.
T.O. PTO driven cane planter for 1, 1.2 & 1.5 m row spacing for tropical region	1 No.
T.O. ground wheel driven cane planter for 1.2 and 1.5 m spacing	1 No.
Total	11

Tools/gadgets fabricated

Name of the tool/ gadget	Quantity
Field Board	60
Display Board	05
Water Cooler stand (Auditorium)	01
Field Levels 12x6"	80
Field Levels 8x5"	60
Farm Layout Display Board	01
Display Board 4'x3'	03
Field Label 4"x6"	40
Field Label 5"x7"	03
Field Board 3x2"	09
Field Board	02
Iron door for Tubewell	01
Iron door (Col+Switch room)	02
Angle Iron Frame for space under stair case in Plant Protection	01
Total	272

Prototype feasibility testing of self propelled tangential axial flow (TAF) combine harvester

The CLASS TAF Combine Harvester (Fig 5.4) was tested at IISR farm for harvesting wheat and paddy crops. The machine worked very well in both the crops. It's capacity was found to be 0.4 ha/h and labour requirement of 3 man-h/ha.

Prototype feasibility testing of tractor operated three-row rotary weeder

It is used for weeding and inter-culturing of three rows of sugarcane crop spaced at 75 cm. The tractor operated rotary weeder was tested at IISR farm. This covers three inter row spacing in each pass. Width covered by each gang was 54 cm.



Fig 5.4 Self propelled tangential axial flow (TAF) combine harvester in operation

Weeds were completely uprooted in the covered area. Field capacity was 0.35-0.40 ha/h.

Front line demonstration of IISR tractor operated Ratoon Management Device

Used for stubble shaving, off-barring, interculturing (deep tilling), fertilizer as well as manure dispensing and earthing up in sugarcane ratoon crop. Front line demonstration of this equipment was conducted at farmer's fields in Sitapur district. Its field capacity was 0.3 ha/h. Labour required was 4 man-h/ha.

Front line demonstration of IISR Raised Bed Seeder (RBS)-cum-sugarcane planter

Equipment is used for planting sugarcane in furrows and drilling two rows of wheat on raised beds as companion crop. Front line demonstrations of this equipment were conducted at farmer's fields in district Bareilly. Equipment was also operated at IISR farm. It's field capacity was 0.2 ha/h and labour requirement was 20 man h/ha.

Front line demonstratio of IISR modified three row cane planter

Front line demonstrations of IISR tractor operated modified three row sugarcane planter was conducted at farmers fields in districts Muzaffarnagar and Raebareli. Effective field capacity of the planter was 0.25 ha/h. Cost of planting was reduced by 65% as compared to conventional method of planting.

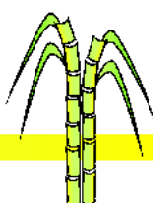
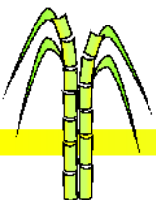




Fig 5.5 IISR tractor operated modified three row sugarcane planter in operation

Front line demonstration of IISR tractor operated paired row sugarcane planter

Front line demonstrations of IISR tractor operated paired row sugarcane planter was conducted at farmers' fields of Sitapur district and IISR farm. About 3 ha area was covered in Sitapur and 8 ha at IISR farm. Equipment is used to plant one pair of sugarcane at 30 cm row spacing. The row spacing between the subsequent pairs could be varied by maintaining the spacing between the tractor tyre and previously planted rows. At IISR farm cane was planted under 30:120 cm row geometry whereas, at farmers fields cane was planted under 30:90 cm row geometry. Farmers were satisfied with the performance of the equipment and were willing to use it in the next season also.





Management of pests and diseases

Effective control of pests and diseases forms an integral part of crop management. However, the indiscriminate use of hazardous chemicals for pest and disease control is fast becoming a threat for both the environment and human health. To counter this problem, it is imperative to develop effective eco-friendly disease and pest management strategies incorporating regular survey and surveillance for monitoring of pests and diseases in various regions, deployment of resistant varieties, enrichment of natural enemies, use of bio-control agents and other innovative approaches.

Survey and surveillance of insect-pests and diseases of sugarcane in sub-tropical area

Survey and surveillance remained a major activity of the Division during 2012-13 wherein factory command areas of various sugar mills of UP, Uttarakhand, Bihar and Maharashtra viz., DSCL group, Bajaj Hindustan group, Balrampur group, Birla group, Mawana group, Dhampur group and mills located at Titawi, Saharanpur, Laksar, Shahjahanpur, Simbhaoli, Seohara, Haridwar, Harinagar, Ahmednagar were surveyed. Due to delayed monsoon and prevailing high temperature, this year, higher incidences of early shoot borer and mealy bug were noticed in several sugarcane growing areas of western districts of Uttar Pradesh. Increasing incidence of GSD in most of the cane growing areas is causing concern.

In general, incidence of red rot was observed only on varieties like CoS 8432, CoS 8436, CoS 88230, CoS 91269, CoSe 95436, CoSe 95422, CoLk 8102 (1-2%) etc, which are in cultivation since long and occasionally in some fields higher incidence of red rot (>20%) was also observed.

Incidence of smut was observed in CoS 767, CoS 87264, CoS 98231, CoSe 92423, CoSe 96275, CoSe 01235, Co 0238 and Co 0239. Incidence of GSD was wide spread affecting most of the varieties, however the incidence was low (1-2%). Leaf scald was also noticed in Co 0238 and CoLk 8102. In some fields, the incidence of stinking rot (variety CoSe 92423) and Pokkah boeng (variety CoS 8436) was noticed especially in water logged condition.

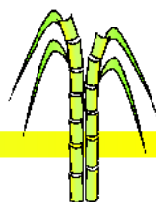
In general, this year incidence of insect-pests was low. However, incidences of early shoot borer (5-10%), top borer (1-15%), mealy bug (5-20%), termite (< 20%) were recorded in few fields. White grub damage (10-20%) was observed in certain pockets. White grub belonging to *Heteronychus* sp. and Plassey borer (5-7%) was specific problem in the command area of Harinagar Sugar Mill.

At Pravaranaagar, maximum incidence of shoot borer was recorded in the first fortnight of May along with the activity of its larval parasite *Sturmiopsis* sp. During August-September parasitisation of *Cotesia flavipes* was also observed.

Evaluation of zonal varieties for red rot, smut and wilt

Under North West Zone (at IISR Farm, Lucknow), 43 AICRP(S) entries were evaluated against red rot, smut and natural incidence of wilt. Nine genotypes viz., Co 07023, CoH 07261, CoH 08263, CoH 09261, CoH 09263, CoLk 07203, CoPb 08217, CoPb 09181 and CoPb 09211 were moderately to highly susceptible (MS to HS) and remaining 34 were resistant to moderately resistant (R to MR) to red rot. Out of 43 genotypes evaluated, 10 genotypes viz., Co 07023, Co 09022, CoPb 07264, CoH 09261, CoH 09263, CoLk 09203, CoPb 09181, CoPb 09214, CoS 07232 and CoS 08235 were susceptible (S) and rest 33 were resistant (R) to smut.

Natural incidence of wilt was noticed in seven genotypes viz., Co 09021, CoH 09263, CoPb 08211, CoPb 08212, CoPb 08217, CoPb 09181 and CoPb 09214. Grassy shoot disease (GSD) was also observed in four genotypes viz., CoH 09263, CoPb 09211, CoS 08234 and CoS 08235.



Under North Central Zone (IISR RC, Motipur), 12 genotypes were screened against red rot (pathotypes Cf 07 and Cf 08). All the genotypes were moderately resistant (MR) to both the pathotypes except CoSe 09452 which showed susceptibility to pathotype Cf 07 and moderately resistant (MR) reaction to Cf 08.

Evaluation/screening of sugarcane germplasm / genotypes against red rot and smut

Standing canes were inoculated using standard plug method during August for red rot evaluation. Of the sixty-one genotypes tested against red rot, 28 selections/genotypes viz., A-46-6, AB-9, AB-33, II-4-4, III-74-10, IV-41-1, IV-43-7, IV-46-2, IV-64-10, V-6-8, V-9-2, V-29-9, V-29-10, LG 07787, LG 08704, LG 08707, LG 08709, LG 08716, LG 08730, LG 08752, LG 08756, LG 09003, LG 09028, LG 09084, LG 09085, LG 09099, LG 09100 and LG 09113 were susceptible (S) and 33 selections viz. A-47-11, B-26-6, C-11-8, I-64-5, II-23-3, II-26-5, II-35-5, II-71-4, II-75-4, III-1-3, III-51-3, III-72-7, IV-39-1, IV-45-9, IV-8-3, LG 06599, LG 08702, LG 08759, LG 09023, LG 09042, LG 09062, LG 09066, LG 09067, LG 09068, LG 09069, LG 09070, LG 09071, LG 09072, LG 09074, LG 09083, LG 09091, LG 09092, LG 09110 were resistant (R) to red rot.

For evaluation against smut, sett dip inoculation was carried out at planting. Twenty seven genotypes viz., A-46-6, A-47-11, I-64-5, II-26-5, II-4-4, II-35-5, II-51-3, II-71-4, III-72-7, III-74-10, IV-39-1, V-6-8, V-9-2, IV-64-10, V-29-10, LG 07787, LG 08702, LG 08704, LG 08759, LG 09023, LG 09062, LG 09066, LG 09067, LG 09069, LG 09070, LG 09092 and LG 09113 were susceptible (S) and 34 selections were resistant (R) to smut.

Three genotypes viz., LG 08702, LG 08709 and LG 09074 showed natural incidence of wilt.

Identification of pathotypes in red rot pathogen

This year 11 new isolates *i.e.* six from CoLk 8102 (IR-38, IR-39, IR-40, IR-41, IR-42 and IR-47), four from CoS 8436 (IR-43, IR-44, IR 45 and IR 46); one from CoLk 07203 (IR-37); and three known pathotypes of North West Zone (Cf 01, Cf 08 and Cf 09) along with an isolate (CoS 8436) received from Shahjahanpur were evaluated for their virulence pattern on 14 designated sugarcane

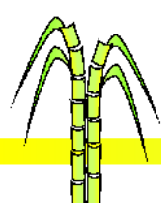
differentials viz., Co 419, Co 975, Co 997, Co 1148, Co 7717, Co 62399, CoC 671, CoJ 64, CoS 767, CoS 8436, BO 91, Khakai (*S. sinense*), Baragua (*S. officinarum*) and SES-594 (*S. spontaneum*) using standard plug method of inoculation. Inoculations were carried out in August and observation was recorded after two months. All the test pathotypes and eleven new isolates resulted in similar disease reaction. This year, no new virulent pathotype was observed in this zone.

Mass multiplication of *Trichoderma* on cheaper substrates and development of suitable delivery system for disease management in sugarcane

In the field experiment conducted to observe the bio-efficacy of *Trichoderma harzianum* multiplied culture developed on press mud (20 kg *Trichoderma* culture mixed with 20 kg pressmud) on four red rot susceptible sugarcane varieties (Co 1148, CoS 767, CoJ 64 & CoLk 8102), no significant effect was observed on the performance of the varieties in comparison to control. *In vitro* evaluation of different sugarcane waste/residue and other materials like cereal grains, groundnut shell, fallen tree leaves, wheat bran and farm yard manure etc. were carried out for multiplication of *T. harzianum*. Sugarcane bagasse, sorghum grains and molasses were found promising substrates for multiplication of *T. harzianum*.

Enhancing efficacy of *Trichoderma* based red rot management system

A total of seventy-two *Trichoderma* isolates were established from sugarcane rhizosphere soil collected from different geographical locations (Lucknow, Deoband, Gola, Palia, Gajraula and Motipur) of sub-tropical India. Average recovery of *Trichoderma* from different locations ranged between 2.6×10^3 to 5.2×10^3 cfu/g air-dried soil. These isolates were purified and characterized for colony characters including growth rates at different temperatures (25°C, 30°C, 35°C & 40°C) using potato dextrose agar medium. The results revealed considerable variability in *Trichoderma* isolates from different sugarcane agro-ecosystems. In growth studies, it was observed that for 56 isolates, the optimum growth temperature was around 30°C, for 14 isolates it was around 25°C, while for two isolates it was around 35°C. Presence of a yellow diffusing pigment in agar medium was



recorded in 36 out of the 72 isolates and yellow conidia were observed in 38 isolates. In 55 isolates, green conidia were observed between 48 to 72 h, while in four isolates green conidia were visible within 48 h and in rest 13 isolates conidia were visible after 72 h.

Ten selected *Trichoderma* isolates were further screened (*in vitro*) for their antagonistic activity against *C. falcatum* using culture filtrate screening method. Culture filtrates of nine isolates showed significant inhibition in pathogen growth relative to control. Among the 10 isolates, two isolates exhibited more than 40% inhibition in *C. falcatum* growth, five isolates showed inhibition in the range of 20-40%, while three isolates showed less than 18% inhibition. The highest inhibition was recorded by culture filtrate of isolate STR-52 (67.0%) followed by STR-40 (40.1%). A field experiment was also carried out with Co 1148 to evaluate the systemic resistance inducing potential of selected *Trichoderma* isolates. The isolates were applied twice; as sett treatment (10^6 spores/ml) at the time of planting and as soil application (@ 2 kg *Trichoderma* mixed culture/ 100 m row) one week before challenge inoculation of *C. falcatum* using the plug method. However, none of the isolates was found effective to the desired level in checking red rot.

Management of red rot through modulating host resistance

Effect of four macronutrients i.e., N @ 150 kg/ha, P_2O_5 @ 60 kg/ha, K_2O @ 60 kg/ha and S @ 40 kg/ha and four micronutrients viz., Mn ($MnSO_4$) @ 25 kg/ha, Zn ($ZnSO_4$) @ 25 kg/ha, Fe ($FeSO_4$) @ 25 kg/ha and Cu ($CuSO_4$) @ 2 kg/ha was studied on red rot development in variety CoLk 7701. There was no significant difference among the treatments with respect to red rot development.

Higher contents of total phenols, PPO and peroxidase activity in resistant genotypes (SES 594, Khakai, BO 91 and CoLk 94184) was noticed as compared to susceptible genotypes (Co 1148, CoJ 64, CoS 8436 and CoLk 7701). Total RNA was isolated at different time intervals from healthy and red rot inoculated stalk tissues of sugarcane genotypes. Data indicated that there is a possible role of chitinase and β 1,3-glucanase genes in conferring red rot resistance in sugarcane as the banding pattern confirmed differential expression of these PR proteins after development of disease

and the intensity of these proteins increased with time. The induction of these proteins in resistant genotypes was in accordance with the difference in gene expression as observed at different time intervals.

Pathotype formation in *Colletotrichum falcatum* in relation to breakdown of resistance in cane genotype

During August, Cf 01 (isolated from Co 1148) was inoculated on the differentials and after three weeks, reisolation was done. Reisolates were again inoculated in the respective host differentials. Six sporulating variant cultures of Cf 01 were established after next round of isolation. These cultures were multiplied on liquid medium and were used for molecular analysis. It was observed that host did influence the virulence behaviour of the reisolates. Host acted as a selective medium to select out any virulence that is capable of breaching the resistance. It was observed that in the reisolates variations also occurred at DNA level.

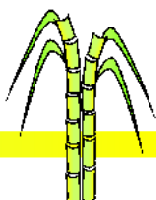
Management of red rot through fungal endophytes in sugarcane

Fungal endophytes were isolated from different upper ground portion and roots of sugarcane plant. The recovered endophytes represented the genera of *Trichoderma*, *Aspergillus*, *Chaetomium*, *Fusarium*, *Penicillium*. The most dominant endophytes were species of *Trichoderma*, *Aspergillus* and *Fusarium*. In dual culture array *Trichoderma* isolated from roots showed less inhibition (60%) of red rot pathogen as compared to *Trichoderma* isolated from leaves (68.84%). *Aspergillus* isolated from leaves and roots showed no significant difference in inhibition percentage.

Selected strains of *Trichoderma* and *Aspergillus* were further evaluated for the release of antifungal volatile substances/ metabolites against *C. falcatum*. All the *Trichoderma* isolates (leaves and roots) inhibited the mycelial growth of red rot pathogen by 30.0 - 62.2%, while the inhibition varied from 40.3 - 56.3% in case *Aspergillus* isolates.

Semio-chemicals for the management of sugarcane top borer

In insects, attraction to food is governed by kairomones. The chemical cues released by the host insects are sensed by the parasites and predators.



To increase the chemical cues, field collected top borer larvae were crushed in water and applied (1000 larvae/ha) as foliar spray in standing sugarcane crop in June. Incidence of top borer (IV brood) in treated plots of CoJ 64, CoLk 8102 and Co 0238 was 11.82, 13.14 and 14.93%, respectively, while incidence in untreated plots was 12.99, 16.62 and 22.93%, respectively. Parasitisation of *Rhaconotus* on IV brood larvae in treated plots of these varieties was 4.28, 5.55 and 5.45%, respectively while it was 4.00, 4.28 and 4.00%, respectively in untreated plots.

Mechanism of resistance against top borer in sugarcane

In nine varieties viz., CoS 94257, CoSe 92423, CoPant 97222, CoS 96268, CoS 767, Co 0238, CoLk 94184, CoJ 64 and CoLk 8102 incidence of top borer was ensured by natural and artificial means in all the plots under this experiment. On the basis of top borer incidence, four varieties viz., CoLk 8102, Co 0238, CoJ 64 and CoLk 94184 were graded as highly susceptible while CoS 94257, CoS 767, CoPant 97222, CoS 96268 and CoSe 92423 were graded as less susceptible.

Observations were taken on morphological characters such as length, breadth, inclination, hairiness of leaf, thickness and hardness of midrib, leaf sheath thickness and girth, height of plant and biochemical characters such as polyphenol oxidase activity, phenol content, reducing sugar at the initiation of 3rd generation of top borer. Amongst all the morphological characters recorded, leaf width showed a significant positive correlation ($r=0.729$) with top borer incidence. Similarly, the top borer incidence was highly influenced by midrib thickness and plant height. Both midrib thickness ($r=-0.750$) and plant height ($r=-0.583$) had negative correlation with the top borer incidence in different genotypes of sugarcane. Preliminary study on biochemical analysis showed that Poly Phenol Oxidase (PPO) activity and phenol content was high and reducing sugar content was low in less susceptible varieties.

Bio-intensive management of white grub in sugarcane

The technology of white grub beetle management through IISR-combo insect trap and grub management through timely application of selective insecticides was demonstrated in eight

sugar mills of UP and three sugar mills of Maharashtra. The newly developed insect trap was further modified by addition of top borer pheromone dispenser along with the white grub pheromone. The modified trap was found to attract top borer moths also in addition to white grub beetles. *Holotrichia consanguinea* was recorded as major species, while *Anomala* sp.; *Anomala dimidiata*, *Apogonia* sp.; *Holotrichia* sp.; *Onthophagus* sp.; *O. calta*; *Schizonycha ruficollis*; and several unidentified species were of minor importance in western Uttar Pradesh. Mass emergence of *H. consanguinea* beetle was recorded from 2nd week of May to last week of June. Beetle emergence almost ceased by 3rd week of July. *Heteronychus* sp. was recorded as major species in certain pockets of West Champaran district of Bihar.

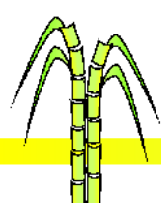
Testing of newly developed trap was done in command area of Triveni Engineering & Industries Ltd., Sugar Unit: Deoband, Saharanpur. The IISR combo insect trap was found highly effective in trapping predominant species *H. consanguinea* along with other species of white grubs. In the command area of the mill, 767 combo traps were installed in 130 villages, which could trap 3,82,505 beetles.

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

In a crop with 28.19% germination, the termite incidence on sett and shoot basis was 37.5 and 5.56%, respectively. Incidence of pink borer at shoot stage was 8.6%. Incidence of top borer II, III and IV brood was 6.16, 16.00 and 11.38%, respectively. Incidence of root borer at shoot stage was low but increased in September. Two parasites, *Stenobracon* sp., *Rhaconotus* sp. and predatory fauna comprising of Coccinellids, spiders and ants were noticed.

Development of technique of mass multiplication of larval parasitoid for management of sugarcane top borer

The top borer damaged shoots collected from field and stored in refrigerator were used for the multiplication of parasitoids. Sugarcane stalk pieces (3-4 inches) split longitudinally into two equal halves with a central tunnel were made. One or two vertical holes (1.5 mm in dia.) are drilled from the rind towards the tunnel. Stored top borer larvae were placed in these tunnels (one per tunnel). To prevent the escape of larvae, the stalk pieces



were wrapped with Parafilm. These were kept in glass jars (4x4 inches) with muslin covering. In each jar either one pair of *Isotima javensis* or one pair of *Rhaconotus scirpophagae* (after 24 hr emergence) were placed. Honey solution was provided in cotton swabs as food for adult parasitoids. Rice grain moth larvae (*Corcyra*) were taken as control. The parasitized top borer larvae were carefully removed by a fine camel-hair brush to a cavity block (with water soaked sponge) and kept in BOD incubator for development of parasites.

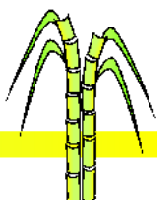
The parasitisation of top borer larvae by *Isotima javensis* and *Rhaconotus scirpophagae* was 22 and 29%, respectively as compared to *Corcyra* larvae (no parasitisation). The female biased sex ratio was observed in *Rhaconotus* whereas male biased ratio was observed in *Isotima*.

Containment of major insect-pests of sugarcane through habitat modifications

To contain the insect pests through habitat modifications, crops grown in the sugarcane agro-ecosystem like mustard, coriander, gram, marigold, tomato, brinjal, jowar, bajra, maize were taken to study the push-pull effect. The incidence of top

borer (I and II brood) ranged from 5.65-15.11% and 4.34-7.09% along with various trap crops, whereas it ranged from 10.79 to 19.24 % in control. The minimum incidence of I brood was observed in plots along with marigold (6.88%), coriander (8.96%), brinjal (12.77%) and tomato (15.11%). However lower incidence of II brood (4.34%) was observed with marigold. The minimum incidence of III brood (8.02%) was observed in plots along with brinjal in comparison to control (12.29%). The incidence of top borer (IV brood) ranged from 12.34 to 13.39% in plots along with jowar, brinjal, bajra and tomato as compared to 18.75% in control.

The maximum parasitisation (30%) of top borer larvae (III brood) by *Isotima javensis*, *Rhaconotus scirpophagae* and *Stenobracon nicevillei* was obtained along plots of bajra, mustard and sorghum, whereas minimum parasitisation was observed along with the plots of tomato and brinjal (18%). The incidence of internode borer ranged from 21.48 to 35.11% and minimum incidence was observed in plots along with jowar and brinjal. The maximum parasitisation (20%) of internode larvae by *Cotesia flavipes* was observed in plots along with jowar, tomato and bajra.





Physiology, Biochemistry and Biotechnology

Improving physiological efficiency and increasing sucrose content in sugarcane is a major challenge faced by sugarcane researchers today. Besides, varietal breeding, successful application of basic and fundamental approaches like transcriptomics, genomics and proteomics can serve as an effective tool to address this problem. Modulating expression of various genes through exogenous application of novel molecules and minimizing post harvest sucrose deterioration is the need of the hour.

Modulating the expression of sucrose metabolizing enzymes for high sugar accumulation in sugarcane

Foliar application of enzyme effectors; Mg, Mn, B, Mg + Mn (soil application), a mixture of Mg + Mn and ethrel was performed along with water treated control using a mid-late maturing variety BO 91 in the month of Dec, 2012. Cane juice analysis after 15 days, showed increased sucrose content in cane stalk by 1.01 (Mg), 0.93 (Mn), 1.05 (boron), 0.99 (Mg + Mn), 1.52 (Mg + Mn soil application), 2.53 (Mg + Mn + ethrel) and 1.28 per cent (ethrel), respectively than control.

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

Utilizing primer pairs developed based on known sequences of SAI gene, the very first nucleotide sequence for *Saccharum spontaneum* SES34 (Gene accession no.: KC570328) was deduced. Additionally, the SAI gene sequence for sugarcane variety CoJ 64 and for *Saccharum officinarum* 28NG210 (Gene accession nos.: KC570326 and KC570327, respectively) were also determined.

Utilising 246,180 *Saccharum officinarum* EST sequences *vis-à-vis* its comparative analysis with ESTs of sorghum and barley and the whole rice genome sequence, 3425 novel gene-tagged markers—namely, conserved-intron scanning primers (CISP)—using the web program GeMprospector were developed. Rice orthologue annotation results indicated homology of 1096 sequences with expressed proteins, 491 with hypothetical proteins.

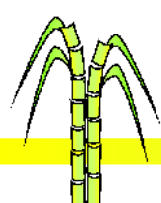
The remaining 1838 were miscellaneous in nature. A total of 367 primer-pairs were tested in diverse panel of samples. The data indicate amplification of 41 % polymorphic bands leading to 0.52 PIC and 3.50 MI with a set of sugarcane varieties and *Saccharum* species. Developed gene-tagged CISP markers exhibited considerable technical functionality with varieties of sugarcane. Also many of the genes associated with sucrose metabolism and photosynthesis were used in development of these functional markers to study the process associated with these traits.

Minimizing post harvest sucrose deterioration and its molecular assessment

Soluble acid invertase (SAI) gene expression analysis using total RNA isolated from fresh and 3, 6, 7 and 8 days stale canes both untreated and treated with electrolyzed water and chemical formulations was performed and results indicated a significant and higher expression of SAI in all untreated stale canes whereas significant reduction in SAI expression in both electrolyzed and chemical formulation treated sets were observed.

Elucidation of the role of species chromosomal complement in sugarcane genotypes adapted to subtropical conditions

Chromosomal variability studies carried out in sugarcane genotypes CoLk 8102, BO 91 and Co 1158, and in two cross populations involving these as parents revealed that the modal chromosome numbers/cell in parents ranged from 108-118 and



in progeny population from 92-120 in CoLk 1158 x BO 91 and 90-112 in BO 91 x CoLk 8102.

Identification and expression analysis of resistance gene analogues against red rot disease in sugarcane

Genomic DNA of red rot resistant and susceptible sugarcane genotypes was amplified with thirty combinations of degenerate primers from known *R*-genes were sequenced and analysed using tools of bioinformatics. Based on matching with the proteins related to disease resistance mechanism, ten putative RGAs have been identified.

Mapping of loci linked to sugar content in sugarcane

Phenotyping of the segregating population developed through selfing as well as bi-parental crossing was carried out during the period. A population in C_2 generation comprising of 130 individuals from a cross of CoLk 7901 x HR-83-65 was phenotyped. Juice analysis exhibited a range of 11.6-18.8 for mean pol % juice during peak period. Variance studies established the suitability of the population for mapping studies. HR brix values for another population in C_1 generation of the same cross ranged from 10.4-22.2. A population from the selfing of CoLk 7901 was advanced to the C_1 stage. HR Brix % during November first week gave values in the range of 9.2-23.2.

The genotyping of the population from CoLk 7901 x HR-83-65 (C_2 generation) was initiated with forty-five primer pair sequences from sugarcane unigenes. DNA isolation and subsequent processing was carried out following routine procedures. Quality checking and quantification was carried out using agarose gels. On an average, the concentration of DNA isolated ranged from 200-250-ng/4 μ g of solution. Forty primer pair sequences

from sugar metabolism-related sugarcane unigene sequences were used for genotyping in this population. Ten of these sequences exhibited variation and the variation is to be analyzed further. Thirty new primer pairs, identified from a set of primer sequences from sugarcane unigenes published elsewhere were synthesized commercially. These will be used for genotyping of parental lines/population in the subsequent year.

Genome sequencing of red rot pathogen

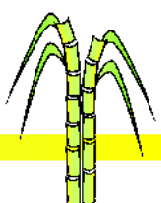
Collection and purification of the available variability of red rot pathogen *Colletotrichum falcatum* has been initiated. During this year Cf 01 (pathotype from Co 1148) was inoculated in the standing cane and through re-isolation, its virulence was established. This virulent culture was purified and then it was multiplied on liquid medium. The cultures were collected and isolation of genomic DNA was carried out.

Development of SSR markers for red rot resistance from EST database of sugarcane

Linkage analysis was carried out based on the genotypic (250 EST-SSR and gSSR primers) and phenotypic data (average of two years screening data against race Cf 01 of red rot) of the mapping population comprising of 134 clones of CoS 96268 self. Linkage map was developed and identified five putative QTLs linked with red rot resistance in sugarcane. The association panel of 124 sugarcane varieties / promising genotypes of sub-tropical India were analyzed for population structure using model-based approach and identified seven genetically distinct groups or admixtures thereof within sugarcane (Fig 7.1). General Linear Model using TASSEL was carried out and identified four EST-SSR markers significantly associated with red rot resistance (race Cf 01) (Fig 7.2).



Fig. 7.1 Population structure of 124 individuals estimated from 77 EST-SSR primers using STRUCTURE. K=7 represents the subpopulation of the 124 individual originated from different places of subtropical part of India



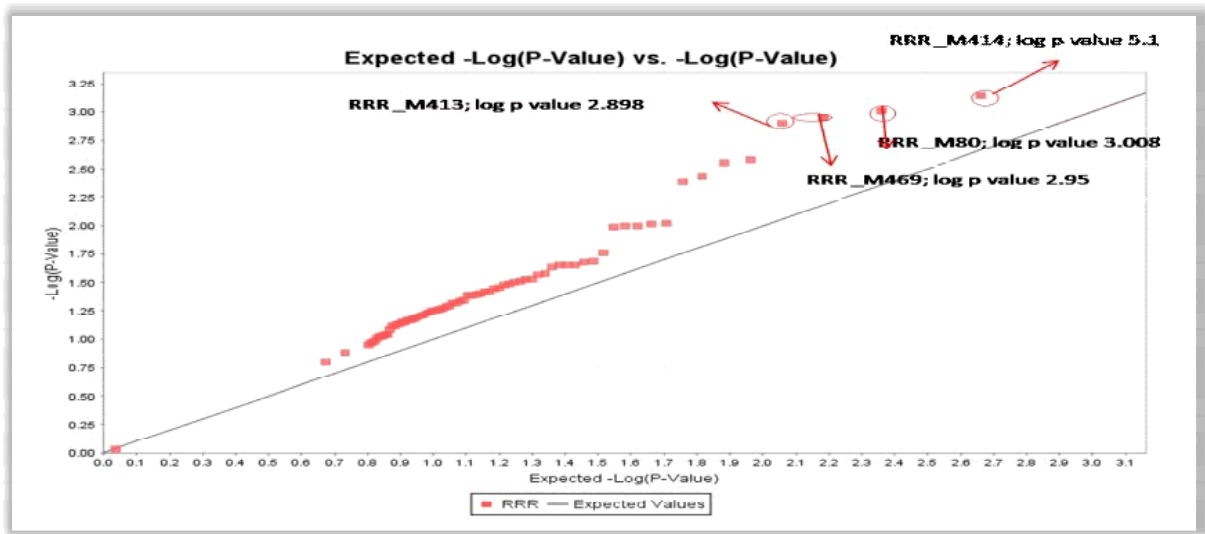
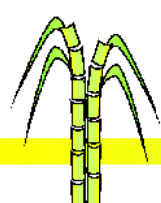


Fig. 7.2 Quartile-quartile (QQ) plot comparing the distribution of observed vs. expected P-value showing LD mapping. Markers associated with red rot resistance shown by arrow





Climate change and sugarcane

In the present scenario climate change has become one of the most important issues to be tackled as there is now clear evidence for an observed increase in global average temperatures and change in rainfall rates. The most imminent climatic changes in recent times are the increase in the atmospheric temperatures due to increased levels of greenhouse gases and irregularities in rain fall pattern. The impact of climate change and the amount of damage which it could cause in terms of growth and production of agricultural crops cannot be overlooked.

Compilation, analysis and documentation of long-term weather database in relation to sugarcane crop culture

The crop season 2012-13 was characterized by relatively higher maximum temperature as compared to LT normal in May to July and October 2012, respectively by 2.0, 4.7, 0.4 and 0.3°C whereas it remained lower during April, August, September, November and December, 2012 and Jan-March, 2013, respectively by 0.9, 0.5, 0.6, 0.5, 1.6, 2.3, 1.7 and 0.4°C. The minimum temperature exceeded LT normal in April, June to September, December 2012 and February and March, 2013 respectively by 0.6, 3.0, 0.4, 0.2, 0.6, 0.8, 1.4, and 0.9°C. It remained below LT normal by 0.6, 0.6, 0.3 and 1.5°C respectively for May, October, November 2012 and January 2013. Morning relative humidity remained below LT normal by 18 and 20 % in May and June 2012. It exceeded LT normal by 6% in April, 2012 and January and February 2013. In rest of the months it varied with < 5 % range. Afternoon RH was lower by 12, 23 and 7 % in May and June and October 2012. It exceeded LT normal by 13 % in February 2013. In rest of the months it varied with < 5 %. The duration of bright sunshine remained lower although the crop season 0.5 to 2.9 hrs/ day. The total rainfall received during the crop season exceeded LT normal by 227 mm. However, a deficit of 121 mm was observed in June 2012 and an excess of 130 mm was witnessed in February 2013.

The long-term (1979-2012) data on average rainfall intensity (total rainfall received in rainy days/ number of rainy days in the season) at Lucknow was analyzed for trend of variability. The data was examined for 1979-1995 and 1996-2012. The average rainfall intensity reflected a declining

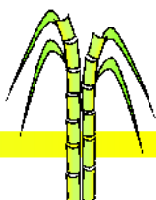
trend (0.5206 mm/ day/ year) for the time span 1979-1995 whereas an inclining trend (0.4737 mm/ day/ year) was observed during 1996-2012, which is in confirmation of climate change projections.

Weather impact on cane quality

The long-term (2000-01 to 2011-12) data on Pol % cane and monthly average weather data collected from Mawana (western UP) was used to develop a weather based workable model to estimate Pol % cane three months prior to harvest based on its relationship with RTD (relative temperature disparity %). The basic correlation between Pol % cane and % RTD (3 months before crushing) was 0.5662. A second order polynomial function was tried on database from 2000-01 to 2009-10, which was successfully validated.

Weather based cane productivity modeling

The long-term (1981-2005) cane productivity data along with monthly average weather data on maximum, minimum, rainfall and number of rainy days was collected from Shahajahanpur district of central Uttar Pradesh. The productivity data was individually correlated with these weather data from April to October (the actual growth span of sugarcane) and composite variables were generated based on weightage of correlations obtained. The productivity data from 1981-2000 was regressed with composite variables and weather based model was generated. The model was successfully validated for 2001 to 2005 with RMSE 8.3%. The observed and estimated productivity were compared and it was found that the estimated data compared well with observed data except for 2004.



Impact of climate change on sugarcane insect-pest dynamics and behaviour

The maximum incidence of top borer brood in III week of June for the period 2000-2012 was correlated with weekly average maximum, minimum and mean temperature, morning, afternoon and mean relative humidity and rainfall from 17 to 24th standard met weeks. It was observed that weather in terms of maximum temperature, mean temperature, morning and mean relative humidity and rainfall in 18th met week (30th April to 6th May) exerted maximum impact on pest incidence. The maximum ($r = -0.6457^*$) and mean temperature ($r = -0.5215^*$) bore significantly negative correlation with maximum pest incidence whereas RH7 ($r = 0.6597^*$), RH mean (0.6187^*) and rainfall ($r = 0.6495^*$) bore positive correlation with maximum pest incidence. The borer incidence pattern as a function of maximum temperature and morning relative humidity are shown in Figs. 8.1 & 8.2.

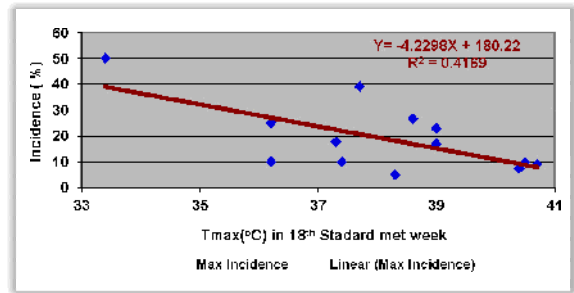


Fig 8.1 Maximum incidence of top borer in III week of June

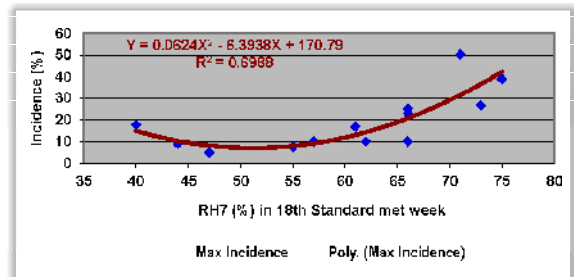
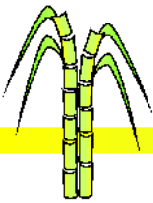


Fig 8.2 Maximum incidence of top borer in III week of June





Post harvest technology

Considering the high nutritive value and growing demand for sugarcane juice, there is an urgent need to carry out focused research on its preservation, shelf life enhancement and packaging. Research on jaggery and khandsari needs special emphasis as it accounts for almost one third of the sweetener consumption with problems like darkening, textural changes and spoilage during storage needing special attention.

Developing a technology for preservation and packaging of sugarcane juice

For reducing darkening of juice colour and loss of flavour, sugarcane juice obtained from blanched rind removed sugarcane (CoLk 94184) at 60-65°C by brass roller crusher (thoroughly cleaned by boiling water) was preserved by adding potassium metabisulphite within permissible limits followed by heat treatment, filtration, pasteurization and immediate filling in autoclaved bottles under aseptic condition. Storability of juice under cold condition was satisfactory up to two weeks with sugarcane juice characteristics such as colour, taste and flavour.

Design and development of a small capacity cane-crushing unit for house hold purpose

The power transmission system of crushing unit was redesigned and developed and is working smoothly. The crushing capacity of this unit is 25-30 kg/h and the percent juice recovery is 55 to 60 (cane weight basis).

Evaluation of shrink-wrap, stretch wrap and modified atmosphere packaging for storage of jaggery cubes and blocks

Jaggery was prepared from cleaned juice obtained from different varieties of sugarcane. Initial values of jaggery quality parameters like brix, pol, reducing sugar, moisture content, pH and colour were determined. The samples were packed in nitrogen, shrink-wrap and stretch wrap conditions for recording of storage data on monthly basis. Out of the samples packed in nitrogen, shrink

wrap and stretch wrap conditions, the nitrogen packing gave best result.

Evaluation of jaggery furnaces (single, double and triple pan) for emission of green house gases and level of bagasse combustion

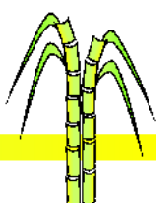
Data for CO, CO₂, O₂, combustion efficiency, flue gas temperature and ambient temperature have been recorded during operation of 3-pan furnace using Flue Gas Analyzer. Carbon mono-oxide (900-2000 ppm), CO₂ (10-15%), O₂ (6-20%), Combustion efficiency (52-73%) and flue gas temperature up to the maximum value of 294 °C were observed.

Refinement of juice extraction process with special reference to sugarcane cleaning and juice filtration for 100 kg jaggery / 8 hrs

The equipment for continuous mechanical cleaning and washing of sugarcane stalks without green tops have been designed. Required materials have been procured and fabrication of the unit is in progress in Engineering Workshop.

Development of power operated jaggery-moulding machine

The batch type mechanical screw press rectangular system for jaggery moulding was redesigned. It has been provided with two vertical shafts for smooth vertical movement of the rotor pistons into the static moulding frame. Third vertical shaft (rectangular) was also provided with spring loaded lever system from backside of rotor system for pressing out the jaggery moulds. A sliding plate, which works as platform for setting



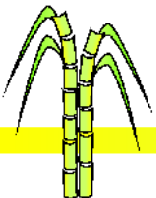
of jaggery, has been provided at bottom of these base moulds.

Development/adoption of suitable mixer for production of value-added jaggery using *aonla* a natural source of vitamin C

A few mixers available in the market were tested for mixing of dried *aonla* shreds with jaggery slurry and found unsatisfactory. Therefore, a manual mixer has been designed.

Optimisation of parameters for shelf life enhancement of jaggery under modified atmosphere packaging

Water vapour permeability of available packaging materials was done. The permeability of PET film 95 micron thickness was done at 10, 20, and 30°C. The value of the permeability was 1.67, 3.94 & 7.86 g/m²/day respectively. Texture study of jaggery cubes was also calculated at the interval of one week.





Sugarbeet research

The research on tropicalized sugarbeet genotypes from the IISR and its coordinating centres revolutionized its cultivation in subtropical India. To harvest more sugar per unit area and time, intercropping of sugarbeet with sugarcane can be done for achieving higher profit. The changing biofuel scenario in the country has started looking at sugarbeet with ethanol as the end product. The availability of efficient sugar processing technology particularly suited to our indigenous factories is essential for the successful commercial exploitation of sugarbeet.

Fifty-two germplasm lines including inbreds (4), composites (9), varieties (3), exotic breeding lines (27), elite selections (5) and new introductions (4) as detailed below were maintained and multiplied at Sugarbeet Breeding Outpost, Mukteswar. The flowering behaviour of partial male sterile lines was studied and pollination was controlled for seed production. Six kg seed of germplasm and advanced breeding lines and 46 kg seed of sugarbeet varieties LS-6 and IISR Comp-1 was produced at the Outpost.

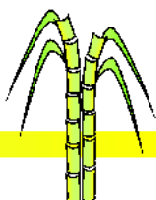


Seventy-one germplasm lines were evaluated for their performance under sub-tropical agro climatic conditions. The lines showing superiority for important attributes are given in table 10.1.

Table 10.1 Features of sugarbeet germplasm

Attributes	Germplasm lines showing superiority
Root yield	HTHB, Esperanza, FC-201, LKS-10, PAC 60002, BTS 601, Oriempoly, LK-8, SYT 06-03, SYT-06-04, Rasoul IN-04, IN-14, IN -10
Top yield	HTHB, LS-6, BTS-601, 436, Oriempoly, LK-8, IN-6, IN-14
Sucrose content	PAC 60002, Shubhra, PAC 60008, PAC 60009, PAC 60007, LKC-HB, 436, INDUS, SYT 06-07, SYT 06-13
Tolerance to root rot	LK-08, LS-6, HTHB, SZ-35, LKS-10, LK-27
Tolerance to Bihar hairy caterpillar	LK-7, LKCLB, LK-8, IN-06, SYT 06-17

In a separate trial, seven sugarbeet varieties viz., PAC 60008, LKC 2010, LKC 2006, LKC 2007, SZ-35, calixta and LKC 2000 along with three standards viz., Shubhra, LS-6 and IISR Comp-1 were evaluated for root and top yield, root quality and natural infestation of diseases and pest. SZ-35 exhibited highest root yield and LKC-2010 top yield. However, none of the entries under test possessed superiority in sucrose content. For gross sugar, SZ-35 followed LNC-2012, PAC 60008 and LKC-2006.





ICT in sugarcane

Interventions in the field of Information and Communication Technologies have touched the life of everyone, irrespective of the profession. The development of efficient software, statistical methodologies, mobile based user friendly interactive modules, etc, were taken up by the institute, with a view to improve upon the technology delivery mechanisms in the field of agriculture.

Estimation of optimum sample size for evaluation and prediction of cross performance

Sugarcane seedlings were grown from open pollinated fluff of important varieties. Data on cane height, number of millable canes, cane weight, cane diameter, internode length and HR Brix for all seedlings were recorded. Maximum variability was observed in single cane weight (57.52%) followed by NMC (56.19%), cane height (28.52%), HR Brix (24.72%), internode length (19.56%) and cane diameter (17.65%). Cane weight (with maximum variability) was considered for finding optimum number of seedlings. Coefficient of variation dropped rapidly from 111.24% to 51.66% from sample size of 60 to 150 after which it remained constant to about 50% up to the sample size of 340 (Fig 11.1). It was concluded from the preliminary analysis that optimum number of seedlings per family to be grown is 150. A computer programme has been developed for drawing random samples of various sizes and calculating sampling error in different sample size.

Development of Decision Support Tools in sugarcane cultivation

Decision Support System (DSS) for Disorder Diagnosis in Sugarcane Crop has been developed using Client-Server architecture in which, knowledge base and inference engine resides on server and accessible to client using web browser. A new structure of knowledge base and inference mechanism for disorder diagnosis has been laid, in which symptoms used for disorder diagnosis has been classified into three different categories viz. Symptom Location (Crop Part), Symptom Attributes and Crop Stage, to ease selection of appropriate symptom for disorder diagnosis.

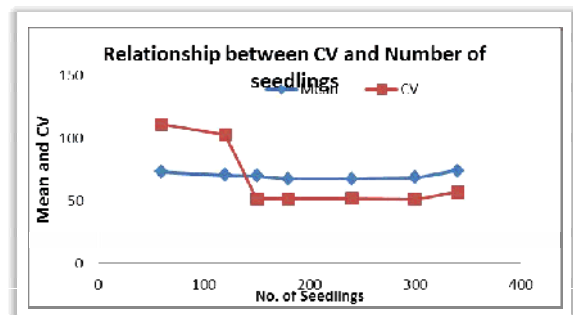
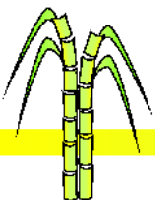


Fig 11.1 Relationship between CV and number of seedlings in the family

Symptom Location (Crop Part) refers to classification of symptoms according to crop part where symptom appears. Five types of symptoms have been defined in this viz. Foliage, Stalk, Root, Crop Appearance and Pest Attributes symptoms. Foliage symptoms appears on foliage part of the sugarcane; Stalk symptoms are related with disorder occurs on stalk/stem of sugarcane; Root symptoms are associated with root and soil part of the crop; Crop Appearance deal with overall appearance of crop showing disorder; and Pest Attributes are identification marks of insect-pest and diseases of sugarcane.

Symptom Attributes has been used to classify symptoms according to certain attributes appears in infected sugarcane crop. Eleven attributes has been used to classify symptoms viz. Age/stage related events, Behaviour events, Biting/chewing /infection signs, Coloured variations/object identification, Drying of objects, Position specific events, Quantified event occurred, Unusual shapes of objects, Spots / patterns seen, Strength observed, Touch and smell effects.

Further, symptoms are also classified depending on crop stage. Two stages of crop has been selected in this classification viz. Shoot Stage



and Cane Stage and all the symptoms has been grouped in above two stages. Figure 11.2 shows the screen shot of Diagnostic Settings, which empower user to make appropriate settings to simplify the diagnosis. Figure 11.3 displays symptom selection screen where symptoms have been grouped into selected categories.

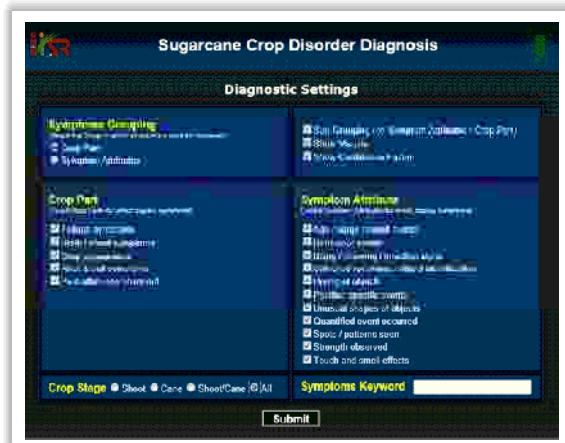


Figure 11.2 Diagnostic settings of DSS



Figure 11.3 Symptom selection screen

Development of data mining and presentation tools in sugarcane

Under this project, which aims to develop data mining and presentation tools in sugarcane domain for analytical exploration and studies, work has been started for collection and compilation of data on sugarcane production and its utilization in India since 1950 onwards. Data collected was recorded in staging area for further cleaning and transformation. The focus is now to make available data in three forms viz. raw data, summary data and meta data. Relational database technology has

been implemented to design and develop the database.

Geographic Information System of sugarcane and sugar in India

Out of 622 districts in the country, sugarcane is grown in around 451 districts of the country, 152 districts had spread index (percentage of sugarcane area to net sown area in a district) of sugarcane more than one were considered for analysis of cross sectional data. These potential sugarcane growing districts (152) had more than 95.58 % sugarcane area with 96.33 % of cane production of the country. All these 152 districts were further classified into five different categories as very low, low, medium, high and very high for sugarcane area, production and yield and mapped on district wise map of India. Main purpose of this study was to classify districts according to levels of productivity, spread of sugarcane crop and on some other typologies into homogeneous groups to study the impact of sugarcane in relation to net sown area of the districts.

Forty three medium to very high spread index districts contribute nearly 75% cane area & 75 % cane production of the country (Table 11.1). Hence, whenever the policies are to be framed for sugarcane, these forty three medium to high cane spread districts should be given greater thrust on technology development and extension activities. However other cane producing districts also need location specific attention for improving overall cane productivity and quality.

Developing efficient statistical design for conducting weed control experiments in sugarcane

Efficiency of two layouts RBD (existing) and RBD with additional row arrangement was compared for estimating random error caused by erratic natural distribution of weed flora in sugarcane field using four weed control treatments viz., pre-emergence application of atrazine (2.0 kg ai/ha), metribuzin (1.0 kg ai/ha) along with manual hoeings and weedy check. Statistical parameters viz. root mean square for error (Root MSE), co-efficient of variation (CV) and coefficient of multiple determination (R^2) were analysed for both types of layouts with respect to weed number and their dry weight under different treatments. Modified layout involving additional row

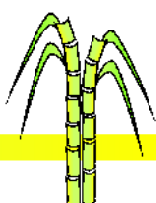


Table 11.1 Distribution of sugarcane area, production and yield in different class interval of sugarcane spread

Percentage of sugarcane area to net sown area in a district - Spread Index	No. of districts	Area ('000 ha)	Production ('000 t)	Yield (t/ha)	State	Districts
> 40 (Very high)	9	1130 (28.57)	71360 (25.79)	63.15	Uttar Pradesh	Bagpat, Bijnor, J.B. Phule Nagar, Kheri, Meerut, Muzaffarnagar, Saharanpur
					Uttarakhand	Haridwar, Udham Singh Nagar
20- 40 (High)	12	823 (20.81)	50513 (18.26)	61.38	Bihar	West Champaran
					Gujarat	Surat
					Haryana	Yamuna Nagar
					Maharashtra	Kolhapur
					Uttar Pradesh	Balrampur, Bareilly, Ghaziabad, Gonda, Kushi Nagar, Moradabad, Pilibhit, Sitapur
10 - 20 (Medium)	22	991 (25.06)	83734 (30.27)	84.47	Andhra Pradesh	Visakhapatnam
					Bihar	Gopalganj
					Gujarat	Navsari
					Uttarakhand	Dehradun
					Karnataka	Bagalkote, Belgaum, Mandya
					Maharashtra	Pune, Sangli, Satara, Solapur
					Tamil Nadu	Cuddalore, Dharmapuri, Erode, Namakkal, Tiruvannmalai, Villupuram
					Uttar Pradesh	Basti, Bullandshahr, Faizabad, Rampur, Shahjahanpur
5 - 10 (Low)	29	525 (13.27)	37460 (13.54)	71.35		
1 - 5 (Very low)	80	486 (12.28)	33582 (12.14)	69.13		
Total	152	3955 (100)	276649 (100)	69.95		

arrangement in existing RBD enabled covariance analysis for weed number and their dry weight resulted in improvement in efficiency of existing design with respect to Root MSE, CV and R² values (Table 11.2).

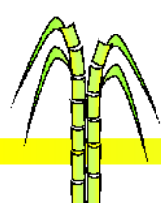
Table 11.2 Statistical parameters for weed numbers (and weed dry weight) as affected by different layouts adopted for weed control trial

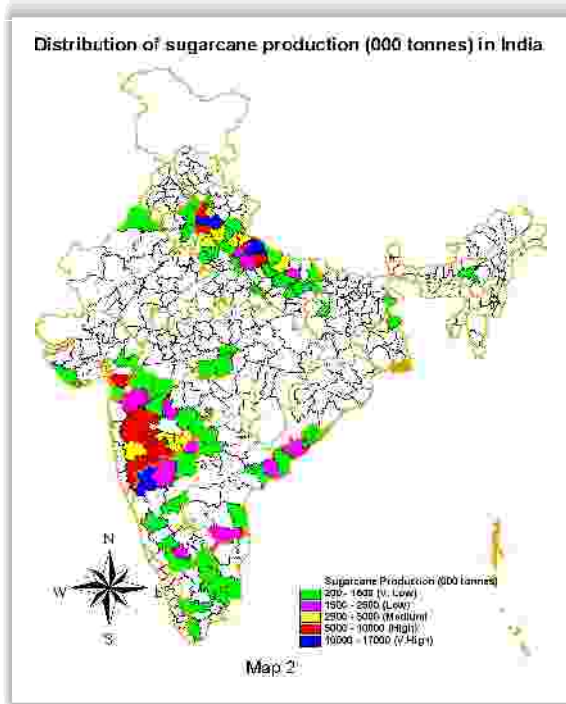
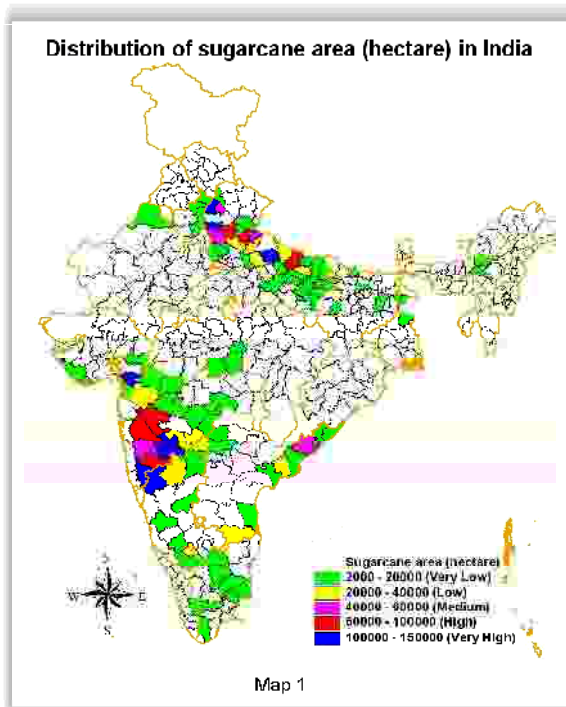
Statistical parameter	Layout	
	RBD with AR*	Existing RBD
RMSE	6.85 (16.14)	7.52 (16.80)
CV	12.31 (31.53)	24.48 (39.88)
R ²	0.86 (0.94)	0.81 (0.94)

*AR = Additional row arrangement; Weed dry weight values in brackets

Analysis of sugar production and trade scenario in South Asia Region

South Asia region now attracts global attention because of rapid growth, global outsourcing, and skill-intensive service exports. The policy changes aimed at taking advantage of the interactions between geography, transportation, factor mobility, and scale economies not only will lift growth in the lagging regions but also will support higher growth rates at the country level and in South Asia. Hence, cooperation among countries can be a powerful way to raise growth, reduce the gap between leading and lagging regions, and reduce vulnerabilities for the poor. India is the major sugarcane producer in Indian subcontinent. All the 4 neighbouring countries collectively grow

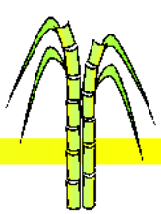




sugarcane in less than 27% of the cane area in India and produces around 20% of the sugarcane production.

Long term growth pattern (1980-2010) in sugar production reveals that in Bangladesh, the production growth rate is much lower than that of consumption, indicating large potential deficits in future. There is no domestic production in Maldives, in Nepal, Pakistan and Sri Lanka. In India, the production growth rate is almost equal to that of consumption. This implies that there could be no large potential deficits or surpluses in India. At the global level, the production growth rate is higher than that of consumption, indicating some potential for export. Overall, it appears that presently there is export surplus for sugar (refined) only in India.

For sugar (refined), the production/consumption ratio is medium for India and Nepal and low for all other countries. The import/consumption ratio is high for Bangladesh, Maldives and Sri Lanka. Production Instability Index is also high in all countries. For sugar (centrifugal), the Production/Consumption Ratio is medium for India, Pakistan and Nepal. The ratio is low for Afghanistan, Bangladesh, Maldives and Sri Lanka. The Ending stocks/consumption ratio is adequate in Bangladesh, India, Maldives, Nepal, Pakistan and Sri Lanka.





Linkage and Collaboration

Linkage and collaboration with various national and international organizations provide a platform for successful exchange of ideas and views between researchers. Training-cum-familiarization programmes organized by the Institute for delegates from different countries have paved the way for development of various collaborative exchange programmes addressing the challenges of sugarcane cultivation and bio-fuel production.

Visit of Chinese delegation to IISR

A delegation of six scientists led by Dr. Yang-Rui Li, President, Guangxi Academy of Agricultural Sciences (GXAAS), Guangxi, China visited IISR on October 11, 2012. The delegation interacted with the scientists of the Institute and visited the various laboratories and fields. The team expressed their interest for enhanced collaborations with the Institute.

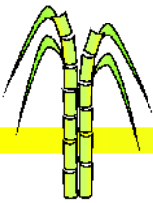


Indo-Brazil cooperation

Dr. S. Solomon, Director, on the invitation of Govt. of Brazil, attended the second workshop under 'Indo-Brazilian Cooperation in Bio-energy' as a member of Indian delegation, held during April 18-20, 2012 at FEQ-UNICAMP, Sao Paulo, Brazil. A paper on 'Indian Sugar Industry and R&D Roadmap to Enhance Sugarcane Production' was presented by Dr. Solomon in the workshop and as a follow-up collaborative programme is being developed between IISR and Govt. of Brazil.

Training for Sri Lankan scientists

A two week Training-cum-Familiarization Visit Programme on Sugarcane Production Management for three Sri Lankan (SRISL) scientists was held from December 17-29, 2012. Mr. L.M.J.R. Wijeyawardhana, Research Officer, Mrs. V.K.A.S.M. Wanasinghe, Research Office and Mr. R.A.P.A. Ranatunga, Development Officer, Sugarcane Research Institute, Sri Lanka participated in the programme which consisted of visit and familiarization at the different divisions and sections of the Institute along with field visit to sugar factories, jaggery manufacturing units and machinery manufacturers.



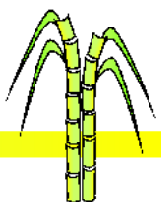


Dr. S. Solomon visited Vietnam

Dr. S. Solomon visited sugarcane fields and sugar units of Vietnam of BOURBON Tay Ninh Sugar Co. from 28-31 January, 2013. He had meetings with several mill officials to discuss the problems related to low sugar recovery in Tay Ninh area and Sugar Factories in South Vietnam.

Sri Lankan Minister with high level delegation visited IISR

“Dedicated efforts of IISR scientists in developing technologies are commendable and wonderful” said Mr. Reginald Cooray, Hon’ble Minister of Minor Export Crops Promotion, Govt. of Sri Lanka during his visit to the institute on June 3-5, 2012 along with a high level five members’ delegation including Mrs. Herath, Additional Secretary; Mr. S.K. Cyril, Chairman of Sugarcane Research Institute, Dr. N.C. Kumarasinghe, Director/CEO of Sugarcane Research Institute, Sri Lanka and Mrs. Chandrika Cooray, Assistant Secretary, MMECP. The delegation visited IISR and Biswan Sugar Mill, Sitapur (UP) to study the research and development activities of Indian sugar industry. High cost of production, low yield, low profit margin, poor technology adoption and preference for cash crops like tea, rubber *etc.*, are major problems of Sri Lankan sugar industry due to which low yields and low sugar recoveries are



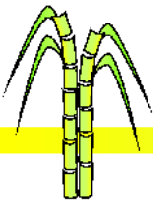


perpetual problems. This led to import of 95% domestic requirement of sugar in Sri Lanka from other countries. Hon'ble Minister Mr. Cooray, informed that the Sri Lanka is trying hard to achieve the target of 30% domestic sugar requirement from own production. The Minister urged IISR scientists to extend help for strengthening research and

development in Sri Lanka in order to improve sugarcane production. Dr. S. Solomon, Director said that there are certain areas like introduction of high sugar variety, improved production technologies, bio-intensive management of pests and diseases, mechanization of sugarcane cultivation, application of GIS and GPS in sugarcane agriculture, water saving sugarcane technology, intercropping with sugarcane and training for human resource capacity building where IISR can extend help to improve sugarcane cultivation in Sri Lanka.

Agricultural Research -Development Conclave for UP & Uttar Pradesh Kisan -Vigyan Sangam-2012 (November 23-24, 2012)

Under the guidance of Indian Council of Agricultural Research (ICAR), Govt. of India, New Delhi, a 2-days Agricultural Research &



Development Conclave for UP & Uttar Pradesh Kisan-Vigyan Sangam 2012 was organized at Indian Institute of Sugarcane Research, Lucknow. The conclave was inaugurated by Prof. R.B. Lal, VC, SHIATS, Allahabad in the presence of Mr Murtaza, Addl. Cane Commissioner, Govt. of U.P., Dr. S. Solomon, Director, IISR, Dr. H. Ravishankar, Director, CISH, Dr. J. K. Jena, Director, NBFGR and Dr S.H.A. Abidi, Ex. Member, ASRB. From all over UP about 500 development officials/scientists and 2000 farmers participated in the Conclave/Sangam. The eminent scientists Prof. A.N. Mukhopadhyay, Dr. I.S. Singh, Dr. Menhi Lal were the key speakers on different topics of interest. A mega Kisan Goshthi, Krishi Shiksha Diwas and a Braing Storming Session were also organized for different stakeholders such as farmers, students and development workers. An Exhibition of technologies from KVKs, Input Industry, Seed Industry, Research Institutions of UP, etc was one of the major attractions for the visitors who got a rare opportunity to interact with each other during two days celebrations.

IISR signed MoUs with different stakeholders

During 2012-13, Indian Institute of Sugarcane Research signed MoUs with different stakeholders such as Universities, State Government, Sugar Industry etc., for increasing linkages and collaborations in the field of education, research and development. The list of MoUs is as under:

Universities/SAUs

University/SAU	Date of signing MoU
Amity University, Lucknow	April 19, 2012
Sam Higginboton Institute of Agriculture, Technology and Sciences, Allahabad	May 25, 2012
Mewar University, Gangrar, Chittorgarh	December 14, 2012

State Government

Name	Sponsor	Duration	Budget (Rs. in lakh)
Sugarcane seed production for Bihar	Govt. of Bihar	March 2013-2018	639.00

Sugar Mills

Name	Sponsor	Duration	Budget (Rs. in lakh)
Sugarcane Development Programme	Upper Doab Sugar Mills, Shamli	March 2013-2015	5.00
Sugarcane Development Programme	Unn Sugar Complex, Shamli	March 2013-2015	5.00

Licensing Agreements Signed

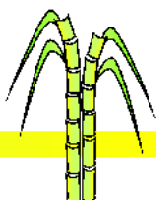
Implement Manufacturer	Date of signing MoU
M/S Shubham Agricultural Implements Pvt. Ltd., Sandila	November 20, 2012
M/S Punjab Engineers, Meerut	January 15, 2013
Gobind Industries (P) Ltd., Barabanki	January 15, 2013



IISR signed MoU with the Govt. of Bihar for Seed Production



IISR Scientists visited Sugar Industries for organizing trainings and solving various other technical issues





IISR: Reaching-out to Stakeholders

Documentation and confirmation of Indigenous Technical Knowledge under sugarcane based cropping systems

Based on the review on ITKs a checklist for identification of sugarcane based cropping systems and ITKs was prepared. On the basis of a rapid rural appraisal of study area four villages were selected from the Seksaria Biswan sugar mill zone for identification of the sugarcane based cropping systems and ITKs. The prevailing cropping systems identified were Paddy-Toria-Sugarcane, Paddy-Potato-Sugarcane, Paddy-Lentil-Sugarcane Paddy-Wheat-Sugarcane, Mentha ratoon-Mustard-Sugarcane, Sesame-Mustard-Sugarcane, Urd-Mustard-Sugarcane, Sugarcane ratoon-Wheat and Maize-Mustard- Sugarcane. The ITKs recorded were indigenous method of identification of sodic soil, land capability classification, soaking of seed cane in water for enhancement of germination, keeping seed cane bundles covered with the animal litters for 7 days for enhancement of germination and destruction of the insects and other disease causing organisms, use of agriculture waste for moisture conservation, a gap of 5-7 cm used to be kept between the setts while planting them in the furrows to protect transmission of sett borne diseases, insects and termites from one sett to another, use of raw dung for control of termite, use of neem cake @ 125-150 kg/ha in the furrows before sett placement to control termites, use of curd/whey @ one kg per 5 kg seed for control of wilt disease of crops specially pigeon pea, use of indigenous light trap for control of insects, etc. Along with these, to protect the crop from blue bull and other wild animals farmers' used light scarcer and indigenous techniques for rat controls such as use of *Saccharum spontaneum* leaves, *Argimone maxicana* to block the rat holes, sprinkling of red colour over trash, etc.

Assessment of sugarcane cultivation machines (RMD & RBS planter) on farmers' fields

To enhance the adoption of sugarcane machines by cane growers for cost and labour

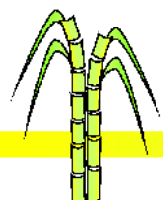
saving, the Front Line Demonstrations (Method and Result) of RMD and RBS Planter machine at farmers' fields in Biswan sugar mill (Sitapur) and Baheri sugar mill (Bareilly) was conducted. A total of 21 demonstrations on RBS planter and 20 on RMD was conducted covering a total areas of 13.0 hectares. Initial response from farmers indicated satisfactory performance of these two machines.

Entrepreneurship development for sugarcane seed production and multiplication

To inculcate the entrepreneurial ability among farmers in order to increase income from sugarcane cultivation, knowledge domain in the area of entrepreneurship and technology package for sugarcane seed crop raising need to triggered. With this basic aim project was initiated in command area of Biswan Sugar mill of Sitapur district (UP). To begin with, autumn seed crop of variety CoLk 94184 was planted with recommended package of practices at sugar mill farm and progressive farmer' field in mill zone raea. Entrepreneurship training module/capsule development is under process.

Krishi Vigyan Kendra

Five on farm trials viz., intercropping of vegetables in banana cultivation, performance of intercropping of turmeric and elephant foot yam in mango orchards, Integrated Pest Management in tomato crops, management of fruit-fly in mango orchards and management of post-partum anestrous in dairy cow, were conducted. 385 demonstrations under different crops were conducted in 56.5 ha area (kharif 27.0 and rabi 29.5 ha respectively) and 2000 animals were covered under vaccination and deworming. The increase in yield under these demonstrations ranged from 6.2% in vegetable pea to 68.0% in sweet sorghum (Green Fodder). Fifty training programmes were conducted for farmers, farm women, rural youth, extension personals etc in which 1075 participants (837 male, 238 female) attended the programme. Two farmers' fairs with approximately 12000 visiting farmers, 26 field visits



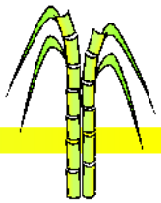
(800 farmers) at KVK, animal health camp and four *Kisan Goshthis* were organized. Seed production of wheat (PBW-550) was carried out in one hectare area and about 11500 seedlings of different vegetables were distributed to farmers. 06 television and 2 radio talks were delivered by KVK staff. *Rajbhasha Patrika 'Kisan Jyoti'* was awarded 3rd prize by *Nagar Raj Bhasha Kriyanvayan Samiti (NARCAS)*, Lucknow in June, 2012.

IISR Regional Centre, Motipur

Evaluation of sugarcane clones under Zonal Varietal Trials for North Central and Eastern Zone

Advanced Varietal Trial (Mid-late) I Plant

A trial comprising of three test genotypes viz. CoP 08437, CoSe 08451 and CoSe 08452 along with



three standard varieties *viz.* BO 91, CoP 9301 and CoSe 92423 was conducted. Observations on yield and quality parameters were recorded as per the technical programme. Based on the observations for cane yield and sucrose (%), the genotype CoSe 08451 was found superior over best standard.

Initial Varietal Trial (Early)

Five genotypes *viz.*, CoP 0943, CoSe 09451, CoSe 09452, BO 153 and UP 094536 along with two standards *viz.* CoP 9301 and CoSe 92423 were evaluated for yield and quality parameters. Observations on yield and quality parameters were recorded as per the technical programme. BO 153 had shown highest cane yield whereas highest sucrose percent was recorded in CoSe 09452.

Initial Varietal Trial (Mid-late)

A trial comprising of three test genotypes *viz.*, CoP 09437, CoSe 09454 and BO 154 along with three standard varieties *viz.*, BO 91, CoP 9301 and CoSe 92423 was conducted. Observations on yield and quality parameters were recorded as per the technical programme. BO 154 was to be found very promising with highest cane yield.

Development of water logging tolerant and red-rot resistant sugarcane clones for North Central Zone

Based on the HR Brix and growth performance, 41 C₁ clones were selected seedling population and planted for further evaluation. 51 C₂ clones were tested under water logging condition. These clones were also screened for red rot resistance. Among them seven clones were promoted for further evaluation. Five C₃ clones namely MG 10-11/18, MG 10-11/21, MG 10-11/36, MG 10-11/53 and MG 10-11/143 were promoted to the station trial 2013-14. Two clones MG 10-11/21 and MG 10-11/36 were proposed for evaluation in State Varietal Trial of Bihar state.

Station Trial

Seven promising clones of early group *viz.*, MG 09-10/30, MG 09-10/49, MG 09-10/57, LG 04006, LG 02039, LG 02434 and LG 01282 along with two standards *viz.*, BO 130 and CoSe 95422 were evaluated for yield and quality parameters under Station Trial 2012-13. MG 09-10/49, 57, LG04006, LG2039, LG02434 and LG 01282 were

found to be significantly superior for cane yield over the best standard. LG 02039 was found to be superior over best standards for both cane yield and sucrose percentage. Similarly, seven promising clones of midlate group *viz.*, MG 09-10/54, Co 0235, LG 07202, LG 03002, LG 04043, LG 05447, MG 09-10/32 along with three standards *viz.*, BO 91, CoP 9301 and CoSe 92423 were evaluated for yield and quality parameters under Station Trial 2012-13. LG 04043 and LG 05447 were significantly superior for cane yield over best standard.

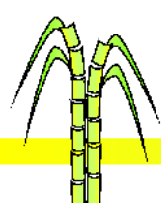
Breeder Seed Production

Three varieties *viz.*, CoLk 94184, Co 0232 and Co 0233 were planted under breeder seed production programme. Approximately 1850 quintals breeder seed was produced and supplied to the farmers and various sugar mills of Bihar. In the meanwhile, the prestigious Bihar Sugarcane Seed Project has been awarded to the IISR, Regional Centre, Motipur by the Sugarcane Industry Department, Government of Bihar. This project has been implemented from the crop season 2013-14 at IISR, RC, Motipur and Harinagar Sugar Mills farms. Nine varieties namely Co 0238, Co 0239, Co 0232, CoS 767, CoP 9301, CoLk 94184, BO 139, CoS 8432 and Co 0118 were planted for seed production in 20 ha area at farm of Harinagar Sugar Mills Ltd., while four varieties *viz.*; CoLk 94184, Co 0232, Co 0233 and BO 153 were planted in five hectares at Motipur.

IISR Outpost, Pravaranagar

Survey and surveillance

Observation on the incidence of insect-pests of sugarcane was recorded fortnightly in the selected area. The borer complex of the area was dominated by early shoot borer and pink borer. Maximum incidence of shoot borer (% dead heart) was 15.60% in May 2012. In general, the incidence varied from 4 to 8% during July 2012 to March 2013. An increase in incidence of shoot borer (9-15%) was observed during the summer months (April 2012 to June 2012). Parasitisation with *Sturmiopsis* sp. was very low and that too observed during the summer months, whereas parasitisation of *Cotesia flavipes* was a little higher but its activity was observed during July-August, 2012 and January 2013. This year incidence of scale insect was not observed in the surveyed area. Incidence of woolly

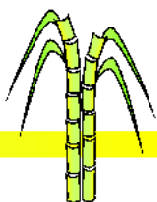


aphid was noticed during Feb, 2012 but presence of its predators viz., *Dipha aphidivora* and *Micromus* sp. was noticed only in August, 2012.

Biological control

For checking the incidence and intensity in borer complex *Trichogramma chilonis*, this year it was released in 475 ha involving 296 farmers. It was observed that in *Trichogramma* released field

incidence of shoot borer was 1.76% in comparison to the untreated control (6.84%). Observation on colonization of *Zygogramma bicolorata* on *Parthenium* grown around the sugarcane fields was taken. The beetle was noticed on the weed from July 2012 and maximum activity of the beetle was observed during September 2012. It was observed that due to mass feeding defoliation of weed was taking place which resulted in the death of plants.

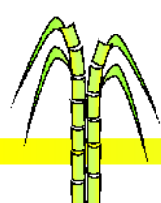


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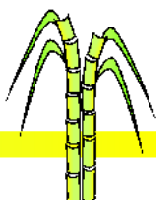
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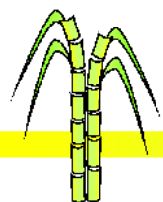
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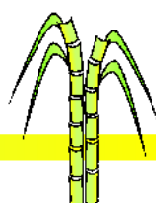
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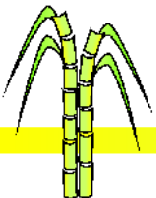
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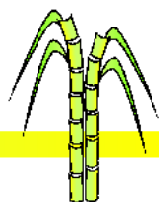
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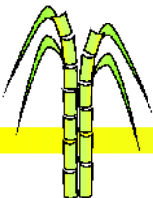
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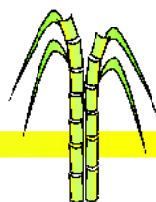
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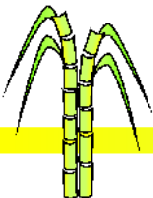
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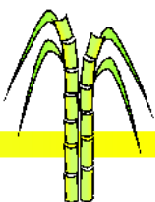
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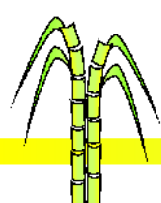
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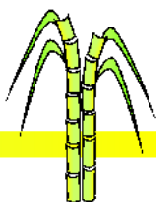
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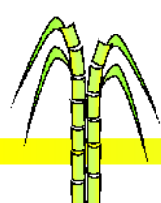
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Technology folders/ Others

Furrow Irrigated Raised Bed (FIRB) method for wheat + sugarcane intercropping Published by IISR, Lucknow. (Singh Ishwar, Srivastava T K and Solomon S).

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Post harvest Management of Sugarcane and value addition (2012) Compiled by A. Chandra, R. Jain, R. Banerjee, P. Singh and S. Solomon., IISR Lucknow, pp 1-90.

Bud chips for rapid seed multiplication in sugarcane

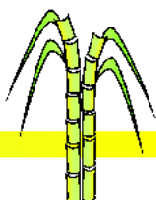
Spaced Transplanting Technique (STP): A promising technique for rapid seed multiplication in sugarcane

Sushil, S.N. and Duttamajumder, S.K. 2013. White grubs of sugarcane and their management & *Ganne ke safed gidar evam unaka prabandhan* (Bilingual-Hindi & English), Lucknow, Indian Institute of Sugarcane Research.

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Dr. S.K. Datta, DDG (Crops) perusing the publications





Technical programme (2012-13)

Division of Crop Improvement

- B 1.1 Evaluation of early maturing sugarcane clones of North West Zone (J. Singh and D.K. Pandey; 02/2009-LT)
- B 1.2 Evaluation of mid-late sugarcane clones for North West Zone (Sanjeev Kumar and P.K. Singh; 02/2009-LT)
- B 1.7 Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions (P.K. Singh, Sanjeev Kumar and J. Singh; 01/95 - LT)
- B 2.3 Development of sugarcane breeding stocks for high sugar (Raman Kapur and S.K. Duttamajumder; 11/93-3/14)
- B 2.9 Development of top borer tolerant genetic stocks of sugarcane (A.D. Pathak, R.K. Rai, Sangeeta Srivastava, M.R. Singh and Rajesh Kumar; 3/2000-2/15)
- B 2.10 Development of sugarcane varieties for moisture deficit environment (Sanjeev Kumar J. Singh and P.K. Singh 02/02 - 2013)
- B.2.13 Development of sugarcane varieties for sub-tropics (J. Singh, D.K. Pandey, P. K. Singh and Sanjeev Kumar; 10/2003-LT)
- B 2.14 Development of breeding stocks of sugarcane for durable resistance to red rot (D.K. Pandey, P. K. Singh, Sunita Lal, J. Singh and Sanjeev Kumar; 10/04- 10/2014)
- B2.15 Developing sugarbeet varieties for Indian agro-climates (A.D. Pathak, Raman Kapur, S.K. Duttamajumder, and Arun Baitha; 09/2008- 09/2013)
- B3.17 Elucidation of species chromosomal complement in sugarcane genotypes under sub-tropical conditions (Sangeeta Srivastava and Raman Kapur; 2010-2015)
- B3.18 Identification and expression analysis of resistance gene analogues against red rot

disease in sugarcane (Sangeeta Srivastava, Ramji Lal, R.K. Singh and M. Swapna; 01/10-12/14)

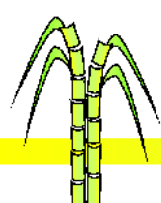
- B3.19 Mapping of loci linked to sugar content in sugarcane (M. Swapna, Sangeeta Srivastava and D.K. Pandey; 12/09-03/15)

Externally Funded Projects

1. Central Sector Scheme for PPV&FRA (J. Singh and P.K. Singh; 2006- LT)
2. ICAR Seed Project "Seed Production in Agricultural Crops" (Sanjeev Kumar and P.K. Singh; 2012-2017)

Division of Crop Production

- A 1.1.31 Standardization and optimization of cane node technology for sugarcane planting (S.N. Singh and T.K. Srivastava; 2/12-3/14)
- A1.2.27 Developing efficient water application techniques in sugarcane (A.K. Singh, T.K. Srivastava, Akhilesh Kr Singh and S.N. Singh; 02/10-01/14)
- A1.2.28 Deep tillage under different moisture regimes and N levels for modifying rhizospheric environment and improving sugarcane yield in plant-ratoon system (S.K. Shukla, Er. A.K. Singh and Rajendra Gupta; 2010-13)
- A 1.2.29 Tillage techniques in plant-ratoon system for improving soil health and increasing sugarcane yield in subtropical India (S.K. Shukla, Er. A.K. Singh and Rajendra Gupta; 3/12-3/16)
- A 1.2.30 Yield maximization through optimizing shoot population density (T.K. Srivastava, A.K. Singh and Ishwar Singh; 2/12-3/15)
- A 2.31 Effect of bio-manuring on sugarcane productivity and soil properties under plant and subsequent ratoon (K.P. Singh, T. K. Srivastava and Pushpa Singh; 03/2003 - LT)



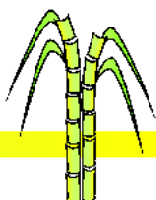
- A 2.35 Assessment of soil fertility status of sugar mill command areas of sub-tropical India (T.K. Srivastava, K.P. Singh R. R. Verma, Om Prakash and R. K. Singh; 03/12-04/14)
- A 7.1 Developing efficient statistical design for conducting weed control experiments in sugarcane (T.K. Srivastava and P.K. Bajpai; 2/10-3/13)
- ET 1.12 Documentation and confirmation of indigenous technical knowledge under sugarcane based cropping system (Kamta Prasad, T.K.Srivastava, K. P. Singh, R. Gupta and A. K. Sah; 2012-15)
- ET 1.13 Assessment of Sugarcane Cultivation Machines (RMD & RBS cum Planter) on Farmers' fields (A.K. Sah, A.K. Singh, Kamta Prasad and R.K. Singh; 9/12-9/15)
- ET 1.14 Entrepreneurship development for sugarcane seed production and multiplication (A.K. Sah, S.N. Singh, Sanjeev Kumar, Ramji Lal, S. N. Sushil and Kamta Prasad; 2012-16)
- A1.2.30 Rationalizing Irrigation Water Use in Sugarcane through Optimizing Field Application Parameters (V. Visha Kumari and Rajendra Gupta, Ishwar Singh, A.K. Singh (11/2013 – 10/2015)
- A 2.36 Assessing nutrient interactions for sustaining sugarcane productivity and soil health (Ram Ratan Verma and Ishwar Singh (2/2013 – 3/2016)
- AS 42 Agronomic evaluation of promising genotypes of sugarcane (S.K. Shukla, Ishwar Singh; Long term)
- AS 63 Plant geometry in relation of mechanization in sugarcane (A.K. Singh, T.K. Srivastava, K.P. Singh; 2011 – 2013)
- AS 64 Response of sugarcane crop to different plant nutrients in varied agro-ecological situations (C. Gupta, S.N. Singh, S.K. Shukla, A.K. Singh; 2011 – 2014)
- AS 65 Enhancing sugarcane productivity and profitability under wheat-sugarcane cropping system (Ishwar Singh, S.N. Singh; 10/2012 – 6/2015)
- AS 66 Priming of cane node for accelerating germination (S.N. Singh, T.K. Srivastava; 2012 – 2013)
- AS 67 Optimization fertigation schedule for sugarcane through micro-irrigation technique under different agro-climatic conditions (R. Gupta, S.K. Shukla, C. Gupta; 2012 – 2014)

Externally Funded Projects

Carbon sequestration potential of sugarcane based cropping system for sustaining crop health and crop productivity in Uttar Pradesh (DST, GOI) 2012 – 2015 (67.204 lakhs)

Division of Crop Protection

- M 2.14 Pathotype formation in *Colletotrichum falcatum* in relation to breakdown of resistance in cane genotype (S.K. Dattamajumder, S.C. Misra and Sangeeta Srivastava; 2/09 - 3/14)
- M 15.4 Management of red rot through modulating host resistance (Ramji Lal, Sangeeta Srivastava, S.K. Shukla, Radha Jain and Sanjeev Kumar; 8/09 – 7/13)
- M 15.5 Management of red rot through fungal endophytes in sugarcane (Sunita Lal and R.K. Singh; 2/09 – 1/14)
- M 15.6 Enhancing efficacy of *Trichoderma* based red rot management system (Deeksha Joshi, A.K. Singh and Pushpa Singh; 2012-2017)
- M 15.7 Mass multiplication of *Trichoderma* on cheaper substrates and development of suitable delivery system for disease management in sugarcane (A. K. Singh and Deeksha Joshi; : 2012-2017)
- M 17 Evaluation/screening of sugarcane germplasm/genotypes against red rot and smut (S.K. Duttamajumder and Ram Ji Lal; 1992-93 to LT)
- M 20.1 Genome sequencing of red rot pathogen (S.K. Duttamajumder, Amaresh Chandra, R.K. Singh, Deeksha Joshi and Nithya, K.; 09/2012-02/2017).
- EM 01 Survey and surveillance of insect-pests and diseases of sugarcane in sub-tropical India (S.K. Duttamajumdar, S.N. Sushil, M.R. Singh and Ramji Lal; 4/06-LT)



- Ento 2.1 Mechanism of resistance against top borer in sugarcane (S.N. Sushil, A. Chandra, A.D. Pathak and M. R. Singh; 4/12-3/17)
- E 4.2(iv) Bio-intensive management of white grubs in sugarcane (S.N. Sushil and Deeksha Joshi; 8/09 - 3/13)
- Ento 11.1 Development of techniques for laboratory mass multiplication of the borers and its parasitoides (M.R. Singh; 2/06 to 3/12)
- Ento 11.2 Development of techniques of mass multiplication of larval parasitoids for management of sugarcane top borer (Arun Baitha and M.R. Singh; 04/12-03/17)
- Ento 15.1 Containment of major insect-pests of sugarcane through habitat modifications (Arun Baitha and M.R. Singh; 4/12 -3/17)
- Ento 15.2 Semiochemicals for the management of sugarcane top borer (M.R. Singh and Arun Baitha; 3/12-2/17)

Division of Plant Physiology and Biochemistry

- PB-22 Physio-biochemical studies concerning survival and establishment of bud chip under normal and encapsulated conditions (Radha Jain, S. Solomon and A.K. Shrivastava; 04/08-03/13)
- PB-23 Optimization of plant population for improving physiological efficiency of sugarcane (R.K. Rai, A.K. Shrivastava, R. Banerji, A. Chandra, Pushpa Singh, S. Solomon and Radha Jain; 2/10-3/13)
- PB-24 Modulating the expression of sucrose metabolizing enzymes for high sucrose accumulation in sugarcane (Radha Jain, A. Chandra and S. Solomon; 10/09 - 3/15)
- PB-26 Developing a technology for preservation & packaging of sugarcane juice (R. Banerji, A. Chandra, S. Anwar and S. Solomon; 2012-2014)
- PB-27 Molecular study to reveal transcriptomes and genes associated with sucrose (GAS) transport and accumulation in sugar (A. Chandra, Radha Jain and S. Solomon; 2012-2017)

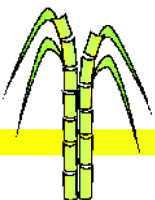
- PB-28 Minimizing post harvest sucrose deterioration and its molecular assessment (S. Solomon, A. Chandra and Radha Jain; 04/2012-03/2015).

Division of Agricultural Engineering

- AE 1.22 D Development of a wide spaced paired row sugarcane cutter planter (A.K. Singh, and Jaswant Singh; 12/08-11/11extended upto 11/2012)
- AE 4.5 Evaluation and refinement of sett cutting mechanism of sugarcane planters (R.D. Singh and P.R. Singh; 3/08-4/12, extended upto 02/14)
- AE 8.1 Design and development of residue mulch-cum-bio-applicator (P.R. Singh, S.K. Shukla and A.C. Srivastava; 9/07 - 2/12)
- AE 9.1 Design refinement of sugarcane-cum-potato planter (P.R. Singh, Rajendra Gupta and A.K. Singh; 7/12 - 6/15)
- AE 1.51 Development of tractor operated sugarcane manager (P.R. Singh, A.K. Singh, Rajendra Gupta and T.K. Srivastava; 4/12 - 12/14)
- AE1.9F Development of sugarcane harvester for small farms (A.K. Singh and P.R. Singh; 3/12- 2/16)
- AE 7.6.2 Development of a jaggery furnace with efficiency boosting device (S.I. Anwar and P.R. Singh; 4/12- 3/15)

Jaggery Unit

- LKO/PHTS/07/2 Development of a small capacity cane crushing unit for house hold purpose (Jaswant Singh and Dilip Kumar; 12/2006 - 03/2013)
- LKO/PHTS/08/01 Evaluation of shrink-wrap, stretch wrap and modified atmosphere packaging for storage of jaggery cubes and blocks (R.D. Singh, Jaswant Singh and S.I. Anwar; 12/2006 - 03/2013)
- LKO/PHTS/11/01 Evaluation of jaggery furnaces (single, double and triple pan) for emission of green house gases and level of bagasse combustion (S.I. Anwar, R.D. Singh and Jaswant Singh; 04/2011 - 03/2014)



LKO/PHTS/11/02 Refinement of juice extraction process with special reference to sugarcane cleaning and juice filtration for 100 kg jaggery/8 hrs (Jaswant Singh, S.I. Anwar, R.D. Singh and Dilip Kumar; 04/2011 - 03/2014)

LKO/PHTS/11/03 Development/ adoption of evaporator for sugarcane juice (R.D. Singh, Jaswant Singh and S.I. Anwar; 04/2011 - 03/2014)

LKO/PHTS/11/04 Development of power operated jaggery moulding machine (Jaswant Singh, R.D. Singh and S.I. Anwar; 04/2011 - 03/2014)

LKO/PHTS/11/05 Development/Adoption of suitable mixer for production of value-added jaggery using *aonla* as a natural source of vitamin C (S.I. Anwar, R.D. Singh and Jaswant Singh; 04/2011 - 03/2014)

AE/PHT-1/2011 Optimization of parameters for shelf life enhancement of jaggery under modified atmosphere packaging (Dilip Kumar and Jaswant Singh; 04/2011 - 03/2014)

Externally Funded Project

LKO/PHTS/12/0 Assessment of harvest and post-harvest losses of major crops/commodities of India [Funded by MoFPI, GOI] (Jaswant Singh, R.D. Singh, S.I. Anwar and Dilip Kumar; 04/2012 - 03/2015)

Agro-meteorology Unit

AM3 Compilation, analysis and documentation of long term weather data base in relation to sugarcane crop culture (Arun Kumar Srivastava, P.K. Bajpai and S.S. Hasan; 3/00 - LT)

AM5 Impact of climate change on sugarcane Insect-pests dynamics & behaviour (Arun Kumar Srivastava, Rajesh Kumar, M.R. Singh and S.N. Sushil; 04/12 to 03/16)

Agricultural Economics, Statistics and Computer Applications section

AES 4.10 Development of decision support tools in sugarcane cultivation (S.S. Hasan, Rajesh Kumar, S.K. Shukla, A.K. Sah and Arun Baitha; 01/08-12/13)

AES 4.12 Developing efficient sugarcane marketing strategies in India (A.K. Sharma and M.R. Verma; 4/10- 3/13)

AES 4.16 Estimation of optimum sample size for evaluation and prediction of cross-performance (P.K. Bajpai, J. Singh, S.S. Hasan and Rajesh Kumar; 3/12-2/15)

AES 4.14 Geographic information system of sugarcane and sugar in India (Rajesh Kumar, S.S. Hasan and P.K. Bajpai; 2012 - 2015)

AES 4.15 Development of data mining and presentation tools in sugarcane (S.S. Hasan, P.K. Bajpai and Rajesh Kumar; 4/12-3/15)

AES 4.16 Use of reflective remote sensing for disease surveillance, nutritional disorder and yield prediction in sugarcane (Rajesh Kumar, Arun Kumar Srivastava, S.K. Duttamajumder, P.K. Bajpai, R.K. Rai and S.S. Hasan; 03/12 to 02/15)

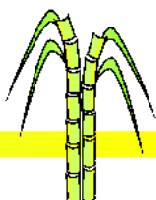
IISR Regional Centre, Motipur, Muzaffarpur, Bihar

B 2.16 (M) Development of waterlogging tolerant and red-rot resistant sugarcane clones for North Central Zone (Devendra Kumar, Sanjeev Kumar and Ramji Lal; 2012-15)

B 1 (M) Evaluation of Sugarcane clones under Zonal Varietal Trials for North Central and Eastern Zone (Devendra Kumar; Long Term)

Externally Funded Project

Bihar Sugarcane Seed Project (Devender Kumar and A.D. Pathak; 03/2013 - 03/2018)

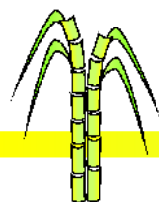




Consultancy and Contract Research

Ongoing Consultancy and Contract Research projects

FMC	Evaluation of sulfentozone 48% F for weed control in sugarcane (A.K. Singh, T.K. Srivastava, S. Solomon)	2012- 2014	7.5 lakh
Sri Ram (DSCCL)	The effect of sugaring on yield and quality of sugarcane crop in composition with bentonite S. sulfozinc and calcium nitrate (S.N. Singh, T.K. Srivastava, V. Visha Kumari, S. Solomon)	2012 - 2014	5.0 lakh
Deepak Fertilizers & Petro chemicals Co. Ltd.	Studies on the effect of Zinc bensulf on yield and quality of sugarcane (R.R. Verma, S. Solomon, S.N. Singh, V. Visha Kumari)	2013 - 2015	6.0 lakh
Nagarjuna Fertilizers	Effect of NP production growth yield and quality of sugarcane in sub-tropical India (S.K. Shukla, T.K. Srivastava, S. Solomon)	Oct. 2012 - March 2014	10.0 lakh
Jain Irrigation	Enhancing water & nutrient use efficiency through drip irrigation & fertigation in spring planted sugarcane under sub-tropical condition (Rajendra Gupta, S.N. Singh)	2012 - 2014	6.0 lakh
NRDC	Performance evaluation of Pusa Hydrogel in sugarcane (Ishwar Singh, T.K. Srivastava, R.R. Verma)	2013 - 2014	1.0 lakh
CSMCRI, Bhavnagar	Evaluation of crop nutrition potential of sea weed sap on sugarcane(Plant & ratoon) (Ishwar Singh, S. Solomon, T.K. Srivastava, S.K. Shukla, R.K. Rai)	2012 - 2013	14.2 lakh
FMC India Ltd	Bio-efficacy of carbosulfan 6G against top shoot borer	March 2012-2014	5.00 lakh
Nagarjuna Fertilizer	Effect of NP-1 product on growth, yield and quality of sugarcane in sub-tropical India	October 2012- March 2014	10.00 lakh
Bayer Crop Science	Evaluation of Fipronil 0.6 GR against ESB and termites	March 2013 -2015	5.00 lakh
DuPont India Pvt. Ltd.	Bioefficacy testing of chlorantraniliprole 35 WG against top, stalk and internode borer in sugarcane	March 2013 -2015	10.00 lakh
Rana Sugars	Evaluation of herbicide in sugarbeet	March 2013 - 2014	1.25 lakh
NRDC	Testing of hydrogel in sugarcane	March 2013 - 2014	1.00 lakh
IPM Biocontrol Labs Pvt Ltd.	Testing of biofertilizer 'Hi-brix' in sugarcane	March 2013 -2015	5.00 lakh
Deepak Fertilizers & Petrochemicals Corporation Ltd.	Studies on the effect of Zinco-Bensulf on yield and quality of sugarcane	March 2013 - 2015	6.00 lakh





Monitoring and Evaluation

Institutional Biosafety Committee

In the meeting of IBSC held on 30 August 2012 under the chairmanship of Director, IISR and subsequently through an In-house Awareness Programme on Biosafety conducted on 5th September 2012, the research activities going on at the Institute, with special reference to the biotechnological research involving sugarcane transformation and future plans in this direction were discussed and the need for the necessary biosafety permission along with other formalities for such research projects were stressed upon by the members. Dr. M. Swapna, Member Secretary gave a presentation on “Sugarcane Biotechnology and Genetic Engineering- Biosafety Issues” signifying the general safety measures to be followed in laboratories and bio-safety measures involved in transgenic production and field testing. The house discussed about the need for strict biosafety norms in the different laboratories and expressed satisfaction on the existing facilities at the Institute.

IRC Meeting

The meeting of the Institute Research Council (IRC) of IISR was held under the Chairmanship of Dr. S. Solomon, Director during September 5-7, 2012. The progress of all the on-going research projects was reviewed and a few new research projects to be initiated were discussed and finalized. Some high priority research programmes to address the problems of low cane/sugar productivity, declining soil health, impact of climate change & weather aberration on sugarcane, deterioration of sugarcane varieties due to red rot and high cost of sugarcane harvesting were suggested by the Chairman, IRC.

Meeting of the Research Advisory Committee (RAC)

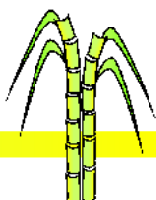
The XVII meeting of RAC of IISR was held on June 28, 2012 under the chairmanship of Dr. S. Nagarajan, Former Chairperson, PPV&FRA and Ex-Director, IARI, New Delhi. Dr. R.P. Sharma, Dr. Bachchan Singh, Dr. J.P. Mishra, Dr. N.

Gopalakrishnan, Dr. S. Solomon, all Heads of Divisions and Dr. A.K. Sharma participated in the meeting. Dr. S. Gopalasundaram, Member Secretary of RAC, SBI, Coimbatore, Shri S. K. Gangwar, GM (Cane), Mawana Sugars Ltd. and Shri Ram Milan Singh, Advisor (Cane), DSCL Group participated in the meeting as special invitees. RAC emphasized upon following points:

- Systematic characterization of germplasm may be taken up with the multidisciplinary approach. Novel ways for managing red rot disease *viz.*, RNAi and miRNA should be explored. Population dynamics study of insect pests should be an integral part of Institute activities.
- International trainings for capacity building of sugarcane research in emerging and modern research techniques.
- Availability of exotic germplasm should be ensured for genetic base broadening.
- An independent unit for social science needs to be created to strengthen extension activities.
- Sugar industry-IISR dialogues should be organized periodically.
- Pathologists should have more collaboration with Crop Improvement and Crop Production divisions.



Research Advisory Committee visited the Fields and Laboratories of the Institute



Institute Management Committee

34th Meeting of the Institute Management Committee was held on March 08, 2013 under the chairmanship of Dr. S. Solomon, Director in the presence of Mr. Murtaza, Mr. Kunwar Ajay Singh (Non-Officio), Dr. O.K. Sinha, Dr. S.K. Shukla, Dr. S.N. Sushil, Mr. Ratnesh Kumar (Member Secretary) and all HoDs, I/c RCM, Programme Coordinator (KVK), Dr. Jaswant Singh, FAO etc. Several decisions on the development of the Institute were taken during the meeting.

Scientific Advisory Committee Meeting of KVK

In accordance with the KVK Guidelines, SAC Meeting of KVK was held on September, 29, 2012 under the chairmanship of Dr. S. Solomon, Director, IISR. The progress report and the action plan of KVK were presented and discussed. The meeting was attended by all HODs of IISR, Officials from District Line Departments, nominated progressive farmers, representatives from Doordarshan and Akashwani and staff of KVK.



Institute Technology Management Committee (ITMC)

The Institute Technology Management Committee (ITMC) meeting of Indian Institute of Sugarcane Research, Lucknow was held on March 26, 2013 under the Chairmanship of Dr. Sushil Solomon, Director, IISR. He welcomed the members and informed about the various Institute technologies which has been commercialized recently as well as in the process for commercialization. The committee also discussed about the new technologies developed by the Institute for its patenting. It was also emphasized that the Intellectual Properties of Institute must be protected. Dr. Solomon reviewed the progress made in terms of Institute - Industry interfaces, contract

services provided and contract research projects carried out in collaboration with private sector. It was apprised to the Chairman that the Institute has earned around Rs. 113 Lakhs during the year by commercializing its various technologies.



RFD Committee meeting

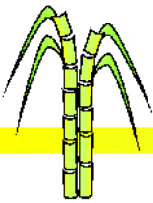
The RFD Committee met number of times during 2011-12. The committee discussed different success indicators and reduced the number of these indicators for the Year 2013-14 RFD, carried out mid-term as well end-of-the-year progress on the achievements on indicators specified for the year 2012-13 RFD. The committee also reviewed the evaluation proforma for RFD 2012-13 in its May 1, 2012 and finalized the section 6 of RFD 2012-13 in its meeting on November 2, 2012.

PMEC meeting

Different rounds of PMEC meetings were held under the Chairmanship of the Director, IISR where in all HODs participated and discussed various issues of prioritization and monitoring.

Monitoring of AICRP(S) Trials

The team constituted under the leadership of Dr. R.B. Doule for monitoring of AICRP(S) trials at the institute visited on 27.08.2012.



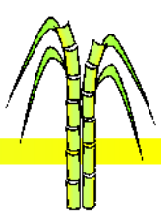
Monitoring of ICAR Seed Project

The Seed Cane plots under ICAR Seed Project were monitored by Dr. Rajendra Prasad, Director, DSR, Mau on 29.06.2012. The trials were also monitored by the team comprising of Dr. R.P. Singh, Director, Seed Farms, BAU, Ranchi and Prof. K. Prabakar, Seed Centre, TNAU, Coimbatore.



Monitoring of DUS Trials

The DUS Trials comprising of 03 New Candidate varieties of sugarcane were monitored on 07.02.2013 at SBIRC, Karnal and 09.02.2013 at IISR, Lucknow by the committee of Dr. P.K. Singh, Dr. T.K. Srivastava and Dr Sanjeev Kumar constituted by PPV&FRA, New Delhi.



Human Resource Development

Model Training Organized

A Model Training Course (MTC) on “Post-harvest management of sugarcane and value addition” approved by Directorate of Extension, Ministry of Agriculture & Cooperation, Govt. of India, New Delhi was organized from November 02-09, 2012. The training was attended by sugarcane development personnel from UP, Bihar, Punjab, Uttarakhand, Odisha and research personnel from UPCSAR, Shahjahanpur, UP. Programme was inaugurated by Dr. G.B. Singh, Ex DDG (NRM), ICAR & VC, JNKVV, Jabalpur. Dr. Singh emphasized the need for fine-tuning of harvesting and crushing schedule of sugarcane to curtail the huge post harvest losses which is of the tune of Rs. 3000-5000 crores per year. The Course Director, Dr. Amaresh Chandra and Dr. S. Solomon, Director, IISR highlighted the technological options for reducing sugarcane post harvest losses in sub tropical India. Lectures and practical sessions on various aspects of post-harvest sucrose losses and value addition in sugarcane were organized. Participants were also exposed to field activities related to post-harvest and live demonstration of jaggery making, value addition and packaging.

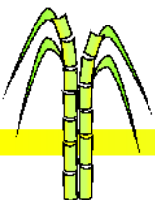


Photo Exhibition Organized: The Magic of Sugarcane

A photography competition was organized during August 15-17, 2012 at IISR to mark the World Photography Day-August 19, 2012. More

than 500 people from all walks of life visited the exhibition. The best entries under different categories such as student, professional etc were suitably awarded.

A Photography Capacity building programme-cum-Exhibition “The Magic of Sugarcane” was organized by IISR in collaboration with Lucknow Camera Club and Society for Sugar Research and Promotion on August 27, 2012. In her inaugural address, Mrs. Bhawana Singh, CEO, Lucknow Cantonment Board appreciated this unique adroitness of science and art with the remark that photography makes any subject alive. Shri Anil Risal Singh, Chairman, Lucknow Camera Club gave a brief about the history of photography and the importance and requirements of photography in the changing scenario.



Post Doctoral Programme at IISR

Under the programme for promotion of sugarcane research and development in Afro-Asian countries, Dr. N.F. Almubarak, Assistant Professor & Head of Field Crop Department, College Of Agriculture, University of Diyala, Iraq has completed Post Doctorate Research Programme in Crop Production Division at IISR, Lucknow, India.



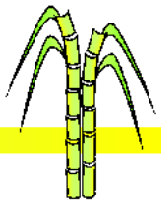
National Seminar on Mechanization of Sugarcane Harvesting

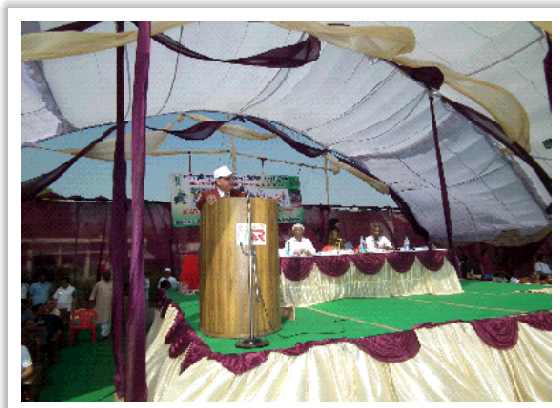
A National Seminar on 'Mechanization of Sugarcane Harvesting- Opportunities and Challenges' jointly organized by IISR, Lucknow and Sugar Technologists Association of India, New Delhi was held at IISR on April 27, 2012. The seminar was inaugurated by Mr. N.C. Bajpai, Deputy Chairman, Planning Commission, Govt. of Uttar Pradesh who in his inaugural address appealed IISR scientists and delegates from R&D institutions to come out with a workable action plan to develop cost effective mechanical sugarcane harvester in near future. Dr. G.B. Singh, Former DG (UPCAR) & DDG (NRM), ICAR, Guest of Honour at the occasion clearly spelt out the urgent need of mechanizing sugarcane harvesting. Dr. S. Solomon, Director informed that the Institute has developed many sugarcane machines like Sett cutting machine, planter, RMD, RBS planter etc. in the past which benefited farmers and sugar industry at large. He also reminded IISR's commitment to develop mechanical harvester and informed that institute has made some progress in this direction with a prototype under field verification. Dr. G.S.C. Rao, President, STAI and Chief Executive, Shimbhaoli Sugars remarked that there is urgent

need to increase sugarcane productivity and enhance farmers' income and technological advancements such as sugarcane harvesters will be necessary for achieving this goal. In the seminar about 150 delegates comprising senior bureaucrats, scientists, implement manufactures, and senior officers from sugar & allied industry and progressive sugarcane farmers participated.

ICAR Sports Tournament-2013 (North Zone) on 19-22 March, 2013 at IISR Campus

ICAR Sports Tournament-2013 for ICAR institutes situated in the North Zone of the country was organized at the institute campus in which 650 participants of 22 different research institutes of U.P., Uttarakhand, Haryana, Punjab, Jammu & Kashmir, Himachal Pradesh participated in 25 different games (outdoor & indoor), field and track events. The programme was inaugurated by Padma Shree Dr. R.C. Sobti, Vice Chancellor, Baba Saheb Bhim Rao Ambedkar University, Lucknow on March 19, 2013 in the newly developed sports





ground situated in the *Ikshupuri* residential colony of the institute. Dr. Sobti congratulated Dr. S. Solomon, Director, IISR in developing beautiful sports facility inside the campus and presume that this may prove milestone in establishing Lucknow as science-cum sports city in times to come. The closing ceremony was marked by the distribution of trophies and medals to the athletes by Dr. Dinesh Sharma, Honourable Mayor of Lucknow on March 22, 2013.

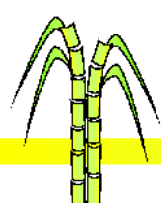
Rajbhasha Hindi Activities

Hindi Karyashala

Three 'Hindi Karyashala' were organized on 19.09.2012, 12.12.2012 and 28.03.2013, wherein more than 175 staff members of the institute were trained for use of Unicode Software and other intricacies of using Hindi in day-to-day official works.

Hindi Fortnight

Hindi Fortnight was celebrated at the Institute during September 14-29, 2012. Various competitions such as essay writing, slogan writing, presentation on Institute's achievements and activities, presentation of research papers in Hindi, Hindi translation, Hindi dictation, Hindi typing, drafting, *Antakshari*, *Aashubhashan*, etc., were arranged for different categories of the staff. A *Kavi Sammelan*, two lectures and a Hindi Workshop were also organized during the celebrations.





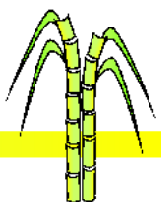
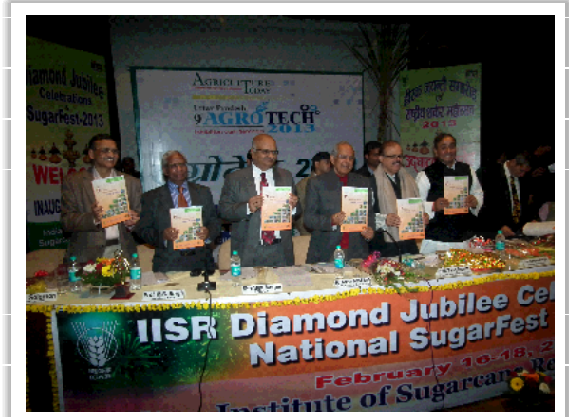
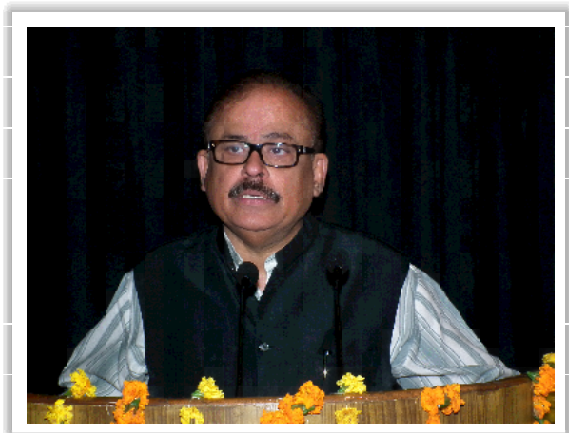
Awards and Recognitions received from NARACAS

Institute's Rajbhasha Patrika 'Ikshu' received second prize, KVK's publication 'Kisan Jyoti' received third prize and Institute received fourth prize for working in Hindi, from NARACAS. Two staff members Shri Brahma Prakash and Shri Subhash Chandra Jaiswal received third and fourth prize respectively in the Essay competition of NARACAS.

National Sugar Fest & Diamond Jubilee Celebrations of IISR (February 16-18, 2013)

National Sugar Fest 2013 was organized on February 16-18, 2013 at Indian Institute of Sugarcane Research, Lucknow (IISR) to commemorate the IISR Diamond Jubilee Celebrations and glorious journey of 60 years since its inception on 16 February, 1952. 'Agro Tech-2013' was also organized in collaboration with Agriculture Today Group, New Delhi during the Fest, with an aim to present holistic and inclusive efforts for developing agriculture *in toto*.

The National Sugar Fest and Agro-Tech were inaugurated by Sri Tariq Anwar Ji, Hon'ble Minister of State for Agriculture & Food Processing Industries, Govt. of India. He also emphasized on strengthening infrastructure like cold storage, cold chain, food processing units etc to avoid 25-40% loss/wastage in vegetables/fruits/grains etc. Hon'ble Agriculture Minister, Govt. of Uttar Pradesh, Shri Kunwar Anand Singh said that only by bringing smile on the faces of farmers, the State or Nation can progress. He emphasized on mechanization of sugarcane cultivation and agriculture to solve the problem of labour scarcity. Dr. Sanjay Singh, Hon'ble Member of Parliament, Prof. R.B. Singh, President, NAAS, Sri Alok Ranjan, APC, Govt. of Uttar Pradesh and Dr. N. Gopalkrishnan, ADG (Commercial Crops), ICAR graced the occasion. Several other dignitaries, more than 15000 scientists, farmers, students, development workers etc participated in different activities and exhibition organized during 03 days of this mega event. Dr. S. Solomon, Director, IISR lead the organizations with Dr. P.K. Singh as Organizing Secretary. Several publications were





released during the programme and various competitions for different stakeholders were also organized.

Trainings/Workshop/Symposium Attended

All scientists of IISR attended, All India Seminar on mechanization of sugarcane harvesting-opportunities and challenges on 27th April 2012 organized by STAI at IISR IISR, Lucknow.

All Scientists of the IISR attended, training on Quality management system as per ISO 9001:2008 standards on 3rd December, 2012 at IISR, Lucknow.

All Scientists and Technical Officers attended the Brain Storming Session on 'IPRs in Agriculture' on 24th November, 2012 organized by IISR, Lucknow.

Dr D.K. Pandey attended inaugural session of "Managing threatening diseases of horticultural, medicinal, aromatic and field crops in relation to changing climatic situation" and Zonal Meeting of Indian Phytopathological society on 3 November 2012.

Dr D K Pandey attended 10 days training programme on Technology Forecasting methods with Application in Agriculture from June 6-15, 2012 at IASRI, New Delhi

Dr J Singh attended training programme on "General Management Programme for Scientists" August 27 - September 7, 2012 at Administrative Staff College of India, Bella Vista, Hyderabad

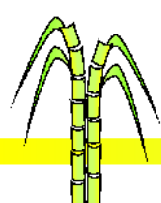
Dr M Swapna attended MDP Workshop on PME of Agricultural Research Projects at NARRM, Hyderabad from 21-25 January, 2013.

Dr M Swapna attended NAIP sponsored training on Scientific Report Writing and Presentation at NARRM, Hyderabad from 25-28 September, 2012.

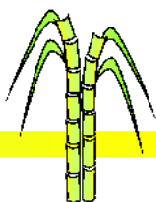
Dr Ram Kewal Singh attended a training on 'IPR and Biotechnology' at NAARM, Hyderabad

Dr Sangeeta Srivastava DBT-CREST Award (2011-12) by Department of Biotechnology, Govt. of India on April 07, 2012

Dr Sangeeta Srivastava delivered Platinum Jubilee Lecture Award in Plant Sciences Section of



- 100th Indian Science Congress held at Kolkata on January 4, 2013.
- Dr Sangeeta Srivastava was nominated as Fellow of Indian Society of Genetics and Plant Breeding in May, 2012.
- Dr. A. K Sah and Kamta Prasad attended a Hindi workshop organized at IISR, Lucknow on September 19, 2012.
- Dr. A. K Sah attended 5th Science Expo 2013 at RSC, Lucknow from Jan. 30 to Feb. 03, 2013 and delivered a lecture in interaction session on the topic "Water cooperation, management and plantation" on Feb. 02, 2013.
- Dr. A.K. Sah attended Group meeting of Jaggery Centres of AICRP on PHT, at IISR, Lucknow on July 07, 2012.
- Dr. A. K. Sah attended MDP workshop on "Advances in Agribusiness Management" organized at NAARM, Hyderabad from January 18-24, 2013.
- Dr. A. K Sah attended workshop on Importance of Plant spacing in Sugarcane, organized on July 27, 2012 by BAMETI, Patna (Bihar).
- Dr. A. K Sah attended XI Agricultural Science Congress on Agricultural Education: Shaping India' Future, organized by NAAS, New Delhi and held at OUAT, Bhubaneswar, Odisha from February 07-09, 2013.
- Dr. R.R. Verma and Ms. V. Visha Kumari attended 21 days national training programme on sugarcane management & development during 1st to 21st July 2013 at IISR, Lucknow.
- Dr. S.K. Shukla attended short course on Use of Simulation Modeling in Climate Change Research: Special reference to Natural Resource Management since 3rd October 2012 to 12th October 2012 at Indian Institute of Soil Science, Bhopal.
- Dr. T. K. Srivastava, Dr. S. K. Shukla, Dr. A.K. Singh, Dr. Ishwar Singh and Ms. V. Visha Kumari attended and presented papers in Third International Agronomy Congress on Agriculture Diversification, Climate Change Management and Livelihoods at New Delhi from November 26-30, 2012.
- Drs S K Duttamajumder, Ram Ji Lal, Deeksha Joshi and A K Singh attended National Conference on "Management of Threatening Diseases of Horticultural, Medicinal, Aromatic and Field Crops in Relation to Changing Climatic Situation" and Zonal Meeting of Indian Phytopathological Society (Mid-Eastern Zone) held at IISR, Lucknow from Nov.3-5, 2012.
- Drs T K Srivastava, Rajesh Kumar, S K Shukla, Chandra Gupta, Ishwar Singh, A D Pathak, D K Pandey, J Singh, Sanjeev Kumar participated in 29th Biennial Workshop of All India Coordinated Research Project on Sugarcane and Crop Production session, organized at TNAU, Coimbatore on October, 19-20, 2012.
- Drs. O K Sinha, A D Pathak, J Singh, P K Singh, Sanjeev Kumar M. Swapna, T K Srivastava, S N Singh, A. K.Singh A K Sah, Ms V Visha Kumari, SK Duttamajumder, Ram Ji Lal, S N Sushil, Maha Ram Singh, Deeksha Joshi, Ms K Nithya, Amresh Chandra, A K Shrivastava, Smt Anita Sawrani, P R Singh, Jaswant Singh, Er A K Singh, Rajendra Gupta, A K Sharma , Arun K Shrivastava and S K Shukla attended workshop and sub-committee meeting on Status of sugarcane development in UP organized at IISR, Lucknow on October 04, 2012.
- Drs. S Solomon, O K Sinha, A D Pathak, P K Singh, Sanjeev Kumar M. Swapna, T K Srivastava, Er A. K.Singh, A K Sah, Ms V Visha Kumari, Ram Ji Lal, S N Sushil, P R Singh, Ms K Nithya, Amresh Chandra, Er A K Singh, Rajendra Gupta, Rajesh Kumar Singh, Ishwar Singh, Sunita Lal, D K Pandey, Ram Keval Singh, Devendra Kumar and S K Shukla attended International Symposium on "Agricultural New paradigms in sugarcane research" on 15-18th Oct 2012 at Sugarcane Breeding Institute, Coimbatore.
- Drs. S Solomon, T. K. Srivastava, A Chandra and Ram Keval Singh attended and presented an oral lecture in International Symposium on new paradigms in sugarcane research at SBI Coimbatore from October 15-18, 2012.
- Drs. T.K. Srivastava, S.K. Shukla, K.P. Singh, S.N. Singh, A.K. Singh, Mrs Hema Pandey, Ishwar Singh, A. K. Sah, Sri Kamta Prasad, Ram Ratan Verma, Ms. V. Visha Kumari, Deeksha Joshi, S S Hasan, and Rajesh Kumar attended SAS statistical software on 28th March 2013 at IISR, Lucknow.



Hasan, S S attended CeRA Sensitization Workshop on February 2, 2013 held at CISH, Rehmankhera and presented report about the utilization of CeRA at IISR, Lucknow

Hasan, S S. attended training programme on "Multimedia Digital Content Development" at National Academy of Agricultural Research Management, Hyderabad during August 22-31, 2012

Ms. V. Visha Kumari attended a workshop on future pathways in Agriculture through youths in India on 1st and 2nd March 2013 at NASC Complex, New Delhi

Rajesh Kumar, Principal Scientist (Ag. Statistics) attended IIRS user interactive meet at Indian Institute of Remote Sensing, Dehradun, Uttarakhand during March 11-12, 2013.

Rajesh Kumar, Principal Scientist (Ag. Statistics) participated and a oral presentation was given during 'Application of Statistical Techniques in International Conference on Statistics and Informatics in Agriculture Research' organized by Indian Society of Agricultural Statistics, New Delhi in its 66th Annual Conference at Indian Agricultural Statistics Research Institute, New Delhi during December 18-20, 2012.

Ram Ji Lal attended International Symposium on "New Paradigm in Sugarcane Research" held at Sugarcane Breeding Institute, Coimbatore from October, 15-18, 2012.

Ram Ji Lal attended AICRP(S) Workshop held at Tamil Nadu Agricultural University campus from October, 19-20, 2012.

P.K. Singh, S.K. Shukla and Sushil S N attended National Sugar Tech-2012 organized by CII (Confederation of Indian Industries) on 31st Aug 2012 at Hotel Taj, Lucknow.

Training Organized

Dr. P. K. Bajpai organised Training in SAS on March 28, 2013.

National Training on Sugarcane Cultivation and Management was organized for sugarcane development personnel of sugar mills during 1-21 July 2012.

Sixteen training sessions of various durations were organized for sugarcane growers during the year 2012-13 at IISR and other locations.

Awards and Recognition

D.K. Pandey, Sunita Lal, P.K. Singh, Sanjeev Kumar, J. Singh and Archana Siraree (2012) received best paper award for "Variability and Correlation between Resistance to Red Rot (*Colletotricum falcatum*) and inter node shape of sugarcane (*Saccharum* Hybrid Complex)". during International Symposium on New Paradigms in Sugarcane Research (ISNPSR-2012) organized by SSRD, Coimbatore & SBI (ICAR), Coimbatore on October 15-18, 2012. Pp. 119-120.

Dr A.K. Singh, Principal Scientist (Agronomy) was elected Treasurer of The Association of Sugarcane technologists of India, Lucknow.

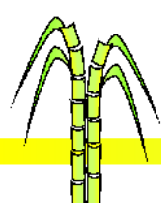
Dr P K Singh served as 'Special Invitee' for the Meeting of Selection Committee for Plant Genome Savior Community Awards- 2011-12 at PPV&FR Authority, New Delhi on 13th September, 2012 under the Chairmanship of Dr R.S. Paroda.

Dr P K Singh worked as 'Expert Member' for the Meetings of 'Project Appraisal Committee' of Uttar Pradesh State Biodiversity Board, East Wing, 3rd Floor, A-Block, PICUP Bhawan, Vibhuti Khand, Gomti Nagar, Lucknow - 226010 from time to time.

Dr P K Singh worked as Organizing Secretary for Agricultural Research & Development Conclave for U.P. and Kisan-Vigyan Sangam-2012 organized on the recommendation of ICAR in collaboration with CISH, NBFGR & CSSRI RRS, Lucknow held at Indian Institute of Sugarcane Research, Lucknow on 23-24 November, 2012.

Dr P K Singh worked as Organizing Secretary for Diamond Jubilee Celebrations of IISR and National Sugar Fest-2013 held at Indian Institute of Sugarcane Research, Lucknow during 16-18 February, 2013 along with Liaison Work for 9th Uttar Pradesh Agro-Tech-2013 organized by Agriculture Today, New Delhi.

Dr S K Duttamajumder received Plant Pathology Leadership Award by Indian Phytopathological Society during "National Conference on Managing Threatening Diseases of Horticultural, medicinal, aromatic and field Crops in relation to changing climatic situation" & Zonal Meeting of Indian

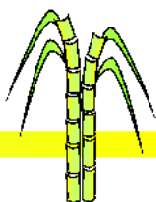


- Phytopathological Society (MEZ) held from November 3-5, 2012 at IISR, Lucknow.
- Dr T K Srivastava, P K Singh and Sanjeev Kumar Conducted Monitoring of DUS Trial at Sugarcane Breeding Institute Regional Centre, Karnal on 7th February, 2013 (vide Office Order No. IISR/PME/2013 dated 30.01.2013).
- Dr. S. Solomon elected as President, Dr T.K. Srivastava & Dr Jaswant Singh as Vice-Presidents, Dr. P.K. Singh as Secretary, Dr. D.K. Pandey as Editor, Dr. A.K. Singh as Treasurer and Dr. A.K. Sah as Joint Secretary of The Association of Sugarcane Technologists of India (ASTI), Lucknow.
- Dr. A. K. Sah nominated as member of Editorial Board in Kisan Jyoti (Annual Magazine, 2012-2013) published by KVK, IISR, Lucknow.
- Dr. A. K. Sah was honored with Commendation letter by Director, BAMETI, Patna for outstanding contribution as resource person in workshop organized by BAMETI at Patna on July 27, 2012.
- Dr. S. K. Shukla received second prize for the poster presentation in International Symposium on new paradigms in sugarcane research at SBI Coimbatore from October 15-18, 2012 for the paper: S K Shukla, A K Singh, Rajendra Gupta and R L Yadav. 2012, Optimizing tillage, moisture regimes and N levels for improving input use efficiency and sugarcane yield in subtropical India.
- Dr. S. N. Singh acted as a member of the committee constituted by the Govt. of India Conducted a study to ascertain the likely impact of poplar plantation on the declining sugarcane productivity and profitability of cane growers in western Uttar Pradesh on June 02-06, 2012 in all the western districts of Uttar Pradesh.
- Dr. T. K. Srivastava acted as Co-Chairman for the session to finalise Technical Programme 2013-14 of the AICRP on Sugarcane held during October 19-20 at Coimbatore.
- Dr. T. K. Srivastava acts as Peer Reviewer for the scientific journals Indian Journal of Agricultural Sciences.
- Dr. T. K. Srivastava was preferred as Chairman, Monitoring Committee, for review and monitoring of training activities of UP Ganna Kisan Sansthan as requested by Cane Commissioner UP.
- Dr. T. K. Srivastava was selected as a Peer reviewer for book "Sugarcane- Bioenergy, Sugar and Ethanol" intended to be published by Springer Publications, Germany.
- Drs P K Singh, S N Singh, A K Singh, Sanjeev Kumar, Ram Keval Singh and S K Shukla Conducted On-site verification of RKVY activities taken up by Cane Department and UPCSR Centres under Basti and Kushinagar districts of Uttar Pradesh from 19-23 June, 2013. The detailed report was submitted to the Cane Commissioner.
- Joshi Deeksha, Misra S C and Singh A K. Best poster presentation award (second) for paper titled "Variability in *Trichoderma* isolates from Sugarcane agro-ecosystem" at the "National Conference on Managing Threatening Diseases of Horticultural, medicinal, aromatic and field Crops in relation to changing climatic situation" & Zonal Meeting of Indian Phytopathological Society (MEZ) held from November 3-5, 2012 at IISR, Lucknow.
- Ms. V. Visha Kumari received best Poster award in International Agronomy Congress, New Delhi for the paper: Menhi Lal, V. Visha Kumari and Asha Gaur, 2012. Rhizosphere modulation through tillage and value added compost in sugarcane ratoon for higher yield.
- Dr. S.N. Sushil nominated as Consulting Editor, Sugar Tech- An international journal of sugar crops and related industries.
- Dr. S.N. Sushil served as Member, Institute Management Committee of CRIJAF, Barrackpore and IISR, Lucknow.

Other Awards

IISR was awarded 3rd Prize for IISR Exhibition Stall (Dr. A.K. Sah exhibited the technologies) in Krishi Fair organized by *Shree Shriksetra Soochana* from May 14-18, 2012 at Puri (Odisha).

IISR was honoured with *UTTAM PURASKAR* (2nd prize) for IISR Exhibition stall (Dr. S.N. Singh and Dr. A.K. Sah demonstrated the technologies) in *Pusa Krishi Vigyan Mela* organized from March 06-08, 2013 at IARI, Pusa.





Dr S. Ayyappan Secretary (DARE) & DG (ICAR) visited IISR Exhibition Stall at Puri



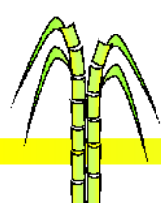
Twenty-five scientists from IISR participated in the International Symposium organized by SBI, Coimbatore



IISR actively participated in Workshop & ISMA Sub Committee Meeting



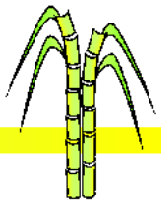
Participation of IISR in farmers' training programmes, Melas etc was duly recognized by the organizers



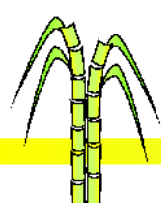
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Distinguished Visitors

Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR visited on 11th August, 2012 and reviewed the research and development programmes of the institute.



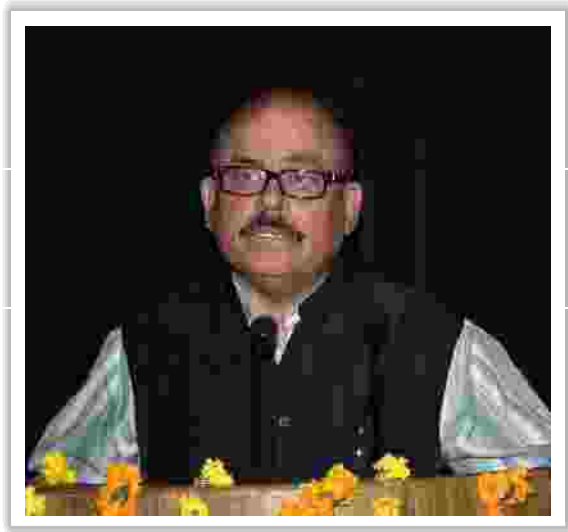
Prof. Swapan K. Datta, DDG (Crop Science), ICAR, New Delhi visited IISR on 26.02.2013 to review the ongoing research activities of the institute. He also inaugurated the 'Ikshu Hub' at the institute.



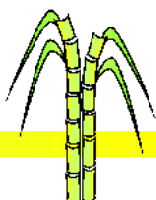
Dr. K.D. Kokate, DDG (Agril. Extension), ICAR, New Delhi visited IISR on 17th February, 2013 and reviewed the progress of KVK of the institute.



Sri Tariq Anwar Ji, Hon'ble Minister of State for Agriculture & Food Processing Industries, Govt. of India visited IISR on 16th February, 2013 and inaugurated the National Sugar Fest-2013 organized on the occasion of Diamond Jubilee Celebrations of the institute.



Mr. Reginald Cooray, Hon'ble Minister of Minor Export Crops Promotion, Govt. of Sri Lanka visited on June 3-5, 2012 along with a high level five members' delegation including Mrs. Herath, Additional Secretary; Mr. S.K. Cyril, Chairman of Sugarcane Research Institute, Dr. N.C. Kumarasinghe, Director/CEO of Sugarcane Research Institute, Sri Lanka and Mrs. Chandrika Cooray, Assistant Secretary, MMECP.





Infrastructure development

During the year 2012-13, institute took-up massive face-lifting programme with internal resources. These included face-lifting of Guest House, Farm area, Ikshupuri residential area, Kharika block, KVK campus, etc. An extremely

useful Play Ground facility for organization of Sports' Events was developed at the Ikshupuri residential area. The list of new infrastructure developed is as below:

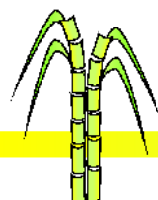
Item	Amount (Rs in Lakh)	Agency
Bio-control Laboratory	62.00	CPWD
Installation of Generator	42.00	CPWD
Prototype shed	13.88	CPWD
Development of Ikshu Hub	0.80	Department
Development of General Store at Ikshupuri Colony	0.35	Department
Installation of Benches and provision of Sheds at Sport Complex at Ikshupuri Colony	1.82	Department
Laying and fixing of interlocking tiles	3.00	Department



Sports Ground at Ikshupuri under preparation

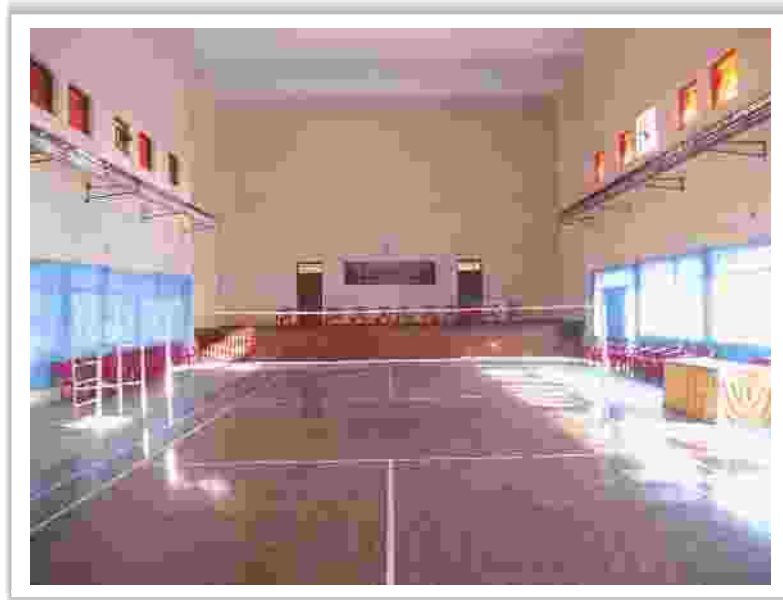


Sports Ground at Ikshupuri ready for ICAR Zonal Sports





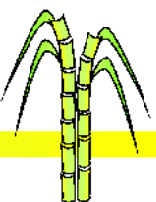
Community Centre: Before and After Facelift



Badminton Court: Ready for the Sports



Institute Campus after Facelift and Gathering of visitors in the Garden



Ikshu Hub

'Ikshu Hub' – a single window outlet for sugarcane products of the Institute was developed near the Main Gate. The Hub was opened for the public by Prof. Swapan K. Datta, DDG (CS), ICAR, New Delhi.



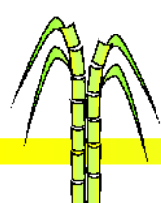
Bio-control Laboratory

Infrastructure for Bio-control Laboratory was completed during the year. The other equipments are being arranged to make the laboratory fully functional.



IISR Cafeteria

IISR Cafeteria was inaugurated on 16th February, 2013 by Dr. N. Gopalkrishnan, ADG (CC), ICAR, New Delhi on the occasion of Diamond Jubilee Celebrations of the institute.

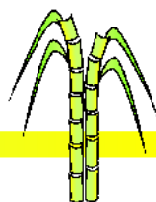




Personnel

(as on March 31, 2013)

Director	:	Dr. S. Solomon
Administration		
Senior Administrative Officer	:	Mr. Ratnesh Kumar
Finance & Account Officer	:	Mr. Arun Kumar Srivastava
Assist. Administrative Officer	:	Mr. Kamala Prasad Yadav
	:	Mrs. Sneha Lata Barjo
	:	Mr. Ram Das
I/C, Security Officer	:	Mr. Sanjay Bhatnagar
PME Cell		
Principal Scientist & Incharge	:	Dr. A.K. Sharma
Principal Scientist	:	Dr. S.K. Shukla
Principal Scientist	:	Dr. S.N. Sushil
Senior Scientist	:	Dr. M. Swapna
Technical Officer	:	Mr. Brahm Prakash and Mrs. Anita Sawnani
Crop Improvement		
Principal Scientist & Head	:	Dr. A.D. Pathak
Principal Scientist (Plant Breeding)	:	Dr. Raman Kapur
	:	Dr. Jyotsnendra Singh
	:	Dr. D.K. Pandey
	:	Dr. P.K. Singh
Principal Scientist (Genetics & Cytogenetics)	:	Dr. (Smt.) Sangeeta Srivastava
Principal Scientist (Genetics)	:	Dr. R.K. Singh
Senior Scientist (Plant Breeding)	:	Dr. Sanjeev Kumar
Senior Scientist (Genetics)	:	Dr. (Ms) M. Swapna
Technical Officer(s)	:	Dr S.K. Awasthi Mr. B.B. Joshi, Smt Hem Lata Madhok, Mr. Raghvendra Kumar, Mr. Ram Kumar Gautam, Mr. Vimal Kumar Saxena, Mr. Ram Murty, Mr. Ram Sewak
Crop Production		
Principal Scientist & Head	:	Dr. T.K. Srivastava
Principal Scientist (Agronomy)	:	Dr. S.K. Shukla
	:	Dr. K.P. Singh
	:	Dr. S.N. Singh
	:	Dr. A.K. Singh



Principal Scientist (Agril. Extention)	: Dr. (Smt.) Hema Pandey
Senior Scientist (Agronomy)	: Dr. Ishwar Singh
Senior Scientist (Agril. Extention)	: Dr. A. K. Sah
Scientist SG (Agril. Extention)	: Mr. Kamta Prasad
Scientist SS (Soil Science)	: Dr. Ram Ratan Verma
Scientist (Agronomy)	: Ms. V. Visha Kumari
Technical Officer(s)	: Dr J.K.S. Gautam, Dr Om Prakash, Mr. Anil Kumar Singh, Dr R. K. Singh, Mr. Ram Darash and Mr. S N Srivastava

Crop Protection

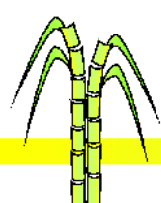
Principal Scientist & Head	: Dr. S.K. Duttamajumder
Principal Scientist (Pathology)	: Dr. Ram Ji Lal
	: Mrs. Sunita Lal
	: Dr. Anil Kumar Singh
Principal Scientist (Agril. Entomology)	: Dr. S.N. Sushil
Senior Scientist (Agril. Entomology)	: Dr. Maharam Singh
	: Dr. Arun Baitha
Scientist SG (Plant Pathology)	: Mr. S.C. Misra
Scientist SS (Pl. Pathology)	: Dr. Deeksha Joshi
Scientist (Plant Pathology)	: Dr. (Ms.) Nithya K.
	: Mr. S.K. Holkar
Technical Officer	: Mr. R B Jadhav, Dr D C Rajak, Smt Pramila Lal, Mr. Amar Nath, Mr. Ashrit Kumar Singh, Mr. B L Maurya, Mr. IP Maurya, Mr. J C Tiwari, Mr. M P Sharma and Mr. Shri Krishna Misra

Agricultural Engineering

Principal Scientist & Head	: Dr. P.R. Singh
Principal Scientist (Farm Mach. & Power)	: Dr. A.K. Singh
Senior Scientist (Soil Water Cons. Engg.)	: Dr. Rajendra Gupta
Technical Officer(s)	: Mr. Jasbir Singh, , Mr. Suresh Kumar Kushwaha, Mr. Chaman Singh, Mr. Julianus Minz, Mr. Rajendra Singh, Mr. Ram Narayan Kureel, Mr. Someshwar Mishra, Mr. Surya Dev Singh and Mr. Ram Sahay Vishwakarma

Jaggery Unit

Principal Scientist (AS & PE) & Incharge	: Dr. Jaswant Singh
Senior Scientist (Farm Mach. & Power)	: Dr. S.I. Anwar
	: Dr. R.D. Singh
Scientist (AS & PE)	: Dr. Dilip Kumar
Technical Officer	: Mr. Sunil Kumar Mishra



Plant Physiology & Biochemistry

Principal Scientist & Head	:	Dr. Amresh Chandra
Principal Scientist (Plant Physiology)	:	Dr. A.K. Shrivastava
	:	Dr. R. K. Rai
	:	Dr. Radha Jain
Principal Scientist (Organic Chemistry)	:	Dr. Pushpa Singh
Senior Scientist (Biochemistry)	:	Dr. Raman Banerji
Technical Officer(s)	:	Dr Namita Arya, Mrs. Anita Sawnani, Mrs. Meena Nigam, Mr. Somendra Prasad Shukla, Dr Ram Kishor and Mr. C. P. Prajapati

Economics & Statistics / AKMU

Pr. Scientist & Incharge	:	Dr. P. K. Bajpai
Pr. Scientist (Agril. Economics)	:	Dr. A. K. Sharma
Senior Scientist (Computer Application)	:	Dr. S. S. Hasan
Technical Officer	:	Dr. Mani Ram Verma

Agrometeorology

Principal Scientist & I/c	:	Mr. Arun Kumar Srivastava
Technical Officer	:	Mr. Surendra Singh

Soil, Water, Plant Analysis and Microbiology Laboratory

Principal Scientist & In-charge	:	Dr. S. K. Shukla
Technical Officer(s)	:	Mrs. Asha Gaur and Mr. Ram Singh

Training Unit

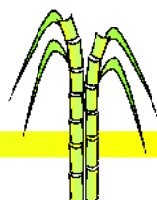
Principal Scientist & In-charge	:	Dr. T. K. Srivastava
Senior Scientist	:	Dr. A. K. Sah
Technical Officer	:	Mr. A. K. Singh

AICRP on Sugarcane

Project Coordinator	:	Dr. O. K. Sinha
Principal Scientist (Agril. Statistics)	:	Dr. Rajesh Kumar
Principal Scientist (Agril. Extension)	:	Dr. R.S. Dohare
Principal Scientist (Agronomy)	:	Dr. Chandra Gupta
Technical Officer(s)	:	Mr. Mahendra Singh, Dr G. K. Singh and Mr. Adil Zubair

Farm Section

Principal Scientist & In-charge	:	Dr. T.K. Srivastava
Farm Manager	:	Mr. C. P. Singh
Technical Officer(s)	:	Mr. B. B. Singh, Mr. Nar Singh and Mr. Faujdar Singh



Institute Technology Management Unit

Nodal Officer & Scientist Incharge	:	Dr. A. K. Sharma
Technical Officer	:	Mr. Brahm Prakash

Krishi Vigyan Kendra

Programme Coordinator & In-charge	:	Dr. R. K. Singh
SMS (Home Science)	:	Dr. (Smt.) Veenika Singh
SMS (Plant Protection)	:	Mr. Deepak Rai
Technical Officer	:	Dr. Rakesh Kumar Singh

Hindi Unit

Principal Scientist & I/C	:	Dr. S. K. Shukla
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Art & Photography

Principal Scientist & In-charge	:	Dr. A. K. Sharma
Technical Officer(s)	:	Mr. Vipin Dhawan, Mr. Y.M. Singh and Mr. Avadhesh Kumar

Dispensary

Incharge	:	Mr. Ratnesh Kumar
Senior Medical Officer	:	Dr. S.K. Sethi
Technical Officer	:	Mr. D.N. Sinha

Library

Principal Scientist & In-charge	:	Dr. Askok Kumar Srivastava
Technical Officer(s)	:	Mr. G. K. Gupta and Mr. Ghanshyam Ram

In-charge, Seed Production Unit	:	Dr. Sanjeev Kumar
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In-charge, Vehicle	:	Mr. K.P. Yadav
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In-charge, Landscaping	:	Mr. S. D. Tewari
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In-charge, Guest House	:	Mr. Ratnesh Kumar
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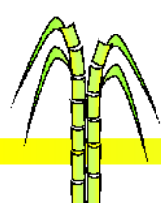
Manager, Guest House	:	Mr. R.K. Singh
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Estate Section

In-charge	:	Mr. M.H. Ansari
Technical Officers	:	Mr. Vinayak Savant, Mr. Krishna Nand Singh, Mr. Kaloo Ram, Mr. Lakhan Lal Verma, Mr. Rajendra Singh, Mr. Umesh Kumar and Mr. Vishva Nath Mehrotra and Mr. G. Prasad

IISR Regional Centre, Motipur (Bihar)

Senior Scientist (Pl.Br.) & Incharge	:	Dr. Devender Kumar
Senior Scientist (Agronomy)	:	Dr. V.P. Jaiswal (on leave)
Technical Officer	:	Dr. Anoop Singh Sachan



Joined

Name	Designation	Date
Ms. Sonali Chopra	Assistant	21.05.2013

Transfers

Name	Designation	From	To	Date
Dr. R.S. Dohare	Pr. Scientist (Ag. Extn.)	Zonal Coordinating Unit-VI, CAZRI, Jodhpur	IISR, Lucknow	21.05.2012
Dr. Ram Ratan Verma	Scientist (Soil Science)	ICAR Research Complex for Goa, Goa.	IISR, Lucknow	01.06.2012
Dr. Anoop Singh Sachan	T-6	IIPR, Kanpur	IISR RC, Motipur	03.09.2012
Mr. Abhishek Kumar Singh	T-4 (Hindi Translator)	ICAR Research Complex for E. Region, Patna	IISR, Lucknow	29.05.2012

Promotions

Name	Designation	Effective Date
Scientific		
Dr. P.K. Singh	Pr. Scientist	01.01.2009
Dr. Anil Kumar Singh (Agro.)	Pr. Scientist	01.01.2009
Dr. Akhilesh Kr. Singh (FMP)	Pr. Scientist	01.01.2009
Dr. (Mrs.) Radha Jain	Pr. Scientist	25.07.2009
Dr. Chandra Gupta	Pr. Scientist	29.09.2012
Dr. (Ms.) Swapna M.	Sr. Scientist	24.11.2007
Dr. S.S. Hasan	Sr. Scientist	11.08.2011
Mr. Kamta Prasad	Scientist (SG)	24.06.2007
Technical		
Dr. S.K. Awasthi	T-9	03.02.2012
Dr. D.C. Rajak	T-9	16.02.2012
Dr.(Mrs.) Namita Arya	T-9	03.02.2012
Mr. Sanjay Bhatnagar	T-9	27.09.2012
Mr. Ram Darash	T-(7-8)	01.01.2012
Mrs. Anita Sawhani	T-(7-8)	27.09.2011
Mr. M.H. Ansari	T-(7-8)	24.02.2011
Mr. Vinayak Sawant	T-(7-8)	04.05.2011
Mr. Vipin Dhawan	T-(7-8)	01.01.2009
Mr. Yogesh Mohan Singh	T-(7-8)	25.06.2010
Mr. G.K. Gupta	T-(7-8)	03.02.2005
Mr. G.D. Dhariyal	T-(7-8)	01.01.2008
Mr. Ghanshyam Ram	T-(7-8)	16.08.2010
Mr. Awadhesh Kumar Yadav	T-6	01.04.2012
Mr. Akhilesh Kumar Singh	T-6	07.01.2011
Mr. Sunil Kumar Mishra	T-6	21.04.2012
Mr. Umesh Kumar	T-6	18.08.2012

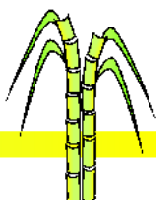
Name	Designation	Effective Date
Mr. B.D. Singh	T-5	01.01.2009
Mr. Somnath Singh	T-4	17.03.2012
Mr. A.K. Vishwakarma	T-3	03.09.2012
Mr. Sudhir Kumar	T-2	31.08.2011
Mr. Heera Lal	T-2	31.08.2011
Mr. Dildar Hussain	T-1	23.07.2012
Mr. Kunwar Kailash	T-1	23.07.2012
Mr. Inder Singh Chauhan	T-1	23.07.2012
Administration		
Mr. H.C. Pandey	Assistant	24.04.2012
Mr. Prashant Kamal Srivastava	Assistant	24.04.2012

Financial Up-gradations to Administration and Supporting Staff Under MACP

Name	Designation	Effective Date
Mr. Ram Sanwarey	Steno Gd. III	26.04.2012
Mr. Vishwanath	LDC	21.11.2011
Mr. Dharmendra Singh	SSS	05.01.2012
Mr. Munna Lal	SSS	24.03.2012
Mr. Badal Ram	SSS	18.05.2012
Mr. Triloki Prasad	SSS	18.05.2012
Mr. Mohd. Hannef	SSS	26.08.2012

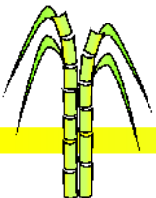
Necrology

Name	Designation	Date
Mr. S.K. Savita	T-5	21.07.2012
Mr Faqir Mohd.	SSS	13.02.2013



Superannuation

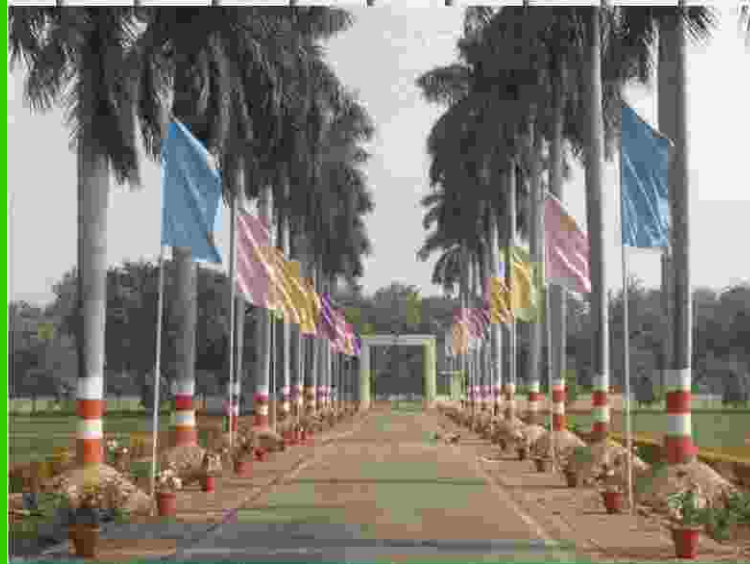
Name	Designation	Date
Dr. A.C. Srivastava	Pr. Scientist	31.05.2012
Er. R.K. Pangasa	Pr. Scientist	30.06.2012
Mr. Ram Hit	T-6	30.04.2012
Mr. G.D. Dhariyal	T-(7-8)	31.08.2012
Mr. S.K. Pal	T-9	31.01.2013
Mrs. Usha Kiran Sharma	Assistant	31.08.2012
Mr. R.K. Khanna	AAO	31.10.2012
Mr. Mohd. Hanif	SSS	31.08.2012



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भारतीय गन्ना अनुसंधान संस्थान

लखनऊ-226 002, उत्तर प्रदेश, भारत

Indian Institute of Sugarcane Research

Lucknow - 226 002, Uttar Pradesh, India

Tel: +91-522-2480735-737; Fax: +91-522-2480738

E-mail: iisrko@sancharnet.in

www.iisr.nic.in