2011-12

Annual Report

भारतीय गन्ना अनुसंधान संस्थान, लखनऊ

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Indian Institute of Sugarcane Research, Lucknow


भारतीय गन्ना अनुसंधान संस्थान, लखनऊ
INDIAN INSTITUTE OF SUGARCANE RESEARCH, LUCKNOW
टेक्नोलॉजी पार्क
TECHNOLOGY PARK
Technology Demonstration
प्रदर्शित तकनीक

वार्षिक प्रतिवेदन
Annual Report

2011-2012

भारतीय गन्ना अनुसंधान संस्थान
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Cover Photograph

Bud chip raised mature sugarcane crop

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Preface

World sugar production is still heavily dependent on weather and characterized by continued cyclical production patterns. In recent years, the cycle has been more pronounced, with larger swings in production and trade. Sugar production in India, in spite of various intrinsic and extrinsic cycles has reached 26 MT (2011-12) registering a growth of around 8% as compared to last year. The major sugar producing states, viz., Tamil Nadu, Uttar Pradesh and Maharashtra have recorded nearly 29, 18 and 11 per cent increase in sugar production, respectively, compared to the previous year. The country has a comfortable surplus of around 4 MT for exports from the current year's production. The projections for 2012-13 showed that the aggregate planted area this year will be as much as it was last year (5.06 M ha) or possibly a little higher because growers have received remunerative prices and are likely to maintain the planted area or even expand it. The higher farm incomes are sure to encourage growers to undertake improved input application and management practices, the positive effect of which may be seen in yield and quality. Subject to normal weather, it is reasonable to expect that in 2012-13 season, India's sugarcane & sugar production will sustain, although sugarcane crop in some areas have been affected by erratic monsoon and this may hinder productivity to some extent.

Sugarcane agriculture in India, especially in sub-tropics is facing serious challenges in terms of sustainability, impacted by multiple factors such as climate change, escalating cost of cane production, declining soil health, emerging new diseases and pests, labour scarcity, abiotic stresses are severely impeding cane productivity and sugar recovery. In Uttar Pradesh alone which has 2.24 M ha under sugarcane cultivation (2011-12), decline in cane productivity and sugar recovery were 17 and 13.4%, respectively, compared to national average. State Governments are addressing some of these problems through Rastriya Krishi Vikas Yojana (RKVY) by distributing seed cane, micro-nutrients, pesticides, etc., to cane farmers. The Government of Uttar Pradesh has recently recommended cultivation of improved sugarcane varieties in the state, released through Cental Varietal Release Committee (CVRC). These programmes and policy reforms may gradually help in bridging the productivity gap, however, the solution to some of these problems is required not only at the technological front but also at the administrative and policy levels. This necessitates strong liaisoning and collaborative efforts on the part of the research organisations, sugar mills and the state cane departments. Keeping this in view, the Institute has re-organized its research priorities to efficiently address the problems of the farmers and the sugar industry. The R & D Roadmap of IISR focuses on transforming sugarcane agriculture through farmer-centric innovations, encompassing development of improved (high yielding-high sugar & diseases - insect pest tolerant) varieties for normal and specific situations, precision planting

& high density sugarcane cropping modules, high productivity-management package for ratoon crop, bio-intensive management of diseases and insect-pests, bio-fertilizers, development of precision machines and refinement of existing ones; improving sugarcane value chain and intensive training & field demonstrations to farmers and cane development officials on the scientific production-management of sugarcane. These initiatives may help in breaking the infamous sugar cycle which erodes the sustainablility of sugar and integrated industries.

Recently, the Institute has initiated many outreach programmes to disseminate its technologies through in-house training, demonstrations in selected areas, organization of Kisan Melas and awareness programmes for cane farmers and cane development officials in the farmers fields & mill area. The current Government decision of mandatory blending of 5% ethanol in petrol is yet another major challenge for our scientists to apply innovative approaches for vertical improvement in sugar productivity. A greater level of preparedness and planning is essential to meet these emerging challenges. The IISR and other sugarcane research institutions have a major role to play in the imminent future to restore the economic sustainability of the contemporary sugar industry.

The Annual Report (2011-12), highlighting the R&D Roadmap and research achievements of IISR band to improve sugarcane production & production efficiency, consists of 30 theme based chapters. This report is a comprehensive reflection of all the Institute's activities during the year 2011-12 (April-March). The unstinted support and guidance received from Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr. Swapan K. Dutta, Deputy Director General (Crop Science), and Dr. N. Gopalakrishnan, Assistant Director General (CC) and RAC members in shaping & developing this institute is duly acknowledged with gratitude and respect. I thank all the Heads of Divisions / Incharges of Sections and all scientists for their cooperation in providing the information in the requisite format. I appreciate the excellent efforts made by the Editorial Board viz., Drs. A. Chandra, T.K. Srivastava, A.K. Sharma, R.K. Singh, S.N. Sushil, Ms. V. Visha Kumari and Mr. Brahm Prakash in compiling and developing the report to its present form.

(S. Solomon)
Director

Contents

Executive Summary

Breeding cane for abiotic tolerance and red rot resistance, suited to sub-tropical cane belt

- Two hundred eighty four genotypes consisting of *Saccharum officinarum, S. barberi, S. sinense,* ISH clones, Ikshu ISH dones, LG selections, commercial hybrids *etc.*, were maintained. Eighteen commercial hybrids with weak sheath adherence were identified. Five genotypes were found to be superior in sugar over CoJ 64 and all these have come from the LG breeding stock utilized in breeding at the NHG in SBI, Coimbatore.
- Two genetic stocks tolerant to top borer (LG 06609 and LG 05610) and two genetic stocks resistant to Cf 08 and Cf 09 races of red rot (LG 06810 and LG 6838) were sent to NHG of SBI, Coimbatore for indusion as parental lines for breeding work.
- Three early (CoLk 11201, CoLk 11202 and CoLk 11203) and three mid-late varieties (CoLk 11204, CoLk 11205 and CoLk 11206) were accepted for multi-location testing under North-western Zone of AICRP (S).
- In station trial, six early clones *viz.*, LG 05003, LG 06599, LG 06605, LG 06361, LG 05020 and LG 05002 and four mid-late clones LG 06810, LG 06839, LG 05306 and LG 06602 were found promising.
- Genetic transformants in variety CoLk 8102 with *Agrobacterium* strain carrying *Cry1Ab* gene have been developed for borer tolerance and further confirmed through Southern hybridization.
- Twenty-six primer pairs designed for RGA showed clear amplifications. Sequence analysis of specific amplicons revealed matching of some of the sequences with the resistance gene-like sequence of *Saccharum* hybrid cultivars.
- Forty primer pairs from sugar metabolism-related sequences were synthesized and are being tested in the parental and segregating population. Five primer pairs showed variation with respect to the clones studied. These along with putative markers for sugar content identified earlier are being tested in mapping population.
- Two hundred fifty four EST-SSRs were validated in 12 sugarcane genotypes, and 52.2 per cent EST-SSRs showed polymorphism. Phenotyping and genotyping of two sets of mapping populations (124 clones of diverse origin and 136 clones of self of CoS 96268) were carried out against red rot using 210 EST-SSR and gSSR primers.
- Marker-trait association by general linear model (GLM) using TASSEL identified two putative EST-SSR markers namely U-Ctg1278_240 and UCtg740_140 associated with number of millable canes and sucrose content, respectively.

Technology for high density cane farming through appropriate agronomy, precision machines and superior varieties

- Under autumn planting, encapsulated bud chips showed higher moisture retention capacity (65%) and early and higher rate of bud germination (70%) and higher rate of plant survival (~ 50%) as compared to un-encapsulated control bud chips.
- With bud chips transplanting techniques, higher seed multiplication rate (5 to 6 times) compared to conventional method, higher cane height (>2.0 m), weight (>1.0 kg), NMC/clump (>4), higher cane yield (~120 t/ha) and saving of 80% seed material were observed. Easiness in transportation of bud chip as seed material as well as its treatment was also noticed.
- Genotype CoPk 05191 produced the highest number of millable cane (99.8 thousand /ha) followed by CoLk 05031 (97.7 thousand/ha) and CoLk 99270 (61.6 thousand/ha). Genotype CoPk 05191 produced thicker and heavier canes (2.59 cm cane diameter and 0.93 kg individual cane weight) as compared to other genotypes. Higher cane (72.68 t/ha) and

sugar yields (8.22 t/ ha) were obtained with genotype CoPk 05191.

- Prototype of tractor operated interculturing equipment was developed for weeding and interculturing of wide spaced paired row cane crop (120:30 cm). The effective field capacity of the equipment was 0.35-0.40 ha/h.
- Higher sugarcane yields (77-82 t/ha) owing to management of weeds through sulfentrazone, (720 or 840 g a.i./ha) were obtained over untreated control (60 t/ha).

Soil Nutrition and Health for Higher Tonnage and Enhanced Quality of the Cane

- A microbial consortia (MC) was evaluated in wheat-sugarcane sequential and inter-cropping systems for its efficacy to reduce the requirement of externally applied nutrients. Seed inoculation and soil application of MC could effectively save 50% of recommended NP and K in both the systems as wheat (5.2 t/ ha) and sugarcane yields (71.9 t/ha) were comparable with that of recommended NPK (5.1 and 71 t/ha).
- Cross sub-soiling at 1.0 m distance recorded the highest ratoon shoot population (192.2 thousand/ha at 180 DAP), number of millable canes (190.2 thousand/ha), ratoon cane (77.1 t/ha) and sugar yield (8.16 t/ha) as compared to control. This treatment was followed by cross sub-soiling at 1.5 m distance and sub-soiling at 1.0 m distance. Higher infiltration rate (3.94 mm/h) and lower bulk density (1.33 Mg/m^3) were recorded in plots where cross sub-soiling at 1.0 m distance was done in plant crop. Root biomass increased from 0.30 t/ha in no sub-soiling to 0.64 t/ha under cross sub-soiling. Under conventional tillage, root biomass production was 0.51 t/ha. Corresponding increase in cane yield was recorded to be 77.1 t/ha over that of 58.8 and 66.3 t/ha.
- Rhizospheric environment of ratoon was compared with that of plant crop. Substantially higher degree of soil nitrogen bonding was recorded with lignin derived residues (66%) in ratoon rhizosphere as compard to plant crop rhizosphere (7%). This indicates higher immobilization of N in ratoon soils. Ratooning induced effects in rhizospheric environment revealed significant decline in CEC roots (31%) of the ratoon crops as compared to the plant crop. The membrane leakages (41%) of the ratoon roots were significantly higher than the plant crop. There was significant reduction in the root NR activity (62%) and N uptake by the ratoon plant as compared to the plant crop during the grand growth phase, when the requirement by the plant for the nutrients is maximum.
- Application of $ZnSO_4$ (25 kg/ha) and sulphur (40 kg/ha) along with recommended dose of NPK was found to significantly add to the cane yield (61 t/ha) as compared to recommended dose of fertilizers alone (55.2 t/ha).

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

- Significantly the highest rate of germination (48.6%), shoots (2,11,600/ha at 150 DAP), number of millable canes (1,34,000/ha), cane yield (84.4 t/ha) and sugar yield (9.67 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 highest under this treatment. Paired row planting (120:30 cm) with irrigation applied in furrows parallel to single row system fetched the IWUE of 3102.7 kg cane/ha-cm.
- Deep tillage before sugarcane planting increased number of millable canes (83,600/ ha), individual cane length (176.5 cm), cane diameter (2.29 cm) and individual cane weight (0.66 kg) over the control. There was 13.23% increase in mean ratoon cane yield (52.37 t/ ha) with deep tillage and sub-soiling over the conventional tillage practices. Tillage and N interaction on water use efficiency (WUE) showed that deep tillage and subsoiling operation conserved soil moisture for better crop growth. The highest WUE (96.97 kg cane/

ha-mm) was obtained with deep tillage and subsoiling with application of 150 kg N/ha. Whereas, the lowest WUE (64.55 kg cane/ha-mm) was obtained with conventional tillage and no N application.

- The highest irrigation water use efficiency (1.21 t/ha-cm) was recorded in irrigation at IW/CPE ratio of 0.75, followed by IW/CPE ratio of 0.50 (1.20 t/ha-cm). Significant highest shoot population (1,66,100/ha), number of millable canes (1,36,100/ha) and cane yield (79.7 t/ha) was observed at 30:120 cm row spacing.

Improving production, quality and economic return of ratoon crop

- Continuous use of SPMC @ 10 t/ha + *Acetobacter* meets the nutritional requirement of crop as yield of 8th ratoon under the treatment (54.2 t/ha) was higher than that with recommended NPK (49.8 t/ha). It also maintained soil quality parameters. Bulk density reduced to 1.23 from 1.4 Mg/m^3, infiltration rate increased from 4.0 to 5.9 mm/h, soil microbial biomass carbon enhanced to 272 from 47.6 mg CO_2 –C/kg soil/day at the harvest of 8th ratoon.
- Potassium fertigation @ 80 kg K/ha in standing plant cane increased number of buds per stubble and number of stalks in ratoon cane.

Management of insect pests and diseases in their "hot-spot" through survey, pathotyping, biocontrol and other innovative approaches

- Factory command area of 20 sugar mills of U.P., Uttarakhand, Madhya Pradesh, Bihar and Maharashtra were surveyed and the incidence of major insect-pests and diseases was recorded. In general, incidence of red rot was low (1-2%) while GSD was a bit high in few fields of western UP. The incidence of stinking rot and Pokkah boeng was noticed especially in waterlogged situations. Top borer infestation was around 10-15%, Damage caused by early shoot borer was 5-30%. White grub infestation was very high (25-50%) in certain fields of western U.P. and Uttarakhand. At Pravaranagar (Maharashtra), maximum incidence of ESB was recorded in the first fortnight of May along with the activity of its larval parasite *Sturmiopsis* sp.
- Eleven new isolates were collected and were evaluated for their virulence pattern on designated 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*) and SES-594 (*S. spontaneum*). All the isolates showed close proximity with already identified *C. falcatum* pathotypes *viz.*, Cf 01, Cf 03, Cf 07 and Cf 10. Hence, there was no emergence of any new virulent pathotype in this zone.
- Gel electrophoresis of PCR products showed expression of chitinase and β-1, 3-glucanase genes after inoculation of pathogen. This expression was higher in resistant over susceptible genotypes.
- Fungal endophytes isolated from different parts *i.e.*, leaf, midrib, bud, node, internode and root of sugarcane (plant and ratoon) in different months. Over-all colonization rate of endophytes was higher in leaves and roots as compared to nodes, internodes and buds. The most dominant endophytes were species of *Trichoderma* and *Fusarium*.
- Dual culture study revealed that *Trichoderma* and *Aspergillus* were antagonistic against red rot pathogen. Efficacy of culture filtrate/metabolites of *Trichoderma* and *Aspergillus* were evaluated. Mycelial growth of *C. falcatum* declined significantly with increasing concentrations of culture filtrate and at 5-10% concentration, complete mycelial inhibition was observed
- One hundred sixty genotypes were screened against red rot (Cf 08 and Cf 09) and smut at IISR, Lucknow. Seventy seven genotypes were moderately resistant (MR), 41 genotypes were susceptible (MS to HS) to both the pathotypes, 42 genotypes showed either (MR)/ susceptible (MS to HS) reaction to one of the pathotypes. In case of smut, 149 genotypes were resistant and remaining 11 were susceptible. Natural incidence of wilt was also recorded and 108

genotypes were found resistant while 52 were susceptible.

- Pheromone traps of top borer, ESB and stalk borer were installed in two sugarcane fields. Lures of top borer proved to be effective in attracting the moths, which resulted in the reduction of the incidence of top borer to some extent, in different broods. There was less attraction for stalk borer and almost nil for ESB moths.
- In an experiment for the control of termites, maximum germination was found of buds with treatment of Chlorpyriphos 20 EC (40.91%), whereas highest cane yield was obtained under treatment of Imidacloprid 17.78 SL (84.67 t/ha). Yield was found significantly low in untreated check (49.33 t/ha).
- Mass emergence of *H. consanguinea* beetle was recorded in western U.P. from 2nd week of May 2011 to last week of June 2011 and almost ceased by July 15. Insect traps were modified (light + pheromone) and fabricated for testing against beetles. The newly developed trap was found more effective in trapping *H. Consanguinea* in comparison to the traps with only pheromone or light alone. Traps were installed in the white grub affected villages of Distt. Saharanpur, Lakhimpur Kheri (Uttar Pradesh) and Pravaranagar (Maharashtra).

Basic and fundamental research on physiology, biochemistry and molecular approaches

- Mixture of chemicals improved and hastened the germination (65-74% vs 25-34 & 15-20 vs 45-50 days) and thereby early growth and leaf development leading to higher attainment of LAI (~1 over 0.3 in control) at 70-75 DAP.
- This also resulted in higher average cane weight. Control (520 g), water primed control (680 g), $MnSO_4$ (930 g), resorcinol (850 g), mixture of coenzymes (810 g) and mixture of phosphorus (750 g).
- Source and sink strength improvement was recorded with GA treatments in variety CoSe 92423. This improvement was recorded even in later stage of growth.
- Real time PCR gene expression revealed differential expression of SPS, SS, SAI and CWI genes in two sets of sugarcane varieties namely CoJ 64 and BO 91 differing in sucrose accumulation and maturity.
- In general, expression of sucrose synthesizing genes was higher and for longer time in high sugar accumulating and early maturing variety CoJ 64 than those of low sugar and mid late maturing variety BO 91.

Improving the native *Gur, Khandsari* and other forms of sugar and making it move in the value addition chain as new marketable products

- The properly assembled crushing unit with effective capacity varying from 20 to 30 kg/h with juice recovery percentage of 50 to 60 (cane weight basis) was tested. In another testing of the modified crusher, it was observed that juice extraction increased up to the maximum value of 64 per cent and crushing capacity reached up to 419 kg/h. The solar dryer unit for 100 kg per batch capacity for drying jaggery from about 12% moisture content to 6% moisture has been developed and tested at full load conditions. The temperature difference between cabinet and ambient ranged from 11 to 26^{0}C. The drying rate of jaggery was found as 0.3 kg moisture per hour. In another study on jaggery packed in nitrogen, shrink wrap and stretch wrap conditions and stored for 6 months revealed that the nitrogen environment expressed best quality in comparison to all other conditions.
- In case of value-added jaggery prepared using aonla, samples showed less amount of sucrose as compared to plain jaggery due to acid inversion carried out in presence of vitamin C (Ascorbic acid). This also resulted in higher values of reducing sugars and reduced pH. The colour of jaggery was also affected. Moisture content, increased like plain jaggery during monsoon period. Loss of vitamin C was observed between 15.96 to 24.67% during storage period.

Research and development activities on sugarbeet

- Fifty two germplasm lines are being

maintained at Mukteswar (Uttarakhand).

- Forty germplasm lines were evaluated for root crop performance and IN-3, IN-14, IN-08, Cauvery, PAC-60009, PAC-60008, Indus, FC-720 were superior in sucrose and gross sugar yield, while LK-8 was tolerant to root rot. Of the three composites and four progenies of hybrids evaluated for root crop, LKC-2006, LKC-2007, HTHB X LS-6 and SR-96 X LS-6 possessed superioriy in root yield. SR-97 X LS-6 and LKC-2007 were found tolerant to root rot. Progenies of SR-97 X LS-6, SR-96 X LS-6 and LKC-2007 were found tolerant to army worm.
- Fifty four kg seed of indeginous varieties and breeding lines were produced.

Information, data compression, analysis and development of new evaluation procedures

- Modified layout involving additional row arrangement in existing RBD for weed control experiments enabled covariance analysis for weed number and their dry weight which resulted in improvement in efficiency of existing design with respect to MSE, CD, CV and R^2 values.
- Database of statewise area, production, productivity, sugar production, sugar recovery, cane crushed, average crushing duration, no of sugar factories (1951-2011) are made available on the Institute website and monthly prices of sugar, *gur* and *khandsari* in different major markets in India (2001-2011) is also made available on intranet of the Institute.
- Software has been developed to provide accessibility of disorder diagnosis system on mobile platform. It consists of interface (View), inference engine and knowledge base (Model) and triggering events (control). Developed system has been successfully tested on mobile.

Trade, economic analysis on domestic prices and area fluctuations

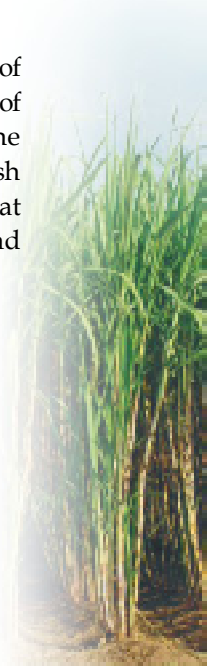
- In value terms, the Indian sugar exports have always been less than 1% of the total exports of all commodities from India. The value of total Indian exports was ₹ 1,14,268 thousand lacs and that of sugar exports ₹ 1142.4 thousand lacs during 2010-11. The shifts in India's sugar trade are increasingly significant for world markets, contributing to period of both undersupply and oversupply. India's record 2007-08 exports accounted for about 11 per cent of global sugar exports, and record imports in 2009-10 accounted for 12 per cent of world sugar imports. The factors of world sugar price fluctuations and implications for cane price acreage in India have been identified.
- The impact assessment of ICT intervention in sugarcane marketing in UP has been assessed. The benefits to farmers on account of saving in travel cost, increased supply of sugarcane to the sugar mill, higher income by allocating more area under sugarcane, an increase in cane productivity, and higher weight of farmers' cane due to fresh sugarcane supply were estimated to the tune of ₹ 8465 million. The impact has also been assessed on sustainability parameters like transparency, coverage, increase in efficiency, financial viability, cost to the Government, replicability, and the work culture towards the use of IT in rural areas.

Patents

- A patent application on "Technology for priming sugarcane plantation material, its packaging, transportation and certification" was filed (No. 1795/ DEL/2011) with New Delhi Patent Office on June 24, 2011.

Seed Production

- Eight thousand six hundred quintals of quality seed of recently released varieties of sugarcane was produced and supplied to the different Sugar Mill areas of Uttar Pradesh and 1185 quintals of seed was produced at IISR Regional Centre, Motipur (Bihar) and distributed to sugar mills in Bihar.



Introduction

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 Amausi Airport and about 5 kms each from Lucknow Railway Station and Alambagh Bus Station. The dimate of the area is sub-tropical semi-arid type. Monthly average maximum temperature during April to June ranges from 36^0 C to 40^0 C and minimum temperature during November to February ranges from 7^0C to 11.5^0 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

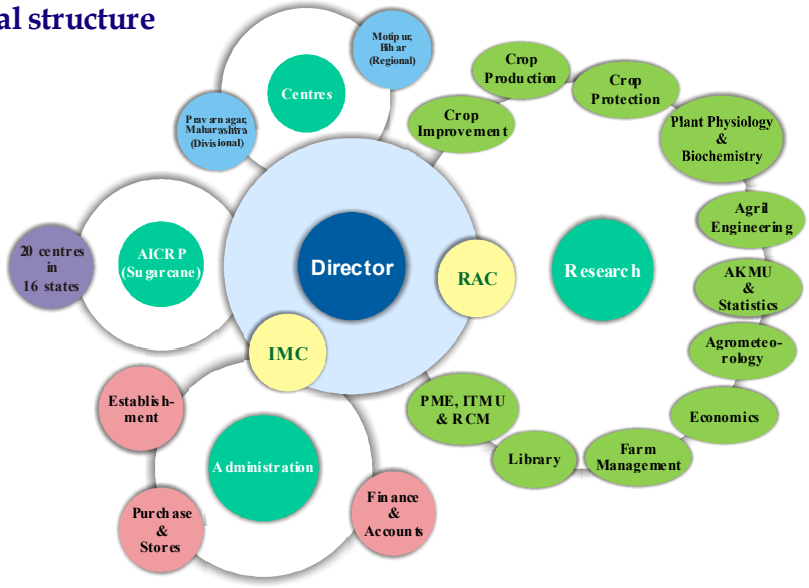
e. Mechanizing sugarcane farming.

Arresting decline in factor productivity

a. Soil biological and nutritional dynamism

b. Carbon sequestering through cropping system.

Organizational structure



Organizational set-up

Divisions

Crop Production
Crop Improvement
Plant Physiology and Biochemistry
Crop Protection
Agricultural Engineering

Service units/Sections

Research Coordination & Management
Microbiology Laboratory
Agrometeorology Laboratory
Agricultural Economics and Statistics
Agricultural Knowledge Management Unit

General facilities

Juice Analysis Laboratory
Library and Reprography
Arts and Photography
Dispensary
Security (Watch and Ward)
Farm
Guest House

Estate and instrument maintenance

Electrical and Tubewell Installation
Civil Repair and Maintenance
Refrigeration and Airconditioning
Instrumentation
Operation and Maintenance of Vehicles

Regional centre

IISR Regional Centre: Motipur, Bihar
Divisional Biocontrol Centre : Pravaranagar (MS)

Financial statement (2011-12)

a. Indian Institute of Sugarcane Research

(₹ in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Estt. Charges	1900.00	1874.05	-	-
T.A.	07.00	06.12	10.00	9.66
HRD	-	-	10.00	8.75
Other Charges	163.70	159.46	258.00	257.96
Works	70.00	65.41	60.00	60.00
Others items	-	-	-	-
OTA	0.50	0.43	-	-
Total	**2141.20**	**2105.47**	**338.00**	**336.37**

b. All India Coordinated Research Project (AICRP) on Sugarcane

(₹ in lacs)

Particulars	Estt. Charges	T.A.	Other Charges (RC)	Total
Revised Estimate	-	-	-	745.00
Expenditure	0.34	3.25	721.82	725.41

c. Revenue Generation

Realisation of Revenue Receipt	Amount (₹ in lacs)
Farm Produce	50.41
Miscellaneous	66.90
Total	117.31

Externally Funded Projects

S. No.	Project	Funding agency	Duration
1	Development of SSR markers for red rot resistance from EST database of sugarcane	DBT, New Delhi	2009-12
2	Association mapping in sugarcane	DBT, New Delhi	2011-13
3	Development of plant growth promoting microbial consortia for rice-wheat-sugarcane cropping system	DBT, New Delhi	2010-12
4	Storability assessment of value added jaggery prepared using *aonla* as a natural source of vitamin C	CST, U.P.	2011-13

Other ICAR Projects/Schemes at IISR, Lucknow

Proj.No./ Abbr.	Project title	Funding agency	Duration
OP-1/09	Outreach programme in network mode on diagnosis and management of leaf spot diseases of field and horticultural crops. (IISR Centre component, mandated crop sugarcane, pathogen: *Colletotrichum)*	ICAR, New Delhi	11th Five Year Plan (2007-12)
Mega seed project	Seed production in agricultural crops and fisheries (IISR Centre component)	-do-	-do-
FIM	AICRP on Farm Implements and Machinery (IISR Centre component)	-do-	-do-
PHT	AICRP on Post-harvest Technology (IISR Centre component)	-do-	-do-
Climate	Network project on impact adoption and vulnerability of Indian agriculture to climate change	-do-	-do-
ITMU	Intellectual property management and transfer, commercialization of agril technology scheme (up-scaling of existing component *i.e.*, IPR under ICAR Hqs. schemes on management of information services	-do-	-do-

Staff Position as on March 31, 2012

a. Scientific staff

i) Indian Institute of Sugarcane Research (IISR), Lucknow

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Agricultural Entomology	0	0	1	0	4	3	5	3
Agronomy	1	1	1	1	7	5	9	7
Biochemistry (Plant Science)	0	0	0	0	2	1	2	1
Biotechnology (Plant Science)	1	1	1	0	2	0	4	1
Microbiology (Agriculture)	0	0	0	0	1	0	1	0
Nematology (Agriculture)	0	0	0	0	1	0	1	0
Plant Pathology	1	1	1	1	4	5	6	7
Plant Physiology	1	1	1	1	2	2	4	4
Agricultural Chemicals	0	0	0	0	1	1	1	1
Soil Science	0	0	1	0	3	1	4	1
Land & Water Management Engineering	0	0	0	0	1	1	1	1
Agricultural Economics	0	0	1	1	1	0	2	1
Agricultural Extension	0	0	0	0	3	3	3	3
Agricultural Statistics	0	0	0	0	1	1	1	1
Computer Application in Agriculture	0	0	0	0	1	1	1	1
Genetics & Plant Breeding	1	1	2	2	7	6	10	9
Process Engineering Unit								
Ag. Process Engineering	1	1	2	1	0	0	3	2
Farm Machinery and Power	1	1	2	2	3	3	6	6
Total	7	7	13	9	44	33	64	49

ii) All India Coordinated Research Project on Sugarcane

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Any crop science subject (Project Coordinator)	1	1	0	0	0	0	1	1
Agronomy	0	0	0	0	1	1	1	1
Plant Breeding	0	0	1	0	0	0	1	0
Agricultural Entomology	0	0	0	0	1	0	1	0
Agricultural Statistics	0	0	0	0	1	1	1	1
Sub Total	**1**	**1**	**1**	**0**	**3**	**2**	**5**	**3**

iii) IISR Regional Station, Motipur (Bihar)

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Plant Breeding	0	0	1	1	0	0	1	1
Agronomy	0	0	0	0	1	1	1	1
Plant Pathology	0	0	0	0	1	0	1	0
Agriculture Entomology	0	0	0	0	1	0	1	0
Sub Total	**0**	**0**	**1**	**1**	**3**	**1**	**4**	**2**
Grand Total	**8**	**8**	**15**	**10**	**50**	**35**	**73**	**53**

SCS - Sanctioned cadre strength, CSP - Cadre strength in position

b. Technical staff

Functional Group	T-1	T-2	T-3	T-4	T-5	T-6	T(7-8)	T-9	Total
	SCS								
Field/Farm Technicians	16	18	22	11	1	1	0	0	69
Workshop Staff including Engineering Workshop	30	4	5	5	0	0	0	0	44
Photography Staff	0	1	1	2	0	0	0	0	4
Laboratory Technicians	2	1	0	0	0	0	0	0	3
Library/Information/Documentation Staff	0	1	2	1	0	0	0	0	4
Medical and Paramedical Staff	0	0	0	0	0	1	0	0	1
Press and Editorial Staff	0	0	1	0	0	0	0	0	1
Sub Total	48	25	31	19	1	2	0	0	126
Field/Farm Technicians (Motipur)	1	1	0	0	0	0	0	0	2
Total	49	26	31	19	1	2	0	0	128

Functional Group	T-1	T-2	T-3	T-4	T-5	T-6	T(7-8)	T-9	Total
	CSP								
Field/Farm Technicians	21	18	21	9	1	1	0	0	71
Workshop Staff including Engineering Workshop	20	3	4	4	0	0	0	0	31
Photography Staff	0	1	1	2	0	0	0	0	4
Laboratory Technicians	2	1	0	0	0	0	0	0	3
Library/Information/Documentation Staff	0	1	2	1	0	0	0	0	4
Medical and Paramedical Staff	0	0	0	0	0	1	0	0	1
Press and Editorial Staff	0	0	1	0	0	0	0	0	1
Sub Total	43	24	29	16	1	2	0	0	115
Field/Farm Technicians (Motipur)	1	1	0	0	0	0	0	0	2
Total	44	25	29	16	1	2	0	0	117

c. Administrative staff

Designation	SCS	CSP
Senior Administrative Officer	1	1
Administrative Officer	1	1
Finance & Accounts Officer	1	1
Asst. Finance & Accounts Officer	1	-
Asst. Administrative Officer	4	4
Private Secretary	2	2
Assistant	17	15
Upper Division Clerk	8	17
Lower Division Clerk	10	10
Personal Assistant	2	2
Steno Grade III	-	2
Supporting Skilled Staff	73	55
Sub Total	**120**	**104**
Upper Division Clerk (Motipur)	1	1
Supporting Skilled Staff (Motipur)	1	1
Total	**122**	**106**

SCS - Sanctioned cadre strength, CSP - Cadre strength in position

Breeding Cane for Abiotic Tolerance and Red rot Resistance, Suited to Sub-tropical Cane Belt

The ultimate goal of sugarcane improvement and selection programme is to make direct genetic gains for yield as well as quality. Enormous yield increase has been achieved in the last century by breeding for yield, disease and insect resistance, and stress tolerance. However, several countries experience sugar yield plateaus. The static sugar yields may be overcome by intensive breeding for new cultivars. Recently developed genomic resources and acquired molecular tools in sugarcane have the potential to further improve sugar yields, but these must be used as tools in support of traditional crop improvement. Evaluation of interspecific hybrid clones involving different *Saccharum* species and intergeneric hybrids involving *Erianthus* clones indicated differential maturity / sugar accumulation pattern. This gives an indication of different juice quality genes in *Saccharum barberi/sinense*, *S. spontaneum*, *S. officinarum/robustum* and *Erianthus*. Pyramiding sucrose genes from these sources seems to have potential to improve the quality traits of sugarcane varieties. Sub-tropical India is characterized by low sugarcane productivity due to weather extremes and other stressful growing conditions, and thus, varieties with economic attributes and adaptation to stressful conditions are need of the hour. Sugarcane varieties with abiotic tolerance and red rot resistance are to be developed through genetic resources, pre-breeding, varietal development and biotechnological interventions.

Germplasm evaluation

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

Maintenance of sugarcane germplasm

The collection of 284 genotypes consisting of *Saccharum officinarum*, *S. barberi*, *S. sinense*, ISH clones, Ikshu ISH clones, LG selections, commercial hybrids *etc.*, was maintained and the required material was supplied to various on-going projects of the Institute. The evaluation of genotypes for the development of core collection for sub-tropical India has been initiated.

Evaluation of genotypes for weak leaf sheath adherence

Weak leaf sheath adherence is a pre-requisite for mechanical harvesting of sugarcane. The need of self-detrashing varieties was put forth during the development of mechanical harvesters which require a lot of energy in cutting, lifting, cleaning and de-topping of canes. The weak adherence of leaf sheath to the cane, even if not self-detrashing, will ease the harvesters in producing clean canes as output. The germplasm collection was evaluated for identification of genotypes with this character. The commercial hybrids with weak sheath adherence were BO 130, CoJ 83, CoLk 94184, CoP 9301, CoPant 84212, CoS 687, CoS 01256, Co 1148, CoS 88230, CoS 90269, CoS 93259, CoS 94270, CoS 96268, CoS99259, CoSe 01235, CoSe92423, CoSe 95436, UP 9530 *etc.*

DUS test centre for sugarcane

Number of varieties under maintenance breeding

At present, 107 sub-tropical varieties of sugarcane are being maintained at DUS testing field as reference collection.

Three new candidate varieties Co 0118, Co 0238 and Co 0239 have been planted for DUS testing as per DUS test specifications along with 08 reference varieties *viz.* Co 453, Co 6811, Co 89029 and CoB 94164, CoS 99259, CoSe 92423, CoS 96268 and CoS 770. The selection of reference varieties for comparison was made on the basis of three grouping characteristics *viz.*, plant growth habit, leaf blade curvature and leaf sheath adherence.

Pre-breeding

Development of sugarcane breeding stock for high sugar

Till date, 50 high sugar breeding stock and many sugarcane varieties, which are at different

stages of AICRP testing and a high sugar female breeding stock, LG 95053 have been developed. This project is into its second phase wherein the high sugar selections developed under the first phase of convergent breeding are being inter-mated to pyramid genes for high sugar. In the process of progeny evaluation, the LG parents giving desirable high sugar progeny in high proportion are also identified as potential parents for high sugar breeding.

Crossing, fluff raising and seedling transplanting

In the 2011 crossing season at SBI, Coimbatore, 9 bi-parental matings, 22 general collections and 11 selfs were effected in the LG clones. The seedlings raised from the fluff of 2010 matings were transplanted in the field. A population of over 5000 seedlings has been established and ratooned in spring to get a uniform crop amenable to selection. These predominantly involved the breeding stock developed in this project. The C_1 population of 2008 season was subjected to selection early in the season and 92 selections were advanced.

Identification of elite clones

Three clones L408402, L408474 & L407554 were selected for inclusion in the Station Trial 2012-13. These were also found to be good ratooners and possessed moderate resistance to the two prevalent races of red rot. These have been bred from the LG material developed in this project.

Identification of high sugar selections

Five genotypes *viz.*, spection no. IV-8-3, V-4-1, V-6-8, V-25-6 & V-26-5 were found to be comparing favourably with CoJ 64 in sugar content and all these have come from the LG breeding stock utilized in breeding at the NHG in SBI, Coimbatore.

Some of these entries have been tested for red rot and found to be moderately resistant.

The above clones have emerged from the third cycle of selection and mating among high sugar selections developed over the years. It is intended to assess the genetic gain made in sugar accumulation potential and to establish the breeding behaviour of these elite genotypes with respect to sugar content.

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

Technology development

Two LG clones LG 06810 and LG 06839 having moderate resistance against two major pathotypes *Cf* 08 and *Cf* 09 were sent for inclusion in National Hybridization Garden, SBI, Coimbatore.

Hybridization programme

Fifteen crosses comprising of eight bi-parental (LG 05817 x LG 97050, BO 91 x CoLk 8102, Co1148 x BO 91, Co1148 x ISH 150, CoS 767 x ISH 150, Co 62198 x ISH 150, CoS 8436 x ISH 147 and BO 91 x Co 61198), five selfs (Co 1148, BO 91, ISH 150, LG 05828, LG 05823) and two general crosses (BO 91 and LG 05828) were attempted at National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore and fluff received will be sown in glasshouse to raise and evaluate seedling population during 2012-13.

Evaluation of progenies of seedling generation (transplanted crop)

A total of 2590 seedling progenies of twelve crosses (four selfs Co 1148, LG 05817, LG 05823, BO 91 and eight bi-parental *viz.*, LG 05817 x LG 05823, BO 91 x CoLk 8102, Co 1158 x BO 91, CoS 96268 x BO 91, CoSe 95422 x LG 05817, Co 86011 x ISH 147, CoS 767 x BO 91, Co 7201 x ISH 150) 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 911 clones comprising of eleven crosses namely, Co 1148 self (21), ISH150 self (209), Co 85002 x SES 594(1), CoS 96268 x BO 91(3), BO 91 x Co 62198 (185), Co1148x ISH 150(105), Co 85002 x ISH 147 (356), Co 7201 x ISH 150 (5), Co 62198 x ISH 150 (7), CoC 671 x ISH 147 (17) and CoS 88216 GC (2) 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 crop. Highest range for the traits number of shoots/clump (5-17), millable canes per clump (3-13) and HR Brix % (12.4-22.8)

were recorded in clones of cross Co 85002 x ISH 147 followed by cross Co1148 x ISH 150 for HR Brix % (13.6-21.4) and cross ISH 150 self for NMC (3-11).

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

A total of fifteen clones (comprised of clones from five different crosses) namely LG 09801, LG 09804, LG 09805, LG 09806 (CoLk 8102 x Co 86002), LG 09808, LG 09809, LG 09810 (BO 91 GC), LG 09812, LG 09813, LG 09814 (CoLk 8002 x Co 62198), LG 09815, LG 09816, LG 09817 (Co1148 x BO 91) and LG 09818, LG 09820 (BO 91 x Co 62198) exhibited moderately susceptible reaction to red rot pathotype Cf 09. While three clones namely LG 09802, LG 09803 and LG 09807 (CoLk 8102 x Co 86002) showed MR reaction to red rot pathotype Cf 09. Seven clones LG 09801, LG 09805, LG 09808, LG 09810, LG 09812, LG 09815 and LG 09820 were found to be promising in yield and quality traits.

Evaluation of clones in 2nd generation and ratoon of first clonal generation for resistance to red rot

A total of 74 moderately resistant (MR)/ moderately susceptible (MS) clones to red rot pathotype Cf 09 comprising of nine families namely ISH-1 x CoSe 96436 (31), CoLk 8002 x Co 62198 (5), BO 91GC (11), CoLK 8102 x Co 86002 (1), CoS 96268 x CoLk 8002 (1), CoSe 95422GC (20), CoPant 97222GC(3), Co 89003GC (1) and CoLk 8002 GC (1) were further inoculated in ratoon crop by *Cf* 09 pathotype using plug method of inoculation to validate the reaction of red rot. Nine clones *viz.*, LG 08804, LG 08809, LG 08810, LG 08814, LG 08819, LG 08822, LG 08826 (ISH-1 x CoSe 96436), LG 08849 (CoS 96268 x CoLk8002) and LG 08866 (CoSe 95422GC) confirmed moderate resistance reaction in plant crop of first clonal generation during 2010-11 as well as in ratoon (2011-12). Two clones namely LG 08849 and LG 08866 were found to be promising in sucrose (>17 %). Seventeen clones showed moderately susceptible reaction to red rot.

Evaluation of advance clones in second plant crop and ratoon

A trial comprising of seven advanced clones were evaluated in CRBD with three replications to validate for disease reaction to red rot and to assess their yield and quality performance along with two checks namely CoJ 64 and CoS 767. Three clones LG 06810, LG 06823B, LG 06839 and LG 07811 showed moderately resistant (MR) reaction to two virulent pathotypes *viz.*, *Cf* 08 and *Cf* 09. LG 06823B showed highest cane yield (88.3 t/ha) followed by LG 07811 (87.1 t/ha) over best check CoS 767 (Table 2.1). Similar trend was noticed in ratoon crop for cane yield as well as red rot reaction in LG 06823B, LG 06839 and LG 07811. Two clones LG 06810 and LG 06839 exhibiting MR reaction to two virulent pathotypes for last three years were sent to National Hybridization Garden, SBI, Coimbatore.

Table 2.1: Performance of advance clones for agronomic traits and reaction to red rot

Clone	NMC (000/ha)	Cane yield (t/ha)	CCS (t/ha)	Single cane wt. (kg)	Sucrose % (12 M)	Red rot reaction	
						Cf 08	*Cf 09*
LG 06810	97.87	86.10	10.23	0.88	17.45	MR	MR
LG 06823B	110.07	88.30	10.76	0.80	17.86	MR	MR
LG 06839	107.57	86.23	10.85	0.81	18.19	MR	MR
LG 06899A	104.27	78.43	10.18	0.75	18.61	MR	MR
LG 07810	77.47	61.10	7.43	0.79	17.43	Wilt	
LG 07811	84.87	87.10	10.75	1.11	18.19	MR	MR
LG 07816	74.50	57.50	7.03	0.78	17.68	-	-
CoJ 64	78.40	47.67	6.17	0.61	18.82	S	S
CoS 767	72.60	49.27	6.09	0.68	18.02	S	S
CD(0.5)	16.27	11.76	1.57	0.06	0.74		
CV(%)	10.48	9.53	10.26	4.27	2.37		

Development of top borer tolerant genetic stocks of sugarcane

Hybridization

Three intergeneric hybrids *viz.*, Awela 68 X IK 76-91, 28 NG 39 X IK 76-81(Eri) and LG 94184 X IK 76-81(Eri) were attempted at Distant hybridization facility, Agali. In addition, three GCs of intergeneric hybrids were collected.

Seedling evaluation

Out of 4500 seedlings derived from three intervarietal, seven intergeneric hybridization and two general collections of intergeneric hybrids, 3428 seedlings survived in field condition. Two thousand seedlings possessed superior initial vigour.

Clonal evaluation

One hundred ninety seven C_2 clones derived from fourteen biparental crosses involving 4 intergeneric hybrids with *Erianthus* sp., 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 per cent brix during January, 2012 were advanced to C_3 clonal stage.

Out of 19 genotypes evaluated in C_4 stage, four with superior economic attributes and top borer tolerance were advanced to station trial.

Two genetic stocks *viz.*, LG 05609 and LG 05610 were included in National Hybridization Garden at Sugarcane Breeding Institute, Coimbatore.

Biochemical associations with top borer tolerance

Variation in hydroxamic acid content in tolerant genotypes (2-5 mg/g fresh weight) and susceptible genotypes (2.0 mg/g fresh weight) was observed.

Development of sugarcane varieties for sub-tropics

During the year under report, three elite clones namely, LG 05302 and LG 05403 and one mid-late maturing selection LG 05398 were accepted in the AICRP Varietal Testing for NW Zone (Table 2.2). Apart from this, one mid-late maturing selection LG 05398 was accepted for evaluation under UP State Varietal Testing Programme at 13 locations for 2012-13. LG 05377 was included in the Institute Station Trial 2012-13, based on its performance in the ratoon crop.

Sixteen advanced clones emanating from different projects along with four standards *viz.*, CoJ 64, CoPant 84211, CoPant 97222 and CoS 767 were evaluated for cane yield and quality attributes. Among the evaluated elite clones, six clones namely LG 05003, LG 06599, LG 06605, LG 06361, LG 05020 and LG 05002 were identified as potential early maturing clones. Under mid-late maturing group, four clones namely LG 06810, LG 06839, LG 05306 and LG 06602 were found to be promising. These clones will be proposed for multi-location testing under AICRP (S).

Technology development

LG 99270 (CoLk 11201) early maturing and LG 06004 (CoLk 11206) and LG 06021 (CoLk 11205) in mid late maturity group were accepted for evaluation under AICRP(S) NW Zone.

Hybridization and raising of seedlings

Fourteen biparental crosses (Co 0238 X ISH 69, Co 86002 X CoH 70, Co 86002 X Co 99006, Co 92006 X Co 1148, ISH 100 X CoSe 92423, CoS 8436 X CoSe 92423, Co 88025 X Co 775, Co 89003 X CoS 510, Co 8353 X Co 99006, BO 91 X Co 89029, CoS 96268 X CoJ 46, CoS 96268 X BO 91, CoLk 8102 X CoH 15 and CoLk 8102 X NCo 310) were attempted at NHG, SBI, Coimbatore during October - November, 2011. In addition, fluff of 17 Zonal crosses comprising of biparental and poly crosses along with 25 general crosses were received for

Table 2.2: AICRP and UP state varietal trial proposals

Clone	Parentage	CCS (t/ha)	Cane yield (t/ha)	Pol (%) juice		Remark
				Nov.	Jan.	
LG 05302	CoLk 8102 x Co 1148	10.88	76.3	18.03	18.83	Early, Very good ratooner
LG 05403	CoS 96260 GC	10.55	81.1	16.47	17.58	Early, good ratooner
LG 05398	CoS 96260 GC	11.10	90.4	–	17.64	Mid-late, good ratooner

evaluation. A total of 7230 seedlings from 30 crosses (2010 crossing) were transplanted in field during August 2011. These seedlings were ratooned during February 2012 for evaluation of morphological and quality traits.

Evaluation of sugarcane crosses and clones

A total of 83 clones (C_2) from 271 (C_1) dones of 28 crosses (2008 crossing series) were selected and planted in the field for multiplication and for further evaluation and multiplication during spring season of 2012. A total of 220 clones (C_1) selected from the seedlings of (2009 crossing series) were planted in the field. The clones were evaluated on the basis of estimation of HR Brix %, juice quality and visual observations for cane diameter, green cane top and other morphological features. A total of 46 clones were advanced to C_3 generation from 123 clones (C_2) on the basis of morphology, yield attributes and juice characteristics for further evaluation along with standards.

Evaluation of PVT clones

A total of 10 selected clones were planted with standards (CoS 767 and CoJ 64) in RCBD for further evaluation. Observations were recorded for yield, yield attributes and juice analysis (November and January). Analysis of variance indicated significant difference among these clones for cane yield, sugar yield and sucrose %.

Development of sugarcane varieties for moisture deficit environment

Hybridization and seedling raising

A total of 10 biparental crosses *viz.*, CoPant 84212 x NCo 310, CoS 8436 x CoSe 92423, CoS 8436 x ISH 147, Co 0238 x Co 62198, CoLk 94184 x Co 62198, CoSe 95422 x Co 62198, Co 0237 x ISH 69, CoLk 8002 x Co 775, CoH 110 x CoA 7602 and CoLk 94184 x BO 130, were attempted at National Hybridization Garden, SBI, Coimbatore during the crossing season 2011. The fluff received for all the crosses along with 15 GCs was sown in the glass house to raise the seedling.

Seedling evaluation

About 4450 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. Seedling crop was ratooned in the month of February for synchronous tillering and growth. 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, 132 C_1 clones were selected from seedling population. Out of 465 C_1 clones of previous year, about 90 clones were promoted to the second clonal generation (C_2) for further evaluation. Out of 27 C_2 clones, 19 clones were selected on the basis of sucrose content and general growth performance. These clones were promoted to the C_3 generation for their evaluation under normal as well as moisture deficit conditions. Seed materials of these clones were also given to the pathologists for red rot screening.

Evaluation of elite clones

Twenty four elite clones 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, best nine genotypes were identified and planted for further evaluation. Out of nine, four genotypes *viz.*, LG 07771, LG 07757, LG 07785 and LG 07776 were also included in the Station Trial.

Evaluation of early maturing sugarcane clones of North West Zone

Initial Varietal Trial (Early)

A trial comprising of eight early maturing clones CoPant 08221, CoPant 08222, CoPb 08211, CoPb 08212, CoPb 08213, CoS 08231, CoS 08232 and CoS 08233 along with two checks CoJ 64 and CoPant 84211 was evaluated for yield and juice quality. CoS 08231 was found to be the best in cane yield (83.7 t/ha) as well as in sugar yield (12.6 t/ha) followed CoPb 08212 (76.5 t/ha, 11.5 t/ha) over best check CoJ 64 (62.6 t/ha, 9.7 t/ha). Clones CoPant 08221, CoPant 08222 and CoPb 08211 showed poor growth at all the stages of crop.

Advance Varietal Trial (Early) I Plant

Five early maturing entries Co 07023, Co 07025, Co 06032, CoH 07261 and CoLk 07201 were evaluated along with two checks CoJ 64 and Co Pant 84211 for their performance as plant crop. Genotype CoLk 07201 was significantly found to be the best for cane and sugar yield (78.3 t/ha, 10.8 t/ha) followed by CoH 07261 over the best check CoJ 64 (48.77 t/ha, 7.33 t/ ha). Genotype Co 006032 was found to be affected by wilt.

Seed multiplication (Early)

Twelve early maturing clones Co 09020, CoH 09261, CoH 09262, CoH09263, CoPb 09181, CoPb 09211, CoPb 09212, CoPb 09213, CoLk 09201, CoLk 09202, CoLk 09203, and CoS 09246 were multiplied for raising Initial Varietal Trial (Early) during 2012-13. These dones exhibited good phenotypic growth.

Evaluation of mid-late sugarcane clones for North West Zone

Initial Varietal Trial (Mid-late)

A trial comprising of eleven test genotypes *viz.*, CoH 08261, CoH 08262, CoH 08263, CoH 08264, CoLk 08201, CoPb 08214, CoPb 08215, CoPb 08216, CoPb 08217, CoS 08234, CoS 08235 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. Genotype CoH 08261 exhibited highest cane yield (84.0 t/ha) followed by CoH 08262 (83.5 t/ha) and CoPb 08217 (82.6 t/ha). However, CoS 08234 recorded highest CCS yield (10.30 t/ha) followed by CoPb 08217 (10.28 t/ha) and CoS 08235 (10.25 t/ha). The genotype CoS 08234 showed the highest sucrose percentage at harvest (18.2%) followed by CoS 08235 and CoPb 08216. Among the standards, CoS 767 was the best check for cane yield (68.7 t/ha) and CoPant 97222 for CCS yield (8.41 t/ha).

Advance Varietal Trial (Mid-late) I Plant

Nine genotypes *viz.*, Co 07028, CoH 07263, CoH 07264, CoLk 07202, CoLk 07203, CoPb 07212, CoPb 07213, CoS 07232 and CoS 07234 along with three standards, CoS 767, CoS 8436, CoPant 97222 were evaluated for yield and quality parameters. The genotype CoLk 07202 recorded highest cane yield (89.5 t/ha) and CCS yield (10.43 t/ha) followed by CoH 07264. These genotypes were significantly superior over all the three standards for cane yield and CCS yield. Among the test genotypes, Co 07028 recorded highest sucrose content at harvest (18.7%) followed by CoH 07264 (17.8%). Among the standard varieties, CoS 767 was the best check for cane yield (73.6 t/ha) and CoPant 97222 was best for CCS yield (8.97 t/ha).

Advance Varietal Trial (Mid-late) II Plant

Seven genotypes *viz.*, Co 06033, Co 06034, CoH 06265, CoH 06266, CoPant 06224, CoPb 06219 and CoS 06247 along with three standards, CoS 767, CoS 8436, Co 1148 were evaluated for yield and quality The genotype CoS 06247 recorded highest cane yield (85.7 t/ha) followed by CoH 06265 (84.4 t/ha). However, CoH 06265 showed highest CCS yield (10.54 t/ha) followed by CoS 06247 (10.07 t/ha). Co 06034 exhibited the highest sucrose content at harvest (18.4%) followed by CoH 06265 (18.1%) and CoH 06266 (18.1%). Among the standards, CoS 767 was the best check for cane yield (70.6 t/ha) and CoS 8436 for CCS yield (8.80 t/ha).

Advance Varietal Trial (Mid-late) Ratoon

Seven genotypes *viz.*, Co 06033, Co 06034, CoH 06265, CoH 06266, CoPant 06224, CoPb 06219 and CoS 06247 along with three standards, CoS 767, CoS 8436, Co 1148 were also evaluated for their ratooning ability. The genotype CoS 06247 showed the best ratooning ability with the highest cane yield (65.4 t/ha) and CCS yield (7.86 t/ha). Among the standard varieties, CoS 767 was the best ratooner, that recorded highest cane yield (62.4 t/ha).

Seed multiplication (Mid-late)

The seed of eight genotypes *viz.*, Co 09021, Co 09022, CoH 09264, CoLk 09204, CoPb 09214, CoS 09231, CoS 09232, CoS 09240 multiplied for the next year's Initial Varietal Trial.

Evaluation of sugarcane clones under AICRP(S) suitable for North Central Zone at Regional Centre, Motipur

Initial Varietal Trial (Early)

Seven entries with standard varieties BO 130 and CoSe 95422 were evaluated in RBD with three replications. None of the entries was significantly superior to the standards.

Initial Varietal Trial (Mid-late)

Six entries with three standard varieties BO 91, CoP 9301 and CoSe 92423 were evaluated in RBD with three replications. None of the entries was significantly superior to the standards.

Advance Varietal Trial (Mid-late) II Plant

Seven entries with three standard varieties BO 91, CoP 9301 and CoSe 92423 were evaluated in RBD, out of which CoP 06436 performed better over standards. However, final observations are being recorded and analyzed.

Advance Varietal Trial (Mid-late) Ratoon

Ratoon crop of AVT Mid-late I Plant crop

comprising of seven entries with three standard varieties BO 91, CoP 9301 and CoSe 92423 was evaluated in RBD. Varieties CoP 06436 and CoSe 07451 were found promising.

Cytogenetic and biotechnological techniques for sugarcane improvement

Genetic improvement of sugarcane through tissue culture

Ability of *in vitro* cultures involving a callus phase to generate desirable variability in the otherwise well adapted sugarcane varieties was assessed. The useful somaclones namely red rot resistant ones was produced from susceptible varieties, particularly CoJ64 and CoS 767. In a wilt susceptible variety, Co 7717, some somadones have shown reduced susceptibility. Somaclone of BO 91 (LG 911) and red rot resistant somaclone of CoJ 64 (LG 641) are being used in crossing.

Genetic transformation in sugarcane for resistance against borers

Southern hybridization analysis

Southern hybridization analysis was carried out on PCR positive T_0 plants to confirm the stable integration of *bar* gene and number of copies. The southern blot result showed stable integration of *bar* gene in sugarcane genome (Fig. 2.1) but in blot intensity of band was very faint. Lane 1 exhibited two fragments indicating the presence of two copies of transgene and lane 2 single copy of transgene (Fig. 2.1).

More events of co-cultivation were also made using embryogenic calli of the variety CoLk 8102 with *Agrobacterium* strain carrying *Cry1Ab* gene for

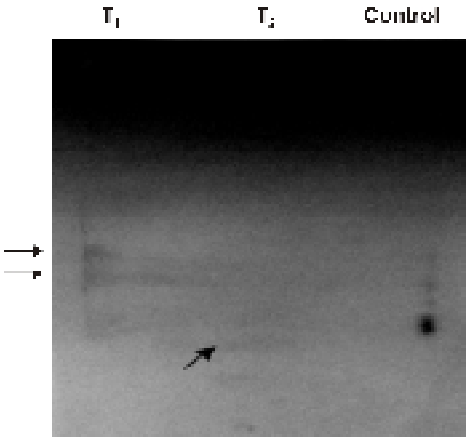


Fig. 2.1: Southern blot of transformants

development of more number of stable genetic transformants against borers in sugarcane.

Elucidation of the role of species chromosomal complement in sugarcane genotypes adapted to sub-tropical conditions

Chromosomal variability studies were carried out in four adapted parents to confirm the earlier findings, and in the cross population of these adapted parents *viz.*, CoLk 8102 x Co1148 and also GCs of two adapted parents CoS 767 and BO 91 to ascertain the chromosome variation pattern in crosses. The chromosome numbers/cell varied from 98-110 in CoLk 8102, 101-126 in Co 1148, 110-126 in CoS 767 and 102-115 in BO 91. The modal chromosome numbers ranged from 108-118. In the cross population of CoLk 8102 x Co1148, the somatic chromosome variability was 76 -128 and in GCs of CoS 767 and BO 91 it ranged from 94-124.

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

To find the possible resistance gene analogues in sugarcane, eighteen primer pairs were designed successfully from the conserved regions of *R*-genes sequences. Besides, thirty RGA primer combinations previously reported in literature on different crops were also used to amplify the homologous sequences from red rot resistant and susceptible sugarcane genotypes. Out of these, 26 primer pairs showed clear amplifications. Specific amplicons were purified and sequenced. Sequence analysis using NCBI BLAST revealed matching of some of the sequences with the NBS/LRR resistance protein-like gene sequences and resistance gene-like mRNA sequence of *Saccharum* hybrid cultivars. Further confirmatory studies of these putative RGAs are in progress for development of RGA specific markers.

Mapping of loci linked to sugar content in sugarcane

Juice analyses in January (and also in February for some low sugar clones) in the segregating population of CoLk 7901 x HR 83-65 exhibited a mean pol % juice range of 11.6 -18.8 during peak period. Variance studies indicated their suitability for QTL analysis. The C_0 generation from the same

cross gave a range of 11.2-22.2 for mean hand refractometer brix readings. A new population of selfed clones of CoLk 7901 was transplanted in the field and was ratooned. The phenotyping will be initiated next year to assess its suitability for use in mapping studies. DNA was isolated from 180 individual plants from the self population of CoS 96268 for further studies. Forty new primer pairs from sugarcane sugar metabolism-related sequences (published elsewhere) were commercially synthesized and these are being tested in the parental and segregating population. Five primer pairs showed variation with respect to the clones studied. The genotyping will be continued in the mapping populations during subsequent years for mapping studies.

Development of SSR markers for redrot resistance from EST database of sugarcane

To test the utility of developed EST-derived SSR markers, a total of 254 EST-SSRs were validated in 12 sugarcane genotypes. Out of these, 52.2% EST-SSRs showed polymorphism. The number of alleles ranged from 2-21 with an average of 6.95 alleles per locus, while poly morphism information content values ranged from 0.16-0.99 with an average of 0.75. These primers were further used for genetic diversity analysis of sugarcane genotypes, which clearly delineated from each other. When tested for functionality, 45.3% of the 254 EST-SSRs showed homology to known genes and 28.7% were hypothetical proteins. These new set of functional markers would be of immense use for various genotyping applications in sugarcane.

Phenotyping of two sets of mapping populations (124 clones of diverse origin & 136 clones of self of CoS 96268) were carried out against red rot. Genotyping of mapping population (136 clones of CoS 96268 self) was carried out using 210 EST-SSR and gSSR primers. Data recording and analysis are in progress.

Association mapping in sugarcane

In the present study, expressed sequence tags (EST) derived simple sequence repeats (SSRs) were used. Two years data of number of millable canes/ clump and sucrose per cent in juice in a set of 124 promising sugarcane varieties of diverse origin were collected. Genotyping of these varieties with 80 polymorphic EST-SSRs primers revealed high level of genetic diversity. Further, marker-trait association by general linear model (GLM) using TASSEL identified two putative EST- SSR markers namely U-Ctg1278_240 and UCtg740_140, (Fig. 2.2) which were associated with sucrose per cent in juice and number of millable canes, respectively. This study showed the utility of EST-SSR markers for molecular dissection of complex traits in sugarcane.

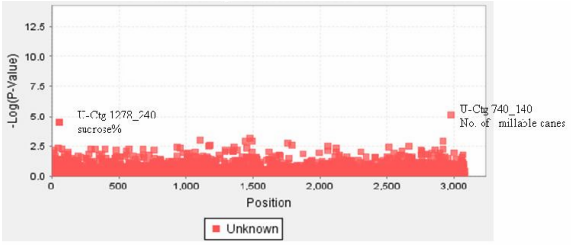


Fig. 2.2: Manhattan plot depicting marker-trait association

प्रदेश में अब गन्ने की 26 प्रजातियां

लखनऊ (एसएनबी)। राज्य सरकार ने गन्ने की उपज 68.60 मी.टन प्रति हेक्टेयर एवं चीनी परता का राष्ट्रीय औसत 10.17 प्रतिशत प्राप्त करने की दिशा में केन्द्र सरकार द्वारा स्वीकृत एवं संस्तुति गन्ने की 26 प्रजातियों को अंगीकृत करने का निर्णय लिया है। इनमें 12 प्रजातियां देर से पकने वाली हैं जबकि 14 शीघ्र पकने वाली प्रजातियां हैं।

नई प्रजातियों को अंगीकृत करने तथा विभाग की जिला एवं राष्ट्रीय कृषि विकास योजना क्रियान्वयन से प्रदेश का बीज गन्ना बदलाव जो वर्तमान में 10 प्रतिशत है को बढ़ाकर आगामी 5 वर्षों में 25 प्रतिशत किये जाने की योजना तैयार की गयी है। इसके फलस्वरूप औसत गन्ना उपज 70 मी.टन हेक्टेयर तथा चीनी परता 10.17 प्रतिशत होना संभावित है।

– राष्ट्रीय सहारा

Technology for High Density Cane Farming through Appropriate Agronomy, Precision Machines and Superior Varieties

Sugarcane is a vegetatively propagated crop grown for sugar and energy in tropical and sub-tropical parts of India. In conventional planting system prevailing in India, about 6 – 8 tonnes seed cane /ha (nearly 10% of total produce) is used as planting material, which comprises of about 33,000, stalk pieces (setts) of 25-30 cm having 2-3 buds. A sugarcane 'clump' comprises of cane stalks arising from subsurface sprouting of the underground buds in the form of tillers which finally develop into millable canes. These millable canes comprise of main shoot (which comes from bud located on the node) and secondary and tertiary tillers. Ultimately, millable canes provide the sink for sucrose accumulation. Thus, the number of millable cane (NMC), individual cane weight and girth constitute the cane yield in sugarcane. There contributions towards final cane yield are 70, 23 and 3%, respectively.

Under sub-tropical conditions, tiller population is either sub- or supra-optimal, if suboptimal, it leads to poor yield due to lower final shoot population/ha area. When excess, it leads to competition and results in poor tiller survival, hence survival and senescence of tillers are important factors governing the final yield of the crop. At present, about 80,000 to 1,00,000/ha final shoot population with cane weight of 0.6 to 0.8 kg are obtained which eventually lead to 65 to 70 t/ha cane yield under variable growth and planting conditions. To obtain a higher cane yield up to 150 t/ha, it is imperative to get 1,50,000 to 2,00,000 millable canes/ha, each of 1.5 to 2 kg weight. Therefore, a great scope exists to improve cane productivity by only increasing number of millable canes per unit area. In this direction, efforts are being made for increasing shoot population density employing various planting techniques and materials. The recent upsurge in identifying innovative methods of planting like primed node and improved bud chip technologies as well as other scientific interventions for early sprouting of buds leading to much advance canopy development *etc.*, will have bearing on sustaining high initial shoot population and number of millable canes.

Bud chip for higher shoot population

During autumn planting conditions, encapsulated bud chips showed higher moisture retention capacity (65%) (Fig 3.1) and early and higher rate of bud germination (70%) and higher rate of plant survival (approx. 50%) as compared to un-encapsulated control bud chips. Average tiller number obtained was 6 per clump.

With bud chips technology, advantages like a higher seed multiplication rate (1:60) over conventional method (1:10); optimization of shoot population; higher cane height (2.5 m), weight (2.0 kg), number of millable canes per clump (5 NMC/clump), and higher cane yield (approx. 120 t/ha) as compared to conventional system (Fig 3.2); higher bud germination (90%) as against 30-35% in conventional system; saving of 80% seed material; and easiness in transportation and seed

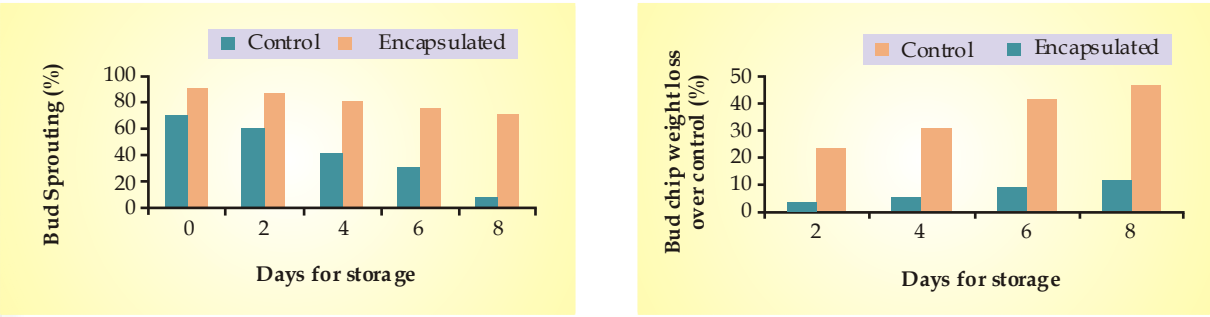


Fig. 3.1: Bud sprouting, moisture and weight loss in encapsulated and normal bud chips

Fig. 3.2: Bud chips raised settling and mature crop

treatment were obtained. Additionally leftover cane may be processed for juice, sugar/jaggery making.

Agronomic evaluation for higher plant population and cane yield

An experiment was conducted to evaluate three sugarcane genotypes (CoPk 05191, CoLk 05031 and CoLk 99270) under three NPK levels (112.5, 45, 45; 150, 60, 60 and 187.5,75,75 kg/ha) with a view to identify suitable genotype under various fertiliser schedules in spring season. Initial soil chemical analysis indicated that soil was low in organic carbon (0.42%), and available nitrogen (230 kg/ha); medium in phosphorus (32.3 kg P_2O_5/ha) and potassium (245 kg K_2O/ha) contents.

In spring planting, genotype CoPk 05191 produced the highest number of millable cane (99,770/ha) followed by CoLk 05031(97,700/ha) and CoLk 99270 (61,550/ha). There was no significant difference in individual cane length between genotypes CoPk 05191 and CoLk 05031. Genotype, CoPk 05191 produced thicker and heavier canes (2.59 cm cane diameter and 930 g individual cane weight) as compared to other

Table 3.1: Influence of different treatments on growth, quality and yield of sugarcane crop

Treatment	Millable canes (000/ha)	Cane length (cm)	Came diameter (cm)	Cane weight (g)	°Brix	Sucrose % juice	Purity (%)	Cane yield (t/ha)	CCS (t/ha)
Genotype				*Spring crop					
Co Pk 05191	99.77	205.5	2.59	930	18.64	16.40	87.83	72.6	8.22
CoLk 05031	97.70	206.2	2.43	702	18.71	16.39	87.62	61.3	6.93
CoLk 99270	61.55	138.1	2.63	582	19.92	17.47	87.69	37.7	4.54
S E m ±	3.55	4.45	0.051	16.06	0.14	0.15	0.47	2.5	0.21
623 CD (P-0.05)	10.64	13.34	0.15	48.14	0.42	0.45	NS	7.64	0.62
Fertility level (NPK kg/ha)									
112.5,45,45	78.58	170.8	2.51	691	18.98	16.60	87.39	51.31	5.86
150,60,60	89.43	189.6	2.51	773	19.25	16.93	87.96	60.00	7.00
187.5,75,75	89.99	190.4	2.62	750	19.05	16.72	87.80	60.44	6.96
S E m ±	3.55	4.45	0.051	16.06	0.14	0.15	0.47	2.55	0.21
C D (P=0.05)	10.64	13.34	NS	48.14	NS	NS	NS	7.64	0.62
Genotype				**Summer Crop					
CoPk 05191	73.62	185	2.36	769	19.04	16.96	88.61	61.90	7.29
CoLk 05031	68.51	183.9	2.37	693	19.37	17.13	88.44	51.98	6.16
CoLk 99270	60.07	119.8	2.52	547	19.08	16.83	88.13	28.47	4.54
S E m ±	2.40	3.14	0.047	15.60	0.11	0.09	0.23	2.43	0.18
623 CD (P-0.05)	7.19	9.41	0.14	46.76	0.33	0.27	NS	7.28	0.55
Fertility level (NPK kg/ha)									
112.5,45,45	60.21	155.2	2.37	591	18.83	16.74	88.46	42.56	4.94
150,60,60	68.07	168.9	2.43	727	19.46	17.09	87.78	50.71	5.97
187.5,75,75	73.92	164.6	2.52	691	19.21	17.08	88.94	48.08	5.69
S E m ±	2.40	3.14	0.047	15.60	0.11	0.09	0.23	2.43	0.18
CD (P=0.05)	7.19	9.41	0.14	46.76	0.33	0.27	0.69	7.28	**0.55**

*Spring planting: 12.02.2011; **Summer planting 15.04.2011

genotypes (Table 3.1). Although, significantly highest sucrose content (17.47%) was analysed in the genotype, CoLk 99270 but the higher cane (72.68 t/ha) and sugar yields (8.22 t/ha) was obtained with genotype CoPk 05191. It was followed by CoLk 05031 (61.38 and 6.93 t cane and sugar yields/ha, respectively) and CoLk 99270. Number of millable canes, individual cane length, weight and cane yield significantly increased up to application of 150, 60, 60 kg NPK/ha. Recommended level of NPK *i.e.*, 150, 60 and 60 kg /ha fetched significantly higher cane (60.00 t/ha) and sugar yields (7.00 t/ha) over 75% of recommended NPK. Different fertility levels could not influence the juice quality parameters significantly.

In summer planting, all the genotypes behaved in similar fashion as in case of spring planting however, with lower values of millable canes, cane length, weight, cane and sugar yields (Table 3.1). The fertility levels of 150, 60, 60 kg NPK/ha maximized cane and sugar yield of summer planted crop as well.

Plant geometry and mechanization for higher shoot population and cane yield

Field experiment was conducted to workout optimum plant geometry of different varieties for suitability to use of farm machinery. The experiment consisted of 12 treatment combinations with 3 planting geometries *viz.*, 120, 150 and 30x120 cm row spacings and 4 varieties *viz.*, 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, replicated thrice.

The data on sugarcane growth, yield attributes and yield indicate that significantly highest shoot population (166.1 thousand/ha), number of millable canes (136.1 thousand/ha) and cane yield (79.7 t/ha) was observed at 30x120 cm row spacing (Table 3.2). Variety CoSe 92423 recorded significantly highest yield (75.7 t/ha) over that of CoS 96275 and CoS 94257, however it was found similar to CoLk 94184 (70.5 t/ha). The quality parameters were not affected by plant geometry but significantly highest sugar yield was obtained at 30x120 cm spacing. Different genotypes showed significant variation for different quality traits. Significantly highest brix° (18.7 °B), pol (16.3%), purity (87.2%) and CCS (11.21%) was harnessed by CoLk 94184. Genotype CoSe 92423 fetched highest sugar yield (7.98 t/ha), which was closely followed by CoLk 94184 and CoS 96275 (Table 3.3).

Development of a wide spaced paired row sugarcane cutter planter

Paired row sugarcane planter was tested in the field at IISR farm (Fig. 3.3). The planter plants single pair of furrows at 30 cm spacing. The spacing between the subsequent pairs of furrows could be adjusted by operating the tractor along the planted

Table 3.2: Effect of plant geometry and varietal growth, yield attributes and yield of sugarcane under different planting geometries and genotypic variations

Treatment	Germination (%) 45 DAS	Shoot count ('000/ha) 180 DAP	NMC ('000/ha)	Cane length (cm)	Cane girth (cm)	Average cane weight (kg)	Cane yield (t/ha)
Planting geometry							
Row spacing							
120 cm	39.8	137.2	104.2	177.5	2.40	0.74	69.4
150 cm	39.2	128.7	91.4	176.0	2.41	0.77	58.0
30x120	40.7	166.1	136.1	178.5	2.37	0.69	79.7
CD (P = 0.05)	NS	12.63	11.26	NS	NS	NS	8.63
Variety							
CoS 96275	39.2	142.3	108.9	173.3	2.37	0.71	66.2
CoSe 93423	44.5	149.0	109.0	180.3	2.56	0.79	75.7
CoS 94257	39.7	146.6	109.9	168.0	2.45	0.73	63.9
CoLk 94184	36.1	138.0	114.3	187.7	2.18	0.68	70.5
CD (P = 0.05)	4.74	8.67	5.34	10.26	0.25	0.10	5.27

Table 3.3: Effect of planting geometry and genotype on quality attributes and sugar yield

Treatment	Cane yield (t/ha)	Irrigation water use efficiency (t/ha-cm)	Juice quality parameters		
			Corrected brix	Sucrose (%)	Purity (%)
Planting method					
Conventional (75 cm row spacing)	64.93	1.12	19.25	16.81	87.34
Paired row planting (30:120 cm row spacing)	68.33	1.18	19.21	16.92	88.07
FIRB method (75 cm row spacing)	62.63	1.09	19.41	17.17	88.47
CD (P=0.05)	4.94		NS	NS	NS
Irrigation scheduling (IW:CPE)					
0.50	57.63	1.20	19.27	16.88	87.63
0.75	67.52	1.21	19.22	16.97	88.28
1.00	70.74	0.98	19.38	17.05	87.97
CD (P=0.05)	4.94		NS	NS	NS

pair of furrows and maintaining uniform spacing of tractor tyres. At IISR farm cane was planted in 30:120 cm row geometry. The effective field capacity of the equipment was 0.20 ha/h.

Prototype of tractor operated interculturing equipment was developed (Fig. 3.4) for weeding and interculturing of wide spaced paired row cane crop (30:120 cm). Sweep shovels were used in place of reversible shovels. The prototype was tested in the field at IISR farm (Fig. 3.5). The effective field capacity of the equipment was 0.35-0.40 ha/h.

IISR tractor operated front mounted sugarcane harvester, with certain modifications in the cutting mechanism, was tested for harvesting of wide spaced paired row planted crop (Fig. 3.6). Windrowing of harvested cane was satisfactory due to wide spacing between the paired rows.

Fig. 3.3: Paired row sugarcane cutter planter in operation

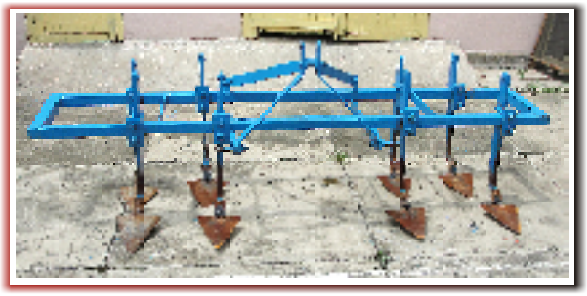


Fig. 3.4: Tractor operated interculturing equipment for wide spaced paired row (30:120 cm) cane crop

Fig. 3.5: Interculturing equipment in operation in wide spaced paired row (30:120 cm) cane crop

Fig. 3.6: IISR tractor operated sugarcane harvester in operation in wide spaced paired row (30:120 cm) cane crop

Evaluation and refinement of sett cutting mechanism of sugarcane planter

Four types of blades have been fabricated and are being used. They are :

1) IISR first model and khalsa type
2) IISR ridger type of two disc planter
3) IISR Multipurpose planter
4) VSI planter developed under NATP

All four blades have been fabricated with different profiles and different angles of cutting edge. Cutting energy of these blades will be measured .

Drive from motor shall be taken through pulleys and a disc will rotate at speed, which can be changed according to change of pulleys. Rotating disc will have two blades; one is of same weight as of cutting blade. First blade will not cut the cane. Cane will be allowed to fall from a cane tube whose angle can be tilted. Lower portion of cane will rest on a slanting plate. Two resistive sensors will sense the cutting energy, which shall be subtracted electronically so that net cutting energy will be displayed. Preliminary testing of test setup as well as blades has been done.

Design and development of residue mulcher cum bioapplicator

Tractor operated residue mulcher-cum-bio applicator was tested in the field. The following observations were made

(i) The mask height of the machine was more and creating problem in PTO shaft rotation.

(ii) Though the actual width of the residue chopper was 0.55 m but it was 0.70 m including the drive system and shaft.

(iii) The main frame of the present prototype was made of MS angle box (65 X 65 X 6 mm) making the machine heavy.

In light of the above observations following modifications were incorporated in the design of the prototype.

(i) The main frame was made using MS angle of size 50 X 50 X 5 mm to reduce the weight of machine.

(ii) The mask height has been reduced by 15 cm to facilitate smooth and trouble free PTO operation.

(iii) The width of the residue choppers was reduced to 45 cm from 55 cm.

The testing of the modified prototype was conducted in the laboratory. The field testing will be conducted in the coming season.

Prototype feasibility testing

Tractor operated three row rotary weeder

Prototype feasibility testing of tractor operated three row rotary weeder was conducted at IISR farm for interculturing of sugarcane. The equipment was tested in cane crop of 75 cm row spacing. The performance of the equipment was satisfactory with effective field capacity of 0.35-0.40 ha/h (Fig. 3.7).

Management and control of weeds in sugarcane

Management of binding weeds in sugarcane

The experimental field was infested with the weeds like *Cyperus rotundus, Convolvulus arevensis* (bind weed), *Dactyloctenium aegyptium, Potulaca oleracea, Trianthema monogyna, Digera arvensis* and *Echinoclaa colonum.*

All the herbicidal treatments were equally effective in controlling weeds and enhancing cane growth and yield (Table 3.4). Herbicides treated plots produced significantly higher number of cane shoots, millable canes, sugar and cane yield as compard to weedy check plots. However, controlling weeds by manual hoeings (3 hoeings at 30, 60 and 90 DAP) proved superior to chemical weeding with respect to weed control efficiency, cane shoot and millable cane population, cane and sugar yields.

Fig. 3.7: Tractor operated three row rotary weeder in field operation at IISR farm

Cane germination and juice quality did not differ significantly due to different treatments. Almix/Dicamba weedicides sprayed as post emergence treatment showed their effectiveness in controlling *Convdvulus arvensis*.

Sulfentrazone 4 F

Field study conducted during 2010-11 and 2011-12 revealed that sugarcane crop faced intense competition with different types of weed flora like *Cyperus rotundus* (85%), broad leaf weed (10%) and grasses (5%) at early stages of crop growth (up to 90 DAP) which resulted in 33% loss in sugarcane yield. However, different doses of sulfentrazone 4F proved effective against all types of weeds and controlled 85-100% broad leaf weeds and *Cyperus rotundus*. Grasses like *Cynodon dactylon* and *Sorghum halepense* could not be controlled however, a good control of *Eleusine indica* and *Digitaria sanguinalis* could be achieved. Overall, sulfentrazoen registered 63-72% weed control at 60 days after planting.

Table 3.4 : Cane germination, shoot population, number of millable canes, Pol % juice, weed dry weight, cane and CCS yield under different treatments

Treatment	Germination (%)	Shoot population ('000/ha) in June	NMC ('000/ha)	Cane yield (t/ha)	Pol % juice	CCS (t/ha)	Weed dry weight at 120 DAP (g/m²)	WCE
T_1	38.2	138	60.4	35.4	17.8	4.68	318	-
T_2	37.4	222	108.2	68.6	17.6	8.14	22	93.1
T_3	39.1	192	89.0	59.2	17.4	6.90	99	68.9
T_4	38.7	191	88.6	58.6	17.4	6.80	95	70.1
T_5	39.3	189	91.2	57.2	17.2	6.90	96	69.8
T_6	38.7	184	88.4	58.4	17.5	6.80	91	71.4
T_7	38.9	186	92.0	56.4	17.4	6.70	98	62.9
T_8	38.4	190	91.6	59.0	17.6	6.50	102	67.9
T_9	37.8	188	89.3	58.2	17.3	6.80	106	66.7
T_{10}	39.4	190	90.2	59.4	17.4	6.70	103	67.6
CD (0.05)	NS	18	9.8	8.5	NS	1.2	15.8	-
CV (%)	8.7	106	10.2	12.8	4.2	8.6	-	-

Treatments : T_1 : Control (Weedy check) , T_2 : Hoeing at 30, 60 and 90 DAP, T_3 : Atrazine @ 2 kg a.i./ha (PE) followed by 2,4-D @ 1 kg a.i./ha at 60 DAP, T_4 : Atrazine @ 2 kg a.i./ha after 1st irrigation and hoeing followed by 2,4-D @ 1 kg a.i./ha) at 75 DAP, T_5 : Metribuzine @ 1.25 kg a.i./ha (PE) followed by 2,4-D (1 kg a.i./ha) at 75 DAP, T_6 : Atrazine @ 2 kg a.i./ha (PE) + Almix* @ 20 g/ha) at 75 DAP, T_7 : Metribuzine @ 1.25 kg a.i./ha (PE) + Almix @ 20 g/ha at 75 DAP, T_8 : Atrazine @ 2 kg a.i./ha (PE)+ Ethoxysulfuron 50 g a.i./ha at 75 DAP, T_9 : Atrazine @ 2 kg a.i./ha (PE) + Dicamba 350 g a.i./ha at 75 DAP and T_{10} : Metribuzine @ 1.25 kg a.i./ha (PE) + Dicamba 350 g a.i./ha at 75 DAP

*Almix is a mixture of chlorimuron ethyl and metsulfuron methyl.

Soil Nutrition and Health for Higher Tonnage and Enhanced Quality of the Cane

Sugarcane, a long duration (10-12 months) and high biomass producing crop, removes substantial quantity of essential nutrients from soil. High dose of fertilizers are, therefore, applied that raises the cost of sugarcane production, often beyond the resources of small and marginal farmers. Further, sugarcane soils have been found to become compact with impeded water infiltration and reduced soil aggregate stability. Micro-nutrient deficiency is another concern for management of nutrients in sugarcane, as Zn and Cu deficiency is increasingly reported from most of the sugarcane producing states in the country. Under the scenario, sustaining soil health to ensure profitable cane yield and quality in sugarcane plant-ratoon system has been attempted through field and laboratory studies. Certain techniques like deep ploughing and sub-soiling, nutrient management through bio-manures in conjunction with efficient microbial fertilizers and inclusion of micro-nutrients in nutrient application schedule have shown conspicuous effects in term of improvement in soil physical, physico-chemical and microbial properties leading to enhanced sugarcane and sugar yield for both plant and ratoon crops.

Development of plant growth promoting microbial consortia for rice-wheat-sugarcane cropping system

A field experiment was conducted to study the effect of plant growth promoting microbial consortia in rice-wheat-sugarcane cropping system. The result revealed that the highest wheat yield of 52.90 q/ha was recorded with 50% recommended NPK + microbial consortia, however the wheat yield of 51.30 q/ha was recorded under 100% recommended NPK (Table 4.1). The highest cane yield of 80.9 t/ha and 71.9 t/ha were recorded with same treatment of 50% recommended NPK + microbial consortia under sugarcane planted either alone or with wheat inter cropping respectively. Result clearly indicate that 50% recommended NPK may be saved by using microbial consortia.

Effect of sub-soiling on soil physico-chemical characteristics and sugarcane productivity

Field experiment was conducted to study the effect of sub-soiling treatments on soil physico-chemical conditions and sugarcane yield. The treatment consisted of 5 sub-soiling treatments *viz.*, no sub-soiling (NSS), sub-soiling at 1.0 m distance (SS-1.0), sub-soiling at 1.5 m distance (SS-1.5), cross sub-soiling at 1.0 m distance (CSS-1.0) and cross sub-soiling at 1.5 m distance (CSS-1.5) and two preparatory tillage *viz.*, four harrowing (4H) and two harrowing (2H). The above treatments were applied in plant crop and residual effect was observed in succeeding ratoon.

Sub-soiling was done in plant crop with tractor-mounted sub-soiler up to depth of 45-50 cm. Cross sub-soiling at 1.0 m distance recorded significantly highest shoot population (192.2 thousand/ha at 180 DAP), number of millable cane (190.2 thousand/ha), cane (77.1 t/ha) and sugar yield (8.16 t/ha) as compared to other treatments (Table 4.2). This treatment was followed by cross sub-soiling at 1.5 m distance and sub-soiling at 1.0 m distance. Higher infiltration rate (3.94 mm/hr) and lower bulk density (1.33 Mg/m^3) were recorded in plots where cross sub-soiling at 1.0 m distance

Table 4.1: Wheat and sugarcane yield as influenced by various treatments

Treatment	Wheat yield (q/ha)	Cane yield (t/ha) in intercropping	Cane yield (t/ha) in sole crop
Control	27.75	46.40	55.25
Microbial consortium (M.C.)	28.81	59.38	70.71
50% of recommended N P & K	41.93	62.75	77.23
50% of recommended N P & K + MC	52.90	71.91	80.88
100% of recommended N P & K	51.30	71.04	80.76
CD (P=0.05)	5.67	1.50	1.32

Table 4.2 : Residual effect of sub-soiling and preparatory tillage on growth and yield of sugarcane ratoon

Treatment	Shoot population 180 DAP ('000/ha)	Root biomass (t/ha) at 120 DAP	NMC ('000/ha)	Cane yield (t/ha)	Cane length (cm)	CCS yield (t/ha)
Sub-soiling						
No sub-soiling	160.7	0.30	150.7	58.8	169.2	5.84
Sub-soiling at 1.0 m	174.4	0.50	165.8	60.3	194.8	5.70
Sub-soiling at 1.5 m	170.0	0.53	164.7	58.7	189.9	5.59
Cross sub-soiling at 1.0 m	192.2	0.64	190.2	77.1	214.9	8.16
Cross sub-soiling at 1.5 m	184.9	0.57	183.4	74.8	205.9	7.61
CD (P=0.05)	12.36	-	5.38	5.21	10.63	1.26
Preparatory tillage						
4 Harrowing	175.8	0.51	171.1	66.3	195.3	6.63
2 Harrowing	177.1	0.51	170.9	65.5	194.7	6.53
CD (P=0.05)	NS	-	NS	NS	NS	NS

was done in plant crop. There was no tangible effect on bulk density and infiltration rate due to preparatory tillage operation. Preparatory tillage did not exhibit any impact on the ratoon growth and yield.

Studies on rhizospheric environment of plant and ratoon crop of sugarcane

Ratooning induced effects in rhizospheric environment were assessed at monthly intervals for assessing impacts on the growth and dry matter accumulation potential of simultaneously initiated plant and three ratoon crops. The quantification of soil physical, chemical and biological alterations during the crop growth cycle indicated that maximum alterations occurred during the grand growth phase. During this phase, the combined effect of compaction along with increase in the moisture content was reflected in elevation of the total phenolic, anilides, organic acid levels and C:N ratios. A significant (>66%) fraction of nitrogen bonded to aromatic carbons was detected by advanced solid-state NMR in a humic acid fraction extracted from a ratoon rhizosphere during grand growth phase. Most of the aromatic-bound nitrogen seemed to be anilide nitrogen. This humic acid fraction were also shown to be rich in lignin-derived residues (>45%). The quantitative analysis indicated that, on an average, amides are bonded to every other aromatic ring of lignin. NMR spectra of mobile humic acid (MHA) fraction from ratoon rhizosphere showed < 2.5 NCH carbons per 100 carbons, which is less than two thirds of the >13.4 nitrogen's per 100 carbons in humic acid samples, indicating that peptides do not account for all of nitrogen. Based on the aromatic C–O–CH_3 ether signals at 55 ppm, it was estimated that at least 66% of all carbon in MHA of ratoon soil is part of lignin-derived residues, corresponding to > 4.5 lignin aromatic rings per 100 carbons. In contrast, in plant rhizosphere, the lignin content was only 7% (~0.5 lignin rings per 100 carbons). The corresponding humic acid fraction extracted from a comparable plant rhizosphere had lesser content of lignin and anilide nitrogen. Its NMR spectrum of carbons bonded to nitrogen showed peak intensities more characteristic of easily degradable peptides.

The impact of these alterations in ratoon rhizosphere was clearly visible on the root properties as there was significant decline in CEC roots (31%) of the ratoon crops as compared to the plant crop. The membrane leakages (41%) of the ratoon roots were significantly higher than the plant crop. The reasons for increase in membrane leakage was corroborated by the fact that during grand growth phase the increased reactive oxygen species (ROS) levels led to oxidative damage in the lipid layer of root plasma membrane. The impact of these alterations in the roots was reflected on the N uptake potential of the ratoon plants. There was significant reduction in the root NR activity (62%) and N uptake by the ratoon as compared to the plant crop during the grand growth phase, when the requirement by the plant for the nutrients is maximum. The declining NPK uptake (49, 59 and

56%) led to development of poor assimilatory apparatus and reduced the dry matter accumulation potential (31, 43 & 49%) in successive ratoon crops as compared to the plant crop. Besides, nitrogen bonded to aromatic carbons are known to be less bioavailable, significant excess of anilide nitrogen detected by NMR in the humic fraction of ratoon rhizosphere explained the yield decline observed in sugarcane ratoon crops.

Studies on soil-crop-weather data set for simulation of MOSICAS sugarcane growth model with reference to nitrogen nutrition

Field experiment was continued in successive ratoon for generating Soil-Crop-Weather related parameters with reference to nitrogen nutrition to run the MOSICAS sugarcane growth model. The treatment consisted of five nitrogen levels *viz.*, 0, 75, 150, 225, 300 kg N/ha allocated in RBD with six replications. The ratoon crop of the experiment was initiated during the month of February, 2011. Sugarcane variety CoSe 92423 was planted on 20-02-2010. Recommended doses of P and K (60kg/ha) were applied as basal and nitrogen was applied as per the treatment. The crop and weather data were recorded and soil analysis is under progress. Apparently highest number of tillers (247.4 thousand/ha) at 180 DAP, NMC (167.8 thousand/ha) and cane yield (79.6 t/ha) was recorded under the treatment of 300 kg N/ha. The highest CCS yield (8.60 t/ha) was recorded with N application of 225 kg/ha. Quality parameters were not affected by N levels.

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

A field experiment was started during February, 2011 with an objective 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 P_2O_5 and 60 kg K_2O/ha. The other nutrient 40 kg S, 25 kg $ZnSO_4$, 10 kg $FeSO_4$ and 5 kg $MnSO_4$ /ha were applied as per the treatment.

Initially soil was low in organic carbon (0.22%), available nitrogen (207 kg/ha), low in potassium (198.3 kg K_2O/ha) and medium in phosphorus (20.7 kg P_2O_5/ha) contents. Germination and number of millable canes were not affected by various nutrients applied (Table 4.3). Crop of sugarcane recorded significantly higher cane yield (61.06 t/ha) in treatment T 9 (NPKSZn). The initial lower soil organic carbon content and available nitrogen and potassium nutrient affected cane yield in treatments where nutrient were applied alone (N or NP or NPK) as compared to that in combination of NPK with other nutrient like S, Zn, Fe and Mn.

Cane quality parameters were not affected by the treatments.

Table 4.3: Response of sugarcane to different nutrients on germination, NMC, cane yield and juice quality parameters of sugarcane

Treatment	Germination (%)	Millable cane ('000/ha)	Cane yield (t/ha)	Juice quality parameters		
				°Brix	Sucrose (%)	Purity
T1 : Control	40.3	69.9	45.4	18.84	16.80	89.17
T2 : N	37.1	78.4	49.2	18.81	16.64	88.45
T3 : NP	36.1	79.0	50.5	18.48	16.33	88.36
T4 : NPK	41.1	85.0	55.2	18.43	16.25	88.15
T5 : NPKS	35.3	81.9	54.6	18.39	16.36	88.98
T6 : NPKZn	36.0	85.9	56.2	18.91	16.73	88.48
T7 : NPKFe	37.7	73.5	50.3	18.68	16.54	88.57
T8 : NPKMn	36.4	82.3	52.0	18.68	16.61	88.88
T9 : NPKSZn	40.6	89.6	61.0	18.68	16.52	88.44
T10 : NPKSZnFe	39.1	87.0	49.8	19.17	16.93	88.32
T11 : NPKSZnFeMn	36.3	85.8	56.1	18.59	16.56	88.91
T12 : FYM 20 t/ha	45.1	74.9	48.1	18.81	16.79	89.20
CD (P=0.05)	NS	NS	2.92	NS	NS	NS

Sustainable Water Usage through Tillage, Planting System, Companion Cropping and Other Profitable Crop Husbandry Practices

Water is the most precious input for sustainable sugarcane production in view of its shrinking availability and growing diversion for other than agricultural usages. In sub-tropical climatic condition, sugarcane requires more than 20000 kilo litres of water for meeting its consumptive as well as evapo-transpirational requirements. Germination and tillering stages of sugarcane crop have been found to be most sensitive to water availability and any scarcity during these stages evince telling effects on cane productivity and profitability, as a result unfettered flooding of sugarcane fields is very common. This often leads to vigorous proliferation of weeds, loss of nutrients and enhanced crop damage due to insect-pests and diseases. Controlled and localized application of water is, therefore, required to enhance the irrigation water use efficiency and the water productivity. Attempts were made to assess the effect of surface and sub-surface drip irrigation methods including fertigation on sugarcane growth and yield. New configuration of furrow irrigation with altered planting geometry were also tried and found to be effective in saving of water without any compromise in cane productivity and quality.

Efficient water application techniques in sugarcane

Field experiment was conducted to study the irrigation water use efficiency (IWUE) under different planting methods and to find out the most water use efficient planting method of sugarcane. The experiment consisted of 10 treatments *viz.*, T_1-Paired row planting (120:30 cm) and irrigation in furrows parallel to both the cane rows (15 cm apart from sugarcane row): PP-FID, T_2-Paired row planting (120:30 cm) and irrigation in furrows parallel to single row (15 cm apart from sugarcane row) of paired rows: PP-FIS, T_3-Furrow planting at 75 cm row spacing and irrigation in furrows of the cane rows : FP-FI, T_4-Furrow planting at 75 cm row spacing and irrigation in furrows opened in the middle of two cane rows : FP-MFI, T_5-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- SFI, T_6-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): FP–ASFI, T_7-Irrigation in deep trench- sugarcane planted at 120:30 cm : TP–T_I, T_8-Irrigation in furrows-sugarcane planted under FIRB system : FIRB–FI, T_9-Flood irrigation (conventional)–Furrow planting (75 cm): FP-F, T_{10}-Flood irrigation (conventional)–Paired row planting (120:30 cm): PP-F. The experiment was laid out in Randomized Block Design with three replications. Irrigation under each treatment was applied at 50% available soil moisture.

The data on sugarcane growth and yield (Table 5.1) indicate significant variation among the treatments. Significantly highest rate of germination (62.3%), shoot count (211.6 thousand/ha at 150 DAP), number of millable canes (134.0 thousand/ha), cane yield (84.4 t/ha) and sugar yield (9.67 t/ha) were recorded under trench planting system in which irrigation was applied in deep trenches (TP-T_I). The irrigation water use efficiency (IWUE) was also observed to be significantly highest (3459.4 kg cane/ha-cm) under this treatment. This system was closely followed by alternate skip furrow irrigation system. Paired row planting (120:30 cm) with irrigation applied in furrows parallel to single row (PP-FIS) system fetched the IWUE of 3102.7 kg cane/ha-cm. Tallest cane (242.7 cm) and thicker canes (2.72 cm) were produced under trench and alternate skip furrow system, respectively. The quality parameters were not affected by different planting methods.

Table 5.1: Growth and yield of sugarcane under different planting methods

Treatment	Germination (%)	Shoot count ('000/ha)		NMC ('000/ha)	Yield (t/ha)	CCS (t/ha)	*IW applied (ha-cm)	IWUE (kg cane/ ha-cm)
	45 DAP	120 DAP	150 DAP					
PP-FID	42.6	153.2	167.4	115.2	72.5	8.30	34.8	2083.6
PP-FIS	41.5	148.9	153.4	102.7	68.3	7.93	22.0	3102.7
FP-FI	46.2	189.3	202.1	118.7	77.5	8.96	34.0	2280.6
FP-MFI	38.4	153.3	167.2	112.7	74.3	8.44	34.4	2159.6
FP-SFI	39.4	148.8	149.8	107.4	73.3	8.59	22.4	3271.9
FP-ASFI	40.3	149.7	150.7	108.2	72.3	8.03	21.2	3408.5
TP-TI	62.3	214.4	211.6	134.0	84.4	9.67	24.4	3459.4
FIRB-FI	55.4	176.7	182.9	118.0	75.5	8.75	34.4	2193.6
FP-F	40.5	147.9	149.0	106.1	70.4	7.99	61.2	1150.2
PP-F	42.2	149.7	150.7	105.3	71.4	8.05	62.0	1152.3
CD (P=0.05)	9.64	16.22	17.45	9.38	5.27	0.45	-	214.35

DAP : Days after planting

Deep tillage under different moisture regimes and nitrogen levels for modifying rhizospheric environment and improving sugarcane yield in plant-ratoon system

A field experiment was conducted at IISR farm with three tillage practices (T_1: Conventional-recommended harrowing and cultivator operations 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 subsoiling at 45-50 cm; two moisture regimes (M_1: 0.5 IW/CPE ratio and M_2: 0.75 IW/CPE ratio) at 7.5 cm depth of irrigation water and four N levels (N_1- 0; N_2-75; N_3-150, N_4-225 kg N/ha) to economize water use under sugarcane plant-ratoon system. Thus, there were 24 treatment combinations replicated thrice in Split Plot Design. Combinations of tillage and moisture levels were kept in main plots and N levels in sub-plots. Sugarcane variety 'CoS 94257' was planted in February 2010 in the experiment. Initial level of soil fertility indicated that soil had 0.40% organic carbon, 273.5 kg availbale N/ha; 45.02 kg available P_2O_5/ha and 260 kg K_2O/ha.

Results on sugarcane ratoon crop revealed that deep tillage before sugarcane planting significantly increased number of millable canes (83,560/ha), individual cane length (176.5 cm), cane diameter (2.29 cm) and individual cane weight (660 g) over that of control. There was 13.23% increase in mean ratoon cane yield (52.37 t/ha) with deep tillage and subsoiling 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 N/ha significantly increased growth, cane and sugar yields (Table 5.2).

Tillage and moisture interaction on ratoon cane yield showed that deep tillage and subsoling (T_3) under suboptimal moisture level (M_1) increased ratoon cane yield (48.25 t/ha) significantly over that with conventional tillage and suboptimal soil moisture regime (40.71 t/ha). The highest ratoon cane yield (56.5 t/ha) was obtained with deep tillage and subsoiling with optimal moisture regime.

Tillage and moisture interaction on water use efficiency (WUE) showed that deep tillage and subsoiling operation conserved soil moisture for better crop growth. The highest WUE (128.6 kg cane/ ha-mm) was obtained with deep tillage and subsoiling under suboptimal moisture regime. Whereas, the lowest WUE (92.08 kg cane/ha-mm) was obtained with conventional tillage and optimal soil moisture regime. Deep tillage and N level significantly increased WUE to the tune of 115.5 kg/ha-mm at 150 kg N application.

Optimizing irrigation schedule in sugarcane under different planting methods

The field experiment comprised 9 treatment combinations (three planting methods *viz.*, conventional planting (75 cm row spacing), paired

Table 5.2 : Influence of different treatments on growth, quality and yield of ratoon crop

Treatment	Millable canes ('000/ha)	Cane length (cm)	Came diameter (cm)	Cane weight (g)	Pol % Juice	Purity (%)	Cane yield (t/ha)	WUE (kg cane/kg water applied)
Primary tillage								
T_1: Conventional (recommended harrowing and cultivator for field preparation)	72.13	173.5	2.267	569	14.99	87.67	46.25	100.3
T_2: Deep tillage through Disc plough (depth 25-30 cm) before planting	83.56	176.5	2.294	660	15.05	87.89	50.37	109.99
T_3: Deep tillage through Disc plough (depth 25-30 cm) and sub soiling (depth 45-50 cm) before planting	84.45	179.75	2.307	669	15.26	88.02	52.37	114.54
S Em±	0.56	0.82	0.0057	6.94	0.070	0.12	0.64	1.34
CD (P=0.05)	1.76	2.58	0.018	21.88	0.22	0.38	2.02	4.22
Moisture level								
M_1: Suboptimum (0.5 IW/CPE ratio) at 7.5 cm depth of irrigation	75.75	173.22	2.286	591.8	15.10	87.77	44.98	119.95
M_2: Optimum (0.75 IW/CPE ratio) at 7.5 cm depth of irrigation	84.35	179.94	2.292	671.4	15.11	87.95	54.35	96.61
S Em±	0.45	0.67	0.0047	5.67	0.057	0.10	0.52	1.09
CD (P=0.05)	1.42	2.11	0.015	17.88	0.18	0.32	1.64	3.44
N level								
N_0	74.89	171.3	2.284	616.7	15.10	87.62	43.95	95.68
N_{75}	78.94	176.06	2.288	623.3	15.16	88.02	47.58	104.07
N_{150}	81.09	178.8	2.303	631.7	14.94	87.87	52.25	113.84
N_{225}	85.27	180.2	2.282	654.7	15.23	87.93	54.88	119.53
S Em±	0.63	1.41	0.0089	5.05	0.775	0.24	0.82	1.96
CD (P=0.05)	1.81	4.06	0.025	14.56	2.23	0.69	2.36	5.65

row planting (120:30 cm row spacing) and FIRB method (75 cm row spacing), and three irrigation schedules viz., irrigation at IW/CPE ratio of 0.50, 0.75 and 1.00) laid out in RBD (factorial) with three replications. Soil of the experimental field was sandy loam in texture with slow infiltration (cumulative) rate (1.2 cm/hr) and bulk density of 1.42 Mg/m^3. Soil could hold 17.3 and 6.5 per cent moisture at field capacity and permanent wilting point, respectively. The soil was low in organic carbon (0.36%), available nitrogen (216 kg/ha) and medium in phosphorus (24.7 kg P_2O_5/ha) and potassium (229 kg K_2O/ha) and slightly alkaline in reaction (pH 7.8). During pre-monsoon period, 4, 5 and 7 irrigations of 8 cm each were applied in the treatments of irrigation at IW/CPE ratio of 0.50, 0.75 and 1.00, respectively and two irrigations were applied in the post monsoon period in all the treatments. Sugarcane variety CoS 94257 was planted on February 26, 2011 and harvested on February 17, 2012.

Experimental findings reveal that germination was higher under FIRB method of planting (54.4%) compared to conventional (47.38%) and paired row (44.6%) methods of planting. However, tiller count recorded at monthly interval, was not affected by planting methods. Paired row planting produced higher cane yield (68.33 t/ha) compared to conventional (64.93 t/ha) and FIRB (62.63 t/ha) methods of planting as a result the irrigation water use efficiency was also higher in paired row planting (1.18 t/ha-cm) as compared to that under conventional (1.12 t/ha-cm) and FIRB method (1.09 t/ha-cm). Yield attributing characters *viz.*, NMC, length, girth and weight of cane and cane quality parameters were not affected by planting techniques.

Irrigation scheduling in sugarcane at IW/CPE ratios of 0.50, 0.75 and 1.00 could not affect germination and tiller count at different growth stages. Whereas, irrigation scheduling at IW/CPE ratio of 0.75 significantly enhanced yield attributing characters, i.e. cane length and cane weight over irrigation at IW/CPE ratio of 0.50 hence resulted in higher cane yield (67.52 t/ha) over that with irrigation at IW/CPE ratio of 0.50 (57.63 t/ha). Irrigation at IW/CPE ratio of 1.0 could not enhance yield attributing characters and cane yield over IW/CPE ratio of 0.75. The cane quality parameters *i.e.*, brix, sucrose (%) and purity (%) were not affected by planting methods as well as irrigation levels.

The highest irrigation water use efficiency (1.21 t/ha-cm) was recorded under irrigation at IW/CPE ratio of 0.75, followed by IW/CPE ratio of 0.50 (1.20 t/ha-cm) and it reduced to 0.98 t/ha-cm in the treatment involving irrigation at IW/CPE ratio of 1.0 (Table 5.3).

Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane

The project was implemented in two districts, Barabanki and Sitapur which were selected purposively as agriculturally backward districts declared by the Planning Commission. From each selected district, two blocks thus, 4 blocks were selected by following stratified random sampling procedure. During the project period, 100 demonstrations (16 on Ring-pit method of planting, 32 on skip furrow method of irrigation, 24 on irrigation at critical growth stages and 28 on trash mulching) were conducted at 116 farmers fields. To assess the impact of demonstrations, the economic and socio-psychological variables were also studied.

The results revealed that there was significant increase in crop yield, irrigation water saving and irrigation water use efficiency over farmers' practice. The highest increase in cane yield was recorded in ring pit method of planting (96.4%) over the conventional method followed by skip furrow method of irrigation (38.8%), irrigation at critical growth stages (28.2%) and trash mulching (25.7%). The saving in irrigation water varied from 21.7 to 44.5%. The increase in irrigation water use efficiency (IWUE) was recorded highest in ring pit method of planting (142.6%) over the conventional method followed by irrigation at critical growth stages (85.2%), trash mulching (72.4%) and skip furrow method of irrigation (68.9%).

The average germination of sugarcane planted during the project period (2008-11) under ring-pit method of planting was 70.80% Similarly, the average germination of cane planted under skip furrow method of irrigation and irrigation at critical growth stages (ICGS) were 37.20 and 36.70%, respectively, which were higher than the germination under farmers' practice (35.10%).

At the first order of tillering stage, number of average tillers per hectare in demonstrated technologies namely, ring pit planting method,

Table 5.3 : Cane yield, WUE and juice quality parameters as affected by irrigation scheduling under different planting methods

Treatment	Cane yield (t/ha)	Irrigation water use efficiency (t/ha-cm)	Juice quality parameters		
			Corrected brix	Sucrose (%)	Purity (%)
Planting method					
Conventional (75 cm row spacing)	64.93	1.12	19.25	16.81	87.34
Paired row planting (30:120 cm row spacing)	68.33	1.18	19.21	16.92	88.07
FIRB method (75 cm row spacing)	62.63	1.09	19.41	17.17	88.47
CD (P=0.05)	4.94		NS	NS	NS
Irrigation scheduling (IW:CPE)					
0.50	57.63	1.20	19.27	16.88	87.63
0.75	67.52	1.21	19.22	16.97	88.28
1.00	70.74	0.98	19.38	17.05	87.97
CD (P=0.05)	4.94		NS	NS	NS

skip-furrow method of irrigation, ICGS and trash mulching were recorded at 90,533, 95,500; 91,838 and 1,09,633, respectively, as compared to 91,333 under farmers' practice. However, in the second order of tillering highest average number of tillers per hectare (2,85,400) was recorded under ring pit method of planting followed by trash mulching (2,58,333), skip furrow method of irrigation (2,23,100), ICGS (2,12,267) and farmers' practice (2,05,367). In third order of tillering, the highest average population of 2,98,467 tillers/ha was recorded with ring pit method of planting followed by ICGS (2,54,667), skip furrow method of irrigation (2,45,167) and trash mulching (2,44,000).

At the grand growth, the highest average plant population was recorded with the ring pit method of planting (1,28,367) followed by skip furrow method of irrigation (99,167), ICGS (93,833) and trash mulching (91,233) as compared to the farmers' practice of 83500 plants/ha. The highest average number of millable cane (NMC) per hectare was recorded with ring pit planting method (1,22,967) followed by skip furrow method of irrigation (93,333), ICGS (89,233) and trash mulching (87,033) as compared to farmers' practice (77,700).

Demonstrated water saving technologies enhanced income of the farmers. The benefit: cost (B:C) ratio under demonstrated technologies increased significantly. Highest increase in B: C ratio was observed in trash mulching technology and the lowest increase in ICGS. However, the B:C ratio under ring pit method of planting and skip furrow irrigation was statistically at par but significantly higher than that of farmers' practice.

The results of the project, thus, indicate that farmers of the areas where FPARP was implemented derived immense benefits in terms of knowledge enhancement, increased adoption, conserving water resource and higher income.

Performance evaluation of 'Pusa Hydrogel' in sugarcane

A field trial on evaluation of 'Pusa Hydrogel' comprising three doses of Hydrogel (control, 2.5 kg and 5.0 kg/ha) and two irrigation levels (irrigation at IW/CPE ratio of 0.50 and 0.75) was laid out in RBD with three replications. The soil of experimental field was sandy loam in texture with bulk density of 1.43 Mg/m^3 and can hold 17.2 and 6.49% moisture at field capacity and permanent wilting point, respectively. It analysed low in organic carbon (0.39%) and available nitrogen (207.8 kg/ha) and medium in phosphorus (25.4 kg P_2O_5/ha) and potassium (227.6 kg K_2O/ha). Sugarcane variety CoJ 64 was planted on May 9, 2011 (late planted). First irrigation after sugarcane germination was applied on June 10, 2011 and further irrigation was not required in the monsoon season due to early onset of monsoon. Hence, the irrigation levels could not be imposed. A total of 1138 mm rainfall was received during monsoon period spread over the period from May 20 to September 26, 2011. During post monsoon period, one irrigation was applied in the month of November. Sugarcane crop was harvested on December 17, 2011.

The soil moisture content, recorded after first irrigation, indicated that there was improvement in moisture content of soil in the Hydrogel treated plots compared to control. Improvement in sugarcane germination (%) due to Hydrogel application was non-significant. The number of tillers recorded at monthly interval, yield attributes *viz.*, cane length, cane diameter and cane weight, and juice quality parameters were not affected by the application of Hydrogel. There was little improvement (4%) in number of millable canes due to Hydrogel application @ 2.5 kg/ha. However, Hydrogel application (2.5 kg/ha) significantly enhanced the cane yield (13%) over control.

Optimization of fertigation schedule in drip irrigated sugarcane under sub-tropical conditions

Sugarcane plant and ratoon crops were irrigated as per the following treatments:

(i) I_1: Drip fertigation at 2 days interval with irrigation water equal to 0.6 E_{pan}

(ii) I_2: Drip fertigation at 2 days interval with irrigation water equal to 0.8 E_{pan}

(iii) I_3: Drip fertigation at 2 days interval with irrigation water equal to 1.0 E_{pan}

(iv) I_4: Drip fertigation at 2 days interval with irrigation water equal to 1.2 E_{pan}

(v) I_5: 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 for plant and ratoon crops both. The cane yield and irrigation water use

efficiency (IWUE) of plant crop were higher than that of ratoon crop for all the irrigation schedules. The results are as follows:

Plant crop

Cane yield and IWUE were significantly influenced by irrigation treatments (Fig. 5.1). The highest cane yield of 93.48 t/ha was recorded when fertigation was scheduled at 1.00 Epan. At this fertigation scheduling, IWUE was 1451.3 kg/ha-cm. The lowest cane yield (69.74 t/ha) was obtained in surface irrigation treatment with 866.1 kg/ha-cm IWUE. The highest IWUE of 1647.1 kg/ha-cm was recorded when fertigation was scheduled at 0.6 Epan. At this IWUE, cane yield was 79.6 t/ha.

Ratoon crop

Cane yield and IWUE were significantly influenced by irrigation treatments (Fig. 5.2). The highest cane yield of 91.36 t/ha was recorded when fertigation was scheduled at 1.00 Epan. At this fertigation scheduling, irrigation water use efficiency (IWUE) was 1134.6 kg/ha-cm. The lowest cane yield (62.35 t/ha) was obtained in surface irrigation treatment with 774.3 kg/ha-cm IWUE. The highest IWUE of 1498.2 kg/ha-cm was recorded when fertigation was scheduled at 0.6 Epan. At this IWUE, cane yield was 72.4 t/ha.

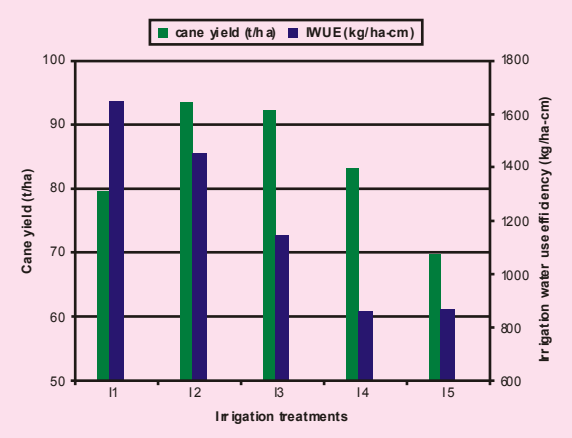


Fig. 5.1: Effect of irrigation treatments on cane yield and irrigation water use efficiency of plant crop

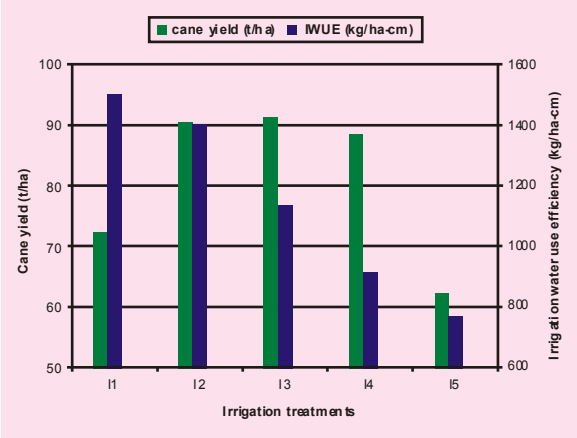


Fig. 5.2: Effect of irrigation treatments on cane yield and irrigation water use efficiency of ratoon crop

Improving Production, Quality and Economic Return of Ratoon Crop

Ratooning, a practice of growing full crop of sugarcane from sprouts of underground stubble left in the field after harvest of the plant (main) crop comprises of about 50% of the total sugarcane area. Sugarcane ratoons save cost in terms of seedbed preparation, seed material and planting operations. Ratoons help in extending the crushing period of sugar mills as they mature earlier than the plant crop. However, most often ratoon crop yields are lower than the plant crop. The major cause of low ratoon productivity in sub-tropics is the prevalence of severe winter conditions coinciding with harvesting of early maturing high sugar varieties which inhibit the sprouting of subterranean stubble buds. Unsprouted stubble causes gaps in subsequent ratoon crop resulting in lower initial plant stand and poor crop yield. Also a detrimental sequence in ratoon crop occurs of reduced plant growth, reduced nutrient recyding and mineralization, reduced activities of micro-organisms, and increased wear and tear on cultivation machinery. This necessitates that research focus be given on tillage, soil structure and quality, water and nutrient use aspects for better management of ratoons.

Effect of biomanuring 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 biomanures and combination of non *Acetobacter* 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. The highest cane yield of 8th ratoon (54.20 t/ha) was recorded with SPMC + *Gluconacetobacter* against the planted cane yield of 77.5 t/ha and 1st ratoon yield of 80.8 t/ha. This was followed by SPMC (53.60 t/ha) and FYM + *Gluconacetobacter* (51.60 t/ha). The growth and yield attributing characters *viz.*, dry matter production, number of millable cane, cane length, cane thickness and weight also exhibited similar trend. Juice quality *viz.*, brix and sucrose % did not differ significantly by different treatments (Table 6.1).

Table 6.1: NMC, cane yield, soil organic carbon and microbial biomass carbon (SMBC) of 8th ratoon under different biomanurial treatments

Treatment	NMC ('000/ha)	Cane length (cm)	Cane yield (t/ha)	Organic C (%)	SMBC (mg CO_2-C/kg soil/ day)
T_0 - Control	51.0	110.0	16.0	0.40	133.7
T_1 - Trash 10 t/ha + *Trichoderma*	56.5	140.0	30.5	0.66	195.5
T_2 - Vermicompost @ 10 t/ha	75.8	145.0	51.0	0.66	103.3
T_3 - FYM @ 10 t/ha	76.5	147.1	51.5	0.67	132.0
T_4 - Biogas slurry @ 10 t/ha	75.0	146.0	51.0	0.66	132.0
T_5 - SPMC @ 10 t/ha	77.0	160.0	53.6	0.70	168.3
T_6 - T_1 + *Acetobacter*	56.5	142.0	30.5	0.66	235.5
T_7 - T_2 + *Acetobacter*	75.9	145.5	51.0	0.66	146.7
T_8 - T_3 + *Acetobacter*	76.7	146.6	51.6	0.67	122.2
T_9 - T_4 + *Acetobacter*	75.5	146.0	51.0	0.66	151.6
T_{10} - T_5 + *Acetobacter*	78.0	165.0	54.2	0.72	108.7
T_{11} - *Dhaincha* + *Acetobacter*	74.9	146.0	50.1	0.66	95.9
T_{12} - NPK (120:60:60 kg/ha)	76.0	143.0	49.9	0.48	63.8
C.D. (0.05) /Initial	11.45	12.48	10.57	0.32	47.6

Soil organic carbon ranged between 0.66 to 0.72% under different treatments of biomanuring, over its initial value of 0.32%. Soil microbial activities enhanced due to different biomanurial treatments. The highest value of soil microbial biomass carbon (SMB-C) of 235.50 mg CO_2-C/kg soil/day was recorded under plots receiving trash compost + *Gluconacetobacter* against initial value of 47.60 mg CO_2-C/kg soil/day.

Improving juice quality and stubble bud sprouting under low temperatures of winter-initiated ratoons

In winter-initiated ratoon, sprouted buds showed relatively higher reducing sugars, soluble protein, proline, H_2O_2 contents and activity of acid invertase and ATPase enzymes and lower content of MDA, total phenols, IAA and activity of catalase, peroxidase and SOD enzymes as compared to the unsprouted ones.

In an experiment (7 rows each of 50 metre length), application of formulation F-1 containing various co-enzymes in a winter initiated ratoon crop in sugarcane variety CoS 96275 improved maximum number of tillers by 9.3%, number of millable canes by 7.5% and cane yield by 18.28%.

Priming of setts with some of the chemical formulations speeded up germination and led to early establishment of the crop stand. It also led to increase in number of tillers and leaf area index. Early germination, early attainment of higher LAI led to more dry matter production and average cane weight.

Management of Insect-pests and Diseases in their "Hot-spot" through Survey, Pathotyping, Biocontrol and Other Innovative Approaches

Almost a quarter of sugarcane tonnage is lost in the field due to insect-pests and diseases. To realize the yield potential, it is utmost necessary to protect the crop from these adversaries. Even today, farmers and extension workers are relying mainly on the chemical pesticides due to their effectiveness; knowing fully-well their hazardous nature to the biosphere. Increasing consciousness towards environmental and human health hazard, it has become imperative to go for environmentally safer alternatives. Thus, a comprehensive management strategy is needed to contain the pests through survey, development and deployment of resistant varieties, enrichment of natural enemies of insect-pests and pathogens and other eco-friendly and innovative approaches to sustain the sugarcane productivity and reduce the reliance on chemical pesticides to make a greener tomorrow.

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

This year (2011-12), factory command area of 20 sugar mills of U.P., Uttarakhand, Madhya Pradesh, Bihar and Maharashtra (Mills of DSCL group, Bajaj Hidustan group, Balrampur Chini Mills group, Birla group and mills located at Titawi, Saharanpur, Laksar, Shahjahanpur, Mawana, Simbhaoli, Harinagar, Dabra and Ahmednagar) were surveyed. Incidence of red rot was observed in genotypes *viz.*, CoS 8432, CoS 8436, CoS 88230, CoSe 95422, CoLk 8102, CoS 767, CoJ 88 (1-2%) *etc.* Low incidence of smut was observed in CoSe 92423, CoSe 98231, Co 0238, Co 0239, CoS 767. Incidence of GSD was wide spread affecting most of the varieties, however, in general, the incidence was low (1-2%). In some fields, the incidence of stinking rot (CoSe 92423) and Pokkah boeng (CoS 8436) was noticed especially in waterlogged situation.

Infestation by the top borer, in general, was 10-15%, however, it was up to 35% in certain fields of western U.P. and Uttarakhand. Damage caused by early shoot borer was 5-30%, while infestation of other borers and sucking pests was low. White grub infestation was 10 to 90% in certain fields of western U.P. and Uttarakhand. White grub was also noticed in Harinagar (Bihar) and Vighnahar (Maharashtra).

At Pravaranagar, maximum incidence of shoot borer was recorded in the first fortnight of May along with the activity of its larval parasitoid *Sturmiopsis* sp. During August-September, parasitisation of *Cotesia flavipes* was also observed. Incidence of scale insect (*Melanaspis glomerata* Green) along with it predatory beetle was noticed in ratoon crop. Incidence of white grub was observed in certain areas. This year, stray incidence of sugarcane woolly aphid was noticed in some fields and presence of predatory larvae of *Dipha aphidivora* and *Micromus* were noticed. Similarly, activity of *Pyrilla* along with its parasitoid *Epiricania* was also observed.

Development of red rot in standing cane through sett-borne infection

Inoculum load (3 treatments) in relation to different incubation periods in sett inoculation and pre-inoculated cane with Plug and Parafilm method were evaluated for the expression of disease in standing cane of Co 1148. The sett-dip inoculation of cane setts with 10^6 conidia/ml badly affected germination (range 3.3 to 5.3% in comparison to 41.33% in control) in all the three incubations. In infected setts produced through parafilm method and plug inoculation, germination was 22.7 and 25.3%, respectively. Inoculation of sett with lower concentration of spore (10^3 conidia/ml), germination was least affected (37.33%). Among all the treatments, the expression of disease in standing cane was highest in 10^4 conidia/ml concentration. It was observed that settling mortality has inverse relationship with disease appearance

in standing cane. The expression of disease at settling stage reduced the possibilities of disease appearance at later stage.

Identification of pathotypes of red rot pathogen

This year, 11 new isolates *i.e.*, two from CoS 8436 (IR-26 and IR-27); two from CoLk 8102 (IR28 and IR-33) and one from clonal selection (CoLk 8102xCoH 15); IR30); two from CoS 8432 (IR-31 and IR 32); two from CoSe 95422 (IR-29 and IR-34); one each from CoS 88230 (IR-35) and CoSe 98231(IR-36) were evaluated for their virulence pattern on designated 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*) and SES-594 (*S. spontaneum*).

All the test collected isolates were evaluated on the designated differentials using plug method of inoculation. The cane stalks were split open longitudinally after 60 days of inoculation and disease reactions of the isolates was recorded and compared with the reaction of the existing pathotypes. It was observed that all the isolates showed close proximity with already identified *C. falcatum* pathotypes *viz.*, Cf 01, Cf 03, Cf 07 and Cf 10. It was concluded that there is no emergence of any new virulent pathotype in this zone.

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

During crop season of 2011-12, 160 genotypes were screened against red rot (Cf 08 and Cf 09) and smut at IISR farm, Lucknow.

Out of 160 genotypes evaluated, 77 genotypes were moderately resistant, while 41 genotypes were susceptible (MS to HS) to both the test pathotypes. Forty two genotypes showed either moderately resistant (MR)/susceptible (MS to HS) reaction to one of the pathotypes. In case of smut, 149 genotypes were resistant and remaining 11 were susceptible. Natural incidence of wilt was also recorded and 108 genotypes were resistant while 52 were susceptible.

At IISR Regional Research Centre, Motipur, 26 genotypes were evaluated against red rot. Eighteen genotypes were resistant/moderately resistant (R/MR), while six genotypes *viz.*, LG 03001, LG 07203, CoLkM 2008-38, CoLkM 2008-53, CoLkM 2008-61 and CoLkM 2008-82 were susceptible (MS to HS) to both the pathotypes (Cf 07 and Cf 08). LG 04006 and CoLkM2008-55 were susceptible (MS/S) to Cf 07 and moderately resistant (MR) to Cf 08. Sixty eight progenies out of 165 were moderately resistant (MR) and 97 were susceptible (S/HS) to both the pathotypes.

Evaluation of Zonal Varieties for redrot, smut and wilt

Of the 37 AICRP entries evaluated against red rot at IISR farm, Lucknow (NWZ), 26 were moderately resistant (MR), 7 genotypes were moderately susceptible (MS to HS) to both the test pathotypes (Cf 08 and Cf 09) while 4 were either moderately resistant (MR)/ susceptible (S/MS) reaction to one of the pathotypes.

Thirty genotypes were found resistant/tolerant and remaining 7 genotypes were susceptible to smut on sett-dip inoculation and natural incidence of wilt was observed on two genotypes.

Of the 22 genotypes evaluated against red rot (Cf 07 and Cf 08) at IISRRC, Motipur (NCZ), 13 genotypes were moderately resistant (MR), while 2 genotypes were moderately susceptible (MS to HS) to both the test pathotypes. Seven genotypes showed either moderately resistant (MR)/ susceptible(S) reaction to one of the pathotypes of *C. falcatum*. Three genotypes *viz.*, CoB 07429, CoBln 07502 and CoSe 08453 were susceptible to wilt (natural incidence).

Improving efficacy of *Trichoderma* for management of red rot of sugarcane

An exploratory trial was conducted to evaluate *Trichoderma* isolates from sugarcane based ecosystem for their biocontrol efficacy against *Colletotrichum falcatum*. Ten selected isolates were screened *in vitro* for production of both volatile and diffusible metabolites inhibitory to *C. falcatum*. Field experiment was carried out to evaluate these isolates for their ability to induce systemic resistance against red rot. The diffusible metabolites produced by *Trichoderma* isolates were found most effective in inhibiting *C. falcatum in vitro* and need to be explored further for their potential to enhance disease control.

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

Three bud setts of CoLk 8102 were planted in March, 2011. Recommended agronomic practices were followed to raise a good crop. Periodic observations on incidence of pests and parasitoids of pests were recorded. Root borer damage in shoot stage was 8.00%. Pink borer damage in shoot stage was in traces. Grasshoppers were 2-3/clump. Nymph and adults of black bug (*Dimorphopterus gibbus*) were 10-12 individuals/clump. The incidence of top borer II brood, III, IV and V brood was 16.35%, 22.89%, 19.33%, and 22.36%, respectively. Incidence of internode borer in August was 9.6%. Root borer incidence in August was 40.67% while it was 44.33% in December. Termite incidence (on cut end damage basis) was 28.60%, while it was 16.22% on bud damage basis. Low population of *Pyrilla perpusilla* were noticed in the month of August. No. of egg masses of *Pyrilla* were 1-2/ clump during September-November. Nymphs of *Pyrilla* were noticed in traces during September to November. *Epiricania melanoleuca* was also noticed in traces. Incidence of mealy bug was 65% on cane basis during June to November. Puparia of white fly were in traces.

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

Sugarcane genotypes (13 early and 28 mid late maturing) were planted in March, 2011 with 75 cm row to row distance (4x6 m plot size, three replications). CoJ 64 and CoPant 84211, CoS 8436 were standards for early maturing group and CoS 767 and CoPant 97222 were for mid late maturing group.

In early group, Co 07024 was least susceptible (LS) and Co 05009 was highly susceptible (HS) against top borer while rest 11 genotypes *viz.*, CoH 05262, Co 07026, CoPb 07211, Co 07025, CoH 07261, CoH 05265, CoLk 05201, CoLk 07201, CoPant 07221, CoPk 05191 and Co 07023 were moderately susceptible (MS). In case of stalk borer 8 genotypes were grouped in LS category and five genotypes in the MS category. In case of internode borer, 12 genotypes showed LS reaction while CoH 05262 gave MS reaction

In mid late group, six genotypes *viz.*, Co 05011, CoH 7265, CoLk 07203, CoPant 05222, CoPant 05224, CoPant 072224 genotypes were least susceptible (LS) to top borer and 15 genotypes *viz.*, UP 05233, CoH 05269, CoPant 97222, CoS 07231, CoS 07233, CoLk 07202, CoH 07263, Co 06633, CoPb 07214, CoS 07234, CoPk 05192, CoPb 07213, CoH 07264, CoPant 06224 and Co 06034 were moderately susceptible (MS). Eight genotypes *viz.*, CoS 07232, Co 07028, CoH 05262, CoS 06047, CoH 05266, CoSe 01424, CoPb 07219 and CoPb 05211 were HS to top borer.

Sixteen genotypes showed LS and seven genotypes *i.e.*, CoH 05266, CoPk 05192, CoPb 07213, CoS 07232, CoS 07231, CoH 05265, CoS 06047 were MS to stalk borer. Five genotypes *viz.*, CoPb 07219, CoH 07263, CoH 07264, CoPb 05211 and CoPant 06224 were HS to stalk borer.

Twenty five genotypes were LS and three genotypes *viz.*, CoPant 05224, Co 06633, CoPant 06224 were MS against internode borer.

Bio-management of termites in sugarcane

The experiment was laid at IISR farm with variety CoPant 84212, comprised 10 treatments *viz.* *Metarhizium anisopliae* sett dipping, *Beauveria bassiana* sett dipping, *Trichoderma harzianum* in furrows, sett dipping in NSKE, *Trichoderma harzianum* + neemazin powder in furrows, Nemazin powder + urea (coated) in furrows, Chlorpyriphos 20 EC @ 1.0 kg a.i./ha (standard check), Imidacloprid 17.8 SL over setts, Chlorpyriphos 10 G soil application and untreated check. Observation on the termite damage was recorded after one month of planting from buds and damage ranged from 8.39-22.19%. Shoot damage was recorded after two months of planting, which ranged from 6.76-17.97%. At harvest cane damage was recorded as 6.56-22.43%. Data on germination and yield were also recorded. Maximum germination was found in Chlorpyriphos 20 EC (40.91%), whereas highest yield was obtained from Imidacloprid 17.78 SL (84.67 t/ha). Yield was found significantly low in untreated check (49.33 t/ha).

Bio-intensive management of white grubs in sugarcane

In western U.P., *Holotrichia consanguinea* was recorded as major species while *Anomala* sp.; *Apogonia* sp.; *Holotrichia* sp.; *Onthophagus* sp.; *O. calta*; *Schizonycha ruficollis*; and several unidentified species were of minor importance.

Mass emergence of *H. consanguinea* beetle was recorded from 2nd week of May 2011 to last week of June 2011. Beetle emergence almost ceased by 15th July. In central U.P., none of the species could cause economic damage.

For the management of the beetles, insect traps were modified and fabricated for testing against beetles of the white grubs under sugarcane agro-ecosystem. The newly developed insect trap having a combination of light and pheromone was found more effective in trapping predominant species *H. consanguinea* along with other species of white grubs in comparison to the traps with only pheromone or light alone. Traps were installed in the white grub affected villages of Distt. Saharanpur & Lakhimpur-Kheri (Uttar Pradesh) and Pravaranagar (Maharashtra). Results were promising.

For the management of the grub stage of the pest, associated entomopathogenic bacteria were isolated from the diseased white grubs collected from infested sugarcane fields of Western U.P. Altogether, nine isolates of entomopathogenic bacteria were obtained. Out of the six isolates tested against white grubs, none of the isolates could cause more than 50% mortality.

A field trial for the management of the grub stage was laid out at Jakhwala, Deoband, Distt. Saharanpur. Altogether nine treatments with three replications comprising of bioagents and insecticides were tried under RBD. Amongst bioagents, *Bacillus cereus* strain WGPSB-2 was found better over others, as it could reduce white grub damage by 57.62% over control with a yield of 49.97 t/ha. Amongst insecticides, Chlorantraniliprole 0.4G was found better, as it could reduce the grub damage by 87.49% with a yield of 62.93 t/ha as against 30.90 t/ha in untreated check.

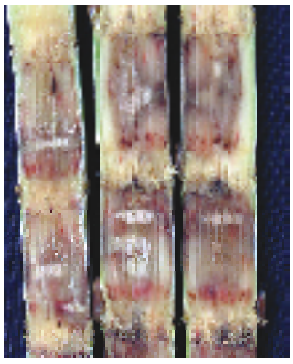
Development of techniques for laboratory mass multiplication of top borer and its parasitoids

Settling from single bud setts of CoLk 8102 (susceptible sugarcane variety to top borer) were raised in plastic tray. Newly hatched larvae of top borer @5 larvae/settling were released in the whorl. Released larvae crawled on leaves and formed silken thread for hanging. Finally larvae mined the mid rib of 2nd/3rd leaf from top and entered the settling and caused dead heart in 90% settlings. However, the top borer larvae could not reach to pupal stage as settlings died early due to dead heart formation. Rice plants were also tried to rear top borer larvae. One egg mass/clump was stapled. Newly hatched larvae crawled on rice leaves and formed silken threads for hanging but could not establish any infestation.

Population dynamics of sugarcane borers (early, top, internode and stalk) through pheromone traps

Pheromone traps of top borer, early shoot borer and stalk borer were installed in two sugarcane fields. Numbers of moths trapped were recorded regularly. The pheromone lures were changed after two months. Lures of top borer proved to be effective in attracting the moths, which resulted in the reduction of the incidence of top borer to a little extent. The per cent incidence of top borer in plots with traps was recorded as 14.54, 13.73, 25.46, 17.11 and 4.33 per cent against without traps as 16.87, 17.93, 29.87, 20.63 and 5.89 per cent in 1st, 2nd, 3rd, 4th and 5th brood, respectively.

In case of stalk borer, very low number of moths were attracted (58 moths). Shoot borer moths could not be found in any of the pheromone traps throughout the year at IISR farm.



Anticipatory and Precautionary Research on Insect-pests and Diseases

The ever-changing dynamics of insect-pests and pathogen population poses a constant threat in sustenance of resistant varieties in cultivation for a long time. Therefore, anticipatory and precautionary research become far more important to find ways and means in containing these pests through matching novelty to avoid sudden resurgence leading to crop failure.

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

The project was initiated to find out the reason and mechanism involved in sudden breakdown/ failure of a resistant sugarcane genotype to red rot after a few years in cultivation. Two approaches have been taken to address the problems *viz.*, (i) the instability of *C. falcatum* cultures and their relationship with pathogenicity *vis a vis* a change in the pathogenic/race behaviour (ii) Host induced variation in the pathogen.

During August, Cf 01 (isolated from Co1148) was inoculated on the differentials and after three weeks of inoculation, cultures were reisolated from the furthest point of infection. Eight sporulating variant cultures of Cf 01 were established after isolation from the differentials. These cultures were multiplied on liquid medium and were used for molecular analysis. It was observed that variations were also occurred at DNA level as reflected in the variation in band patterns. This indicated that passage through moderately resistant or resistant host forces selection of different *C. falcatum* genotypes with difference in qualitative DNA composition (Fig. 8.1).

Twenty six variants Cf 01 cultures established earlier were inoculated on Co1148 to ascertain any change in the virulence behaviour after long preservation. It was observed that there was a decline in the aggressiveness of the pathogen in a few variants.

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 sulphur @ 40 kg/ha and 4 micronutrients *viz.*, Mn

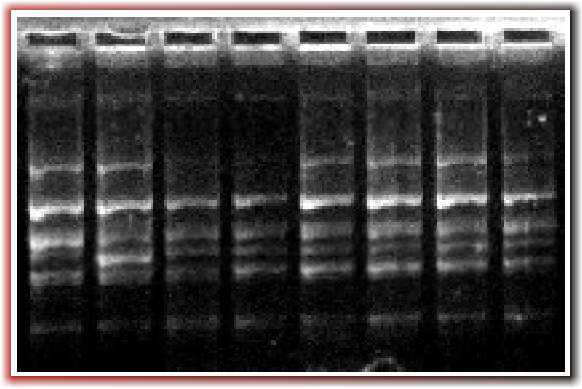


Fig. 8.1 : Band pattern of variants of Cf 01

($MnSO_4$) @ 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 CoLk 7701. There was no significant difference among the treatments with respect to red rot development.

Data indicated higher contents of total phenols (203.75 µg /100 mg dry wt), PPO (0.158 ΔOD/mg protein) and peroxidase (2.19 ΔOD/mg protein) activity in resistant genotypes (SES 594, Khakai, BO 91 and CoLk 94184) as compared to susceptible one (Co 1148, CoJ 64, CoS 8436 and CoLk 7701; phenols, 199.75 µg /100 mg dry wt; PPO, 0.072 ΔOD/mg protein; Peroxidase, 2.01 ΔOD/mg protein) in both control and inoculated genotypes.

Gel electrophoresis of PCR products showed expression of chitinase and β-1,3-glucanase genes after inoculation of pathogen. This expression was higher in resistant genotypes as compared to susceptible ones.

Management of red rot through fungal endophyte in sugarcane

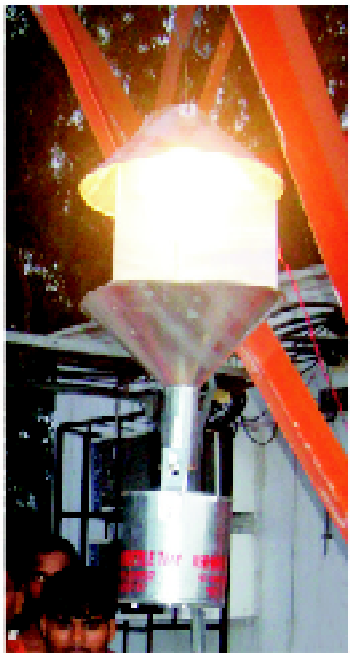
Fungal endophytes isolated from different parts *i.e.*, leaf, midrib, bud, node, internode and root of sugarcane (plant and ratoon) in different months.

Over-all colonization rate of endophytes was higher in leaves and roots as compared to nodes, internodes and buds. The most dominant endophytes were species of *Trichoderma* and *Fusarium*. Dual culture study revealed that *Trichoderma* and *Aspergillus* were antagonistic against red rot pathogen. Efficacy of culture filtrate/ metabolites of *Trichoderma* and *Aspergillus* were evaluated. Mycelial growth of *C. falcatum* dedined significantly with increasing concentrations of culture filtrate and at 5-10% concentration complete mycelial inhibition was observed.

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, cowpea, chickpea, marigold, tomato and brinjal were taken to study the push-pull effect. The incidence of top borer (II brood) ranged from 24.95 to 32.06% along with various trap crops as against 30.01 to 38.67% in control. The minimum incidence of II brood was observed in plots along with marigold, coriander, brinjal and mustard. The minimum incidence of III brood (20.52%) was observed in plot along with brinjal. However, incidence of IV brood ranged from 12.54 to 30.29%. Minimum incidence (12.54 to 13.62%) was recorded in plots along with marigold, coriander and brinjal.

The incidence of internode borer ranged from 11.86 to 22.90% and minimum incidence was observed in plots along with jowar and maize. The maximum parasitisation (60%) of top borer larvae (IV brood) by *Isotima javensis*, *Rhaconotus scirpophagae* and *Stenobracon nicevillae* was obtained along plots of tomato-chickpea-sorghum whereas minimum parasitisation was observed along the marigold-coriander (25%) and chickpea-sugarcane (26.66%). However, when marigold was followed after mustard the parasitisation was 50%.



Basic and Fundamental Research in Physiology, Biochemistry and Molecular Biology

Sugarcane provides more than 70% of the world's sugar. Research so far has largely contributed in increasing the cane yield rather sucrose content in stalk *per se*. Sugar recovery in the world varies between 8 and 14% depending on the varieties, milling operations and post-harvest logistics. At the variety level, not much success has been reported in increasing the sucrose content per unit dry matter basis. At the national level especially in sub-tropical part, pol in cane hovers around 11-13% which ultimately lead to the sugar recovery of 9 to 10% only. Economically, increasing sucrose content is more beneficial than corresponding increase in cane yield. Hence, concerted effort is needed to improve the sucrose content and thereby sucrose recovery. All these are possible when basic and fundamental research is strengthened particularly using the frontier science techniques and technologies. Microarray, transcriptomes and utilizing the whole genome sequence information along with physiological attributes will certainly provide useful leads in this direction.

Improving physiological efficiency of sugarcane

(1) Germination

In sub-tropical India, sugarcane takes 35-45 days for germination. Attempts have been made to reduce this period by treating three-bud setts with certain chemicals in autumn planted sugarcane. In resorcinol (0.1%) treated setts, 13% germination was observed in 7 DAP. After 30 days of planting, the germination was as follows: control (25%), water primed control (64%), mixture of coenzymes (100 ppm) treated setts (74%) and mixture of phosphates (100 ppm) treated setts (68%). By reducing this period, early growth of shoots and leaf development took place which led to attainment of LAI of nearly 1 in 70-75 dap as compared to 0.3 in control. This also resulted in higher average cane weight. The average cane weights were as follows: control (520 g), water primed control (680 g), $MnSO_4$ (930 g), resorcinol (850 g), mixture of coenzymes (810 g) and mixture of phosphorus (750 g).

Per cent germination under soaking of setts in zinc sulphate was maximum (33.3%) while in water soaked and diluted H_2SO_4 soaked were 24.4 and 25.2%, respectively after 41 days of planting revealing the role of Zn^{2+} ion for enhancing germination in aqueous zinc sulphate solution soaked setts.

(2) Physiological interventions to improve cane and sugar yield

Source and sink strength improvement was recorded with GA treatments in variety CoSe 92423 in maturity and later stages of crop growth. The treatment of GA increased the cane weight/cane by 45, 39, 73, 73 and 73% in the month of Dec, Jan, Feb, Mar and April compared with control, respectively. The cane height was increased by 15, 26, 32, 33 and 36%, respectively in the months of Dec, Jan, Feb, Mar and April, respectively than control. The numbers of internodes/cane was increased by 39, 42, 32, 30 and 39% in Dec, Jan, Feb, Mar and April months, respectively than control. Similarly leaf area/cane was increased by 30, 28, 33, 38 and 36%. Corresponding increase in leaf dry weight/cane was 38, 39, 40, 36 and 38%, respectively in the months of Dec, Jan, Feb, Mar and April. The juice weight/cane was increased by 28, 27, 12 20 and 63%, respectively in the months of Dec, Jan, Feb, Mar and April months and reducing sugar % decreased by 14, 11, 3, 14 in the months of Dec, Jan, Feb, Mar but increased in the month of April by 28%. The juice purity % was decreased by 11, 14, and 67% in the months of Dec, Jan and April but increased by 13.5% in the month of Feb. The Brix% was increased by 1, 3, 4, 5 and 3%, respectively in the months of Dec, Jan, Feb, Mar and April with GA treatment than control. Invariably the activity of amylase was 0.338 ± 0.22 mg starch hydrolyzed/h/g fw, acid invertase

specific activity was 0.012 ± 0.002 ìmol/mg of proteins/min and sucrose synthetase was 573 ± 22 nmoles of sucrose synthesized/min/g fw in leaflaminae treated with GA whereas in control, it was 224 mg starch hydrolyzed/h/g fw, 0.044 ± 0.002 ìmol/mg of proteins/min and 110±11.5 nmoles of sucrose synthesized/min/g fw for amylase, acid invertase and sucrose synthetase, respectively.

(3) Expression of sucrose metabolizing enzymes

(a) Foliar application of enzyme effectors on sucrose yield

Effect of foliar application of $MgCl_2$, $MnCl_2$, boron and ethrel was studied to improve sucrose content in cane stalk of low sugar variety BO 91. Results obtained indicated increase in sucrose content in cane juice due to enzyme effectors (Mg, Mn and Boron) and growth hormone (ethrel) (Fig. 9.1); effect was the highest using manganese application. During maturation phase, the activity of SAI showed progressive decline, being quicker in early ripening variety compared to late maturing ones. *In vitro* studies with enzyme effectors indicated inhibitory effect of Mn and Mg on SAI activity (Fig 9.1) and stimulatory on SPS activity (Fig 9.2).

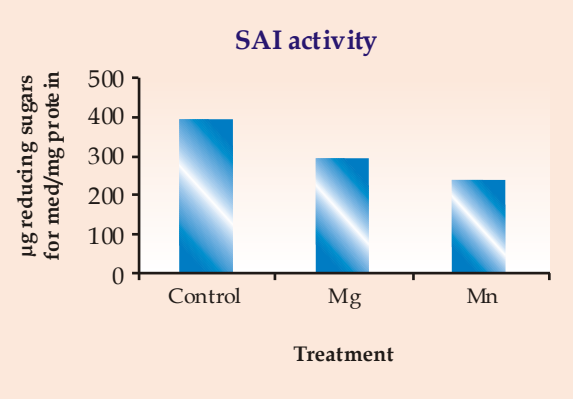


Fig. 9.1: Effect of enzyme effectors and growth hormone (ethrel) on sucrose content in cane juice

(b) Real Time PCR analysis of gene(s) of sucrose metabolism

To better understand the sink activity, expression analysis of gene(s) responsible for the synthesis and breakdown of sucrose is important especially in varieties having ability to accumulate

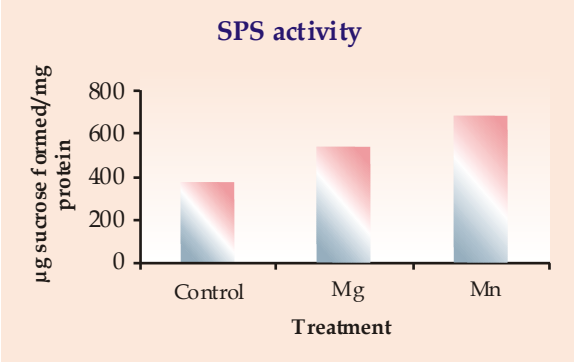
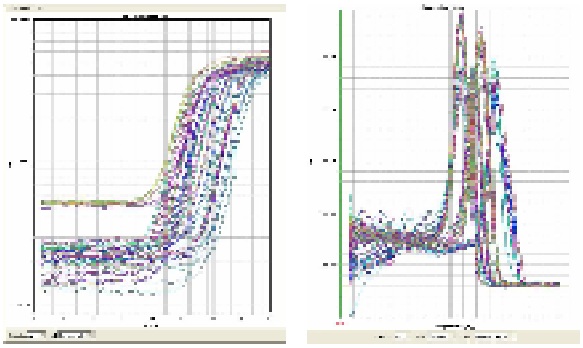


Fig. 9.2: *In vitro* effect of enzyme effectors on SAI and SPS activity

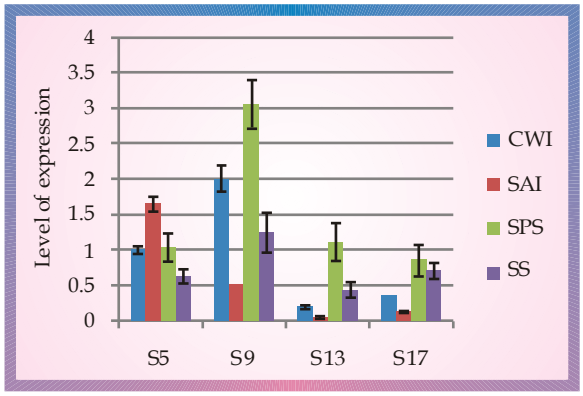
differing levels of sucrose. Associations of gene expression with biological traits have been based on alterations in the timing and intensity of gene expression with various treatments including nature of genotypes and developmental stages. In this direction, expression of genes associated with synthesis and cleavage of sucrose with respect to stage in low and high sucrose bearing varieties as well as expression behaviour of genes namely CWI, SAI, SPS and SS through real time PCR and their association with low and high sucrose bearing varieties were carried out.

Based on amplification plot (A) and dissociation (melting) curve (B) of SPS, SS, SAI and CWI indicated well amplification of designed RT-PCR primers and reaction conditions (Fig 9.3). Real time PCR data depicted early inhibition of soluble acid invertase (early decline in expression) in CoJ64 over BO 91 variety (Fig 9.4). In CoJ 64, CWI gene expression was high at later stage of plant growth in top portion (relatively immature), while it was high in early month of maturity of crop in bottom portion of cane. Its overall expression level was higher in CoJ64 than those of BO 91 (Fig. 9.4).



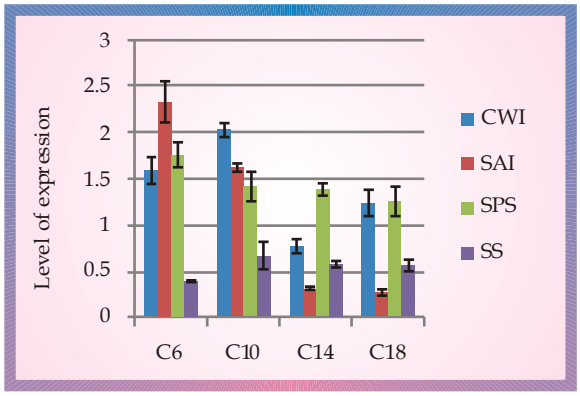
(A) (B)

Fig. 9.3: Amplification plot (A) and dissociation (melting) curve (B) of SPS, SS, SAI and CWI



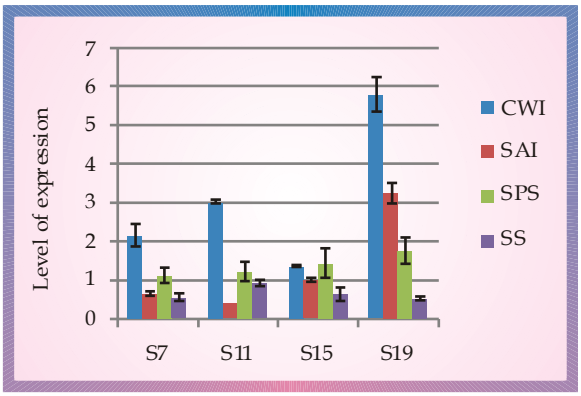
Nov. Dec. Jan. Feb.

(A) BO 91 top portion of cane



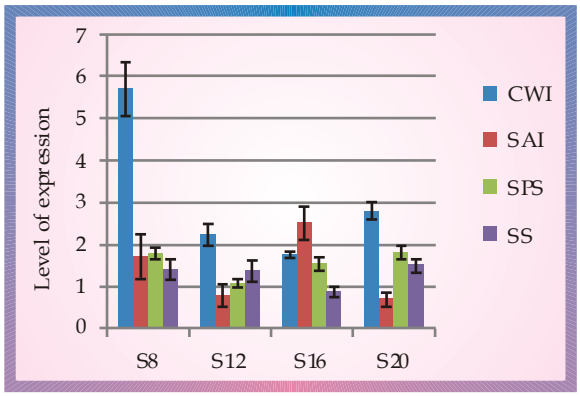
Nov. Dec. Jan. Feb.

(B) BO 91 bottom portion of cane



Nov. Dec. Jan. Feb.

(C) CoJ 64 top portion of cane



Nov. Dec. Jan. Feb.

(D) CoJ 64 bottom portion of cane

Fig. 9.4: Real time PCR based expression of CWI, SAI, SPS and SS genes in BO91 and CoJ 64 varieties in different portions of the cane. Actin gene was used as control to estimate the level of expression

Real time PCR gene expression revealed differential expression of SPS, SS, SAI and CWI in two sets of sugarcane genotypes differing in sucrose accumulation and in general, expression of sucrose synthesizing genes was higher and for longer time in high sugar accumulating variety than those of low sugar variety. Study also indicated their differential behaviour in different portion of cane accumulating the sugar.

(c) Expression profile of SAI gene in stale cane

Post-harvest sucrose deterioration in sugarcane is one of the major problems of low sucrose recovery in sub-tropical India. Soluble acid invertase (SAI) gene expression increased with cane staling immediately after cane harvesting. Data presented in Fig. 9.5 indicated higher expression of SAI gene in canes stored after 5 days at room temperature in two varieties, CoLk 94184 and BO 91; expression level was comparatively very high in variety CoLk 94184. SAI expression analysis was studied in different parts of cane stalk; in middle portion of stale cane, increase in SAI expression was least in variety CoLk 94184 as compared to top portion exhibiting highest increase, while in variety BO 91, level of variation was highest in basal potion of cane stalk.

An effort was also made to investigate the minimization of post-harvest sucrose losses and SAI expression using chemical formulation and electrolyzed water. As compared to stale cane, treated stalk showed lower expression of SAI gene indicating their controlling effect on SAI activity and sucrose losses in stale canes.

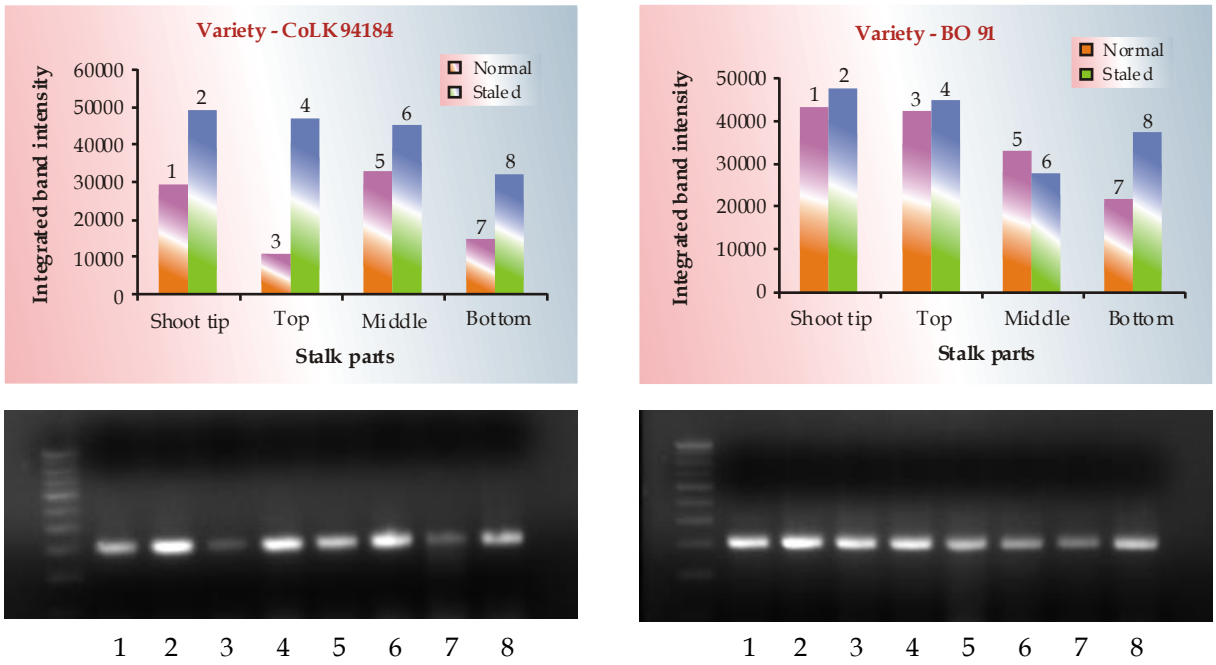
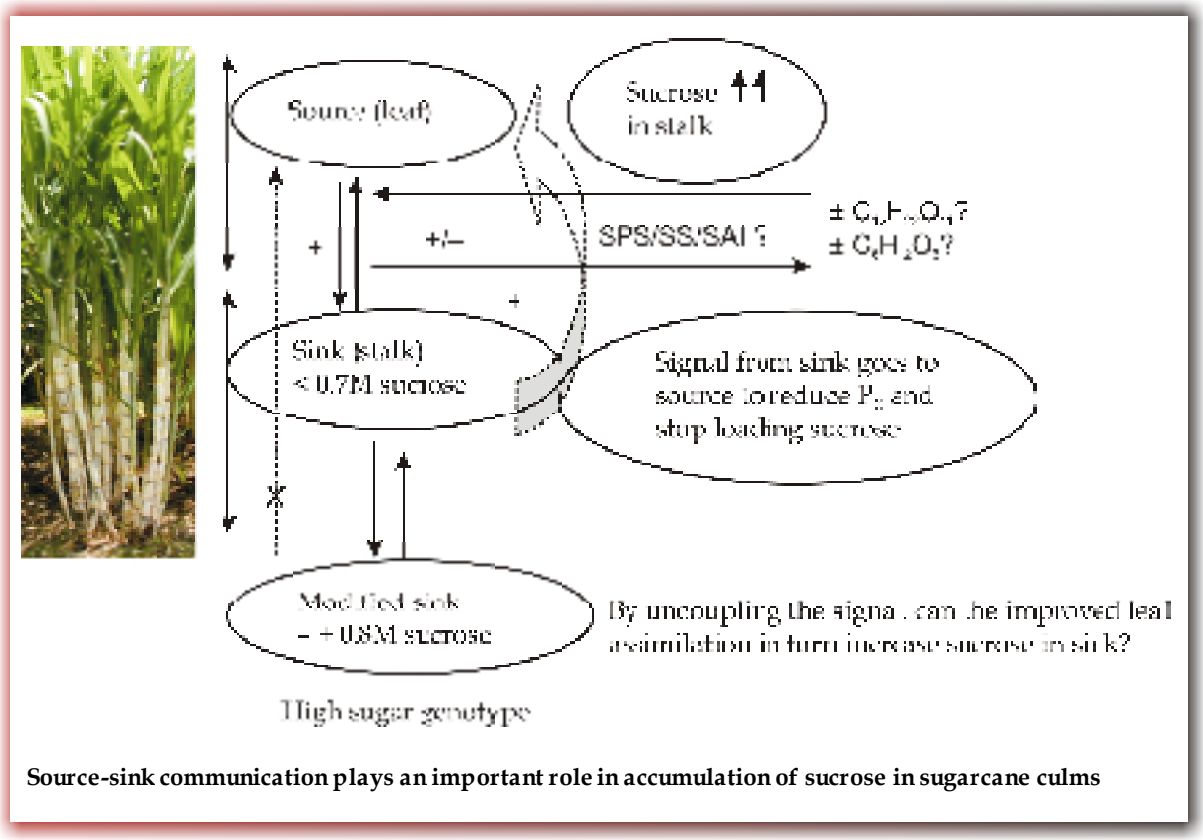


Fig. 9.5: Invertase expression in fresh & stale cane by performing qRT-PCR



Source-sink communication plays an important role in accumulation of sucrose in sugarcane culms

Climate Change Impacts on Cane Farming

Climate change has emerged as one of the most complex, challenging and serious issue of recent times globally. Model predictions indicate temperature rise up to 4°C in some parts of the country, which may increase the uncertainty in weather patterns in general and temporal and spatial distribution and intensity of rainfall in particular by the end of this century. Sugarcane cultivation and industry are directly exposed to uncertainties associated with climate change induced weather variability. Such abrupt and frequent changes in temperature and rainfall (in terms of drought and floods) are likely to increase vulnerability of productivity and quality of sugarcane in the country. The climate and weather variability produces impacts across an integrated value chain comprising of sectors such as: cane cultivation (growing and harvesting and consequently crop tonnage), its marketing, transport and milling (cane quality). The crop performance in various stages of growth and development is largely affected by the temporal and spatial variability of weather. In view of the above facts, the climate change study has been initiated in a systematic manner at this Institute. The major objectives of the programme are i) to provide an estimate of impact of climate change on sugarcane productivity and quality in Uttar Pradesh based on literature review, ii) to calibrate and validate DSSAT model for sugarcane under sub-tropical environment, iii) to quantify the suitability of various agronomic measures for adaptation to climate change and iv) to collect and compile relevant indigenous traditional knowledge on sugarcane crop particularly in the context of climate change and organize climate change awareness programme for farmers and other stakeholders.

Potential productivity of sugarcane in eastern Uttar Pradesh

The radiation based potential productivity of sugarcane was estimated through simulation modeling for eastern Uttar Pradesh. The data on potential and long-term (1981-2009) average productivity in these districts is shown in Table 10.1. The potential productivity ranged from 78.3 to 86.1 t/ha whereas long-term (1981-2009) average productivity ranged from 44.5 to 54.4 t/ha.

Table 10.1: Potential and average cane productivity in selected districts of eastern Uttar Pradesh

District	Productivity (t/ha)	
	Potential	Observed (LT average)
Deoria	79.0	49.5 ± 4.4
Kushinagar	86.3	52.5 ± 3.9
Gorakhpur	79.0	54.4 ± 5.4
Basti	79.3	51.1 ± 5.8
Barabanki	79.0	48.4 ± 7.3
Raibareli	80.1	44.5 ± 5.9
Hardoi	86.3	46.9 ± 5.6
Sitapur	78.3	48.6 ± 5.7
Lakhimpur Kheri	79.2	50.2 ± 6.2

Impact of maximum temperature deviation in July on potential productivity of sugarcane in Gorakhpur district of eastern Uttar Pradesh

The month of July is crucial for cane growth and development because crop enters in elongation phase with the onset of monsoon. The maximum temperature deviation in July is very important for growth of the crop and its final productivity. The impact of deviation of the maximum temperature from normal on the potential productivity of the crop was assessed through crop modeling. The long-term (1970 – 2006) average maximum temperature for the month of July in Gorakhpur was 33.3 ± 1.1°C. The impact of deviation of maximum temperature both below and above LT normal on potential productivity of sugarcane in the district is presented in Fig 10.1. The average rate of decline in potential productivity is 0.23 t/ha/°C with temperature decline up to 5.0°C below normal.

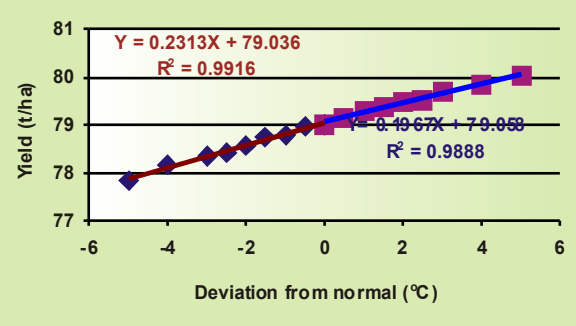


Fig. 10.1: Maximum temperature deviation and potential productivity of sugarcane

Above normal, the rate of productivity increase is nearly 0.2 t/ha/°C for the same range of deviation.

Weather database compilation and updation

Meteorological data at IISR, Lucknow for the year 2011-12 is given in Table 10.2. The weather during the crop season 2011-2012 was characterized by lower average maximum temperature in April, May, June, July, August, November and December 2011, respectively by 1.3, 0.3, 2.0, 0.6, 1.0, 0.6 and 2.1°C as compared to long term average (1980-2010). It also remained lower in January, February and March 2012, respectively by 1.5, 1.0 and 1.1°C as compared to LT average (1980-2011). It remained at par with LT average during September and October 2011.

The minimum temperature exceeded LT average during September, November and December 2011 and January and February 2012, respectively by 0.8, 1.4, 0.1, 1.5 and 0.1°C. It remained lower during April, May, June, July August and October 2011 and March 2012, respectively by 0.9, 0.4, 0.9, 0.4, 0.4, 0.2 and 1.2°C as compared to LT average.

Morning relative humidity remained lower than LT average during April, September, October 2011 and February 2012, respectively by 4, 1, 3 and 4%. It exceeded LT normal during May, June, July, August, November and December 2011, respectively by 7, 3, 3, 2, 1 and 4%. It remained normal during January and March 2012.

Afternoon relative humidity was above LT normal during May, June, July, August, September, November, December 2011 and January 2012, respectively by 5, 7, 2, 5, 3, 10, 12 and 3%. It remained below LT normal during April, and October 2011 and February and March 2012, respectively by 2, 2, 2 and 1%.

The duration of bright sunshine remained lower than LT average all through the crop season from April 2011 to March 2012 ranging from 1.1 to 3.3 h/day except during January 2012 where it exceeded LT normal by 0.4 h/day. The maximum reduction in duration of bright sunshine was observed in November 2011 (3.3 h/day) and minimum was in March 2012 (1.1 h/day).

During the crop cycle 2011-2012 the total rainfall received was 1218 mm as against LT normal of 917 mm. During monsoon season (June-September), the total rainfall received was 1095.6 mm as against LT normal of 799.8 mm. Thus monsoon rainfall excess was 295.8 mm.

Table 10.2 : Meteorological data at IISR, Lucknow

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Rainy days	Duration of sunshine (h/day)
	Maximum	Minimum	07 Hrs.	14 Hrs.			
April 2011	36.5	19.6	50	20	5.6	1	4.7
May 2011	38.8	24.3	66	36	22	3	3.5
June 2011	35.6	25.3	75	56	140	6	2.9
July 2011	33.1	25.4	90	74	264	12	1.6
August 2011	32.0	25.1	92	78	410.4	14	2.3
September 2011	32.7	24.9	90	72	281.2	10	2.9
October 2011	32.3	18.3	87	47	0	0	4.5
November 2011	28.1	13.2	92	52	0	0	2.1
December 2011	22.0	8.0	96	55	0	0	1.4
January 2012	19.9	8.7	92	52	62.2	3	1.8
February 2012	24.5	10.4	83	38	33.6	1	4.0
March 2012	30.6	13.8	74	28	0	0	5.2
Average	30.5	18.1	82.3	50.8			3.1
Total					**1218**	**50**	

The total number of rainy days during crop cycle 2011-2012 was 50 as against LT average of 44. The number of rainy days during monsoon was 42 against LT average of 36.

Long-term weather variability trends

Long-term (1981-2010) annual and monthly average maximum and minimum temperature at Lucknow in central UP was analyzed for decadal (1981-1990, 1991-2000 and 2001-2010) trend variability following standard statistical procedure. The pattern of variability and decadal trend lines are shown in Fig. 10.2 and 10.3. Both the maximum and minimum temperatures reflected an inclining trend during 1981-1990 and 2001-2010 whereas a dedining trend for both the parameters was noticed during 1991-2000. The minimum temperature trend during 2001-2010 was found to be statistically significant with an increasing rate of 0.86°C/decade. During 1981-1990, the monthly maximum temperature reflected an increasing trend in months of January, February, April, May, June, August, September and November whereas a declining trend in March, July, October and December. During 1991-2000, an increasing trend was reflected in April and November in contrast to declining trends in rest of the calendar months. During 2001-2010, an inclining trend was noticed in January to April, June, August, October and December. A declining trend was seen in May, July, September and November.

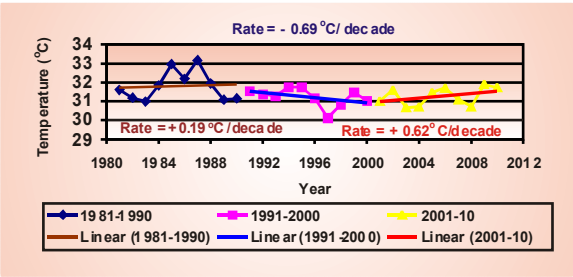


Fig. 10.2 : Decadal pattern of annual maximum temperature

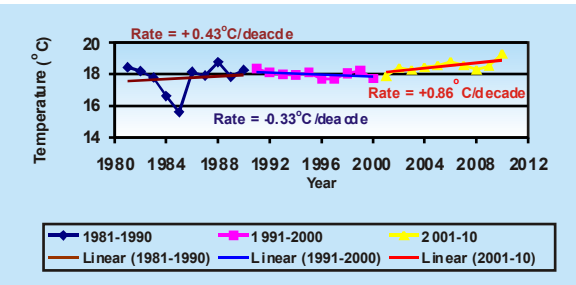


Fig. 10.3 : Decadal pattern of annual minimum temperature

The declining trend in January and July, respectively @ 0.28°C and 0.18°C/y during 1991-2000 was found to be statistically significant. The monthly minimum temperature reflected an indining trend in February, March, May, June and August to December and declining trend in January, April and July during 1981-1990. During 1991-2000, inclining trends were noticed in May, October and November whereas declining trends were reflected in rest of the calendar months. Inclining trends were reflected in January to April, June, November and December in contrast to declining trends in rest of the months during 2001-2010. The inclining rate @ 0.3 °C/y in the month of October during 1991-2000 and 0.26 °C/y in the month of November during 2001-2010 were found statistically significant.

Long-term productivity trends of plant and ratoon cane

The long-term (1981-2009) productivity pattern of plant and ratoon crops of sugarcane in some districts covering eastern, central, Bareilly and western zones of Uttar Pradesh were analyzed for crop performance. The compound growth rate of plant and ratoon crops in different districts is presented in Table 10.3.

Table 10.3 : CGR of plant and ratoon crop productivity in UP during 1981-2009

Zone	District	CGR (% per annum)	
		Plant	Ratoon
Eastern	Kushinagar	-0.14	0.55*
	Deoria	-0.23	0.37
	Gorakhpur	0.06	0.68
	Basti	0.41	0.97*
Central	Barabanki	0.84*	1.77*
	Sitapur	0.72*	1.49*
	Lakhimpur	0.72*	1.94*
	Hardoi	0.48	1.52*
	Raibareli	-0.80	-0.14
Bareilly	Shahajahanpur	0.36	0.97*
	Bareilly	0.44	1.29*
	Pilibhit	0.66*	1.65
	Rampur	0.79*	0.99*
	Moradabad	0.74*	0.65*
	Bijnore	0.41	1.09*
Western	B. Shahar	0.50	0.93*
	Meerut	0.65*	1.43*
	M. Nagar	0.34	0.96*
	Ghaziabad	0.50*	0.83*
	Saharanpur	0.25	0.87*

* Statistically significant

Improving the Native *Gur, Khandsari* and Other Forms of Sugar and Making it Move in the Value Addition Chain as New Marketable Products

Jaggery, one of the most important sweeteners in India is a traditional unrefined non-centrifugal sugar consumed in the Asia, Africa, Latin America and the Carribean continents. It is a concentrated product of cane juice without separation of the molasses and crystals and can vary from golden brown to dark brown in colour. Jaggery has great nutritive and medicinal value. Jaggery industry is dominantly decentralized cottage industry of India which once met about 40 to 50% sweeteners requirement of Indian population, is now using just 20 to 30% of the total sugarcane production. About one third to one half jaggery produced needs to be stored every year and the loss of jaggery during storage range from 7 to 25% depending upon the storage and packaging conditions. Hence, research efforts are required on value-added production technology to develop jaggery into suitable particle sizes and explore potential for domestic market and export.

Designing and development of crushing units

Design and development of a small capacity cane crushing unit for household purpose

The properly assembled crushing unit was tested providing adequate power through proper chain sprocket system. It was found to work smoothly and without making any kind of noise. Its effective capacity varied from 20 to 30 kg/h with juice recovery percentage of 50 to 60 (cane weight basis) depending upon the number of passes.

Refinement of 3-roller horizontal power driven crusher developed at IISR

The modified crusher was tested cane variety CoS 94257 (Plant crop) and the results have been summarized in Table 11.1.

Table 11.1 : Test results of refined crusher

Parameter	Cane feeding		
	4-5 canes	6-7 canes	8-9 canes
Energy consumption at no load, MJ/h	5.22	5.22	5.22
Crushing capacity, kg/h	308.60	363.89	418.67
Juice extraction, % (cane basis)	57.36	61.25	64.05
Energy consumption/h, MJ	10.35	11.34	12.50
Energy consumption/kg cane, kJ	33.55	31.17	29.86
Cane crushed/MJ, kg	29.83	32.11	33.52

It has been observed that juice extraction increased up to the maximum value of 64 per cent and crushing capacity reached up to 419 kg/h. Capacity and extraction are expected to improve further with other favourable factors. It was also observed that about 40-50 of total energy is used for running the crusher only, which is expected to decrease over further usage of crusher. With increased capacity, more cane is crushed per unit of energy.

Design and development of storage and packaging techniques

Development of a solar drier for jaggery drying

The solar dryer unit for 100 kg per batch capacity for drying jaggery from about 12% moisture content to 6% moisture has been developed (Fig. 11.1). The unit was tested at full load conditions. Observations of ambient temperature, ambient humidity, cabinet temperature and cabinet humidity were measured at each hour starting from morning (10 hrs) to evening (16 hrs). The temperature difference between cabinet and ambient ranged from 11 to 26 ^{0}C. Similarly, the difference in per cent humidity of ambient and cabinet was 40 to 1. The drying rate of jaggery was found as 0.300 kg moisture per hour.

Fig. 11.1: Solar drier for jaggery drying

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

Jaggery was prepared using a suitable variety of sugarcane. Initial values of the jaggery quality parameters like brix, pol, reducing sugar, moisture content, pH and colour were determined initially and after storage of six months. The samples were packed in nitrogen; shrink wrap and stretch wrap conditions. It was found that in the nitrogen environment expresses best quality in comparison to all other conditions (Table 11.2).

Storability assessment of value-added jaggery prepared using *aonla* as a natural source of vitamin C

In case of value-added jaggery, samples showed less amount of sucrose as compared to plain jaggery due to acid inversion carried out in presence of vitamin C (Ascorbic acid). This also resulted in higher values of reducing sugars and reduced pH. The colour of jaggery was also affected. However, it did not affect storability of samples and the samples remained intact after storage period. Moisture content reduced like plain jaggery during initial part (drying phase) and increased during remaining period (monsoon period) as per the normal jaggery behaviour. Loss of vitamin C was observed between 15.96 to 24.67 per cent during storage period. Other quality parameters also changed and that too happened with plain jaggery. Loss of vitamin C during storage in value-added jaggery made from sugarcane variety CoS 96257 is shown in Fig. 11.2.

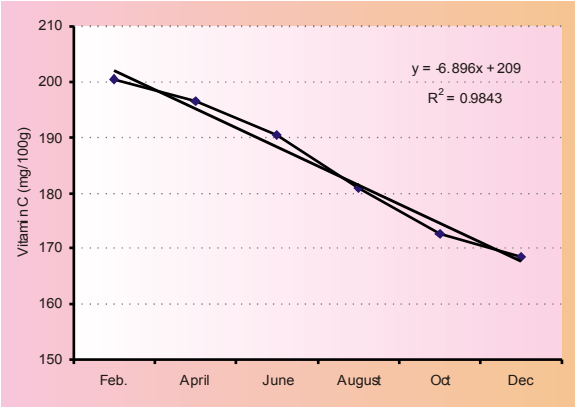


Fig. 11.2: Loss of vitamin C during storage in value-added jaggery made from sugarcane variety CoS 96257

Refinement of juice extraction process with special reference to sugarcane cleaning

The cane was harvested close to the ground both manually as well as with the windrower harvester and detrashed manually. Roots and mud clods were removed with the help of a knife. The cane was then washed thoroughly below the water tap and also by water spray under pressure. Samples of such cleaned canes were crushed employing horizontal cane crusher. It was found that the juice was very clean and contained minimum impurities. The jaggery prepared from these cleaned canes was very good in appearance and quality as well.

Development of power operated jaggery moulding machine

A batch type screw press rectangular system for moulding the jaggery developed earlier was tested. Efforts were made to make it power operated.

Table 11.2: Effect of different packaging conditions on the quality of jaggery during storage

Packing condition	brix	Pol %	Reducing sugar	Moisture	pH	Colour reading
Initial value of sample	13.5	77.1	5.6	7.1	6.4	193
Nitrogen environment	12.4	72.3	6.2	9.2	5.9	230
Stretch wrap condition	14.8	79.7	7.9	14.5	6.9	295
Shrink wrap condition	14.1	76.2	7.2	13.5	6.6	260

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

A few mixers available in the market were tried for mixing of dried *aonla* shreds with jaggery slurry. These mixers did not work satisfactorily as further cutting of shreds was observed, which was not desired.

Diversification of sugarcane based by-products

Identification of inhibitors in sugarcane biomass hydrolysates and their effect on ethanol yields

The lignocellulosic biomass of sugarcane yields ethanol *via* pre-treatment, saccharification and fermentation. However, the yields of fermentable sugars and ethanol are quite low as compared to the theoretical yields. During pre-treatment and hydrolysis of sugarcane lignocellulose wide range of compounds are formed and some of these compounds tend to inhibit the enzymatic reactions and micro organisms used for the hydrolytic processes. The work was taken up for identification of compounds responsible for lowering the yields of the ethanol during its production from lignocellulosic biomass with the objectives of identifying and quantifying the intermediate compounds formed in sugarcane biomass hydrolyzates and study the effects of the inhibitory compounds on the fermentable sugar and ethanol yields.

Pretreatment of sugarcane trash, mandatory for saccharification led to the production of inhibitors in the hydrolysates to be further processed for saccharification and fermentation. Five inhibitors were identified in the acid pretreated trash namely, 5 hydroxy-2 methyl furfural, furfural, levullinic acid, 3,4 dihydroxy benzoic acid and vanillic acid. Their effects [with 3 mg/L of 5 hydroxy-2 methyl furfural, 50 mg/L of furfural, 0.3 mg/L of levullinic acid, 0.3 mg/L of 3,4 dihydroxy benzoic acid and 0.7 mg/L of vanillic acid] were evaluated on saccharification of sugarcane trash hydrolysates. The inhibitors treated biomass hydrolysates were tested at two cellulase enzyme (Cellulase) loads of 30 and 60 FPU at three residence times (24 hrs, 72 hrs and 168 hrs). Significant inhibition occurred in cellulosic digestibity and reducing sugar contents with both 30 and 60 FPU at all the three residence times. However, maximum depression in cellulose digestibility and reducing sugar contents occurred at 30 FPU with furfural (21.16% and 30.6%) followed by 5 hydroxy-2 methyl furfural (10.1 and 35.46%), 3,4 dihydroxy benzoic acid (12.43 and 26.83% and vanillic acid (15.46 and 30.0%) respectively as compared to the untreated trash hydrolysates.

Research and Development Activities on Sugarbeet

Sugarbeet (*Beta vulgaris* L.), a temperate crop, was introduced in India during 1950s. It is a man-made crop and is the product of human selection from fodder beet for higher sugar content. Sugarbeet has shown its potential as agriculturally feasible under Indian conditions, having potential to yield comparable to sugarcane in half the time with water saving of 30-40%. The suitable varieties have been identified and the production technology has been developed. The mechanization of sowing operation has been done. The ecological niches for the successful cultivation of the crop have been identified. Most of the components are already worked out and can be integrated in a mission mode with the appropriate Government policy, industrial entrepreneurship and a committed agricultural department. It may also be mentioned that sugarbeet has an in-built tolerance to saline and alkaline soil conditions, thus, it has the potential to bring under plough and reclaim vast tracts of salt-affected soils in the country, estimated to be around 6.7 million hectares. For integrating sugarbeet with the existing cropping pattern, a lot of work has been done but still some more research may be required for the new locales. It can easily be grown as an intercrop with sugarcane to increase sugar productivity per unit time and area. Sugarbeet has potential to contribute the future demend of ethanol by growing it in salt affected soils.

Developing sugarbeet varieties for Indian agro-climates

The research work on sugarbeet is carried out at two locations *i.e.*, Lucknow and Mukteswar. The root crop evaluation and raising of steckling crop for germplasm maintenance and breeding work is carried out at IISR, Lucknow; while flowering, breeding and seed production activities are carried out at Mukteswar, Uttarakhand.

Germplasm maintenance

The germplasm maintained at Mukteswar is presented in Table 12.1.

Germplasm evaluation

Forty germplasm lines were evaluated for root crop performance at Lucknow in RBD with two replications. IN-3, Multipoly x LK-4, Multipoly x SR-97, Multipoly x LK-8, IN-14, IN-08, Cauvery, PAC-60009, PAC-60008, Indus, IN-14, IN-08, IN-08, FC-720 were found to be better in sucrose content and gross sugar yield, while LK-8 to be tolerant to root rot.

Probable sources for genetic improvement in sugarbeet for various economic traits are presented in Table 12.2.

Table 12.1: Sugarbeet germplasm at Mukteswar

Type of material	Number	Details
Inbreds	4	LK-4, LK-7, LK-8 and LK-27
Composites	7	IISR Comp-1, LKC-95, LKC-11, LKC-HB, IISR Comp-2000, LKC Comp-2006 and LKC-2007
Varieties	5	LS-6, R-06,IISR Comp-1,LKS-10 and LKC-95
Exotic breeding lines	27	SR-96, SR-97, SR-125, Rasoul, Shirin, 7112, 436, Zarghan, Perfo, Hilma, FC-712, PAC-60002, PAC-60006, BTS-601, BTS-602, BTS-603, BTS-604, BTS-605, FD IND-1, FD IND-2, Falicita, Esperanza, Multipoly, Arriba, Calixta, Capitana and Sandrina
Elite selections	5	HTHB, LKC-IB, LKC-LB, L-33 and HBS
New introductions	4	FC-201, FC-720, FC-722 and FC-722 CMS
Total	52	

Table 12.2: Sugarbeet germplasm for genetic improvement study

Attributes	Germplasm lines showing superiority
Root yield	LK-8, IN-01, IN-08, IN-09, Indus, PAC-60008, PAC-60007, Multipoly x LK-4, Multipoly x SR-97 and Multipoly x LK-8
Top yield	LK-8, Multipoly x LK-8 and Multipoly x LK-4
Sucrose content	Shubhra, SR-125, PAC 60008, IN-06, IN-08, IN-15, IN-16, PAC 60006 and Capitana
Tolerance to root rot	LK-08, Multipoly x LK4, Multipoly x SR-97 and Multipoly x LK8
Tolerance to Bihar hairy caerpiller	Multipoly x LK4 and Multipoly x LK8

The germplasm received from the USA and Iran were evaluated for flowering behaviour and pollen fertility. Male sterility was observed in SR-96, 7112, FD IND-2, BTS-604 and FC-722 CMS.

Evaluation of elite material for root crop performance

Some experimental composites and crosses were made at Mukteswar. The composites *viz.*, LKC-2000, LKC-2006 and LKC-2007 and crosses *viz.*, LK 502 x LS 6, HTHB X LS-6, SR-97 X LS-6, SR-96 X LS-6 along with three standards *viz.*, LS-6, IISR Comp-1 and Shubhra were evaluated for root crop performance at Lucknow.

The composites *viz.*, LKC-2006, LKC-2007, HTHB X LS-6 and SR-96 X LS-6 possessed superioriy in root yield. SR-97 X LS-6 and LKC-2007 were tolerant to root rot. All the entries under the test were at par in performance for sucrose content in root. Progenies of SR-97 X LS-6, SR-96 X LS-6 and LKC-2007 were tolerant to army worm. The detailed features of material under study are presented in Table 12.3.

Seed production at Mukteswar

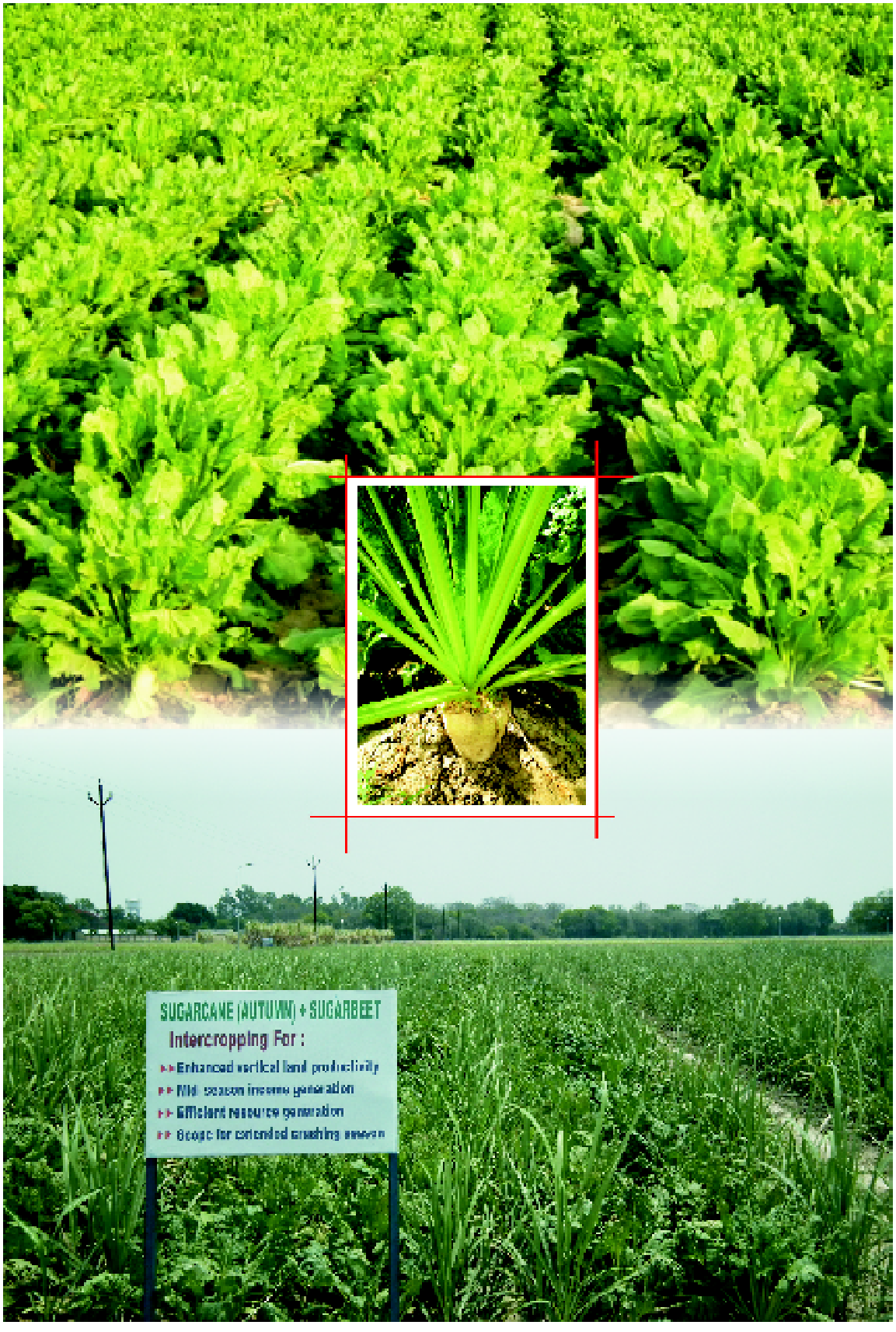
The indigenous variety LS-6 was taken for bulk seed programme and 42 kg of seed was produced and sold. In addition, 12 kg seed of thirty-six germplasm/ breeding lines/composites and hybrids was produced at Mukteswar (Table 12.4).

Table 12.3: Performance of composites and crosses in relation to standards

Genotype	Plant population (000/ha)	Single root weight (kg)	Root yield (t/ha)	Top yield (t/ha)	Root length (cm)	Crown size (cm)	Sucrose (%)	Sugar yield (t/ha)
LKC-2006	84.00	0.99	83.29	7.81	30.00	10.10	13.51	11.25
LK 502 x LS 6	56.50	0.97	54.69	6.93	28.07	10.93	14.02	7.67
LKC-2007	82.33	0.97	80.24	10.76	28.37	9.83	14.23	11.41
HTHB X LS-6	94.83	0.54	81.47	9.98	27.53	10.10	14.25	11.61
SR-97 X LS-6	59.50	1.05	32.07	4.99	31.97	10.03	14.06	4.51
SR-96 X LS-6	92.67	1.04	97.41	9.10	29.83	10.63	14.02	13.66
LKC-2000	81.00	0.97	86.89	9.91	28.03	9.93	14.48	12.58
Shubhra	77.83	0.86	80.59	6.46	29.47	9.17	15.55	12.53
IISR Comp-I	83.17	0.88	73.10	14.69	30.57	9.80	13.94	10.19
LS-6	83.83	1.07	81.72	13.58	30.37	10.10	14.13	11.55
CD	6.20	0.70	7.58	1.06	2.08	1.98	1.27	1.00
CV at 5%	4.47	1.98	8.44	4.76	7.45	5.87	4.39	8.29

Table 12.4: Seed production at Mukteswar centre

Material	Quantity of seed produced (kg)
Indigenous varieties	42
Germplasm/breeding lines	12
Total	54


SUGARCANE (AUTUMN) + SUGARBEET
Intercropping For :
Enhanced vertical land productivity
Mid season income generation
Efficient resource generation
Scope for extended crushing season

Information, Data Compression, Analysis and Development of New Evaluation Procedures

The application of the principles and methods of experimental design, the role of statistical modeling, and the pervasive use of simulation methods are but three instances of statistical developments that have had a deep impact upon science. The widespread influence of interactions between statistics and other disciplines and the very nature of statistics as the science of the "meaning and use of data" establish the statistical sciences as the discipline with the most central and complex cross-disciplinary activity.

Decision support tools in sugarcane cultivation

Software agents have been developed to provide accessibility of disorder diagnosis system on mobile platform. It consists of interface (View), inference engine and knowledge base (Model) and triggering events (control). Developed system has been successfully tested on mobile phone having following specifications: Make & Brand (Samsung GT S3850); Display resolution (240 x 320); Display size (3.14"); Network : (GPRS); Browser : (Dolphin 2.0).

There are two important concerns in mobile web applications *viz.*, interoperability and usability. Interoperability issues stem from the platform fragmentation of mobile devices, mobile operating systems, variety of screen sizes and browsers. Review of usage of mobile devices indicates a variety of mobile devices, mobile operating systems, mobile browsers and screen sizes. Therefore, mobile web application development should take into consideration devices characteristics and should be cross-platform. Thus, for the development of decision support system in sugarcane for wider accessibility on mobile devices, usage pattern and characteristics of mobile devices will need to be undertaken. Major characteristics of mobile devices to be undertaken in further work will be make of device, mobile operating system, mobile browsers, various screen sizes and also mobile service providers of India. Further, three main factors related to usability has been reviewed in this work *viz.* loading time of application on mobile device, size of the application components/modules and language/scripts applied in application development. World Wide Web Consortium (W3C) provides valuable guidelines for developing mobile web applications with usability concerns and these guidelines will be taken into consideration while developing the mobile web applications along with other valuable usability guidelines.

GIS based map of fibre per cent in cane in India

Bagasse, the fibrous residue leftover after the processing of sugarcane for sugar, has about 48% moisture and 48.5% of fibre. It is the cellulose content of bagasse that is responsible for its use in all the cellulose based industries. In India, nearly 28.15 million t of fibre is produced directly from sugar industry which is the cheapest source of raw material for pulp based industries because of its high cellulose content. The fibre % in cane at district and state level and its production at state level has been estimated to work out the strategies to use fibre % in cane as a fuel source to provide heat energy. By using the data for the years 1988-89 to 1991-92, 148 districts of the country were classified into five zones based on fibre % in cane and sugar recovery % in sugar mills (Table 13.1). A GIS based map of fibre % has been developed. The fibre % in cane ranged from 13.76 to 18.22%. Less cane intensive districts were found to be covered in zones having higher fibre % in cane.

Table13.1 : Average value of latitude, longitude, recovery (%), yield (t/ha) and fibre (%) in different classes of fibre (%) in cane

Zone	Group of fibre (%) in cane	Average value of latitude	Average value of longitude	Average value of sugar recovery in cane (%)	Average value of sugarcane yield (t/ha)	Average value of fibre (%) in cane
Zone I	13-14	20.61 N	76.34 E	9.59	72.26	13.76
Zone II	14-15	20.94 N	78.02 E	9.36	67.18	14.49
Zone III	15-16	21.92 N	79.02 E	9.15	60.87	15.46
Zone IV	16-17	23.29 N	81.49 E	8.42	53.64	16.35
Zone V	>17	27.40 N	84.59 E	7.61	36.05	18.22

Developing an 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.*, mean square for error (MSE), standard error (SE), critical difference (CD), 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 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 MSE, CD, CV and R^2 values (Table 13.2 and 13.3).

Table13.2 : Statistical parameters for weed numbers as affected by different lay-outs adopted for weed control trial

Statistical parameter	Layout	
	RBD with AR*	Existing RBD
MSE	27.04	81.00
CD	10.4	18.0
CV	36.2	62.4
R^2	0.95	0.81

*AR = Additional row arrangement

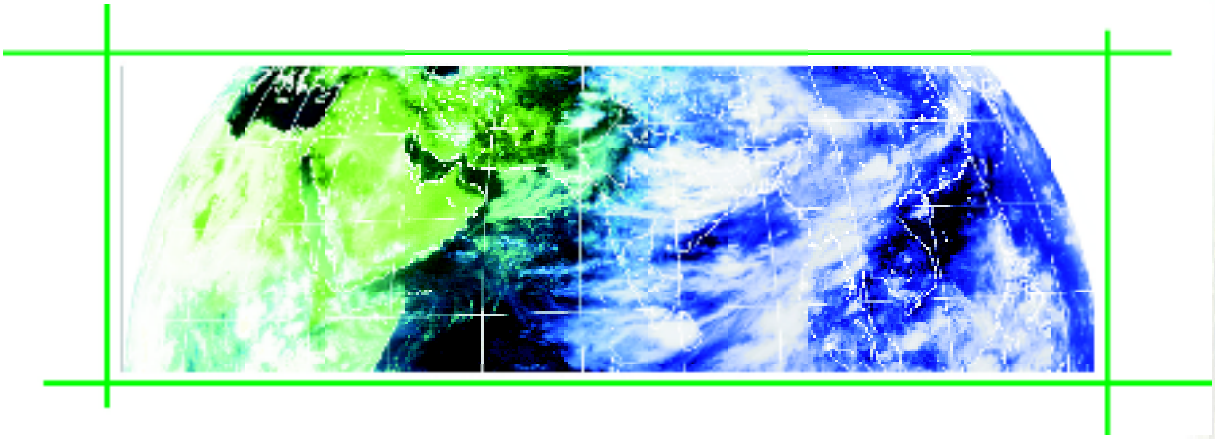
Table13.3 : Statistical parameters for weed dry weight as affected by different layouts adopted for weed control trial

Statistical parameter	Layout	
	RBD with AR*	Existing RBD
MSE	24.90	50.13
CD	9.98	14.6
CV	16.48	23.35
R^2	0.90	0.75

*AR = Additional row arrangement

Genetic stock database

The database on genetic stock has been initiated during the year.



14 Trade, Economic Analysis on Domestic Price and Area Fluctuation

The world sugar supply during any particular year is not only influenced by production, seasonality in production, consumption, export and import levels but also by the opening stocks or the previous year surplus stocks. Sugar production is concentrated over 3-5 month crushing seasons timed to take advantage of maximum sugar content. This characteristic creates a strong seasonality in sugar output, availability and exports and can lead to world price volatility during a year. India is the largest consumer of sugar in the world and the second largest producer. Happenings in Indian sugar sector have a telling impact on international sugar scenario. The production of sugar in India is directly related to sugarcane production and thus, in the years of high sugarcane production, sugar produced is also higher and *vice versa*. Indian sugar cycle is considered quite violent and it creates instability in a short span of 4 to 5 years. All sugar producing countries face such adverse weather conditions but Indian sugarcane and sugar production fluctuates more violently. Thorough understanding of sugar trade and its implications on cane acreage and sugar price fluctuations would help in developing suitable strategy to better manage the instability in sugar production.

Analysis of Indian sugar export scenario

In an exploratory study, the composition and extent of Indian sugar exports was analysed by using the data from 1997-98 to 2010-11. Indian sugar exports are covered under the heading Harmonized System (HS) code no. 17 and entitled "Sugar and sugar confectionery" comprising 38 different categories of products for exports, broadly grouped into four 4-digit categories (1701, 1702, 1703 and 1704). In value terms, the Indian sugar exports have always been less than 1% of the total exports of all commodities from India (Fig. 14.1). The value of total Indian exports was ₹ 11,42,648 crore and that of sugar exports ₹ 11,424 crore during 2010-11 (Fig. 14.2).

The shifts in India's sugar trade are increasingly significant for world markets, contributing to periods of both undersupply and oversupply. India's record 2007-08 exports accounted for about 11 per cent of global exports, and record imports in 2009-10 accounted for 12 per cent of world imports. The factors of world sugar price fluctuations and implications for cane price acreage in India have been delineated and analysed (Fig. 14.3). These are seasonal nature of sugar production, asset fixity due to capital intensive and specialized nature of machinery, equipments and sugar mills, long growth period of sugarcane, low price elasticity of developed importers, divergent growth trends in world sugar production and consumption, protectionism and preferential trade in sugar and residuality of world sugar market.

Indian sugar industry typically follows a 4 to 5 year cycle. Higher sugarcane and production

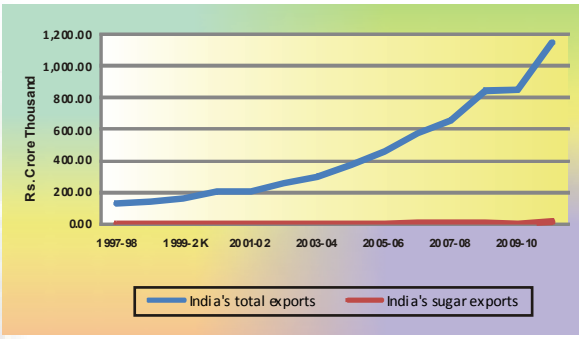


Fig. 14.1: Sugar exports and total exports of India

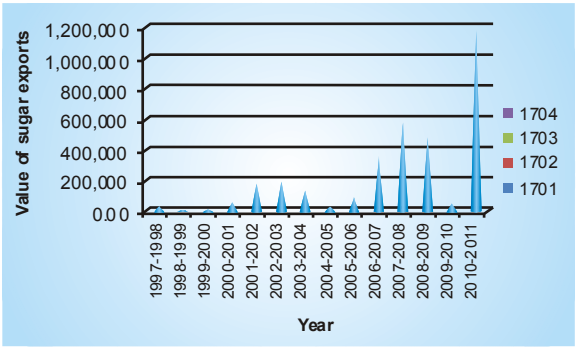


Fig. 14.2 : India's sugar exports in value terms (₹ in lacs) under 4 major categories

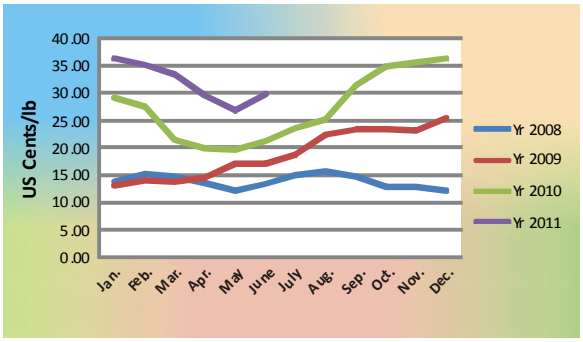


Fig. 14.3: Worldraw sugar prices

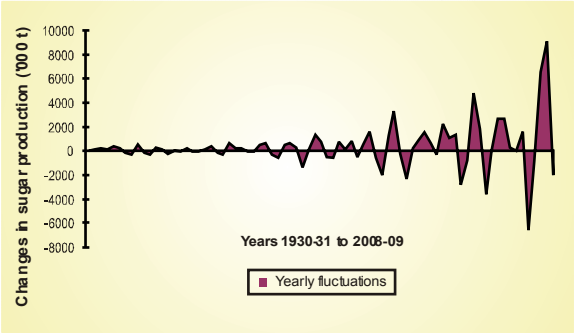


Fig. 14.4 : Yearly fluctuations in sugar production in India

results in a fall in sugar prices and non-payment of dues to farmers. This compels the farmers to switch to other crops, thereby, causing a shortage of sugarcane, consequently an increase in sugarcane prices and extraordinary profits. Taking into account the prevalent higher prices for cane, farmers then switch back to sugarcane. Of late, the Indian sugar industry was on an upward trend since 2003, after weathering the rough patch of 1999-2003. This upward trend has resulted in strong capacity expansion. Sugar inventories grew, which coupled with the expectation of an increase in sugarcane prices also put some pressure on margins in the short term. The other major jolt came during 2007-08, and the sugar production reduced by more than 10 million t in a single year. The susceptibility to monsoons remains the key driver for the availability of sugarcane, and hence, the overall performance of the sugar sector. There remained numerous ups and downs in Indian sugar production over the years but the earlier ones were mild while these are quite violent in recent years which put the sugar sector out of gear. The changing pattern of fluctuations have been depicted in Fig 14.4.

Impact assessment of ICT intervention in sugarcane marketing in UP

Sugarcane is a perishable raw material for sugar industry and it must be processed at the earliest after harvesting in order to minimize losses in cane tonnage and sugar recovery. This involves multiple services such as survey of cane area, calendar of supply, monitoring of sugar mills/ centre, issue of supply tickets, weighing of harvested cane, payment and various other activities related to sugarcane development. The number of cane growers supplying cane to a factory ranges between 10 and 40 thousand in Uttar Pradesh, and the farmers need authentic, accurate and timely information/services for smooth marketing of their produce at best possible prices and without any hindrance. Consequently, the interactions for activities between the farmers and the sugar mills are numerous and spread out over the year and have a direct bearing on the income of both. Each cane grower had to make about 53 trips to sugar mill per annum to organize his cane supply and receive price payments. The impact assessment of Sugarcane Information System (SIS) developed by UP Sugarcane Department on farmers' welfare and the benefits as perceived by them was carried out based on the primary data compiled from the farmers by carrying out rapid appraisals, as well as through interactive meetings. The benefits to farmers on account of saving in travel cost, increased supply of sugarcane to the sugar mill, higher income by allocating more area under sugarcane, an increase in cane productivity, and higher weight of farmers' cane due to fresh sugarcane supply were estimated to the tune of ₹ 8465 million. The impact has also been assessed on sustainability parameters like transparency, coverage, increase in efficiency, financial viability, cost to the Government, replicability, and the work culture towards the use of IT in rural areas. The SIS has been implemented without any budgetary support from the Government, at no cost to the Department as its entire expenditure has been borne by the sugar mills which are the delivery centres. The annual financial gains to the sugar mills from the implementation of SIS are more than the cost of the project and annual recurring charges.

Education and Training

Education is important for the economic growth of a nation. It gives us knowledge of the world around us and develops perspective of looking things differently. Education brings up questions and also helps us devise ways to find satisfactory answers to them. Education is about knowing that everything has a science to it. It is about learning to reason everything till every question meets its answer. It empowers citizens with analytical abilities, leads to better confidence levels and fortifies one with will power and goal setting competencies. The sharing of facilities is also one tool to impart education. The infrastructure created and the new information generated out of research activities need to be shared with other researchers interested to have exposure to frontier areas of sugarcane research. Organizing suitable training programmes is one of the most convenient tool available with the organization for adequate capacity building of fellow researchers. IISR has state-of-the-art facilities and a team of highly qualified sugarcane experts, imparting training to farmers, millers and managers.

International training programme

The Institute has developed following four International Training Programmes on sugarcane related aspects especially for Afro-Asian nationals. These are:

1. Mechanization of sugarcane cultivation
2. Agro-technology for maximizing sugarcane production
3. Protection technology for sustaining sugarcane productivity
4. Manufacturing and storage of jaggery.

The Institute also offers post-doctoral training programmes to researchers from Afro-Asian region.

Training of sugarcane development personnel

The Institute regularly organizes one 3-4 weeks training programme for sugarcane development personnel from sugar mills to update them with the latest knowledge of sugarcane farming. The training is becoming popular and

gradually drawing attention of the sugar industries. A 21-day training on Sugarcane Management and Development for cane development personnel of sugar mills was organized on July 1-21, 2011 in which 32 cane managers/officers from U.P., Bihar, Karnataka, Andhra Pradesh and Haryana participated. The major objectives of this training was to accelerate large-scale adoption of sugarcane technologies in sugar mill areas by grooming and developing cane managers/officers of sugar mills into "torch-bearer" of IISR technologies and to spread the technologies with expected dividends of high sugarcane and sugar productivity.

Training of sugarcane growers

1. Three-days Farmers' Training sponsored by Hasanpur Sugar Mills, Hasanpur Road, Samastipur, Bihar was organized on August 29-31, 2011. In this training, 25 farmers from Hasanpur Sugar mill areas participated.
2. Five-days Farmers' Training on '*Ganne Ki Unnat Krishi Taknik*' sponsored by ATMA, Gopalganj, Bihar was organized on November 15-19, 2011. In this training, 30 farmers from

Gopalganj district of Bihar participated. They were provided with knowledge in sugarcane production, protection and farm machineries for maximizing the sugarcane yield at their farms.

3. Ten-days training on '*Ganne Ki Unnat Krishi Taknik*' sponsored by ATMA, Begusarai, Bihar was organized on February 8-17, 2012 for 21 farmers. In this training, they were apprised with knowledge in sugarcane production, protection and farm machineries for maximizing the sugarcane yield at their farms.

4. For the 10 farmers of Muzaffarpur, Bihar, 5 days training programme on '*Ganne Ki Unnat Krishi Taknik*' sponsored by ATMA, Muzaffarpur, Bihar was organized on March 13-17, 2012. In this training farmers were imparted knowledge as well as skills about production, protection and mechanization of sugarcane production technologies.

Training to entrepreneurs

Under central sector scheme AICRP on PHT, seven-days farmers' training on "Quality Jaggery Production" was organized at IISR, Lucknow.

Training programme on "Tractors and Machinery" was organized at IISR Lucknow on November 5, 2011, in collaboration with Eicher Tractors Ltd. Fifty farmers and tractor drivers were trained on operation and maintenance of tractor and IISR designed sugarcane machineries.

Training visit of farmers

About 760 farmers from Uttar Pradesh, Bihar, Maharasthra, Madhya Pradesh and Rajasthan visited the Institute farm in different batches ranging from 6 to 96 farmers.

Training to students

During the period under report, trainings to 53 undergraduate/post-graduate students of Biotechnology, Microbiology, Biochemistry *etc.* from different Institutes and Universities were imparted under the expert guidance of the scientists of this Institute. In addition, about 500 students from different colleges also visited the Institute who were imparted knowledge on the use of science in sugarcane development.

16 Linkages and Collaborations

The Institute has developed a five-pronged strategy to strengthen its liaison and collaboration activities. As a part of strategy, collaboration, with (i) International research organizations, (ii) National research organizations like ICAR/CSIR Institutes, Central Line Departments, (iii) collaboration with state - level research organizations such as, SAUs, State Line Departments and federations *etc.*, (iv) collaboration with private sector such as sugar mills *etc.*, (v) collaboration with local Institutes/organizations at Lucknow have been strengthened. Under its multi-pronged strategy, IISR has developed linkages with various agencies at National and International level.

Collaboration with international research institutions

- A five member delegation comprising Mr. Gunawan Budiarto, Mr. Budiarto, Mr. Alfarina Kardiana Sari, Ms. Nanik Setyaningsih and Ms. Nining Hermawati from PT. Perkebunan Nusantara X (Persero), Jalan Jembatan Merah 3-11, Surabaya – 60175, Indonesia facilitated by Dr. R. P. Singh, Advisor Sugar Mills, the Haryana State Coopertive Supply and Marketing Federation Ltd. (Hafed) and Dr. S. K. Taneja visited the Institute on September 26, 2011.

The team discussed about emerging sugarcane research needs with Dr. R.L. Yadav, Director, Dr. A.K. Sharma, Pr. Scientist & I/c, RCM and Dr. T.K. Srivastava, HOD, Crop Production of the Institute. The team visited the Engineering Workshop, MHAT Unit, Jaggery Unit and Tissue Culture Lab. In the field, they visited the standing crop raised by bud-chip technique and ring pit method of planting. The team members were more interested in tissue culture and in bud-chip technique. They were keen to have more knowledge on the tissue culture for which they were suggested to provide letter of intent for initiation of action for 1-2 week training at this Institute. The visit was coordinated by Dr. T. K. Srivastava, Head, Division of Crop Production.

- A five member delegation comprising Prof. Abraham Haileamlak, Dean of College of Public Health, Jimma University, Ethiopia along with other delegation members facilitated by Mr. Raghubir Singh, International Project Consultant, D.K.Y. Sales Pvt. Ltd., and Dr. D.V.Yadav, Ex. Head, Division of Crop Production, IISR, Lucknow visited the Institute on August 24, 2011. The team discussed with Dr. R. L. Yadav, Director, Dr. A.K. Sharma, Pr. Scientist & I/c, RCM and Dr. T.K. Srivastava, HOD, Crop Production of the Institute for possible knowledge transfer collaboration with Jimma University, Ethiopia. Dr. A.K. Sharma coordinated the visit. The team visited the Engineering Workshop, MHAT Unit, Jaggery Unit and Tissue Culture Lab. In the field, they visited the standing crop raised by bud-chip technique and ring pit method of planting.

Collaboration with national research institutions

The Institute has developed linkages with National level research organisations such as SBI, Coimbatore on effecting matings/hybridization (crossing) involving proposed parents and supply of viable fluff for raising sufficient seedling populations; and the supply of germplasm for evaluation in a phased manner, *inter alia*. For the development of improved parental clones for sub-tropical agro-climate with high sugar accumulation potential and to enrich breeding population in the National Hybridization Garden at Sugarcane Breeding Institute, Coimbatore, 42 high sugar LG selection have been sent to the Sugarcane Breeding Institute so far for enriching the breeding populations in the National Hybridization Garden (NHG), SBI, Coimbalore as part of Institute research projects. Over thirty selections that are already in NHG after quarantine are being increasingly used in crossing in order to identify parents transmitting the genes for high sugar content in juice, particularly early in the season. During the year 2011-12, the Institute scientists (breeders) under different research projects also attempted crossings at National Hybridization Garden, SBI, Coimbatore.

The Fluff Supply Programme is also carried out in the Institute under the auspices of the AICRP on Sugarcane. The programme deals With the development of sugarcane varieties for sub-tropical region from the fluff of zonal crosses sent from Sugarcane Breeding Institute, Coimbatore.

The seedcane of many genotypes, and the early maturing clones (received from SBI centres) to be tested in Initial Varietal Trial (Early) has been multiplied.

IISR, Lucknow has also established linkages with IVRI, Mukteswar as Institute's sugarbeet breeding outpost which is active in producing seed of IISR bred sugarbeet varieties and supplying the seed to the end users.

The Institute has also strengthened its linkages with national research organization like NBRI, Lucknow; CDRI, Lucknow; CIMAP Lucknow; and NSI, Kanpur. Collaboration with national/state level sugarcane research organizations in the country has also been made through inviting the scientists/officers in the seminar/ brain storming sessions organized at the Institute.

An ICAR Network Programme on Climate change on assessment of impact of climate change on productivity and quality of sugarcane in sub-tropical India and opportunities of agronomic adaptation has been in operation since April 2009 where many ICAR Institutions are also participating.

Collaboration with central line departments

The Director of the Institute represents various policy planning and decision making bodies/ organizations/committees working for the development of sugarcane in India. The Director also represents some organizations in their apex-level management/decision making committees.

Deptt. of Biotechnology: The Deptt. of Biotechnology, Ministry of Science and Technology, Govt. of India., New Delhi sponsored three research project *viz.*, Development of SSR markers for red rot resistance from EST database of sugarcane, Association mapping in sugarcane and Development of plant growth promoting microbial consortia for rice-wheat-sugarcane cropping system.

Collaboration with state agencies/state research organizations

The Institute has linkages with Sugarcane Research Stations and State Agricultural Universities through AICRP on Sugarcane for testing of technologies developed by the Institute and their dissemination to the farmers. The Institute also liasions with State Sugar Departments and sugar factories for testing and verification of research results of the Institute.

The AICRP on Sugarcane has its co-ordinating unit located at the Institute and is coordinating the sugarcane research development through its 20 different co-operating centres located in different states in the country. In this way, the Institute is strengthening its linkages with SAUs/ other general Universities through AICRP cooperative centres.

IISR: International Collaboration


IISR: International Collaboration

In addition, the Institute liasions as a cooperating centre of three other AICRPs, *viz.*, AICRP (FIM), AICRP (BC), and AICRP (PHT).

U.P. Council of Agricultural Research, Lucknow

The Institute has carried out one research project "Enhancing field water use efficiency in sugarcane cropping system through FIRBS" funded by UPCAR, Lucknow. Institute scientists were invited in various state level meetings/ committees and seminars organized by the Council. In addition, the Institute also provides agromet advisory services to state level Weather Watch Group being coordinated by UPCAR. The Institute also sponsored its scientists regularly to the Weather Watch Group meetings at UP Council of Agricultural Research, Lucknow.

State Cane Department

The Institute carried out an impact assessment study of Sugarcane Information System (SIS) on ICT based intervention implemeted by U.P. Sugarcane Deptt., to improve the functioning of sugarcane marketing. The Institute also took-up the matter of CVRC released varieites for cultivation in U.P. without any hindrance. The Institute also sends its Newsletters/ Annual Reports to cane-federations of various states as well as to the State Cane Departments.

Collaboration with universities

In order to encourage sugarcane research in Academic institutions, the Institute has signed MoUs with a few leading Universities for adeqauate capacity building of research in all branches of sugarcane research. Through MoUs, the Institute encourages guidance or co-guidance to Ph.D. scholars. During the year 2011-2012, the Institute has signed MoUs with C.S. Azad University of Agriculture & Technology, Kanpur and Amity University, Lucknow and MoUs with two other universities are in pipeline.

Collaboration with private organizations

Collaboration with private seed/ fertilizer/ pesticide companies/industries has also been made through contract research programmes. The Institute has five contract research projects pertaining to evaluation of drip irrigation system, two new products, Pusa Hydrogel and Fungbact Kit and insecticides/weedicides. In order to commercialize the equipments/machinery developed at IISR, Lucknow, meets/field days were also organized with the manufacturers of farm machinery and equipments.

a. Collaboration with sugar mills

- In an attempt to have linkages with the sugar mills of the country, the Institute conducts a 3-4 weeks training programme exclusively for the cane development officers of the sugar mills. In addition, the meetings organized by Indian Sugar Mill Association (ISMA) were represented by the Director of the Institute. The Institute also sends its newsletters to all sugar mills in the country. The Institute also provides consultancy services to many sugar mills.
- Under one externally funded programme on Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane (FPARP), the Institute carried out field demonstrations on 4 different water efficient and high yielding sugarcane production technologies. Demonstrations were conducted during 2011-12 crop season on farmers's fields in sugar mill are as of Biswan, Rauzagaon and Haidergarh under this project. The officials/representatives of sugar mills also visit the Institute to know about the latest research developments.

b. Linkages with farmers

The farmers in Lucknow district were linked through Frontline Demonstrations, on-farm trials, advisory services, *Kisan Gosthies*, Field Days, *etc.*, as a regular programme of KVK, IISR, Lucknow. The KVK, housed at IISR, regularly imparts both on-campus and off-campus trainings to farmers, farm families and rural youths of Lucknow district in diverse fields of agriculture, animal husbandry and home science.

Industrial Perspective

Industrial organization studies indicate how the industry environment affects the behaviour and performance of the firm. Collaboration with industry is critical for academia to create scientific knowledge and obtain industrial data. In turn, collaboration with research institutes is crucial for organizations in joint, scientific-based research projects in order to develop solutions for production-sourced problems. Both parties need to be in contact *via* collaborations with the aim of developing new data, methods and technology. To strengthen mutual collaborations and add value, much more attention from both sides should be paid to this subject. Within this context, there should be greater interest from industrialists and academicians, bureaucracy and government regulations should be revised to stimulate the joint projects, field studies should receive more attention in research organizations, two-way communication should be built between industrialists and academicians, institute-industry collaboration centers should be more effective, and finally, mutual publicity should be increased. In this chapter, IISR-Sugar Industry collaboration is evaluated from the viewpoint of its outreach activities in sugar mill area.

Sugar Mills of Uttarakhand State

A team of scientists visited 7 sugar mills of Uttarakhand state *viz.*, Kiccha Sugar Company, Kichha, Distt. U.S.Nagar; The Bajpur Cooperative Sugar factory Ltd., Bajpur, Distt. U.S.Nagar; Kashipur Sugar Mills, Kashipur, Distt. U.S.Nagar; R.B.Narayan Singh Sugar Mills Ltd., Laksar, Distt. Haridwar; Uttam Sugar Mills Ltd., Libberhedi, Distt. Haridwar; Laxmi Sugar Mills Company Ltd., Iqbalpur, Distt. Haridwar and Doiwala Sugar Company Ltd., Doiwala, Distt. Dehradun. During the visit in the month of October 2011, survey was conducted in different villages of Udham Singh Nagar and Haridwar districts of Uttarakhand for untimely flowering and top borer damage in sugarcane. As such, at this period, flowering was not observed in any part of these districts. However, people from various sugar mills reported that during previous year, 10-20% flowering was recorded in most of the varieties, while it was 80-95% in CoSe 92423 & CoS 94270 in different areas. The pest level in all the crop area surveyed was low. During the survey, it was observed that the damage caused by the top borer, in general, was 10-15% only, however, it was up to 35% in few fields. Damage caused by other borers, sucking pests and diseases was low.

Press conference

Interaction with farmers

Gwalior Sugar Company Ltd., Dabra, Gwalior (MP)

A team of scientists visited Gwalior Sugar Company Ltd., Dabra, Gwalior for interaction with the mill officials and farmers of the command area for resolving various issues related to cane cultivation. Survey was also conducted in different villages under mill command area for assessment of insect pests and disease occurrence in sugarcane.


शनल शुगर फेस्ट 2012 की तैयारी पूरी
IISR: Outreach Activities

Variety Co 1148 was grown in about 95% area while CoS 88230 and CoS 8436 were grown in about 5% area only. During the survey, it was observed that the damage caused by the top borer, in general, was 5-10% only, however, it was 25-30% in few fields. Damage caused by other borers such as internode borer, stalk borer and sucking pests was about 5% only. Lectures were delivered to the Mill officials and farmers on different aspects related to cane cultivation. A press meet was arranged by the Mill on various issues related to cane development.

Shri Vighnahar Sahakari Sakhar Karkhana Ltd., Nivruttinagar and Padmashree Dr. Vitthalrao Vikhe Patil Sahkari Sakhar Karkhana Ltd., Pravaranagar (Maharashtra)

A team of plant protection scientists visited white grub affected areas under Shri Vighnahar Sahakari Sakhar Karkhana Ltd., Nivruttinagar on 27th Aug 2011 and delivered a lecture to the mill officials on Insect Pest Management in sugarcane

Installation of IISR-White grub beetle trap in mill command area and interaction with farmers

in general and white grub management in particular. The team also visited Padmashree Dr. Vitthalrao Vikhe Patil Sahkari Sakhar Karkhana Ltd., Pravaranagar and Biological Control Centre of the Institute. Interacted with the Mill officials and their research farm near Chanchupur. At Pravaranagar, mass rearing of *Dipha aphidivora* in shade net, *Trichogramma chilonis*, *Corcyra cephalonica*, and *Zygogramma bicolorata* in small scale in laboratory condition was under progress.

Bajaj Hindustan Limited, Gola Gokaran Nath, Lakhimpur Kheri (UP)

A team of scientists visited the command area of the Mills regarding white grub damage in certain pockets. Critical observations were made in the affected fields of previous year of the village Kishunuvapur and nearby areas. A lecture was delivered to the farmers on the management of insect pests in sugarcane. The newly developed IISR-White Grub Beetle Trap was installed near the affected fields of the village Kishunuvapur. During evening hours, few numbers of beetles belonging to minor species of white grub *viz.*, *Holotrichia* sp., *Onthophagus calta*, *Apogonia* sp. were trapped. Farmers were advocated for suitable management strategy to be adopted for containing the insect pest problem of sugarcane in general and white grubs in particular.

Installation of IISR-White grub beetle trap

Triveni Engineering & Industries Ltd., Sugar Unit: Deoband, Saharanpur (UP)

Regular visits of the Scientists have been made to the command area of Triveni Engineering & Industries Ltd., Sugar Unit: Deoband, Saharanpur. Lectures were delivered to the mill officials and

farmers of the command area. The newly developed insect traps were installed and observations were taken on beetle catch. Farmers of Ghaloli and Chandana villages have got fabricated the IISR model of the trap and started using for mass trapping of the beetles. Farmers were advocated for suitable management strategy to be adopted for containing the insect pest problem of sugarcane in general and white grubs in particular.

MOU with DSCL Group, Hardoi (UP)

A MOU has been signed with DSCL group for establishment of biocontrol unit and technical support on pest and disease management. Monthly visit of scientists of different disciplines were made for monitoring of pest and diseases of sugarcane in the command areas of four sugar units of DSCL group *viz*., Hariawan, Loni, Ajabapur and Rupapur. Construction of Biocontrol unit is in progress.

Research Institute – Sugar Industry Interface

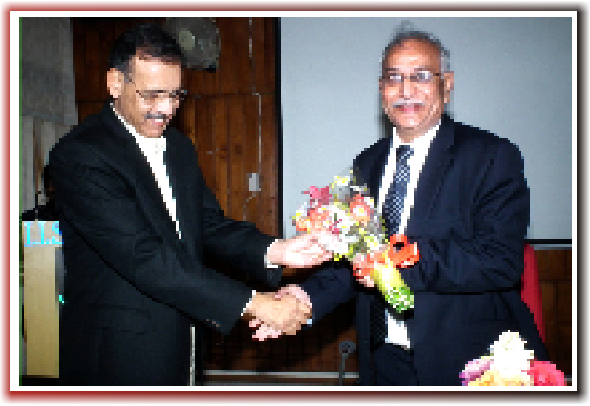
• Meeting with STAI

A sugar industry – research institute interface and stakeholders meet was organized at the Institute premises on January 20, 2012. Dr. G.S.C. Rao, President, Sugar Technologist Association of India, New Delhi and Executive Director & CEO, Simbhaoli Sugars Limited was the Chief Guest and Key Speaker on the occasion. Mr. Deepak Guptara, President, U.P. Sugar Mills Association also participated in the interface meeting. Dr. G.S.C. Rao, President, STAI presented an overview of technological developments in sugar industry in his presentation entitled "Sugar Industry: Food and Energy Alternatives". He emphasized that the age old cane management system need to be changed for the better future of the cane growers as well as for the sugar industry. He also expressed the expectations of sugar industry from the IISR, Lucknow on the following fronts.

a) Mechanization of sugarcane cultivation particularly the cane harvesting should be made the part of all India Coordinated Research Project
b) Intercropping of sugarcane with wheat crop
c) Varietal screening trials with ISMA
d) Chemical and biological control of borers
e) Crop surveillance/programmes for disease monitoring *etc*.
f) Seed certification or system for analyzing purity of seed
g) Nitrogen fixation by sugarcane to reduce the demand for nitrogen fertilizer
h) Training and education programme
i) Need for collaborative research on cellulosic degradation and ethanol production

During the interaction with the scientists of the Institute, the need for organizing regional conferences in collaboration with sugar mills on "sugarcane + wheat intercropping system" and "energy cane" was emphasized so that better fine tuned research programmes and extension activities could be planned. The need for one day seminar in collaboration with STAI was also emphasized for developing well focussed collaborative programmes.

The IISR, Lucknow was requested to conduct more trials of its varieties at locations suggested by



ISMA. The Institute will also help the sugar industry in maintaining the seed quality standards. It will also help by providing seed cane of its high sugar variety CoLk 94184. Dr. Rao also desired that the demonstration of machinery developed at IISR, Lucknow be carried out in Simbhaoli Sugar Mill area.

Summarizing the interface meeting, Dr. S. Solomon, Director, highlighted that the Institute is organizing year 2012 as the "Year of Excellence" and Dr. G.S.C. Rao, President, STAI's visit is the first from sugar industry that may lead to excellence in this direction. Sugar industry - research Institute

interfaces would help in better understanding of each other's concerns and ultimately in the healthy growth of sugar sector of India, in general, and that of U.P., in particular. The farming community will be the ultimate beneficiary of research organizations and sugar industry collaborative activities. Dr. S. Solomon also highlighted that the interface with the sugar industry will also help the Institute in fine tuning its research agenda.

• IISR-Mawana Sugars Interface meeting

Low sugarcane productivity and decreasing sugar recovery in western Uttar Pradesh are major concerns to be addressed immediately for well – being of sugar industry and sugarcane farmers. To discuss the issues, an interactive meeting between senior managers of Mawana Sugars and IISR Scientists was held on February 14, 2012 under the chairmanship of Dr. S. Solomon, Director, IISR, Lucknow. Mr. Sunil Kakaria, Managing Director of Mawana Sugars along with other high level officials of the group had detailed discussion with scientists. Sharp decline in sugar recovery up to the tune of 1.0 unit, lack of high sugar early maturing variety, decreasing soil fertility and health, incidence of insect-pests, scarcity of labour and supply of poor cane quality are major concerns for sugar mills. Due to these constraints, group is incurring huge revenue loss, as Mr. Kakaria said. Dr. Solomon suggested complete package of cane cultivation practices including techniques of soil health improvement, improved sugarcane varieties, varietal planning, three tier seed production programme, ratoon management, bio-intensive management of top borer and red rot, technique to improve sugar recovery, training of sugar mill cane development staff *etc.*, for improving productivity and recovery on sustained basis.

Mawana Sugars officials & IISR authority planned some collaborative programme to conduct survey in mill zone areas in order to identify and assess the on-spot problems and launch Seed and Soil Programme soon to address the sugar industry problem in more concerted and sustained manner.

18 Transfer of Technology

Dissemination of innovative and promising sugarcane production technologies to sugarcane growers, sugar mill personnel and sugarcane development staff of state governments is very important for realization of enhanced sugarcane and sugar productivity in the country. Complete range of technology transfer tools involving training, demonstration, organization of *Kisan Mela* and *Kisan Goshthi*, mass media programme and extension through print media, hence needs to be employed for effective involvement of all the stakeholders' that can ensure rapid adoption of useful technologies by the end users. Concerted efforts were made in this direction and sugarcane equipments like ratoon management device (RMD), raised bed sugarcane planter (RBS) and three row sugarcane planter were taken to farmers' fields for frontline demonstrations. Many innovative training sessions for farmers, students and sugar mill personnel were also organized.

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

Reconnaissance survey has been carried out for selection of the study locale and the measurement tools have been finalized. ITKs on sugarcane and sugarcane based cropping systems have been collected from the different sources.

Frontline demonstrations (FLD)

IISR tractor operated ratoon management device (RMD)

Frontline demonstrations of IISR tractor operated ratoon management device was conducted at farmers fields of Barabanki and Lakhimpur Kheri districts. About 10 ha area was covered in Barabanki and 16 ha in Lakhimpur Kheri district (Fig. 18.1). Equipment perform stubble shaving, deep tilling & off-barring, fertilizer & organic manure application and earthing up operations in a single pass of the equipment. Farmers were satisfied with the performance of the equipment and were willing to purchase it for further use in their field.

Fig. 18.1: IISR tractor operated ratoon management device in field operation

IISR raised bed seeder (RBS)-cum-sugarcane planter

Frontline demonstrations of IISR tractor operated raised bed seeder-cum-sugarcane planter was conducted at farmers fields of Unnao and Lucknow districts (Fig. 18.2). About 10 ha area was covered in Lucknow and 9 ha in Unnao. Equipment was used to sow the seeds of wheat/urdbean/mungbean on the raised beds and plants cane in the furrows. Farmers were satisfied with the performance of the equipment and were willing to use it in the next season also.

Fig. 18.2: IISR tractor operated RBS Cane Planter in operation

IISR modified three row cane planter

Frontline demonstrations of IISR tractor operated modified three row sugarcane planter was

Fig. 18.3: IISR tractor operated modified three row sugarcane planter in field operation

conducted at farmers fields of Lucknow, Lakhimpur Kheri and Fatehpur districts (Fig. 18.3). Total area of 20 ha was planted by the machine. Farmers were satisfied with the performance of the machine. Cost of planting was reduced by 65% as compared to conventional method of planting.

IISR tractor operated paired row sugarcane planter

- Frontline demonstrations of IISR tractor operated paired row sugarcane planter was conducted at farmers fields of Sitapur district and IISR farm (Fig. 18.4). About 12 ha area was covered in Avadh Sugar Mill, Hargaon, 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.

Fig. 18.4: IISR tractor operated paired row sugarcane planter in field operation

- Frontline demonstrations carried out at farmers' fields in different districts of Uttar Pradesh showed significant increase in crop yield, irrigation water saving and irrigation water use efficiency over farmers' practice. The maximum increase in cane yield was recorded in ring pit method of planting (96.4%) over the conventional method followed by skip furrow method of irrigation (38.8%), irrigation at critical growth stages (28.2%) and trash mulching (25.7%). Farmers of the areas, where FPARP was implemented, derived immense benefits in terms of knowledge enhancement, increased adoption, conserving water resource and higher income.
- Forty five demonstrations on RMD and RBS planter were conducted on farmers fields in mill zone areas of Biswan and Ramgarh sugar mills in Sitapur District (UP).

On-and off station demonstrations

a. On-station

- **Planting methods:** Ring-pit, Flat, Double row in trenches
- **Varieties:** CoLk 09202, CoS 94257, CoS 96275, Co 0238, CoS 99259, CoS 96268, CoPt 97222, CoS 8436

b. Off-station

Forty five demonstrations on RMD and RBS planter were conducted on farmers' fields in mill zone areas of Biswan and Ramgarh sugar mills.

Impact assessment of proven IISR technologies

Sugarcane was planted at Technology Park of the Institute to assess the following IISR Technologies:

- Promising early sugarcane variety CoLk 94184
- Bio-intensive management of top borer
- IISR made sub -soiler for deep ploughing
- Companion cropping with sugarcane on raised bed configuration
- Seed multiplication through STP & bud chip technique

Seed production and distribution

Total of 8600 quintals of sugarcane seed of recently released varieties was produced at the Institute main farm at Lucknow during 2011-12 against the target of 8000 quintals (Table 18.1). In addition to this, 1185 quintals seed was produced at IISR Regional Centre, Motipur (Table 18.2). For the crop season 2012-13, newly released varieties such as CoPk 05191, Co 05011, CoSe 03234 and CoS 07250 have been included in the seed production chain.

Table 18.1: Sugarcane seed production at IISR, Lucknow

Name of variety	Maturity group	Quantity (quintals)
CoLk 94184	Early	2500
CoS 96268	Early	3200
Co 0238	Early	1500
Co 0118	Early	300
Co 0239	Early	200
Co 0124	Midlate	100
CoPant 97222	Midlate	800

Table 18.2: Sugarcane seed production at IISR Regional Centre, Motipur

Name of variety	Maturity group	Quantity (quintals)
CoLk 94184	Early	465
Co 0232	Early	212
Co 0233	Midlate	508

Knowledge dissemination

a) Extension brochures/Folder published and distributed

The following extension brochures sugarcane production technologies were prepared, published and distributed to farmers and extension personnel.

- CoLK 94184 (Birendra): A new IISR sugarcane variety
- Improving ratoon cane productivity by modulating rhizosphere
- A promising technique for multiplication of sugarcane seed
- Sugarbeet : A supplementary sugar crop for India
- Management of Redrot
- White grubs of sugarcane and their management
- Waste heat recovery system for jaggery furnaces
- Value-added jaggery with natural vitamin C
- IISR at a glance.

b) Demand driven dissemination of technologies

The technology of bio-control of diseases and insect-pests in sugarcane crop was disseminated to DSCL group of sugar industries in Hardoi and Lakhimpur Kheri districts of Uttar Pradesh. A Memorandum of Understanding (MOU) was signed between IISR, Lucknow and DSCL group of sugar industries for establishing bio-control laboratories in sugar mill command areas and also supply basic culture of *Trichoderma* and *Trichograma* for multiplication. IISR Scientists also monitored the development of diseases and insect-pests in the sugar mill area by visiting the cane command area of these sugar mills.

c) Exhibition

- An exhibition of sugarcane production technology was organized in *Kisan Mela* entitled "Towards second green revolution through use of quality seeds" at DSR, Kushmaur, Mau on February 24-25., 2012 The major objective of exhibition was to showcase the remunerative sugarcane production technologies through meaningful display of exhibits and sugarcane machines. About 1200 farmers, entrepreneurs, manufacturers, delegates and development personnel visited the exhibition site and got benefited by interacting with the scientists.
- An exhibition of sugarcane production technology was organized in "*Science Expo*" at Regional Science City, Lucknow on February 1-5, 2012. The major objectives of exhibition was to showcase the sugarcane production technologies developed by IISR through meaningful display of exhibits and sugarcane machines. About 3000 students, scientists, teachers, entrepreneurs, manufacturers, delegates and development personnel visited the IISR Stall and got benefited by interacting with the scientists.

- An exhibition of sugarcane production technology was organized in "*Pusa Krishi Vigyan Mela*" at IARI, New Delhi on March 1-3., 2012. The major objective of exhibition was to showcase the remunerative sugarcane production technologies through meaningful display of exhibits and sugarcane machines. About 2000 farmers, entrepreneurs, manufacturers, delegates and development personnel visited the exhibition site and got benefited by interacting with the scientists. IISR stall adjudged the best.
- An Exhibition and *Kisan Mela* was organized on the occasion of National SugarFest on March 23-24, 2012 at Institute premises. Elaborate display of sugarcane technologies with the help of posters, live material, specimen *etc.*, were done for the benefit of 500 students and 750 farmers, development personnel and officials visiting in the SugarFest.
- An exhibition of sugarcane production technology was done in "*Kisan Mela*" organized on March 29, 2012 at IGFRI, Jhansi (Uttar Pradesh). About 300 farmers from Jhansi and adjoining districts visited the Institute's stall and got acquainted with latest development in sugarcane cultivation technology. Healthy cane setts of CoLk 94184 were distributed to Dabra Sugar mill, Gwalior and farmers.
- Exhibited IISR sugarcane machineries in the 2nd International Exhibition and Conference on Agril. Machinery & Equipment at IARI, Pusa, New Delhi on December 8-10, 2011.

d) *Kisan Mela*

A *Kisan Mela* was organised on the occasion of the National SugarFest on March 23-24, 2012 at Institute premises. About 1500 farmers attended the *Kisan Mela*. The technology exhibition stalls of different research organizations, manufacturers, KVKs and line departments were under demonstration. An elaborate display of sugarcane production technologies with the help of posters, live material, specimen *etc.*, were done for the benefit of the farmers, development personnel and officials visiting the *Kisan Mela*. The visiting farmers saw various exhibitions stalls and interacted to learn the know how on technologies being demonstrated.

e) Field visits

Twenty six groups, comprising of 768 farmers from different states under ATMA, National Horticulture Mission scheme *etc.*, visited the Indian Institute of Sugarcane Research, Lucknow. During the visit, different technologies of sugarcane production, on-farm demonstrations, jaggery and *khandsari* processing unit, implements and machines developed and vermicompost unit were shown and explained to them.

f) Technical guidance

Technical guidance to 2000 farmers/ extension/workers/student/ development staff was provided during their visits to the experimental farm of the Institute.

h) Media coverage

THE TIMES OF INDIA	
New Director Joins	25 December 2011
हिन्दुस्तान	
गन्ना अनुसंधान संस्थान के निदेशक बने डॉ सोलोमन	25 दिसम्बर 2011
आर्गेनिक गुड़ सेहत के लिए है बेहद फायदेमंद	17 फरवरी 2012
शुगर फेस्ट कल से	22 मार्च 2012
खेल-खेल में गन्ना उत्पादन की तकनीक सीखी	24 मार्च 2012
दावे के मुताबिक उपज न हो तो मिलेगा मुआवजा	25 मार्च 2012
hindustantimes.com	
Sugarbeet may help bridge sweet gap	2 June 2011
IISR training for latest sugarcane production technique	29 June 2011
the pioneer	
राष्ट्रीय शर्करा महोत्सव 23 व 24 को	22 मार्च 2012
राष्ट्रीय शर्करा महोत्सव का शुभारम्भ	24 मार्च 2012
राष्ट्रीय सहारा सच कहने की हिम्मत	
गन्ना अनुसंधान संस्थान में ऑनलाइन परीक्षा भवन का उद्घाटन	9 अक्टूबर 2011
नई तकनीक के उपयोग से गन्ना उत्पाद बढ़ा	17 फरवरी 2012
भारतीय गन्ना अनुसंधान संस्थान का शर्करा महोत्सव कल से	22 मार्च 2012
स्वतंत्र भारत लखनऊ और कानपुर से प्रकाशित	
गन्ना अनुसंधान संस्थान के नए निदेशक बने डॉ सुशील	25 दिसम्बर 2011
गन्ना उत्पादन के लिए केन नोड तकनीकी अधिक उपयागी	3 फरवरी 2012
गन्ना उपज एवं चीनी परता में आई कमी पर हुआ मंथन	15 फरवरी 2012
भारतीय गन्ना अनुसंधान संस्थान का स्थापना दिवस समारोह	17 फरवरी 2012
गन्ना किसानों को नवीन तकनीकों के उपयोग से उत्पादन बढ़ाने की सलाह	24 मार्च 2012
किसानों को अधिकार व तकनीकी की जानकारी दी गयी	25 मार्च 2012
दैनिक प्रभात	
आई आई एस आर में शुगर फेस्ट का होगा भव्य आयोजन	10 मार्च 2012
नेशनल शुगर फेस्ट 2012 की तैयारी पूरी	22 मार्च 2012
शुगर फेस्ट 2012 का शानदार आगाज	24 मार्च 2012
हर मायने में यादगार रहा शुगर फेस्ट-2012	25 मार्च 2012
वर्ष 2012 को उत्तम वर्ष मनाने का लिया संकल्प	17 फरवरी 2012
दैनिक जागरण	
पदभार ग्रहण किया	25 दिसम्बर 2011
उत्पादन बढ़ाने में सहयोग करें वैज्ञानिक	21 जनवरी 2012

दैनिक जागरण	
कृषि विशेषज्ञों ने भ्रमण किया	3 फरवरी 2012
प्रौद्योगिकी ने बढ़ाया गन्ना उत्पादन	17 फरवरी 2012
राष्ट्रीय शर्करा महोत्सव 23 से	22 मार्च 2012
the pioneer	
Delegation from Ethiopia pays visit to IISR	8 April 2011
IISR develops technique for organic gur preparation	5 May 2011
IISR's training on sugarcane mgmt from July 1	29 June 2011
Programme on 'Sugarcane development' begins	2 July 2011
IISR scientists instrumental in popularizing modern irrigation techniques	21 October 2011
Dr Solomon new director of IISR	25 December 2011
Meet on Sugarcane Information system held at IISR	31 January 2012
Rizvi to be awarded for developing CIS	31 January 2012
Meet of sugar group managers, IISR scientists held	15 February 2012
City briefs – Review	15 February 2012
IISR celebrates Foundation Day	17 February 2012
National Sugar Fest inaugurated at IISR	24 March 2012
जनसंदेश टाइम्स	
60 वर्षों में संस्थान ने कई उपलब्धियां हासिल की	17 फरवरी 2012
शर्करा महोत्सव में उद्यमियों को सम्मानित किया जाएगा	22 मार्च 2012
अमर उजाला	
डॉ सोलोमन बने आई आई एस आर के निदेशक	25 दिसम्बर 2011
उत्तम वर्ष के रूप में मनाया जाएगा 2012	17 फरवरी 2012
23 मार्च से शुरू होगा राष्ट्रीय शर्करा महोत्सव	22 मार्च 2012
नेशनल शुगर फेस्ट का भव्य आगाज	24 मार्च 2012
आज	
गन्ना किसानों को नवीन तकनीकों से उत्पादन बढ़ाने की सलाह	24 मार्च 2012
युनाइटेड भारत	
गन्ना उत्पादन की तकनीकों व उत्पादों पर आधारित शर्करा महोत्सव कल से	22 मार्च 2012
राष्ट्रीय शर्करा महोत्सव	24 मार्च 2012
इन्क़िलाबी नज़र	
नवीन विधियों से किसान जागरूक हों	24 मार्च 2012
कैनविज टाइम्स	
राष्ट्रीय शर्करा महोत्सव का शुभारम्भ	24 मार्च 2012
गन्ना चूसा, खेती सीखी	25 मार्च 2012

19

Krishi Vigyan Kendra

Krishi Vigyan Kendra (KVK) is the district level vocational centre with an aim to accelerate agricultural production and allied activities for improving the economic status of the agrarian community. KVK works with the mandate of 'on-farm testing', refining and documenting technologies and providing skill and knowledge oriented vocational training to the farmers of the district of its location. It runs the need based skill oriented training programme for creating job opportunities for rural community. It also acts as a facilitator to coordinate the extension activities of different line departments for the benefit of the farmers. ICAR controlled KVKs also coordinate in disseminating host Institute technologies.

On Farm Trials

OFTs are most important mandatory component of KVK under which assessment and refinement of developed technologies is carried out in location specific agro-climatic conditions. Six OFTs were conducted pertaining to various major thrust areas, which are summarized below:

Effect of Paclobutrazol to control irregular bearing in mango cv. Dashahari

On farm trial to assess the effect of paclobutrazol to control of irregular bearing in mango cv. Dashari were conducted. In off season, soil application of paclobutrazol (3.2 ml per m. canopy) recorded 76.4% yield (Fig 19.1) when compared with on main season fruit yield (17.0 t/ha).

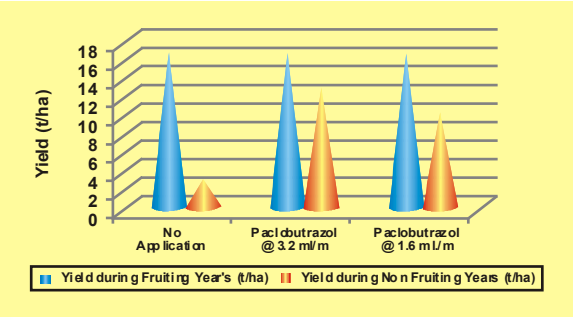


Fig. 19.1: Effect of Placloboutrazol tocontrol irregular bearing in mango

Evaluation of three different models of Kitchen Gardening for three different type of farm families

Three vegetable gardening modules *viz.*, i) 100 sqm (five members), ii) 150 sqm (7 members) and 200 sqm (9 members) were demonstrated to rural farm families under the supervision of farm women. On an average, 79% of the requirement of vegetables were met through nutritional vegetable gardening.

Intercropping of potato, coriander and mustard in autumn planted sugarcane

On-farm trial to assess the effect of intercropping of potato, coriander and mustard on the net return in sugarcane cultivation were carried out. Sugarcane + potato realized a net return of ₹ 1.70 lakh/ha followed by sugarcane + coriander (₹ 1.41 lakh) and ₹ 1.15 lakh in sugarcane + mustard which was compared to the farmers' practice (sole crop) with net returns of ₹ 0.94 lakh/ha (Table 19.1) (80, 50 and 22% increase in net return per ha was recorded, respectively over farmer practice).

Table 19.1: Performance of potato, coriander and mustard as intercrop in sugarcane

Technology option	SEY* (t/ha)	Net income (₹ in lakh)
Sugarcane sole crop (F P)	70.5	0.94
Sugarcane +Potato	146.7	1.70
Sugarcane +Corriander	103.2	1.41
Sugarcane +Mustard	88.0	1.15

*Sugarcane equivalent yield (SEY)

Assessment of newly released high yielding varieties of wheat

Varieties of wheat *viz.*, PBW 343 (Farmer practice), CBW- 38, Shatabdi (K 0307) and PBW 550 were evaluated in farmers' field at five locations. PBW 550 recorded highest grain yield (62.0 q/ha) with ₹ 50,120 as net income followed

by CBW 38 (59 q/ha) with ₹ 46,040, and K0 307 (57 q/ha) with ₹ 43,320.

Site specific nutrient management in potato

An experiment was laid out to find out appropriate fertilizers use in potato cultivation in Lucknow district.

Fertilization on the soil test value resulted in 22% increase in productivity of potato (Fig. 19.2)

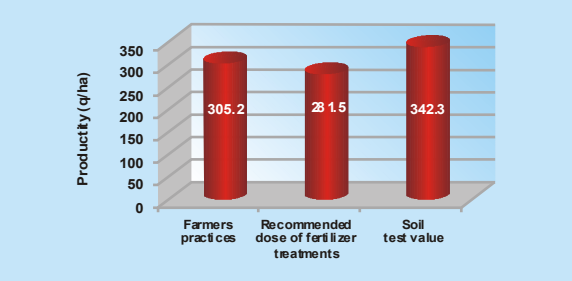


Fig. 19.2: Performance of site specific nutrient management in potato

Control of neonatal mortality of calves

No mortality in calves was recorded with providing different types of dewormer at 10 days after birth with Embazine, one month with piperazine and three month with destodin tablet.

Frontline Demonstrations (FLDs)

FLDs on oilseeds, pulses and other crops or enterprises were conducted at farmers field in an area of 50.2 ha. (*Kharif* 15.0 ha and *Rabi* 35.2 ha) of about 245 farmers. These farmers were supported with high quality seed materials of newly released varieties. They were also provided with the technological inputs through effective field oriented training programmes. There was wide variation in yield of crops as compared with the yield obtained at farmer's field with their local practices. Details of demonstration are presented (Table 19.2).

Animal husbandry activities covered approximately 2000 animals under vaccination and deworming for increasing milk production and disease management.

Transfer of Technology

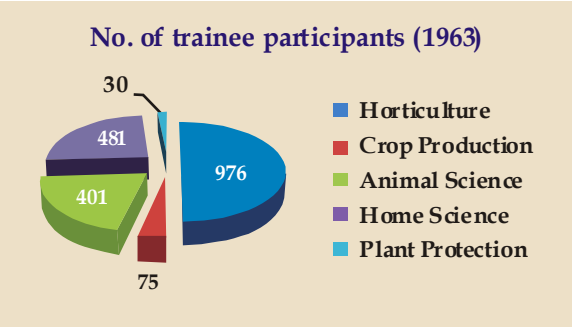
- The farmers who visited the Krishi Vigyan Kendra, Lucknow, during the year with problems related to field and horticultural crops were informed and acquainted about latest developed technology.
- ***Kisan Mela*:** A *Kisan mela* was organized at Indian Institute of Sugarcane Research, Lucknow on March 23-24, 2012. About 1500 farmers attended the *Kisan Mela*. Technology exhibition stalls of different research organizations, manufacturers, KVKs and line departments were also demonstrated in *Kisan Mela*. The visiting farmers were shown various exhibitions stalls and exposed to learn the know how on technologies being demonstrated.
- ***Kisan Gosthi*:** Two *Kisan Gosthies* were organized on November 4-5, 2011. The topics of discussion in *Gosthies* were i) Nursery management in vegetable crops ii) Interaction with farmers on IPM iii) Integrated feeding breeding management iv) general farming

Table 19.2: Details of FLDs conducted

Season	Crop enterprises	Thematic area	Area (ha)	No. of farmers	Average yield (q/ha)		Per cent increase
					Demo.	Check	
Kharif 11	Sweet sorghum	Green fodder	5	33	596.8	354.5	68.3
	Pigeonpea	ICM	5	27	21.3	15.2	40.1
	Sesamum	ICM	5	18	4.2	3.2	31.2
Rabi 11-12	Mustard	ICM	5	23	24.5	17.8	37.6
	Veg. pea	Varietal evaluation	3	13	109.0	95.0	9.5
	Potato	Seed and planting materials	5	10	310.0	246.2	19.9
	Wheat	Varietal evaluation	5	7	57.0	49.5	15.2
		Zero tillage	5	6	45.2	43.6	3.7
	Fieldpea	HYV	5	28	28.0	21.0	33.3
	Barseem	HYV	5	62	500.8	401.6	24.7
	Sugarbeet	Feed & fodder	2.2	18	453.0	-	
	Total		**50.2**	**245**			

issues were covered. About 150 progressive farmers participated.

- **Field visits**: Thirteen groups of farmers (400) from different states under ATMA, Horticulture Mission *etc.*, scheme, visited at KVK, Lucknow. During the visit, they were shown different technologies of sugarcane crop, jaggery and *khandsari* processing unit, Krishi Vigyan Kendra, vermicompost unit and developed implements related to sugarcane cultivation.
- **Animal Fertility Camp:** KVK organized a animal camp at village Mirakhnagar of Mohanlalganj block on July 5, 2012 in which 215 buffaloes and cows were got checked against infertility problem. Possible solutions provided to farmers by veterinary officers.
- **Seed Production Programme:** The Kendra produced 120 qtls. wheat seed (var.-K 307) truthfully labeled seed and about 2500 seedling of tomato and distributed it to the farmers.
- **Lectures :** KVK Programme Coordinator and Subject Matter Specialists delivered **52** lectures on various aspects *viz.*, Nursery management of vegetable and horticultural crops, and rejuvenation in mango, *aonla* and guava orchard. Seed production technique of potato, tomato, chilly and important cucurbits, scientific cultivation of solanaceous vegetables, tuber crops, leafy vegetables, okra, vegetable pea, cucurbits *etc.*, during *Kisan Gosthi*, training programme, field days and farmers field school *etc.*
- **Technology/knowledge dissemination through mass media :** Four TV talks and two Radio talks were delivered by Dr. R.K. Singh, PC, KVK during the year. Four TV talks were delierved by Dr. Rakesh Kumar Singh, TO, KVK during the year.
- **Trainings :** Krishi Vigyan Kendra, IISR, Lucknow offered 83 training courses for participating farmers, farm women, rural youths and extension personals on various topics during the year 2011-12 with an objective to improve skill and enterprise of under privileged farmers through improvement in agriculture production and allied enterprises. All training programmes were fully skill oriented and conducted following the principles of "Teaching by doing" and "Learning by doing". Total 1963 participants (1437 male, 426 Female) attended the programme.



- Two hundred progressive farmers of six different blocks of Lucknow district attended eight training programmes of two-days duration at KVK sponsored by UP Horticulture Technology Mission.

Publications

(a) Papers in Research Journals (National/International)

Singh, S.N., Singh, S.C., Singh, G.K., Singh, R.K. and Sharma, M.L. (2011) Influence of intercropping vegetables with winter harvested plant cane for enhanced productivity of subsequent ratoon in sub-tropical India. *Vegetable Science* **38**: 197-199.

Selvakumar, G., Sushil, S.N., Stanley, J., Mohan, M., Deol, A., Rai, Deepak, Ramkewal, Bhatt, J.C. and Gupta, H.S. (2011) *Brevibacterium frigroritolerans* a novel entomopathogen of *Anomala dimidata* and *Holtrichia longipennis* (Scarabaeidae: Colepoptera). *Biocontrol Sciences and Technology* **21** : 821-827.

Ramkewal, Rai, Deepak and Gupta, J.P. (2011) Efficacy of spiromesifen against European red spider mites, *Panonychus ulmi* Koch and two spotted spider mites, *Tetranychus urticae* Koch in apple. *Pantnagar Journal of Research* **9**: 158-163.

(b) Book

Audyanik Phasal Prabandhan (2011) Singh, R.K., Rai, Deepak, Singh, Rakesh Kumar and Singh, Veenika (Eds.), Krishi Vigyan Kendra, IISR, Lucknow. 117 p.

(c) Book Chapters

Agarwal, Ankur and Singh, R.K. (2011) *Jalvayu Parivartan Ka Audhyanik Phasal Utpadan Par Prabhav. Audhanik Phasal Prabandhan*. pp. 1-4.

Singh, R.K. and Singh, Rakesh Kumar (2011) *Audhanik Phasal Utpadan Mein Mrida Parikshan Ka Mahatva. Audhanik Phasal Prabandhan*. pp. 5-7.

Agarwal, Ankur and Singh, R.K. (2011) *Sabjiyon Ki Sanrakshit Kheti. Audhanik Phasal Prabandhan*. pp. 8-12.

Singh, R.K. and Dwivedi, Deepa Hansraj (2011) *Samsheetoshna Phalon Mein Sasya Kiryaein Evam Prabandhan. Audhanik Phasal Prabandhan*. pp. 13-18.

Singh, R.K. and Singh, D.B. (2011) *Kela Ki Kheti : Ek Labhkari Vyaysaya. Audhanik Phasal Prabandhan*. pp. 19-22.

Singh, D.B., Chaudhary, Bali Sharan and Singh, R.K. (2011) *Aam Ke Bagon Ka Jeernoddhar. Audhanik Phasal Prabandhan*. pp. 23-24.

Singh, R.K., Srivastava, B.K. and Rai, Deepak. (2011) *Sabzi Utpadan Hetu Mahatvapoorna Jaankariyan. Audhanik Phasal Prabandhan*. pp. 25-31.

Sushil, S.N., Rai, Deepak and Singh, R.K. (2011) *Sabziyon Mein Samanvit Keet Prabandhan. Audhanik Phasal Prabandhan*. pp. 31-41.

Singh, R.K., Rai, Deepak and Singh, S.N. (2011) *Aaloo Ki Kheti. Audhanik Phasal Prabandhan*. pp. 42&47.

Singh, R.K. and Srivastava, B.K. (2011) *Tamatar Ki Kheti : Ek Labhkari Vyaysaya. Audhanik Phasal Prabandhan*. pp. 48-52.

Rai, Deepak and Sushil, S.N. (2011) *Samekit Keet Prabandhan Mein Pheromone Trap Ka Mahatava. Audhanik Phasal Prabandhan*. pp. 53-55.

Dwivedi, Deepa Hansraj, Chaudhary, Bali Sharan and Singh, R.K. (2011) *Phoolon Ki Kheti. Audhanik Phasal Prabandhan*. pp. 56-58.

Singh, R.K., Tiwari, R.S. and Mishra, S.S. (2011) *Masalon Ki Kheti. Audhanik Phasal Prabandhan*. pp. 59-67.

Singh, S.N., Singh, R.K., Singh, V.K and Singh, Rakesh Kumar. (2011) *Shardkaleen Ganne Me Sabjiyon Evam Masalon ki Antahkheti. Audhanik Phasal Prabandhan*. pp. 68-77.

Singh, Veenika, Singh, R.K. and Rai, Deepak (2011) *Phalon Va Sabjiyon Ka Phasaloprant Prabandhan. Audhanik Phasal Prabandhan*. pp. 78-81.

Singh, Veenika, Rai, R.K and Rai, Deepak (2011) *Audhyanik Phaslon Ka Prasanskaran Evam Mulyavardhan. Audhyanik Phasal Prabandhan*. pp. 82-91.

Singh, Veenika, and Singh, Rakesh Kumar (2011) *Bahuupyogi Pudina : Ek Jaankari. Audhyanik Phasal Prabandhan*. pp. 92-95.

Rai, Deepak , Sushil, S.N. and Singh, Rakesh Kumar (2011) *Madhumakshi Palam : Parichay Evam Mahatva. Audhyanik Phasal Prabandhan*. pp. 96-105.

Singh, Veenika, Thakur, S., and Singh, Rakesh Kumar (2011) *Shahad Ek – Upyog Anek. Audhyanik Phasal Prabandhan*. pp. 106-109.

Singh, Rakesh Kumar, Rai, Deepak and Singh, Veenika (2011) *Khumb* (Mushroom) *Ki Kheti Audhyanik Phasal Prabandhan*. pp. 110-117.

(d) Papers presented in Conferences/ Symposia/Seminars

Paper presented in Global Conference of Women in Agriculture held on March 13-15, 2012

Singh, R.K., Singh, Veenika, Singh, Rakesh, Kumar and Rai, Deepak (2012) Farm women participation in nutritional vegetable gardening : A step towards achieving nutritional security. pp. 148-149.

Paper presented in 14th Indian Agricultural Scientists and Farmers Congress on "Diversification in Agriculture and Agripreneurship" held at SIEMAT, Allahabad on February 18-19, 2012"

Singh, V.K., Singh, R.K, Singh, Rakesh K. and Kumar, Manish (2012). Transfer of improved technology through frontline demonstration in sesame (*Sesamum indicum* L.). *pp. 56.*

Singh, R.K., Sharma, A.K. and Singh, Rakesh K. (2012). Knowledge management for agri-business at KVK level: Implications from micro evidences. *pp. 76.*

Paper presented in National Conference on Applied Zoological Research for National Food Security and Environmental Protection held at CRRI, Cuttack on February 15-16, 2012

Singh, R.K., Mishra, S.S., Singh, Rakesh Kumar, Rai, Deepak and Singh, Veenika (2012). Efficacy of imidacloprid against virus vector for raising healthy crop of seed potato. *pp. 68-69.*

(e) Technical/Popular articles

Singh, R.K., Singh, Rakesh Kumar and Rai, Deepak (2011) Scientific cultivation of banana. Nand Prsar Jyoti, *Rabi* crop, Special Issue. pp. 8-14.

Participation in Seminar/Symposia/ Conferences *etc.*

- Dr. R.K. Singh attended Annual Zonal Workshop of KVKs (Zone IV) at GBPUA&T, Pantnagar, on May 12-13, 2011; 6th National Symposium on "Noni-A Panacea for Wellness" at Trade Centre, Chennai on October 1-2, 2011; 6th National Conference on KVK-2011 at JNKVV, Jabalpur on December 2-4, 2011; Mid-term Review Zonal Workshop of KVKs of Zone IV at Zonal Project Directorate, Kanpur on December 22-24, 2011; National Workshop for Dissemination of Horticultural Technologies through KVK Personnel at IIHR, Bangalore on January 18-19, 2012; 14th Indian Agricultural Scientists & Farmers Congress at SIEMAT, Allahabad on February 18-19, 2012 and Global Conference on Women in Agriculture at NASC Complex, New Delhi on March 14-15, 2012.
- Dr. Rakesh Kumar Singh attended Summer School on "Adaptive Production Technologies for Sugarbeet Cultivation in India at IISR, Lucknow, on June 1-21, 2011.

Awards and Recognitions

- Dr. R.K. Singh, Programme Coordinator awarded Bioved fellowship Award–2012 for his outstanding contribution in the field of Horticulture (Vegetable Science) in 14th Indian Agricultural Scientists and Farmers Congress on Diversification in Agriculture and Agripreneurship held on February 18-19, 2012 at SIEMAT, Allenganj, Allahabad.
- KVK, Lucknow awarded 1st Prize for stall and technology exhibition in state level farmers fair organized by KVK, Unnao on November 5, 2011.
- KVK, Lucknow awarded 3rd Prize for stall and technology exhibition in state level farmers fair organized by U.P. Soil Reclamation Corporation, Lucknow on November 21, 2011.

Awards/Honours/Recognitions

An award is something given to a person or a group of people to recognize their excellence in a certain field; a certificate of excellence. Awards are often signified by trophies, titles, certificates, commemorative plaques, medals, badges, pins or ribbons. An award may carry a monetary prize given to the recipient. An award may also simply be a public acknowledgement of excellence, without any tangible token or prize. Awards can be given by any person or Institution, although the prestige of an award usually depends on the status of the awarder. Usually, awards are given by an organization of some sort, or by the office of an official within an organization or Government. ICAR also supports and encourages programmes to acknowledge and formally recognize the contributions, exemplary performance and continuous service of its employees to the NARS. The awards and recognitions received by IISR employees during 2011-12 reveals the level of professional competence of this esteemed organization.

Awards

- Dr. Amaresh Chandra, PS and Head, Plant Physiology and Biochemistry Division was awarded DBT-CREST 2011-12 Fellowship by DBT, Ministry of Science and Technology, Govt. of India.
- Dr. Sangeeta Srivastava was awarded DBT-CREST Award (Cutting Edge Research Enhancement and Scientific Training Awards) of Department of Biotechnology, Govt. of India for the year 2011-12.
- Dr. Sangeeta Srivastava was awarded Woman Botanist Gold Medal 2011 by the Indian Botanical Society at 34th IBS Conference held at Lucknow University from 10-12 October, 2011 for best paper presentation by a woman scientist under 50 years of age.
- Dr. S.N. Sushil was elected as Fellow of the "Society for Biocontrol Advancement", Bangalore on May 25, 2011.

Recognitions

- Dr. S.K. Duttamajumder was nominated by the DG, ICAR to act as a member of Management Committee of IISR, Lucknow
- Dr. S.K. Duttamajumder was nominated to act as a member in the Review Committee on Genetic Manipulation (RCGM) under the Department of Biotechnology, Govt. of India.
- Dr. S.K. Duttamajumder was nominated to act as a member of Monitoring Committee of *Bt* brinjal and *Bt* maize.
- Dr. A.D. Pathak served as DBT nominee in Institute Bio Safety Committee of UP Council of Sugarcane Research, Shahjahanpur.
- Dr. P.K. Singh was nominated as the Chairman of the Committee for On Site Verification of Applicants for 'Plant Genome Saviour Community Award – 2010-11 by the Govt. of India under the National Gene Fund.
- Dr. P.K. Singh was nominated for Coordination of Interactions and Visits of Netherland's Delegation to India for IPR issues related to plant varieties on May 2-4, 2011 by PPV&FRA, New Delhi.
- Dr. Sangeeta Srivastava was nominated as Fellow of Indian Botanical Society (FBS) at 34th IBS Conference held at Lucknow University.
- Dr. Arun Kumar Srivastava was recognized as expert on sugarcane for Annual Review meeting on FASAL on "Assessment of *Kharif* 2011 and Planning for *Rabi* 2011-12 during March 1-2, 2012 organized jointly by IMD and BHU.
- Dr. Chandra Gupta was nominated as representative for the Member of the Board of Studies in Functional Hindi (UG) and Hindi

& Journalism (PG) in Avinashilingam Deemed University for Women, Coimbatore for two years w.e.f. March 25, 2011.

- Dr. Sangeeta Srivastava nominated as Editorial Board member of the journal "Indian Journal of Fundamental and Applied Life Sciences" in 2012.
- Dr. P.K. Singh is Member of Project Approval and Monitoring Committee of UP State Biodiversity Board, Lucknow.
- Sh. Brahm Prakash, Technical Officer was elected as a member of the Executive Committee of Indian Society of Agricultural Marketing for two years (2012 and 2013).

Prizes

- Dr. Chandra Gupta was awarded 3rd best poster award for a research paper on Integrated Nutrient Management in Sugarcane Production presented in the National Symposium on Balanced Fertilizer to Sustainable Soil Health, Crop Production and Food Security held at G.B. Pant University of Agriculture & Technology, Pantnagar (Uttarakhand) on November 25-26, 2011.
- The Exhibition Stall of Indian Institute of Sugarcane Research was adjudged the Best under ICAR stall category at the *Pusa Krishi Vigyan* Mela organized on the theme "Prosperity through Innovative Farm Technologies" held at IARI, New Delhi on March 1-3, 2012. The award was presented by Mr. Sompal Shastry, Hon'ble Ex. Union Agriculture and Water Resource Minister, Govt. of India in the valedictory session.

Publications

An important part of the work completed in academia is sharing our knowledge & technologies with others. This communication takes place when we write research papers, present at scholarly conferences, publish in peer-reviewed journals, and publish in books. The process of writing a research paper can be one of the more rewarding experiences, one may encounter in academics. Becoming an experienced researcher and writer in any field or discipline takes a great deal of practice. There are few individuals for whom this process comes naturally. Even the most seasoned academic veterans have had to learn how to write a research paper at some point in their career. Therefore, with diligence, organization, practice, a willingness to learn (and to make mistakes!), and, perhaps most important of all, patience, a scholar will find that he/she can achieve great things through his/her research and writing.

Papers in Research Journals

A. Indian Journals

Anwar, S.I., Singh, R.D. and Singh, J. (2011) Process development for production of jaggery (*gur*) with *aonla* as a natural source of vitamin C. *Journal of Institution of Engineers (India)* **92**: 33-35.

Baitha, A., Sinha, O.K., Maurya, B.L. and Rajak, D.C. (2011) Age preference of females on biological attributes in *Tetrastichus howardi* (Olliff.) (Eulophidae: Hymenoptera). *Jour. Plant. Prot. and Environ*. **8**: 45-48.

Bajpai, P.K., Krishna, P. and Malik, M. (2012). Selection of appropriate growth model for prediction of sugarcane area, production and productivity of India. *Sugar Tech.* **14**: 188-191.

Brahm Prakash, Sharma, A.K., Mohd. Ashfaque and Srivastava, S. (2011). Improving agricultural marketing: A pre-requisite for ensuring food security of the country. *Indian Journal of Agricultural Marketing* **25**: 150-161.

Brahm Prakash, Sharma, A.K., Mohd. Ashfaque and Singh, Rakesh K. (2011). Revamping MGNREGES in the twelfth plan: Implications from village level implementation status in the Central Uttar Pradesh. *Indian Journal of Agricultural Economics* **66**: 317-318.

Chandra, A. (2011) Physio-biochemical and molecular approaches to enhance sucrose content in sugarcane: Indian initiatives. *Sugar Tech.* **13**: 315-321.

Chandra, A., Jain, R. and Solomon, S. (2012) Complexities of invertases controlling sucrose accumulation and its retention in sugarcane. *Curr. Sci.* **102**: 857-866.

Hasan, S.S., Bajpai, P.K., Kumar, R., Singh, S.N. and Sah, A.K. (2011) Information and communication technologies tools for effective management of data in sugar mill zone. *Indian J. Sugarcane Technol.* **26** : 55-59.

Hooda, K.S., Joshi, D., Shridhar and Bhatt, J.C. (2011) Management of damping-off of tomato with botanicals and bio-products in North Western Himalayas. *Indian J. Hort.* **68**: 219-223.

Hooda, K.S., Sushil, S.N., Joshi, D., Bhatt, J.C., Hedau, N.K. and Gupta, H.S. (2011) Efficacy of different modules for the management of major pests of tomato (*Lycopersicon esculentum*) and garden pea (*Pisum sativum*) in Himalayas. *Indian Phytopathology* **64**: 335-341.

Jain, R. and Srivastava, S. (2012) Nutrient composition of spent wash and its impact on sugarcane growth and biochemical attributes. *Physiology and Molecular Biology of Plants* **18**: 95-99.

Jain, R., Solomon, S. and Chandra, A. (2011) Some discernible physio-biochemical changes associated with improved sprouting of sugarcane setts treated with Ethephon. *Sugar Tech.* **13**: 123-128

Joshi, D., Bhatt, J.C., Hooda, K.S. and Gupta, A. (2012) Management of finger millet (*Eleusine coracana*) blast under field conditions by plant extracts. *Indian J. Agric. Sci.* **82** : 284-287.

Krishna Priya, S.R. and Bajpai, P.K. (2011) Computation to growth rates for sugarcane using non-linear growth models. *Indian J. Sugarcane Technol.* **26**: 23-29

Kumar, R. and Hasan, S.S. (2011) Trend of sugar recovery and sugar losses due to low recovery in a crushing period of sugarcane. *Indian J. Sugarcane Technol.* **26**: 43-52.

Kumar, S., Pandey, D.K., Singh, P.K. and Singh, J. (2011) Genotype x environment interaction and stability analysis for sugarcane genotypes evaluated in multi-locational trials. *Journal of Sugarcane Research* **1**: 28-34.

Nithya, K., Khalid, A.I.M.B., Valluvaparidasan, V., Paranidharan, V. and Velazhahan, R. (2012) Molecular detection of *Colletotrichum falcatum* causing red rot disease of sugarcane (*Saccharum officinarum*) using a SCAR marker. *Annl. Appl. Biol.* **160**: 168-173.

Pathak, A.D., Kapur, R., Kumar, R. and Vishwakarma, M.K. (2011) Impact of different vernalization treatments on flowering and seed production in sugarbeet (*Beta vulgaris* L.). *Indian J. Sugarcane Technol.* **26**: 24-27.

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Sah, A.K., Verma, R.P., Prasad, K., Kumar, R. and Hasan, S.S. (2011) Training impact on sugarcane development personnel: Attitudinal change and their correlates. *Indian J. Sugarcane Technol.* **26**: 40–42.

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Sharma, A.K., Brahm Prakash and Singh, Rakesh K. (2011). Impact of kisan credit card innovation on improving Uttar Pradesh cane growers' access to institutional credit. *Indian Journal of Agricultural Economics* **66**: 475-476.

Sharma, A.K., Yadav, R.L., Yadav, D.V. Brahm Prakash and Singh, M. (2011). Problems and prospects of new ICT interventions in sugarcane extension in Uttar Pradesh. *Indian Journal of Agricultural Economics* **66**: 537.

Shrivastava, A.K., Srivastava, A.K., Solomon, S., Sawnani, A. and Shukla, S.P. (2011) Sugarcane cultivation and sugar industry in India: Historical perspectives. *Sugar Tech.* **13**: 266-274.

Shrivastava, A.K., Sawnani, A. and Shukla, S.P. (2011) Sugarcane varieties in ancient India. *Asian Agri-History* **15**: 323-326.

Shrivastava, A.K., Sawnani, A., Shukla, S.P. and Solomon, S. (2011) Sugarbeet physiology. *Cooperative Sugar* **43**: 39-45.

Shrivastava, A.K., Srivastava, A.K. and Solomon S. (2011) Sustaining sugarcane productivity under depleting water resources. *Curr. Sci.* **101**: 748-754

Shukla, S.K. and Yadav, R.L. (2011) Improving growth and yield of winter initiated sugarcane (*Sachharum spp.* hybrid complex) ratoon through bioagents amended pressmud cake in subtropical India. *Indian J. Agric. Sci.* **81**: 1184-1186.

Shukla, S.K., Singh, P.N. and Chauhan, R.S. (2011) Effect of organic wastes amended with *Trichoderma* and *Gluconacetobacter* on physicochemical properties of soil and sugarcane ratoon yield in udic ustochrept. *Indian J. Agron.* **56**: 254-259.

Singh P.K. (2011) Implementation of Protection of Plant Varieties and Farmers' Rights Act 2001. *Indian J. Genet.* **71** : 190-198.

Singh S.N., Sah, A.K., Singh, R.K., Singh, V.K. and Hasan, S.S. (2011) Alternatives to rice (*Oryza sativa L.*)- wheat (*Triticum æstivum L.* emend. Fiori & Paol.) cropping system for enchanced productivity and profitability in Indian sub-tropics. *Tropical Agriculture* **88**: 135-140.

Singh S.N., Singh, P.K., Singh, G.K., Singh, V.K., Prakash, Om and Kumar, R. (2011) Comparative effect of polybag culture and conventional methods of planting at different

dates on rapid multiplication of seed cane (*Saccharum* species complex) in sub-tropical India. *Indian J. Agric. Sci.* **81**: 751-755.

Singh, J., Singh, A.K., Sharma, M.P., Singh, P.R. and Srivastava, A.C. (2011) Mechanization of sugarcane cultivation. *Sugar Tech.* **13**: 310-314.

Singh, A.K., Lal, M. and Singh, S.N. (2011) Agronomic performance of new genotypes under different planting geometries and N levels. *Indian J. Sugarcane Technol.* **26**: 6-9.

Singh, A.K., Lal, M. and Singh, S.N. (2011) System productivity and yield advantage of autumn sugarcane (*Saccharum* spp. Hybrids) and linseed (*Linum usitatissium*) intercropping under sub-tropics. *Indian J. Sugarcane Technol.* **26**: 7-9.

Singh, J., Singh, R.D., Anwar, S.I. and Solomon, S. (2011) Alternative sweeteners production from sugarcane in India: Lump sugar (jaggery). *Sugar Tech.* **13**: 366-371.

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Singh, M.R., Tanwar, R.K. and Sharma, M.P. (2011) Evaluation of insect pest management methods against cane borers of sugarcane ratoon crops. *Indian J. Sugarcane Technol.* **26**: 33-36.

Singh, P. and Solomon, S. (2011) Effect of ambient temperature on the storage quality of harvested sugarcane. *Journal of Southern Agriculture* **42**: 375-379.

Singh, P. and Solomon, S. (2011) Effect of spraying of electrolysed water on post-harvest quality of sugarcane at high ambient temperature. *Cooperative Sugar* **42**: 49-52.

Singh, R.K., Khan, M.S., Singh, R., Pandey, D.K., Kumar, S. and Lal, S. (2011) Analysis of genetic differentiation and phylogenetic relationship among sugarcane genotypes differing in response to red rot. *Sugar Tech.* **13**: 137–144.

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Singh, S.N., Singh, A.K., Singh, S.C., Sharma, M.L. and Kumar, R. (2011) Enhancing sugarcane (*Saccharum* spp. Hybrid) productivity by integrating organic, inorganic and biological sources of N in sub-tropical India. *Indian J. Sugarcane Technol.* **26**: 14-15.

Singh, S.N., Singh, S.C., Singh, G.K., Singh, R.K. and Sharma, M.L. (2012) Influence of intercropping vegetables with winter harvested plant cane for enhanced productivity of subsequent ratoon in sub-tropical India. *Vegetable Science* **38**: 197-199.

Singh, S.N., Srivastava, T.K., Singh, A.K., Yadav, R.L. and Singh, Todi (2011) Managing initial planting density for enhanced productivity of sugarcane plant-ratoon system in sub-tropical India. *Indian J. Sugarcane Technol.* **26**: 56-58.

Singh, S.N., Yadav, D.V., Singh, Todi and Singh, G.K. (2011) Optimizing plant population density for enhancing yield of ratoon sugarcane (*Saccharum* spp.) in sub-tropical climatic conditions. *Indian J. Agric. Sci.* **81**: 571-574.

Singh, S.N., Yadav, R.L., Lal, M., Singh, A.K., Singh, G.K., Prakash, Om and Singh, V.K. (2011). Assessing feasibility of growing sugarcane by a polythene bag culture system for rapid multiplication of seed cane in sub-tropical climatic conditions of India. *Plant Prod. Sci.* **14**: 229-232.

Solomon, S. (2011) Sugarcane byproducts based industries in India. *Sugar Tech.* **13**: 408-416.

Solomon, S. (2011) The Indian sugar industry: An overview. *Sugar Tech.* **13**: 255-265.

Solomon, S., Singh, P., Shrivastava, A.K., Singh, P., Chandra, A., Jain, R. and Prajapati, C.P. (2011) Physio-biochemical method of preserving sucrose in harvested sugarcane at high ambient temperature in a subtropical climate. *Sugar Tech.* **13**: 60-67.

Srivastava, S., Gupta, P.S., Singh, P.K., Singh, J. and Jain, R. (2011) Genetic diversity analysis of *Saccharum spontaneum* germplasm using SSR-SSCP and RAPD markers. *Indian J. Agric. Sci.* **81**: 914-20.

Srivastava, S., Singh, V. and Gupta, P.S. (2011) Ribosomal DNA sequence based characterization of *Trichoderma* strains antagonistic to *Colletotrichum falcatum* causing red rot disease of sugarcane. *Sugar Tech.* **13**: 245–249.

Srivastava, S. and Jain R. (2011) *In-situ* monitoring of chromium cyto-toxicity in sugarcane. *J. Environ. Biol.* **32**: 759-763.

B. Foreign Journals

Jain, R., Srivastava, S. and Chandra, A. (2012) Evaluating sugarcane cultivars for low temperature stress tolerance by electrolyte and phenolic measurements. *Tropical Agr. (Trinidad)* **89**: 78-84.

Selvakumar, G., Sushil, S.N., Stanley, J., Mohan, M., Deol, A., Rai, D., Ramkewal, Bhatt, J.C. and Gupta, H.S. (2011) *Brevibacterium frigoritolerans*- a novel entomopathogen of *Anomala dimidiata* and *Holotrichia longipennis* (Scarabaeidae: Coleoptera). *Biocontrol Sci. and Tech.* (U.K.) **21**: 821-827.

Shukla, S.K., Singh, P.N., Chauhan, R.S. and Yadav, R.L. (2012) Recycling of organic wastes amended with *Trichoderma* and *Gluconacetobacter* for sustenance in soil health and sugarcane ratoon yield in *Udic Ustochrept. Communications in Soil Science and Plant Analysis* **43**: 1073-1097.

Singh, S.N., Singh, A.K., Malik, J.P.S., Kumar, R., Sunderpal and Sharma, M.L. (2012) Cultural-practice packages and trash management effects on sugarcane ratoons under sub-tropical climatic conditions of India. *Journal of Agricultural Science* **150**: 237-247.

Srivastava, D.C., Baitha, A., Singh, M.R. and Bajpai, P.K. (2012) Natural parasitisation and incidence of top borer, *Scirpophaga excerptalis* worker. *International Sugar Journal* **114** : 197-202.

Srivastava, S., Pathak, A.D. and Gupta, P.S. (2011) Molecular characterization based on RAPD markers of high and low sugar intergeneric hybrids of *Saccharum* and *Erianthus*. *Tropical Agr. (Trinidad)* **88**: 186-192.

Swapna, M., Sivaraju, K., Sharma, R.K., Singh, N.K. and Mohapatra, T. (2011) Single strand conformation polymorphism: A potential tool for diversity analysis and varietal identification in sugarcane. *Plant Molecular Biology Reporter* **29**: 505-513.

Books

Duttamajumder, S.K., Sharma, A.K. and Brahm Prakash (2011) Vision -2030: IISR, Lucknow, 37 p.

Jain, R., Solomon, S., Li, Y.R., Chandra, A. and Shrivastava, A.K. (2012) Ethephon: Impact on Sugarcane Physiology and Sugar Productivity, Agrotech Publishing Academy ISBN 8183212220, 125 p.

Sai Prasad, S.V., Kantwa, S.R., Singh, G.P., Bharadwaj, C., Sushil, S.N., Hooda, K.S. and Verma, S. (2012). Plant Sciences. New Vishal Publications, New Delhi, 440 p.

Sushil, S.N., Sah, A.K., Kumar, S., Singh, M.R., Baitha, A., Hasan, S.S., Rajak, D.C., Singh, G.K., Brahm, Prakash and Murti, R. (Eds.) (2012) Souvenir-National SugarFest-2012 and Awareness programme on PPV&FRA held on March 23-24, 2012. IISR, Lucknow. 83 p.

Swapna, M. and Srivastava, S. (2012) Molecular Marker Applications for Improving Sugar Content in Sugarcane. Springer Briefs in Plant Sciences VII ISBN 978-1-4614-2256-3.

Yang, Rui Li, Srivastava, M.K., Rao, G.P., Singh, Priyanka and Solomon, S. (2012) Balancing Sugar and Energy Production in Developing Countries : Sustainable Technologies & Marketing Strategies. IBDC, India, 1050 p.

Book Chapters

Kumar, S. and Singh, J. (2012) Sugarcane. *In:* Breeding of Field Crops (Ed.: D.N. Bharadwaj), Agrobios India, Jodhpur pp. 709-732.

Kumar, S., Singh, J., Singh, R.K. and Singh, P.K. (2012) *Paudha Kisma Aur Krishak Adhikar Sanrakshan Adhiniyam 2001 Ke Pariprekshya Me Krishako Ke Adhikar*. *In* : Souvenir: National SugarFest-2012 & 'Awareness Programme on PPV & FRA, 2001' held at Indian Institute of Sugarcane Research, Lucknow during March 23-24, 2012.

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Shrivastava, A.K. and Srivastava, S. (2012) Sugarcane: Physiological and Molecular Approaches for Improving Abiotic Stress Tolerance and Sustaining Crop Productivity. *In*: Improving Crop Resistance to Abiotic Stress (Eds. Narendra Tuteja, Sarvajeet Singh Gill, Antonio F. Tiburcio, and Renu Tuteja). First Edition. Wiley-VCH Verlag GmbH & Co. KGaA, Germany Vol. 2, pp. 885-921.

Singh, P. (2011) Sugar and Jaggery Industrial Waste Management. *In*: Food Processing Waste Management: Treatment and Utilization Technology (Eds. Joshi, V.K. and Sharma, S.K.), New India Publishing Agency, New Delhi, pp. 229-255.

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Solomon, S. and Singh, P. (2011) Post-harvest Sugar Losses and Their Management in Sugarcane. *In* : Sugarcane Alternatives: Sugar Biofuel and Environment. (G.Hunsigi. Ed) Prism House, Bangalore.

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Yadav, R.L. and Shukla, S.K. (2011) Resource Conserving Techniques in Sugarcane Based Cropping System. *In*: Resource Conserving Techniques in Crop Production, (Eds. Sharma, A.R. and Behera, U.K.) ISBN: 9788172336738, pages 523. Scientific Publishers, New Delhi.

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Paper presented in Seminars/Symposia/ Conferences

A. International

Paper presented in the 4th IAPSIT International Sugar Conference IS-2011 New Delhi on Balancing Sugar and Energy Production in Developing Countries: Sustainable Technologies and Marketing Strategies held at New Delhi during November 21-25, 2011

Ansari, M.I., Madan, V.K. and Lal, R.J. (2011) Identification of red rot pathogen (*Colletotrichum falcatum*) of sugarcane with the help of dot blot hybridization for selecting healthy seed material. pp. 732-734.

Chandra, A., Jain, R. and Solomon, S (2011) Functional analysis of enzyme effectors and plant growth regulators on sucrose metabolizing enzymes and their corresponding genes in sugarcane. pp. 680-684.

Jain, R., Shrivastava, A.K., Solomon, S. and Chandra, A. (2011) Influence of Gibberelic acid and ethephon on growth, sucrose metabolizing enzymes and sugar contents of sugarcane. pp. 413-418.

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Singh, P. and Solomon, S. (2011) Assessment of sequential deterioration in cane quality in a sugar mill using MDH method. pp 426-428.

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Banerjee, N., Bharadwaj, V., Yadav, S., Singh, J. and Singh, R.K. (2012) Utility of EST-SSR markers for association mapping in sugarcane. p. 76.

Chandra, A., Jain, R. and Solomon, S. (2012) Differential expression of genes associated with sucrose accumulation in sugarcane. p. 97.

Singh, R.K., Yadav, S., Banerjee, N., Bharadwaj, V., Swapna, M., Duttamajumder, S.K., Srivastava, S. and Kapur, R. (2012) Development and characterization of EST-SSR markers for sugarcane. p. 186.

Paper presented in IUPAC sponsored 2nd International Conference on APCHNE: Role of Chemistry for Sustainable Agriculture held at New Delhi during February 15-18, 2012

Singh, A.K., Chauhan, R.S. and Srivastava, T.K. (2012) Effect of pre-emergence application of sulfentrazone in spring planted sugarcane under sub-tropical India. p. 87.

B. National

Paper presented in 46th Annual Convention and International Symposium of ISAE held at GBPUA&T, Pantnagar during February 27-29, 2012

Anwar, S.I. and Singh, J. (2012) Juice extraction affected by angle of extraction in 3-roller power driven horizontal sugarcane crushers. p. 42.

Kumar, D., Singh, J., Rai, D.R., Kumar, M., Bhatia, S. and Singh, J. (2012) Effect of modified atmosphere packaging on keeping quality of jaggery. p. 18.

Singh, A.K., Sharma, M.P. and Singh, J. (2012). Development of tractor operated front mounted cane harvester. p. 189.

Singh, J. and Kumar, R.D. (2012) Development of a small capacity cane crushing unit for household purpose. p. 26

Singh, R.D., Singh, J., Anwar, S.I. and Kumar, D. (2012). Effect of different packaging conditions on quality and shelf life of jaggery during storage. p. 27.

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Gupta, C., Esther Shekinah, D. and Sundara, B. (2011) Performance of sugarcane under

different planting techniques and drip fertigation. p. 203

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Yadav, R. L., Prakash, Om, Suman, A., Singh, S. N. and Prasad, S. R. (2011) Integrated management of urea N and FYM inoculated with *Gluconacetobacter diazotraphicus* for enhancing N use efficiency in sugarcane. p. 181.

Paper presented in National Symposium on Soil Health Improvement for Enhancing Crop Productivity held at Tamil Nadu Agricultural University, Coimbatore

Gupta, C. and Lal, P. (2011) Organic manures for sustained production of rice –wheat-cropping system. pp. 35-36.

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Paper presented in National Seminar on Indian Agriculture – Preparedness for Climate Change held at IARI, New Delhi during March 24-25, 2012

Rai, R.K., Singh, P., Shrivastava, A.K., Srivastava, A.K., Pathak, A.D., Chandra, A. and Solomon, S. (2012). Differential response of anti oxidative system to extended winter chill in sugarcane varieties during ripening phase in subtropical India.

Paper presented in the 34th All India Botanical Conference held at Lucknow University, Lucknow during October 10-12, 2011

Srivastava, S. (2011) Diploidization of *Saccharum* chromosomes and genomic stability in sugarcane. p. 42.

Paper presented in National Symposium on "Biodiversity and Food Security: Challenges & Devising Strategies" held at IIPR, Kanpur during December 10-11, 2011

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Singh, P. and Arya, N. (2012) Sugar and bioenergy production *via* lignocellulosic route. p. 109.

Paper presented in First National Seminar on Sustainable Sugarcane Initiative (SSI) held at TNAU, Coimbatore during August 24-25, 2011

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Folders

- CoLK 94184 (Birendra): A new IISR sugarcane variety
- Improving ratoon cane productivity by modulating rhizosphere
- A promising technique for multiplication of sugarcane seed
- Sugarbeet : A supplementary sugar crop for India
- Managementof redrot
- White grubs of sugarcane and their management
- Waste heat recovery system for jaggery furnaces
- Value-added jaggery with natural vitamin C
- IISR at a glance.

Technical Programme (2011-12)

Organization's technical programme at any point of time is an indicator of the level of its professional competence at national and international fora as well as its effectiveness in forward and backward linkages with its stakeholders. IISR has an inbuilt-mechanism to prioritise its research programmes.

The ongoing and newly initiated research projects reorganized under thematic areas/ core programmes are as under:

Breeding cane for abiotic tolerance and red rot resistance, suited to sub-tropical cane belt

- Development of sugarcane varieties for sub-tropics
- Development of waterlogging tolerant and red rot resistant sugarcane clones for North Central Zone
- Development of sugarcane varieties for moisture deficit environment
- Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions
- Development of sugarcane breeding stocks for high sugar
- Development of top borer tolerant genetic stocks of sugarcane
- Development of breeding stocks of sugarcane for durable resistance to red rot
- Genetic improvement of sugarcane through tissue culture
- Genetic transformation in sugarcane for resistance against borers
- Elucidation of the role of species chromosomal complement in sugarcane genotypes adapted to sub-tropical conditions
- Identification and expression analysis of resistance gene analogues against red rot disease in sugarcane
- Mapping of loci linked to sugar content in sugarcane
- Development of SSR markers for red rot resistance from EST database of sugarcane (DBT Project)
- Association mapping in sugarcane: DBT Project (Research Associate Programme)

Technology for high density cane farming through appropriate agronomy, precision machines and superior varieties

- Yield maximization through optimizing shoot population density
- Optimization of plant population for improving physiological efficiency of sugarcane
- Optimization and standardization of cane node technology for sugarcane planting
- Agronomic evaluation for higher plant population and cane yield
- Physio-biochemical studies concerning survival and establishment of bud chip under normal and encapsulated conditions
- Planting geometry in relation to mechanization in sugarcane.
- Development of a wide spaced paired row sugarcane cutter planter
- Evaluation and refinement of sett cutting mechanism of sugarcane planter
- Design and development of residue mulcher-cum-bio applicator

All India Coordinated Research Project on Farm Implements and Machinery- IISR Centre

- Manufacturing of prototypes for conducting field adoptability trials under varying agro-climatic and soil conditions
- Prototype feasibility testing of self propelled tangential axial flow (TAF) combine harvester
- Prototype feasibility testing of tractor operated three row rotary weeder

- Frontline demonstration (FLD) of IISR tractor operated ratoon management device (RMD)
- Frontline demonstration (FLD) of IISR Raised Bed Seeder (RBS)-cum-sugarcane planter
- Frontline demonstration (FLD) of IISR modified three row cane planter
- Frontline demonstration (FLD) of IISR tractor operated paired row sugarcane planter
- Management and control of weeds in sugarcane

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

- Development of plant growth promoting microbial consortia for rice-wheat-sugarcane cropping system
- Effect of sub-soiling on soil physico-chemical characteristics and sugarcane productivity
- Studies on rhizospheric environment of plant and ratoon crop of sugarcane
- Studies on soil-crop-weather data set for simulation of MOSICAS sugarcane growth model with reference to nitrogen nutrition
- Response of sugarcane crop to different plant nutrition in varied agro-ecological situation

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

- Developing efficient water application techniques in sugarcane
- Optimization of fertigation schedule in drip irrigated sugarcane under sub-tropical conditions
- Deep tillage under different moisture regimes and N levels for modifying rhizospheric environment and improving sugarcane yield in plant-ratoon system.
- Optimization of fertigation schedule for sugarcane through micro-irrigation technique
- Optimizing irregation schdule in sugarcane under different planting methods.
- Performance evaluation of Pusa Hydrogel in sugarcane

Improving production, quality and economic return of ratoon crop

- Effect of bio-manuring on sugarcane productivity and soil properties under plant and subsequent ratoons
- Improving juice quality and stubble bud sprouting under low tempeature of winter initiated ratoon
- Improving productivity and quality of ratoon cane through integration of organics, bioagents and inorganic fertilizers with special reference to potassium nutrition
- Improving productivity of winter initiated ratoon of sugarcane in sub-tropical India

Management of insect-pests and diseases in their "hot-spot" through survey, pathotyping, biocontrol and other innovative approaches

- Survey and surveillance of insect-pests and diseases of sugarcane in sub-tropical area
- Development of red rot in standing cane through sett-borne infection
- Evaluation/screening of sugarcane germplasm/genotypes against red rot and smut
- Improving efficacy of *Trichoderma* based red rot management system
- Mass multiplication of *Trichoderma* on cheaper substrate and development of suitable delivery system for disease management in sugarcane
- Monitoring of insect pest and bioagents in sugarcane agro-eco system
- Evaluation of varieties / genotypes for their reaction against major insect pests
- Bio-management of termites in sugarcane
- Bio-intensive management of white grubs in sugarcane
- Development of techniques for laboratory mass multiplication of top borer and its parasitoids
- Population dynamics of sugarcane borers through pheromone traps
- Semiochemicals for the management of sugarcane top borer.

Anticipatory and precautionary research on important insect pests and diseases of cane

- Pathotype formation in *Colletotrichum falcatum* in relation to breakdown of resistance in cane genotype
- Management of red rot through modulating host resistance

- Management of red rot through fungal endophyte in sugarcane
- Molecular characterization of red rot pathogen
- Mechanism of resistance against top borer in sugarcane
- Containment of insect–pests of sugarcane through habitat modifications

Basic and fundamental research on physiology, biochemistry and molecular approaches

- Modulating the expression of sucrose metabolizing enzymes for high sugar accumulation in sugarcane
- Molecular study to reveal transcriptomes and genes associated with sucrose (GAS) transport and accumulation in sugarcane
- Minimizing post harvest sucrose deterioration and its molecular assessment
- Physio-biochemical assessment of sugarcane for tolerance to waterlogging
- Developing a technology for preservation and packaging of sugarcane juice

Climate change impacts on cane farming

- Compilation, analysis and documentation of long-term weather database in relation to sugarcane crop culture
- ICAR Network Programme on climate change on assessment of impact of climate change on productivity and quality of sugarcane in sub-tropical India and opportunities of agronomic adaptation
- Impact of climate change on sugarcane Insect-pests dynamics and behaviour

Improving the native *Gur, Khandsari* and other forms of sugar and making it move in the value addition chain as new marketable products

- Refinement of 3-roller P.D. horizontal sugarcane crusher developed at IISR, Lucknow
- Design and development of a small capacity cane crushing unit for household purpose
- Storability assessment of value added jaggery prepared using *aonla* as a natural source of vitamin C.
- Development of a solar drier for jaggery drying
- Evaluation of jaggery furnaces (single, double and triple pan) for emission of green house gases and level of bagasse combustion
- Refinement of juice extraction process with special reference to sugarcane cleaning and juice filtration for 100 kg jaggery/8 hrs.
- Development/adoption of evaporator for sugarcane juice
- Development of power operated jaggery moulding machine
- Development /adoption of suitable mixer for production of value added jaggery using *aonla* as a natural source of Vitamin C
- Evaluation of shrink-wrap, stretch warp and modified atmosphere packaging for storage of jaggery cubes and blocks
- Identification of inhibitors in sugarcane biomass hydrolysates and their effect on ethanol yields.

Research and development activities on sugarbeet

- Developing sugarbeet varieties for Indian agro climates

Information, data compression, analysis and development of new evaluation procedures.

- Developing an efficient statistical design for conducting weed control experiments in sugarcane
- Development of decision support tools in sugarcane cultivation
- Estimation of optimum sample size for evaluation and prediction of cross-performance
- Geographic information system of sugarcane and sugar in India
- Development of data mining and presentation tools in sugarcane

Trade economic analysis on domestic price and area fluctuation

- Developing efficient sugarcane marketing strategies
- Expl. study: Analysis of Indian sugar export scenario
- Expl. study: Study of global factors responsible for sugar production and price fluctuations

Consultancy, Contract Research and Patents

Realising the need for revamping the Agricultural Research System in the wake of the liberalization and globalization of markets, the Indian Council of Agricultural Research (ICAR) has developed norms for generating a system of partnership, resource generation, training, consultancy, contract research, contract service and incentives and rewards so that the techniques, technologies and knowledge are generated and/or transferred and in the process entrepreneurship developed, visibility assured, goodwill generated and much needed incentive and reward system created. IISR has got reasonable infrastructure and expertise of international repute for imparting training, consultancy, and contract research and services.

Consultancy

A MoU has been signed between IISR and DSCL group of sugar industries for transfer of technology of bio-control of diseases and insect-pests in sugarcane crop in Hardoi and Lakhimpur Kheri districts of U.P.

Contract research projects

During the year, the following five contract research projects were undertaken :

Patents

A patent application entitled "Technology for priming sugarcane planting material, its packaging, transporation and certification" was filed on June 24, 2011 (Application Number : 1795/DEL/2011). The abstract of the application was published on July 29, 2011 in its official journal.

Title	Period	Principal Investigator	Amount (₹ in Lacs)	Firm/company
Evaluation of Sulfentrazone 4 F for control of weeds in sugarcane	03/10-02/12	R.S. Chauhan	5.00	FMC India Private Limited
Evaluation of regent 0.3G against early shoot borer and termites along with the yield and sugar recovery parameters in sugarcane	03/10-02/12	S.N. Sushil	5.00	Bayer Crop Science
Enhancing water and nutrient use efficiency through drip irrigation and fertigation in spring planted sugarcane under sub-tropical conditions	10/11-9/13	Rajendra Gupta	5.00	Jain Irrigation Ltd., Jalgaon
Economising nutritional need and reducing incidence of pests and diseases through fungbact kit in sugarcane cultivation	03/11-4/13	S.N. Singh	6.00	Pramukh Agri-clinic, Surat
Performance evaluation of Pusa Hydrogel of sugarcane	04/11-03/12	Ishwar Singh	1.00	National Research Development Coorporation

Monitoring and Evaluation

A comprehensive view of Institute annual performance is must which may be able to answer the vital questions like, what are institute's main objectives for the year, what actions are proposed to achieve these objectives, and how to determine progress made in implementing these actions? The organization's yearly activities need to be a link in the chain of long cherished goal/mission and vision of the organization in order to impart continuity in its approach. For this to achieve, a system to both evaluate & monitor is needed. Of late, the emphasis on the measurement of the performance has been laid with the philosophy that what gets measured gets done, helps in seeing and rewarding success, and in recognizing failures to correct them in time. ICAR has made an in-built mechanism in the Institute functioning to monitor and evaluate the yearly progress in the form of RAC, IRC, IMC, ITMC, IBSC *etc.*. The latest development is the introduction of RFD, and it is expected that with these developments, the research Institutes will be able to shift their focus from resource- allocation to result orientation.

Research Advisory Committee (RAC) Meeting

In accordance with the ICAR Office Order F. No. 4 (11)/07-IA.III dated March 11, 2011, the XVII meeting of newly constitutated RAC of Indian Institute of Sugarcane Research, Lucknow was held on June 16-17, 2011 under the chairmanship of Dr. S. Nagarajan. Drs. B.L. Jalali, Bachchan Singh, J. P. Mishra, V. P. Singh, N. Gopalakrishnan, R.L.Yadav and A.K. Sharma were other members of the RAC who participated in the meeting.

Dr. S. Nagarajan, in his opening remarks emphasized that there is a need to achieve global competitiveness in sugarcane germplasm collection as India cannot live in isolation. All best material available anywhere in the world should be made available to the premier Sugarcane Research Institutes of India (SBI and IISR) for enriching the germplasm of sugarcane. Quarantine facilities available at NBPGR, New Delhi should be utilized, if any pest related issues come in the way of the import of the germplasm. He also added that the country's two ICAR research institutions on sugarcane need to complement each other. Both the Institutes need to benefit from the strength of each other and address the national problem and the new challenges. There should be free and frequent exchange of ideas and materials between these two establishments. There is a need for a strong collaboration between these two institutes in some specified areas like development of multiple markers (Markers developed at SBI need to be validated at IISR and *vice versa)*. The Chairman highlighted that the heart of Institute research lies in its agronomical and agricultural engineering research. These research disciplines have the potential for providing solutions to the emerging challenges in sugarcane cultivation in the country by developing sustainable sugarcane production technology. He also added that the Agril. Engineering research in the institute needs to be made strong and competitive so that the suitable machines be developed and popularized to solve the emerging acute labour scarcity problems in sugarcane cultivation. The Chairman stressed upon the fact that the policy directives pertaining to the sugar sector of the country should come from the Sugarcane Research Institutes, and in order to address these issues, economics and statistics discipline need to be upgraded to a better level. Considering the importance of sugarcane as a source of energy and its use in ethanol and paper

industry, he also emphasized that there should be an observer/representative from sugar mills/ concerned industry so that their exact concerns could also find a place in the research agenda of the Institute. He also desired that there is a need to promote research on varietal development and value added production technology for *gur* and *khandsari* industry in the North India as there is considerable diversion of cane for *gur* and *khandsari*. There is a need to identify thematic areas for research and form groups across disciplines to work on these areas so that the challenge research could be taken up. The RAC made following recommendations to re-organize the research agenda of the Institute to meet the national needs and aspirations:

- In order to address the major challenges of sugar, distillation, energy, pulp and paper, *khandsari* etc., the institute experiments and trials should be aggregated in to 10 to 12 thrust programmes. Under each programme, there can be many projects to address complex issues. Each project shall be executed by way of an array of experiments/ trials / data analysis / HRD activity *etc.*
- There is a need to create infrastructural facilities for flood/cold tolerance within 2-3 years. Bihar and North UP faces periodically damage due to flood that reduces cane plant population per unit area, anaerobic conditions create abiotic stress and this must be examined as inter disciplinary project on a mission mode. Same way, cold chamber facilities are needed to screen and breed cane tolerant to "cold bite" that occurs each year in the NW Indian cane belt.
- Publish 2 or 3 success stories per year as outcome of the efforts of IISR, to show visibility and to give research audit the economic gain made due to research efforts.
- The new cane node pseudo-seed planting technology needs holistic research as it seems to be a path breaking approach.
- The Institute should file patent for its machine drawings and for the new cane node "Pseudo-seed planting system" within next three months.
- There should be an inter-institute research programme on "Sub-tropical cane germplasm usage to breed superior varieties (main crop and ratoon) with high sugar recovery, tolerance to cold, flood and red rot". Both IISR and SBI should pool their talent and material and address this more than what they are doing now.
- The following broad programme outlines were suggested, the first five as core programmes and the next six as extra core programmes:

1. Technology for high density cane farming through appropriate agronomy, precision machines and superior varieties
2. Improving production, quality and economic return of ratoon crop
3. Breeding cane for abiotic tolerance and red rot, suited to sub-tropical cane belt
4. Soil nutrition and health for higher tonnage and enhanced quality of the cane
5. Management of pests in their "hot-spot" through survey, pathotyping, biocontrol and other innovative approaches
6. Sustainable water usage through tillage, planting system, companion cropping and other profitable crop husbandry practices
7. Improving the native *Gur, Khandsari* and other forms of sugar and making it move in the value addition chain as new marketable products (interact with CFTRI)
8. Trade economic analysis on domestic price and area fluctuation
9. Basic and fundamental research on physiology and biochemistry and molecular approaches
10. Anticipatory and precautionary research on important insect pests and diseases of cane
11. Information, data compression, analysis and development of new evaluation procedures
12. Research and development activities on sugarbeet
13. Climate change impacts on cane farming
14. Other activities like AICRP on Sugarcane.

The RAC also made division-specific recommendations.

Institute Research Council (IRC) Meetings

To review and discuss the on-going research projects, two IRC meetings were held during the year. First meeting was held under the Chairmanship of Dr. R.L. Yadav, Director of the Institute during August 16-19, 2011. Research findings of 53 Institute on-going research projects were discussed.

The second meeting of IRC was held under the Chairmanship of Dr. S. Solomon, Director of the Institute during February 8–9, 2012 to take stock of the Institute's research agenda and discuss the concept notes for undertaking new research projects.

Dr. S. Solomon, the Chairman, IRC and Director, IISR, in his opening remarks, stressed the need to orient the sugarcane research programme to better satisfy the stakeholders. Chairman highlighted that as per new guidelines every scientist must devote at least 25% of his or her time in field experiments. Every scientist must aim on yearly basis to publish at least two research papers in the high impact journals. The Council has also issued directives that at least two novel technologies having patent protection must be developed from the Institute every year. Translating this into action would mean that each division must aim to develop at least one novel technology or success story in a year so that the Institute may be able to cater to the needs of the stakeholders on continuous basis. The Chairman highlighted that all extant, notified and newly identified varieties in AICRP workshop should be registered with PPV&FRA within two months of the identification of the variety in the Workshop of AICRP. He further stressed that the genetic resources which have a potential value must be registered at NBPGR. He asked the Member Secretary, IRC to read out to the members the particular points of the Proceedings of the meeting of RAC and Directors under the chairmanship of the Secretary, DARE and D.G., ICAR where it has been highlighted that "Public-Private Partnership may be strengthened for improving germplasm utilization".

The chairman also advocated for addressing the burning issues of the sugar industry *viz.*, low productivity, low seed replacement rate, effect of adverse climatic conditions and soil degradation on cane quality and productivity. Twenty three concept notes were presented for taking up new research projects.

In view of the current requirement of sugar industry and RAC recommendations, the Chairman suggested five high priority research programmes to address the problems of low cane/sugar productivity, dedining soil health, impact of climate change & weather aberration on sugarcane, deterioration of sugarcane varieties due to red rot and high cost of sugarcane harvesting. These programmes to be initiated with immediate effect, are as follows:

- Assessment of soil fertility status of sugar mill command areas of sub-tropical India (P.I.: Dr. T.K. Srivastava; Duration : March 2012-April 2014)
- Development of sugarcane harvester for small farms (PI : Er. P.R.Singh; Duration : March 2012- March 2015)
- Genome sequencing of red rot pathogen (PI: Dr. S.K. Duttamajumder; Duration : March 2012-2015)
- Impact of climate change on sugarcane Insect-pests dynamics and behaviour (PI : Dr. Arun K. Srivastava; Duration : March 2012 to March 2016)
- Use of reflective remote sensing for disease surveillance, nutritional disorder and yield prediction in sugarcane (PI: Dr. Rajesh Kumar; Duration: March 2012 to March 2015)

Institute Technology Management Committee

In accordance with the ICAR Guidelines for Intellectual Property Management and Technology Transfer/Commercialization, the Institute Technology Management Committee (ITMC) with the following members was reconstituted on

Institute Technology Management Committee Meeting February 6, 2012

January 17, 2012 to decide on all issues of IP management and technology transfer/ commercialization. A meeting of ITMC was held under the chairmanship of Dr. S. Solomon, Director, IISR, Lucknow on February 06, 2012.

The Member Secretary, ITMC also apprised the members about one patent application filed with the Patent Office, the database on MOUs signed with IISR and sent to ICAR, the ICAR approval of hike in testing fee of products to ₹ 2.5 lacs per year and the soil and water analysis service charges prescribed during the year 2011 –12.

Name, Designation & Address	Position
Dr. S. Solomon, Director, IISR, Lucknow	Chairman
Dr. Amaresh Chandra, HOD (Pl. Physiology & Biochemistry)	Member
Dr. T.K. Srivastava, HOD (Crop Production)	Member
Dr. P.K. Singh, Senior Scientist (Crop Improvement)	Member
Dr. Poonam J. Singh, Scientist (SS), NBFGR, Lucknow	Member
Dr. Shashi Rana, Officer-in-charge, Patent Cell, CST, Lucknow	Member
Dr. A.K. Sharma, Pr. Scientist & Officer I/c ITMU	Member Secy.
Sh. Ratnesh Kumar, Sr. Administrative Officer, IISR, Lucknow	Special Invitee
Sh. S. Kumar, Administrative Officer, IISR, Lucknow	Special Invitee
Sh. A.K. Srivastava, Finance & Accounts Officer, IISR, Lucknow	Special Invitee

Institutional Bio-safety Committee

The IBSC met on April 2, 2011 wherein on-going projects related to biotechnology and the need for biosafety measures in these projects was discussed.

Dr. S. Solomon	Chairman
Dr. Amaresh Chandra	Member
Dr. Sangeeta Srivastava	Member
Mrs. Nimisha Sharma	Member
Dr.S.C. Sethi	Member
Dr. Neelam S. Sangwan (CIMAP)	Member
Dr. M. Swapna	Member Sec.

Institute Management Committee Meeting

The 33rd meeting of the Institute Management Committee (IMC) was held on February 10, 2012 under the chairmanship of Dr. S. Solomon at IISR, Lucknow.

Name, Designation & Address	Position
Dr. S. Solomon, Director, IISR	Chairman
Sh. S.P. Singh, Additional Cane Commissioner, Govt. of U.P.	Member
Sh. S.K. Pankaj, Jt. Director, Cane Commissioner, Bihar	Member
Sh. Dattatrya Bharane	Member
Dr. O.K. Sinha, PC(S)	Member
Dr. S.K. Duttamajumdar, HOD, Crop Protection, IISR	Member
Dr. (Smt.) Sangeeta Srivastava, PS (Crop Improvement), IISR	Member
Sh. Ratnesh Kumar, SAO	Memb. Sec.

Institute Joint Staff Council (IJSC)

The IJSC with the following composition met on May 30, 2011 and discussed matters pertaining to staff welfare.

Dr. R.L. Yadav, Director, IISR - Chairman	
Members Elected	**Members Nominated**
Sh. Someshwar Mishra, T-5	Dr. S.N.Sushil, Sr. Scientist (Entomology)
Sh. Niranjan Lal, T-5	Sh. Ratnesh Kumar, SAO
Sh. Anand Mohan Srivastava, Asstt.	Sh. S. Kumar, AF&AO
Sh. Raj Kumar Yadav, Asstt.	Sh. P.K. Srivastava, Asstt.
Sh. Shiv Kumar Soni, SS Grade-II	Sh. Inder Singh, SS Grade-I
Sh. Rajender Kumar, SS Grade-I (Member Secy.)	Dr. G.K. Singh, T-7-8, Member Secretary

Result Framework Document

As per ICAR guidelines, the Institute submitted its RFD targets and progress report for the period January 2011 to March 2011 to ICAR in time. The Institute also submitted the RFD targets for the year 2011-12 on March 31, 2011 after thorough discussion at the Institute level. The Strategic Plan (2011-16) and the Citizen Charter (2011-12) have also been prepared and submitted to ICAR.


RFD Strategic Plan Citizen Charter

Human Resource Development

The effective performance of an organization depends not just on the available resources, but its quality and competence as required by the organization from time to time which in turn depends on the level of quality and utilization value of human resources. The term human resources refers to the knowledge, skills, creative abilities, talents, aptitude, values and beliefs of an organizational work force. The more important aspects of human resources are aptitude, values, attitudes and beliefs. IISR is also following positive personnel policies like career advancement schemes, encouraging higher education, sponsoring its employees to attend different seminars/symposia/workshops/meetings/trainings to strengthen HRD activities.

Human Resource Development activity in the Institute is carried out by encouraging the scientists as well as other staff members to undertake higher studies, participate in seminars, conferences, symposia, trainings *etc*. The scientists were also encouraged to undertake subject specific trainings according to their area of research work. Scientists were also encouraged as resource persons/instructors for providing trainings to the extension personnel from sugar factories. The events like review meetings, workshops, brainstorming sessions, and national seminars were also organized in the Institute to help the scientists in developing better communication skills and also in focusing their research efforts in the priority areas.

Conference/Seminar/Workshop/Training attended

A) Participation of Dr. S. Solomon and Dr. R.L. Yadav, Director

- Dr. S. Solomon attended Director's Conference at NASC Complex, New Delhi, on February 17-18, 2012 and visited command area of Gwalior Sugar Co. Dabra at Dabra Sugar Mills, Gwalior, on February 25-26, 2012.
- Dr. R.L. Yadav attended Personality Test Board for Civil Services Exam. 2010 of UPSC as Advisor at UPSC, New Delhi on April 18-23, 2011; Meeting of Directors & Project Coordinators of Crops Division in ICAR at New Delhi on May 12-14, 2011; Foundation Day celebrations of NAAS at New Delhi on June 4-6, 2011; Director's Conference, Annual Day Function of ICAR and Award Ceremony at NASC Complex, New Delhi on July 15-16, 2011; Indo-Brazilian Bioenergy Workshop at CMSRI, Bhavnagar on August 1-2, 2011; Executive Committee Meetings of Sugar Technologists Association of India at New Delhi, on June 4-6, 2011 and August 7-8, 2011.

B) Group participation of the scientists

- Drs. R.L. Yadav, S.K. Duttamajumder, Amaresh Chandra, T.K. Srivastava, K.P. Singh and A.K. Singh attended National Seminar on Fly Ash based Amendments for Amelioration of Degraded Soils to Increase Crop Production in the Gangetic Plains at CSSRI Regional Station, Lucknow on May 7-8, 2011.
- Drs. T.K. Srivastava, J. Singh, P.K. Singh, D.K. Pandey and S. Kumar attended National Conference on 'Forest Biodiversity: Earth's Living Treasure' at UP Forest Department, Lucknow on May 22, 2011.
- Drs. T.K. Srivastava, A.K. Sharma, J. Singh and R.K. Singh attended Seminar on Role of IPR in Business Perspectives at CST, Lucknow on May 23, 2011.
- All IISR Scientists attended National Consultation on Sugarbeet as a Supplementary Sugar Crop in India at IISR, Lucknow on June 1, 2011.
- Drs. S.N. Singh, Kamta Prasad and Deeksha Joshi attended Summer School on "Adaptive Production Technologies for Sugarbeet Cultivation in India" at IISR, Lucknow on June 1-21, 2011.

- Drs. Raman Kapur, S.K. Duttamajumder, Amaresh Chandra, T.K. Srivastava and Devendra Kumar attended Meeting cum Workshop on Towards More Effective Role of Heads of Divisions and Regional Stations in ICAR Institutes at CIAE, Bhopal on June 14-15, 2011.
- Drs. R.L. Yadav, O.K. Sinha, T.K. Srivastava, A.D. Pathak, J. Singh, Rajesh Kumar, S.K. Shukla, G.M. Tripathi, Ram Ji Lal, S.N. Singh, A.K. Singh, P.K. Singh, M.R. Singh, Sanjeev Kumar, Ishwar Singh and Chandra Gupta attended Group Meeting of All India Coordinated Research Project on Sugarcane at OUAT, Bhubaneswar on October 17-19, 2011.
- Drs. S. Solomon, Amaresh Chandra, A.K. Shrivastava, Raman Kapur, Sangeeta Srivastava, Radha Jain and Priyanka Singh attended 4th IAPSIT International Sugar Conference & Expo (IS-2011) on Balancing Sugar and Energy production in Developing Countries : Sustainable Technologies and Marketing Strategies at New Delhi on November 21-25, 2011.
- Drs. P.R. Singh, Jaswant Singh, R.K. Pangasa, A.K. Singh, R.D. Singh and S.I. Anwar attended 4th QRT Meeting of AICRP on PHT at IISR, Lucknow on December 22-23, 2011.
- Drs. P.R. Singh, Jaswant Singh, R.K. Pangasa, A.K. Singh, R.D. Singh and S.I. Anwar attended 5th QRT Meeting of AICRP on FIM at IISR, Lucknow on December 26-29, 2011.
- Drs. O.K. Sinha, Rajesh Kumar, Ram Ji Lal and Sanjeev Kumar attended Sugarcane Breeders and Pathologists Meet and Zonal Breeders Meet at SBI, Coimbatore on January 23-24, 2012.
- Drs. Amaresh Chandra, R.K. Singh and Radha Jain attended International Conference on Plant Biotechnology for Food Security: New Frontiers at NASC Complex, New Delhi on February 21-24, 2012.
- Drs. Jaswant Singh, A.K. Singh, R.D. Singh and S.I. Anwar attended 46th Annual Convention of ISAE and International Symposium on Grain Storage at GBPUA&T, Pantnagar on February 27-29, 2012.
- Drs. Ram Ji Lal and S.N. Sushil attended Survey of Command Area for Prevalence of Diseases and Insect Pests at Command areas of Gwalior Sugar Co. Ltd, Dabra (MP) on March 4-6, 2012.
- Drs. S. Solomon, A. Chandra, S.K. Duttamajumder, T.K. Srivastava, A.D. Pathak, K.P. Singh, Pushpa Singh and R.K. Rai attended National Seminar on Management of Salt affected soil and water : Challenges of 21st Century at CSSRI Regional Station, Lucknow on March 16-17, 2012.
- Drs. S.N. Sushil and D.C. Rajak attended Survey of Insect Pest Incidence at Command Areas of Triveni Sugar Mills, Deoband, Saharanpur on March 27-29, 2012.
- Drs. S.K. Duttamajumder and S.N. Sushil attended National Meeting on Agricultural Entomology for the 21st Century: The Way Forward" at NBAII, Bangalore on August 24-25, 2011 and monitored IISR Bio-control Centre, Pravarnagar Activities at IISR Bio-control Centre, Pravarnagar on August 28, 2011.
- Drs. P.R. Singh and Akhilesh Kumar Singh visited Demonstration of Cane Harvesters at TNAU, Coimbatore & Sathy, Tamil Nadu on February 18-20, 2012.

C) Individual participation of the scientists in Seminars/ Conferences/ Training

Crop Production

- Dr. T.K. Srivastava attended FAI-IISR Agro-retailers Training on Balanced and Efficient Fertilizer Use at IISR, Lucknow on June 30, 2011; Interaction Meeting on the Administrative, Financial and Technical Issues in Respect of KVKs organized by ICAR at NASC Complex, New Delhi on December 14, 2011; Stakeholders meeting of CISH at CISH, Lucknow on December 19, 2011 and Capacity Buildings Programme on International Trade Towards Enhancement of Competitiveness of Indian Agriculture at Indian Institute of Foreign Trade, New Delhi on January 9-13, 2012.

- Dr. Hema Pandey attended National Consultation on Gender Perspective at NASC Complex, Pusa, New Delhi on August 8-9, 2011.
- Dr. S.N. Singh attended Stakeholders Meeting for Finalization of the Network Programme on the Utilization of Solid Organic Waste at NASC Complex, Pusa, New Delhi on October 12-13, 2011.
- Dr. S.K. Shukla attended Seminar on Balanced Fertilization and Importance of K in Increasing Productivity at CSAUA&T, Kanpur on November 4, 2011; National Seminar on New Vistas of R & D in Agri. & Allied Sectors at NDUA&T, Faizabad on November 19, 2011 and gave a presentation of Research Project Proposal on Carbon Sequestration Potential of Sugarcane based Cropping System for Sustaining Soil Health and Crop Productivity in U.P. at Department of Biotechnology, Govt. of India, New Delhi on February 28, 2012.
- Dr. A.K. Singh attended 2nd International Conference on Agro Chemicals Protecting Crops Health and Natural Environment (ACPHNE) : Role of Chemistry for Sustainable Agriculture at New Delhi on February 15-18, 2012 and Training Programme on "Assessment of Quality and Resilience of Soil" at IISS, Bhopal on January 9-13, 2012.
- Dr. A.K. Sah attended Regional Workshop on Agri-Services for Inclusive Rural Growth at Hotel Clarks Avadh, Lucknow on June 21, 2011.
- Ms. V. Visha Kumari attended Professional Attachment Training as a Part of Revised FOCARS Training on January 23-April 24, 2012 and training on Sensor Based Application for Enhancing Input Use Efficiency by Wireless Irrigation and Fertigation Control on February 14-27, 2012 at Water Technology Centre, IARI, New Delhi.

Crop Improvement

- Dr. A.D. Pathak attended Workshop on 'Sugarcane Development Programme in Bihar' at BAMETI, Patna on November 15, 2011; National Seminar on "Management of Salt Affected Soils and Waters : Challenges of 21st Century at CSSRI Regional Research Station, Lucknow on March 16-17, 2012; Pollination Control and Observation on Flowering at IVRI, Bareilly & IVRI Campus, Mukteshwar on May 3-5, 2011 and participated in discussion on Exploring Potential of Sugarbeet in Uttarakhand with Sugar and Agriculture Department at Sugar Department, Uttarakhand, Dehradun on September 20, 2011.
- Dr. J. Singh attended 4th Meeting of the "Task Force for Special Test" at NASC Complex, New Delhi on February 13, 2012.
- Dr. R.K. Singh attended National Training on Bioinformatics in Multi-omics Era: A Microbial Genomics Perspectives at NBAIM, Mau on February 23-March 3, 2012.
- Dr. Sangeeta Srivastava attended Consultation of Biotechnology Research in India at NASC Complex, New Delhi on July 26-27, 2011; 34th Indian Botanical Society Conference at Lucknow University, Lucknow on October 10-12, 2011 and DST Sponsored Programme on "Project Management : Methodology and Evaluation for Women Scientists" at Academic Staff College of India, Hyderabad on January 2-6, 2012.
- Dr. P.K. Singh attended Review Meeting of Mega Seed Project at IARI, New Delhi on September 19-20, 2011 and Meeting of the Selection Committee for "Plant Genome Saviour Community Award-2010-11 at PPV & FRA, New Delhi on December 27, 2011.
- Dr. M. Swapna attended Training on "Computational Tools for Genome Resource Data Analysis in Fisheries Domain" under NAIP Funded NABGR at NBFGR, Lucknow on October 12-22, 2011; Development of DNA Chip for Microbial Identification using DNA Probes at NBAIM, Mau on January 28-February 10, 2012 and "Allele Mining in Natural Genetic Resources for Target Trait Improvement and Their Conservation" at NBFGR, Lucknow on February 25-March 9, 2012.

Crop Protection

- Dr. Sunita Lal attended Training Programme on "Harnessing Leadership among Women"

at Indian Institute of Public Administration, New Delhi, on February 20-24, 2012 and Review Meeting of Outreach Programme at IIHR, Bangalore on March 3-4, 2012.

- Dr. Arun Baitha attended QRT Meeting on Biological Control of Crop Pests and Weeds at IARI, New Delhi on March 16, 2012.
- Dr. Nithya, K. attended Professional Attachment Training as a Part of Revised FOCARS Training at NRCPB, IARI, New Delhi on January 23-April 24, 2012.

Plant Physiology & Biochemistry

- Dr. Amaresh Chandra attended Annual Day Celebration of NAAS at NASC Complex, New Delhi on June 5-6, 2011; Institute Management Committee Meeting at IGFRI, Jhansi on July 26, 2011 and March 6, 2012; Brain storming session of "Prioritization of Plant Physiology and Biochemistry Research for 12th Five Year Plan" at IARI, New Delhi on August 5-6, 2011; RAC Meeting at UPCSR, Shahjahanpur on January 17-18, 2012; Meeting Regarding ISO 2012 at Krishi Bhawan, New Delhi on February 23, 2012 and GM Foods and Safety Workshop at Biotech Park, Lucknow on March 16, 2012.
- Dr. Ashok Kumar Shrivastava attended Brain Storming Session on "Prioritization of Plant Physiology and Biochemistry Research for 12th Five Year Plan" at IARI, New Delhi on August 5, 2011 and Workshop on "Scientific Report Writing and Presentation" at NAARM, Hyderabad on March 19-22, 2012.
- Dr. Pushpa Singh attended Indo-Brazil Workshop on Bioenergy at CSMCRI, Bhavnagar on August 1-2, 2011.
- Sh. Raman Banerji attended Training programme on Creative Writing in Agriculture at Indian Institute of Mass Communication, New Delhi, on March 12-16, 2012.
- Dr. Radha Jain attended First International Seminar on Sustainable Sugarcane Initiative (SSI) at Sugarcane Breeding Institute, Coimbatore on August 24-25, 2011.

Agricultural Engineering

- Dr. P.R. Singh attended Workshop on Stress Management at Hotel Taj, Lucknow on April 28, 2011; Coordination Committee Meeting of AICRP on Farm Implements and Machinery at IASRI, New Delhi on July 23, 2011; 2nd International Exhibition and Conference on Agricultural Machinery and Equipment at IARI, New Delhi on December 8-10, 2011 and Workshop on Stress Management at NAARM, Hyderabad on February 14-16, 2012.
- Dr. Jaswant Singh attended CCM of the AICRP on PHT at CIPHET, Ludhiana on August 18-20, 2011; Brain-storming Meeting for Formulation of Platform on "Secondary Agriculture" at IASRI, New Delhi on November 18, 2011; National Conference on Appropriate Technologies for Indian Food Processing Industries at UAS, Bangalore on March 5-6, 2012.
- Dr. Akhilesh Kumar Singh attended Coordination Committee Meeting of AICRP on Farm Implements and Machinery at IASRI, New Delhi on July 23, 2011 and Interaction Meet of Scientists of Farm Machinery & Power and Mechanical Engineering Discipline of ICAR Institutes at CIAE, Bhopal on March 16-18, 2012.
- Dr. Rajendra Gupta attended Sensor Based Application for Enhancing Input Use Efficiency by Wireless Irrigation and Fertigation Control at Water Technology Centre, IARI, New Delhi on February 14-27, 2012.

Agricultural Knowledge Management Unit

- Dr. P.K. Bajpai attended Workshop cum Software Installation Training Programme "Strengthening Statistical Computing for NARS" at IASRI, New Delhi on November 3, 2011.

Agrometerology

- Shri Arun K. Srivastava attended National Stakeholders Consultation on Climate Change at CRIDA, Hyderabad on July 20, 2011; QRT Review Meeting of NPCC Programme at BAU, Ranchi on July 29-30, 2011; Annual Review Meeting on FASAL on Assessment of *Kharif* 2011 and Planning for *Rabi* 2011-12 at BHU, Varansai on March 1-2, 2012 and Final Workshop of NPCC at NASC Complex, New Delhi on March 22-23, 2012.

RCM

- Dr. Ashwani Kumar Sharma attended Seminar on Role of IPR in Business Perspectives at CST, Lucknow, on May 23, 2011; Training on Data Analysis of Natural Resource Management Research using SAS at IASRI, New Delhi on June 20 – 25, 2011; Sugarcane Price Fixation Meeting under the chairmanship of the Chairman, CACP at Krishi Bhawan, New Delhi on July 19, 2011; Meeting of Sugarcane Price Fixation Committee under chairmanship of Cane Commissioner at U.P. *Ganna Kisan Sansthan*, Lucknow on September 30, 2011; Fixation of SAP in UP state for cane crushing period 2011-12 under the chairmanship of the Chief Secretary, Govt. of U.P. at Yojana Bhawan, Lucknow on October 10, 2011; Seminar on Role of Science & Technology in Development of State at Council of Science & Technology, U.P., Lucknow on February 27, 2012; RFD Meeting of Crop Science Division at Krishi Bhawan, New Delhi on February 21, 2012 and HYPM Workshop at IASRI, New Delhi on March 3, 2012.

AICRP on Sugarcane

- Dr. O.K. Sinha attended Meeting of Directors & Project Coordinators at NASC, New Delhi on May 12, 2011; Meeting of Project Coordinators at CIAE, Bhopal on June 16, 2011; Interactive Meeting of the Project Coordinators at Krishi Bhawan, New Delhi, on June 23, 2011; 2nd Special Meeting of Vice Chancellors and Project Coordinators at NASC Complex, New Delhi on September 26-27, 2011; Group Meeting of AICRP on Sugarcane at OUAT, Bhubaneswar on October 17-19, 2011; National Workshop on "Best Management Practices for Sustainable Quality Sugarcane Production" at Yashada, Pune on January 12, 2012; Sugarcane Breeders & Pathologists Meeting & Zonal Breeders Meet of AICRP at SBI, Coimbatore on January 23 - 24, 2012 and Annual Breeder Seed Review Meeting at NASC Complex, New Delhi on March 29, 2012.
- Dr. Chandra Gupta attended National Symposium on Balanced Fertilizer to Sustainable Soil Health, Crop Production and Food Security at GBPUA&T, Pantnagar on November 25-26, 2011.

D) Individual participation of the technical officers in Seminars/ Conferences

- Dr. J.K.S. Gautam and Sh. Adil Zubair attended Group Meeting of All India Coordinated Research Project on Sugarcane at OUAT, Bhubaneswar on October 17-19, 2011.
- Sh. Brahm Prakash attended Executive Committee Meeting of Indian Society of Pulses Research and Development at IIPR, Kanpur on April 2, 2011; General Body Meeting of Indian Society of Pulses Research and Development at PAU, Ludhiana on May 11, 2011; Seminar on Role of IPR in Business Perspectives at CST, Lucknow on May 23, 2011; Meeting of Sugarcane Price Fixation Committee at U.P. *Ganna Kisan Sansthan*, Lucknow on September 30, 2011; Meeting of Sugarcane Price Fixation Committee at Yojana Bhawan, Lucknow on October 10, 2011; 25th Annual Conference of the Indian Society of Agricultural Marketing at NAARM, Hyderabad on November 22-24, 2011 and Seminar on Role of Science & Technology in Development of State at CST, Lucknow on February 27, 2012.
- Dr. M.R. Verma and Sh. Ghanshyam Ram attended Training in Web Agris Software and Database Input Preparation for Agris Database of FAO at IASRI, New ARIC, DKMA, KABI, New Delhi on February 8-10, 2012.
- Sh. Jasbeer Singh and Sh. R.S. Vishwakarma attended 2nd International Exhibitiion and Conference on Agricultural Machinery and Equipment at IARI, New Delhi on December 8-10, 2011.
- Dr. Ram Kishore attended Model Training Course on "Management of Salt Affected Soils and Poor Quality Water for Sustainability and Livelihood at CSSRI, Karnal on January 5-12, 2012.
- Smt. Mithlesh Tewari attended Summer School on "Adaptive Production Technologies for Sugarbeet Cultivation in India at IISR, Lucknow on June 1-21, 2011.

Workshops, Seminars and Symposia Organized

Seminars are basically arranged to discuss current issues and problems or to share ideas. A seminar is a small group discussion in a formal setting with dear agenda. In a seminar, a speaker present a theme or a set of papers and it is discussed by all those who participate. Symposia can be organized by a group of researchers/teachers in a resourceful institution to focus on important issues that are related for the professional growth of other researchers at initial stages. The messages, issues, problems to be discussed need to be systematically outlined for worthwhile discussions and for arriving at some meaningful conclusions. It comprises experts in a field which could be drawn from different fields focusing the theme. The presentation could be in the form of a research paper, a review, or a model to visualize professional problems and issues in a given context. Workshops are generally organized by an institution or association in order to develop certain instructional materials, book, resources material, supportive material, work book *etc.*, or to develop certain skills of teachers/researchers. Researchers could be trained in certain new laboratory skills. A workshop comprises a small, selected group of teachers or experts drawn from actual working situations or related experts who theories on the activities. IISR, a premier research institution in India, play a pivotal role by organizing seminars, symposia and workshops on important aspects of sugarcane research and development.

National Consultation on "Sugarbeet as a supplementary sugar crop in India"

The National Consultation on "Sugarbeet as a supplementary sugar crop in India" sponsored by the Directorate of Sugarcane Development, Government of India Lucknow, was organized at Indian Institute of Sugarcane Research, Lucknow on June 01, 2011. The meeting was attended by researchers, development workers, representatives from seed industries, processing industries and officers from Government of India and UP Government. The inaugural session was chaired by Shri. Shivajirao Deshmukh, IAS (Retd.), Director General, Vasantdada Sugar Institute, Pune. The inaugural address was delivered by the Chief Guest, Dr. Gurbachan Singh, Agriculture Commissioner, Government of India, New Delhi. In this session, the Guest of Honour, Dr. A.N. Mukhopadhyay, Former Vice Chancellor, AAU highlighted the importance of this crop in India. Dr. R.B. Deshmukh, Director, VSI gave brief account of sugarbeet research and development activities in Maharashtra. Shri R.P. Bhagaria, Chief Director (Sugar), Directorate of Sugar, Ministry of Consumer Affairs, Government of India highlighted activities of the Government in promotion of sugar industries and sugarcane. The chairman stressed the need of

sustainable policy for sugarbeet in XII five year plan, identification of areas for sugarbeet growing and implementation of programmes. The technical session was chaired by Dr. Gurbachan Singh, Agriculture Commissioner, Government of India, New Delhi and co-chaired by Dr. R.L. Yadav, Director, Indian Institute of Sugarcane Research, Lucknow and Dr. A.D. Pathak, Principal Scientist, IISR, Lucknow was rapporteur of the session.

The following status papers were presented:

- Status paper on agrotechniques by Dr. Raman Kapur, IISR, Lucknow
- Status paper on processing by Prof. S.K. Mitra, NSI, Kanpur
- Seed scenerio by Mr. Mohan Bajikar, SES Vanderhave,
- Sugarbeet for diverse end-use by Dr. D.K. Rana, JK Agri-Genetics Ltd., Hyderabad

The representatives of Indian Sugar Mill Association and National Federation of Cooperative Sugar Factories gave their views. After detailed discussion, the following recommendations emerged:

1. A study may be commissioned to work out techno-economic feasibility of sugarbeet cultivation in India, which should clearly bring out :
   a. What are the industrial hiccups?
   b. What are the areas where sugarbeet can be grown in the country?
   c. Relationship between farmers and industries
   d. Seed production modalities
   e. Incentives required by the industry and the farmers to promote sugarbeet cultivation in India
   f. Whether sugarbeet be processed separately or with cane
   g. For this study, budgetary allocation be made.
2. The encouraging results obtained so for by various organizations in the country may be upscaled.
3. NSI as well as VSI should develop a process of mixing beet and cane juice for efficient processing.

ICAR sponsored Summer School on "Adaptive production technologies for sugarbeet under Indian conditions"

ICAR sponsored Summer School on "Adaptive production technologies for sugarbeet under Indian conditions" was organized at Indian Institute of Sugarcane Research, Lucknow during June 1-21, 2011 by Dr. Raman Kapur as Course Director and Dr. A.D. Pathak as Course Coordinator. Twenty two participants belonging to eleven desciplines of agriculture from three states attended the summer school. In addition to lectures from Institute scientists, guests speakers from VSI, Pune; Sriganganagar; multinational seed companies including Dr. Muzzaffar Adiyaman

from Turkey delivered the lecture on "International experiences". A trip to Sugarbeet Breeding Outpost, Mukteswar was also organized for orientation to sugarbeet breeding and seed production.

Institute's foundation day

India Institute of Sugarcane Research (IISR) celebrated its foundations day on February 16, 2012. Foundation day marks the successful journey of 60th glorious years of sugarcane research, since the establishment of the Institute in the year 1952. At the occasion, IISR begins the year long celebration

as the Year of Excellence- 2012.

The programme of many colours including lecture on healthy human life, *hasya vyanga kavi sammelan*, highlights of IISR technologies, honour toretired scientists and prize distribution was held. Dr. V.P. Agnihotri, Ex. Director, IISR was the chief guest at the occasion who honoured the retired scientists of IISR. Dr. S. Solomon, Director, IISR delivered welcome address and highlighted the Institute's achievements during last 60 years. Dr. Solomon said that the large scale adoption of IISR technologies *viz.*, improved cane variety (CoLk 94184), three tier seed production technique, STP and ring pit methods of planting, intercropping with sugarcane, bio-intensive management of top borer and red rot, sugarcane machines, sugarbeet cultivation techniques, training module for cane managers *etc.*, not only doubled the sugarcane yield but also made the country self sufficient in sugar production. At the same time, Dr. Solomon also reminded the commitment of IISR to address the emerging challenges in sugarcane and sugar sector. To address these issues, IISR decided to celebrate the year 2012 as the Year of Excellence. During year long celebration, many activities will be organized to strengthen the research, development and management in sugarcane and sugar sector of the country.

At the occasion, a *hasya vyanga kavi sammelan* was organized in which eminent *kavis* electrified the audience with their humorous presentations.

Group Meeting of AICRP on Sugarcane held at the Orissa University of Agriculture & Technology, Bhubaneswar

The Group Meeting of All India Coordinated Research Project on Sugarcane was held from 17th to 19th October, 2011 at the Orissa University of Agriculture & Technology, Bhubaneswar. On 17th October, 2011, the concurrent technical sessions of Crop Improvement, Crop Production, Pathology and Entomology were held. The annual progress was reviewed and technical programme for 2012-13 was finalized. On 18th October, 2011, the opening session was held under the chairmanship of Prof. D. P. Ray, Hon'ble Vice-Chancellor, OUAT. Sri R.L. Jamuda, Commissioner cum Principal Secretary, Agriculture Department, Government of Orissa was the Chief Guest. Dr. N. Gopalakrishnan, ADG (CC), ICAR, Dr. R.L. Yadav, Director, IISR, Lucknow, Dr. N. Vijayan Nair, Director, SBI, Coimbatore and Dr. S. S. Nanda, Dean of Research & Director, Extension Education, OUAT, Bhubaneswar graced the occasion. About 150 delegates from AICRP centres, officials from sugar industry and state agriculture departments were present. Dr. S.S. Nanda, Dean of Research welcomed the participants and highlighted the research contributions of the Sugarcane Research Station, Nayagarh under OUAT, Bhubaneswar. He briefly narrated thirty years of sugarcane research in Orissa and demand for improved technologies in the State. Dr. O.K. Sinha, Project Coordinator (Sugarcane) presented the Coordinator's Report for the year 2010-11. Shri R. L. Jamuda, IAS, Principal Secretary (Agriculture), Govt. of Orissa highlighted the constraints in sugarcane production in the Orissa State and the initiatives taken by the Government to overcome the problems of the farmers as well as the sugar factories. He stressed upon collective effort by OUAT and the State Department of Agriculture for production and distribution of quality planting material of sugarcane through three-tier seed production system by utilizing opportunities available at the Govt. farms, research station farms and sugar factories' captive seed nurseries. The production capacity of the existing tissue culture laboratories in the private, public sector undertakings and agricultural university should be fully explored to produce disease-free seed material of new varieties so that the area under high yielding and high sucrose varieties could be quickly occupied.

Dr. N. Gopalakrishnan, ADG (CC), ICAR highlighted the initiatives of ICAR on sugarcane research. He stressed upon developing low cost technology for waterlogging and salinity tolerance as well as mitigating effects of climate change on cane productivity. He urged for increasing cane productivity, adoption of new varieties and other technologies by the farmers. He laid emphasis on efficient use of water and mechanizing cane cultivation to reduce the cost of cultivation of sugarcane in order to address the problems of global competition. Dr. R. L. Yadav, Director, IISR highlighted on the new technologies like cane node technology for breaking yield barrier in cane production. Dr. N. Vijayan Nair, Director, SBI, Coimbatore mentioned that the decline in soil productivity, alteration in physico-chemical and biological properties of soil and adress effects of climate change on cane productivity are the major bottlenecks in increasing cane productivity through varieties.

In the presidential remarks, Prof. D.P. Ray, Hon'ble Vice-Chancellor, OUAT, Bhubaneswar

called for the adoption of new production technologies like Sustainable Sugarcane Initiatives (SSI) and tissue culture to enhance the cane production in the State. He expressed his happiness over the release of two new varieties of sugarcane, Sabita and Neelamadhab developed by SRS, Nayagarh (OUAT). He wished for the success of the Group Meeting.

In the end, Dr. P. K. Das, HOD, Plant Breeding & Genetics, OUAT proposed the vote of thanks.

Technologies developed and recommended

- Five sugarcane varieties, *viz.*, CoPK 05191 and Co 05011 for North West Zone; CoSnk 05103 and CoSnk 05104 for Peninsular Zone; and CoA 05323 for East Coast Zone were identified for release.
- For improving bud sprouting and cane yield in winter initiated ratoon, application of fresh sulphitation press mud cake (SPMC) @ 20 t/ha at ratooning or fresh SPMC + 25 kg $ZnSO_4$/ha has been found most effective.
- Sub-soiling as well as cross sub-soiling at 1.0 m was found effective in enhancing cane yield and sustaining soil health.
- Sugarcane dones moderately resistant to red rot, smut and wilt were identified.
- For management of whitefly (*Aleurolobus barodensis*) in sugarcane agro-ecosystem, removal of lower leaves followed by foliar application of imidacloprid (0.005%) + 2% urea proved effective.

Zonal Breeders Meet of AICRP on Sugarcane

Zonal Breeders Meet for all the zones of AICRP on Sugarcane was organized at the Sugarcane Breeding Institute, Coimbatore on 24th January, 2012. Breeders and Pathologists of AICRP centres participated in the meeting. Dr. O.K. Sinha, Project Coordinator (Sugarcane) welcomed the participants and briefed the agenda of the meeting. The meeting was chaired by Dr. N. Vijayan Nair, Director, Sugarcane Breeding Institute and Principal Invesigator (Crop Improvement). Dr. Nair stressed on the importance of estimating pol% cane which represents sugar recovery and urged all the breeders to report this parameter. Dr. Nair reviewed the crossing programme at National Hybridization Garden and Distance Hybridization Facility. He laid emphasis on identifying proven crosses for including in zonal crosses. In the technical session, discussion was held on promoting IVT entries to AVT based on red rot rating, sucrose (%) juice and field stand of the crop. Entries of AVT of all the zones were finalized. In addition, new zonal crosses were identified. The meeting ended with concluding remarks by Dr. Nair and thanks to the chair and the participants.

Independence Day

Independence Day was celebrated on August 15, 2011 with the presence of all scientists, officers and the staff members. Flag hoisting ceremony, an address by Dr. R.L. Yadav, the Director of the Institute and a unity walk were the hallmarks of the day. Dr. R.L. Yadav, emphasized to take inspiration on this eve to carry out duties with devotion from the great sons and the leaders of India. The sweets were also distributed to mark the occasion by the Staff Recreation Club, IISR, Lucknow.

Republic Day

Republic Day was celebrated on January 26, 2012. All the scientists, officers and staff members participated in an event organized in front of the main Institute building. Dr. S. Solomon, Director of the Institute addressed the participants to mark the occasion. A tug of war was also organized on the occasion. On this occasion, the winners of IISR logo competitions were also awarded. The sweets were

also distributed to mark the occasion by the Staff Recreation Club, IISR, Lucknow.

Vigilance Awareness Week

IISR organized Vigilance Awareness Week of the year 2011 from October 31st to Novemver 5, 2011. A pledge was administered to all the staff of the Institute.

National SugarFest 2012

The Institute organized National SugarFest 2012 on March 23-24, 2012 in order to bring all the stakeholders of sugarcane research under one umbrella. Number of sugar mills, departments, students and households as sugar consumers participated in SugarFest. Numerous activities were organized to make the stakeholders aware of the importance of sugar in life.

Awareness Programme on PPV&FRA

Two days awareness programme on 'Protection of Plant Varieties & Farmers' Rights Act, 2001' was organized at the Institute on March 23-24, 2012. Lectures and field visits to DUS field were organized during the programme. More than 700 farmers attended the programme.

Hindi Pakhwara

In order to promote the use of Rajbhasha *Hindi* in official activities, *Hindi Pakhwara* (fortnight) was organized during September 14-30, 2011. Various activities such as noting, drafting, translations, oral lectures, essays, *shrut lekh*, were organized to promote the use of *Hindi* in official & scientific work. The authors of books on sugarcane published in *Hindi* during last 10 years were also honoured. In all, seventy two prizes were distributed. Lectures on '*Hindi Wakya Rachna*' and '*Tulsi Ka Ghatna Sanyojan*' *by* Dr Jeetendra Nath Pandey, Ex Professor, Deptt of Hindi, University of Lucknow and *Kavi Sammelan* were the main attractions of the event. Dr. Pandey stressed upon the principles of the use of Hindi language and in this context quoted appropriate references from the works of Tulsidas.

National Science Day

National Science Day was organized at the Institute on February 28, 2012 in which about 150 UG/PG students of BBA University, Integral University, Amity University and 6 other colleges participated. An interactive meet under the chairmanship of Dr. S. Solomon, Director, on frontiers of research in sugarcane and on clean energy options was also held on this occasion.

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Social Welfare Activities

Social welfare exists as an indispensable aspect of modern social organization because of the nature of man himself. Man is a social being whose very survival as an individual and a species depends upon the cooperation and help of other human beings. Thus, a developing society can neither survive nor advance without including in its developmental processes, the creation of new instruments of cooperation and the adaptation of those that already exist to meet the needs of a changing situation. IISR also encourages social welfare activities for its staff in the area of sports, health, recreation and in the overall development of work culture.

Welcome of new Director

IISR family welcomed Dr.S. Solomon as new Director of the Institute on December 22, 2011.

Sports activities

The Institute contingent comprising 63 players took part in ICAR Inter-institutional Sports Meet (North Zone) held at CSWR&TI, Dehradun on April 18-21, 2011. The Institute took part in almost all the events of the tournament and bring laurels to the Institute by securing wining positions in many events.

Annual sports competition organised by Staff Welfare Club of the Institute were organized during the month of January 2012. The awards to the winners in these competitions were delivered by Dr. S. Solomon, Director of the Institute on the occasion of Foundation Day Function of the Institute held on February 16, 2012.

Awareness about better health and hygiene

Institute declared its premises as Tobacco, Alcohol and Smoking free zone to instill and

maintain a strict sense of discipline among the staff. In order to create awareness about diseases and related vaccine programmes, health camps were organized where valuable health related information was disseminated by the experts.

A proposal to hire a lady doctor has also been passed in the Institute IMC.

A 'No Tobacco Awareness programme' was organized at the Institute in collaboration with Sahara Hospital, Lucknow. The Institute dispensary has been renovated.

Special programmes for family members

The Institute organized a visit of the staff family members to the Regional Science Centre, Lucknow for 3 days on February 3-5, 2011 for creating awareness about science among children. During this event, bus service was provided to the staff to see the advances made in science by different organizations.

Competitions and cultural activities were organized for women and children during National SugarFest organized on March 23-24, 2012.

Meeting to revive IISR Cooperative Society Ltd.

A meeting of the office bearers of the IISR Cooperative Welfare Society was held under the Chairmanship of the Director to revive the society for the welfare of the members. It was emphasized that the new executive body of the society be constituted by organizing a General Body Meeting.

Awareness about better banking services by banks

A meeting of all the staff of the Institute was organized on January 13, 2012 with the representatives of the Bank of India during which the features of unique Star Suraksha Saving Bank Account with multiple benefits scheme were discussed.

Awareness about scientific and technical developments

Meetings of all the staff were regularly convened and powerpoint presentation were made to apprise them about the latest developments in the area of scientific and technical persuits. During this period, the following presentations were made to all the staff categories.

- Scientific presentation by Dr. A.K. Shrivastava: March 26, 2012
- Stress management by Dr. P.R. Singh: February 23, 2012

Farewell functions

Farewell parties were organized to the superannuating fellow scientists by respective units, ARS forums and collectively by all categories of the staff. During this year, eights farewells parties were organized and the unique feature of the superannuating staff were highlighted.

Book fairs

One book fair was organized to provide exposure to the newly released books on different aspects on January 23-24, 2012.

Other functions

The Agricultural Engineering Workshop celebrated Shri Vishwakarma Puja on September 17, 2011.

28 Distinguished Visitors

Premier professional organizations focus on all facets of the visitor experience. IISR is also committed to understanding and enhancing visitor's experiences in informal learning settings through research, evaluation and dialogue.

Dr. M. Mahadevappa Ex Chairman, ASRB, New Delhi visited Institute on February 2, 2012.

Dr. Mohan Joseph Modayil, the then Chairman, ASRB visited IISR, Lucknow on October 7, 2011.

Dr. Gurbachan Singh, Agricultural Commissoner, Govt. of India visited the Institute on June 1, 2011.

Dr. Shivajirao Deshmukh, Retd. IAS, Director General, VSI, Pune visited the Institute on June 1, 2011.

Dr. S.S. Khanna, Ex-Member Planning Commission and V.C., NDUAT, Faizabad on March 15, 2012.

Dr. B.S. Bisht, Vice-chancellor, GB Pant University of Agriculture & Technology, Pantnagar on March 21, 2012.

Sh. Kamran Rizvi (IAS), Cane Commissioner, Govt of UP visited IISR on February 7 and March 23, 2012.

Sh. Sunil Kakaria, Managing Director, Mawana Sugars on February 14, 2012.

Dr. A.G. Powar, Ex-Director of Extension-Education, Dr. Bala Saheb Sawant Kokan Krishi Vidhyapeeth, Dapoli on December 26-29, 2011.

Dr. R.P. Kachru, Ex. Assistant Director General (Process Engineering), ICAR on December 22-23, 2011.

Dr. Bangali Baboo, National Director, NAIP, visited the Institute on January 07, 2012.

Dr. R.B. Deshmukh, Ex. Vice Chancellor, MPKV, Rahuri visited the Institute on June 1, 2011.

Dr. N. Gopalakrishna, ADG (CC), ICAR visited Institute on June 16-17, 2011.

Infrastructure Development

Infrastructure generally defines as the set of interconnected structural elements that provide framework for an organisational development. For a scientific Institute, it typically refers to the technical structure that supports the research functional ability. Developed farms, modern laboratories equipped with latest and sophisticated equipments, irrigation facilities, well connected roads, electrical/genset connection, and telecommunication all add forth to enable, sustain and enhance the research accomplishments. Viewed functionally, infrastructure facilitates the production of services. Hence, there is every need to maintain and create need based infrastructure on annual basis.

The infrastructure created/civil works carried out during the year 2011-12 consisted of the following work items:

S. No.	Item	Amount (₹ in lakh)	Agency to whom work allotted
1.	Re-carpeting to main office roads & adjacent road of office campus	32.11	CPWD, Lucknow
2.	Development work of Administrative building of KVK, providing & fixing signase plates, stainless steel letters & other miscellaneous work	4.12	-do-
3.	Construction of new building of bio-agent lab	62.23	-do-
4.	Repair & renovation of quarter no.E-5	1.75	-do-
5.	Development of Administrative building of KVK	7.58	-do-
6.	PVC pipeline at Regional Centre, Motipur	7.8	CPWD, Patna
7.	Construction of Prototype shed	11.98	CPWD, Lucknow
8.	Rewiring of quarter no. E-5	1.66	Other agency
9.	Development work of electric supply to KVK	3.70	-do-
10.	White washing, painting & distemper of the Institute	4.32	-do-
11.	Replacement of fixture & fitting of plumbering items in 6 Nos. of VIP suites	0.89	-do-
12.	Development of lawn front & left side of KVK	0.98	-do-
13.	Replacement of feeder pillar I/F at Nematology	0.81	-do-
14.	Making functional the farm road light from colony to office	0.99	-do-
15.	Development work at Devikhera gate	0.98	-do-
16.	Miscellaneous repair works & remaining work of main gate	1.85	-do-
17.	Installation of light fitting on gate of KVK	1.08	-do-

Personnel

(as on March 31, 2012)

Organization's success depends on employees' performance. Poor performance is detrimental to organization's success. While employee development is critical to the success of an organization, both the employee and the organization must recognize that most of the responsibility for development falls on the employee. Some things that the employee should consider in their own development include seeking a variety of assignments, tackling tough problems and asking for feedback. Coaching is another helpful activity, both in looking for opportunities to coach others and finding good coaches for him or herself. It can help to ask for feedback when working with a variety of people and in a variety of situations. Employees should be looking for developmental relationships that can provide a variety of learning. They can also identify goals for new skills and abilities and then look for ways to meet those goals. It can also be helpful to have appropriate HRD and manpower planning policies. Creating a well-rounded approach to managing and coaching work force requires the expertise of a human resources leader and the support of organization's executive leadership. The Institute is following suitable HRD policies for its sanctioned cadre strength of 73 scientists, 128 positions of technical staff and 122 positions of administrative and supporting staff.

Director	:	Dr. S. Solomon
Administration		
Senior Administrative Officer	:	Sri Ratnesh Kumar
Administrative Officer	:	Sri Shatrughan Kumar
Finance & Accounts Officer	:	Sri A.K. Srivastava
Drawing & Disbursing Officer	:	Sri Shatrughan Kumar
Asstt. Administrative Officer	:	Sri R.K. Khanna
	:	Sri K.P. Yadav
	:	Smt. S.L. Barjoo
	:	Sri Ram Das
I/C, Security Officer	:	Sri Sanjay Bhatnagar
Research Coordination and Management/PME Cell		
Principal Scientist & Incharge	:	Dr. A.K. Sharma
Technical Officer	:	Sri Brahm Prakash, Dr. G.K. Singh, Dr. M.R. Verma, Sri C.P. Singh and Smt. Anita Sawnani
Crop Production		
Principal Scientist & Head	:	Dr. T.K. Srivastava
Principal Scientist (Agronomy)	:	Dr. S.K. Shukla
	:	Dr. K.P. Singh
	:	Dr. S.N. Singh
Principal Scientist (Agril. Extension)	:	Dr. (Smt.) Hema Pandey
Senior Scienist (Agronomy)	:	Dr. A.K. Singh
	:	Dr. Ishwar Singh
Senior Scientist (Agril. Extension)	:	Dr. A.K. Sah
Scientist SS (Agril. Extension)	:	Sri Kamta Prasad
Scientist (Agronomy)	:	Ms. V. Visha Kumari
Technical Officer	:	Dr. S.K. Awasthi , Dr. Om Prakash, Sri Ram Singh, Sri S.N. Srivastava, Dr. R.K. Singh, Smt. Neelam Singh and Sri A.K. Singh

Plant Physiology & Biochemistry

Principal Scientist & Head	:	Dr. Amaresh Chandra
Principal Scientist (Plant Physiology)	:	Dr. Ashok Kumar Shrivastava
	:	Dr. R.K. Rai
Principal Scientist (Organic Chemistry)	:	Dr. (Smt.) Pushpa Singh
Senior Scientist (Plant Physiology)	:	Dr. (Smt.) Radha Jain
Senior Scientist (Biochemistry PS)	:	Sri Raman Banerjee
Technical Officer	:	Dr. (Smt.) Namita Arya, Smt. Mithilesh Tewari, Smt. Anita Sawnani, Sri Ram Darash, Sri S.P. Shukla, Dr. Ram Kishore and Sri C.P. Prajapati

Crop Improvement

Principal Scientist & Head	:	Dr. A.D. Pathak
Principal Scientist (Plant Breeding)	:	Dr. Raman Kapur
	:	Dr. Jyotsendra Singh
	:	Dr. D.K. Pandey
Principal Scientist (Genetics & Cytogenetics)	:	Dr. (Smt.) Sangeeta Srivastava
Principal Scientist (Biotechnology)	:	Dr. R.K. Singh
Senior Scientist (Plant Breeding)	:	Dr. P.K.Singh
	:	Dr. Sanjeev Kumar
Scientist SS (Genetics)	:	Dr. M. Swapna
Technical Officer	:	Smt. Hem Lata Madhok, Sri Ram Hit, Sri V.K. Saxena, Sri Ram Kumar, Sri Ram Moorti, Sri Ram Sewak, Sri S.K. Mishra and Sri R.K. Gautam

Crop Protection

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

Agricultural Engineering

Principal Scientist & Head	:	Dr. P.R. Singh
Principal Scientist (Ag.Str./Proc.Engg.)	:	Dr. Jaswant Singh
Prinicipal Scientist (Farm Mach. & Power)	:	Dr. A.C. Srivastava
Prinicipal Scientist (Elec. & Instr.)	:	Er. R.K. Pangasa
Senior Scientist (Farm Mach. & Power)	:	Dr. A.K. Singh
	:	Dr. S.I. Anwar
	:	Dr. R.D. Singh
Senior Scientist (Soil Water Cons. Engg.)	:	Dr. Rajendra Gupta
Scientist (Ag.Str./Proc. Engg.)	:	Er. Dilip Kumar

Technical Officer	:	Sri S.K. Pal, Sri Jasbeer Singh, Sri M.H. Ansari, Sri S.K. Kushwaha, Sri S.K. Misra, Sri Vinayak Sawant, Sri V.N. Mehrotra, Sri S.K. Savita, Sri R.N. Kureel, Sri Mathura Prasad, Sri Someshwar Misra, Sri K.N. Singh, Sri Rajendra Singh, Sri J. Minj, Sri L.L. Verma and Sri Sant Lal
Economics & Statistics/ AKMU		
Principal Scientist) & I/C	:	Er. R.K. Pangasa
Principal Scientist (Statistics)	:	Dr. P.K. Bajpai
Principal Scientist (Ag. Economics)	:	Dr. A.K. Sharma
Scientist SS (Computer Science)	:	Dr. S.S. Hasan
Technical Officer	:	Dr. Mani Ram Verma
Agrometeorology		
Principal Scientist & I/c	:	Sri Arun Kumar Srivastava
Technical Officer	:	Sri Surendra Singh
Microbiology Laboratory		
Principal Scientist & Incharge	:	Dr. S.K. Shukla
Technical Officer	:	Smt. Asha Gaur and Smt. Meena Nigam
Training Unit		
Principal Scientist & I/c	:	Dr. T.K. Srivastava
Senior Scientist (Agril. Extension)	:	Dr. A.K. Sah
Technical Officer	:	Sri A.K. Singh
AICRP on Sugarcane		
Project Coordinator	:	Dr. O.K. Sinha
Principal Scientist (Agril. Statistics)	:	Dr. Rajesh Kumar
Senior Scientist (Agronomy)	:	Dr. Chandra Gupta
Technical Officer	:	Dr. J.K.S. Gautam, Sri Mahendra Singh and Sri Adil Zubair
Farm		
Scientist Incharge	:	Dr. T.K. Srivastava
Farm Manager	:	Sri C.P. Singh
Technical Officer	:	Sri Nar Singh, Sri Raghvendra Kumar, Sri Jiyan Ram, Sri Satya Narayan, Sri B.B. Singh, Sri Kaaloo Ram and Sri Shyam Lal Yadav
Institute Technology Management Unit		
Nodal Officer & Scientist Incharge	:	Dr. A.K. Sharma
Technical Officer	:	Sh. Brahm Prakash
Krishi Vigyan Kendra		
Programme Coordinator & Incharge	:	Dr. R.K. Singh
Technical Officer	:	Dr. Rakesh Kumar Singh
SMS (Home Science)	:	Dr. (Smt.) Veenika Singh
SMS (Plant Protection)	:	Sri Deepak Rai
Hindi Unit		
Principal Scientist & I/c	:	Dr. S.K. Shukla
Technical Officer	:	Dr. (Ms.) Bandana Gupta
Art & Photography		
Scientist Incharge	:	Dr. A.K. Sharma
Technical Officer	:	Sri Vipin Dhawan, Sri Y.M. Singh and Sri Avadhesh Kumar

Dispensary

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

Library

Scientist Incharge	:	Dr. Ashok Kumar Shrivastava
Technical Officer	:	Sri G.K. Gupta, Sri G.D. Dhariyal and Sri Ghanshyam Ram
Incharge, Seed Production Unit	:	Dr. J. Singh
Incharge, Vehicles	:	Sri K.P. Yadav
Incharge, Landscaping	:	Sri S.D. Tewari
Guest House		
Manager	:	Sri R.K. Singh
Estate	:	
Officer-In-charge	:	Dr. P.R. Singh
Technical Officer	:	Sri M.H. Ansari
IISR Regional Centre, Motipur (Bihar)		
Senior Scientist (Plant Breeding) & Incharge	:	Dr. Devender Kumar
Senior Scientist (Agronomy)	:	Dr. V.P. Jaiswal (On leave)

Appointments

Name	Designation	Date
Dr. S. Solomon	Director	22.12.2011
Dr. A.D. Pathak	Head of the Division (Crop Improvement)	11.07.2011
Dr. P.R. Singh	Head of the Division (Agricultural Engineering)	12.09.2011
Dr. (Ms.) Nithya K.	Scientist (Plant Pathology)	23.12.2011
Ms. V. Visha Kumari	Scientist (Agronomy)	23.12.2011

Joining after completing the deputation

Name	Designation	From	To	Date
Dr. P.K. Singh	Senior Scientist (Plant Breeding)	PPV&FRA, New Delhi	IISR, Lucknow	12.05.2011
Sh. Anand Mohan Shrivastava	Assistant	CISH, Lucknow	IISR, Lucknow	28.04.2011

Transfers

Name	Designation	From	To	Date
Dr. (Smt.) Vineeka Singh	SMS (Home Science)	KVK, Chnyalisaur (Uttarkashi)	KVK, IISR, Lucknow	18.04.2011
Dr. Chandra Gupta	Sr. Scientist (Agronomy)	SBI, Coimbatore	IISR, Lucknow	13.06.2011
Dr. A.K. Singh	Principal Scientist (Plant Pathology)	CISH, Lucknow	IISR, Lucknow	12.09.2011
Sh. Deepak Rai	SMS (Plant Protection)	KVK, Chnyalisaur (Uttarkashi)	IISR, Lucknow	23.08.2011
Sh. T.S.N. Murthy	AF&AO	IISR, Lucknow	CTCRI, Rajamundari	15.07.2011
Sh. Devendra Singh	T-4	IISR, Lucknow	Basar Regional Station, ICAR Research Complex for NEH Region, Umiam	08.04.2011

Promotions

Name	Designation	Effective date
Scientific		
Dr.S.N. Singh	PS (Agron.)	14.12.2008
Administrative		
Smt. Chaman Ara Siddiqui	Assistant	06.04.2011
Mrs. Rashmi Sanjai Srivastava	PA	06-04-2011
Sh.Ram Das	AAO	04.10.2011
Technical		
Sh.Sri Kishan	T-3	26.05.2009
Sh. Harish Chandra	T-3	16.12.2010
Sh. Devendra Singh	T-4	07.02.2010
Sh. Ashrit Kumar Singh	T-5	03.02.2010
Sh. J.S. Bisht	T-5	03.02.2010
Sh.J.C. Tewari	T-5	03.02.2010
Sh. B.L. Maurya	T-5	03.02.2010
Sh.Shridhar Tewari	T-5	01.07.2010
Sh.Kaaloo Ram	T-5	03.02.2010
Sh.S.K. Mishra	T-5	24.04.2010
Sh.R.K. Gautam	T-6	01.01.2010
Sh.Ram Singh	T-6	01.01.2010
Smt.Pramila Lal	T-6	26.11.2010
Dr.R.K. Singh	T-6	12.04.2011
Dr. Ram Kishore	T-5	29.05.2009
Sh.K.N. Singh	T-6	25.04.2009
Sh.S.K. Kushwaha	T-6	01.01.2009
Sh.J. Minz	T-5	01.07.2010
Sh.Sant Lal	T-5	03.02.2010
Sh.L.L. Verma	T-5	01.07.2009
Sh.Shyam Lal	T-5	03.02.2010
Sh.Suresh Kumar	T-4	29.06.2011
Sh.Prahlad Narayan	T-4	29.06.2011
Sh.Ramesh Prasad	T-I-3	25.05.2009
Sh.Ram Kishun	T-I-3	29.06.2011
Sh.K.A. Khan	T-I-3	29.06.2006
Sh.Pooran Lal	T-I-3	29.06.2006
Sh.Pyare Lal	T-I-3	29.06.2006
Sh.Brij Kishore	T-3	29.06.2011
Sh. Patandeen	T-3	29.06.2011
Sh.Keshav Prasad	T-3	29.06.2011
Sh.Deep Chandra	T-3	29.06.2011
Sh.R.N. Sharma	T-3	29.06.2011
Sh. Arun Kumar Nath	T-4	13.06.2011
Sh.Ghanshyam Ram	T-6	16.08.2005
Sh.R.K. Singh	T-4	27.05.2011
Sh.Saheb Deen	T-4	10.07.2011
Sh.Jagjit Singh	T-4	14.06.2011
Sh.A.K. Singh	T-5	03.07.2011
Sh.Ramayan Singh	T-6	22.03.2008
Sh.N.M. Wadekar	T-5	03.02.2010
Smt.Meena Nigam	T-6	01.01.2012
Sh. C.P. Prajapati	T-5	05.09.2011
Sh.D.N. Sinha	T-5	03.02.2010
Sh.Yogendra Rai	T-2	05.07.2008

Promotions under MACP

Name	Designation	With effect from
Sh. R.K. Yadav	Assistant	26.02.2012
Sh. Ganesh Singh	UDC	03.11.2011
Sh. H.C. Pandey	UDC	03.11.2011
Sh. Hari Lal	UDC	06.10.2011
Sh. S.K. Sharma	SSS	04.09.2011
Smt. Veenna Sharma	PA	02.07.2011
Sh. R.V. Dwivedi	UDC	25.08.2011

Superannuations

Name	Designation	Date
Dr. Om Prakash	Pr. Scientist (Entomology)	31.05.2011
Dr. R.S. Chauhan	Pr. Scientist (Agronomy)	31.07.2011
Dr. Todi Singh	Sr. Scientist (Soil Science)	31.07.2011
Sh. K.A. Khan	T-I-3	31.08.2011
Smt. Bhaganta	SSS	31.08.2011
Dr. R.L. Yadav	Director	30.11.2011
Sh. Niranjan Lal	T-5	30.11.2011
Sh. J.S.Bisht	T-5	31.12.2011
Dr. R.S. Verma	Pr. Scientist (Agronomy)	31.01.2012
Dr. G.M. Tripathi	Pr. Scientist (Entomology)	31.01.2012
Sh. Harish Chandra	SSS	29.02.2012
Sh. Shatrughan Kumar	AO	31.03.2012
Dr. (Ms.) Bandana Gupta	Hindi Translator (T-4)	31.03.2012

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