वार्षिक प्रतिवेदन
Annual Report
2010 - 11

भाकृअनुप
ICAR

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

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Preface

Sugarcane and sugar production in India typically follow a 6 to 8 year cycle, wherein 3 to 4 years of higher production are followed by 2 to 3 years of lower production. After two consecutive years of declining sugar production (Year 2007-08 and 2008-09), the production resurged in the Year 2009-10, and is set to gain strongly in the upcoming Year 2010-11. India's total centrifugal sugar production in Year 2010-11 is forecast at 24.7 million tonnes on expected improved sugarcane supplies due to higher cane planting and yields. Relatively strong cane prices *vis-a-vis* last year and also compared to competing food crops (rice, wheat, pulses) during the Year 2009-10 have supported higher cane acreage. Assuming normal monsoon and subsequent weather condition, yields are expected to improve over last year's performance. The sugarcane production is likely to increase by about 20% compared to 292 million tonnes in Year 2009-10. The sugar consumption is forecast to increase to 24.5 million tonnes on account of growing population and continued growth in economy. In order to meet the ever increasing demand of sugar in India, the most suited way to enhance sugar production in the country is to effect an increase in the yield of the cane crop, as the cane area increase is less likely to occur on account of compulsions arising out of food security and water availability concerns.

The Indian Institute of Sugarcane Research as per its mandate has directed its research towards cane yield enhancement. The main research focus during the year was on development of high sugar and high yielding genotypes, improvement in seed cane quality, significant reduction in seed cane quantity required per hectare, refinement and verification of potential sugarcane cultivation machines developed by the Institute, and proper management of the ratoon crop. Number of genotypes were advanced to State/AICRP (S) Varietal Trials in order to develop high sugar varieties of sugarcane. In addition, the research work on improving the parent material (used in developing sugarcane varieties) is being carried out so that it may help in breaking the yield barriers in cane cultivation. Emphasis was also given on disseminating technologies through demonstrations in some selected areas, and through *Kisan Mela* and trainings to farmers and sugar mill cane development officials for wider coverage. Monthly crop advisories to cane growers under public-private partnership were also issued through SMS based innovative approaches.

The challenges confronting the sugar sector of India are many and there is a need to critically review the adopted path of each stakeholder and its compatibility with the emerging scenario. The recently introduced performance oriented approaches in sugarcane research in the form of RFD calls for greater coordination within the sugarcane research system of the country so that piecemeal efforts could be put into a coherent whole development strategy. There is also a need to reflect technological competence in sugarcane research in terms of patents obtained. The Institute also understands that there is a need to re-organize the research agenda to meet the national needs and aspirations. Hence, different kinds of reviews were held to peep into the envisaged vision and prepare the future agenda for research. The unstinted encouragement, support and guidance received in this respect 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) is highly appreciated and duly acknowledged.

The present Annual Report carrying the above description in detail, consists of 25 theme-based chapters. The report is a mirror of all the Institute activities during the year 2010-11 (April–March). I thank all the Heads of Divisions/Incharges of Sections and scientists for their cooperation in providing the information in the requisite format. Dr. A.K. Sharma, Principal Scientist (Agril. Econ.) & I/c RCM, Mr. Brahm Prakash (T 7-8), Mr. Mahendra Singh (T 9), Dr. G.K. Singh (T 7-8), the Technical Officers, Mr. Mohammad Ashfaque, R.A. and Mr. D.C. Pant, LDC, RCM, deserve special appreciation of their sincere efforts in the compilation, editing and presenting the information nicely, and bringing out this report in time. Thanks are also due to Institute photographers Mr. Vipin Dhawan, Mr. Yogesh Mohan Singh and Mr. Avadhesh Kumar Yadav in improving the presentation of the report with good quality photographs.

(R.L. Yadav)
Director

Contents

कार्यकारी सारांश

फसल सुधार

सेकरम ऑफिसिनेरम, एस. बारबरी, एस. साइनेन्स, आई एस एच क्लोन, इक्षु आई एस एच क्लोन, एल जी चयन एवं व्यावसायिक संकर आदि सहित 284 जीन प्रारूपों का रख-रखाव किया गया तथा संस्थान में शोधरत परियोजनाओं के लिए आवश्यक बीज सामग्री की आपूर्ति की गयी। आई एस एच क्लोन, एल जी चयन, व्यावसायिक संकर तथा प्रजाति स्तरीय क्लोन आदि की तुलना में इक्षु आई एस एच क्लोन में बेहतर पेड़ी निष्पादन देखा गया।

गन्ना एवं चीनी उपज तथा गुणवत्ता आदि के लिए 14 उन्नतशील जीन प्रारूपों तथा चार मानक प्रजातियों के मूल्यांकन में जीन प्रारूप एल जी 05398 की गन्ना एवं शर्करा की सर्वाधिक उपज आँकी गयी। चार जीन प्रारूप क्रमशः एल जी 05302, एल जी 05403, एल जी 99270 तथा एल जी 05480 को शीघ्र पकने तथा पाँच जीन प्रारूप क्रमशः एल जी 05398, एल जी 04099, एल जी 04438, एल जी 06021 तथा एल जी 06004 को मध्य देरी से परिपक्वता के लिए उपयुक्त पाया गया।

सी$_1$ पीढ़ी के 79 क्रन्तकों में से 29 क्रन्तकों को सी$_2$ पीढ़ी में पुर्नमूल्यांकन हेतु प्रोन्नत किया गया। चयनित क्रन्तकों में एल जी 08752 में दिसम्बर माह में सर्वाधिक शर्करा (20.22%) आँकी गई। इसके पश्चात्, एल जी 08709 (19.32%) तथा एल जी 08745 (19.06%) का स्थान रहा। सी$_2$ पीढ़ी के 42 क्रन्तकों में 24 क्रन्तकों को सुक्रोज स्तर तथा सामान्य वृद्धि दर्शाने के आधार पर चयनित किया गया। इन क्रन्तकों को सी$_3$ पीढ़ी में सामान्य एवं कम नमी वाली दशाओं में मूल्यांकन हेतु प्रोन्नत किया गया।

सी$_2$ पीढ़ी के 300 चयनों के शीघ्र ब्रिक्स के लिए किए गये मूल्यांकन में 48 चयन, शीघ्र परिपक्वता व उच्च शर्करा युक्त प्रजाति कोजे 64 की तुलना में उच्च शर्करा युक्त प्रभावशाली अभिजनक पाये गये। इनमें से 22 प्रजातीय श्रेष्ठता के लिए पुर्नमूल्यांकन हेतु प्रोन्नत किए गए।

चोटी बेधक सहनशीलता, सामान्य ओज तथा ब्रिक्स के लिए सी$_3$ पीढ़ी के 48 जीन प्रारूपों के किए गए मूल्यांकन में 19 जीन प्रारूप सी$_4$ पीढ़ी में मूल्यांकन हेतु चयनित किए गये। बीस क्रन्तकों तथा दो मानक प्रजातियों (कोशा 767 व कोजे 64) के चोटी बेधक सहनशीलता एवं शर्करा स्तर के लिए किए गये मूल्यांकन में चार क्रन्तक एल जी 06602, एल जी 06605, एल जी 06606 तथा एल जी 06607 को आर्थिक महत्व के गुणों में श्रेष्ठता के कारण स्थानीय परीक्षणों हेतु सम्मिलित किया गया।

दस क्रन्तकों तथा दो मानक प्रजातियों (कोजे 64 तथा कोशा 767) के लाल सड़न रोग के प्रति अवरोधिता की पुष्टता तथा उनकी उत्पादकता एवं अन्य लक्षणों व गुणों के आँकलन हेतु किए गये मूल्यांकन परीक्षण में चार क्रन्तक, एल जी 06810, एल जी 06823 ए, एल जी 06839 तथा एल जी 06856 ने दो तीक्ष्ण रोगाणु प्रभेद सी एफ 08 तथा सी एफ 09 के विरूद्ध मध्यम अवरोधिता दर्शायी जबकि एल जी 06823 ए की गन्ना उपज सर्वाधिक (91 टन/हे.) पायी गयी। एल जी 06856 में 300 दिनों की अवधि में 19.8 प्रतिशत सुक्रोज अंकित किया गया।

एक उच्च प्रजातीय परीक्षण में पाँच शीघ्र परिपक्वता वाले जीन प्रारूप कोह 05262, कोह 05265, को 05009, कोलख 05201 तथा कोपक 05191 एवं दो मानक प्रजातियों कोजे 64 तथा कोपन्त 84211 को द्वितीय बावक फसल के रूप में आंकलन हेतु मूल्यांकित किया गया। सर्वश्रेष्ठ मानक प्रजाति, कोपन्त 84211 द्वारा गन्ना व शर्करा की प्राप्त उपज (53.3 टन/हे., 6.8 टन/हे.) की तुलना में जीन प्रारूप कोपक 05191 द्वारा क्रमशः 108.6 टन/हे. व 13.4 टन/हे. उपज प्राप्त हुई जबकि कोलख 05201 का द्वितीय स्थान रहा।

उत्तर पश्चिमी क्षेत्र के लिए मध्य-देरी से परिपक्वता वाले 18 जीन प्रारूपों एवं दो मानक प्रजातियों (कोजे 64 तथा कोपन्त 84211) को गन्ने की उपज एवं अन्य गुणों के लिए किये गये एक मूल्यांकन परीक्षण में को 0303 तथा कोबलन 03172 ने अधिक उपज दी जबकि को 0306 में सुक्रोज का स्तर सर्वाधिक रहा।

बावक फसल के प्रदर्शन के आधार पर तीन चुनिंदा क्रन्तक, एल जी 05350, एल जी 05306 तथा एल जी 04439 को वर्ष 2011-12 के स्थानीय परीक्षणों हेतु सम्मिलित किया गया। इसके अतिरिक्त, एक मध्य-देरी से परिपक्व होने वाला क्रन्तक एल जी 02434 एवं दो शीघ्र परिपक्व होने वाले क्रन्तकों एल जी 05302 तथा एल जी 05403 को उत्तर प्रदेश राज्य प्रजातीय परीक्षण कार्यक्रम के अन्तर्गत 13 विभिन्न स्थानों पर मूल्यांकन हेतु स्वीकृत किये गये।

बावक एवं पेड़ी दोनों फसलों में किए गये परीक्षणों के आधार पर मध्य-देरी से परिपक्व होने वाले एक जीन प्रारूप एल जी 05447 को उत्तर प्रदेश राज्य प्रजातीय परीक्षण कार्यक्रम के अन्तर्गत मूल्यांकन हेतु सम्मिलित किया गया। चार अभिजनक, एल जी 06601, एल जी 06602, एल जी 06603 तथा एल जी 06604 को गन्ना प्रजनन संस्थान, कोयम्बटूर के राष्ट्रीय संकरण उद्यान में सम्मिलित किया गया।

उत्तर पश्चिमी क्षेत्र के लिए जीन प्रारूप कोलख 05201, कोलख 07201, कोलख 07202 व कोलख 07203 अखिल भारतीय

समन्वित शोध परियोजना (गन्ना) के अन्तर्गत बहुस्थानीय मूल्यांकन परीक्षण की विभिन्न अवस्थाओं में है।

लाल सड़न रोगरोधी दो सोमाक्लोन को गन्ना प्रजनन संस्थान, कोयम्बटूर के राष्ट्रीय संकरण उद्यान भेजा गया। इनका प्रयोग संकरण में किया जा रहा है।

बेधकों के विरूद्ध कीटरोधिता हेतु आनुवांशिक रूपान्तरण के लिए तना बेधक सुग्राही गन्ने की प्रजाति कोलख 8102 को क्राई 1 ए बी जीन से रूपान्तरित किया गया। रूपान्तरणों को गस परीक्षण तथा प्रतिरोधी जीन के पी.सी.आर. विस्तार द्वारा विकसित एवं इसकी पुष्टि की गई। एलाइजा विश्लेषण से स्पष्ट हुआ कि रूपान्तरित पौधों में अरूपान्तरित पौधों की अपेक्षा *क्राई 1 ए बी* प्रोटीन 0.39 से 5.08 गुना अधिक थी। कीट जैव परीक्षण अध्ययन में रूपान्तरित पौधों की पत्तियों को सूण्डियों को खिलाने से उनके भार में 30-50 प्रतिशत की कमी हुई जिससे अन्तोगत्वा उनकी मृत्यु हो गई।

गन्ने में लाल सड़न रोग के विरूद्ध प्रतिरोधी जीन एकरूपता की पहचान तथा अभिव्यक्ति विश्लेषण के अन्तर्गत 19 अग्रिम तथा 18 विपरीत प्राइमरों के 42 विभिन्न संयोगों को पी.सी.आर. के लिए प्रयुक्त किया गया। इनमें से 22 प्राइमरों ने स्पष्ट विस्तार दर्शाया। कुल 520 बने पटटों में 60 प्रतिशत से अधिक बहुरूपी थे।

गन्ने के ई एस टी डेटाबेस से लाल सड़न रोगरोधिता हेतु एस एस आर संसूचकों के विकास के लिए भारतीय मूल के 4169 विशिष्ट ई एस टी प्राइमरों में से कुल 235 नये ई.एस.टी. - एस. एस.आर. प्राइमर अभिकल्पित एवं विकसित किये गये। कुल 222 (94.5%) प्राइमरों में से जिन्होंने विस्तार प्रदर्शित किया, 118 प्राइमरों (53.2%) में बहुरूपता पायी गयी।

फसल उत्पादन

जीन प्रारूप कोपक 05191 से गन्ने की सर्वाधिक उपज (76.37 टन/हे.) प्राप्त हुई जो एल जी 05031 (71.56 टन/हे.) के लगभग समतुल्य थी। नाइट्रोजन, फास्फोरस व पोटाश की संस्तुत मात्रा (150:60:60 किग्रा./हे.) के प्रयोग द्वारा संस्तुत मात्रा के 75 प्रतिशत प्रयोग करने की तुलना में गन्ने (69.13 टन/हे.) तथा शर्करा की सर्वाधिक उपज (8.74 टन/हे.) प्राप्त हुई।

खेत में पानी भरने की दशा के अन्तर्गत 1140 किग्रा. गन्ना/हे.-सेमी क्षमता की तुलना में जोड़ी पंक्तियों में बुवाई (120-30 सेमी) के साथ एकान्तर नाली सिंचाई विधि द्वारा सिंचाई जल उपयोग क्षमता 4106 किग्रा. गन्ना/हे.-सेमी के साथ बुवाई को एक प्रभावी विधि के रूप में चिन्हित किया गया। 3955 किग्रा. गन्ना/हे./सेमी. की सिंचित जल उपयोग क्षमता के साथ खाई बनाकर की गयी बुवाई के अन्तर्गत पेरने योग्य गन्नों की संख्या (176.3 हजार/हे.), गन्ना उपज (88.6 टन/हे.) तथा शर्करा उपज (10.05 टन/हे.) पाई गयी।

गन्ने में 0.50 आई.डब्लू./सी.पी.ई. अनुपात की तुलना में 0.75 आई.डब्लू./सी.पी.ई. अनुपात पर सिंचाई करने पर उपज को प्रभावित करने वाले गुणों जैसे गन्ने की लम्बाई, गन्ने का भार, पेरने योग्य गन्नों की संख्या तथा उपज (57.36 टन/हे) में वृद्धि हुई। 0.50 आई.डब्लू./सी.पी.ई. अनुपात पर सिंचित जल उपयोग क्षमता सर्वाधिक (0.94 टन/हे.-सेमी) दर्ज की गई जो 0.75 तथा 1.00 आई.डब्लू./सी.पी.ई. अनुपात पर की गई सिंचाई के उपचारों के अन्तर्गत घटकर क्रमशः 0.8 तथा 0.6 टन/हे.-सेमी रह गयी।

बुवाई के पूर्व गहरी जुताई तथा अवभूमिकर्षण करने से पेरने योग्य गन्नों की संख्या (87,670/हे), गन्ना उपज (61.54 टन/हे) तथा जल उपयोग क्षमता में वृद्धि दर्ज की गयी। गहरी जुताई, अवभूमिकर्षण तथा 150 किग्रा. नाइट्रोजन प्रति हेक्टेयर के उपयोग से सर्वाधिक जल उपयोग क्षमता (96.97 किग्रा/हे/मिमी) प्राप्त हुई।

बुवाई पूर्व की गई जुताई एवं 1.0 मीटर दूरी पर की गयी क्रॉस अवभूमिकर्षण के अन्तर्गत सर्वाधिक रिसाव दर (4.31 मिमी/घंटा), न्यूनतम स्थूलता घनत्व (1.33 मिग्रा/मी^{3}), सर्वाधिक गन्नों की संख्या (बुवाई के 180 दिनों बाद 209.2 हजार/हे), पेरने योग्य गन्नों की संख्या (180.8 हजार/हे), गन्ना (87.8 टन/हे) तथा शर्करा उपज (9.26 टन/हे) दर्ज की गई।

अनुपचारित नियंत्रण (18.7 टन/हे) की तुलना में सातवीं पेड़ी की सर्वाधिक उपज (57.40 टन/हे) सल्फीटेशन प्रेसमड केक के साथ ग्लूकोनाएसीटोबैक्टर के प्रयोग से प्राप्त हुई, जबकि सल्फीटेशन प्रेसमड केक (54.80 टन/हे) तथा गोबर की खाद + ग्लूकोनाएसीटोबैक्टर (54.30 टन/हे) उपचारों का क्रमशः द्वितीय एवं तृतीय स्थान रहा। मृदा जीवाणु जैवभार कार्बन की आरम्भिक मात्रा (47.60 मिग्रा. सी ओ$_2$ सी/किग्रा. मृदा/दिन) की तुलना में सूखी पत्ती की कम्पोस्ट + ग्लूकोनाएसीटोबैक्टर प्राप्त प्लाट्स में मृदा जीवाणु जैवभार कार्बन का सर्वाधिक स्तर (234.70 मिग्रा. सी ओ$_2$-सी/किग्रा मृदा/दिन) दर्ज किया गया।

घने बुवाई घनत्व (30,000 से 60,000 तीन आँख के टुकड़े/हे) वाली बावक फसल से ली गई दूसरी पेड़ी (कोसे 92423) में रिक्त स्थान में स्पष्ट कमी (36.52 से 10.90%) देखी गयी। बिना रिक्त स्थान भराई (68.09 टन/हे) की तुलना में बावक फसल में बुवाई के 45 दिनों बाद तीन आँख के टुकड़ों द्वारा रिक्त स्थान भरने पर पेड़ी की उपज (75.08 टन/हे) में 9.31% की वृद्धि दर्ज की गयी। नियंत्रण की तुलना में कटाई से एक माह पूर्व बावक फसल में सिंचाई के जल द्वारा पोटाश की 80 किग्रा/हे. के प्रयोग द्वारा पेड़ी गन्ने की 10.54% अधिक उपज प्राप्त हुई।

सल्फीटेशन प्रेसमड केक (एस.पी.एम.सी.) को 20 टन/हे. की दर से प्रयोग करने अथवा एस.पी.एम.सी. (10 टन/हे.) + जिंक सल्फेट (25 किग्रा/हे.) के प्रयोग से पेड़ी फसल में अधिक किल्ले निकले तथा पेरने योग्य गन्नों की संख्या (99,500/हे.) तथा उपज (71 टन/हे.) में वृद्धि हुई।

कृषकों के खेतों में मूल्यांकित की गई विभिन्न प्रौद्योगिकियों में बुवाई की परम्परागत विधि की तुलना में गोल गड्ढा विधि से की गई बुवाई से गन्ने की उपज (107.9%), सिंचाई के जल उपयोग क्षमता (आई.डब्लू.यू.ई.) तथा शुद्ध लाभ (₹ 164574/हे.) में सर्वाधिक वृद्धि दर्ज की गयी। गन्ने की फसल के सूखे पत्तों को पलवार के रूप में बिछाने की तकनीक में सर्वाधिक लाभ : लागत अनुपात (2.08) प्राप्त हुआ जबकि एकान्तर कूँड़ में सिंचाई करने पर लाभःलागत अनुपात 1.86 प्राप्त हुआ।

फसल सुरक्षा

प्रचलित कीटों एवं रोगों की जानकारी हेतु उत्तर प्रदेश तथा बिहार की आठ चीनी मिलों के अधिकार क्षेत्रों का सर्वेक्षण किया गया। मध्य उत्तर प्रदेश तथा बिहार के अधिकांश क्षेत्रों में लाल सड़न रोग पाया गया। हरीनगर चीनी मिल, हरीनगर, बिहार में कोसे 95422 तथा कोजे 88 प्रजातियाँ लाल सड़न रोग से विशेषतया प्रभावित पाई गई। मध्य उत्तर प्रदेश में लाल सड़न रोग मुख्यतः कोलख 8102, कोसा 767, कोसा 8432 तथा कोसा 8436 प्रजातियों पर प्रभावी रहा। हरीनगर चीनी मिल के अधीनस्थ क्षेत्रों में प्लासी बेधक, स्केल कीट तथा श्वेत मक्खी का प्रकोप नजर आया। डी. एस. सी. एल. शुगर, रूपापुर के अधीनस्थ क्षेत्र के कुछ खेतों में शरदकालीन फसल में पोरी बेधक का प्रकोप 70% तक पाया गया, जबकि बसन्तकालीन फसल में इस कीट का प्रकोप कम रहा। कुछ स्थानों पर शरदकालीन फसल में तना बेधक का प्रकोप लगभग 10-15% तक रहा जबकि चोटी बेधक का प्रकोप 20-30% रहा।

जैवकारकों द्वारा उपचारित गन्नों को *कौलेटोट्राइकम फल्केटम* के रोगाणुओं द्वारा उपचारित करने पर मृदा में *ट्राइकोडर्मा* मिश्रित कल्चर का प्रयोग लाल सड़न रोग के संक्रमण को 72% तक रोकने में कारगर रहा, जबकि एम.एच.ए.टी. तथा *ट्राइकोडर्मा* मिश्रित कल्चर + एम.एच.ए.टी. के उपचार में लाल सड़न रोग से क्रमशः 46 तथा 76% सुरक्षा मिली। *ट्राइकोडर्मा हार्जियानम* के मृदा में प्रयोग करने से मृदा में समष्टिपोषक तत्वों जैसे नाइट्रोजन, फास्फोरस तथा पोटाश की उपलब्धता में क्रमशः 27, 65 तथा 44 प्रतिशत वृद्धि हुई।

लाल सड़न उपचारित एवं अनुपचारित गन्नों के टुकड़ों में कुल फीनोल्स, अपचायक शर्करा स्तर, पॉलीफीनॉल ऑक्सीडेज तथा परॉक्सीडेज क्रियाशीलता नापी गयी। विभिन्न जीन प्रारूपों के विभिन्न जैव रसायनिक गुणों में विभिन्नता पाई गयी। प्राथमिक आँकड़ों से यह ज्ञात हुआ है कि नियंत्रण की तुलना में लाल सड़न रोग से उपचारित जीन प्रारूपों में अपचायक शर्करा, कुल फीनौल स्तर, पराक्सीडेज तथा पी पी ओ क्रियाशीलता कम पाई गई परन्तु कोलख 94184 में अधिक पाई गई। कोजे 64 तथा को 1148 जीन प्रारूपों में कुल फीनौल तथा अपचायक शर्करा स्तर में उल्लेखनीय वृद्धि पाई गई।

विभिन्न महीनों में गन्ने के 35 जीन प्रारूपों के पूर्णतया स्वस्थ पौधों की गांठों की बीच से कलिकाएं, पत्तियाँ तथा शिराओं से अन्तःजीवी फफूंदी पृथक किए गये। फसल वृद्धि के आरम्भिक महीनों में अन्तःजीवी फफूंदी का समग्र रूप से समूहीकरण दर 40 प्रतिशत थी जो बाद के महीनों में बढ़कर 60 प्रतिशत हो गयी। ये अन्तःजीवी फफूंदी 8 विभिन्न कवकीय वर्गों के थे जिनमें *ट्राइकोडर्मा, एसपरजिलस* तथा *फ्यूजेरियम* प्रमुख थे। समूहीकरण की तीव्रता पौधे की आयु तथा गन्ने के जीन प्रारूप पर निर्भर होने के कारण भिन्न-भिन्न रही। अध्ययन में *ट्राइकोडर्मा* तथा *एसपरजिलस* प्रजातियों में लाल सड़न रोगाणु के विरूद्ध विरोधी गुण पाये गये।

भारतीय गन्ना अनुसंधान संस्थान प्रक्षेत्र के विभिन्न खेतों में उचित फैरोमॉन जाल लगाकर गन्ने के विभिन्न बेधकों जैसे अगेती तना तथा चोटी बेधकों की जनसंख्या गतिविज्ञान का अध्ययन किया गया। उपरोक्त तीनों बेधकों में चोटी बेधक पतंगे प्रथम, द्वितीय, तृतीय एवं चतुर्थ अण्डकों के निकलने के दौरान क्रमशः 274, 354, 498 तथा 300 वयस्क पतंगे प्रति जाल की दर से पकड़े गये। फैरोमॉन यौन आकर्षण जाल लगे खेत में चोटी बेधक का प्रकोप प्रथम, द्वितीय, तृतीय एवं चतुर्थ अण्डकवार क्रमशः 7.1, 10.5, 5.45 तथा 3.44 प्रतिशत रहा, जबकि बगैर आकर्षण जाल वाले खेत में यह क्रमशः 9.8, 11.9, 6.88 व 4.09 प्रतिशत रहा।

बुवाई के एक माह पश्चात गन्ने के टुकडों एवं कलिकाओं की दीमक द्वारा क्षति क्रमशः 5.16 से 17.33 प्रतिशत तथा 7.15 से 24.66 प्रतिशत के मध्य रही। तने में हुई क्षति 5.53 से 32.33 प्रतिशत के मध्य रही। क्लोरपाइरीफॉस द्वारा उपचारित खेत में सर्वाधिक उपज (68.25 टन/हे) प्राप्त हुई, जबकि इमिडाक्लोप्रिड उपचारित खेत में अनुपचारित नियंत्रण (46.54 टन/हे) की अपेक्षा अधिक उपज (65.84 टन/हे) प्राप्त हुई।

पश्चिमी उत्तर प्रदेश में श्वेत भृंग (*होलोट्राइचिया कॉनसनगुनिया*) मई के तृतीय सप्ताह से जून के अन्तिम सप्ताह के मध्य सर्वाधिक संख्या में मौजूद रहे। केवल फैरोमॉन या प्रकाश जाल की तुलना में प्रकाश तथा फैरोमॉन दोनों के संयोग से बना जाल श्वेत भृंग की प्रमुख प्रजाति *एच. कॉनसनग्रानिया* को पकड़ने हेतु अधिक प्रभावी पाया गया। प्रकाश व फैरोमॉन दोनों के संयोग से बने जाल में कुल पकड़े गये कीटों में 44.58 प्रतिशत *एच. कॉनसनग्रानिया* कीट पकड़े गये जबकि प्रकाश फैरोमॉन जाल में यह क्रमशः 28.06 तथा 27.35 रहे।

जैवकारकों में *बेसिलस सेरियस* प्रभेद डब्लू.जी.पी.एस.बी. 2 अन्य की तुलना में बेहतर पाया गया तथा नियंत्रण की तुलना में श्वेत भृंग कीट से होने वाली क्षति में 59.8% की कमी लाने में सहायक रहा। कीटनाशियों में, क्लोरनट्रानिलीप्रॉल 0.4 जी अन्य की तुलना में सर्वश्रेष्ठ रहा तथा इससे श्वेत भृंग कीट से होने वाली क्षति में 83.7% की कमी हुई।

गन्ने के प्रमुख कीटों के प्रभावशाली जैवकारकों के बड़ी संख्या में बहुगुणन हेतु *पी.डी.ए.* माध्यम पर *बेवेरिया बेसियाना* तथा *मेटाराइजियम एनिसोप्लिया* के शुद्ध कल्चरों का बहुगुणन किया गया। *मेटाराइजियम एनिसोप्लिया* की वृद्धि *बेवेरिया बेसियाना* की तुलना में तीव्र रही। दोनों कवकों के रोगाणु, बुवाई के दो सप्ताह पश्चात परिरक्षित कर लिए गये।

प्रयोगशाला में गन्ने के टुकड़ों पर पाले जा रहे तना बेधक कीट की सूण्डियों पर खेत से एकत्रित किए गये *कोटेशिया फ्लेवाइप्स* का बहुगुणन किया गया।

प्रवरनगर (महाराष्ट्र) में जैवनियंत्रण क्रियायें तना बेधक (*चाइलो इन्फसकैटेलस*) का सर्वाधिक प्रकोप मई के प्रथम पखवाड़े में दर्ज किया गया तथा इसकी सूण्डियाँ परजीवी *स्टरमिओरसिस* की सर्वाधिक तीव्रता भी इसी समय पाई गई। अगस्त-सितम्बर के दौरान *कोटेशिया फ्लेवाइप्स*, एक अन्य लार्वा परजीवी की पराश्रयता भी देखी गई। इसी प्रकार, स्केल कीट (*मेलानास्पिस ग्लोमेराटा* ग्रीन) की कीट संख्या व इस कीट की कीटभक्षी तथा परजीवी क्रियाशीलता भी दर्ज की गई। पेड़ी फसल में, इस कीट का प्रकोप जुलाई 2010 से देखा गया तथा मार्च 2011 में इसका सर्वाधिक प्रकोप (76.88%) दर्ज किया गया, जबकि सर्वाधिक पराश्रयता (21.05%) अक्टूबर में पाई गई। सितम्बर 2010 में कीटभक्षी कीट की उपस्थित भी संज्ञान में आई।

पाइरिला का प्रकोप मई 2010 से देखा गया तथा इसकी सर्वाधिक तीव्रता अगस्त (लगभग 55 वयस्क तथा 166 निम्फ/100 ठूँठ) में देखी गई। *एपीफ्रिकेनिया* के नये कुकून जुलाई 2010 में रखे गये। इस वर्ष कुछ ही खेतों में गन्ने के ऊनी माहू का प्रकोप पाया गया। जुलाई-अगस्त 2010 की समयावधि में डीफा *एफिडीवोरा* का प्रकोप भी देखा गया तथा माइक्रोमस का प्रकोप अक्टूबर 2010 तक देखा गया।

पादप दैहिकी एवं जैव रसायन

दो रसायनिक मिश्रण एफ-1 तथा एफ-5 शरदकालीन जनित पेड़ी की उत्पादकता के साथ प्रस्फुटन बढ़ाने में सहायक पाये गये। इन मिश्रणों से पेरने योग्य गन्नों की संख्या (एफ 1 में 39% तथा एफ 5 में 35%) तथा औसत गन्ने के भार (एफ 1 में 54% तथा एफ 5 में 67%) में वृद्धि होने से उत्पादकता में वृद्धि हुई। पेरने योग्य गन्नों की संख्या में हुई यह वृद्धि अधिकतम तापमान में वृद्धि के कारण सम्भव हुई। गन्नों के औसत भार में हुई यह वृद्धि इन मिश्रणों द्वारा वृद्धि को उत्प्रेरित करने के कारण हुई जिससे गन्ने की ऊंचाई (एफ 1 में 17% तथा एफ 5 में 25%) तथा गन्ने की मोटाई (एफ 1 में 20% तथा एफ 5 में 27%) में वृद्धि हुई। शरदकालीन जनित पेड़ी (कोसा 96275) के प्रस्फुटन में 20-23% की वृद्धि पाई गई।

गन्ना कटाई से पूर्व मृदा में जिंक सल्फेट डालने पर गन्ना कटाई के एक सप्ताह उपरान्त (अनुपचारित पताव बिछाने के नियंत्रण की तुलना में 2% अधिक) की तुलना में कटाई से पूर्व जिंक सल्फेट का पर्णीय छिड़काव करने पर व्यावसायिक गन्ना शर्करा (अनुपचारित पताव बिछाने के नियंत्रण की तुलना में 6% अधिक) में कटाई उपरान्त क्षति को रोकने में प्रभावी पाया गया। कटे हुए गन्नों पर बैन्जाएल्कोनिय क्लोराइड (0.2%) तथा सोडियम मेटासिलीकेट (0.5%) के संयुक्त प्रयोग के बाद पताव से ढकने पर कटाई के एक सप्ताह उपरान्त तक सुक्रोज में होने वाली क्षति को रोकने में अत्यन्त प्रभावी पाया गया। कटे हुए गन्नों पर विद्युत आवेशित जल के छिड़काव के उपरान्त पताव से ढाँकना भी सुक्रोज क्षति को रोकने में अत्यंत सहायक सिद्ध हुआ।

नमी को बनाए रखने तथा दीर्घकालीन भण्डारण के लिए कटे अंकुरित-चिप्स पर विभिन्न भौतिक एवं रसायनिक विधियां अपनाई गई। रसायनिक विधि के अन्तर्गत अंकुरिका-चिप्स को सर्वप्रथम सोडियम एल्जिनेट (6%) विलयन तथा बाद में कैल्शियम क्लोराइड विलयन (100 एम एम) को कवकनाशी तथा पी.जी.आर. रसायनों में 10 मिनट के लिए भिगोया गया। तत्पश्चात इन अंकुरिका-चिप्स को पंखों के नीचे 2 घन्टे तक सुखाने के उपरान्त पॉलीथीन की थैलियों में रखकर कम तापमान (10^0 से.) पर भण्डारित कर लिया गया। आरम्भिक परिणामों ने दर्शाया है कि कम तापमान पर भण्डारित इन अंकुरिका-चिप्स में नमी की क्षति की दर कम रही तथा इनकी बुवाई पर प्रस्फुटन भी अधिक (85.90%) तथा तीव्र गति से हुआ। इन अंकुरिका-चिप्स में अपचायक शर्करा स्तर तथा इन्वर्टेज क्रियाशीलता भी कम रही, जबकि रसायनिक विधि से इनके उपचार में भण्डारण दशाओं के अनुसार अपनी सीमाएं रही।

गन्ने की प्रजाति कोसे 92423 के तीन आँख के टुकड़ों को जिंक सल्फेट (जिंक 100 पी.पी.एम.) विलयन में 24 घंटों तक भिगोए रखने से ग्रीष्म एवं बसन्तकाल में बुवाई के 55 दिनों बाद अनुपचारित नियंत्रण की तुलना में प्रस्फुटन प्रतिशत में क्रमशः 35 तथा 100% की वृद्धि हुई। जिंक सल्फेट द्वारा उपचारित अंकुरिकाओं में अपचायक शर्करा में, अनुपचारित नियंत्रण की अंकुरिकाओं के 18.7% की तुलना में, 3.07% की वृद्धि दर्ज की गई। उपरोक्त दोनों उपचारों में सुक्रोज के स्तर में क्रमशः 7.6 तथा 10.8% की कमी आई।

बाथिंग माध्यम के सुक्रोज स्तर के विरूद्ध, कम शर्करा युक्त प्रजाति कोसे 92423 की तुलना में सुक्रोज माध्यम से उच्च शर्करा युक्त प्रजाति कोलख 94184 में सुक्रोज शोषण अधिक हुआ। इसका कारण कोलख 94184 की शीघ्र परिपक्वता तथा शर्करा का उच्च संचयन जैसे गुणों से सम्बद्ध हो सकता है।

तना विस्तार दर, कैनोपी कवरेज तथा किल्लों की मृत्यु दर में परिवर्तन करके गन्ने की बावक फसल की उत्पादकता वृद्धि करने के प्रयास किए गये। जिबरेलिक अम्ल, इन्डोल एसीटिक अम्ल तथा काइनेटिन द्वारा उपचार करने से गन्ने के भार में क्रमशः 8.5, 14.8 तथा 27.65%, गन्ने की ऊंचाई में 21.1, 22.2 तथा

17.7% तथा पेरने योग्य गन्नों की संख्या में 69.3, 72 तथा 33.3% की वृद्धि पाई गई। जिबरेलिक अम्ल, इन्डोल एसीटिक अम्ल तथा काइनेटिन द्वारा आये ये परिवर्तन क्रमशः प्रसार दर, पत्तियों का क्षेत्रफल सूचकांक तथा किल्लों की मृत्यु दर में परिवर्तन के कारण संभव हुआ।

गन्ने की प्रजाति कोसे 92423 के पुष्पित एवं अपुष्पित गन्नों में स्त्रोत तथा अवशोषण के अभिलेखन से अपुष्पित गन्ने की तुलना में पुष्पित गन्ने में इकाई गन्ना भार (5%) तथा सुक्रोज संचयन (2.44%) में वृद्धि पाई गई। अपुष्पित गन्नों की तुलना में पुष्पित गन्नों में गन्ने के भण्डारण ऊतकों में सुक्रोज संग्रहण में 24% वृद्धि पाई गई।

एक शीघ्र परिपक्व प्रजाति कोसे 64 तथा एक मध्य-देर से परिपक्व होने वाली प्रजाति बी ओ 91 के गन्नों की परिपक्व अवस्था में निचले एवं शीर्ष भाग का अम्ल घुलनशील-इनवर्टेज, शर्करा तथा रस की गुणवत्ता के मानदंडों के लिए मूल्यांकन किया गया। अर्धमात्रिक आर.टी.पी.सी.आर. आधारित एस.ए.आई. का अक्टूबर माह में अधिक प्रस्फुटन देखा गया जो कि परिपक्वता आने तक धीरे-धीरे घटता गया। गन्ने के शीर्ष भाग में एस.ए.आई. प्रस्फुटन का उच्च स्तर अंकित किया गया जो कि शर्करा मात्रा से नकारात्मक रूप से सम्बद्ध था। अग्रिम प्रजाति कोजे 64 में एस.ए.आई. प्रस्फुटन का स्तर बी ओ 91 की अपेक्षा कम आँका गया जो कि इनके भिन्न परिपक्वता अवस्थाओं का आधार है।

शर्करा एकत्रीकरण तथा शर्करा चयोपचयी किण्वक में प्रभावोत्पादक किण्वक-द्विसंयोजक धनायन (मैंगनीज, मैंगनीशियम) तथा पौध वृद्धि नियामकों (जिब्रेलिक अम्ल, इथ्रेल) के प्रभाव का अध्ययन करने के लिए गन्ने की बी ओ 91 प्रजाति में परिपक्वता प्रारम्भ होने से पूर्व मैग्नीज़, मैगनीशियम आयनों तथा जिब्रेलिक अम्ल व इथ्रेल का छिड़काव किया गया। निम्न शर्करा गन्ना प्रजाति में उपरोक्त प्रभावोत्पादक किण्वकों का छिड़काव करने से शर्करा मात्रा व्यावसायिक गन्ना चीनी, एस/आर अनुपात में वृद्धि तथा अपचायक शर्करा में कमी आयी।

मैंगनीशियम तथा मैंगनीज़ का छिड़काव करने से एस.ए.आई. की विशिष्ट क्रियाशीलता में कमी आयी जबकि एस.पी.एस. तथा एस.एस. में वृद्धि आँकी गयी। प्रभावोत्पादक किण्वकों का एस.ए.आई, एस.पी.एस तथा एस.एस. किण्वक क्रियाशीलता में अन्तर का सत्यापन करने के लिए ट्रान्सक्रिप्ट प्रकटन स्तरों का अध्ययन किया गया। बी ओ 91 प्रजाति में मैंगनीज तथा मैंगनीशियम के उपचार से एस.एस. में वृद्धि एवं एस.ए.आई. में कमी का रूझान आँका गया। एस.एस. एवं एस.ए.आई. ट्रान्सक्रिप्ट स्तरों एवं किण्वक क्रियाशीलता में सीधा एक-दूसरे के साथ सम्बन्ध पाया गया। एस.पी.एस. क्रियाशीलता के विपरीत, एस पी एस ट्रान्सक्रिप्ट स्तर में रासायनिक उपचारों से अन्तर नहीं आया।

गन्ना उत्पादन में यंत्रीकरण

द्विपंक्ति विधि से बोये गये गन्ने की कटाई एवं कटे गन्नों को समेटने के लिए ट्रैक्टर के अग्र भाग में समायोजित होने वाला एक गन्ना कटाई यंत्र विकसित किया गया। चालन एवं प्रक्षेत्र क्रियाओं के समय कटाई यंत्र को ऊँचा उठाने तथा नीचे लाने के लिए मृदु इस्पात का ढाँचा तथा हाइड्रौलिक बेलन द्वारा नियंत्रित भुजाएं आदि संलग्नक तैयार किये गये। यंत्र के कर्तन छुरों को ट्रैक्टर पी.टी.ओ. से शक्ति संप्रेषित की गयी। गन्ना कटाई के समय आंशिक रूप से गिरे हुए गन्नों को उठाने तथा गन्नों की कर्तन छुरों की ओर अग्रेषण के लिए यंत्र के मुख्य ढाँचे में संलग्नक लगाये गये। यंत्र की औसत प्रक्षेत्र धारिता 0.15-2.0 हे./घंटा एवं प्रक्षेत्र क्षमता 50-60% आँकी गयी।

30:120 सेमी पंक्ति ज्यामिति में ट्रैक्टर चालित द्विपंक्ति गन्ना बुवाई यंत्र का वृहत् स्तर पर प्रक्षेत्र परीक्षण किया गया। यंत्र की प्रभावी प्रक्षेत्र धारिता 0.20-0.25 हे./घंटा तथा प्रक्षेत्र क्षमता 65-70% आँकी गयी।

ट्रैक्टर चालित एवं अग्र भाग में समायोजित होने वाले भाग कटाई यंत्र को उसकी कटाई तकनीक में सुधार के उपरांत चौड़ाई पर बोयी गयी द्विपंक्ति गन्ने की कटाई के लिए परीक्षण किया गया। द्विपंक्ति विधि से चौड़ाई पर बोये गये गन्ने के कारण कटे हुए गन्ने को समेटने का कार्य ठीक ढंग से सम्पन्न हुआ। यंत्र में और भी सुधार कार्य प्रगति पर हैं।

गन्ना बुवाई यंत्रों में प्रयुक्त होने वाले विभिन्न कर्तन छुरों आई.आई.एस.आर. रिजर टाइप, बहुउद्देशीय, वी.एस.आई. तथा खालसा गन्ना बुवाई यंत्र का विनिर्माण किया गया तथा विभिन्न छुरों द्वारा कटाव में प्रयुक्त होने वाली ऊर्जा का मापन कार्य प्रगति पर है।

रेजिड्यू मल्चर-कम-बायोअप्लीकेटर के विभिन्न संघटकों को अभिकल्पित तथा निर्मित करके जोड़ा गया। इस इकाई का परीक्षण लगभग 4-5 टन प्रति हेक्टेयर की दर से समान रूप से फैली हुई पताव की कटाई में संतोषजनक पाया गया। उक्त मशीन पताव को 45 से.मी. के बैण्ड में दो भागों में काटने में समर्थ है। ट्रैक्टर की दो किलोमीटर प्रति घंटा की निर्धारित गति से, कटे हुए बैण्ड्स के ऊपर द्रव के रूप में लगभग 180 लीटर प्रति हेक्टेयर जैव पदार्थो का प्रयोग किया गया।

आई.आई.एस.आर. शक्ति चालित पत्तियाँ निकालने की मशीन के चालन परीक्षण के समय कोशा 95270 प्रजाति के कटे हुए गन्ने शीर्ष की ओर से मुखद्वार के मध्य प्रवेशित किये गये। औसतन पत्तियाँ निकालने की क्षमता 80 प्रतिशत पाई गयी। इस क्षमता को बेहतर बनाये रखने के लिए शक्ति हस्तांतरण वी-पट्टों को समय-समय पर बदलने की आवश्यकता पड़ी। यंत्र की कार्य क्षमता 1.0-2.4 टन गन्ना प्रति घंटा आंकी गयी।

मटर तथा गेहूँ के प्रारूप बिजाई यंत्र का परीक्षण करने के लिए दो हेक्टेयर क्षेत्र में मटर तथा 36 हेक्टेयर क्षेत्र में गेहूँ की बुवाई की गयी।

बिसवाँ चीनी मिल क्षेत्र के अधीनस्थ क्षेत्र के किसानों के 10 हेक्टेयर क्षेत्र में पेड़ी प्रबन्धन यंत्र का अग्रिम पंक्ति प्रदर्शन किया गया। इस यंत्र से गहरी जुताई, जड़ों की कटाई, उर्वरक एवं खाद डालना तथा मिट्टी चढ़ाना आदि जैसी विभिन्न क्रियाएं संतोषजनक ढंग से सम्पादित हुई। इन सभी कार्यों को एक साथ सम्पादित करने में लगभग 3 घंटे प्रति हेक्टेयर की दर से समय लगा।

किसानों के 15 हेक्टेयर क्षेत्र में आई.आई.एस.आर. रेज्ड बेड सीडर-कम-शुगरकेन प्लान्टर का अग्रिम पंक्ति प्रदर्शन संतोषजनक ढंग से संम्पादित किया गया।

हरदोई, सीतापुर, उन्नाव, तथा लखीमपुर खीरी जनपदों में आई.आई.एस.आर. तीन पंक्ति परिमार्जित गन्ना बुवाई यंत्र के अग्रिम पंक्ति प्रदर्शन के अंतर्गत किसानों के 73 हेक्टेयर क्षेत्र में बुवाई की गयी।

चुकन्दर उत्पादन एवं सुधार

चुकन्दर के पाँच अभिजनकों का उनकी जड़ उपज के लिए लखनऊ में किये गये मूल्यांकन से 7112 में शर्करा की मात्रा तथा कुल शर्करा उपज अधिक पायी गयी जबकि प्रवेशिका फैलिएटा जड़ गलन के लिए सहिष्णु पायी गयी। विशिष्ट वर्ग की प्रजनन सामग्री का लखनऊ में मूल्यांकन करने पर, मिश्रित क्रमशः एल.के.सी. 2000 तथा एल.के.सी. 2007 अधिकतम चीनी एवं जड़ उपज पायी गयी। एफ.सी. 722, लोहित सेलेक्शन-6 तथा एल.के.सी.-2007 जड़ गलन के लिए सहिष्णु पायी गयीं। एल.के.सी. 2000 तथा 7112 x एल.एस.-6 की भावी पीढ़ी ने जड़ों में अधिक शर्करा की मात्रा दर्शायी। एफ.सी. 722 x एल.एस. 6, तथा एल.के.सी. -2007 सैनिक कीट के लिए सहिष्णु पायी गयीं। देशी प्रजाति एल. एस. -6 का वृहद स्तर पर बीज उत्पादन किया गया तथा 30 कि. ग्रा. बीज पैदा किया गया। इसके अतिरिक्त, 36 जननद्रव्यों का 8 कि.ग्रा. बीज गढ़ मुक्तेश्वर में पैदा किया गया।

बीज उत्पादन

संस्थान ने इस वर्ष बीज गन्ना उत्पादन के लिए 800 टन निर्धारित लक्ष्य को पीछे छोड़ते हुए नवीनतम् विकसित गन्ना प्रजातियों का कुल 1190 टन बीज पैदा किया। इसमें 995 टन संस्थान के मुख्य प्रक्षेत्र तथा 195 टन क्षेत्रीय शोध केन्द्र, मोतीपुर (बिहार) द्वारा उत्पादित किया गया।

अन्य

सभी प्रकार के लगभग 134 प्रकाशित वैज्ञानिक लेखों में से संस्थान के वैज्ञानिकों द्वारा गत वर्ष 31 शोध पत्र प्रकाशित किये गये जिसमें 20 शोध पत्र राष्ट्रीय पत्रिकाओं में तथा शेष 11 शोध पत्र विदेशी पत्रिकाओं में प्रकाशित हुए। संस्थान द्वारा बनाई गयी नवीन मशीनों की व्यवहारिकता का आंकलन भी किया गया। गन्ना उत्पादन करने वाले क्षेत्रों में लगभग 27 प्रदर्शनों तथा गन्ना किसानों के लिए 2 प्रशिक्षण कार्यक्रमों का भी आयोजन किया गया। विभिन्न मानव संसाधन प्रबन्धन एवं अन्य साम्थर्य निर्माण कार्यक्रमों में 40 वैज्ञानिकों एवं 11 अधिकारियों ने भाग लिया।

Executive summary

Crop Improvement

A 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 material was supplied to various on-going projects of the Institute. Ikshu ISH clones showed better ratooning performance over ISH clones, LG selections, commercial hybrids and species level clones *etc.*

Genotype LG 05398 recorded the highest cane and sugar yield out of 14 promising genotypes and four standard varieties evaluated for cane yield and quality traits. Four genotypes *viz.*, LG 05302, LG 05403, LG 99270 and LG 05480 were identified as potential early maturing genotypes, while LG 05398, LG 04099, LG 04438, LG 06021 and LG 06004 were found promising as mid-late maturing genotypes.

Out of 79 C_1 clones, 27 clones were promoted to the second clonal generation for further evaluation under moisture deficit environment. Among the selected clones, LG 08752 had shown highest sucrose (20.22%) in December followed by LG 08709 (19.32%) and LG 08745 (19.06%). Out of 42 C_2 clones, 24 clones were selected on the basis of sucrose content and general growth performance. These clones were promoted to C_3 generation for their evaluation under normal as well as moisture deficit conditions.

Evaluation of 300 selections in C_2 for early brix revealed that 48 selections were found to have high sugar (potential breeding stock), as compared with early maturing sugar check variety, CoJ 64. Twenty two selections were advanced for further evaluation of varietal merit.

Out of 48 C_3 genotypes evaluated for top borer tolerance, general vigour and brix, 19 advanced to C_4 stage. Four clones *viz.*, LG 06602, LG 06605, LG 06606 and LG 06607 possessing superiority in traits of economic importance were advanced to station trial after evaluation of 20 clones along with two standards *viz.*, CoS 767 and CoJ 64 for top borer tolerance and sugar yield.

In a evaluation trial of 10 clones along with two checks *viz.*, CoJ 64 and CoS 767 to validate for disease reaction to red rot and to assess their yield and quality performance, clones LG 06810, LG 06823A, LG 06839 and LG 06856 showed moderately resistant reaction to two virulent pathotypes *viz.*, Cf 08 and Cf 09, while LG 06823A also showed highest cane yield (91.0 t/ha). LG 06856 also showed 19.8% sucrose in juice at 300 days.

Five early maturing entries *viz.*, Co 05009, CoH 05262, CoH 05265, CoLk 05201 and CoPk 05191 with two checks *viz.*, CoJ 64 and Co Pant 84211 were evaluated for their performance as second plant crop in an advance varietal trial (Early) II Plant. Genotype CoPk 05191 was significantly found to be the best for cane (108.6 t/ha) and sugar yield (13.4 t/ha) followed by CoLk 05201 over the best check CoPant 84211.

In an evaluation trial of 18 entries along with two standards *viz.*, CoJ 64 and Co Pant 84211 for cane yield, quality and other attributes, Co 0303 and CoBln 03172 exhibited superior yield while, Co 0306 gave highest sucrose content.

Three elite clones namely, LG 05350, LG 05306 and LG 04439 were included in the Station Trial 2011-12 based on their performance in the plant crop. Apart from this, two early selections, LG 05302 and LG 05403 and one mid-late maturing selection LG 02434 were accepted for evaluation under UP State Varietal Testing Programme at 13 locations.

A mid-late maturing genotype, LG 05447 was accepted in the UP State Varietal Testing Programme based on its performance, both in plant and ratoon crops.

Four genetic stocks *viz.*, LG 06601, LG 06602, LG 06603 and LG 06604 were included in National Hybridization Garden of Sugarcane Breeding Institute, Coimbatore.

Genotypes CoLk 05201, CoLk 07201, CoLk 07202 and CoLk 07203 are at different stages of testing in multilocation evaluation under AICRP (S) for North Western Zone.

Two somaclones resistant to red rot have been sent to the National Hybridization Garden at SBI, Coimbatore and are being involved in crossing.

Towards genetic transformation in sugarcane for resistance against borers, sugarcane cultivar CoLk 8102 susceptible to stalk borer was

transformed with the *Cry1Ab* gene. Transformants were developed and confirmed with GUS assay and PCR amplification of bar gene. ELISA analysis showed that transformed plants produced 0.39 to 5.08 times higher expression of *Cry1Ab* protein in comparison to untransformed plants. Insect bioassay studies revealed that weight loss was 30-50% in the larvae feeding on transformed plant foliage leading to mortality.

Under identification and expression analysis of resistance gene analogues against red rot disease in sugarcane, 19 forward and 18 reverse primers in 42 different combinations were used for PCR amplification. Out of these, 22 primers showed clear amplification. A total of 520 bands were produced of which more than 60% were polymorphic.

For the development of SSR markers for red rot resistance from EST database of sugarcane, a total of 235 new EST-SSR primers were designed and developed from 4169 unique ESTs of Indian origin. Out of 222 (94.5%) primers which showed amplification, 118 primers (53.2%) were polymorphic.

Crop Production

Higher cane yield (76.37 tonnes/ha) was harvested with genotype CoPk 05191 and it was comparable with LG 05031 (71.56 tonnes/ha). Recommended level of NPK *i.e.*, 150, 60 and 60 kg/ha fetched higher cane (69.13 t/ha) and sugar (8.74 t/ha) yields over 75% of recommended NPK.

Paired row planting (120-30 cm) with the irrigation applied in furrows parallel to one row was identified as highest irrigation water use efficient method of planting with IWUE of 4016 kg cane/ha/cm against 1140 kg cane/ha-cm under flooding. Highest number of millable canes (176.3 thousand/ha), cane yield (88.6 t/ha) and sugar yield (10.05 t/ha) were recorded under trench planting with IWUE of 3955 kg cane/ha-cm.

Irrigation scheduling at IW/CPE ratio of 0.75 enhanced the yield attributing characters *i.e.*, cane length, cane weight and number of millable canes and yield (57.36 t/ha) over at 0.50. The irrigation water use efficiency was higher (0.94 t/ha-cm) at IW/CPE ratio of 0.50 and it reduced to 0.8 and 0.6 t/ha-cm in the treatment of irrigation at IW/CPE ratio of 0.75 and 1.00, respectively.

Pre-planting deep tillage and subsoiling increased number of millable canes (87,670/ha) and cane yield (61.54 t/ha) and water use efficiency. The highest WUE (96.97 kg cane/ha-mm) was obtained with deep tillage and subsoiling with application of 150 kg N/ha.

Higher infiltration rate (4.31 mm/h) and lower bulk density (1.33 Mg/m^3), highest shoot population (209.2 thousand/ha at 180 DAP), number of millable canes (180.8 thousand/ha), cane (87.8 t/ha) and sugar yield (9.26 t/ha) were recorded under pre-planting tillage operation of cross sub-soiling at 1.0 m distance.

Application of SPMC with Gluconacetobacter recorded the highest cane yield (57.40 t/ha) of 7th ratoon followed by SPMC (54.80 t/ha) and FYM + Gluconacetobacter (54.30 t/ha) against control (18.7 t/ha). The highest value of soil microbial biomass carbon (SMB-C) of 234.70 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.

The apparent reduction (36.52 to 10.90%) in gaps of second ratoon (CoSe 92423) was observed when initiated from plant crop raised with increased planting density (from 30,000 to 60,000 three-bud setts/ha). Gap filling in plant cane with 3-bud setts at 45 DAP produced 9.31% higher ratoon cane (75.08 t/ha) than without gap filling (68.09 t/ha). Application of 80 kg K/ha through irrigation water in plant cane before one month of harvesting produced 10.54% higher ratoon cane over control.

Application of sulphitation press-mud cake (SPMC) @ 20 t/ha or SPMC 10 t/ha + 25 kg $ZnSO_4$/ha tangibly promoted the bud sprouting in ratoon, increased the number of millable canes (99,500/ha) and cane yield (71.0 t/ha).

Among different technologies evaluated at farmers field, the ring-pit method of planting was reckoned with the highest increase in cane yield (109.70%), irrigation water use efficiency (IWUE) and net return (₹ 164574/ha) over conventional method of planting. Highest B:C ratio was calculated for trash mulching technology (2.08) followed by skip furrow method of irrigation (1.86).

Crop Protection

Sugarcane command areas of eight sugar mills in UP and Bihar were surveyed for the prevalence of insect-pests and diseases. Red rot was found in several areas of central U.P. and Bihar. In

Harinagar Sugar Mills, Bihar, the major varieties affected with red rot were CoSe 95422 and CoJ 88. In Central U.P., the varieties affected with red rot were CoLk 8102, CoS 767, CoS 8432 and CoS 8436. The incidence of plassey borer, scale insect and white fly was observed in the command area of Harinagar Sugar Mills, Bihar. In command area of DSCL Sugar, Rupapur in certain fields, the incidence of internode borer was recorded to the tune of 70% in autumn planted crops, while its incidence was low in spring planted crops. In certain locations, the incidence of stalk borer was about 5-15% while the incidence of top borer was found to be 20-30%.

Twenty five genotypes evaluated were resistant to both (Cf 08 and Cf 09) the pathotypes of red rot, while eight genotypes were moderately to highly susceptible to both the pathotypes. Seven genotypes exhibited susceptible reaction to one pathotype and resistance to other pathotype. LG 05311 showed resistant reaction to pathotype Cf 08.

Thirty six genotypes were resistant to smut. Only five genotypes *viz*., LG 05605, LG 05340, LG 05377, LG 05417 and LG 06609 showed susceptibility.

When treated canes were challenge inoculated with *Colletotrichum falcatum,* cane stalks were protected from red rot infection in soil application of TMC (72.0%), MHAT (46.0%) and TMC+ MHAT (76.0%). Soil application of *T. harzianum* enhanced the availability of macronutrients *i.e.,* N, P, K by 27.0, 65.0 and 44%, respectively.

Studies on modulating host resistance indicated lower reducing sugars, total phenols contents, peroxidase and PPO activity in red rot inoculated genotypes over control except peroxidase in CoLk 94184, which showed higher activity. CoJ 64 and Co 1148 showed marked increase in total phenols and reducing sugars contents.

Endophytic fungal population was isolated from nodes, internodes, buds, leaves and midrib of apparently healthy 35 sugarcane genotypes in different months. Overall colonization rates of endophytes were 40% in early month of the crop growth and 60% in later months. Endophytes belonged to eight different fungal taxa of which *Trichoderma, Aspergillus* and *Fusarium* were dominant. Frequency of the colonization varied depending on the age of the plant and genotypes of sugarcane. Dual cultures studies revealed that *Trichoderma* and *Aspergillus* species are having antagonistic properties against red rot pathogen.

Population dynamics of sugarcane borers *viz*., early shoot, top and stalk borers were studied by installing their respective pheromone traps in separate sugarcane fields at Institutes farm. Amongst these three lures, top borer moths were trapped effectively *i.e*., 274, 354, 498 and 300 adult moths per lure during I, II, III and IV brood emergence. Infestation percentage of top borer was recorded (brood wise) as 7.1, 10.5, 5.45 and 3.44% in plots having pheromone trap, where as it was 9.8, 11.9, 6.88 and 4.09% in plots without pheromone traps in I, II, III and IV broods, respectively.

The mean incidence of top borer (III brood) was recorded as 7.76% in conserve release of all parasitoids followed by conserve release of larval parasitoids, *Stenobracon nicevillei* and *Rhaconotus scirpophagae*. However, incidence of IV brood was recorded as 16.03% in conserve release of all parasitoids followed by conserve release of larval parasitoids, *S. nicevillei* and *R.scirpophagae. Isotima javensis* and *R. scirpophagae* played a significant role in reducing incidence of III and IV brood.

After one month of planting, sett damage by termites varied from 5.16 -17.33% and bud damage from 7.15-24.66%. Shoot damage ranged from 5.53-32.33%. Maximum yield was obtained in plots with chlorpyriphos treatment (68.25 t/ha) followed by imidacloprid (65.84 t/ha), whereas it was 46.54 t/ha in untreated check.

In western U.P., mass emergence of white grubs (*H. consanguinea*) beetle was recorded from third week of May to last week of June.

Trap with a combination of light and pheromone was found more effective in trapping predominant species *H. consanguinea* in comparison to the traps with either pheromone or light. Out of the total beetle catch, a mean of 44.58% *H. consanguinea* was trapped in the trap having combination of light and pheromone followed by that of light (28.06%) and pheromone (27.35%).

Amongst bioagents, *Bacillus cereus* strain WGPSB-2 was better over others, and reduced white grub damage by 59.8% over control. Amongst insecticides, Chlorantraniliprole 0.4G was found sueprior to others, as it reduced the white grub damage by 83.7%.

For mass multiplication of potential bioagents

of sugarcane insect pests, pure cultures of *Beauveria bassiana* and *Metarhizium anisopliae* were routinely multiplied on potato dextrose agar (PDA) medium. Growth of *Metarhizium anisopliae* was faster than *Beauveria bassiana*. Spores of *Metarhizium anisopliae* and *Beauveria bassiana* were harvested after two weeks of seeding.

Field collected *Cotesia flavipes* was multiplied on stalk borer larvae (factitious host) reared on cane bits in laboratory. Mature host larvae were offered individually to gravid females of *Cotesia flavipes* for parasitisation in plastic jars. Parasitized larvae were shifted to natural food in glass tubes (10 cm x 3 cm) and kept at 27±2 ^{0}C and 70% RH. From single larvae, about 35-36 cocoons were obtained and out of them, 62.5 % parasitic emergence was recorded with 66.67% female population.

The varieties/genotypes for their reaction against major insect pests were also evaluated. The infestation of borer pests remained quite low. In early genotypes, incidence of top borer III and IV brood was maximum in CoH 05262 (9.66%), whereas minmum incidence was in CoLk 05201 (3.43%) in III brood. Among the mid-late genotypes, maximum incidence of top borer was recorded on Co 0327 (17.12%) and minimum was in CoPk 05192 (1.67%). Minimum incidence of internode and stalk borer was recorded in Co 05009 (4.66%) and CoPk 05191 (1.6%), respectively.

Biological control activities for insect-pests of sugarcane were also carried out at Pravaranagar (Maharashtra). Maximum incidence of shoot borer (*Chilo infuscatellus*) was recorded in the first fortnight of May and it coincided with the maximum activity of its larval parasite *Sturmiopsis* sp. During August-September parasitisation of *Cotesia flavipes*, another larval parasite was also observed. Similarly, population build up of scale insect (*Melanaspis glomerata* Green) and the predatory and parasitic activity containing this pest were also recorded. In ratoon crop, the infestation was noticed from July 2010 and maximum incidence (76.88%) was recorded in March 2011, however, maximum parasitisation (21.05%) was observed during October. Presence of predatory beetle was also noticed during September 2010.

The activity of *Pyrilla* was noticed from May 2010 and it reached its peak during August (about 55 adults and 166 nymphs/100 clumps). Fresh cocoons of *Epiricania* were noticed in July 2010. This year stray incidence of sugarcane woolly aphid was noticed in some fields. The activity of *Dipha aphidivora* was also noticed during July–August, 2010 and *Micromus* was also observed up to October, 2010.

Plant Physiology & Biochemistry

The two chemical formulations F-1 and F-5 were found to be effective in improving the sprouting of stubble buds *vis a vis* the productivity of winter- initiated ratoon. These formulations improved productivity by increasing NMC (39% in F-1 and 35% in F-5), average cane weight (54% in F-1 and 67% in F-5). The increase in NMC was due to increase in T_{max} and not due to reduction in mortality percentage. The increase in average cane weight appeared to be due to stimulation of growth by these formulation which resulted in increased cane height (17% in F-1 and 25% in F-5) as well as increase in cane diameter (20% in F-1 and 27% in F-5). In a large scale trial of the two promising formulations for improving sprouting and yield of winter-initiated ratoons (CoS 96275), initial results indicated improvement in sprouting by 20-23%.

A pre-harvest foliar application of zinc sulphate on sugarcane was found effective in reducing post-harvest loss in commercial cane sugar (6.0% over untreated trash covered control) in comparison to pre-harvest soil application of zinc sulphate (2.0% over untreated trash covered control) after one week of staling. The application of benzalkonium chloride (0.2%) and sodium metasilicate (0.5%) over harvested cane followed by covering with trash was found to be effective in minimizing sucrose loss in harvested cane stored for a period of one week. The spraying of electrolyzed water (EW) on the harvested cane followed by covering with trash was also effective in reducing sucrose losses.

Physical and chemical methods of bud chips encapsulation was performed for moisture retention and long duration storage. Under chemical method, bud chips were first soaked in sodium alginate (6%) solution, and then in calcium chloride solution (100mM) mixed with fungicide and PGR chemicals for 10 minutes. The encapsulated bud chips were dried under fan for 2 hrs and kept in polyethylene bags and stored at low temperature (10^{o}C) conditions. The preliminary data indicated lower rate of moisture loss and faster higher rate of bud germination (85-90%) of encapsulated bud chip seed material planted if stored at low temperature conditions. The encapsulated bud chips showed lower reducing sugars contents and invertase

activity. However, in chemical method of bud chip encapsulation, there are certain limitations as per storage conditions.

Soaking of three bud setts of variety CoSe 92423 in zinc sulphate (Zn 100 ppm) solution for 24 hours increased the sprouting percentage by 35 and 100% over control after 55 days of planting in summer and spring, respectively. Increase in reducing sugar by 307% in zinc sulphate treated buds and 187% in buds from untreated control was recorded. Decrease in sucrose was 76% and 10.8%, respectively in these two treatments.

In vitro sucrose uptake by internodal slices of high sugar variety CoLk 94184 from sucrose medium was higher than that of low sugar variety CoSe 92423, irrespective of the sucrose content of bathing medium. The higher *in vivo* sucrose transport and *in vitro* sucrose uptake are possibly linked to early maturity and high accumulation characteristics of CoLk 94184.

Attempts were made to improve cane yield (plant cane) by changing the stalk extension rate, canopy coverage and tiller mortality. The treatment of GA, IAA and kinetin improved per cane weight by 8.5, 14.8, 27.65%, cane length by 21.1, 22.2, 17.7, and number of millable canes by 69.3, 72.0, 33.3%, respectively. These changes due to GA, IAA and kinetin were due to change in extension rate, LAI and reduced mortality of tillers, respectively.

Perturbation in source and sink was recorded in flowered and non-flowered cane of variety CoSe 92423 led to increase in unit cane weight (5%) and sucrose accumulation (2.44%) in flowered cane compared with non-flowered cane. The *in vitro* uptake of sucrose in the slices of internodal tissue was increased by 24% in flowered cane compared with non flowered cane.

Top and basal portion of cane stalk of two sugarcane genotypes, CoJ 64 (an early maturing genotype) and BO 91 (a mid-late maturing genotype) were evaluated for soluble acid invertase (SAI), sucrose and juice quality parameters during ripening phase. Semi quantitative RT-PCR based SAI expression showed its higher expression in the month of October which decreased gradually with cane maturity. Apical portion of stalk tissues showed comparatively higher level of SAI expression and it showed negative correlation with sucrose content. Sugarcane cultivar CoJ 64 showed comparatively lower expression of SAI gene than those of BO 91, which is largely responsible for their different maturing behaviour.

To study the effect of different enzyme effectors; divalent cations (Mn^{++}, Mg^{++}) and plant growth regulators (GA and ethrel) on sucrose accumulation and sucrose metabolizing enzymes, foliar spray of different chemicals (Mg^{++}, Mn^{++}, GA and ethrel) was performed before the onset of cane ripening in sugarcane cultivar BO 91. Results indicated increased sucrose content, CCS, S/R ratio and reduced content of reducing sugars in low sugar genotype by foliar application of enzyme effectors. Specific activity of SAI decreased while SPS and SS increased by the application of Mg^{++} and Mn^{++}. Transcript expression levels were studied to verify changes in SAI, SPS and SS enzyme activity due to enzyme effectors. An increasing trend of SS and decreasing trend of SAI was observed due to Mn^{++} and Mg^{++} treatment in cultivar BO 91. SS and SAI transcript levels and enzymes activities were directly correlated with each other. Unlike SPS activity, SPS transcript level was not changed due to chemical treatment.

Mechanization of sugarcane cultivation

A front mounted tractor operated harvester was developed for cutting and windrowing of two rows of sugarcane. Attachments, consisting of a M.S. frame and hydraulically controlled arms through hydraulic cylinders, were developed for raising and lowering of harvester during transportation as well as field operation. Power to the cutting blades was provided through tractor PTO. Attachments were also provided with the main frame for windrowing of harvested cane by guiding the cane towards cutting blades during harvesting operation and up to some extent for raising the partially lodged canes. The average effective field capacity of the equipment was 0.15-0.20 ha/h with field efficiency of 50-60%.

The tractor operated paired row sugarcane cutter planter was field tested at large scale for planting of cane at 30:120 cm row geometry. The effective field capacity of the equipment was 0.20-0.25 ha/h with a field efficiency of 65-70%.

IISR tractor operated front mounted sugarcane harvester, with certain modifications in the cutting mechanism, was used for harvesting of wide spaced paired row planted crop. The windrowing of harvested cane was proper due to wide spacing between the paired rows. The refinements are still in progress.

Four types of blades of various profiles and angles used in different types of sugarcane planters *viz*., IISR ridger type, multipurpose, VSI and Khalsa sugarcane cutter planters were fabricated and the measurement of cutting energy of different types of cutting blades is in progress.

Different components of the residue mulcher–cum- bio applicator were designed, fabricated and assembled. The preliminary trials revealed that the chopping unit worked satisfactorily in the field having uniformy spread trash (4-5 t/ha). The machine is able to chop the trash in two bands having width of 45 cm each. Bio application was carried out in form of liquid over the chopped band(s) through gravitational force. Total amount of liquid dispensed as spray was 180 l/ha at a tractor forward speed of 2 km/h.

Under the feasibility trial of IISR power operated detrasher, the harvested canes of variety CoS 95270 were fed from their green tops side through the feeding chute to the detrashing rollers. Average trash removal efficiency was 80.0%. Power transmitting V-belts needed to be replaced from time to time for achieving better detrashing efficiency. The output of the detrasher ranged from 1.0 to 2.4 tonnes of cane/h, depending upon the feeding of canes.

Prototype feasibility trials were conducted in 2 ha area for drilling pea and 36 ha area for wheat. Farmers were satisfied with the performance of the seed drill.

The FLD of ratoon management device (RMD) was conducted at farmers' fields in 10 ha area in Biswa Sugar Mill area. Operations like deep tilling, off barring, application of manure and chemical fertilizers in free-flowing and in liquid form and earthing–up were got executed satisfactorily. It took nearly three hours per hectare of ratoon field to complete all assigned task in one pass of the tractor.

The FLD of IISR raised bed seeder (RBS)-cum-sugarcane planter was conducted satisfactorily in 15 ha area at farmers field.

The FLD of IISR modified three row cane planter was undertaken satisfactorily at farmers' fields in 73 ha area in Hardoi, Sitapur, Unnao and Lakhimpur Kheri districts.

The 3-roller horizontal power driven crusher were modified and tested. It yielded 66% juice on cane basis with cane crushing capacity of 450 kg/h.

Sugarbeet production and improvement

Evaluation of five germplasm lines of sugarbeet for root crop performance at Lucknow revealed that 7112 was found to be superior in sucrose content and gross sugar yield, while Feliata was found to be tolerant to root rot. Evaluation of elite material for root crop performance at Lucknow revealed that the composites *viz*., LKC-2000, followed by LKC-2007 possessed the highest gross sugar and root yield. FC-722 x LS-6 and LKC-2007 were tolerant to root rot. LKC-2000 and progenies of 7112 x LS-6 mating had shown higher sucrose content in root. Progenies of FC-722 x LS-6, FC-722 x LS-6 and LKC-2007 were tolerant to army worm. The indigenous variety LS-6 was taken for bulk seed programme and 30 kg of seed was produced. In addition, 8 kg seed of 36 germplasm/ breeding lines/composites and hybrids was produced at Mukteswar.

Cane seed production

About 1190 t of sugarcane seed of recently released varieties (995 t at the IISR Main Farm, Lucknow and 195 t at IISR Regional Centre, Motipur) was produced during 2010-11 against the target of 800 t.

Miscellaneous

In addition to research activities, the number of publications made during the year were 134, out of which, 31 were research papers. Twenty research papers were published in national and 11 in foreign journals. The Institute carried out feasibility trials of machinery developed in recent past. About 27 demonstrations on sugarcane were carried out in cane command areas. Two training programmes for sugarcane farmers were undertaken. Forty scientists and 11 officials participated in various human resource management and other capacity building activities.

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 1st January, 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 climate 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 11.5^0C. 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 subtropical 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

The strategies and corresponding programmes in detail are as follows :

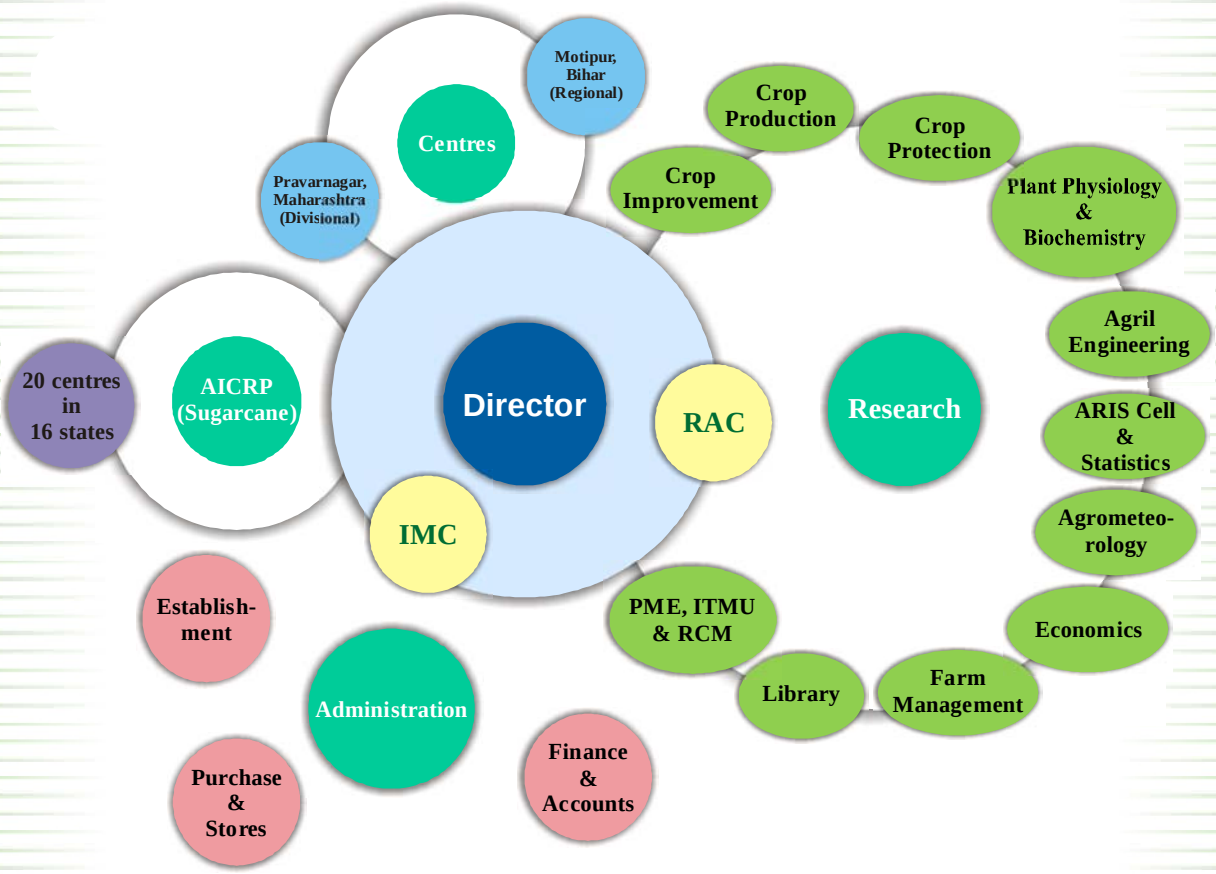
Issues	Strategies	Programmes
A. Increasing levels of cane yield	1) Developing high yielding, disease resistant and pest tolerant, good ratooning varieties	• Pre-breeding programme
		• Molecular breeding programme
		• Varietal development programme
		• Mapping the virulence and population diversity of pathogens and insect-pests.
		• Identification of sources of resistance against major diseases and pests
		• Identification of disease/pest resistant cane genotypes
		• Evaluation of physio-biochemical attributes associated with higher productivity
	2) Designing and developing planting methods, planting geometry and integrated nutrient supply system for maximizing yield of plant and ratoon crops	• Optimising plant population density in sugarcane plant-ratoon system • Developing integrated nutrient management technology for sugarcane plant ratoon system
		• Nutrient use efficiency at cellular and organ level.
		• Design and development of equipments for different planting methods and planting geometries
		• Precise and efficient application of fertilizers and pesticides
	3) Improving quality seed production	• Maintenance and production system of quality seed cane
		• Determination of optimum nutritional and water requirement for quality seed production
		• Production of healthy seed cane with high vigour through bio-agents
		• Physiological and biochemical criteria for quality seed cane
		• Heat treatment of seed cane
	4) Increasing physiological efficiency of sugarcane varieties for biomass and sugar	• Dry matter production and partitioning to assess cane yield and sucrose
	5) Quantifying the effect of climate on yield and quality of sugarcane	• Climate/ weather relationships on yield and quality of sugarcane in different agro-climatic zones of the country
	6) Management of red rot and borers	• Biological control of red rot
		• Characterization of biodiversity of red rot pathogen
		• Biocontrol of borers
B. Increasing sugar recovery	1) Developing high sugar early maturing varieties	• Pre-breeding programme
		• Molecular breeding programme
		• Varietal development programme
		• Identification of early maturing red rot resistant varieties
		• Evaluation of plant attributes associated with high sugar and early maturity
	2) Balancing nutrition requirement to sustain high sugar recovery	• Balancing the nutrient use and amelioration of deficiencies
	3) Using ripeners for advancing maturity	• Increasing sucrose content for early harvest
	4) Minimising post-harvest sucrose losses	• Management of post-harvest sucrose losses

Issues	Strategies	Programmes
C. Declining factor productivity	1) Crop residue recycling 2) Introduction of legumes in cropping system 3) Rhizosphere bio-engineering	
D. Reducing cost of cane cultivation	1) Mechanizing sugarcane cultivation	• Mechanization of various operations in sugarcane cultivation
	2) Enhancing input use efficiency and reducing use of costly inputs like pesticides	• Reducing use of seed cane and cost of planting operations
		• Improving nutrient, water and herbicide use efficiencies
		• Development of cost effective protection technology
		• Optimizing tillering and higher nutrient use efficiency
		• Improving water use efficiency
	3) Enhancing productivity of ratoon cane	• Developing agro-techniques to improve ratoon productivity
		• Plant protection measures for ratoon
		• Improving sprouting of stubble buds
		• Equipment for increasing ratoon productivity
E. Making cultivation of sugarbeet in India a success	1) Sugarbeet improvement and seed production	• Development of high yielding and tropicalized varieties of sugarbeet • Development of agro-techniques and plant protection measures • Development of seed production technology
F. Policy related programmes	1) Improving production and marketing efficiency	• *Ex-ante* and *ex-post* economic evaluation of sugarcane production technology • Forecasting parameters of sugarcane and sugar production • Identification of production and marketing constraints • Pricing policies for sugarcane and its end products • Development of transportation models • Reducing cost of sugarcane production for boosting farmers' income and sugar exports as well
	2) Adaptive research	• Sugarcane adaptive research at farmers' field in linkages with sugar industries, State cane departments, State agricultural universities and other sugarcane related organizations
G. Human resource development	1) Training the available manpower in the emerging and frontier areas like biotechnology, bioinformatics, *etc.*	• Need based training for scientific and technical personnel in emerging and frontier areas relating to individual discipline in collaboration with the centre of excellence both at National and International level
	2) Training sugarcane development personnel, farmers, *etc.*	• Training and consultancy services related to sugarcane cultivation. Different Divisions along with Extension & Training Unit and KVK will take part in training programme organized by the Institute on sugarcane production, protection and management to farmers, cane development personnel, extension workers and to those interested in sugarcane cultivation.

Organizational structure

The current organizational structure of the Institute is shown below :

Organizational Structure



The detailed organizational set-up is given below:

Divisions

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

Service units/Sections

Research Coordination & Management
Radio Tracer Laboratory
Agro-meteorology Laboratory
Agricultural Economics and Statistics
AKMU (ARIS Cell)
Central Laboratory

General facilities

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

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)

Research support services and activities

Research coordination & management unit

This unit monitors the progress of research projects, maintains research project files and prepares periodical reports for submission to the Council. It helps in coordinating the consultancy and advisory matters related to improvement in productivity of sugarcane and sugar. It is responsible for organising Institute Research Council meeting and other meetings on technical matters. It also compiles the research achievements of the Institute for publishing as well as for onward communication to the Council. It also attends to various querries received from other Institutes on aspects related to sugarcane research. It is entrusted with the responsibility of printing Annual Report, IISR Newsletter, *Ikshu Samachar* and other publications. The unit also coordinates the preparation of six-monthly progress reports of scientists and its communication to ICAR.

Library and reprography

The IISR Library is well established and has a rich collection of books and Indian and foreign journals. During the year 2010-11, Library budget was ₹ 13.94 lakh, out of which ₹ 1,69,513.00 was spent on purchase of 81 books, ₹ 21,615.00 was spent on subscription of 13 Indian journals, ₹ 11.71 lakh on 10 foreign journal, ₹ 11,115.00 spent on 20 Hindi/English magazines, and ₹ 21,132.00 on 23 Hindi/English newspapers.

Total numbers of titles of serial publication like annual reviews/advances, and Indian and foreign journals reached to 386 comprising of 20,400 set/volumes. During the year, 581 issues of Indian/foreign journals, newspapers and Hindi/English magazines and 12 CDs were received. There are 13 foreign journals, 42 Indian journals out of which 08 are in Hindi; 10 newspapers; and 10 Hindi/English magazines providing current affairs, are on the subscription list. Some of the journals in the Library date back as early as 1913.

Consortium of e Resources in Agriculture (CeRA) is a centralized service. It is in operation since 2007, all the journals/serial publication of Annual Reviews Inc., Elsevier, CSIRO, IndianJournal.com, Informatics, Oxford Journals, Nature, Springer Link, Taylor & Francis, Wiley on Library can be accessed directly through internet by the Institute Scientific Staff. Through CeRA, the Institute provided 35 copies of research papers to various Institutes/SAUs from October 2010 to March 2011.

The literature relating to sugarcane, new researches on sugarcane from 2006 to 2010 *i.e.* research papers published as well as those of Institute Staff, in English, during these years is being updated. Holding list *i.e.* list of serial publications, available in the IISR Library, technical programmes of the Institute for 2000-2010, are being regularly updated. Shelf list has been prepared and is ready for display.

Radio tracer laboratory

The Radio Tracer Laboratory of the Institute houses sophisticated instruments like Liquid Scintillation Counter, Advanced Gamma Counting System, Orion pH and Ion Analyser, Infra-red Gas Analyzer, Pressure Chamber and other sophisticated equipments related to assay of radio nucleides. This facility is being utilized for the determination of photosynthesis, metabolism and nutrient uptake and use efficiency studies. The laboratory also houses Microbiology unit of the Institute which is working on the management of red rot using microbes and the development of biofertilizers.

Agrometeorology laboratory

The laboratory provides information on daily, monthly and annual temperature range, relative humidity, rainfall, wind velocity and sunshine hours. Continuous weather recording is done through automatic weather station. Long term database on weather variables is compiled and updated.

Juice analysis laboratory

The laboratory is equipped with Sucromat, Rapid Pol Extractor and Brix spindle. Sugarcane juice samples received from different divisions/ sections are processed and analysed to estimate brix using Brix-Hydrometer, Temperature, clarification using lead sub-acetate, juice polarization using Autopol Analyzer. This unit provides estimation of sugarcane quality parameters like brix, pol, fibre and reducing sugars in cane juice samples. Samples are analysed for chemical and biochemical parameters such as Total Carbohydrates, Reducing Sugars, Protein (Glomalin), Dehydrogenase, Acid Phosphatase, Alkaline Phosphatase, Amylase, Invertase, Cellulase, Phosphorus.

Central laboratory

Central Laboratory provides facility for the estimation of micronutrients in plant and soil samples. The laboratory is equipped with advanced and micro-processor based instruments like Flow injector analyzer, UV and visible spectrophotometer, neutron moisture probe, leaf area meter, atomic absorption spectrophotometer and ion analyzer.

Soil Science laboratory

The laboratory is equipped with instruments like polarized Zeemna Atomic Absorption Spectrophotometer, UV-V Spectrophotometer, Flame Photometer, pH Meter, EC Meter, Wet Sieving Method of Yodor Apparatus, Double Ring Infiltrometer and Core Sampler. The laboratory provides facilities for the estimation of macro-and micro-nutrients in soils and samples of plant, *etc*. The laboratory also provides facilities for soil physical parameters like aggregate size distribution, bulk density and infiltration rate.

Biotechnology laboratory

The laboratory is equipped with instruments like PCR, electrophoresis systems, gel documentation system, - 20 and –80°C deep freezer, centrifuge, water bath, BOD, Laminar flow and culture room. The lab has the facilities for carrying out research on DNA finger printing, genetic diversity study, molecular breeding, genetic transformation and micropropagation aspects.

AKMU (ARIS Cell)

AKMU (ARIS Cell) is well equipped with latest computing and printing facilities. Campus-wide Local Area Network (LAN) has been developed using Fiber Optic and UTP cabling on Ernet based network. The auditorium, KVK, guest house and farm section have been connected to the main IISR network through optical fibre cabling. LINUX operating system is being used as field and print server to provide printing, campus-wide messaging and data sharing services. The unit is well connected to Internet *via* dial-up connectivity. Internet and E-mail services are being shared on existing network through Proxy Server. The IISR also received 256 kbps C-Band VSAT link for Internet connectivity on ERNET backbone under ICAR Net project. The unit has been further strengthened with two Xeon based Windows server to meet the LAN requirement and e-mail facility in its own address and Internet connectivity to the existing 65 nodes using UTP and optical fibre cable network. The IISR has obtained its own domain under ERNET, India. During the year, AKMU compiled information for Institute Information Bank (Institute Profile and Crop Profile), updated the Website of Indian Institute of Sugarcane Research, Lucknow (www.iisr.nic.in) and the Intranet Site of Indian Institute of Sugarcane Research, Lucknow (iisr.ernet.local).

Different softwares *viz*., estimation of juice quality parameters, weather data analyses, statistical analysis of experimental data, processing of pay bills, word processing, presentation *etc*., are available for use in research and administration. The unit also maintains information on sugarcane crop and sugar industry.

Arts and photography

It provides facility for indoor and outdoor photography. It also helps in preparing coloured, black and white transparencies, photographs, charts, histograms and drawings related to research work.

Farm

The Research Farm of the Institute has an area of 186.50 ha comprising 129.09 ha under cultivation and 57.41 under orchard, buildings, roads, channels, *etc*. About 0.4 ha block has been earmarked for conducting DUS testing of sugarcane varieties, and developed with specially designed GI weaven net fencing and approximately 200 m underground pipe line. The farm is well equipped with agricultural machinery, equipments and bullock pairs.

To maintain soil health, green manuring with *dhaincha* is a regular practice at the Research Farm. The crops like paddy, wheat, barley, gram, mustard and forages are also grown in rotation with sugarcane.

Women's Cell

As per Council's instructions, a Women's Cell is functioning since July 22, 1997.

Krishi Vigyan Kendra

Krishi Vigyan Kendra under the administrative control of IISR, Lucknow w.e.f. October 25, 1999 is disseminating technological activities as per its mandate. Its activities are reported in the following chapters under relevant headings.

Dispensary

Dispensary provides health care services to the Institute's staff and their dependents.

Electronic communication

The Institute is equipped with fax and e-mail facilities. An improved EPABX facility has been established and intercom facility has been provided to the scientists and administrative staff.

Financial statement (2010-11)

A. Main Institute

(₹ in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Estt. Charges	1660.00	1660.06	-	-
T.A.	5.00	4.97	9.00	8.55
HRD	-	-	-	-
Other Charges	35.00	54.52	237.00	226.20
Works	68.00	53.26	81.00	81.04
Others items	16.00	10.00	117.00	128.20
OTA	-	-	-	-
Total	**1784.00**	**1782.81**	**444.00**	**443.99**

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

(₹ in lacs)

Particulars	Estt. Charges	T.A.	Other Charges (RC)	NRC	Total
Revised Estimate	167.56	21.62	65.35	115.47	370.00
Expenditure	191.42	17.70	61.73	98.75	369.60

C. Externally Funded Projects

S. No.	Projects	Funding agency	Duration
1	Enhancing field water use efficiency in sugarcane cropping system through FIRBs	UPCAR, Lucknow	2006-10
2	Farmer's participatory action research on water use efficiency technologies for improving productivity and sustainability of sugarcane	Central Water Commission, Ministry of Water Resources, Govt. of India	2008-11
3	Development of SSR markers for red rot resistance from EST database of sugarcane	DBT, New Delhi	2009-12

D. 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 Yr 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-

E. Revenue Generation

S. No.	Realisation of Revenue Receipt	Amount (₹ in lacs)
1	Farm Produce	51.24
2	Miscellaneous	14.33
	Total	**65.57**

Staff Position

A. Scientific Staff

i) IISR, Lucknow

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Agricultural Chemistry	0	0	0	0	1	0	1	0
Agricultural Entomology	1	0	1	0	5	4	7	4
Agronomy	1	1	2	2	7	5	10	8
Biochemistry (Plant Science)	0	0	0	0	2	2	2	2
Biotechnology (Plant Science)	1	1	1	0	1	0	3	1
Microbiology (Agriculture)	0	0	0	0	1	0	1	0
Nematology (Agriculture)	0	0	0	0	1	0	1	0
Plant Breeding	1	1	2	2	6	4	9	7
Plant Pathology	1	1	2	1	5	3	8	5
Plant Physiology (Ag/Hort. Crops)	1	2	1	0	2	2	4	4
Soil Science-Soil Chemistry/Fertility	1	0	0	0	2	1	3	1
Soil Science-Soil Physics/Soil & Water Conservation	0	0	1	0	1	1	2	1
Agricultural Structure & Process Engineering	0	0	1	1	0	0	1	1
Electronics & Instrumentation	0	0	1	1	0	0	1	1
Farm Machinery & Power	1	1	2	1	2	3	5	5
Soil & Water Conservation Engineering	0	0	0	0	1	1	1	1
Organic Chemistry*	0	0	0	0	0	1	0	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 & Cytogenetics	1	0	1	0	2	2	4	2
Coordinating Unit of Process Engg.								
Project Coordinator	1	1	0	0	0	0	1	1
Farm Machinery & Power	0	0	0	0	1	0	1	0
Agricultural Structure & Process Engineering	0	0	1	0	0	0	1	0
Sub Total	**10**	**8**	**17**	**9**	**46**	**34**	**73**	**51**

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	0	1	0
Plant Breeding	0	0	1	0	0	0	1	0
Agricultural Entomology	0	0	0	0	1	1	1	1
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	**11**	**9**	**19**	**10**	**52**	**37**	**82**	**56**

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	16	16	14	1	1	0	0	69
Workshop Staff including Engineering Workshop	22	6	8	1	0	0	0	0	37
Photography Staff	0	1	1	1	0	0	0	0	3
Laboratory Technicians	2	1	0	0	0	0	0	0	3
Library/Information/Documentation Staff	0	1	3	1	0	0	0	0	5
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	45	25	29	17	1	2	0	0	119
Field/Farm Technicians (Motipur)	1	1	0	0	0	0	0	0	2
Total	46	26	29	17	1	2	0	0	121

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	1
Asst. Administrative Officer	4	3
Private Secretary	2	2
Assistant	17	16
Upper Division Clerk	9	12
Lower Division Clerk	10	10
Personal Assistant	2	2
Steno Grade III	-	2
Supporting skilled staff	73	57
Sub Total	**121**	**108**
Upper Division Clerk (Motipur)	1	1
Supporting skilled staff (Motipur)	1	1
Total	**123**	**110**

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

Crop management for high cane productivity under different environments

2.1 Sugarcane based production system

This section covers research outcomes of experiments conducted on related to preparations, tillage, seed cane saving and evaluation of techniques developed for economizing seed cane, agronomic evaluation of promising genotypes and studies related to rice-wheat-sugarcane cropping system.

Effect of sub-soiling on soil physico-chemical characteristics and sugarcane productivity (AS 59)

A field experiment was conducted to study the effect of sub-soiling 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, sub-soiling at 1.5 m distance, cross sub-soiling at 1.0 m distance and cross sub-soiling at 1.5 m distance and two preparatory tillage *viz.*, four harrowings and two harrowings. The experiment was conduted in strip-plot design with three replications.

The sugarcane variety CoSe 92423 was taken for the experiment. Sub-soiling was done with tractor-mounted sub-soiler up to the depth of 45-50 cm. Higher infiltration rate (4.31 mm/h) and lower bulk density (1.33 Mg m^{-3}) were recorded under cross sub-soiling at 1.0 m distance. Apparent reduction in bulk density was recorded under cross sub-soiling at 1.0 m distance during mid June and at harvest. There was no tangible effect on bulk density and infiltration rate as was recorded due to preparatory tillage operation. The germination was not affected by tillage treatments. Cross sub-soiling at 1.0 m distance recorded significantly highest shoot population (209.2 thousand/ha at 180 DAP), number of millable cane (180.8 thousand/ha), cane (87.8 t/ha) and sugar yield (10.45 t/ha) followed by cross sub-soiling at 1.5 m distance and sub-soiling at 1.0 m distance. Preparatory tillage did not exhibit any impact on the sugarcane growthand yield (Table 2.1).

Table 2.1 : Effect of sub-soiling and preparatory tillage on growth and yield of sugarcane

Treatment	Germination (%) DAP		Shoot population ('000/ha) DAP			Root biomass (t/ha) at 120 DAP	NMC ('000/ha)	Cane yield (t/ha)	Cane length (cm)	CCS yield (t/ha)
	30	45	120	150	180					
Sub-soiling										
No sub-soiling	37.9	40.7	17.3	183.3	170.8	0.36	163.8	62.3	205.2	7.38
Sub-soiling at 1.0 m	38.7	40.8	181.4	197.3	174.8	0.59	173.8	77.8	219.4	8.84
Sub-soiling at 1.5 m	37.9	41.7	175.1	191.8	171.3	0.50	170.8	72.8	211.3	8.25
Cross sub-soiling at 1.0 m	38.9	42.3	215.2	242.8	209.2	0.76	180.8	87.8	261.3	10.45
Cross sub-soiling at 1.5 m	37.1	41.8	197.4	199.8	199.6	0.66	174.3	81.7	214.9	9.26
CD (P=0.05)	NS	NS	12.66	11.95	15.22	-	7.27	6.63	12.31	1.93
Preparatory tillage										
Four harrowing	38.1	41.3	189.2	204.1	185.9	0.58	173.3	78.1	223.3	8.97
Two harrowing	38.2	41.6	188.9	201.9	184.4	0.57	172.1	76.0	221.6	8.70
CD (P=0.05)	NS	NS	NS	NS	NS	-	NS	NS	NS	NS

Studies on seed cane economy in sugarcane cultivation (AS 60)

The germination of cane buds recorded at 30, 45 and 60 DAP was found significantly higher under 3-bud sett planting as compared to 2 and 1-bud sett (Table 2.2). This trend reflected in the growth and yield of cane. Accordingly, the cane yield under 3-bud sett planting (72.52 t/ha) was significantly higher than 2-bud (63.72 t/ha) and 1-bud (57.68 t/ha) sett planting. An increased seed rate although did not affect germination of cane buds but it had a significant effect on the growth and yield of seed cane. Dipping of cane setts in 100 ppm GA_3 solution and bavistin (0.1%) for 15 minutes indicated significant adverse effect on the germination of cane buds, population of shoots & millable canes and the cane yield than that obtained with dipping of setts only in bavistin (0.1%).

Physio-biochemical studies concerning survival and establishment of bud chip under normal and encapsulated conditions (PB 22)

Physical and chemical methods of bud chips encapsulation was performed for moisture retention and storage for long duration. In chemical encapsulation method, bud chips were soaked in sodium alginate (6%) solution, and then in calcium chloride solution (100 mM) mixed with fungicide and PGRs for 10 min. These encapsulated bud chips were dried under fan for 2 h and stored at low temperature (10°C) conditions. Preliminary data indicated lower rate of moisture loss and early and higher rate of bud germination (85-90%) of encapsulated bud chips, stored at low temperature conditions. These bud chips showed lower content of reducing sugars and invertase activity (Tables 2.3). However, this method of bud chip encapsulation has certain limitations.

Sugarcane bud chips treated with PGRs and calcium chloride solutions showed improved sprouting, rooting activity, plant vigour and tillering of bud chip raised settlings under field conditions. Bud chip nursery raised in small plastic cups as well as under field conditions and their subsequent transplanting under field conditions during autumn and spring planting seasons recorded 80% survival and luxuriant growth.

Development of plant growth promoting microbial consortium for rice-wheat-sugarcane cropping system (IARI-IISR DBT-1/10)

The project aims to develop microbial consortium of isolates identified for nutrient transformation and phyto-simulation and its formulations for longer shelf life and easy application and to evaluate its beneficial impact in rice-wheat-sugarcane cropping system.

Table 2.2: Effect of sett size, seed rate and sett treatment on growth and yield of seed cane

Treatment	Germination (%) DAP			No. of tillers (DAP)			NMC ('000/ha)	Cane yield (t/ha)	CCS (%)
	30	45	60	120	150	180			
Sett size									
S_1 : (1-bud)	12.35	22.42	28.16	148	171	132	99	57.68	11.30
S_2 : (2-bud)	21.39	31.57	36.28	162	188	146	116	63.72	11.32
S_3 : (3-bud)	29.64	34.16	40.13	188	208	163	124	72.52	11.40
CD (P=0.05)	7.68	2.42	3.52	12.80	15.76	14.86	7.65	5.44	NS
Seed rate (per ha)									
R_1 : 80,000 buds	19.32	30.08	34.18	160	181	152	110	62.66	11.32
R_2 : 1,20,000 buds	22.94	28.68	35.54	172	197	142	116	66.62	11.38
CD (P=0.05)	NS	NS	NS	9.56	13.44	9.03	5.56	3.35	NS
Sett treatment									
T_1 : Bavistin	24.26	31.89	36.72	175	193	153	118	68.54	11.36
T_2 : Bavistin + GA_3	18.02	26.89	33.00	157	185	141	108	60.64	11.32
CD (P=0.05)	5.15	4.39	3.35	10.88	7.22	10.86	9.34	6.86	NS

Table 2.3 : Changes in germination, bud moisture, reducing sugars and invertase activity of normal and encapsulated bud chips with storage of time

Days of storage	Room temperature		Low temperature (10^{0}C)	
	Normal bud chips	Encapsulated bud chips	Normal bud chips	Encapsulated bud chips
Germination (%)				
1	80	90	80	90
5	70	80	80	90
10	40	60	70	85
Bud moisture (%)				
1	67	68	67	67
5	63	64	66	68
10	55	50	67	67
Reducing sugar (%)				
1	0.637	0.364	0.648	0.496
5	0.693	0.765	0.656	0.455
10	0.900	0.954	0.696	0.500
Invertase activity (µg reducing sugars formed per mg protein)				
1	76	114	91	52
5	102	154	102	65
10	156	169	114	76

A field experiment was conducted in the first week of November 2010. Ten treatment combinations *i.e.*, two cropping sequences in main plot (sugarcane alone and sugarcane + wheat) and five treatments (T_1 : Control, T_2 : Microbial consortia (MC), T_3 : $N_{50}P_{50}K_{50}$, T_4 : $N_{80}P_{80}K_{80}$ + MC, T_5 : $N_{100}P_{100}K_{100}$) were laid out in split plot design with three replications. All the treatments were imposed as per lay out. So far, wheat crop has been harvested and the highest yield of 52.91 q/ha was obtained with $N_{100}P_{100}K_{100}$ closely followed by the yield of 51.3 q/ha in $N_{50}P_{50}K_{50}$ + microbial consortia. However, the yields of 41.93, 28.81 and 27.68 q/ha were recorded under the treatments $N_{50}P_{50}K_{50}$, microbial consortia (alone) and control. In case of sugarcane, the crop stand is very good and the crop is yet to harvest.

Agronomic evaluation of promising genotypes of sugarcane (AS 42)

An experiment was conducted to evaluate three sugarcane genotypes (CoPk 05191, LG 05031 and LG 99270) under three NPK levels (112.5,45,45; 150,60,60 and 187.5,75,75 kg/ha) to identify suitable genotype under various fertilizer schedules in spring season. Initial soil chemical analysis indicated that soil was low in organic carbon (0.44%), available nitrogen (220 kg/ha), medium in phosphorus (34.3 kg P_2O_5/ha) and potassium (225 kg K_2O/ha) contents.

Genotype LG 05031 produced the highest number of millable canes (1,10,400/ha) followed by CoPk 05191 and LG 99270 (Table 2.4). There was no significant difference in individual cane length between genotypes CoPk 05191 and LG 05031. However, the highest cane length (210.5 cm) was measured with CoPk 05191. Genotype CoPk 05191 produced the thickest and heaviest canes (2.30 cm diameter and 1036 g individual cane weight). Significantly higher cane yield (76.37 t/ha) was harvested with genotype CoPk 05191. Although it was at par with LG 05031 (71.56 t/ha). Growth parameters and cane yield significantly increased up to the application of 150, 60, 60 kg

Table 2.4 : Influence of different treatments on growth, quality and yield of sugarcane crop

Treatment	Millable canes (000/ha)	Cane length (cm)	Cane diameter (cm)	Cane weight (g)	°Brix	Pol (%) juice	Purity (%)	Cane yield (t/ha)	CCS (t/ha)
Genotype									
CoPk 05191	101.3	210.5	2.30	1036	19.39	17.30	89.23	76.37	9.18
LG 05031	110.4	205.4	2.06	853	20.37	18.18	89.22	71.56	9.03
LG 99270	86.4	155.7	2.30	702	20.79	18.57	89.30	47.17	6.09
CD (P=0.05)	8.20	15.23	0.16	65.2	0.72	0.69	NS	4.80	0.45
Fertility level (NPK kg /ha)									
112.5,45,45	93.10	165.9	2.25	800	20.01	17.90	89.41	64.30	8.00
150,60,60	101.1	178.2	2.19	874	20.31	18.18	89.49	69.13	8.74
187.5,75,75	103.9	182.5	2.21	917	20.23	17.98	88.85	71.67	8.94
CD (P=0.05)	8.20	15.23	NS	65.2	NS	0.69	NS	4.80	0.45

NPK/ha. Recommended level of NPK *i.e.*, 150, 60 and 60 kg/ha fetched significantly higher cane (69.13 t/ha) and sugar yields (8.74 t/ha) over 75% of recommended NPK. Different fertility levels could not influence juice quality parameters significantly.

2.2 Ratoon management in sugarcane

Improving productivity of winter initiated ratoon of sugarcane in sub-tropical India (AS 58)

The winter ratoon of early variety of sugarcane (CoS 96268) was initiated for third year of experimentation in the first week of January 2010. Application of Sulphitation Pressmud Cake (SPMC) @ 20 t/ha significantly promoted the bud sprouting in ratoon during winter season and resulted in the highest production of tillers (2,80,000/ha) and subsequently higher millable canes (99,500/ha) and cane yield (71.0 t/ha). However, the results of this treatment were comparable with the treatment of SPMC 10 t/ha + 25 kg $ZnSO_4$/ha. Thus, it clearly suggested that the productivity of winter initiated ratoon can be enhanced through application of pressmud cake @ 20 t/ha or the dose of SPMC along with 25 kg $ZnSO_4$/ha at the time of ratoon initiation (Table 2.5).

Improving juice quality and stubble bud sprouting under low temperatures (PB 18)

Effect of various treatments/formulations applied to improve sprouting and performance of winter-initiated ratoon crop of sugarcane variety CoSe 92423 on growth characteristics relative to control were studied. Two formulations, namely, F-1 (mixture of vitamins) and F-5 (a botanical formulation) were more effective in improving the sprouting of stubble buds and productivity of winter- initiated ratoon. These formulations improved productivity by increasing NMC (39% in F-1 and 35% in F-5) and average cane weight (54% in F-1 and 67% in F-5). The increase in NMC was due to increase in Tmax and not due to reduction in mortality %. The increase in average cane weight may be attributed to the stimulation of growth by these formulations, which resulted in increased cane height (17% in F-1 and 25% in F-5) as well as increase in cane diameter (20% in F-1 and 27% in F-5).

Six formulations were tested to observe their effect on the establishment of the crop stand in the autumn planted sugarcane variety CoSe 92423. As compared to control, the maximum number of tillers produced were 318% in Formulation 4 and 267% in Formulation 3. Thus, the establishment of the crop stand may be enhanced by using these formulations.

Table 2.5 : Effect of treatments on number of shoots, NMC, cane yield and pol % juice of winter Initiated ratoon

Treatment	Number of shoots ('000/ha)	NMC ('000/ha)	Cane yield (t/ha)	Pol (%) Juice
Recommended practice (control)	260.0	88.0	59.0	17.3
One irrigation in plant crop 30 days before ratooning followed by irrigations at 15 days interval during winter (up to 1st week of Feb.)	265.0	89.0	60.5	17.1
Application of sulphitation pressmud cake (fresh) @ 20 t/ha at ratooning	280.0	99.5	71.0	17.2
Application of 60 kg K_2O/ha before 30 days of rationing	262.0	91.0	62.0	17.3
Intercropping of legume, Senji *(Melilotus alba)*, in ratoon for green manuring	262.0	92.0	61.5	17.0
Soil application of $ZnSO_4$ @ 25 kg/ha before 30 days	263.0	90.5	62.5	17.1
Soil application of 60 kg K_2O+ 25 kg $ZnSO_4$/ha 30 days before ratooning with irrigation	265.0	91.5	60.5	17.2
Soil application of 25 kg $ZnSO_4$+ SPMC (fresh) @ 10 t/ha	279.0	98.0	69.5	17.3
CD (P = 0.05)	7.50	5.05	3.78	NS

Effect of biomanuring on sugarcane productivity and soil properties under plant and subsequent ratoons (A 2.31)

A field experiment was initiated in spring 2003 to evaluate the efficacy of different biomanures 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 7th ratoon (57.40 t/ha) was recorded with SPMC + *Gluconacetobacter* against the plant cane yield of 77.5 t/ha and 1st ratoon yield of 80.8 t/ha. This was followed by SPMC (54.80 t/ha) and FYM + *Gluconacetobacter* (54.30 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 the different treatments (Table 2.6).

Soil organic carbon ranged between 0.64 and 0.69 under different treatment 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 234.70 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.

Optimizing plant population density in sugarcane plant-ratoon system (A 3.23)

The gaps in the second ratoon crop (second crop cycle) of sugarcane *cv.* CoSe 92423 decreased subsequently from 36.52 to 10.70% when raised with increasing planting density from 30,000 to 60,000 three-bud setts/ha (Table 2.7). Consequently, the number of shoots and millable canes and also the cane yield increased significantly in the second ratoon cane too with successive increase of planting density from 30,000 to 60,000 three-bud setts/ha in plant cane. Gap filling in plant cane with 3-bud setts at 45 DAP produced 75.08 t/ha ratoon cane, being 10.27% more than that obtained without gap filling (68.09 t/ha). Application of 80 kg K/ha through irrigation water in plant cane before one month of harvesting produced significantly higher ratoon cane yield to the tune of 11.93% over no K application in plant cane (67.62 t/ha). CCS% cane did not yield any significant difference due to different treatments in the study.

Table 2.6 : NMC, cane yield, soil organic carbon and microbial biomass carbon (SMBC) of 7th ratoon under different biomanurial treatments

Treatment	NMC ('000/ha)	Cane length (cm)	Cane yield (t/ha)	Organic C (%)	SMBC (mg CO_2-C /kg/ solid)
T_0 - Control	53.0	105.0	18.7	0.45	136.9
T_1 -Trash 10 t/ ha +*Trichoderma*	61.0	136.5	33.6	0.65	195.6
T_2 -Vermicompost @ 10 t/ ha	80.8	147.2	53.9	0.65	102.7
T_3 – FYM @ 10 t/ha	81.5	145.6	53.5	0.65	132.0
T_4 - Biogas slurry @ 10 t/ ha	81.0	145.0	53.2	0.65	132.0
T_5 – SPMC @ 10 t /ha	85.5	155.7	54.8	0.68	166.2
T_6 - T_1 + *Acetobacter*	60.	136.8	33.5	0.65	234.7
T_7 - T_2 + *Acetobacter*	80.5	147.4	54.0	0.65	146.7
T_8 - T_3 + *Acetobacter*	81.0	145.5	54.3	0.65	122.2
T_9 - T_4 + *Acetobacter*	80.3	145.3	54.1	0.65	151.6
T_{10} - T_5 + *Acetobacter*	85.5	155.9	57.4	0.69	108.7
T_{11} – *Dhaincha* + *Acetobacter*	78.4	145.0	507	0.64	97.8
T_{12} – NPK (120:60:60 kg/ha)	75.78.0	145.4	51.0	0.49	63.8
C.D. (P=0.05)	14.54	13.39	11.07	0.32	47.6

Table 2.7 : Effect of seed rate, gap-filling and K application followed in planted sugarcane on the growth and yield of ratoon crop

Treatment applied in plant cane	Effect on sugarcane ratoon					
	No. of clumps ('000/ha)	Gaps (%)	No. of shoots ('000/ha)	NMC ('000/ha)	Cane yield (t/ha)	CCS (%)
Seed rate (3-bud setts/ha)						
30,000	18.42	36.52	214	101	60.14	11.38
40,000	22.65	26.40	244	109	68.50	11.33
50,000	26.44	18.30	272	118	76.30	11.42
60,000	30.37	10.70	290	128	81.40	11.41
CD (P = 0.05)	3.65	7.54	17.38	6.48	4.82	NS
Gap filling						
No gap filling	21.34	20.30	247	109	68.09	11.36
Gap filling with 3-bud setts at 45 DAP	27.60	25.66	263	119	75.08	11.42
CD (P = 0.05)	5.32	4.29	15.10	8.85	6.42	NS
K application						
Without K	22.14	21.42	248	110	67.62	11.38
80 kg K/ha through irrigation water before one month harvesting of plant cane	26.80	24.54	262	117	75.69	11.40
CD (P = 0.05)	3.82	2.86	11.36	5.47	6.58	NS

Studies on rhizospheric environment of plant and ratoon crop of sugarcane (C 15.8)

The study was conducted to quantify and compare the soil and plant physical, chemical and biochemical properties in simultaneously initiated plant, ratoon I, II and III crops.

Quantification of soil rhizospheric alterations during the crop growth cycle has indicated that maximum alterations occurred during the grand growth phase in ratoon crops. Combined effect of compaction along with increase in the moisture content was reflected in the elevation of total phenolic, organic acid levels and C: N ratios.

The impact of these alterations was clearly visible on root properties as there was significant decline in CEC roots of successive ratoon crops as compared to the plant crop during the grand growth phase. The membrane leakages of ratoon roots were significantly higher than the plant crop.

The impact of changes in root properties was reflected on the N uptake potential of the ratoon plants. There was significant reduction in the root NR activity of the successive ratoon crops and N uptake by the ratoon crop as compared to the plant crop during the grand growth phase, when the requirement by the plant for the nutrient was maximum, thus, explaining reduction in dry matter accumulation contents in successive ratoon crops as compared to the plant crop.

2.3 Crop management for improving physiological efficiency and sucrose content

Optimization of plant population for improving physiological efficiency of sugarcane (PB 23)

Soaking of three bud setts of sugarcane variety CoSe 92423 in zinc sulphate (Zn 100 ppm) solution for 24 h increased the sprouting percentage by 35 and 100% compared to water soaked setts after 55 days of planting in summer and spring, respectively. Increase in reducing sugar by 307% in zinc sulphate treated buds and 187% in buds from control was recorded. Decrease in sucrose was 76% and 10.8%, respectively in these two treatments.

Results revealed that early formed tillers contributed more to millable cane formation than late stage tillers, in both autumn as well as spring planted crop of sugarcane *cv*. CoSe 92423. The cane produced from late stage tillers has less average cane weight as well as height. The millable canes from summer planted crops recorded lesser extraction per cent, low brix and sucrose % as compared to autumn and spring planted crops. Although T (max) was 100% higher in autumn cane than spring and late planted crops but conversion of these tillers in millable cane was 50% in autumn cane and 25% in spring and late planted cane. Average unit cane weight were 1.0, 0.80 and 0.533 kg in autumn, spring and late planted cane, respectively.

The *in vitro* sucrose uptake from sucrose containing medium by internodal slices of high sugar variety CoLk 94184 was higher than that of low sugar variety CoSe 92423, irrespective of the maturity status of the internodes. The slices of mature internodes with high endogenous sucrose, also exhibited greater sucrose uptake from the medium. This uptake seems to involve energy dependent active sucrose uptake that may depend upon the capacity of parenchyma cells to store sucrose and apparent free space (AFS) of a variety. The time course studies of *in vitro* sucrose uptake by slices of immature internodes of variety CoLk 94184 and CoSe 92423 also revealed that sucrose uptake increased with time and throughout the study period, the uptake by immature slices from CoLk 94184 was higher compared to that from CoSe 92423, indicating a higher rate of sucrose uptake *in vitro* by cells of high sugar variety. This was true for the passive diffusion as well as energy dependent active sucrose uptake and the rate of sucrose uptake. It seems that the high quality cane (CoLk 94184) tends to have higher photoassimilate translocation and thus store higher quantities of sucrose in the storage compartment during their maturation phase (Tables 2.8, 2.9 and 2.10).

In order to improve cane yield of plant cane by changing the stalk extension rate, canopy coverage and tiller mortality, the treatment of GA, IAA and kinetin increased cane weight by 8.5, 14.8 and 27.65%, cane length by 21.1, 22.2, 17.7 % and NMC by 69.3, 72.0, 33.3%, respectively. A change due to GA, IAA and kinetin was because of change in extension rate, LAI and reduced mortality of tillers, respectively.

Table 2.8: *In vitro* **sucrose uptake/release by immature and mature tissue slices of sugarcane from sucrose medium of variable concentration**

Bathing medium sucrose (mM)	CoLk 94184			CoSe 92423		Sucrose uptake mM/L juice
	Sucrose content (mM)		Sucrose uptake mM/L juice	Sucrose content (mM)		
	Before incubation	After incubation		Before incubation	After incubation	
Immature tissue slices						
60	235 ± 6.5	338 ± 12.8	102.65	221.45 ± 3.7	297.65 ± 12.7	76.20
100	237 ± 4.5	332 ± 11.6	94.40	122.6 ± 6.1	205.31 ± 12.2	82.64
200	260 ± 3.4	360 ± 10.2	99.70	127.65 ± 3.8	230.18 ± 11.8	102.53
300	266 ± 4.2	413 ± 12.3	147.38	238.06 ± 4.4	342.04 ± 10.4	103.98
400	317 ± 3.8	470 ± 12.8	152.37	153.65 ± 5.2	259.66 ± 11.4	106.01
Mature tissue slices						
100	537.04 ± 2.8	453.93 ± 11.8	-83.11	448.45 ± 3.5	382.37 ± 12.4	-66.08
200	484.90 ± 4.0	411.60 ± 10.6	-73.30	421.23 ± 5.5	363.29 ± 14.3	-57.90
400	485.08 ± 3.2	509.58 ± 12.3	+24.50	362.28 ± 4.5	424.63 ± 11.2	+62.35
500	478.69 ± 8.3	547.43 ± 14.5	+68.74	355.89 ± 7.6	458.85 ± 13.4	+102.96
600	456.21 ± 8.9	635.48 ± 16.1	+179.27	381.76 ± 6.2	509.47 ± 12.5	+127.71

Note: ('+'denotes sucrose uptake by tissue slices and '-'denotes sucrose release from tissue slices into the bathing medium. Figures before ± denotes mean of three replications and after that, it denotes SE).

Table 2.9: *In vitro* **sucrose uptake by sugarcane (variety CoLk 94184) internodal tissue slices of different maturity**

Internode	Sucrose content (mM)		Sugar uptake mmoles/L juice
	Before incubation	After incubation	
2nd top	96.05	206.75	110.20
5th top	422.27	564.93	142.66
8th top	470.55	622.58	152.03
12th top	485.51	648.96	163.45
2nd bottom	522.23	699.36	177.13

Note: Internodal tissue slices were taken from 2nd top, 5th top, 8th top, 12th top and 2nd bottom internodes of variety CoLk 94184, osmotically equilibrated with PEG-6000 solution for two h and incubated in 600 mM sucrose bathing medium for 24 h. at 25 ± 2°C. Sucrose content of tissue sap was measured prior to and after incubation (mean of three replicates±S.E.

Perturbation in source and sink was recorded in flowered and non-flowered cane of variety CoSe 92423 led to increase in per cane weight (5%) and sucrose accumulation (2.44%) in flowered cane compared with non-flowered cane. The *in vitro* uptake of sucrose in the slices of internodal tissue was increased by 24% in flowered cane compared with non flowered cane.

Modulating the expression of sucrose metabolizing enzymes for high sugar accumulation in sugarcane (PB 24)

(A) Expression profile of SAI gene in relation to sucrose content in sugarcane

The top and basal portion of cane stalk of two varieties of sugarcane, CoJ 64 (an early maturing genotype) and BO 91 (a mid-late maturing genotype) were evaluated for soluble acid invertase

Table 2.10: Time course study on sucrose uptake by sugarcane immature internodal tissue slices from sucrose bathing medium

Time (h)	Sucrose content (mM) (CoLk 94184)		Sugar uptake mmoles/L juice	Sucrose content (mM) (CoSe 92423)		Sugar uptake mmoles/L juice
	Before incubation	After incubation		Before incubation	After incubation	
1	173.97	228.07	54.10	87.17	118.91	31.20
6	135.96	206.56	70.60	65.78	106.58	40.80
12	201.16	300.40	99.24	105.26	172.86	67.60
24	126.44	266.74	140.30	110.63	209.13	98.50
36	153.31	346.91	193.60	109.05	250.84	141.79
48	104.31	340.11	235.80	48.20	223.60	175.40

Note: Immature 3rd top internodal tissue slices of variety CoLk 94184 and CoSe 92423 were osmotically equilibrated with PEG -6000 solution and incubated in 400 mM sucrose bathing medium at 25 ± 2°C for 1,6, 12. 24,36 and 48 h. Sucrose concentration from tissue sap was estimated prior to and after the incubation (mean of three replicates ±S.E.).

(SAI), sucrose and juice quality parameters in different months of cane ripening. High sugar genotype (CoJ 64) showed higher sucrose content as compared to low sugar genotype (BO 91); top portion showed lower sucrose content (Fig 2.2). SAI

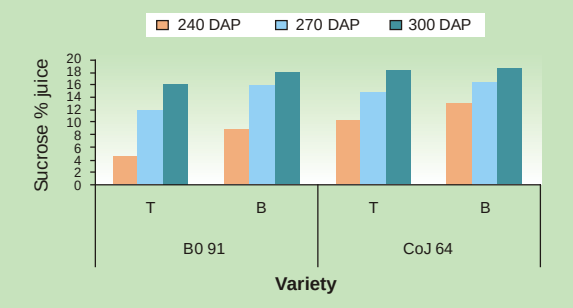
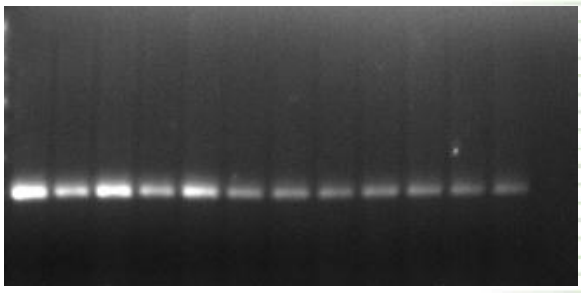


Fig.2.2: Sucrose content in top and basal portion of cane stalk in two sugarcane cultivar at different growth stages. T-Top, B- base

expression using SAI specific primer showed higher SAI expression in the month of October (240 DAP) and it decreased gradually with the cane maturity. Apical portion of stalk tissues showed comparatively higher level of SAI expression and it showed negative correlation with sucrose content. Variety CoJ 64 showed comparatively lower expression of SAI gene than variety BO 91 (Fig 2.3).



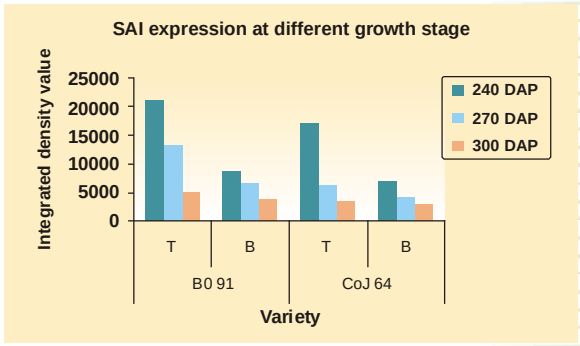


Fig.2.3 : SAI expression in top and base portion of cane stalk of two sugarcane cultivars at different growth stages

Note: Lanes 1& 2, BO 91 top & base; lanes 3 & 4, CoJ 64 top & base (240 DAP); lanes 5 & 6, BO 91 top & base; lanes 7 & 8, CoJ 64 top & base (270 DAP); lanes 9 & 10, BO 91 top & base; lanes 11 & 12, CoJ 64 top & base (300 DAP). T- Top, B- base. DAP- Days after planting

(B) Effect of different enzyme effectors on sucrose content and sucrose metabolizing enzymes

The modulating effect of divalent cations (Mn^{++}, Mg^{++}) and plant growth regulators (GA and ethrel) on sucrose accumulation and sucrose metabolizing enzymes was investigated. Foliar spray of different chemicals (Mg, Mn, GA and ethrel) was performed before the onset of ripening using

sugarcane cultivar BO 91. After 25 days of chemical application, stalk tissues of treated plants and untreated control as well as cultivar CoJ 64 were sampled for juice analysis and different sucrose metabolizing enzymes and their expression through RT-PCR (Fig. 2.4). Results obtained

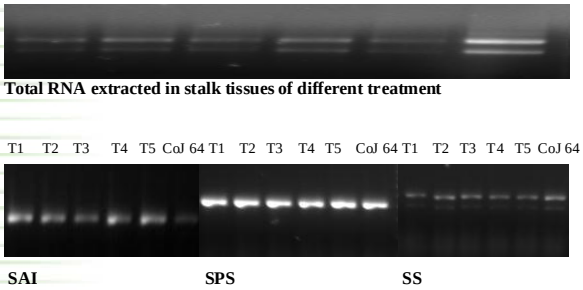


Fig. 2.4: SAI, SPS and SS expression through RT-PCR in response to enzyme effectors. T1 = Control; T2= GA; T3 = Mg; T4 = Mn; T5 = Ethrel

indicated appreciable increase in sucrose content in low sugar genotype by foliar spray of enzyme effectors namely Mg^{++} and Mn^{++} ions in different months of cane ripening. In addition to sucrose content, S/R ratio and CCS per cent in cane juice also increased with cane maturity, higher increase was observed in Mn and Mg treatments compared to untreated control. Reducing sugars decreased in both high and low sucrose genotypes as cane matured; decrease was more in low sugar genotype, following spray of enzyme effectors on genotype BO 91. Specific activity of SAI enzyme was comparatively high in low sugar genotype, decreased further by Mg and Mn treatments. SPS and SS activity were comparatively higher in high sugar genotype; their activity increased in stalk tissues by chemical treatments. Effect of divalent cations was more pronounced on SPS activity, GA and ethrel did not show any definite trend. Transcript expression levels were studied, which revealed that SPS, SS and SAI genes were differentially expressed in low and high sugar genotypes. These results are in agreement with the enzyme activities for SPS, SS and SAI, which also indicated that SS and SAI transcript were differentially expressed in different treatments similar to enzyme activity. An increasing trend of SS and decreasing trend of SAI were observed due to Mn and Mg treatment in cultivar BO 91. SS and SAI transcript levels and enzymes activities were directly correlated with each other. Unlike SPS activity, SPS transcript level was not altered due to chemical treatment.

Resource management in sugarcane based cropping system

3.1 Nutrient management in sugarcane based cropping system

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

A field experiment was conducted 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 randomized block design with six replications. The experiment was initiated during the month of February, 2010 (Spring season). Sugarcane variety CoSe 92423 was planted on February 20, 2010. Recommended doses of P and K (60 kg/ha) were applied as basal and nitrogen was applied as per the treatment. The crop and weather data were recorded. Apparently, the highest number of tillers (225.6 thousand/ha) at 120 DAP, NMC (167.8 thousand/ha), cane yield (95.5 t/ha) and CCS yield (10.54 t/ha) was recorded under the treatment of 300 kg N/ha.

3.2 Water management in sugarcane based cropping system

Developing efficient water application techniques in sugarcane (A 1.2.27)

A field experiment was conducted to study the irrigation water use efficiency (IWUE) of 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 – TI, 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 randomised block design with three replications. Irrigation under each treatment was applied at 50% ASM.

The data on sugarcane growth and yield (Table 3.1) indicated significant variations among the treatments. Significantly, the highest rate of germination (44.26%), shoot count (243.21 thousand/ha at 150 DAP), NMC (176.34 thousand/ha), cane yield (88.61 t/ha) and sugar yield (10.05 t/ha) were recorded under trench planting system in which irrigation was applied in deep trenches (TP-TI). However, the irrigation water use efficiency (IWUE) was observed to be significantly highest (4016.1 kg cane/ha.cm) under paired row planting (120-30 cm) with the irrigation applied in furrows parallel to single row (PP-FIS). This system was closely followed by trench system of planting (Table 3.2). The quality parameters were not affected by different planting methods.

Deep tillage under different moisture regimes and N levels for modifying rhizospheric environment and improving sugarcane yield in plant-ratoon system (A 1.2.28)

A field experiment was conducted at IISR farm with three tillage practices (T_1: Control-recommended harrowing and cultivator for field preparation, T_2: Deep tillage through disc plough (depth 25-30 cm) before planting and T_3: Deep tillage through disc plough (depth 25-30 cm) before planting and sub-soiling at 45-50 cm, two moisture

Table 3.1: Growth and yield of sugarcane under different planting methods

Treatment	Germination (%) at DAP		Shoot count ('000/ha) at DAP				NMC ('000/h)	Yield (t/ha)	CCS (t/ha)
	30	45	120	150	180	210			
PP-FID	26.21	40.74	170.24	192.38	175.24	165.28	150.24	74.21	8.56
PP-FIS	24.26	39.26	163.23	176.37	164.29	160.26	148.29	72.29	8.47
FP-FI	32.29	44.38	210.38	232.29	215.39	180.24	156.21	79.34	8.99
FP-MFI	27.36	36.62	170.36	192.24	177.26	164.36	148.34	74.29	8.85
FP-SFI	26.58	37.26	165.29	172.24	169.29	162.34	141.29	75.29	8.71
FP-ASFI	25.27	37.59	166.37	173.26	170.29	163.85	142.31	74.26	8.49
TP-TI	44.26	60.29	238.24	243.21	210.24	189.34	176.34	88.61	10.05
FIRB-FI	42.29	52.21	196.34	210.25	198.29	176.69	155.29	78.26	8.61
FP-F	23.25	38.27	164.29	171.29	174.26	159.29	138.24	71.29	8.08
PP-F	24.26	38.24	166.34	173.24	169.34	160.39	137.24	70.24	7.84
CD (P= 0.05)	7.32	8.66	22.63	26.35	24.3	12.83	11.23	6.73	0.57

Table 3. 2 : Effect of planting methods on juice quality, yield attributes and irrigation water use efficiency (IWUE)

Treatment	Brix	Pol (%)	Purity (%)	CCS (%)	Cane lenth (cm)	Cane girth (cm)	Av.cane wt (kg)	*IW applied (ha-cm)	IWUE (kg cane/ ha/cm)
PP-FID	18.51	16.58	89.57	11.54	215.31	2.89	1.39	30.8	2409.4
PP-FIS	18.87	16.86	89.34	11.72	211.28	2.84	1.38	18.0	4016.1
FP-FI	18.47	16.36	88.57	11.33	230.35	3.48	1.62	34.0	2333.5
FP-MFI	19.15	17.13	89.45	11.92	216.27	3.21	1.46	34.0	2185.0
FP-SFI	18.62	16.64	89.36	11.57	221.34	3.14	1.64	22.4	3361.2
FP-ASFI	18.43	16.45	89.25	11.43	218.34	3.52	1.72	21.2	3502.8
TP-TI	17.49	16.10	89.74	11.35	262.27	3.14	1.66	22.4	3955.8
FIRB-FI	17.23	15.69	91.07	11.00	214.28	2.98	1.40	34.0	2301.8
FP-F	17.87	16.20	90.66	11.34	215.15	3.00	1.45	59.6	1196.1
PP-F	18.12	16.10	88.85	11.16	216.25	2.92	1.38	61.6	1140.3
CD (P= 0.05)	NS	NS	NS	NS	11.73	0.43	0.25	-	286.42

*Irrigation was applied at 50% ASM in each treatment

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 economise water use under modified rhizospheric environment in 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 on February 14, 2010 in the experiment. Initial level of soil fertility indicated that soil had 0.40% OC, 273.5 kg availbale N/ha; 45.02 kg available P_2O_5/ha and 260 kg K_2O/ha.

Results on sugarcane plant crop revealed that deep tillage and sub-soiling before sugarcane planting increased number of millable canes (87,670/ha), individual cane length (194.2 cm),

cane diameter (2.18 cm) and individual cane weight (740.8 g) over the control. There was 10% increase in mean cane yield (61.54 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 sub-optimal regime (0.5 IW/CPE). Application of nitrogen up to 150 kg N/ha significantly increased growth, cane and sugar yield.

Tillage and moisture interaction on cane yield (Table 3.3) showed that deep tillage (T_2) under suboptimal moisture level (M_1) increased cane yield (56.6 t/ha) significantly over T_1M_1 (50.24 t/ha-conventional tillage and suboptimal soil moisture regime). The highest cane yield (67.16 t/ha) was obtained with T_3M_2 (deep tillage and subsoiling with optimal moisture regime) also indicated superiority with optimal moisture regime.

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. Deep tillage and subsoiling increased WUE to the tune of 5.52 kg/ha mm at no N application whereas this increase was 8.32 kg cane/ha-mm at 150 kg N/ha application.

Optimizing irrigation schedule in sugarcane under different planting methods (AS 61)

The experiment comprising nine treatment combinations (three planting methods *viz.*, conventional planting (75 cm row spacing), paired row planting (30:120 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) was laid out in RBD (factorial) with three replications. The soils of the experimental field was sandy loam in texture with slow infiltration rate (1.0 cm/h) and bulk density of 1.45 g/cc and could hold 16.9 and 6.44 per cent moisture at field capacity and permanent wilting point, respectively. The experimental site was low in

Table 3.3: Effect of deep tillage and sub-soiling on sugarcane yield (t/ha) and water use efficiency (WUE- kg cane/ha-mm)

Treatment	Control (recommended harrowing and cultivator for field preparation)	Deep tillage through Disc plough (depth 25-30 cm) before planting	Deep tillage through Disc plough (depth 25-30 cm) and sub soiling (depth 45-50 cm) before planting	Mean
Sugarcane yield (t/ha)				
Moisture regimes (IW/CPE ratio)				
0.5	50.24	56.60	55.92	54.26
075	62.03	59.44	67.16	62.88
Mean	56.14	58.00	61.54	-
CD (P=0.05)	T: 2.02	M: 1.63	TxM : 2.82	
Water use efficiency (WUE- kg cane /ha-mm)				
Nitrogen level (kg/ha)				
0	64.55	67.53	70.07	67.38
75	77.24	81.48	85.4	81.38
150	88.65	95.38	96.97	93.7
225	87.08	90.61	97.32	91.7
Mean	56.14	58.00	61.54	-
CD (P=0.05)	T: 2.87	N: 1.94	Tx N : 3.34	

organic carbon (0.32%), available nitrogen (198 kg/ha) and phosphorus (18.1 kg P_2O_5/ha) and medium in potassium (237 kg K_2O/ha) and slightly alkaline in reaction (pH = 8.1). During pre-monsoon period, in all 7, 9 and 12 irrigations of 8 cm each were applied as 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 March 8, 2010 and harvested on February 4, 2011.

The results indicated that germination (%) was almost equal in all the planting methods (varied from 39.2 to 41.8%). The observations recorded on tiller count in May revealed that the difference in tiller count under different planting methods was non-significant. The tiller count recorded in June and July was significantly higher under paired row planting method (149.6 and 158.0 thousand/ha) and flat method (140.6 and 150.7 thousand/ha) over FIRB method (132.9 and 137.2 thousand/ha, respectively). However, the difference in tiller count under different planting methods become non-significant in August and September due to higher rate of tiller mortality under flat and paired row planting method over FIRB method. The germination (%) and tiller count at different growth stages were not affected by irrigation scheduling at different IW/CPE ratio.

The cane yield was almost equal (varied from 54.53 to 57.8 t/ ha) in all the planting techniques as a result, the irrigation water use efficiency was also almost same. Yield attributing characters *viz.*, NMC, length, girth and weight of cane and cane quality parameters were not affected by planting techniques. Irrigation scheduling at IW/CPE ratio of 0.75 significantly enhanced yield attributing characters *i.e.*, cane length, cane weight and number of millable canes over irrigation at IW/CPE ratio of 0.50, hence, resulted in higher cane yield (57.36 t/ha) under the treatment of irrigation at IW/CPE ratio of 0.75 compared to 52.7 t/ha in irrigation at IW/CPE ratio of 0.50. The application of irrigation at IW/CPE ratio of 1.00 could not enhance yield attributing characters and cane yield over irrigation at IW/CPE ratio of 0.75. The cane quality parameter *i.e.*, brix, sucrose % and purity % were not affected by planting methods as well as irrigation levels.

The irrigation water use efficiency was higher (0.94 t/ha-cm) in irrigation at IW/CPE ratio of 0.50 and it reduced to 0.8 and 0.6 t/ha-cm in the treatment of irrigation at IW/CPE ratio of 0.75 and 1.00, respectively.

Optimization of fertigation schedule in drip irrigated sugarcane under sub-tropical conditions (C 6.6)

Sugarcane crop planted on October 15, 2009 was drip irrigated with water equalling to 0.6, 0.8, 1.0 and 1.2 times pan evaporation. To compare the results, one control was also kept, which was irrigated with 8 cm irrigation water at 1.00 IW/CPE ratio. The highest sugarcane yield of 91.36 t/ha was recorded when sugarcane crop was drip fertigated with irrigation water equal to 0.8 Epan. In drip fertigated treatments, the lowest yield of 78.38 t/ha was recorded when the irrigation was scheduled at 0.6 Epan. However, this yield was significantly higher than the conventionally surface irrigated crop (72.65 t/ha). The highest irrigation water use efficiency (1190.46 kg/ha-cm) was observed when drip fertigation was scheduled at 0.6 Epan and lowest irrigation water use efficiency (754.42 kg/ha-cm) was observed when drip fertigation was scheduled at 102 Epan. However, with conventional surface irrigation, the irrigation water use efficiency was only 654.68 kg/ha-cm).

3.3 Weed management in sugarcane based cropping system

Management of binding weeds in sugarcane (AS 62)

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

All the weedicidal treatments were equally effective in controlling weeds and enhancing cane growth and yield (Table 3.4). Weedicide-treated plots produced significantly higher number of cane shoots, millable canes, sugar and cane yield as compared 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.

Cane germination and juice quality did not differ significantly due to different treatments. Almix/Dicamba weedicides sprayed as post emergence treatment showed their effectiveness (Table 3.5) in controlling *Convolvulus arvensis* (bind weed).

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

Treatment*	Germination (%)	Shoot population in June ('000/ha)	NMC ('000/ha)	Cane yield (t/ha)	Pol % juice	CCS (t/ha)	Weed dry weight at 120 DAP (g/m²)	WCE
T_1	39.6	140	65.8	37.4	17.6	4.63	310	-
T_2	40.1	220	101.4	71.2	17.8	8.16	21	93.2
T_3	40.8	190	90.4	60.4	17.9	6.82	98	68.4
T_4	36.0	188	89.6	61.2	17.6	6.62	92	70.3
T_5	40.5	192	88.6	59.6	17.3	6.71	94	69.7
T_6	36.3	184	85.4	58.4	17.8	6.59	86	72.2
T_7	40.4	183	87.2	59.8	17.1	6.49	101	67.4
T_8	37.8	189	86.1	60.2	17.5	6.38	107	65.5
T_9	38.5	179	84.2	57.4	17.4	6.54	111	64.2
T_{10}	40.7	182	85.4	58.4	17.2	6.32	110	64.5
CD (P=0.05)	NS	21	10.6	9.6	NS	1.24	18.6	-
CV	9.2	10.4	8.6	10.2	3.9	9.8	-	-

Table 3.5 : Weed density (species composition and number/m²) before spraying and 120 days after planting (DAP)

Treatment*	Weed number/m² before PE spraying								Weed number/m² at 120 DAP							
	Cr	Co	Da	Po	Tr	Di	Ec	Total	Cr	Co	Da	Po	Tr	Di	Ec	Total
T_1	125	20	22	9	28	18	27	250	168	22	24	0	67	28	36	345
T_2	60	6	0	0	0	0	6	72	78	5	3	0	0	0	10	96
T_3	120	0	3	0	0	0	4	127	80	0	2	0	0	0	12	94
T_4	128	0	5	0	0	0	4	137	68	0	0	0	0	0	9	77
T_5	138	7	0	0	0	0	7	152	39	8	3	0	0	0	18	68
T_6	120	11	10	0	0	0	4	145	82	0	0	0	0	0	8	90
T_7	142	12	0	0	0	0	2	156	80	0	0	0	0	0	7	87
T_8	108	4	0	0	0	0	1	113	32	4	0	0	0	0	9	45
T_9	118	0	0	0	0	0	6	124	98	0	0	0	0	0	6	104
T_{10}	128	9	1	0	0	0	3	141	79	0	0	0	0	0	11	90

Cr : *Cyperus rotundus*, Co : *Convolvulus arvensis*, Da : *Dactyloctenium aegyptium*, Po: *Portulaca oleracea*, Tr: *Trianthema monogyna*, Di : *Digera arvensis*, Ec : *Echinocloa colonum*

*Treatment : T_1- Weedy check, T_2- Hoeing at 30, 60 and 90 DAP, T_3- Atrazine 2 kg a.i./ha(PE) - 2, 4-D 1 kg a.i./ha at 60 DAP, T_4- Atrazine 2 kg a.i./ha after 1st irrigation and hoeing 2, 4-D 1 kg a.i./ha at 75 DAP, T_5- Metribuzine 1.25 kg a.i./ha(PE) - 2, 4-D 1.0 kg a.i./ha at 75 DAP, T_6- Metribuzine 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

Developing an efficient statistical design for conducting weed control experiments in sugarcane (A 7.1)

Efficiency of two different layouts RBD (existing) and paired – plot arrangement (proposed) were 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 atrazin (2.0 kg a.i./ha), metribuzin (1.0 kg a.i./ha), manual hoeings and weedy check.

Statistical analysis of recorded data indicated that paired – plot arrangement, which provides check to each experimental unit, proved more efficient as compared to RBD as it reduced MSE from 635.7 to 248.1, C.D. from 35.6 to 22.2 and C.V. from 50.70 to 46.0% (Table 3.6).

Table 3.6 : Statistical parameters as effected by different lay-outs adopted for weed control trial in sugarcane

Statistical parameter	Type of lay-out	
	RBD	Paired-plot
Error mean sum of square (MSE)	635.7	248.1
Standard error (SE)	14.6	9.1
Critical difference	35.6	22.2
Co-efficient of variation (CV)	50.7	46.0

Genetic improvement of sugarcane for higher cane and sugar productivity under biotic and abiotic stresses

4.1 Studies on *Saccharum* germplasm

Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions (B.1.7)

Maintenance of sugarcane germplasm : A collection of 284 genotypes consisting of *Saccharum officinarum*, *Saccharum barberi*, *Saccharaum sinense*, ISH clones, Ikshu ISH clones, LG selections, commercial hybrids *etc.*, was maintained and the desired material was utilized for various on-going projects of the Institute. About 74 genotypes including commercial hybrids and LG selections were added to the collection during the period.

Evaluation of genotypes for ratooning potential : Better ratooning ability is the most important and desired feature of sugarcane varieties.All the genotypes available in the collection were evaluated for their ratooning potential (Table 4.1). In general, Ikshu ISH clones had shown better ratooning performance because of *Saccharum spontaneum* as immediate parent in their pedigree.

4.2 Development of sugarcane varieties and breeding stocks for sub-tropics

Fourteen promising genotypes emanating from different breeding projects along with four standard varieties were evaluated for cane yield and quality attributes as station trials (Table 4.2). Among the test genotypes, LG 05398 recorded the highest cane and sugar yield. Based on the yield and quality attributes, four clones *viz.*, LG 05302, LG 05403, LG 99270 and LG 05480 were identified as potential early maturing genotypes. Similarly, LG 05398, LG 04099, LG 04438, LG 06021 and LG 06004 were found to be promising as mid-late maturing genotypes. These genotypes may be proposed for multi-location testing under AICRP(S).

Development of sugarcane breeding stocks for high sugar (B 2.3)

High sugar selections developed previously (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

Table 4.1: List of genotypes having good ratooning potential

Group	Genotype
Ikshu ISH clones	Ikshu ISH 24, Ikshu ISH 23, Ikshu ISH 22, Ikshu ISH 13, Ikshu ISH 15, Ikshu ISH 15, Ikshu ISH 21, Ikshu ISH 16, Ikshu ISH 10, Ikshu ISH 2, Ikshu ISH 5, Ikshu ISH 8, Ikshu ISH 18, Ikshu ISH 20, Ikshu ISH 6 and Ikshu ISH 9
ISH clones	ISH 1, ISH 164, ISH 135, ISH 14, ISH 147. ISH 133, ISH 133, ISH 150, ISH 34 and ISH 5
Commercial hybrids	CoLK 08201, CoLk 94184, Co 0238, BO 91, CoPant 90223, CoLk 8102, CoH 108, Co 740, B 37161, BO 110, Co 87268. Co 89029, CoPant 84212, CoSe 92423, CoLk 8001, CoS 767, CoSe 95422 and CoLk 9710,
LG selections	LG 03701, LG 04061, LG 05823, LG 05817, LG 04043, LG 97023, LG 95056, LG 95053, LG 94126, LG 01118, LG 96001, LG 96115 and LG 97032
Species level clones	Khakai, Kewali 14 G, Khadya, Oramboo, Mungo-II, 57-NG-27, Tukyu No. 1, Baraukha, Kavenzire, Manjuria, Agoule and White Pindaria

Table 4.2 : Performance of promising genotypes under station trial

Genotype	Single cane weight (kg)	Pol % juice (Nov)	Pol % juice (Jan)	Pol % juice (Feb)	CCS% (Feb)	Cane Yield (t/ha)	CCS at harvest (t/ha)
LG 05398	0.707	14.14	17.61	17.64	12.28	90.37	11.10
LG 05403	0.838	16.47	17.58	18.62	13.00	81.14	10.55
LG 05405	0.488	14.30	16.86	16.95	11.74	47.81	5.64
LG 05302	0.608	18.03	18.81	20.36	14.27	76.32	10.88
LG 05319	0.691	11.00	15.93	17.89	12.37	67.47	8.35
LG 04438	0.608	12.93	16.58	18.34	12.71	86.11	10.95
LG 05416	0.587	14.06	15.98	16.44	11.31	70.25	7.95
LG 05601	0.773	13.32	15.60	15.23	10.27	88.50	9.13
LG 06021	0.759	14.05	16.81	18.73	13.07	82.25	10.75
LG 99270	0.626	17.44	18.75	19.77	13.80	73.79	10.18
LG 04099	0.635	14.04	17.40	19.58	13.65	80.45	10.98
LG 06011	0.578	12.95	15.69	15.67	10.66	69.73	7.44
LG 06004	0.753	14.69	16.59	17.12	11.82	89.13	10.54
LG 05480	0.580	16.01	18.39	18.91	13.17	74.44	9.81
CoJ 64	0.520	17.13	18.00	19.54	13.67	61.15	8.36
CoPant 84211	0.545	16.48	18.05	17.83	12.25	60.25	7.70
CoS 767	0.634	15.07	16.74	17.91	12.39	68.42	8.48
CoPant 97222	0.711	15.69	18.46	17.90	12.45	71.27	8.87
CD (P= 0.05)	0.10	1.09	1.03	1.23	0.96	8.41	1.244
CV (%)	10.85	5.31	4.32	4.92	5.54	9.10	10.841

proportion are also identified as potential parents for high sugar breeding.

In 2010, 15 bi-parental mating, 15 general collections and 7 self's were effected in the LG clones at SBI, Coimbatore. Fluff obtained from these crosses has been sown in the mist chamber for further transfer of seedlings to the field with the onset of rains. From the fluff of 2009 crosses, nearly 900 seedlings were transplanted in the field.

In the C_0 generation of 2008 crosses, the growth was not uniform to allow effective selection. For that reason, seedling-to-row progeny was planted in autumn in C_1. In another unreplicated trial, nearly 300 selections in C_2 were evaluated for early brix. Forty eight were found to have high sugar (*potential breeding stock, BS*) compared to an early maturing sugar check variety, CoJ 64. Twenty two were advanced for further evaluation of varietal merit. The cross-wise selections are as below (Table 4.3)

Evaluation of promising selections in separate replicated trials in plant and ratoon crops allowed inclusion of LG 03040, LG 06361 and LG 06599 in the station trial 2011-12.

A mid-late maturing variety, LG 05447 was accepted in the UP State Varietal Testing Programme, based on its performance both in plant and ratoon crops.

Development of top borer tolerant genetic stocks of sugarcane (B 2.9)

Four biparental crosses *viz.*, Co 1158 X CoLk 8002, Co 1158 X BO 91, BO 91 X CoLk 8102 and Co 1158 X CoLk 8002, were attempted at SBI, Coimbatore and eight intergeneric hybrids *viz.*, CoLk 8102 X (Co 7201 X IND 84-466), CoLk 94184 X IK 76-81, 28NG-31 X IK 76-91, IK 76-56 X IK 76-158 , 51NG-156 X (Co 7201 X SES 1378), 28NG-39 X IK 76-81 and Awela -68 X IK 76-91 at distant

Table 4.3: Selections in PVT (C_2)

Mating	Number of selections evaluated	High sugar (BS)	Varietal material (Vtyl)	BS + Vtyl	Total selection	Per cent selection	Per cent selection of BS	Per cent selection of Vtyl
CoLk 94184 GC	15	1	3	0	4	26.7	6.7	20.0
CoC 671 x ISH 147	7	1	4	0	5	71.4	14.3	57.1
LG 99122 x NCo 310	5	0	0	0	0	0.0	0.0	0.0
CoLk 94184 x CoLk 97147	6	1	0	0	1	16.7	16.7	0.0
CoLk 97169 x CoS 8436	2	0	0	0	0	0.0	0.0	0.0
CoS 96268 GC	41	4	12	2	16	39.0	9.8	29.3
LG 01016 GC	10	5	2	1	7	70.0	50.0	20.0
LG 01118 GC	82	21	20	1	41	50.0	25.6	24.4
LG 95053 GC	30	4	3	1	7	23.3	13.3	10.0
LG 99001 GC	38	4	10	2	14	36.8	10.5	26.3
LG 99022 GC	3	0	0	0	0	0.0	0.0	0.0
LG 99112 GC	49	6	8	0	14	28.6	12.2	16.3
LG 95037 GC	2	0	0	0	0	0.0	0.0	0.0
Total	290	47	62	7	109	37.6	16.2	21.4

hybridization facility, Agali. In addition, three GCs of intergeneric hybrids were collected.

In all, 1747 seedlings derived from eight crosses and two GCs were planted clonally for C_1 evaluation. One hundred seventy nine C_1 clones derived from fourteen biparental crosses involving four intergeneric hybrids with *Erianthus* sp as male parent, ten GCs and four self were evaluated for initial vigour, cane forming ability and HR Brix. One hundred ninety seven advanced to C_1 Clonal stage.

Forty eight C_3 genotypes evaluated for top borer tolerance, general vigour and brix, 19 advanced to C_4 stage (Table 4.4).

Table 4.4: Performance of C_3 genotypes

Attribute	Range of population	Range of selected clones
NMC ('000/ha)	72 - 121	97 - 117
Cane weight (kg)	0.7 - 1.4	0.9 - 1.1
HR brix % at Nov. 2010	16.4 - 22.6	18.8 - 22.6
HR brix % at Feb. 2011	18.2 - 23.6	19.2 - 23.4

Twenty clones along with two standards *viz.*, CoS 767 and CoJ 64 were evaluated at advanced stage for top borer tolerance (Table 4.5) and sugar yield (Table 4.6). Four clones *viz.*, LG 06602, LG 06605, LG 06606 and LG 06607 possessing superiority in traits of economic importance were advanced to station trial. The detailed features of clones advanced to station trial are presented below:

Five entries *viz.*, LG 06601, LG 06602, LG 06603, LG 06604 and LG 06605 were included in station trial of 2011-12 of the Division. In addition, CoLk 07201 was promoted to advance varietal trial of the North western zone under AICRP (S). Four genetic stocks *viz.*, LG 06601, LG 06602, LG 06603 and LG 06604 were included in the National Hybridization Garden (NHG) of Sugarcane Breeding Institute, Coimbatore.

Development of sugarcane varieties for moisture deficit environment (B 2.10)

A total of 11 biparental crosses *viz.*, Co 1158 x BO 91, CoJ 83 x BO 91, CoS 96268 x BO 91, CoJ 83 x CoPant 97222, BO 91 x Co 62198, Co 1148 x Co 775, CoS 8436 x CoSe 92423, Co 98010 x Co 94008, CoPant 84212 x Co 94008, Co 89003 x CoSe 92423 and Co 89003 x CoPant 97222 were attempted at National Hybridization Garden, Coimbatore during the crossing season 2010. The fluff received for all the crosses along with 15 GCs was sown in the glass house to raise the seedling. The fluff sown in the glass house recorded very good germination.

A total of 3635 seedlings raised from fluff of previous year crosses were transplanted in field

Table 4.5: Top borer infestation in advanced stage clones

Genotype	Top borer infestation (%)		Total carbohydrate (mg/g fwt)	Reducing sugar (mg/g fwt)	Protein content (mg/g fwt)
	III brood	IV brood			
LG 06602	4.00	8.00	32.40	8.50	15.30
LG 06605	5.45	7.8	22.30	6.45	17.32
LG 06606	6.56	6.5	29.78	7.4	15.34
LG 06607	5.45	6.6	27.34	6.89	14.46
CoJ 64	15.5	10.34	8.3	2.50	3.40
CoS 767	9.09	10.34	20.20	6.46	11.94
CD (P=0.05)	8.38	6.78	2.48	1.49	2.72
CV (%)	12.87	11.98	8.67	5.82	5.72

condition. Observations were recorded on survival and general growth vigour at early stage. Seedling crop was ratooned in the month of February for further evaluation. The final selection will be carried out on the basis of HR brix and general growth performance of the individual clones.

Based on the HR brix and general growth performance, about 465 C_1 clones were selected from seedling population. These clones were selected from different families comprising of CoSe 95422 x CoSe 95423 (12), CoSe 92423 x CoS 9436 (03), CoSe 95422 x CoSe 92423 (04), BO 91 x CoS 96268 (10), CoSe 95422 x Co 62198 (29), CoS 8436 x BO 91 (12), CoS 8436 x SP 80-185 (17), CoJ 83 x BO 91 (01), CoS 8436 x CoSe 92423 (02), CoH 110 x Co 775 (06), BO 91 x Co 86002 (68), Co 98010 x CoPant 97222 (30), CoPant 84211x Co 62198 (01), CoS 8636 GC (63), Co 86249 GC (15), CoSe 92423 GC (63), SP 80-185 GC (39), Co 1158 GC (37), Co 0238 GC (44) and Co 0239 GC (9).

Out of 79 C_1 clones, 27 clones were promoted to the second clonal generation (C_2) for further evaluation. Among the selected clones, LG 08752 had shown the highest sucrose (20.22%) in December followed by LG 08709 (19.32%) and LG 08745 (19.06%). Out of 42 C_2 clones, 24 clones were selected on the basis of sucrose content and general growth performance (Table 4.7). These clones were promoted to C_3 generation for their evaluation under normal as well as moisture deficit conditions. Seed materials of these clones were also being screened against red rot disease.

Development of sugarcane varieties for sub-tropics (B 2.13)

Thirteen biparental crosses were attempted at NHG, SBI, Coimbatore during October - November, 2010. In addition, fluff of 17 zonal crosses comprising of biparental and poly crosses were received for evaluation under this project. The fluff received for these crosses was sown in glass house to raise seedling population. The seedling will be transplanted during July/August, 2011. A total of 3217 seedlings from 28 crosses (2009 crossing) were transplanted in field during August

Table 4.6: Yield and quality attributes of advanced stage clones

Genotype	Parentage	NMC (000/ha)	Yield (t/ha)	Pol (%) in Nov '10	Pol (%) in Feb '11	CCS (%)	CCS (t/ha)
LG 06602	NB 94-545 GC	107.3	83.4	16.56	17.37	11.74	9.79
LG 06605	CoLk 8102 X CoS 96260	98.33	76.78	17.67	18.45	10.47	8.03
LG 06606	Co 7201 GC	92.67	80.67	16.98	18.13	10.89	8.78
LG 06607	CoJ 8201 GC	88.97	79.42	17.07	19.67	11.08	8.80
CoJ 64		67.33	62.22	17.63	16.36	10.57	6.58
CoS 767		72.67	55.66	14.71	17.35	11.59	6.45
CD (P=0.05)		12.4	4.69	1.04	1.10	1.53	1.80
CV (%)		10.39	9.81	4.79	5.59	6.62	9.74

Table 4.7: Sucrose content in C_2 clones promoted to the next generation

Clone	Sucrose (%) in November	Sucrose (%) in January
LG 07707	15.8	17.6
LG 07711	17.6	17.8
LG 07751	15.7	16.6
LG 07713	15.5	16.6
LG 07750	17.4	17.6
LG 07743	15.2	16.7
LG 07771	18.2	18.3
LG 07788	17.6	19.6
LG 07721	16.7	17.6
LG 07777	17.6	18.0
LG 07791	15.4	17.5
LG 07783	16.2	17.0
LG 07765	15.1	16.2
LG 07785	17.5	17.7
LG 07727	17.4	17.5
LG 07724	15.2	16.8
LG 07757	18.4	18.5
LG 07703	!6,9	17.0
LG 07725	14.2	15.5
LG 07782	17.1	18.8
LG 07787	14.8	16.1
LG 07768	15.2	16.2
CoS 767	15.4	17.8
CoS 8436	15.7	18.7
Mean	16.3	17.4
SE	0.24	0.20
Range	14.2-18.4	15.5-19.6

2010. These seedlings were ratooned during February 2011 for evaluation of morphological and quality traits.

A total of 271 clones from 28 crosses (2008 crossing series) were selected and planted in the field for multiplication and evaluation along with standards (CoJ 64, CoS 767) during autumn season. A total of 539 clones selected from the seedlings (2007 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 with two standards (CoS 767 and CoJ 64). A total of 123 clones were selected considering morphology of the clones and juice characteristics for further evaluation along with standards.

A total of 12 selected clones were planted with four standards (CoS 767, CoPant 97222, CoJ 64 and CoPant 84211) in RCBD for further evaluation (Table 4.8). Observations were recorded for yield, yield attributes and juice analysis (November and February). Analysis of variance indicated significant difference among these clones for cane yield, sugar yield and sucrose %.

Development of breeding stocks of sugarcane for durable resistance to red rot (B 2.14)

Elite clones LG 05817 and LG 05823 were found to be moderately resistant against red rot pathotypes Cf 01, Cf 08 and Cf 09 using plug method of inoculation and were used in hybridization to initiate first cycle of recurrent selection for population improvement.

Five selfs of Co 1148, LG 05817, LG 05823, BO 91, CoLk 8102 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 and five general crosses were attempted at National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore and fluff received was sown in the glass house to raise and evaluate seedling population during 2011-12.

A total of 3265 seedling progenies of nine crosses namely Co 85002 x SES 594, CoS 96268 x BO 91, BO 91x Co 62198, Co 1148 x ISH 150, Co 85002 x ISH 147, Co 7201 x ISH 150, Co 62198 x ISH 150, Co 1148 self and ISH 150 self were transplanted and evaluated for their performance on per clump basis. Observations on number of tillers 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.

One hundred eighty five progenies from seven families *viz.*, CoLk 8102 x Co 62198 (22 selections), CoLk 8102 x Co 86002 (42 selections), BO 91 x Co 62198 (21 selections), CoLk 8002 x Co 62198 (42 selections), Co 1148 X BO 91 (16 selections), Co 1148 x ISH 150 (2 selections) and BO 91GC (40 selections) were selected and advanced to first clonal generation on the basis of progenies performance for their growth performance, ratooning ability, NMC and HR brix in ratoon of seedling generation. These progenies will be screened for resistance to red rot using plug method of inoculation.

Table 4.8: Performance of PVT clones for yield and quality traits

Clone	Cane yield (t/ha)	CCS (t/ha)	NMC (000 ha)	SCW (kg)	Sucrose % (November)	Sucrose % (February)
LG 06004	94.6	11.93	108.13	0.94	16.1	18.07
LG 06020	40.4	5.47	86.00	0.58	16.63	19.17
LG 05003	70.17	5.90	79.23	0.81	18.04	21.12
LG 05020	68.97	10.53	90.87	0.75	17.08	19.23
LG 05002	73.03	9.37	116.50	0.79	15.46	18.15
LG 5029	61.33	9.13	102.73	0.8	15.32	17.25
LG 04012	65.63	9.23	99.63	0.61	15.9	19.52
LG 06017	68.27	7.37	81.50	0.84	15.05	17.65
LG 06021	56.3	6.47	75.10	0.86	15.06	19.18
LG 06050	62.97	8.97	106.23	0.96	15.52	17.69
LG 06040	60.20	8.43	93.40	0.76	16.52	19.58
LG 06011	60.57	7.60	88.53	0.66	14.29	15.47
CoJ 64	43.03	7.73	90.00	0.53	17.50	19.6
CoPant 84211	51.77	8.33	78.53	0.60	16.54	18.11
CoS 767	72.27	9.23	96.53	0.79	16.55	18.38
CoPant 97222	68.00	6.37	102.23	0.78	16.92	19.27
GM	63.59	8.25	93.45	0.75	16.16	18.59
SEd	5.40	0.68	7.03	0.06	0.90	0.88
CD (P=0.05)	11.03	1.38	14.35	0.12	1.83	1.79
CV %	10.40	10.06	9.21	9.81	6.79	5.79

A total of 74 moderately resistant (MR)/ moderately susceptible (MS) clones to red rot pathotype Cf 09 comprised of 9 families namely ISH1 x CoSe 96436 (31), CoLk 8002 x Co 62198 (5), BO91 GC (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 identified and advanced to second clonal generation for further testing against two pathotypes Cf 08 and Cf 09 of red rot.

Eleven clones of 2007 seedlings were selected for further evaluation. These clones showed moderately resistant and moderately susceptible reaction to two pathotypes Cf 08 and Cf 09 of red rot. Six clones *viz.*, LG 07811, LG 07812, LG 07815, LG 07816, LG 07807 and, LG 07809 also showed good ratoonability and high Pol (>19%) .

A trial comprising of 10 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 *viz.*, LG 06810, LG 06823A LG 06839 and LG 06856 showed moderately resistant (MR) reaction to two virulent pathotypes *viz.*, Cf 08 and Cf 09, while LG 06823A also showed highest cane yield (91.0 t/ha). LG 06856 also showed 19.8% sucrose in juice at 300 days.

Evaluation of early maturing sugarcane clones of North West Zone (B1.1)

Advance Varietal trial (Early) II Plant: Five early maturing entries *viz.*, Co 05009, CoH 05262, CoH 05265, CoLk 05201 and CoPk 05191 with two checks *viz.*, CoJ 64 and Co Pant 84211 were evaluated for their performance as second plant crop. Genotype CoPk 05191 was significantly found to be the best for cane and sugar yield (108.6 t/ha, 13.4 t/ha) followed by CoLk 05201 over best check, CoPant 84211 (53.3, 6.8 t/ha). Genotypes Co 05009 and CoH 05265 were found to be affected by wilt.

Initial Varietal Trial (Early): A trial comprising of early maturing entries *viz.*, Co 07023, Co 07024, Co 07025, Co 07026, CoH 07261, CoLk 07201, CoPb 07211 and Co Pant 07221 along with two checks *viz.*, CoJ 64 and Co Pant 84211 were evaluated for yield and juice quality. Clones namely, CoLk 07201 (79.6 t/ha) was superior in sugar yield over the best check, Co Pant 84211 (42.5 t/ha) followed by CoH 07261 (75.3 t/ha). Genotypes Co 06032 and Co 7226 were found to be affected by wilt.

Seed multiplication : Nine genotypes *viz.*, Co Pant 08221, Co Pant 08221, CoPb 08211, CoPb 08212, CoPb 08213, CoS 08231, CoS 08232 and CoS 08233 were multiplied for raising Initial Varietal Trial for 2011 -12.

Evaluation of mid-late sugarcane clones for North West Zone (B 1.2)

Initial Varietal Trial (Mid-late): A trial comprising of seventeen test genotypes *viz.*, Co 07027, Co 07028, CoH 07263. CoH 07264, CoH 07265, CoLk 07202, CoLk 07203, CoPant 07223, CoPant 07224, CoPb 07212, CoPb 07213, CoPb 07214, CoS 07231, CoS 07232, CoS 07233, CoS 07234 and CoSe 01424 along with three standard varieties *viz.*, CoPant 97222, CoS 767 and CoS 8436 was conducted. Various observations on yield and quality parameters were recorded. Genotype CoH 07263 exhibited the highest cane yield (89.8 t/ha) and CCS yield (12.18 t/ha) followed by CoH 07264. The genotype CoPb 07214 showed highest sucrose percentage at harvest (20.4%) followed by Co 07028. Among the standards, CoPant 97222 was the best check for cane yield (74.1 t/ha) and CCS yield (10.29 t/ ha).

Advance Varietal Trial (Mid-late) I 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 parameters. The genotype CoH 06265 recorded the highest cane yield (84.7 t/ha) and CCS yield (11.67 t/ha) followed by CoS 06247. These genotypes were significantly superior over all the three standards for cane yield and CCS yield. Among the test genotypes, Co 06034 recorded the highest sucrose content at harvest (20.0%) followed by CoH 06265 (19.6%) and CoH 06266 (19.6%). Among the standard varieties, CoS 767 was the best check for cane yield (66.8 t/ha) and CoS 8436 was the best for CCS yield (9.08 t/ha).

Advance Varietal Trial (Mid-late) II Plant: A trial comprising of eight genotypes *viz.*, Co 05011, CoH 05266, CoH 05269, CoPant 05222, CoPant 05224, CoPb 05211, CoPk 05191 and UP 05233 along with three standard varieties *viz.*, CoS 767, CoS 8436 and Co 1148 was conducted. Various observations on yield and quality parameters were recorded. The genotype CoPant 05224 recorded the highest cane yield (89.1 t/ha) as well as CCS yield (12.13 t/ha) followed by UP 05233. CoPant 05222 exhibited the highest sucrose content at harvest (20.1%) followed by Co 05011 (19.4%) and CoPant 05224 (19.3%). Among the standards, CoS 767 was the best check for cane yield (70.4 t/ha) and CCS yield (9.03 t/ha).

Advance Varietal Trial (Mid-late) Ratoon: Eight genotypes *i.e.*, Co 05011, CoH 05266, CoH 05269, CoPant 05222, CoPant 05224, CoPb 05211, CoPk 05191 and UP 05233 along with three standard varieties *viz.*, CoS 767, CoS 8436 and Co 1148 were evaluated for their rationing ability. The genotype UP 05233 had shown best ratooning ability with the highest cane yield (63.7 t/ha) and CCS yield (7.31 t/ha) followed by CoPant 05224. Among the standard varieties, CoS 8436 was the best ratooner, that recorded highest cane yield (59.2 t/ ha).

Seed multiplication: The seed of eleven genotypes *viz.*, CoH 08261, CoH 08262, CoH 08263, CoH 08264, CoLk 08201, CoPb 08214, CoPb 08215, CoPb 08216, CoPb 08217, CoS 08234 and CoS 08235 was multiplied for the next years's Initial Varietal Trial.

Inter zonal varietal trials under AICRP(S) (B 1.3)

Early varietal trial : Eighteen entries *viz.*, Co 0301, Co 0302, Co 0303, Co 0305, Co 0306, Co 0308, Co 0312, Co 0314, Co 0315, CoA 03081, CoS 03292, CoSe 03234, PI 96-0843, CoP 03181, CoOr 03151, CoBln 03171, CoBln 03172 and CoBln 03173 along with two standards *viz.*, CoJ 64 and Co Pant 84211 were evaluated for cane yield, quality and other attributes. Co 0303 and CoBln 03172 exibited superior yield while, Co 0306 gave highest sucrose content.

In addition, 16 early entries *viz.*, Co 0114, Co 0211, Co 0309, Co 0310, Co 0313, Co 0316, MS 0219, CoM 0250, CoM 0251, CoM 0261, CoOr 03151, CoOr 03152, CoC 03061, CoC 03062, CoJ 03192, and BO 138 and 35 mid-late entries viz., Co 0112, Co 0311, Co 0317, Co 0318, Co 0320, Co 0322, Co 0323, Co 0325, Co 0326, Co 0328, CoVc 99134, MS 0209, MS 0217, MS 0221, CoM 0265, CoM 0272, CoVSI 03301, CoA 03082, CoV 03102, CoC 03063, CoLk 9910, BO 141, CoBln 03174, CoBln 03175 and CoBln 03176 were multiplied.

Evaluation of sugarcane clones under AICRP(S) suitable for North Central Zone at Regional Centre, Motipur (B 1M)

Under this project, three trials of mid-late category and two trials of early group were carried

out during the crop season 2010-11. Salient results are as follows:

Advance Varietal Trial (Early) II Plant and Ratoon: Three entries against standards *viz.*, BO 130 and CoSe 95422 were evaluated in RBD with four replications. The entry CoBln 05501 was found superior over checks.

Advance Varietal Trials (Mid-late) II Plant and Ratoon: Seven entries against three checks (Bo 91, CoP 9301 and CoSe 92423) were tested in RBD at Regional Centre, Motipur. Out of seven entries, Co 05020 was found to be better over standard checks.

Advance Varietal Trial (Mid-late) I Plant: Seven entries including three standards (BO 91, CoP 9301 and CoSe 92423) were tested in RBD. Entry CoP 06436 was found promising.

Fluff Supply Programme (B 2)

Under this project, crosses are made for each sugarcane agro-climatic zone based on proposals from breeders for their respective zones. Consequently, fluff is supplied to each participating centre for development of location-based sugarcane varieties for the zone. Under this project, several entries have been proposed and are at various stages of AICRP testing in both the early and mid-maturity group. The advance material is being evaluated for identification of varietal candidates.

During the year under report, three elite clones namely, LG 05350, LG 05306 and LG 04439 were included in the Station Trial 2011-12 of the Division, based on their performance in the plant crop. Apart from this, two early selections, LG 05302 and LG 05403 and one mid-late maturing selection LG 02434 were accepted for evaluation under UP State Varietal Testing Programme at 13 locations.

4.3. Cytogenetic and biotechnological techniques for sugarcane improvement

Genetic improvement of sugarcane through tissue culture (B 3.7)

This project has capitalized on the ability of *in vitro* cultures involving a callus phase to generate variability in order to effect minor modifications in the otherwise well adapted sugarcane varieties. Over the years, from an exhaustive field evaluation of hundreds of somaclonal variants produced from a large number of sugarcane varieties of subtropical India, some morphologically interesting somaclones were isolated, such as top borer tolerance, flowering tendency, shift in maturity, changes in sucrose content, cane girth, bud shape and size, internode shape, *etc.* Many of these changes marked in the early generations, tended to taper off in successive clonal generations, particularly those related to agronomic characters such as number of millable canes, cane height, girth and weight, and pol % in juice. The useful somaclones among these were some red rot resistant ones produced from susceptible varieties, particularly CoJ 64 and CoS 767. In a wilt susceptible variety, Co 7717, some somaclones have shown reduced susceptibility.

Two somaclones resistant to red rot have been sent to the National Hybridization Garden at SBI, Coimbatore and are being involved in crossing.

Genetic transformation in sugarcane for resistance against borers (B 3.15)

Sugarcane cultivar CoLk 8102, a subtropical variety susceptible to stalk borer was transformed with the *Cry1Ab* gene. Transformants were developed and confirmed with GUS assay and PCR amplification of bar gene last year. ELISA analyses and insect bioassay tests were carried out this year for their further confirmation.

Expression of *Cry1Ab* in transformants

Enzyme-linked immunosorbent assay (ELISA) was carried out for detection and quantification of *Cry1Ab* protein in leaf tissue samples of primary transformants. The *Bt* Quant-*Cry1Ab* plate kit designed by Central Institute for Cotton Research (CICR), Nagpur, India, was used for the quantitative laboratory assay. Samples of 100 mg of leaf tissue from primary transformants and control plants were cleaned with 70% alcohol and ground to a fine powder in liquid nitrogen. The ground tissue was resuspended in 0.5 ml of 1X *Cry1Ab* extraction buffer (supplied with kit) and processed as per the manufacturer's instructions. The plate was read within 30 min of the addition of stop solution. The intensity of colour development was measured spectrophotometrically with a microplate reader (BioRad, USA) at 450 nm at NBRI, Lucknow. The results showed that transformed plants produced 0.39 to 5.08 times higher expression of *Cry1Ab* protein in comparison to untransformed plants (Fig. 4.1).

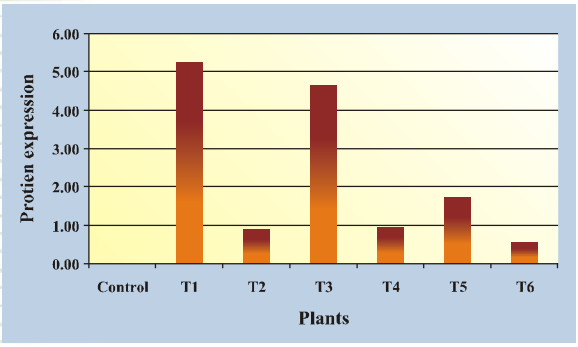


Fig. 4.1: *Cry1Ab* protein expression in transformants

Insect bioassay

The leaves of transformed plants (T_1, T_3), which showed high expression rate of *Cry1Ab* protein (Fig. 4.1) were used for insect bioassay to evaluate impact of protein on stalk borer larvae. Ten newly hatched stalk borer larvae were released to the glass tubes containing foliage of transformed sugarcane plants and kept at 27 ± 1^{0}C and 70% relative humidity maintained in the BOD for further larval development. A separate control was maintained after feeding the larvae on leaves of normal sugarcane. The neonate larvae of stalk borer were allowed to feed on the transformed foliage for four days and after fifth day and onwards larvae become sluggish and stopped feeding on leaves. While in untreated check, larvae were feeding and a continuous increase in size was observed. Weight loss was 30-50% in the larvae feeding on transformed plant foliage (Fig. 4.2) which led to mortality as compared to those feeding on leaves of control plants (Fig. 4.3). Further confirmation of transformed plants using southern blot is in progress.

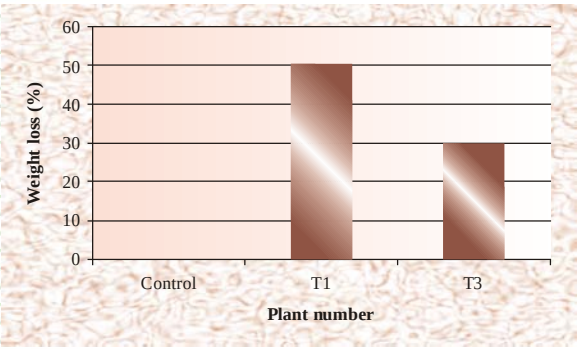


Fig. 4.2: Weight loss in stalk borer larvae fed upon transformed sugarcane plants

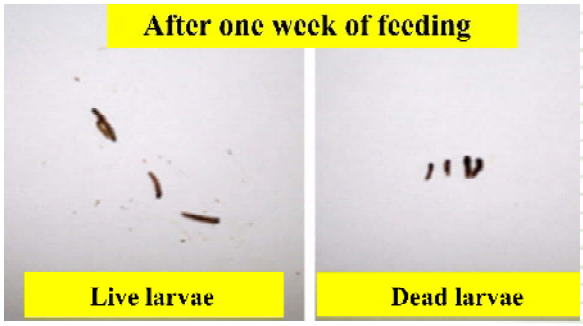


Fig. 4.3: Insect bioassay

Elucidation of the role of species chromosomal complement in sugarcane genotypes adapted to subtropical conditions (B 3.17)

Chromosome variability in proven parents, crosses and clonal generations, and meiotic peculiarities of proven parents for efficient meiotic chromosomal transmission and also to understand the contribution of species-specific chromosomes in elite genotypes of sugarcane is being studied from June 2010. Preliminary studies on chromosomal variability were carried out in proven parents *viz.*, CoJ 64, CoS767, CoLk 8102, BO 91, CoSe 92423, Co 1148 and CoS 8436. Somatic chromosome number variation and mitotic index was determined based on chromosome squash preparations from root/shoot tips. Mitotic index of root-tips was more than that of different segments of shoot apices in all the genotypes. The chromosome number/cell varied from 92-126 and the modal chromosome numbers ranged between 104 and 118. The % of cells having chromosome numbers other than the modal number, ranged between 23.88 and 40.63.

Identification and expression analysis of resistance gene analogues against red rot disease in sugarcane (B 3.18)

In a study to identify red rot specific disease resistance gene analogues, the plant disease resistance (R) genes share certain homologies across the genera in their conserved sequences. To find the possible resistance gene analogues in sugarcane, degenerate primers were designed using the conserved regions of sequences of known *R*-genes selected from the literature. These primers as well as those available in literature were used to amplify the homologous sequences from red rot resistant and susceptible sugarcane genotypes. Nineteen forward and eighteen reverse primers in

forty two different combinations were used for PCR. Out of these, twenty two primers showed clear amplification. A total of 520 bands were produced of which more than 60% were polymorphic. Further studies on these as well as new set of primers is in progress.

Mapping of loci linked to sugar content in sugarcane (B 3.19)

The project was initiated with the aim of mapping genomic regions involved in sugar accumulation in sugarcane and also for involving validation of some putative markers identified earlier. Juice analysis in January (and also in February for some low sugar clones) in the segregating populations (CoS 96268 self, CoLk 7901 x HR-83-65 and LG 94114 x ISH 176) established that the first two population have a wide range for mean pol% (9.16-18.2 and 10.2-19.8, respectively). Three low sugar genotypes *viz*., LG 07651, LG 06592 and LG 06953 were sent to National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore for probable use as parental lines. DNA was isolated from 180 individual plants from the self population for marker studies. Twenty primers were screened during the period of reporting and these did not show polymorphism with respect to sugar content. Thirty new primer pairs from sugarcane unigenes were commercially synthesized for testing in the parental and segregating population. Polymorphic bands from contrasting clones are being eluted for further sequencing.

Development of SSR markers for red rot resistance from EST database of sugarcane (DBT 1/09)

Focus was imparted on designing and development of EST-SSR markers using EST database of sugarcane. A total of 235 new EST-SSR primers were designed and developed from 4169 unique ESTs of Indian origin. Two hundred twenty two (94.5%) primers showed amplification. Out of 222 primers, 118 (53.2%) were polymorphic. Furthermore, 80 EST-SSR, available in public domain were also tested for polymorphism. Phenotyping of two sets of mapping populations were carried out against red rot. Genotyping (Fig.4.4) has been completed with 60 EST-SSR primers and further works are in progress.

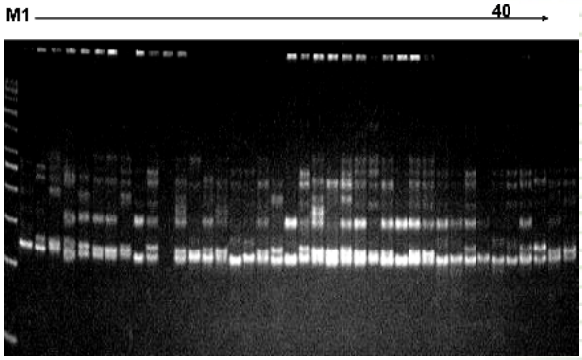


Fig.4.4 : Genotyping of different varieties/elite genotypes of sugarcane using EST-SSR -364 primer. M=50 bp standard ladder, 1=CoS 94270, 2=CoS 7268, 3=CoS 91269, 4=CoH 119,5= 5-CoPant 97222,6=CoJ 89, 7=CoS 687, 8= CoH 92201 ,9=CoS 245, 10=CoS 99259, 11=CoS 94257, 12=CoP 9702, 13=CoS 425, 14=CoSe 96436, 15= CoH 99, 16=CoS 90265, 17=CoPant 96219, 18=BO 137, 19=CoS 03279, 20=Co 453, 21=CoS 97246, 22=CoSe, 0235, 23=CoSe 98231, 24= CoS 95255, 25=CoS 8207, 26=CoJ 88, 27=CoJ 83, 28=UP 0097, 29=CoSe 92423, 30=CoH 56, 31=CoP 9206, 32=CoS 770, 33=C089029, 34=CoSe 95436, 35=CoS 88230, 36=BO 109, 37=CoH 92, 38=UP 05, 39=CoPant 84221, 40=Co 1336

Equipping and strengthening of designated DUS test centres under central sector scheme for implementation of PVP Legislation (DUS Testing Project)

A total of 108 sugarcane varieties collected earlier from different sugarcane research centres of sub-tropical region, were maintained as reference collection at the Institute Farm. Observations were recorded as per sugarcane DUS descriptor for further validation. All the varieties have been planted in the field under maintenance of reference collection.

Epidemiology and integrated disease management

5.1. Epidemiology of diseases of sugarcane

Survey and surveillance of insect pests and diseases of sugarcane in sub tropical area (EM 01)

Sugarcane command area of eight sugar mills *viz*., Simbhawali Sugar Mills Unit: Chilwaria, Bahraich; Balrampur Chini Mills Ltd., Unit: Tulsipur; Unit: Balrampur; Unit: Manakapur; Unit; Babhnan; Rozagaon Sugar Mills Ltd., Rozagaon, Faizabad; Triveni Engineering and Industries Ltd., Unit: Deoband; Sugar mills of DSCL Group Unit: Hardoi, Unit: Rupapur in Uttar Pradesh and Harinagar Sugar Mills Ltd., Harinagar, West Champaran in Bihar were surveyed for the prevalence of insect-pests and diseases.

Red rot was found in several areas of central U.P. and Bihar. In Harinagar Sugar Mills, Bihar, the major varieties affected with red rot were CoSe 95422 and CoJ 88 and in central U.P., the varieties affected were CoLk 8102, CoS 767, CoS 8432 and CoS 8436. Incidence of smut was also observed in CoSe 98231 in few fields of the command area of Balrampur Chini Mills Ltd., Unit: Babhnan. Minor incidence of pokkah boeng, leaf scald and GSD was also observed at certain locations.

Monitoring of insect pests was also carried out. Incidence of plassey borer, scale insect and white fly was observed in the command area of Harinagar Sugar Mills, Harinagar, Bihar. In command area of DSCL Sugar, Rupapur, incidence of internode borer in certain fields was recorded to the tune of 70% in autumn planted crops, while its incidence was low in spring planted crops. At certain locations, incidence of stalk borer was about 10-15% in autumn planted crop and 5-10% in spring planted crops, while the incidence of top borer was 20-30%. In Simbhawali Sugar Mills Unit: Chilwaria, Bahraich, the incidence of army worm was noticed in large area. In addition, the incidence of top borer and green borer was also noticed.

Survey was also conducted to assess the insect pest infestations in the command area of Triveni Engineering & Industries Ltd., Deoband. In certain pockets, white grub infestation varied from 10 to 100%. Other important insect pests recorded were early shoot borer (5-25%) and top borer (5-10%).

Development of red rot in standing cane through sett-borne infection (M 2.15)

Healthy setts of Co 1148 were treated with three different concentrations of *Colletotrichum falcatum* spore suspension (10^3, 10^4 and 10^6 conidia/ml) and three different periods of incubation (8, 16 and 24 h). In general, all the treatments affected the bud germination except the treatment of 10^3 conidia/ml with 8 h of incubation. Similarly, in all the treatments, bud mortality was increased with the increase in the concentration of spore and incubation period.

It was concluded that when the level of infection in seed cane was high, due to failure of germination, the initial crop stand was poor and this in turn, lowered the incidence of red rot in standing cane. On the contrary, if the level of infection was low in seed cane, the germination was least affected and it ensured a good crop stand. In this condition, the disease development also delayed and resulted in a staggered appearance of disease at settling and standing cane stage.

5.2. Identification of causal organism(s), pathotypes/strains of sugarcane pathogens for development of resistance

Pathotype formation in *Colletotrichum falcatum* in relation to breakdown of resistance in cane genotype (M 2.14)

The project was initiated to find out the reasons and mechanism involved in sudden breakdown/failure of a resistant sugarcane genotype to red rot after a few years in cultivation. Initially, 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 2010, Cf 01 (isolated from Co 1148) was inoculated on the differentials and after three weeks of inoculation, cultures were reisolated from the furthest point of infection. Nine sporulating variant cultures of Cf 01 were established after isolation from the differentials. These reisolated cultures were grown on liquid media and the ten days growth was harvested for analysis of DNA.

These nine variants Cf 01 cultures were simultaneouly inoculated on Co 1148 to ascertain any change in the virulence behaviour after passing through differential hosts. In most of the cases, the pathogen retained the virulence. These cultures were also molecularly characterized using 11 ISSR primers (primer 1, 5-14). However, no visible difference was observed in the band patterns.

Identification of pathotypes of red rot pathogen (AICRP: PP 14)

Twelve new isolates *i.e.*, two from CoS 8436 (IR-14 and IR-15), one each from CoS 8432 (IR-16) and CoS 767 (IR-17) and eight isolates of CoLk 8102 (IR-18 to IR-25) were evaluated for their virulence pattern on the designated differentials *viz.*, Co 419, Co 975, Co 997, Co 1148, Co 7717, Co 62399, CoC 671, CoJ 64, CoS 767, BO 91, Baragua (*S. officinarum*), Khakai (*S. sinense*), SES-594 (*S. spontaneum*), CoS 8436 and CoLk 8102. All the test isolates were inoculated using plug method of inoculation. The cane stalks were split open longitudinally after 60 days of inoculation. The disease reaction of the test isolates was recorded and compared with the reaction of the existing pathotypes.

It was observed that both the isolates of CoS 8436 (IR-14 and IR-15) showed close proximity with the pathotype Cf 07, while an isolate of CoS 8432 (IR-16) nearly matched with pathotype Cf 02. Isolate IR-17 (CoS 767) showed close proximity with pathotype Cf 09. All the eight isolates of CoLk 8102 (IR-18, IR-19, IR-20, IR-21, IR-22, IR-23, IR-24 and IR-25) segregated in two groups based on their reaction on set of differentials. Isolates (IR-18, IR-19, IR-20, IR-23, IR-24 and IR-25) showed a close proximity with pathotype Cf 02 except virulence on Co 7717, while isolate IR-21 and IR-22 nearly matched pathotype Cf 07. Hence, it was concluded that there is no emergence of any new virulent pathotype in this zone.

Seven pathotypes *viz.*, Cf 01, Cf 02, Cf 03, Cf 07, Cf 08, Cf 09 and Cf 11 (North West Zone) and 4 pathotypes *viz.*, Cf 04, Cf 05, Cf 06 and Cf 10 (East Coast Zone) were maintained *in vitro* condition.

5.3. Disease management in sugarcane

Management of red rot of sugarcane through bioagents (M 15.3)

When treated canes were challenge inoculated with *Colletotrichum falcatum*, cane stalks were protected from red rot infection in soil application of TMC (72.0%), MHAT (46.0%) and TMC+ MHAT (76.0%). Soil application of *T. harzianum* enhanced the availability of macronutrients *i.e.*, N, P, K by 27.0, 65.0 and 44.0%, respectively. There was also increase in uptake of micronutrients *i.e.*, Cu (6.0%), Fe (100.0%), Mn (79.0%) and Zn (55.0%), respectively.

In ratoon crop, *Trichoderma* application enhanced emergence/sprouting of clumps (15.0%), tiller population (8.0%), cane height (5.0%), internodal length (2.0%), number of internodes (8.0%), cane girth (4.0%), number of millable canes (4.0%), single cane weight (5.0%) and total yield (23.0%) over untreated diseased check.

Trichoderma isolate Th-37 and Th-38 were found highly antagonistic against *C. falcatum*. Total genomic DNA was extracted from mycelium mats of these isolates by CTAB procedure. Universal primers pair ITS-4 and ITS-5 was used to amplify Internal Transcribed Spacer (ITS) regions of the rDNA cluster (ITS1-5.8S-ITS2) and PCR products were directly sequenced. Sequences from other related organisms obtained from the Blast search of database of National Centre for Biotechnological Information (NCBI) was compared. The 5.8S region was found conserved and much of the sequence variability was due to transition/transverse mutations in the ITS1 and ITS2 regions. The analysis showed that both the strains belonged to the *T. harzianum* clad. These strains are distinct yet have close genetic similarity coefficients (up to 0.77) in matching with several established strains/ isolates of *T. harzianum* reported worldwide. The SNPs located in the ITS1 and ITS2 regions were helpful in the differentiation of *T. harzianum* isolates.

Management of red rot through modulating host resistance (M 15.4)

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 ($MnSO_4$), Zn ($ZnSO_4$) and Fe ($FeSO_4$) @ 25 kg/ha each 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.

Three red rot (Cf 01) resistant genotypes *viz.*, BO 91, CoLk 94184 and CoS 96268 and six susceptible genotypes *viz.*, Co1148, CoJ 64, CoLk 7701, CoS 767, CoLk 8102 and CoS 8436 were inoculated and samples were analyzed for biochemical and DNA studies.

Total phenols, reducing sugars content, polyphenol oxidase and peroxidase activity were determined in red rot inoculated and uninoculated cane stalks. Variations were observed among different genotypes for different biochemical attributes. Preliminary data indicated lower reducing sugars, total phenols contents, peroxidase and PPO activity in red rot inoculated genotypes over control except peroxidase in CoLk 94184, which showed higher activity. CoJ 64 and Co 1148 showed marked increase in total phenols and the contents of reducing sugars.

Total DNA was extracted from both red rot inoculated and uninoculated cane stalks of selected genotypes. Single stranded $_c$DNA was synthesized using Oligo ($_d$T) primers. Chitinase and 1,3-glucanase specific primers were synthesized and used for PCR. The PCR products were separated on 2% TAE Agarose gel. The banding pattern showed that there was enhanced expression of these genes after inoculation of red rot pathogen in resistant genotypes as compared to susceptible ones.

Management of red rot through fungal endophyte in sugarcane (M 15.5)

Endophytic fungal population were isolated from nodes, internodes, buds, leaves and midrib of apparently healthy 35 sugarcane genotypes in different months. Overall colonization rates of endophytes were 40% in early months of the crop growth. In later months, the colonization was 60%. Endophytes belonged to eight different fungal taxa of which *Trichoderma, Aspergillus,* and *Fusarium* were dominant. Frequency of the colonization varied depending on the age of the plant and genotypes of sugarcane. Dual culture studies revealed that *Trichoderma* and *Aspergillus* species are having antagonistic properties against red rot pathogen.

Improving efficacy of *Trichoderma* for management of red rot of sugarcane (M 15.6)

Soil samples from sugarcane rhizosphere and other areas were collected from three different geographical locations [Lucknow, Deoband (Saharanpur) in UP and Motipur, Bihar]. These samples were processed and fifty seven isolates of *Trichoderma* were established. Isolates were purified through single spore culturing and stored in glycerol. Based on growth rate assessment, ten isolates were selected and characterized for their colony characters, growth rates at four temperature levels (25, 30, 35 and 40^{0}C) and morphology. Considerable variation in growth was observed among the isolates. At 25^{0}C, the growth ranged from 46.3 to 64.6 mm across the isolates while at 30^{0}C, the radial growth recorded varied from 44.6 to 71.3 mm among the isolates. All the isolates showed poor growth at 35^{0}C (< 2 to 7.6 mm) and no growth at 40^{0}C. Secretion of bright yellow pigment in agar was observed in three isolates (STr-10, 16 & 29) and formation of yellow conidia observed in eight isolates. In isolates STr-5, 9, 13, 15, 16 and 23 chlamydospores, both terminal and intercalary were formed within seven days. Phialides were in whorls of 2-4 with globose to subglobose conidia. Based on differences in growth rates, colony character and morphology, these isolates were tentatively identified as *T. harzianum*, *T. aggressivum* and *T. asperellum*.

5.4. Evaluation of germplasm/genotypes against major diseases of sugarcane

Evaluation/screening of sugarcane germplasm/genotypes against red rot and smut (M 17)

Forty one genotypes were screened against red rot and smut along with susceptible checks *viz.*, CoJ 64 (for Cf 08) and CoS 767 (for Cf 09) and CoLk 9617 (for smut).

Red rot

Twenty five genotypes were resistant to both the pathotypes, while eight genotypes *viz.*, LG 05610, LG 05358, LG 05389, LG 05399, LG 06443, LG 06571, LG 06577 and LG 06610 were

moderately susceptible (MS) to highly susceptible (HS) to both the pathotypes. Seven genotypes exhibited susceptible reaction to one pathotype and resistant to other pathotype. LG 05311 showed resistant reaction to pathotype Cf 08.

Smut

Thirty six genotypes were resistant to smut. Only five genotypes *viz.*, LG 05605, LG 05340, LG 05377, LG 05417 and LG 06609 showed susceptibility.

Wilt

Natural incidence of wilt was observed in LG 05313, LG 05340, LG 06463, LG 06538 and LG 06640.

Evaluation of varieties/genotypes for resistance to red rot, smut and wilt (AICRP: PP 17)

a) North Western Zone (IISR, Lucknow)

Thirty three genotypes *i.e.*, 7 Advanced Varietal Trial (mid-late) Plant-I, 9 Initial Varietal Trial (early) and 17 Initial Varietal Trial (mid- late) were screened against red rot (Cf 08 and Cf 09) using plug method .

Red rot

Among the genotypes tested in AVT (mid-late) Plant-I, 5 genotypes *viz.*, Co 06034, Co 06266, CoPant 06224, CoPb 06219 and CoS 06247 showed moderately resistant (MR) reaction to both the pathotypes. Co 06033 and Co 06265 were susceptible (S) to pathotype Cf 09 while moderately resistant (MR) to Cf 08.

In IVT (early), Co 07023 and CoLk 07201 were found moderately resistant, while Co 07026 and CoH 07261 were moderately susceptible (MS) to highly susceptible (HS) to both the pathotypes. Co 07024 was moderately resistant (MR) to Cf 08 and susceptible (S) to Cf 09. Co Pant 07222 was susceptible (S) to Cf 08 but showed moderately resistant (MR) to Cf 09.

In IVT (mid-late), 12 genotypes *viz.*, Co 07028, CoH 07263, CoH 07264, CoLk 07202, CoLk 07203, CoPant 07223, CoPb 07213, CoPb 07214, CoS 07231, CoS 07232, CoS 07234 and CoSe 01424 were moderately resistant (MR), to both the pathotypes. CoH 07265 was highly susceptible (HS) to both the pathotypes. CoPb 07211 was highly susceptible (HS) to Cf 08 and moderately resistant (MR) to Cf 09. Co 07027 and Co Pant 07224 were moderately resistant (MR) to Cf 08 and susceptible (S) to highly susceptible (HS) to Cf 09.

Smut

Four genotypes *viz.*, Co 06033, CoPant 06224, CoS 06247 and Co 07024 were found susceptible to smut and remaining twenty nine genotypes were resistant.

Wilt

Natural incidence of wilt was observed in CoS 06247 and Co 07024.

b) North Cenral Zone, (IISR Regional Station, Motipur, Bihar)

At IISR Regional Station, Motipur, 14 genotypes *i.e.*, 3 Advanced Varietal Trial (early) Plant-II, 7 Advanced Varietal Trial (mid-late) and 4 Advanced Varietal Trial (mid-late) Plant-I were evaluated against red rot (Cf 07 and Cf 08) using plug method.

In AVT (early) Plant-II, genotype CoSe 05451 showed moderately resistant (MR) reaction, while CoSe 05451 showed susceptible (S) reaction to both the pathotypes. CoBln 05501 was susceptible to Cf 07 and moderately resistant (MR) to Cf 08.

In AVT (mid-late) Plant-II, two genotypes *viz.*, CoSe 05452 and CoBln 04174 were moderately resistant (MR) and three genotypes *viz.*, Co 05019, Co 05020 and CoBln 05502 were susceptible (S) to highly susceptible (HS) to both the pathotypes. Co 05018 and CoP 05437 were susceptible (S) to highly susceptible (HS) to one pathotype and moderately resistant (MR) to the other.

In AVT (mid-late) Plant-I, CoSe 06456 was moderately susceptible (MS) to susceptible (S) to both the pathotypes, while CoP 06437, CoSe 06456 and CoSe 07451 were moderately resistant (MR) to one pathotype and moderately susceptible (MS) to susceptible (S) to other pathotype.

Natural incidence of wilt was observed in five genotypes *viz.*, Co 05018, Co 05019, CoP 05437, CoBln 05502 and CoSe 06456.

Bio-ecology and integrated management of insect-pests

6.1. Bio-ecology of insect-pests of sugarcane

Biological control activities at Pravaranagar, Maharashtra (EM 01a)

Seasonal fluctuation in the incidence of early shoot borer (*Chilo infuscatellus*) and pink borer (*Sesamia inference*) was recorded from April 2010 to March 2011. Maximum incidence of shoot borer was recorded in the first fortnight of May and it coincided with the maximum activity of its larval parasite *Sturmiopsis* sp. During August-September, parasitisation of *Cotesia flavipes*, another larval parasite was also observed.

Similarly, population build up of scale insect (*Melanaspis glomerata* Green) and the predatory and parasitic activity containing this pest was also recorded. In ratoon crop, the infestation was noticed from July 2010 and maximum incidence (76.88%) was recorded in March 2011, however, maximum parasitisation (21.05%) was observed during October. Presence of predatory beetle was also noticed during September 2010.

The activity of *Pyrilla* was noticed from May 2010 and it reached its peak during August (about 55 adults and 166 nymphs/100 clumps). Fresh cocoons of *Epiricania* were noticed in July 2010. This year stray incidence of sugarcane woolly aphid was noticed in some fields. The activity of *Dipha ahidivora* was also noticed during July–August, 2010 and *Micromus* was also observed up to October, 2010.

Population dynamics of sugarcane borers (early, top, internode and stalk) through pheromone traps (AICRP: E 32)

Population dynamics of sugarcane borers *viz.*, early shoot, top, and stalk borers were studied by installing their respective pheromone traps in separate sugarcane fields at IISR farm. Amongst these three lures, top borer moths were trapped effectively *i.e.*, 274, 354, 498 and 300 adult moths per lure during I, II, III and IV brood emergence. Infestation percentage of top borer was recorded (brood wise) as 7.1, 10.5, 5.45 and 3.44% in plots having pheromone trap, where as it was 9.8, 11.9, 6.88 and 4.09% in plots without pheromone traps in I, II, III and IV broods, respectively.

In case of stalk borer, the moths trapped were in low numbers, whereas luring was nil in case of early shoot borer.

Monitoring of insect pest and bioagents in sugarcane agro-ecosystem (AICRP: E 30)

Three bud setts of CoLk 8102 were planted in March, 2010. Recommended agronomic practices were followed to raise a good crop. Observations on incidence of insect pests and their bio-agents were recorded.

The incidence of top borer II brood, III brood, IV brood, V brood, internode borer and stalk borer was 7.14, 18.92, 16.57, 27.94, 23.17 and 2.43%, respectively. The incidence of pink borer in June and July was 3.64 and 2.5%, respectively. In 6 m row, root borer incidence was 5.50, 34.76 and 45.0% in June, July and October, respectively. Sett damage due to termite was 13.46% and shoot damage was 27.45%. In September and November, muddy tunnels of termites were observed on 31.48 and 38.84% canes but canes were not damaged. Pyrilla nymphs and adults, and its parasite, *Epiricania melanoleuca* was noticed in traces. Egg masses of pyrilla (2.0-5.0/ clump) were noticed in September to December.

The incidence of mealy bug (on cane basis) was 7.51, 36.00, 32.00 and 17.43% in June, July, August and November, respectively. In case of black bug (*D. gibbus*)/cane, it was 15.7, 15.51, 14.50 and 10.0% in June, July, August and October, respectively. Average puparia of white fly/leaf were 3.33 and 5.00 in July and September, respectively.

6.2. Management of insect-pests of sugarcane through bio-agents, chemicals and IPM technology

Colonization of parasitoid for management of top borer, *Scirpophaga excerptalis* Walker (E.4.2 ii)

A field experiment was carried out with variety CoLk 8102 in RBD. All agronomic practices were followed to raise a good crop. Observations on incidence of top borer were made in each brood (III, IV, V) by counting the dead hearts and total shoot in each row in the control as well as in the parasitoid released plots. Conserve release of parasitoids (*Trichogramma* sp., *Telenomus* sp., *Stenobracon nicevillei*, *Isotima javensis*, *Rhaconotus scirpophagae*) against III, IV and V brood and application of carbofuran @ 1 kg.a.i/ha against III brood was done.

The mean incidence of top borer (III brood) was recorded as 7.76% in conserve release of all parasitoids followed by conserve release of larval parasitoids, *Stenobracon nicevillei* and *Rhaconotus scirpophagae*. However, incidence of IV brood was recorded as 16.03% in conserve release of all parasitoids followed by conserve release of larval parasitoids, *S. nicevillei* and *R.scirpophagae*. *Isotima javensis* and *R. scirpophagae* played a significant role in reducing incidence of III and IV brood.

Bio-management of termites in sugarcane (E.4.2 iii)

The experiment on bio-management of termite comprised of 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, Neemazin powder + urea (coated) in furrows, chlorpyriphos 20 EC @ 1.0 kg a.i. /ha (standard check), Imidacloprid 17.8 SL over setts, *Verticillium lecanii* sett dipping and untreated check was laid out at IISR farm (cv. CoPant 84212) under spring planting. After one month of planting, observation on the termite damage was recorded by digging the setts. Sett damage varied from 5.16-17.33% and bud damage from 7.15-24.66%. Shoot damage ranged from 5.53-32.33%. Maximum yield was obtained in plots with chlorpyriphos treatment (68.25 t/ha) followed by imidacloprid (65.84 t/ha), whereas it was 46.54 t/ha in untreated check.

Bio-intensive management of white grubs in sugarcane (E 4.2 iv)

In western U.P., *Holotrichia consanguinea* was recorded as the dominant species while *Schizonycha ruficollis*; *Onthophagus calta, Anomala* sp, *Apogonia* sp.; *Holotrichia* sp., *Onthophagus* sp., were recorded as minor species. Mass emergence of *H. consanguinea* beetle was recorded from third week of May to last week of June.

In order to manage the white grubs, both beetle and grub stages of the pest were targeted. For the management of the beetles, traps were fabricated for mass trapping of beetles under sugarcane agro-ecosystem. Trap with a combination of light and pheromone was found more effective in trapping predominant species *H. consanguinea* in comparison to the traps with either pheromone or light. Out of the total beetle catch, a mean of 44.58% *H. consanguinea* was trapped in the trap having combination of light and pheromone followed by that of light (28.06%) and pheromone (27.35%).

For the management of the grub, associated entomopathogenic bacteria were isolated from the diseased white grubs collected from infested sugarcane fields. Seven entomopathogenic bacteria were isolated. Out of the three bacterial isolates tested against white grubs, none caused mortality more than 50%.

A field trial was also conducted at Jakhwala, Deoband, Distt. Saharanpur with nine treatments and three replications in RBD. The treatments comprised of five bioagents and three insecticides, (Chlorantraniliprole 0.4 G @ 20 kg/ha; Fipronyl + Imidacloprid 80 G @ 150 g/ha; Chlorpyriphos 10 G @ 25 kg/ha) along with untreated check. Amongst bioagents, *Bacillus cereus* strain WGPSB-2 was better over others, which reduced white grub damage by 59.8% over control. Amongst insecticides, Chlorantraniliprole 0.4G was found sueprior to others, as it reduced the white grub damage by 83.7%.

Development of high temperature tolerant strain of *Trichogramma chilonis* and *T. japonicum* (E 4.2.1 iv)

The deleterious effect of high temperature on survival, development period and female

emergence of *Trichogramma chilonis* and *T. japonicum* was more at 40^{0}C as compared to 26-38^{0}C in the laboratory on host, *Corcyra cephalonica* for 10 generations.

Trichogramma reared at 38^{0}C was released in the net house to test their efficacy in searching the top borer eggs. However, none of the top borer egg masses was parasitized in this temperatre.

Development of techniques for laboratory mass multiplication of top borer and its parasitoids (E 11.1)

Newly hatched larvae of top borer were released on the young central crown leaves (with small stalk attached) of sugarcane in the jars. The mouth of the jar was covered with muslin cloth and kept at 27 ± 2^{0}C and 70 ± 5 RH in a BOD incubator. It was observed that larval acceptance was 80%. Larvae tunnelled mid rib of soft crown leaf and fed upon leaf tissue near growing point, moulted once but could not reach the growing point.

In similar fashion, sorghum plants and their soft stalks were offered to newly hatched larvae of top borer. It was observed that acceptance of sorghum plants by larvae was much less (10-30%). Larvae tunnelled mid ribs of soft leaf and fed upon near growing point. Larvae moulted once and did not reach the growing point due to drying of plants. Newly hatched larvae of top borer were released to the glass tubes containing about 10 cm long soft top portion of sorghum stem. The mouth of the glass tubes was plugged with cotton plugs and kept at 27 ± 2 ^{0}C and 70 ± 5 RH in a BOD incubator. In 10-20% of cut stalks larvae entered successfully and only one larva was observed in each infested stalk. Larvae tunnelled the stalk and moulted twice but fragile third instar larvae did not moult.

The artificial diet developed last year was tried again. Neonate larvae survived on the diet for three days with an increase in body size but did not bore the diet and also did not moult.

Mass multiplication of potential bioagents of sugarcane insect pests (AICRP: E 27)

Pure cultures of *Beauveria bassiana* and *Metarhizium anisopliae* were routinely multiplied on potato dextrose agar (PDA) medium. Growth of *Metarhizium anisopliae* was faster than *Beauveria bassiana*. Spores of *Metarhizium anisopliae* and *Beauveria bassiana* were harvested after two weeks of seeding. Pure cultures of both fungi were maintained on PDA.

Field collected *Cotesia flavipes* was multiplied on stalk borer larvae (factitious host) reared on cane bits in laboratory. Mature host larvae were offered individually to gravid females of *Cotesia flavipes* for parasitisation in plastic jars. Parasitized larvae were shifted to natural food in glass tubes (10 cm x 3 cm) and kept at 27 ± 2 ^{0}C and 70% RH. From single larvae, about 35-36 cocoons were obtained and out of them, 62.5% parasitic emergence was recorded with 66.67% female population.

Evaluation of varieties/genotypes for their reaction against major insect pests (AICRP : E 4.1)

Five genotypes of early group, *viz*., CoLk 05201, CoH 05262, CoH 05265, CoPk 05191, Co 05009, (control CoJ 64, CoPant 84211) and 14 genotypes of mid late group Co 05011, CoPb 05211, CoPant 05222, CoPant 05224, UP 05233, CoH 05266, CoH 05269, CoPk 05192, Co 0327, Co 0424, CoLk 99271, CoLk 04238, CoPant 04222, CoS 03222 (control Co 1148 and CoS 767), were evaluated against major insect-pests. Infestation of borer pests remained quite low. In early genotypes, incidence of top borer III and IV brood was maximum in CoH 05262 (9.66%), whereas minimum incidence was in CoLk 05201 (3.43%) in III brood. Among the mid-late genotypes, maximum incidence of top borer was recorded on Co 0327 (17.12%) and minimum was on CoPk 05192 (1.67%). Minimum incidence of internode and stalk borer was recorded in Co 05009 (4.66%) and CoPk 05191 (1.6%), respectively.

7 Development of appropriate farm machinery for mechanization of sugarcane cultivation

7.1 Design and development of equipments

Development of sugarcane harvester (AE 1.9E)

A front mounted tractor operated harvester was developed for cutting and windrowing of two rows of sugarcane. Attachments, consisting of a M.S. frame and hydraulically controlled arms through hydraulic cylinders, were developed for raising and lowering of harvester during transportation as well as field operation. Power to the cutting blades was provided through tractor PTO. Attachments were also provided with the main frame for windrowing of harvested cane by guiding the cane towards cutting blades during harvesting operation and up to some extent for raising the partially lodged canes (Fig. 7.1).

Fig. 7.1: Tractor operated front mounted sugarcane harvester

Field trials were conducted at IISR farm during 2007-08 and 2008-09 at a cutting blade speed of 300 rpm. The cutting and windrowing was satisfactory for crops which were not lodged and where the canopy was not intermingled with the other rows (Fig. 7.2). The harvester was tested at IISR farm at different speeds of cutting blades (300-350, 450-500 and 600-650 rpm) during 2009-10. The cutting was clean without any splitting and rupture of cane stubbles at cutting blade speed of 450-500 rpm. The average effective field capacity of the equipment was 0.15-0.20 ha/h with field efficiency of 50-60%.

Fig. 7.2: Tractor operated front mounted sugarcane harvester in operation

IISR tractor operated front mounted sugarcane harvester, with certain modifications in the cutting mechanism was used for harvesting of wide spaced paired row planted crop. Windrowing of harvested cane was proper due to wide spacing between the paired rows. Further refinement is needed for conducting further trials.

Development of a wide spaced paired row sugarcane cutter planter (AE 1.22D)

The tractor operated paired row sugarcane cutter planter was field tested at large scale at IISR farm for planting of cane at 30:120 cm row geometry (Fig 7.3). The effective field capacity of the equipment was 0.20-0.25 ha/h with a field efficiency of 65-70%.

The second prototype of paired row planter was developed with arrangements for furrow making at both ends of the paired row (Fig.7.4). The power transmission system was also modified for preventing it from dust and dirt.

Another prototype was developed for interculturing of cane crop planted under wide spaced paired row geometry (30:120 cm). Sweep shovels have been used for improving interculturing efficiency.

Fig. 7.3: Paired row sugarcane cutter planter in operation

Fig. 7.4: Side view of paired row sugarcane cutter planter with attachments for furrow making at both ends of paired row

Evaluation and refinement of sett cutting mechanism of sugarcane planter (AE 4.5)

Four types of blades of various profiles and angles being used in different sugarcane planters *viz.*, IISR ridger type, multipurpose, VSI and Khalsa sugarcane cutter planters, were fabricated.

Design and development of residue mulcher-cum-bio applicator (AE 8.1)

Different components of the residue mulcher–cum-bioapplicator were designed, fabricated and assembled (Fig. 7.5). The preliminary trial was conducted at IISR farm. The chopping unit worked satisfactorily in the field having uniformly spread trash (4-5 t/ha). The machine is able to chop the trash in two bands having width of 45 cm each. It was observed that the machine could be used smoothly when cane rows are straight and

Fig.7.5: Residue mulcher-cum-bio applicator

uniformly spaced. Bio application was carried out in liquid form over the chopped band(s) through gravitational force. Total amount of liquid dispensed as spray was 180 l/ha at a tractor forward speed of 2 km/h. Need was felt to increase the quantity of liquid sprayed.

To make the equipment more useful, 1 L-shaped blades were got fabricated and mounted with the unit in place of straight curved blades used for chopping the trash. This was done to use the equipment for strip tilling for sugarcane planting as well as intercultural operations in sugarcane.

7.2 Prototype feasibility trials of equipments

Tractor operated sugarcane harvester (FIM/IISR/PFT/2009/1)

The feasibility trial of IISR tractor operated front mounted sugarcane harvester was conducted on variety CoS 95270 planted with row to row spacing of 75 cm at IISR farm. The performance of the equipment was satisfactory in cutting and windrowing of harvested cane. The equipment experienced failures in lodged/partially lodged cane fields.

Sugarcane detrasher (FIM/IISR/PFT/2009/2)

The feasibility trial of IISR power operated detrasher (Fig. 7.6) was conducted at IISR farm. The harvested canes of variety CoS 95270 were fed from their green tops side through the feeding chute to the detrashing rollers. Average trash removal

Fig. 7.6: Sugarcane detrasher in operation

Fig.7.7: Zero Till Drill in operation

efficiency was 80.0%. Power transmitting V-belts needed to be replaced from time to time for achieving better detrashing efficiency. The output of the detrasher ranged from 1.0 to 2.4 tonnes of cane/h depending upon the feeding of canes.

Zero till drill (FIM/IISR/PFT/2009/4)

The seed drill (Fig. 7.7) was taken to farmer's field in Lucknow district, near Bakshi-ka-Talab area. Feasibility trials were conducted during 2009-10 and 2010-11 seasons. A key farmer was selected in the village Asti, Bakshi-ka-Talab, Lucknow for conducting the feasibility trials. Farmer's tractor (35 hp) was used for the trial. Moisture content of soil ranged between 12 and 18% (db). Prototype feasibility trials were conducted in 2 ha area for drilling pea and 36 ha area for wheat. Farmers were satisfied with the performance of the seed drill.

Development of suitable post-harvest technology

8.1 Post-harvest losses in sugarcane

Management of post-harvest deterioration of sucrose in sugarcane (PB 19)

Pre- harvest foliar application of zinc sulphate on sugarcane was found to be effective in reducing post- harvest loss in commercial cane sugar (6.0% over untreated trash covered control) in comparison to pre-harvest soil application of zinc sulphate (2.0% over untreated trash covered control) after one week of staling.

A combined application of benzalkonium chloride (0.2%) and sodium metasilicate (0.5%) over harvested cane followed by covering with trash was effective in minimizing sucrose loss in the harvested stored cane for a period of one week. Spraying of chemical formulation showed appreciable decline in acid invertase activity and minimized loss in CCS over water sprayed and trash covered cane. In late season harvest, untreated cane, water sprayed + trash covered and chemical treated + trash covered cane recorded acid invertase activity to the order of 6.34, 3.54 and 2.53 units, respectively after 240 h of staling. This indicates the inducing effect of high temperature on sucrose loss through invertases *vis-à-vis* beneficial impact of chemical treatment on sucrose retention in harvested stored cane.

An eco-friendly method *i.e.*, spraying of electrolyzed water (EW) followed by covering with trash was also effective in reducing sucrose losses in harvested cane. The loss in CCS in water sprayed + trash covered and electrolyzed water (pH 7.0) sprayed + trash covered, 240 hours after harvest were 4.02 and 2.76 units (Fig. 8.1). The MDH-

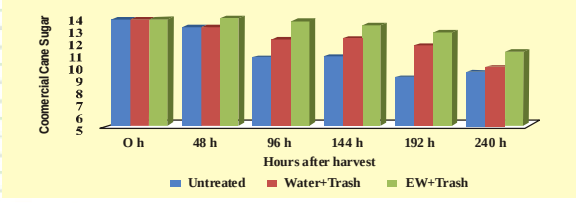


Fig. 8.1. Effect of spraying electrolyzed water on commercial cane sugar content of harvested stored cane

mannitol levels were 28693.23, 17359.83 unit/brix. Besides, reducing sugars and titrable acidity index were relatively less in the EW treated cane showing its beneficial effect on cane storage.

8.2 Sugarcane processing for manufacturing of jaggery and developing storage techniques

Refinement of 3-roller horizontal power driven crusher developed at IISR (LKO/PHT/07/05)

The rollers of the crusher were modified and fitted. The thickness of collar of king roller was increased to 25 mm with 35 mm depth. Accordingly, size of other two rollers was reduced to accommodate modified king roller. All old bushes were refined and replaced which helped in proper alignment of all the components. The crusher was then tested. It yielded juice recovery of 66% (cane basis) and had cane crushing capacity of 450 kg/h.

Design and development of a small capacity cane crushing unit for household purpose (LKO/PHTS/07/2)

Different components fabricated earlier *viz.*, one set of three horizontal rollers (king, feed and extraction), one set of three gears for power transmission, sugarcane entry and bagasse exit port and framing plate in rectangular shape were assembled maintaining proper alignment. Adequate power transmission system was developed using 0.5 hp motor. The unit was tested and found working satisfactorily. The capacity of the unit was 60 kg/h with juice recovery percentage of 50% on cane weight basis.

Development of a solar drier for jaggery drying (LKO/PHT/07/07)

The drier was tested at no load condition. The ambient temperature, ambient humidity, cabinet temperature and temperature of each tray were measured at each hour starting from morning to

evening. It was observed that the temperature of drying chamber was upto 21^{0}C higher as compared to ambient temperature. Temperature of each tray varies from 31 to 42^{0}C.

Evaluation of shrink-wrap, stretch wrap and modified atmosphere packaging for storage jaggery cubes and blocks (Evaluation of packaging materials for modified atmosphere packaging of jaggery) (LKO/PHT/08/01)

Jaggery was prepared using a suitable variety of sugarcane (CoPant 84212). Jaggery quality parameters like brix, pol, reducing sugar, moisture content, pH and colour were determined before and after storage of six months (Table 8.1). The data revealed that the quality of the jaggery cubes are maintained during storage.

Table 8.1 : Quality parameters of jaggery during storage

Storage condition	brix	Pol %	Reducing sugar (%)	Moisture	pH	Colour Reading
Initial value	13.63	77.5	5.7	7.3	6.5	190
Stored in Nitrogen environment	12.45	72.3	6.2	9.2	5.9	230

Jaggery samples were packed in the form of shrink wrap and stretch warp and kept for storage. Before the storage the colour reading of the jaggery samples with the help of Mini Scan XE Plus was determined.

8.3 Diversification of sugarcane based by-products

Identification of inhibitors in sugarcane biomass hydrolysates and their effect on ethanol yields (PB 21)

Factors that increase the monosaccharides to ethanol conversion efficiency from the chemical or biological pretreated sugarcane biomass include production of less biomass and by-products namely 5 hydroxy-2 methyl furfural (HMF), furfural, levullinic acid, 3,4 dihydroxy benzoic acid and vanillic acid. In order to reduce the synthesis of by-products, effect of dinitrophenol on pre-treatment of sugarcane trash was evaluated. 1,4, Dinitrophenol (0.1 mM) was used in acid and microbial pre-treatment of sugarcane trash to be further processed for saccharification and fermentation. The production of inhibitory compounds were minimized significantly when dilute sulphuric acid pre-treatment was carried out whereas with *Aspergillus terrus*, the inhibitors showed a diminishing trend. The trash hydrolysates prepared with dinitrophenol were subjected to saccharification at two enzyme (cellulase) loads of 30 and 60 FPU at three residence times (24, 72 and 168 h). Significant improvement occurred in the cellulosic digestibility and reducing sugar contents with both acid and microbial pre-treated hydrolysates with 30 FPU at all the three residence times evaluated. Cellulose digestibility and reducing sugar contents in microbial pre-treated biomass were found to have improved by 68 and 85% with 30 FPU cellulase as compared to the untreated trash hydrolysates.

Sugarbeet improvement, its seed production and crop management

Developing sugarbeet varieties for Indian agro climates (B 2.15)

The research work on sugarbeet is being carried out at two locations *i.e.,* Lucknow (UP) and Mukteswar (Uttarakhand). The activity at Lucknow pertains to root crop evaluation and raising of steckling crop for germplasm maintenance and breeding; while activity at Mukteswar is related to flowering, breeding and seed production.

Sugarbeet germplasm maintenance at Mukteswar

Germplasm evaluation

Five germplasm lines were evaluated for root crop performance at Lucknow in randomized block design with three replications. Entry 7112 was found to be better in sucrose content and gross sugar yield, while Felicita was found to be tolerant to root rot (Table 9.1).

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

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, LKC-2000, LKC-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, Felicita, 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 9.1: Root crop performance of new germplasm

Germplasm	Root weight (kg)	Crown size (cm)	Root length (cm)	Sucrose (%) at 180 days	Root yield (kg/ plot)	Gross sugar (kg/plot)	Root rot incidence (%)
Felicita	0.71	9.00	26.00	13.07	24.11	3.15	11.70
7112	0.76	8.20	26.00	13.94	28.13	3.91	7.20
FC-722	0.69	7.90	24.20	13.14	18.96	2.49	9.70
FC-201	0.66	8.40	23.00	13.56	20.05	2.71	10.40
FC-720	0.68	8.50	27.50	12.60	19.35	2.44	13.40
LS-6	0.69	8.20	25.40	12.80	22.20	2.85	8.40
IISR Comp-1	0.68	8.40	24.00	13.00	20.44	2.65	7.80
Shubhra	0.66	7.80	24.00	13.30	20.53	2.73	18.20
CD at 5%	0.53	0.21	0.12	0.43	1.01	0.52	-
CV %	8.53	11.08	6.73	6.57	5.60	4.13	-

Evaluation of elite material for root crop performance

Some new composites and experimental crosses were made at Mukteswar. The composites *viz.*, LKC-2000, LKC-2006 and LKC-2007 and crosses *viz.*, Felicita x LS-6, 7112 x LS-6, LS-6 x 7112, FC-722 cms 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-2000, followed by LKC-2007 possessed the highest gross sugar and root yield (Table 9.2). FC-722 x LS-6 and LKC-2007 were tolerant to root rot. LKC-2000 and progenies of 7112 x LS-6 mating had shown higher sucrose content in root. Progenies of FC-722 x LS-6, FC-722 x LS-6 and LKC-2007 were tolerant to army worm.

Evaluation of sugarbeet hybrids with JK Agri-Genetics Ltd (CR 01/08)

Five sugarbeet hybrids *viz.*, Arriba, Calixta, Capitana, Esperanza and Sandrina supplied by JK Agri-Genetics Ltd (material developed by KWS, Germany) were evaluated against three standards *viz.*, IISR Comp-1, LS-6 and Shubhra for their performance at Lucknow conditions on different dates of sowing and varying harvesting at different intervals. The performance of these hybrids was tested at three dates of sowing *i.e.*, 16-10-09, 31-10-09 and 16-11-09 to find the suitable sowing date. The studies carried out for two consecutive years indicated that the October end followed by November middle was suitable time for sugarbeet sowing. Sandrina was superior in terms of root yield and Capitana in sugar yield and estimated ethanol yield when sown in first fortnight of October. In November mid sown crop, Calixta was superior in root yield, while Capitana was better in estimated ethanol yield. Capitana possessed lesser impurities in juice as compared to standards because the sodium and potassium contents were less. Arriba and Esperanza were tolerant to root rot.

Table 9.2: Root crop performance of composites and crosses

Breeding material	Plant population ('000/ha)	Root weight (kg)	Sucrose (%) at 180 days	Root yield (t/ha)	Gross sugar (t/ha)	Root rot incidence (%)
LKC-2000	88.4	0.80	13.78	70.86	9.76	12.60
LKC-2006	89.6	0.70	12.20	62.36	7.61	10.40
LKC-2007	87.9	0.80	13.34	70.04	9.34	6.80
Felicita x LS-6	89.3	0.51	10.42	45.44	4.73	16.60
7112 x LS-6	86.3	0.58	13.48	50.12	6.76	10.30
LS-6 x 7112	87.1	0.70	11.96	61.04	7.30	11.30
FC-722 x LS-6	85.2	0.55	12.96	47.03	6.10	6.30
LS-6	88.2	0.52	12.68	45.72	5.80	8.40
IISR Comp-1	86.2	0.51	13.03	43.86	5.71	7.80
Shubhra	86.3	0.50	13.34	43.50	5.80	18.20
CD at 5%	0.8	1.13	3.43	5.28	0.52	0.59
CV %	1.0	10.53	6.57	7.24	4.09	7.89

Seed Production at Mukteswar

The indigenous variety LS-6 was taken for bulk seed programme and 30 kg of seed was produced. In addition, eight kg seed of thirty-six germplasm/ breeding lines/ composites and hybrids was produced at Mukteswar.

Technology adoption, constraints analysis, socio-economics, statistical modeling, database and computer applications

10.1 Technology adoption and analysis of constraints

Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane (MWR-1/08)

Effect of demonstrated technologies on yield, irrigation water and irrigation water use efficiency in sugarcane

Twenty five demonstrations on the fields of cane growers in Rauzagaon, Haidergarh and Biswan sugar mill command areas were conducted. There was a significant increase in crop yield, irrigation water saving and irrigation water use efficiency in demonstrated technologies over conventional techniques. The maximum increase in cane yield was recorded in ring-pit method of planting (109.70%) over the conventional method followed by skip furrow method of irrigation (49.12%), irrigation at critical growth stages (18.44%) and trash mulching (17.63%) (Table 10.1). The saving in irrigation water varied from 20.0 to 60.9 per cent. The increase in irrigation water use efficiency (IWUE) was recorded highest in ring-pit method of planting (151.61%) over the conventional method followed by skip furrow method of irrigation (149.78%), irrigation at critical growth stages (90.58%) and trash mulching (41.17%).

Table 10.1. Effect of demonstrated technologies on yield, saving in irrigation water and irrigation water use efficiency in sugarcane

Technology	No. of demon-strations	Average yield (t/ha)	Increase in cane yield (%)	Irrigation water applied (ha-cm)	Saving in irrigation water (%)	Irrigation water use efficiency (IWUE) (kg cane/ha-cm)	Increase in IWUE (%)	Cost of pro-duction (₹/ha)	Gross return (₹/ha)	Net return (₹/ha)	B:C ratio
Skip furrow method of irrigation	8	93.50 (62.70)	49.12	56.00 (72.20)	28.93	1669.64 (668.42)	149.78	66910	191675	124765	1.86
Ring-pit method of planting	1	130.00 (62.00)	109.70	70.00 (84.00)	20.00	1857.14 (738.10)	151.61	108426	273000	164574	1.52
Trash mulching	8	76.33 (64.89)	17.63	52.22 (62.67)	20.01	1461.70 (1035.42)	41.17	50787	156477	105690	2.08
Irrigation at critical growth stages	8	73.17 (61.78)	18.44	48.89 (78.67)	60.91	1496.63 (785.31)	90.58	64090	149999	85909	1.30
Farmers practice overall average *	-	-	-	-	-	-	-	66764, 41273	127428, 133025	60664, 91752	0.91, 2.22

Note: 1. Figures in parentheses are corresponding values under farmers practices.
2. The figures with asterisk (*) mark relates to plant crop and ratoon crop, respectively.

Comparative economics of demonstrated technology over farmer's practice in plant and ratoon crops of sugarcane

Among the demonstrated technologies, the cost of sugarcane cultivation was the highest in case of ring-pit method of planting. The highest net return (₹ 1,64,574/ha) was also recorded under this technology followed by skip furrow method of irrigation (₹ 1,24,765/ha), trash mulching (₹ 10,5,690/ha) and irrigation at critical growth stages (₹ 85,909/ha). However, the highest B:C ratio was observed in trash mulching technology (2.08) followed by skip furrow method of irrigation (1.86), ring-pit method of planting (1.52) and irrigation at critical growth stages (1.30). The highest return accrued from the ring pit technology well compensated the higher cost (Table 10.1).

10.2 Socio-economics and policy analysis

Developing efficient sugarcane marketing strategies in India (AES 4.12)

Cane supply arrangements are extremely important both for the growers and the sugar factory. Sugarcane is perishable and the sucrose contents get reduced if it is not milled within a short period after harvesting. The factory wants a planned inflow of cane from large number of farmers (10,000 to 15,000 farmers) in about 150 to 180 days. Hence, there arises a need to carry out planning to complete the operations efficiently for the maximum benefit of the farmers and the factory as per existing institutional (Acts and Orders) norms. Broadly, three types of sugarcane supply arrangements exist in India. Maharashtra & Gujarat have a similar system, the tropical states of Tamil Nadu, Andhra Pradesh & Karnataka follow another system and the sub-tropical States *i.e.*, UP, Bihar, Punjab & Haryana have a different system. In Maharashtra, Gujarat and some parts of the North Karnataka, the growers supply cane ex-field to the factory and the sugar factories (which are mostly organized as cooperatives) arrange for the harvest and transportation of the sugarcane.

The sugarcane in sub-tropical states is purchased through the Cane Cooperative Unions/ Societies and the sugar factory does not have direct relationship with the growers. The payments for the cane was also made through these societies (though a change has now occurred under which payment is directly sent to bank account of the growers on the advice of the cane society). These societies enter into agreement with the factory regarding the supply of cane. Under this arrangement, the sugarcane is harvested by the grower and supplied at the purchase centre/factory gate. The factory meets the cost of transportation from the purchase centre to the factory. The Cane Cooperative Union/Societies prepare supply calendar and issue supply slips (*Parchies*) to the growers. These supply slips are issued on the basis of the last 2-3 years supplies of sugarcane. The quota of a farmer is divided in the expected days of running of the sugar factory and he/she is issued supply slips in equitable proportion. The supply entitlements are fixed on the basis of last 2-3 years supply. There are other constraints pertaining to weighment, delivery at gate or at the purchase centres, long waiting period at the purchase centres *etc.*

The success of sugarcane union in UP has taken place with a legislative framework which empowers the State Govt: (a) to notify a particular cane growing area as a reserved for, or as assigned to a particular factory (b) to allow sales only through co-op societies, and (c) to prescribe the manner in which non-members can sell through the cane-growers' co-operative societies. A provision was made in 1954 by way of Sugarcane Purchase Order 1954 in UP to compulsorily supply the cane to sugar mills in UP through cane cooperative societies. Consequently, cooperative societies and cane development councils were made in sugar mill cane command area. At present, UP has a good network of 166 cane cooperative marketing unions. The concentration of these societies in the state is highly skewed in favour of major cane growing districts where there exist more sugar mills. Four major cane growing districts have cane unions varying from 10 to 13 in number. These unions supply nearly 95% of the sugarcane crushed by sugar mills in the state. The main objective of these societies is to help farmers in marketing sugarcane by making arrangements for cane supply to the sugar mills as well as to regulate supply of sugarcane to the mills in accordance with the sugarmill's requirement. The cane unions framed under the above framework also help the member growers with supplies of improved seeds, fertilizers & chemicals, growth hormones and implements and other requisites of production and through popularization of improved techniques. These also serve weighment facilities and fair price of the cane to the sugarcane growers. With the active involvement of the cane unions, farmers got better prices for their cane. On the other hand, the financial condition of cane unions has also improved.

With the growth of private sector sugar mills under liberalization regime in India, the importance of cane unions has dwindled and these are being viewed as obstructive in the growth of sugar sector. The cane societies which perform marketing functions are also not being much encouraged by the State Govt. There is a large number of marketing societies where the post of the marketing secretary is vacant, and the post is not being filled by the Govt. The volume of business is too large to be handled efficiently by any individual marketing society. There are instances where private sugar mills are drawing cane supplies directly from the farmers and paying them higher prices. Most of the sugar factories in U.P. have already computerized the operations such as i) preparation of cane supply calendars; ii) issuance of supply tickets to the farmers; iii) making cane price payment through the banks, and, iv) maintenance of grower-wise records *etc*. The above functions were previously done by the cane societies. There need to be a direct link between the factories and the farmers. The factories in UP should enter into a direct contract with the growers like in southern States and execute tri-partite agreement with banks and farmers for procurement of sugarcane and to facilitate the availability of soft loans to farmers. The sugar mills also need to invest in loading/unloading and weighment infrastructure for facilitating efficient cane marketing

The proportion of cane transport from the field to the mills by various transport modes was also estimated.

10.3 Development of statistical model/ procedure

Climate change on assessment of impact of climate change on productivity and quality of sugarcane in sub-tropical India and opportunities of agronomic adaptation (ICAR Network Programme)

The DSSAT simulation model has been fine-tuned to estimate cane productivity. The model has been validated for CoSe 95422, CoSe 01421, CoSe 98231, CoSe 92423, CoSe 01235 and CoSe 03234 for Seorahi conditions in eastern Uttar Pradesh and CoJ 64 and CoLk 8102 for Lucknow conditions in central Uttar Pradesh. The relationship of simulated and observed yields is presented in Fig.10.1. The RMSE for observed and simulated yield is 5.01%.

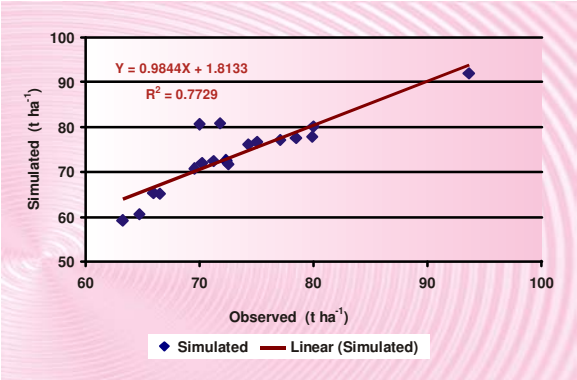


Fig 10.1 Simulated and observed yield of sugarcane

10.4 Development of database and information systems

Compilation, analysis and documentation of long-term weather database in relation to sugarcane crop culture (AM3)

Weather database compilation and updation

The daily weather data on maximum and minimum temperature, morning and afternoon relative humidity, duration of bright sunshine, rainfall, wind speed, pan and evaporation were compiled and updated up to March 2011. The weather during the crop season 2010-2011 was characterized by higher average maximum temperature in April, May, June, July, August and December 2010, respectively by 3.3, 0.1, 1.8, 0.5, 0.1 and 0.3^{0}C as compared to long term average (1980-2009). It also remained higher in February and March 2011, respectively by 0.1 and 0.3^{0}C as compared to long term average (1980-2010). It was lower than long term average in September, October, November 2010 and January 2011, respectively by 0.5, 0.1, 0.6 and 2.0^{0}C.

The minimum temperature exceeded long term average during April, May, June, July, August, September, October and November 2010 and March 2011, respectively by 2.7, 0.7, 1.0, 0.7, 0.2, 0.4, 1.6, 3.3 and 0.5^{0}C. It remained lower during December 2010, January and February 2011, respectively by 0.3, 0.9 and 0.1^{0}C as compared to long term average.

Morning relative humidity remained lower than long term average during April, May and June, December 2010 and January 2011, respectively by 12, 1, 10, 3 and 3%. It exceeded long term normal during August, September 2010, January and

February 2011, respectively by 1, 2, 1 and 1%. It remained normal during July, October and November 2010.

Afternoon relative humidity was above long term normal during May, August, September, October and November 2010, respectively by 2, 1, 4, 2 and 9%. It remained below long term normal during April, June, July, December 2010, January and February 2011, respectively by 5, 12, 1, 10, 3 and 2%.

The duration of bright sunshine remained lower than long term average all through the crop season from April 2010 to March 2011 ranging from 0.1 to 5.1 h/day. The maximum reduction in duration of bright sunshine was observed in November 2010 (5.1 h/day) and minimum was in March 2011 (0.1 h/day).

During the crop cycle 2010-2011, the total rainfall received was 685.6 mm as against long term normal of 915.8 mm. During monsoon season (July-September), the total rainfall received was 595.2 mm as against long term normal of 677 mm. Thus, monsoon rainfall deficit was 81.8 mm.

The total number of rainy days during the calendar year 2010 was 41 as against long term average of 44. The number of rainy days during monsoon was 32 against long term average of 35.

The long-term variability trend of number of rainy days at Lucknow was analyzed from weather database from 1979-2009 (Table 10.2).

Table 10.2: The variability indices for number of rainy days at Lucknow

Month	Rainy days			
	Range	Mean	CV (%)	Rate of change/ y
January	0-4	1.16	94.6	-0.02
February	0-5	1.42	104.1	-0.025
March	0-4	0.81	151.6	-0.004
April	0-2	0.54	131.8	0.007
May	0-5	1.87	85.9	0.037
June	0-12	5.26	44.2	0.035
July	5-19	11.48	29.6	-0.012
August	4-20	10.77	37.8	0.031
September	1-16	8.1	40.8	-0.033
October	0-6	1.58	103.0	-0.012
November	0-2	0.42	160.3	-0.021
December	0-3	0.71	137.1	-0.031
Annual	32-59	44.12	17.1	-0.048
SW Monsoon	22-49	34.13	18.5	0.03

Data warehouse on sugarcane production system (AES 4.8)

An initiative to adopt Information & Communication Technology (ICT) based database management techniques in sugarcane field management by developing "Farmer's Field Information System" has been undertaken.

The software uses five categories of data *viz.*, farmer information, farmer's field, history of field crops, operations performed and input used during various farm operation schedules. Database of the software stores the information in various tables and incorporates relationship among them using Entity-Relationship Modeling Technique. The software provides a number of data management modules to add and update data with user-friendly interfaces. Further, to view information about sugarcane farmers, history of field crops, crop operations schedule and input used at various levels, the software generate reports in various tabular formats. The viewing of data may be achieved using search engine based approach, which facilitate the user to search on a variety of parameters stored in the database *viz.*, farmer's name, state/district/village, field area, crops undertaken, variety, date of planting, operations performed, duration of operation, input used, date of harvesting, input rate, production and productivity, *etc.*

The software requires wider availability to ensure its accessibility to users; hence, web-oriented approach has been used in application design, which works in client-server architecture. In web-oriented nature of application, data and programme modules resides on central web and database server and gives accessibility to user with web browser on Internet communication channel. It also provides user-friendly graphical user interface and online remote accessibility to its users. Software is under verification stage of various modules developed and further need addition of scheduling modules.

Development of decision support tools in sugarcane cultivation (AES 4.10)

The behaviour of decision support system for disorder diagnosis in sugarcane crop has been identified *viz*., problem solving and knowledge management. The problem solving behaviour uses available knowledge to solve disorder diagnosis problem, while knowledge management is the updation of knowledge. Conceptualization reveals that farmer, extension worker, diagnostician and domain expert are four actors in the system. Farmer and domain expert are responsible for getting diagnosis of disorder and diagnostic knowledge updation, respectively. Diagnostician has responsibility to diagnose the disorder. Further, extension worker acts as secondary actor, responsible to find disorder categories under which diagnosis has to be made. Agent oriented approach has been applied to develop the system. Analysis of actors, analysis of problem statement and heuristic approach has been adopted in agent identification and to specify their characteristics. Seven agents *viz*., farmer, registration, diagnostic, explanation, domain expert, knowledge update, and knowledge base work in this system. Further, two types of modules are identified for agents namely, functional and interface modules. Heuristic approach was applied while identifying and designing modules of an agent.

Functional modules are associated with actual functional performance of the agent, which generate output with some processing on input provided. Tabular template explains such modules for various agents identified earlier along with input, output and knowledge level attributes. Various modules of an agent along with knowledge base constitute 'Model' component of Model-View-Controller (MVC) architecture which get triggers by some user input. 'Control' component of MVC has been mapped in the template using the Input column. Input to agent could be from user or earlier agent/modules and work as trigger to the agent/module. 'Output Produced' column shows the processed result of each module.

Farmer and domain expert interact with the system for getting diagnosis and knowledge updation, respectively, using 'farmer' and 'domain expert' agent. Interface modules of 'farmer' agent provide interface for farmer to interact with the system. Since objective of interface modules is to provide an interface for user interaction and thus correspond to 'view' component of MVC architecture.

Knowledge Base agent performs management of knowledge. Knowledge represented in this consisted of domain ontology and domain model. Entity-Relation modeling scheme has been applied for knowledge representation in which Entities represent the various knowledge used by the system, Knowledge-coding (identification key) scheme has been used for setting relation among them. Knowledge representation has been made using two type of entities 'Data Table' and 'Rule Table'.

Data Tables are repository of domain ontology acquired during knowledge acquisition. Knowledge categories covered by these tables are crop disorders, textual & multimedia symptoms and other concepts concerned with sugarcane crop and disorders. 'Rule Table' along with line joining two entities, maintain the relation among domain ontology defined earlier by domain models. Three types of components are used by agents in developed system *viz*., Interface module, Functional module and Knowledge base.

In MVC architecture implemented in this work, all functional modules of agents reside in web server and knowledge base agent in database server (depending on volume of knowledge) for execution at server-end only. Output of the functional module along with display/control element is communicated to client-end using view component. On getting user input through view component, controller checks the same to decide the change of model state (possibly call to new agent) and also View (new user interface). All the communication between Server and Client machine in web application are made using http protocol. Sample architecture of agent's modules for disorder diagnosis is shown in Figure 10.2.

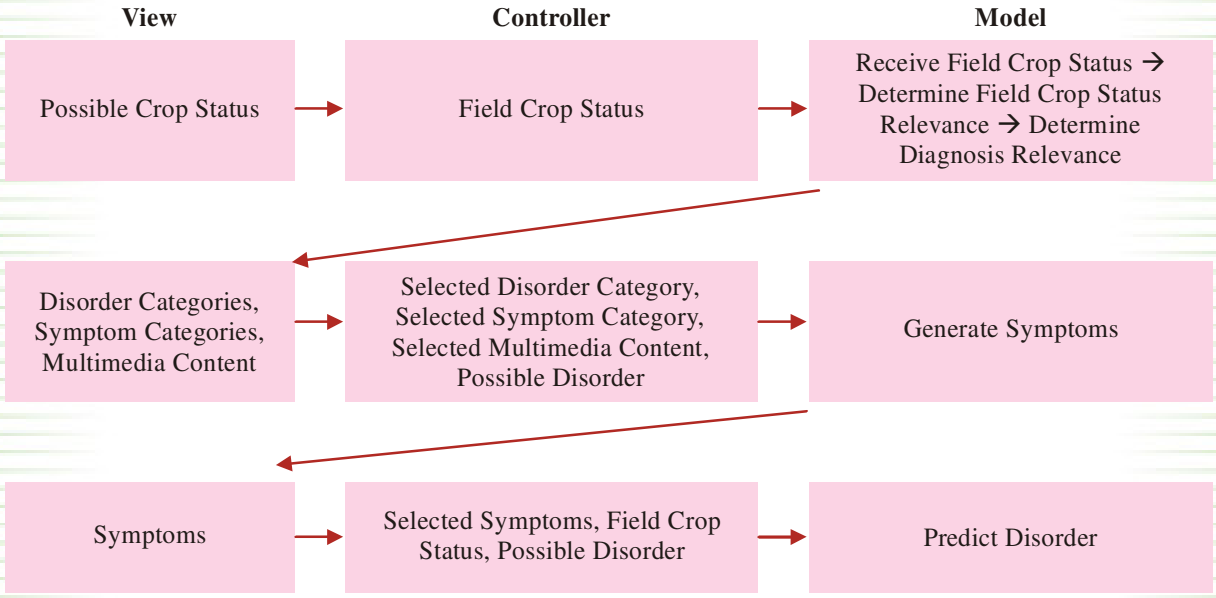


Figure 10.2: Agent network design in MVC

Microsoft ASP.NET technology has been adopted in developing web-based expert system. Windows 2003 operating system on Intel Xeon based server has been adopted to provide basic operating platform at server end. Internet Information Services (IIS) server software has been used to host the web-based expert system for disorder diagnosis. Web server stores all the modules of agents. Knowledge Base is the repository of all the expert knowledge to be used by the experts for providing solutions to problems in their domain.

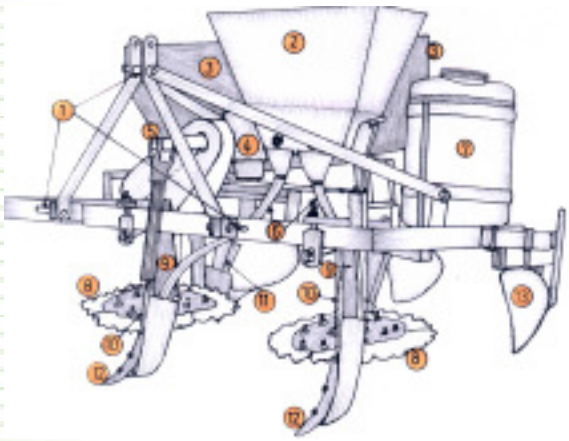
Transfer of technology

11.1 Technology testing

A. Frontline demonstrations (FLD) under farm field conditions

A.1 IISR tractor operated ratoon management device (RMD) (FIM/IISR/FLD/09/01)

The productivity of sugarcane ratoon crop is lower than its plant crop mainly due to untimely, improper and inadequate management of cultural operations. Investigations reveal the importance of shaving stubbles (above the ground surface), off-barring or cutting old roots on either side of the stubbles, interculturing, deep tilling or breaking hard pan of the underneath soil, applying fertilizer, manure, insecticide, pesticides and finally providing desired cover of loose soil over the stubbles. These are required to be done after harvesting plant cane and before or after sprouting (with or without stubble shaving) of buds from stubbles. Ratoon management device was, thus, developed as an integrated unit by amalgamating various subunits (Fig. 11.1) for executing requisite cultural operations to improve productivity of sugarcane ratoon crop. The prototype was evaluated at IISR farm and was taken to farmers' field for Frontline Demonstrations.



1. Three point linkage, 2. Fertilizer box, 3. Manure box, 4. Gear box-drive to stubble shaving unit, 5. Universal joint, 6. Fertilizer delivery pipe, 7. Liquid chemical box, 8. Shaving blade, 9. Deep tiller, 10. Off-barring cutting edge, 11. Chute to deliver manure, 12. Double edged shovel, 13. Interculturing and soil ridge making unit

Fig. 11.1 : Ratoon Management Device (RMD): An integrated unit for ratoon crop

The frontline demonstration (FLD) of the Ratoon management device (RMD), was conducted at farmers' fields in accordance with the agronomic recommendations in 10 ha area in Biswa Sugar Mill area. The operations like deep tilling, off barring, application of manure and chemical fertilizers in free-flowing and in liquid form and earthing –up were got executed in the presence of farmers. The adjustments were made as per the requirement of the crop. The prototype was operated with a 35 hp tractor. The depth of tilling to break-open soil hard pan and off barring or cutting old roots of the preceding crop was 30-35 cm and 15-20 cm, respectively. The crop inputs like farmyard manure @ 6 t/ha, urea @ 150 kg/ha and liquid chemical (gamma BHC) solution @ 600 l/ha were applied with the help of RMD. Farmyard manure was made free flowing by mixing it with sand and dry clay soil (only if the manure was moist). The soil cover around and over tillers varied from 7 to 10 cm. The tractor was operated @ 2.5-3.0 km/ha. It took nearly three hours per hectare of ratoon field to complete all assigned task in one pass of the tractor.

A.2 IISR raised bed seeder (RBS)-cum-sugarcane planter (FIM/IISR/FLD/09/02)

The IISR Raised Bed Seeder (RBS)-cum-sugarcane planter (Fig. 11.2) was taken to farmers' fields in Barabanki district. Feasibility trials were

Fig. 11.2: IISR RBS Cane Planter in operation

conducted. A FLD was conducted in 15 ha area at farmers' field in village Nidura, Kursi Road, Barabanki. The farmers were satisfied with the performance of the IISR RBS cane planter.

A.3 IISR modified Three row Cane Planter (FIM/IISR/FLD/09/03)

IISR Modified Three Row Cane Planter was taken to farmers' fields in Hardoi, Sitapur, Unnao and Lakhimpur Kheri districts of U.P. Frontline demonstrations were conducted during the year. Key farmers were identified for conducting the FLDs. FLDs were conducted in 73 ha area at farmers' fields in these districts. The farmers were satisfied with the performance of the IISR Three Row Cane Planter.

A.4 Water use efficient technologies for improving productivity and sustainability of sugarcane

Twenty five demonstrations (Table 11.1) on the fields of cane growers were conducted during 2010-11 crop season in Rauzagaon, Haidergarh and Biswan Sugar mill command areas. There was a significant increase in crop yield, irrigation water saving and irrigation water use efficiency. The maximum increase in cane yield was recorded in ring-pit method of planting (109.70%) over the conventional method followed by skip furrow method of irrigation (49.12%), irrigation at critical growth stages (18.44%) and trash mulching (17.63%). The saving in irrigation water varied from 20.0 to 61.0 per cent. The increase in irrigation water use efficiency (IWUE) was recorded highest in ring-pit method of planting (151.61%) over the conventional method followed by skip furrow method of irrigation (149.78%), irrigation at critical growth stages (90.58%) and trash mulching (41.17%).

The comparative economics of four technologies was well demonstrated to farmers. Among the demonstrated technologies, the highest B/C ratio was observed in trash mulching technology (2.08) followed by skip furrow method of irrigation (1.86), ring-pit method of planting (1.52) and ICGS (1.30). The highest net return (₹ 164574/ha) was recorded in case of ring- pit method of planting followed by skip furrow method of irrigation (₹ 124765/ha), trash mulching (₹ 105690/ha) and ICGS (₹ 85909/ha).

B. On–farm demonstrations

During the year 2010-11 following technologies were demonstrated at Institute's farm to sensitize the visiting farmers and cane development staff of sugar mills.

Planting method	Varietal performance	Intercropping
Ring- pit	CoLk 94184	Flat method- Sugarcane (CoLk 94184)+Wheat (PBW 343)
Flat	CoS 99259	FIRB method - Sugarcane (CoLk94184)+Wheat (PBW 343)
Trench	CoSe 92423 CoS 96268 CoS 94257 CoPt 97222 CoS 96275 CoS 8436 Co 0238	

11.2 Seed production and distribution

Nine thousand nine hundred and fifty quintals of sugarcane seed of recently released varieties (Table 11.2) was produced at the Institute's main farm at Lucknow during 2010-11. In addition, 1950 quintals seed was also produced at IISR Regional Centre, Motipur (Bihar). The newly released varieties such as Co 0118, Co 0239, Co 0124 and CoH 128 have been included in the seed production chain for the crop season 2011-12.

Table 11.1: Demonstrations on water use efficient technologies

Sl. No	Technology	Sugar Mill Zone				Total
		Biswan	Kamlapur	Rauzagoan	Haidergarh	
1.	Trash mulching	6	1	1	0	8
2.	Skip furrow method	5	0	1	2	8
3.	Irrigation at C G S	4	0	2	2	8
4.	Ring- pit planting method	0	0	1	0	1
	Total	15	1	5	4	25

Table 11.2: Sugarcane Seed Production

a. At IISR, Lucknow

Name of variety	Maturity group	Quantity (in quintals)
CoLk 94184	Early	2800
CoS 96268	Early	3000
Co 0238	Early	650
CoS 99259	Midlate	900
CoPant 97222	Midlate	600
CoS 94257	Midlate	1800
CoS 96275	Midlate	200

b. IISR Regional Centre, Motipur (Bihar)

Name of variety	Maturity group	Quantity (in quintals)
CoLk 94184	Early	1000
Co 0232	Early	300
Co 0233	Midlate	400
BO 141	Midlate	250

11.3 Knowledge dissemination

a) Extension brochures published and distributed

The following four extension brochures (Hindi) on water use efficient sugarcane production technologies were prepared, published and distributed to farmers and extension personnel.

1. गड्ढा बुवाई विधि अपनाकर सिंचाई जल की बचत करें।
   संकलन-डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।
2. गन्ने की क्रान्तिक वृद्धि अवस्थाओं पर सिंचाई कर पानी बचाएँ।
   संकलन-डी.वी.यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।
3. एकान्तर नाली सिंचाई विधि अपनाकर गन्ने में पानी बचाएँ।
   संकलन-डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।
4. गन्ने की पेड़ी में पताई बिछाकर सिंचाई जल की बचत करें।
   संकलन-डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।

b) Documentary films made

1. Water saving technologies in sugarcane.
2. सिंचाई जल बचत के लिए गन्ना उत्पादन तकनीक।

c) 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.

d) Exhibitions

An exhibition of sugarcane production technology was organized in "AGRIVISION-2011" on the occasion of X Agricultural Science Congress on 10-12 Feb., 2011 held at NBFGR, Lucknow. The major objective of exhibition was to showcase the remunerative sugarcane production technologies XASC through meaningful display of exhibits and sugarcane machines. About 1000 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 in "Agri-Expo" was organized on 27th Feb., 2011 at Dashehri Village (Kakori) in Lucknow district. The "Agri-Expo" was organized by CISH, Lucknow. The main objective of exhibition was "showcasing of agricultural technologies through exhibition". About 500 farmers from the nook and

corner of the state visited the Institute's stall and got acquinted with latest development in sugarcane cultivation technology.

An Exhibition and *Kisan Mela* was organised on the occasion of IISR Foundation Day on February 16, 2011 at the Institute premises. An elaborate display of sugarcane production technologies with the help of posters, live material, specimen *etc*., was made for the benefit of about 1000 farmers, development personnel and other officials that visited the exhibition.

e) *Kisan Mela*

A *Kisan Mela* was organised on the occasion of the Institute Foundation Day on February 16, 2011 at Institute premises. About 1000 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 visited in the *Kisan Mela*. The visiting farmers saw various exhibitions stalls and interacted to learn the knowhow on technologies being demonstrated

f) Field visits

Twenty seven groups, comprising of 423 farmers from different states under ATMA, National Horticulture Mission scheme *etc*., visited at KVK of 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.

g) Farmers' day and *Kisan Goshthi*

The farmer's day was celebrated on 23rd December 2010 at Raitha village. A *Kisan Gosthi* on producing healthy potato seed through "Seed Plot Technique" was also organized in this village where 25 farmers participated. Another *Kisan Gosthi* was also organized on sugarcane cultivation. The important aspects covered were variety, IPM, INM, the production technology and the mechanization in sugarcane cultivation. About 500 cane growers participated.

h) Media coverage

I. IISR

The media coverage of the Institute activities in terms of TV coverage and press releases is as follows:

T.V. coverage

S. No.	Title	T.V. Programme	Name of Scientist	Date of Telecast
1.	गन्ने की खेती में सामयिक कार्य	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. गया करन सिंह	09.06.2010
2.	गन्ना बुवाई, सिंचाई जल बचत एवं अधिक उपज की कृषि तकनीक	कृषि दर्शन, दूरदर्शन, नई दिल्ली	डा. ए.के. साह	08.11.2010
3.	गन्ने में कीटों का प्रकोप व बचाव	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. एम.आर. सिंह	11.02.2011
4.	बसन्तकालीन गन्ने की बुवाई के लिए तैयारी	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. ए.के. साह	14.02.2011
5.	गन्ने के साथ अंतः फसली खेती	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. एस.एन. सिंह	15.02.2011
6.	भारतीय गन्ना अनुसंधान संस्थान का स्थापना दिवस	समाचार, दूरदर्शन, लखनऊ "राजधानी से" ई.टी.वी., उत्तर प्रदेश	–	16.02.2011
7.	गन्नें में सामयिक कार्य	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. ए.के. साह	07.03.2011

Press media coverage

S. No.	Title	Name of Newspaper	Place of Publication	Date
1.	स्थापना दिवस समारोह	दैनिक जागरण	लखनऊ	9 फरवरी, 2011
2.	गन्ना अनुसंधान संस्थान का स्थापना दिवस समारोह	हिन्दुस्तान	लखनऊ	10 फरवरी, 2011
3.	भारतीय गन्ना अनुसंधान संस्थान का स्थापना दिवस 16 को	राष्ट्रीय सहारा	लखनऊ	10 फरवरी, 2011
4.	Foundation Day	The Times of India	Lucknow	11 February, 2011
5.	IISR hold foundation day; focus on management of plant diseases	The Pioneer	Lucknow	17 February, 2011
6.	MoU signed for better crop output	The Pioneer	Lucknow	17 February, 2011
7.	Food for thought: Pesticides can cause cancer	The Hindustan Times	Lucknow	17 February, 2011
8.	जैविक खाद से बढ़ेगी गन्ने की उपज	दैनिक जागरण	लखनऊ	17 फरवरी, 2011
9.	अब सहफसली खेती के बिना गुजारा नहीं-कृषि भूमि और जोत लगातार घटने की चुनौती, गन्ना अनुसंधान संस्थान ने मनाया स्थपना दिवस	अमर उजाला	लखनऊ	17 फरवरी, 2011
10.	गन्ना अनुसंधान संस्थान ने मनाया स्थापना दिवस	स्वतंत्र भारत	लखनऊ	17 फरवरी, 2011
11.	गन्ने में बीमारी व कीटों से बचाव के लिए ट्राइकोडर्मा के प्रयोग पर जोर	आज	लखनऊ	17 फरवरी, 2011
12.	कृषि क्षेत्र में अग्रणी पाँच किसान सम्मानित - गन्ना अनुसंधान संस्थान ने मनाया स्थापना दिवस	युनाइटेड भारत	लखनऊ	17 फरवरी, 2011
13.	खेती की नयी तकनीक का प्रदर्शन	जनसंदेश टाइम्स	लखनऊ	17 फरवरी, 2011
14.	किसान मेले में प्रदेश के पाँच किसान सम्मानित	राष्ट्रीय सहारा	लखनऊ	17 फरवरी, 2011
15.	भारतीय गन्ना अनुसंधान संस्थान- यहाँ की बात कुछ और है	राष्ट्रीय सहारा	लखनऊ	28 फरवरी, 2011
16.	गन्ना की खेती अपनाकर आय बढ़ाये किसान	राष्ट्रीय सहारा	लखनऊ	10 मार्च, 2011

II. KVK : The KVK activities covered by media are as follows:

T.V. coverage

S. No.	Title	T.V. Programme	Name of Scientist	Date of Telecast
1.	पशुओं में संक्रामक बीमारियाँ एवं टीकाकरण	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. राकेश कुमार सिंह	04.05.2010
2.	सूक्ष्म पोषक तत्वों की पूर्ति	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. ओम प्रकाश	01.06.2010
3.	पशुओं में टीकाकरण	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. राकेश कुमार सिंह	08.06.2010
4.	पशुओं में अन्तः परजीवी	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. राकेश कुमार सिंह	09.08.2010
5.	सब्जियों की सह फसली खेती	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. आर के सिंह	27.08.2010
6.	कृषि चौपाल में फल एवं सब्जियों की जानकारी	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. आर के सिंह	22.09.2010
7.	मृदा तथा पौधों में पोषक तत्वों की कमी के लक्षण एवं उपचार	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. ओम प्रकाश	12.11.2010
8.	आलू भन्डारण में सावधानियाँ	कृषि दर्शन, दूरदर्शन, लखनऊ	डा. आर के सिंह	07.03.2011

Radio talks

S.No.	Title	Radio Station	Name of Scientist	Date of Telecast
1.	मृदा परीक्षण के पश्चात ही उर्वरकों का प्रयोग करें	आकाशवाणी, लखनऊ	डा. आर.के. सिंह	03.05.2010
2.	गन्ने की फसल मे मई माह की उन्नत सस्य क्रियांए	आकाशवाणी, लखनऊ	डा. आर.के. सिंह	17.05.2010
3.	फसलों में सूक्ष्म पोषक तत्वों का प्रबंधन	आकाशवाणी, लखनऊ	डा. आर.के. सिंह	28.05.2010
4.	एकीकृत पोषक तत्व प्रबंधन	आकाशवाणी, लखनऊ	डा. ओम प्रकाश	14.06.2010
5.	पपीते की उन्नत बागवानी	आकाशवाणी, लखनऊ	डा. ओम प्रकाश	12.08.2011

12 Education and training

12.1 International Training Programme

The Institute has developed following four International Training Programmes on sugarcane related aspects. 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.

12.2 Training of sugarcane development personnel

The Institute regularly organizes one one-month 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.

12.3 Training of sugarcane growers

1. Five-days Farmers' training programme on '*Ganne Ki Unnat Krishi Taknik*' sponsored by ATMA, Samstipur, Bihar was organized from 18-22 May, 2010. In this training, 17 farmers from Samastipur district of Bihar participated. They were provided with knowledge in sugarcane production, protection and farm machineries for maximizing the sugarcane yield at their farms.
2. Five-days Farmers' training programme on '*Ganne Ki Unnat Krishi Taknik*' sponsored by Jan Kalyan Sansthan, Haridwar, Uttarakhand was organized from 18-22 Jan., 2011. In this training, 23 farmers from Haridwar district of Uttarakhand participated. The knowledge in various aspects of sugarcane cultivation like

improved varieties, planting methods, nutrient management, water management, integrated disease and pest management, mechanization of sugarcane cultivation, jaggery making *etc*., were provided.

12.4 Training to entrepreneurs

Under central sector scheme, AICRP on PHT, seven-days farmers' training on "Quality Jaggery Production" was organized at IISR, Lucknow during January 3-9, 2011. Total 23 participants from Uttar Pradesh, Uttarakhand and Punjab participated in the training.

12.5 Trainings at KVK Lucknow

Eighty three trainings for practicing farmers, farmwomen, rural youths and two for in- service

personnel were organized. In addition, 20 trainings on different horticultural crops under State Horticulture Mission, sponsored by DHO, Lucknow, were organized. In all, 1934 trainees were trained on different aspects.

Eighty three (83) trainings, including 40 off campus trainings, 41 On campus, were organized for practicing farmers' (81), and in-service personnel (2) for upgrading their knowledge and skill on various thematic areas *viz*., weed management, resource conservation technologies, cropping system, seed production (crop production), off season vegetables, nursery raising, training and pruning, rejuvenation of old orchards (Horticulture), soil fertility management, soil and water conservation, production and use of organic inputs, management of problematic soil, soil sampling and testing (soil health and fertility), minimization of nutrient losses in processing, income generating activities for empowerment of rural women, kitchen gardening, value addition, women and child care (Home Science), dairy management, piggery management, poultry management, disease management, goat farming, production of quality animal products (Livestock production management) *etc*. Total 1934 trainees were trained during 2010-11.

12.6 Sponsored training

Twenty trainings, each of two- days duration for five hundred farmers of Lucknow district under National Horticulture Mission Programme was carried out at KVK, IISR, Lucknow during March 22-April 12, 2011, in which (500) selected progressive farmers of different blocks of Lucknow district were trained. Training was mainly focused on improved technologies pertaining to mango, potato, banana, gladiolus, rose, spices crop, nursery raising and protected cultivation of vegetables.

12.7 Training to students

During the period under report, trainings to 30 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.

13 Awards and recognition

13.1 Awards

- Dr. R.L.Yadav, Director, IISR, Lucknow was awarded Dr. M.S.Swaminathan Bharat Ratna Award for his outstanding contribution to Agronomy.
- Dr. R.L. Yadav, Director was awarded for his excellent contribution in the field of Scientific Writing in Hindi by *Bhartiya Krishi Anusandhan Samiti*, Karnal.
- Dr. Amaresh Chandra received ICAR Award for Outstanding Inter-disciplinary Team Research in Agriculture & Allied Sciences for the Biennium 2007-2008 in July, 2010.
- Dr. S. Solomon was awarded *Rashtriya Gaurav* Award by the India Friendship Society, New Delhi in year 2010.

13.2 Recognition

1. Dr. Amaresh Chandra was awarded Fellow of the Range Management Society of India, Jhansi in year 2010.

13.3 Member of Institute Management Committee

- Dr. Sangeeta Srivastava nominated as Member of Management Committee of IISR, Lucknow for a period of three years.
- Dr. Amaresh Chandra has been nominated as Member of the Management Committee of IGFRI, Jhansi for a period of three years w.e.f. 16.4.2010.

13.4 Member of the Executive Committee of Professional Societies/Editors of Journals

- Dr. R.L. Yadav has been elected as President, Association of Sugarcane Technologists of India and Member, Executive Council of Sugar Technologists Association of India.
- Dr. R.L. Yadav has been nominated as Member, Screening Committee for SDF Loans, Ministry of Food and Food Processing Industries, Govt. of India.
- Sh. Brahm Prakash was elected as Joint Secretary of Indian Society of Pulses Research and Development for a period of three years. (2010-2012).
- Dr. S. Soloman was nominated as Executive Editor of Sugar Tech- an International Journal of Sugar Crops and Integrated Industries
- Dr. R.K. Singh was nominated as Editor for Sugar Tech Journal for the year 2011 published by Springer India.

13.5 Nominations

- Dr. S. K. Duttamajumder was nominated to act as a Member of Monitoring Committee of *Bt* brinjal and *Bt* maize.
- Dr. S.K. Duttamajumder has been nominated as a Member in the Review Committee on Genetic Manipulation (RCGM), under the Department of Biotechnology, Govt. of India.
- Dr. A.D. Pathak was nominated as DBT nominee in the Institute Bio- safety Committee of UP Council of Sugarcane Research, Shahjahanpur.
- Dr. R.K. Singh was nominated as Member of the "Board of Studies for Biotechnology", DAVV, Indore.

13.6 Refree for Journals/Reviewers

Dr. Amaresh Chandra – Reviewer for various journals viz. Genome, Euphytica, Journal of Agronomy and Crop sciences, Acta Physiolgiae Plantarum, Sugar Tech, Indian Journal of Agricultural Sciences, Biochemical Systematics and Ecology, Journal of Plant Biochemistry and Biotechnology, Range Management and Agroforestry and Scientia Agricola.

13.7 Other Recognitions

- Dr Raman Kapur was an invited speaker on sugarbeet as a supplementary crop at the training programme on improved cultivation of sugarcane and sugarbeet for cane development staff of North Karnataka Sugar Industries at University of Agricultural Sciences, Dharwad from October 12-15, 2010, jointly organized by Nijalingappa Sugar Institute, UAS, Dharwad and SES, Vanderhave.
- Dr. Arun Kumar Srivastava, P.S. (Agromet) was recognized as expert by IMD, Govt. of India, New Delhi on sugarcane crop for DST sponsored project on 'Study on climatic impact on sugarcane growth and yield in eastern Uttar Pradesh region'.
- Dr. A.D.Pathak chaired session on "Feasibility of sugarbeet production in India: Agronomic view point" in Seminar on Sugarbeet and Fodder beet introduction in India at University of Agricultural Sciences, Dharwad (Karnataka) on July 15, 2010.
- Dr. S. Solomon, Secretary of the International Association of Professionals in Sugar and Integrated Technologies (IAPSIT) for a period of 4 years (2010-2013).
- Dr. S. Solomon, President and Coordinator: 4th IAPSIT International Sugar Conference on Balancing Sugar and Energy Production in Developing Countries: Sustainable Technologies and Marketing Stratigies.21-25th November, 2011, New Delhi.
- Dr. S. Solomon, President, Society for Sugar Research & Promotion, organizing International Conference IS-2011 in Nov. 2011

Linkages and collaborations

The Institute has developed a 6- 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 as detailed below:

14.1 Collaboration with International Research Institutions

At International level, the institutional linkages exist with International Bureau of Plant Genetic Resources and International Society of Sugarcane Technologists to participate in the sugarcane genetic resources programme, and with different foreign universities and Governments dealing with sugarcane like, USA, Brazil, Cuba, and Australia.

A collaborative research project on Development of a Precision N Application Technology based NDVI index using Green Seeker sensors for intercropping in the Institute as wheat is in operation in the Institute as CIMMYT/RWC-USAID Programme. The Institute is also exploring areas of common interest in sugarcane research with Japan and Australia.

14.2 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 subtropical 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 so far have been sent to the Sugarcane Breeding Institute 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 2010-11, 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 subtropical region from the fluff of zonal crosses sent from Sugarcane Breeding Institute, Coimbatore. At present, the work done under this programme involves the identification of promising genotypes in different clonal generations and not from the seedling population.

The seed cane 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.

14.3 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.

Directorate of Sugarcane Development: The Directorate sponsored short-term trainings during the year to the Institute.

One collaborative research project on Energy and Water Balance and Crop Growth Monitoring Using Satellite Data is in operation in the Institute as Space Application Centre (ISRO), Govt. of India programme.

Deptt. of Biotechnology: The Deptt. of Biotechnology, Ministry of Science and Technology, Govt. of India., New Delhi sponsored one research project *viz.*, Development of SSR markers for red rot resistance from EST database of sugarcane. One scientist of the Institute has also been nominated to act as DBT representative in Institute Bio-safety Committee of U.P. Council of Sugarcane Research, Shahjahanpur for a period of 3 years.

14.4 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 liaises 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 22 different co-operating centres located in the different states of the country as shown below, In this way, the Institute is strengthening its linkages with SAUs/other general Universities through AICRP cooperative centres.

AICRP Cooperative Centres

SAUs	ICAR	Others	Centre names
18	2	2	Anakapalle, (ANGRAU, Hyderabad); Buralikson (AAU, Jorhat); Bethuadahari (W.B.); Cuddalore, (TNAU, Coimbatore); Coimbatore, (SBI, Combatore); Faridkot, (PAU, Ludhiana); Ludhiana, (PAU, Ludhiana); Kolhapur, (MPKV, Rahuri); Kota (MPUA&T, Udaipur); Mandya, (UAS, Bangalore); Navasari, (NAU, Navasari); Nayagarh, (OUA&T, Bhubaneshwar); Padegaon, (MPKV, Rahuri); Pantnagar, (GPPUA&T, Pantnagar); Pusa, (RAU, Samastipur); Pawarkheda (JNKVV, Jabalpur); Shahjahanpur, (UPCSR, Shahjahanpur); Sankeshwar, (UAS, Dharwad); Sriganganagar, (RAU, Bikaner); Thiruvella, (KAU, Trichur); Uchani, CCSHAU, Hisar); Lucknow, (IISR, Lucknow)

In addition, the Institute liasions as a cooperating centre of 3 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 sponsors its scientists regularly to the Weather Watch Group meetings at UP Council of Agricultural Research, Lucknow.

State Cane Department: U.P. State collaborated in extension programmes and provided the feedback for refinement technology. The Institute also sends its Newsletters/ Annual Reports to cane-

federations of various states as well as to the State Cane Departments.

14.5 Collaboration with Private Organizations

Collaboration with private seed/ fertilizer/ pesticide companies/industries has also been made through contract research programmes. The Institute has 3 contract research projects out of which One is on evaluation of sugarbeet hybrids, and 2 are on evaluation of insecticides. 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. In the area of technology dissemination/extension, the Institute signed a MoU with a private new agency Reutors.

Dr. R.L. Yadav, Director of the Institute attended following meetings to promote collaborations with private sector:

- The 4th Council Meeting of the STAI on April 27, 2010 held at New Delhi.
- National Symposium on "Potassium for improving soil health and crop productivity" on September 30, 2010 held at Amity University, Noida.
- Executive Council Meeting of the STAI on Jan. 05, 2011 at New Delhi.

A. Collaboration with Sugar Mills

- In an attempt to have linkages with the sugar mills of the country, the Institute conducts a one-month 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 some sugar mills in the country. The Institute also provides consultancy services to the sugar mills.
- Consultancy services were provided to Harinagar Sugar Mills Ltd., West Champaran Bihar for providing consultancy regarding cane quality checking and juice analysis.
- 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.

- 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 four different water efficient and high yielding sugarcane production technologies. Twenty five demonstrations were conducted during 2010-11 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.

14.6 Collaboration with local Institutions

Institute shares its resources of guest houses, lab facilities *etc*., for the use of other ICAR Institutes such as CISH, Lucknow, NBFGR, Lucknow CSSRI Regional Centre, Lucknow. The Directors of the other ICAR Institutes are also invited to the Institute on important occasions. Actively participated in the organization of X Agricultural Science Congress at NBFGR, Lucknow during January 10-12, 2011 and shared the Institute facilities of guest house *etc*.

15

Publications

15.1 Research Papers in Indian Journals

Anwar, S.I. (2010) Calorific value of jaggery bagasse as affected by its composition. *Agril. Eng. Today* **34**(1):47-49.

Chandra A., Jain, R., Rai, R.K. and Solomon, S. (2011) Revisiting the source–sink paradigm in sugarcane. *Curr Sci.* **100** : 978-980.

Chandra, A., Jain, R., Rai, R.K. and Solomon, S. (2010) Designing and application of sucrose controlling enzyme soluble acid invertase (SAI) gene based specific primer-pairs in sugarcane. *Natl. Acad. Sci. Lett.*, **33**: 355-359.

Hasan, S.S., Kumar, R., Shukla, S.K., Baitha, A., Sah, A.K., Singh, S.N. and Kumar, S. (2010) Expert system for decision support in sugarcane domain. *Indian J. Sugarcane Technol.* **25(**1 & 2): 93-96.

Jain, R., Kulshreshtha, N., Shahi, H.N., Solomon, S. and Chandra, A. (2010) Effect of leaf stripping on cane and sugar yield in sugarcane. *Sugar Tech.* **12** : 70-71.

Jain, R., Solomon, S., Shrivastava, A.K. and Chandra, A. (2010) Sugarcane bud chips : A promising seed material. *Sugar Tech.* **12** :67-69.

Kapur, R., Duttamajumder, S.K. and Rao, K. Krishna. (2011) A breeder's perspective on the tiller dynamics in sugarcane. *Curr Sci.* **100**(2)**:** 183-189.

Kumar, R., Hasan, S.S., Bajpai, P.K. and Singh, S.N. (2010) Economic Analysis of sugarcane cultivation in different states of India. *Indian J. Sugarcane Technol.* **25**(1 & 2) : 97-101.

Prasad, Kamta., Kumar, Rajesh, Prakash, N., Sah, A.K. and Verma, R.P. (2010) Indigenous soil and water conservation practices prevailing among the tribal farmers of Mizoram. *Indian J Soil Conservation* **38** (1) : 31-36.

Rai, R.K., Singh, P., Chandra, A. and Yadav, R.L. (2010) Salinity induced changes in phosphorus fractions of sugarcane leaf laminae adversely affect sucrose content. *Indian J Plant Physiol.* **15**: 278-282.

Sah, A.K. (2010) Management Style in Pradeshik Cooperative Dairy Federation (PCDF), Uttar Pradesh, *Indian J Dairy Sci.* **62** (6) : 1-5.

Sah, A.K., and Kumar, Rajesh. (2010) *Perhi Ganna Taknik men Kisano Ka Gyan Astar, Pragrahan Sthiti Avam Samasyaen: Shodh Ankalan, Bhartiya Krishi Anusandhan Patrika* **25** (2-3).

Sah, A.K., Hasan, S.S. and Kumar, R. (2010) Integrated Communication Strategy (ICS) in sugarcane. *Indian J. Sugarcane Technol.* **25** (1 & 2) : 89-92.

Singh, G.K., Yadav, R.L. and Shukla S.K. (2010). Effect of planting geometry, nitrogen and potassium application on yield and quality of ratoon sugarcane in sub-tropical climatic conditions. *Ind. J. Agri. Sci.* **80**:1038-42.

Singh, G.K., Yadav, R.L. and Shukla, S.K. (2010) Planting geometry, nitrogen and potassium application on yield and quality of ratoon sugarcane in sub-tropical climatic conditions. *Ind J Agri Sci.* **80**(12) : 1038-42.

Singh, K.K., Mall R.K., Singh R.S. and Srivastava A.K. (2010). Evaluation of CANEGRO Sugarcane model in East Uttar Pradesh, India *J. Agromet.* **12**(2): 181-186.

Singh, K.P., Srivastava, T.K., Suman, A. and Singh, P.N. (2010) Sugarcane productivity and soil health in a bionutrition–based multi–ratooning system under sub- tropics. *Ind J Agri Sci.* **80**(8) : 746 – 48.

Singh, P., Tiwari, P., Arya, N., Suman, A., Rai, R.K., Kumar, R. and Shrivastava, A.K. (2010) Cellulose digestibility and monomeric sugar yields in acid pretreated sugarcane bagasse. *Indian J. Sugarcane Technol.***25**(1 & 2): 66-76.

Singh, P.K., Singh, A.K., Kumar, S. and Singh, J. (2010) Seed-cane marketing – a multi-million industry in the offing. *Curr. Sci.* **99**(7): 883-887.

Tiwari, P., Arya, N., Suman, A., Rai, R.K. and Singh, P. (2010) Simultaneous saccharification and fermentation of monosaccharides in acid pre-treated bagasse of sugarcane varieties with *Saccharomyces cerevisiae*. *Indian J. Sugarcane Technol.* **25**(1 & 2): 77-80.

15.2 Research Papers in Foreign Journals

Anwar, S.I. (2010) Determination of moisture content of bagasse of jaggery unit using microwave oven. *J. Eng. Sci. Tech.* **5**(4) : 472-478.

Anwar, S.I. (2010) Fuel and energy saving in open pan furnace used in jaggery making through modified juice boiling/concentrating pans. *Energ Convers Manag* **51** : 360-364.

Jain, R., Srivastava, S., Solomon, S., Shrivastava, A.K. and Chandra, A. (2010) Impact of excess zinc on growth parameters, cell division, nutrient accumulation, photosynthetic pigments and oxidative stress of sugarcane. *Acta Physiologiae Plantarum* **32** : 979-986.

Jain, R. and Solomon, S. (2010) Growth stimulating effect of Ethephon on sprouting and early vigour of sugarcane bud chips. *Int. Sugar J.* **28**(3): 14-18.

Jain, R., Solomon, S., Shrivastva, A.K. and Chandra, A. (2010) Effect of ethephon and calcium chloride on growth and biochemical attributes of sugarcane bud chips. *Acta Physiol. Plant* **33**: 905-910.

Jain, R., Singh, S.N., Solomon, S. and Chandra, A. (2010) Potential regulatory role of gibberllic acid on sprouting and early stalk growth of sugarcane, *Guangxi Agril Sci.* **41** : 1025-1028.

Khan, M.S., Yadav, S., Srivastava, S., Swapna, M., Chandra, A. and Singh R.K. (2011) Development and utilization of conserved-intron scanning marker in sugarcane. *Aust J Bot.* **59** : 38-45.

Singh, R.D. and Tiwari, G.N. (2010) Energy conservation in the greenhouse system: a steady state analysis. *Energy* – The International Journal **35** : 2367-2373.

Singh, S.N., Sah, A.K., Prakash, Om, Singh, R.K. and Singh, V.K. (2010) Assessing impact of zero-tilled wheat growing in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system of India's Central Uttar Pradesh in Indo-Gangetic Plain region. *Outlook on Agril* **39**(3) : 197-202.

Singh, S.N., Yadav, R.L., Yadav, D.V., Singh, P.R. and Singh, I. (2010) Introducing autumn sugarcane as a relay intercrop in skipped row planted rice-potato cropping system for enhanced productivity and profitability in the Indian sub-tropics. *Expt Agri* **46**(4) : 519-530.

Singh, V., Singh, P.N., Yadav, R.L., Awasthi, S.K., Joshi, B.B., Singh, R.K., Lal, R.J. and Duttamajumder, S.K. (2010) Increasing the efficacy of *Trichoderma harzianum* for nutrient uptake and control of red rot in sugarcane. *J Hort Forestry* **2**(4)**:** 66-71.

15.3 Books

Yadav, R.L. (2010) Economics of Sugarcane Farming. ISBN 978-3-8383-5788-1. Pp 1-258. Lambart Academic Publishing Co., Germany.

Yadav, R.L. (2011) Sugarcane-wheat cropping system of South Asia: An analysis of socio-economic impact on Indo-Gangetic plain region. ISBN 978-3-8433-7823-9. Pp 1-112. Lambart Academic Publishing Co., Germany.

15.4 Book Chapters

Yadav, D.V., Jain, R. and Rai, R.K. (2010) Impact of heavy metals on sugarcane. In: Soil Heavy Metals, Soil Biology, Vol 19 (Eds. Irena Sherameti and Ajit Verma) pp 339-367, Springer-Verlag Berlin Heidelberg.

15.5 Bulletins/Manuals

Srivastava, T.K., Prasad, Kamta, Sah, A.K., Gupta, Rajendra and Singh, K.P. (2011) Farmers' Participatory Action Research on Water Use Efficient Technologies for Improving Productivity and Sustainability of Sugarcane. Indian Institute of Sugarcane Research, Technical Bulletin: 1/2011.

15.6 Popular Articles

Anwar, S.I. (2010) *Taaki Gud Bhatti Garam Rahe. Krishi Chayanika* (January-March) : 10-12.

Anwar, S.I. and Singh, J. (2010) Modified pans for open pan jaggery furnance. Operation manual no. AE/10/01.

Brahm Prakash, Singh KK and Om Prakash (2011) *Bhartiya Krishi me dalhani faslon ki mahatta. Kisan Jyoti* **2**: 44-48.

Sah, A.K. (2010) *Ganne Ke Pramukh Hanikarak Keet Evam Samekit Prabandhan*. *Ganna Masik* **42**(9) : 9-12.

Sah, A.K. and Singh, S.N. (2010) *Sharadkalin Ganne Ke Sath Aloo Evam Rajma Ki Labhdayak Kheti. Ganna Utpadan Takniki. Ganna Kheti Traimasik*. October- December, 2010, 13-16.

Sah, A.K. (2011) K*am Pani Mein Ganna Utpadan Kee Krishi Taknik. Krishak Srinkhala,* March, 2011, 26-27.

Singh, V., Awasthi, S.K. and Duttamajumder, S K. (2011) *Sulphitation Pressmud Mein Jaiva Niyantrak Trichoderma Viksit Karne Ki Saral Vidhi. Kisan Jyoti* **1-2**:12-14.

Singh, A.P., Awasthi, S.K. and Lal, Ramji (2010) *Ganney Kay Lal Saran Rog Ka Samakit Prabandhan Dwara Ganne Kee Upaj Evam Gudvatta Mai Vraddhi. Kisan Jyoti* **1-2**: 10-11.

Singh, M.R., Singh, V. and Sharma, M.P. (2011) *Kisan Bhai Aise Karein Keetnashi Rasayanon Ka Chayan Va Banayein Unka Ghol. Kisan Jyoti* **1-2** : 64-67.

Srivastava, T.K., Singh, Rajesh Kumar and Singh, Rakesh Kumar (2011) *Zayad Ganne Ki Labhdayak Kheti. Khad Patrika* **52**(3) : 23-28.

15.7 Papers presented in Seminars, Symposia, Conferences, Workshop *etc.*, in English

International

Papers presented in the 4th International Conference on Plants and Environmental Pollution, organized by the Intl. Soc. of Environmental Botanists & NBRI, Lucknow, December 8-11, 2010

Singh, R.K., Khan, M.S., Yadav, Sonia, Singh, M.R., Madhok, H.L. and Srivastava, S. (2010) Genetic transformation of sugarcane with *Cry1Ab* gene for stalk borer resistance. p 59-60.

National

Papers presented in X Agricultural Science Congress on Soil, Plant and Animal Health for Enhanced and Sustained Agricultural Productivity held at NBFGR, Lucknow, February 10-12, 2011,

Bajpai, P.K., Verma, R.S. and Yadav, R.L. (2011) Developing efficient statistical design for conducting weed control experiments in sugarcane. p. 65.

Banerji, R., Solomon, S., Kumar, Rajesh, Singh, Pushpa, Kishor, Ram, and Chandra, A. (2011) Inhibitory effect of pre-harvest foliar application of zinc sulphate on sucrose inversion in the harvested sugarcane. p. 287.

Brahm Prakash, Sharma, A.K. and Singh, G.K. (2011) Diversification options for sugarcane based sustainable production system in Uttar Pradesh. p. 58.

Chandra, A., Jain, Radha, Rai, Rama Kant and Solomon, S. (2011) Source-sink dynamics in sugarcane: A molecular functional approach to enhance sucrose content. p. 318.

Chauhan, R.S. and Singh, S.N. (2011) Enhancing productivity of sugarcane ratoon (*Saccharum* species complex) by optimising plant population in sub-tropical India. p 69.

Gupta P.S. and Srivastava S. (2011) Molecular assessment of genetic diversity among *Saccharum* species germplasm. p. 422

Hasan, S.S., Bajpai, P.K., Rajesh Kumar, Sharma, A.K., Sah, A.K. and Manral, S.C. (2011) Sugarcane field management system. p. 429.

Jain, Radha, Chandra, A. and Solomon, S. (2011) Modulating expression pattern of SAI gene in relation to sucrose content using enzymes effectors in sugarcane. p. 420.

Khan, M.S., Yadav, S., Singh, R.K., Srivastava, S., Duttamajumder, S.K., Swapna, M. and Kapur, R. (2011) Development of functional molecular markers in sugarcane. p. 428.

Kumar, Rajesh, Prakash, N. and Prasad, Kamta (2011) Development of extension modules for production of demand driven commodities. p. 316.

Kumar, Rajesh, Hasan, S.S., Bajpai, P.K. and Sharma, A.K. (2011) Economics of sugarcane cultivation in different states of India. p. 131.

Pandey, D.K., Lal, Sunita, Singh, P.K., Singh, J. and Kumar, S. (2011) Early generation selection of progenies from different families in sugarcane (*Saccharum* sp. Hybrids) for resistance to red rot (*Colletotrichum falcatum*) and sucrose. p 217.

Pathak, A.D., Kapur, R., Bhatnagar, S., Vishwakarma, M.K., Kumar, S. and Kumar, R. (2011) Simulating vernalization requirement for induction of flowering in sugarbeet (*Beta vulgaris* L.). p. 140.

Rai, R.K., Singh, P., Chandra, A., Srivastava, A.K, Solomon, S. and Darash Ram. (2011) Hormonal regulation of tiller numbers and cane weight to improve ratoon crop yield of sugarcane. p. 104.

Rai, R.K., Singh, Pushpa, and Chandra, A. (2011) Comparative analysis of physiological characteristics, apparent free space, yield and sucrose components in sugarcane varieties. p. 143.

Sah, A.K. and Verma, R.S. (2011) Extension strategy for sustainable sugarcane development : A system perspective. p. 128.

Kumar, Sanjeev, Singh, J., Pandey, D.K. and Singh, P.K. (2011). Assessment of some promising sugarcane genotypes for their ratoonability under subtropical condition. p. 108.

Kumar, Sanjeev, Singh, J., Pandey, D.K. and Singh, P.K. (2011) Evaluation of Inter-specific hybrids of sugarcane for quality traits under subtropical condition. p. 109.

Sharma, A.K. and Singh, Rakesh K. (2011) Milch-animal health management in mid plain zone of Uttar Pradesh : Micro evidences and major implications. pp. 239-240.

Shukla, S.K., Yadav, R.L. and Suman, Archna (2011) Mode of *Gluconacetobacter* inoculation with different levels of nitrogen and its effect on sugarcane growth, yield and sugar production. pp. 55-56.

Singh, A.K., Yadav, R.L, Pathak, A.D. and Suman, A. (2011) Effect of integrated nutrition on nitrogen use efficiency, productivity and quality of mid-late maturing sugarcane genotypes under sub-tropical Indian conditions. pp. 52-53.

Singh, Ishwar (2011) Productivity and profitability of wheat + sugarcane intercropping under FIRB system. pp. 110-111.

Singh, K.P. (2011) Enhancing nutrient use efficiency and soil quality of ratoon cane through integration of bio-manures. p 20.

Singh, M.R., Tanwar, R.K. and Sharma, M.P. (2011) Evaluation of different insect pest management modules against cane borers of sugarcane. pp 222-223.

Singh, Priyanka and Solomon, S. (2011) Sucrose loss and expression of invertase activity in harvested sugarcane juice during late crushing season. p. 105.

Singh, Pushpa, Rai, R.K. and Arya, Namita. (2011) Sugarcane Lignocelluloses : A potential on-site carbon and nutrient resource. p. 346.

Singh, Rakesh K., Singh, R.K., Sharma, A.K. and Singh, V.K. (2011) Introduction and performance of sugarbeet as fodder crop in Lucknow district. p. 485.

Singh, R.K., Singh, J., Suman, Archana, Singh, A. K., Madhok, H.L. and Singh, Vijai (2011) Effect of *in vitro* inoculated *Gluconacetobacter diazotrophicus* in micropropagated plantlets in sugarcane. p. 210.

Singh, S.N., Yadav, R.L. and Singh, Todi (2011) Enhancing productivity of sugarcane plant-ratoon system by minimising gaps and potassium fertigation in sub-tropical India. p. 54.

Siraree, Archana, Pandey, D.K., Kumar, Sanjeev and Singh, J. (2011) Environmental impact on morphological characters of sugarcane varieties. p. 357.

Srivastava, S., Lal, Ramji, Singh, R.K., and Swapna, M. (2011) Identification of resistance gene analogue polymorphism for red rot disease in sugarcane. p. 203

Srivastava, A.K., Solomon, S., Rai , R.K., Jain, Radha, Singh, Pushpa, Kumar, Rajesh, Sawnani, Anita, and Shukla, S.P. (2011) Improving productivity of winter-initiated ratoon crops of sugarcane. p. 106.

Srivastava, A.K., and Srivastava A.C. (2011). Impact of number of tractor on productivity of sugarcane in Uttar Pradesh. p. 129.

Srivastava, A.K., Shrivastava, A.K. and Singh, S.N. (2011) Long-term weather trends and likely impact on sugarcane in central Uttar Pradesh. p. 348.

Srivastava, S., Lal. Ramji, Singh, R.K. and Swapna, M. (2011) Indentification of resistance gene analogue polymorphism for red rot disease in sugarcane. p 203.

Srivastava, T.K. and Singh, K.P. (2010) Nitrogen use dynamics, soil health and sugarcane (*Saccharum* spp. complex hybrid) productivity in a bio-nutrition based multi-ratooning system. p 6.

Sushil, S.N., Tripathi, G.M., Rajak, D.C. and Yadav, R.L. (2011) Development of efficient insect trap against white grub beetles (Coleoptera: Scarabaeidae) in sugarcane agro-ecosystem of sub-tropical India. pp 212-213.

Swapna, M., Srivastava, S. and Pandey, D.K. (2011) Targetting genes linked to sugar content for quality improvement: A molecular marker approach. p. 408.

Tripathi, G.M., Kumar, A. and Singh, S.K. (2011) Eco-friendly management of sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner. p. 214.

Tyagi, V.P., Brahm Prakash and Sharma, A.K. (2011) Pulse crops : The best option for crop diversification and sustainable production system. p. 41.

Yadav, R.L. and Sharma, A.K. (2011) IISR role in mitigating the emerging challenges on sugarcane cultivation in India. Souvenir. Pp.136-141.

Papers presented at the XIX National Symposium on "Resource Management Approaches towards Livelihood Security" held at the University of Agricultural Sciences, Bengaluru during December 2-4, 2010.

Chauhan, R.S. and Singh, S.N. (2010) Improving productivity of winter initiated ratoon of sugarcane (*Saccharum* complex hybrid) in sub-tropical India. p 75.

Shukla, S.K., Yadav, R.L., Singh, P.N., Singh, S.N. and Suman, Archna (2010) Effect of sugarcane trash management with *Trichoderma viride* on soil organic carbon, nutrient availability and sugarcane ratoon yield in subtropical India.

Singh, Ishwar (2010) Optimizing irrigation schedule in sugarcane (*Saccharum* spp. Hybrid) under different planting methods. p. 214.

Singh, K.P. and Suman, Archna (2010) Enhancing nutrient use efficiency of plant cane through integration of bio-organics. p 73.

Singh, S.N., Prakash, Om, Singh, V.K. and Singh, Rakesh K. (2010). Enhancing wheat (*Triticum aestivum*) productivity through zero-tilled seeding and nitrogen nutrition under rice (*Oryza sativa*) – wheat cropping system. p. 415.

Papers presented in National Conference of Plant Physiology, organized by Dept. of Plant Physiology Institute of Agricultural Sciences, BHU, Varanasi. Nov. 25-27, 2010

Jain, Radha, Solomon, S. and Chandra, S. (2010) Physiological changes associated with ethephon treatment leading better bud sprouting in sugarcane (Abst. No. 06-28). p. 215.

Khan, M.S., Yadav, Sonia and Singh, R.K. (2010) Species specific functional marker in sugarcane. p. 174.

Rai, R.K., Singh, P., Shrivastava, A.K., Chandra, A. and Yadav, R.L. (2010) Early treatment of ethrel modifies shoot development and increases sucrose accumulation in sugarcane by changing source and sinks relationship. p. 217.

Shrivastava, A.K., Solomon, S., Rai, R.K, Jain, Radha, Singh, P., Kumar, Rajesh, Sawnani, A. and Shukla, S.P. (2010) Physiological interventions for improving sprouting of stubble buds in winter-initiated ratoon crops of sugarcane p. 312.

Singh, R.K., Khan, M. S., Yadav, Sonia, Singh, M.R. and Madhok, H.L. (2010) An efficient protocol for development of transgenic against borer in sugarcane. p. 286-287.

Papers presented in All India Seminar on Engineering Interventions to Enhance Income of Small and Marginal Farmers organized by the IE(I) Delhi State Centre, Sept. 29-30, 2010

Kumar, D. and Singh, J. (2010) Advanced packaging techniques for bio-products. pp. 148-155.

Singh, R.D. (2010) Determination of calorific value of bagasse of jaggery plant. pp 192-194.

Singh, R.D., Anwar, S.I. and Singh, J. (2010) Improving shelf life of jaggery with modified atmosphere packaging. pp.

Singh, J., Anwar, S.I., Singh, R.D., Singh, A.K. and Kumar, D. (2010) Jaggery manufacturing technology. pp 124-128.

Papers presented in 45th Annual Convention of Agricultural Engineering organized by Dr. PD Deshmukh Krishi Vidyapeeth, Akola during January 17-19, 2011

Anwar, S.I. (2011) Effect of extraction angle on juice extraction in 3-roller power driven horizontal sugarcane crushers. p. 169.

Singh J, and Singh, R.D. (2011) Development of a solar dryer for jaggery drying. p. 168.

Singh, R.D., Singh J., Anwar, S.I., and Kumar, D. (2011) Effect of modified atmosphere packaging on quality and shelf life of jaggery. p. 208.

Paper presented in National Conference on Managing Agri-Food Supply Chain, organized by IIM, Lucknow on April 9-11, 2010 at Lucknow

Sharma, A.K., Yadav, R.L. and Yadav, D.V. (2010). World sugar market and implications for sugar supply in India.

Paper presented in Sugar Asia, 2010 during July 9-10, 2010 at New Delhi

Shrivastava, A.K., Srivastava, A.K. and Solomon, S. (2010) Sustaining sugarcane productivity under depleting water resources.

15.8 Papers presented in *Hindi*

भारतीय कृषि अनुसंधान समिति द्वारा आयोजित "बरानी एवं सीमित सिचाई क्षेत्रों में कृषि, वानिकी एवं पशु पालन-समस्या व समाधान" विषय पर 13 वीं कृषि विज्ञान संगोष्ठी, जनवरी 21-23, 2011, राष्ट्रीय कृषि वानिकी अनुसंधान केन्द्र, झांसी, उ.प्र.

ब्रह्म प्रकाश, यादव, रतन लाल एवं शर्मा, ए.के. (2011) सीमित सिंचाई क्षेत्रों हेतु उन्नत गन्ना उत्पादन प्रौद्योगिकी। पृष्ठ 91.

सिंह, जी.के. तथा शर्मा, ए.के. (2011) असिंचित/सीमित क्षेत्रों हेतु गन्ना उत्पादन तकनीक। पृष्ठ 90.

सिंह, एस.एन., साह, ए.के., प्रकाश, ओम, सिंह, आर.के., सिंह, वी. के. तथा सिंह, राकेश.के. (2011) धान-गेहूँ फसल प्रणाली के अन्तर्गत गेहूँ की जीरो टिल ड्रिल विधि से बुवाई करने के प्रभाव का अध्ययन। पृष्ठ 91.

कुमार, राजेश, गुप्ता, राजेन्द्र, साह, ए.के. एवं हसन, एस.एस.(2011) बुन्देलखण्ड क्षेत्र के लिए गन्ना उत्पादन कृषि तकनीक - एक आंकलन एवं सुझाव, पृष्ठ 54-57।

वर्मा, आर.एस., साह, ए.के. एवं कुमार, राजेश (2011) सूखा प्रभावित क्षेत्रों के लिए गन्ना उत्पादन की कृषि तकनीक, पृष्ठ 40।

ओम प्रकाश, सिंह, एस.एन., सिंह, आर.के., साह, ए.के., कुमार, राजेश एवं सिंह, राकेश कुमार (2011) गन्ना की उपज एवं चीनी परत बढ़ाने में उन्नत सस्य तकनीकियों का योगदान, पृष्ठ 48-49।

ओम प्रकाश, सिंह, एस.एन. एवं कुमार, राजेश (2011) जैविक संसाधनों द्वारा गन्ने की टिकाऊ खेती व उत्पादकता बढ़ाने की संभावनाएं, पृष्ठ 60।

15.9 हिन्दी में प्रकाशित प्रसार पुस्तिकायें

गड्ढा बुवाई विधि अपनाकर सिंचाई जल की बचत करें। संकलन-डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के., साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।

गन्ने की क्रान्तिक वृद्धि अवस्थाओं पर सिंचाई कर पानी बचाएँ। संकलन-डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।

एकान्तर नाली सिंचाई विधि अपनाकर गन्ने में पानी बचाएँ। संकलन- डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।

गन्ने की पेड़ी में पताई बिछाकर सिंचाई जल की बचत करें। संकलन- डी.वी. यादव, आर.पी. वर्मा, कामता प्रसाद, ए.के. साह, राजेन्द्र गुप्ता, एवं के.पी. सिंह।

15.10 Documentary films developed

Water Saving technologies in Sugarcane.

सिंचाई जल बचत के लिए गन्ना उत्पादन तकनीक।

KVK

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

Arora, R.K., Singh, R.K. and Gulati, Sunil (2010) Managing loss from ground frost- A major constraints to potato production in North – Western plains. *Potato Journal* **37** *(1-2) : 74-75.*

Singh, S.N., Shah, A.K., Singh, R.K., Singh, V.K. and Hasan, S.S. (2010) Diversification of potato (*Solanum tuberosum*,L.) based crop sequences for higher production potentials and economic returns in India's Central Uttar Pradesh. *J. Sustainable Agric.* **34** (2): 141-152

(ii) Technical/Popular articles

Singh, R K. and Singh, Rakesh Kumar (2011) Training manuals on *Phal, Phool, Sabjee Evam Masalo ki Utpadan Taknik* under State Horticulture Mission Scheme, 1-55.

Yadav, R.K., Kumar, Raj, Chowdhery, Harshvardhan and Singh, R.K. (2011) *Tamatar Ki Unnat Kheti- Eak Labhkari Vyaysay. Kisan Jyoti* **2** (1-2) : 27-28.

Agarwal, Ankur, Pant, Tribhuvan and Singh, R.K. (2011) *Sabjiyon ki Surakshit Kheti. Ibid:* 18-22.

Agarwal, Ankur, Pandey, Vandana, Arya, M.C. and Singh, R.K. (2011) *Jalvayu Parivartan Ka Udyaniki Phasalon Par Prabhav. Ibid:* 58-61.

Singh, Rakesh Kumar and Verma, S.P. (2011) *Gramin Parivesh Me Pashu Poshan, Samasyae Evam Unka Samadhan. Ibid:* 36-38.

Singh, A.K ., Singh, Rakesh Kumar and Prasad, Kamta (2011) *Pashuon Mein Prajanan Sambandhi Samasyaein Va Unka Nidan. Ibid:* 39-40.

Singh, Neelam and Tewari, Mithlesh (2011) *Amla Ki Vibhinn Utpad Tyyarr Karne Ki Vidhiyan. Ibid:* 32-33.

Tewari, Mithlesh and Singh, Neelam (2011) *Amarud ki jelly. Ibid:* 34-35.

Tewari, Mithlesh (2011) *Kachcha Aahar -Sehat Ka Raj. Krishak Shrinkhala* ,Feb 2011

(iii) Presentation in Conferences/Symposia/ Seminars:

Presented in X Agriculture Science Congress on Soil, Plant and Animal Health for Enhanced and Sustained Agricultural productivity at NBFGR, Lucknow, February 10-12, 2011.

Singh, R.K., Sharma, Jyotsana, Trehan S.P and Singh, Rakesh Kumar (2011) Response of soil solarization on multiplication of *in-vitro* planting materials under field conditions. p 155.

Singh, Rakesh K., Singh, R.K., Sharma, A.K, and Singh, V.K. (2011) Introduction and performance of sugarbeet as fodder crop in Lucknow District. p 485.

Prakash, Om, Singh, S. N., Singh, V.K. and Singh, R.K. 2011: Enhancing of cane and sugar and also saving of irrigation water through ring – pit method of planting in sub-tropical India. p 86.

Technical programme (2010-11)

Crop management for high cane productivity under different environment

Sugarcane based production system

AS 59 Effect of sub-soiling on soil physico-chemical characteristics and sugarcane productivity (A.K. Singh, P.N. Singh and Akhilesh Kr. Singh; Duration : 2/08 – 3/12)

AS 60 Studies on seed cane economy in sugarcane cultivation (S.N. Singh, Radha Jain and Todi Singh).

PB 22 Physio-biochemical studies concerning survival and establishment of bud chip under normal and encapsulated conditions (Radha Jain, A.K. Shrivastava and S. Solomon, Duration: 04/08 - 03/11)

IARI-IISRDBT-1/10 Development of plant growth promoting microbial consortium for rice-wheat sugarcane cropping system (Archna Suman, R.L. Yadav, K.P. Singh; Duration: 11/10-4/12)

AS 42 Agronomic evaluation of promising genotypes of sugarcane (S.K. Shukla and Ishwar Singh; Duration long term LT)

Ratoon management in sugarcane

AS 58 Improving productivity of winter initiated ratoon of sugarcane in sub-tropical India (R.S. Chauhan and S.N. Singh; Duration : 2/07 – 2/11)

PB 18 Improving juice quality and stubble bud sprouting in sugarcane under low temperatures (A.K. Shrivastava, S. Solomon, R.K. Rai, Pushpa Singh, Radha Jain and Rajesh Kumar Duration : 3/04 – 3/11)

A 2.31 Effect of biomanuring on sugarcane productivity and soil properties under plant and subsequent ratoons (K.P.Singh; Duration : 3/03– Long term)

A3.23 Optimizing plant population density in sugarcane plant-ratoon system (S.N.Singh, R.L. Yadav and Todi Singh; Duration : 2/07 – 4/11)

C15.8 Studies on rhizospheric environment of plant and ratoon crop of sugarcane (R.L. Yadav, Archna Suman, R.K. Rai and Pushpa Singh; Duration: 2008-11).

Crop management for improving physiological efficiency and sucrose content

PB 23 Optimization of plant population for improving physiological efficiency of sugarcane (R.K. Rai, A.K. Shrivastava, R. Banerji, A. Chandra, Pushpa Singh, S. Solomon and Radha Jain; Duration: 2/10 – 3/13)

PB 24 Modulating the expression of sucrose metabolizing enzymes for high sucrose accumulation in sugarcane (Radha Jain, A. Chandra and S. Solomon; Duration : 10/09 – 3/12)

Resource management in sugarcane based cropping system

Nutrient management in sugarcane based cropping system

Expl. Trial Studies on soil-crop-weather data set for simulation of MOSICAS sugarcane growth model with reference to nitrogen nutrition (A.K. Singh, D.V. Yadav and P.N. Singh; Duration : 2009-12).

Water management in sugarcane based cropping system

A 1.2.27 Developing efficient water application techniques in sugarcane

(A.K. Singh, D.V. Yadav, S.N. Singh and P.N. Singh; Duration : 2010-14)

A1.2.28 Deep tillage under different moisture regimes and N levels for modifying rhizospheric environment and improving sugarcane yield in plant-ratoon system (S.K. Shukla, R.L. Yadav, A.K. Singh and Rajendra Gupta; Duration : 3/10 - 3/14).

AS 61 Optimizing irrigation schedule in sugarcane under different planting methods (Ishwar Singh; Duration : 2/09 - 3/13)

C6.6 Optimization of fertigation schedule in drip irrigated sugarcane under subtropical conditions (Rajendra Gupta and D.V. Yadav; Duration : 10/9 - 2/13).

Weed management in sugarcane based cropping system

AS 62 Management of binding weeds in sugarcane (R.S. Verma and R.S. Chauhan; Duration : 2/09 - 1/13)

A7.1 Developing an efficient statistical design for conducting weed control experiments in sugarcane (R.S. Verma, P.K. Bajpai and R.L. Yadav; Duration: 2/10 - 3/13)

Genetic improvement of sugarcane for higher cane and sugar productivity under biotic and abiotic stresses

Studies on *Saccharum* germplasm

B.1.7 Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions (Sanjeev Kumar and J. Singh; Duration : 01/95 - LT)

Development of sugarcane varieties and breeding stocks for sub-tropics

B2.3 Development of sugarcane breeding stocks for high sugar (Raman Kapur and S.K. Duttamajumdar; Duration: 11/93 – 03/14)

B2.9 Development of top borer tolerant genetic stocks of sugarcane (A.D. Pathak, R.K.Rai, M.R. Singh and Rajesh Kumar; Duration : 03/00 – 02/10)

B2.10 Development of sugarcane varieties for moisture deficit environment (Sanjeev Kumar, J. Singh and D.K. Pandey; Duration : 03/02 – 02/12)

B2.13 Development of sugarcane varieties for sub-tropics (J. Singh, D.K. Pandey and Sanjeev Kumar; Duration : 10/2003 – LT)

B2.14 Development of breeding stocks of sugarcane for durable resistance to red rot (D.K. Pandey, Sunita Lal, J. Singh and Sanjeev Kumar; Duration: 10/04 – 10/10)

B1.1 Evaluation of early maturing sugarcane clones of North West Zone (J. Singh and D. K. Pandey; Duration: 2/09 – LT)

B 1.2 Evaluation of mid-late sugarcane clones for North West Zone (Sanjeev Kumar and P.K. Singh; Duration : 2/09 – LT)

B 1.3 Inter zonal varietal trials under AICRP(S) (A.D. Pathak; Duration : 2008 – LT)

BIM Evaluation of sugarcane clones for North Central Zone at Regional Centre, Motipur (Devender Kumar).

B 2 Fluff Supply Programme (Raman Kapur, J. Singh and M. Swapna; Duration : LT)

Cytogenetic and biotechnological techniques for sugarcane improvement

B3.7 Genetic improvement of sugarcane through tissue culture (Raman Kapur and R.K. Singh; Duration: 08/92 – LT)

B3.15 Genetic transformation in sugarcane for resistance against borers (R.K. Singh, Raman Kapur, Sangeeta Srivastava, and M.R. Singh; Duration 10/06 – 09/11)

B3.16 Optimizing standards for sugarcane seed production through micro propagation (R.K. Singh, Vijai Singh,

J. Singh and A.K. Singh; Duration : 10/06–09/10)

B3.17 Elucidation of species chromosomal complement in sugarcane genotypes under subtropical conditions (Sangeeta Srivastava and Raman Kapur; Duration : 6/10 - 5/15)

B3.18 Identification and expression analysis of resistance gene analogues against red rot disease in sugarcane (Sangeeta Srivastava, Ramji Lal, R. K. Singh and M. Swapna; Duration : 1/10–12/14)

B 3.19 Mapping of loci linked to sugar content in sugarcane (M. Swapna, Sangeeta Srivastava and D.K. Pandey Duration : 12/09 – 3/15)

DBT-1/09 Development of SSR markers for red rot resistance from EST database of sugarcane (R.K. Singh, Sangeeta Srivastava, S.K. Dattamajumder, M. Swapna and Raman Kapur; Duration: 01/09-01/12)

DUS Testing Equipping and strengthening of designated DUS test centres under central sector scheme for implementation of PVP legislation

Epidemiology and integrated disease management

Epidemiology of diseases of sugarcane

EM 01 Survey and surveillance of insect-pests and diseases of sugarcane in sub-tropical area (HoD and members of the Div. of Crop Protection; Duration : 2006 - LT).

M 2.15 Development of red rot in standing cane through sett-borne infection (S.C. Misra and S.K. Duttamajumder; Duration : 2/09-3/12)

Identification of causal organism(s), pathotypes/strains of sugarcane pathogens for development of resistance

M 2.14 Pathotype formation in *Colletotrichum falcatum* in relation to breakdown of resistance in cane genotype (S.K. Duttamajumder, S.C. Misra and Sangeeta Srivastava; Duration : 2009-2014)

PP 14 Identification of pathotypes in red rot pathogen (HoD Crop Protection and Ramji Lal; Duration 2002-Long term)

Sugarcane disease management

M 15.3 Management of red rot of sugarcane through bio-agents (V. Singh, and Ramji Lal; Duration : 2004-12/10).

M 15.4 Management of red rot through modulating host resistance (Ramji Lal, V. Singh, Sangeeta Srivastava, S.K. Shukla, Radha Jain and Sanjeev Kumar; Duration : 08/09 - 07/13)

M 15.5 Management of red rot through fungal endophyte in sugarcane (Sunita Lal and R.K. Singh; Duration: 2/09 - 1/14).

M 15.6 Improving efficacy of *Trichoderma* for management of red rot of sugarcane

OP 1/09 Diagnostic and management of leaf spot diseases of field and horticultural crops: Red rot in sugarcane (CCPI Smt Suneeta Lal).

Evaluation of germplasm/genotypes for major diseases of sugarcane

M 17 Evaluation / screening of sugarcane germplasm /genotypes against red rot and smut (HoD Crop Protection and Ramji Lal; Duration : 2002- Long term).

PP 17 Evaluation of varieties/genotypes for resistance to red rot, smut and wilt (HoD Crop Protection and Ramji Lal; Duration : 2002-Long term).

Bio-ecology and integrated management of insect-pests

Bio-ecology of insect pests of sugarcane

EM 01a Biological control activities at Pravaranagar (M.S.). (R.B. Jadhav).

E 32 Population dynamics of sugarcane borers (early shoot borer, top borer,

internode borer and stalk borer) through pheromone traps (G.M. Tripathi; Duration : 2008-11)

E 30 Monitoring of insect-pests and bio-agents in sugarcane agro-ecosystem (M.R. Singh and A. Baitha; Duration 2006-long term).

E 11.1 Development of techniques for laboratory mass multiplication of top borer and its parasitoids (M. R. Singh; Duration : 2/06 - 3/12).

E 27 Mass multiplication of potential bio-agents of sugarcane insect-pests (A. Baitha; Duration : 2003-Long term).

E 4.1 Evaluation of varieties / genotypes for their reaction against major insect-pests (G.M.Tripathi; Duration : 2003-Long term).

Management of insect-pests of sugarcane through bio-agents, chemicals and IPM technology

E 4.2 (ii) Colonization of parasitoids for management of top borer *Scirphophaga excerptalis* Walker (Arun Baitha and G.M. Tripathi; Duration : 10/08 - 3/11).

E 4.2 (iii) Bio-management of termites in sugarcane (G.M. Tripathi, S.N. Sushil and M.R. Singh; Duration : 2/09 - 1/12).

E 4.2(iv) Bio-intensive management of white grubs in sugarcane (S.N. Sushil, G.M. Tripathi and Deeksha Joshi; Duration: 8/09 - 3/13).

E4.2.1(iv) Development of high temperature tolerant strain of *Trichogramma chilonis* and *Trichogramma japonicum* (Arun Baitha; Duration : 10/05-9/10).

Development of appropriate farm machinery for mechanization of sugarcane cultivation

Design and development of equipments

AE 1.9 E Development of sugarcane harvester (A.K. Singh, M.P. Sharma and Jaswant Singh; Duration : 8/06 – 4/10)

AE 1.22D Development of a wide spaced paired row sugarcane cutter planter (A.K. Singh, A.C. Srivastava and Jaswant Singh; Duration : 12/08 – 11/11)

AE 4.5 Evaluation and refinement of sett cutting mechanism of sugarcane planter (R.K. Pangasa and P. R. Singh; Duration : 3/08 - 4/12)

AE 8.1 Design and development of residue mulchur-cum-bio applicator (P.R. Singh and A.C. Srivastava; Duration: 9/07 - 8/10)

Prototype feasibility trials of equipments

FIM/IISR/PFT/2009/1: Prototype feasibility trial of IISR tractor operated sugarcane harvester (A.K. Singh, M.P. Sharma and Jaswant Singh)

FIM/IISR/PFT/2009/2: Prototype feasibility trial of IISR power operated sugarcane detrasher (A.K. Singh, M.P. Sharma and Jaswant Singh)

FIM/IISR/PFT/2009/4: Prototype feasibility trial of zero till drill (R.Gupta, P.R. Singh and R.K. Pangasa)

Development of suitable post-harvest technology

Post-harvest losses in sugarcane

PB19 Management of post-harvest deterioration of sucrose in sugarcane (S. Soloman, Raman Banerji and Pushpa Singh; Duration : 03/04 - 3/11).

Sugarcane processing for manufacturing of jaggery and developing storage techniques

LKO/PHT/07/05: Refinement of 3-roller horizontal power driven crusher developed at IISR (S.I. Anwar and Jaswant Singh)

LKO/PHTS/07/2: Design and development of a small capacity cane crushing unit for household purpose (Jaswant Singh and Dilip Kumar)

LKO/PHT/07/07: Development of a solar drier for jaggery drying (Jaswant Singh, R.D. Singh and Dilip Kumar)

LKO/PHT/08/01: Evaluation of shrink-wrap and modified atmosphere packaging for stored jaggery cubes and blocks (R.D. Singh, Jaswant Singh and S.I. Anwar; Duration : 1/09 - 12/12)

Diversification of sugarcane based by-products

PB 21 Identification of inhibitors in sugarcane biomass hydrolyzates and their effect on ethanol yields (Pushpa Singh and A.K. Shrivastava; Duration 04/08-03/11).

Sugarbeet improvement, its seed production and crop management

B2.15 Developing sugarbeet varieties for Indian agro climates (A.D. Pathak Raman Kapur, S. K. Duttamajumder and Arun Baitha; Duration : 09/08 – Long term).

CR-1/08 Evaluation of sugarbeet hybrids (A.D. Pathak, R.L. Yadav, D.V. Yadav, Raman Kapur, S. Solomon, S.K. Duttamajumder and R.K. Tiwari; Duration : 10/08 - 09/10)

Technology adoption, constraints analysis, socio-economics, statistical modeling, database and computer applications

Technology adoption and analysis of constraints

MWR-1/08 Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane (T.K. Srivastava, R.P. Verma, A.K. Sah, Kamta Prasad, Rajendra Gupta and K.P. Singh; Duration : 1/08 - 3/11)

Socio-economics and policy analysis

AES 4.11 Developing a database and analysing contribution of sugarcane in Indian economy (A.K. Sharma, R.L. Yadav, D.V. Yadav and Hema Pandey; Duration 1/08-3/11)

AES 4.12 Developing efficient sugarcane marketing strategies in India (A.K. Sharma, R.L. Yadav, D.V. Yadav and M.R. Verma; Duration : 1/10 to 3/12).

Development of statistical model/ procedure

ICAR Net work Climate change on assessment of impact of climate change on productivity and quality of sugarcane in sub-tropical India and opportunities of agronomic adaptation (Arun K. Srivastava, Ashok K. Shrivastava and S.N. Singh; Duration: 2007-12)

AM 3 Compilation, analysis and documentation of long-term weather database in relation to sugarcane crop culture (Arun K. Srivastava, P.K. Bajpai and S.S. Hasan; Duration : 3/00-LT)

AES 4.8 Data warehouse on sugarcane production system (S.S. Hasan, P.K. Bajpai and Rajesh Kumar; Duration: 1/06 - 3/11)

AES 4.10 Development of decision support tools in sugarcane cultivation (S.S. Hasan, Rajesh Kumar, S.K. Shukla, A.K. Sah and Arun Baitha, Duration: 1/08 - 12/10)

Transfer of Technology

FIM/IISR/FLD/09/01 Front line demonstration (FLD) of IISR tractor operated ratoon management device (RMD) (A.C Srivastava and P.R. Singh)

FIM/IISR/FLD/09/04 Prototype feasibility trial of zero till drill (P.R. Singh and A.K. Singh)

FIM/IISR/FLD/09/02 Frontline demonstiration (FLD) of IISR raised bed seeder (RBS) cum sugarcane planter (A.K. Singh, M.P. Sharma and Jaswant Singh)

FIM/IISR/FLD/09/03 Frontline demonstration (FLD) of IISR modified 3-row cane planter (P.R. Singh and A.C. Srivastava)

Consultancy, contract research and patents

A. Consultancy

Crop advisory services for the state of UP on sugarcane crop (R.L. Yadav, D.V. Yadav, S.N. Singh, Vijai Singh, Maharam Singh, A.K. Singh and Mahendra Singh, 07/09 - 07/10)

An MoU was signed with Reuters India Pvt. Ltd. on 21.07.2009 to extend advisory services on sugarcane crop for the state of UP. The Reuter India Pvt. Ltd. deposited ₹ 1.00 Lakh in advance to the Institute as consultancy, charges. Since then, the Institute regularly sent the advisory services to the Reuters up to July 2010.

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.

Consultancy services were provided to Harinagar Sugar Mills Ltd., West Champaran Bihar for providing consultancy regarding cane quality checking and juice analysis.

B. Contract research projects

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

Code	Title	Period	Concerned Scientists	Amount (₹ in Lacs)	Firm/company
CR-1/08	Evaluation of sugarbeet hybrids	10/08-09/10	A.D. Pathak, R.L. Yadav, D.V. Yadav, Raman Kapur, S.Solomon, S.K. Duttamajumder and R. K. Tiwari	5.00	J K Agri Genetics Ltd., Hyderabad
CR-1/10	Evaluation of Sulfentrazone 4%F for control of weeds in sugarcane	03/10-02/12	R.S. Chauhan, D.V. Yadav and R. L. Yadav	5.00	FMC India Private Limited
CR-2/10	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, G.M. Tripathi, S.K. Duttamajumder, D.V. Yadav, and R.L. Yadav	5.00	Bayer Crop Science
CR-3/10	Enhancing water and nutrient use efficiency through drip irrigation and fertigation in spring planted sugarcane under subtropical conditions	10/11 - 9/13	Rajendra Gupta, R.L. Yadav and S.N. Singh	5.00	Jain Irrigation Ltd., Jalgaon
CR-1/11	Economising nutritional need and reducing incidence of pests and diseases through fungbact kit in sugarcane cultivation	03/11 - 4/13	S.N. Singh, R.L. Yadav, T.K. Shrivastava and M.R. Singh	6.00	Pramukh Agri-clinic, Surat

C. Externally funded research projects

The Institute conducted the following externally funded research projects during 2010-11.

MWR-1/08	Farmers' Participatory Action Research Project (FPARP) on water use efficient technologies for improving productivity and sustainability of sugarcane (T.K. Srivastava, Kamta Prasad, A.K. Sah, Rajendra Gupta and K.P. Singh; Duration January, 2008 to March, 2011) Total cost ₹ 50 lakhs.
DBT-1/09	Development of SSR markers for red rot resistance from EST database of sugarcane : (R.K. Singh, Sangeeta Srivastava, S.K. Dattamajumder, M. Swapna and Raman Kapur; Duration : 15.01.09 to 14.01.12). Total cost ₹ 38.22 lakhs.

18 Monitoring and evaluation

18.1 Quinquennial Review Team

Quinquennial Review Team (QRT) was constituted by the Council vide its letter no.F.4-3/2009-LA.III dated October 27, 2009 to review the work done by the Indian Institute of Sugarcane Research, Lucknow and All India Coordinated Research Project on Sugarcane during the year 2005 to 2009. The constitution of QRT was as follows :

Name & Address	Designation
Dr. N.N.Singh, VC, Birsa Agricultural University, Kanke, Ranchi	Chairman
Dr. O.P. Dubey, Ex- Assistant Director General (Plant Protection), ICAR, New Delhi	Member
Dr. G.C. Srivastava, Ex- Head, Division of Plant Physiology, IARI, New Delhi	Member
Prof. Narayan Rishi, Director, School of Sciences, Jaipur National University, Jaipur	Member
Dr. M.N. Premchandran, Head, Division of Crop Improvement, SBI, Coimbatore	Member
Prof. P. Kumar, Former Professor (Agricultural Economics), IARI, New Delhi	Member
Dr. A.K. Shrivastava, Principal Scientist (Plant Physiology), IISR, Lucknow	Member Secretary

The first meeting of the QRT was held at the Institute on June 11, 2010. In the meeting, salient achievements for the period 2005-09 were presented by Heads of Divisions and I/C Sections. The Chairman and Members of QRT gave their valuable inputs. The second meeting of review team was held at Sugarcane Research Institute, Pusa, Bihar on July 23, 2010. The research work undertaken by the centres of AICRP on Sugarcane *viz.*, Sugarcane Research Institute, Pusa, Bihar; Sugarcane Research Centre, Buralixon (Assam), Sugarcane Research Station (Department of Agriculture), Bethuadahari

(West Bengal) and G.S. Sugarcane Breeding and Research Station, Seorahi, Kushinagar (U.P.) was reviewed in this meeting. In its third meeting at Sugarcane Breeding Institute, Coimbatore on August 25-26, 2010, the QRT reviewed the work done at Sugarcane Breeding Institute, Coimbatore; SRS, Cuddalore; RARS, Anakapalle; SRS, Thiruvella; ZARS, Mandya; ARS, Sankeshwar; SRS, Nayagarh, and SRS, ANGR Agril. University, Vuyyuru. Fourth meeting of QRT was held at Punjab Agricultural University, Ludhiana on September 30 – October 01, 2010, to review the work done at centres of AICRP (Sugarcane) *viz.*, PAU, Ludhiana: PAU Regional Station, Faridkot; UPCSR, Shahjahanpur; GBPUA&T, Pantnagar; ARS, Srigaganagar: ARS, Kota; Regional Research Centre, Uchani; SBI Regional Centre, Karnal, and IISR, Lucknow. Fifth meeting of QRT was held at Navsari Agricultural University, Navsari on November 15-16, 2010 to review the work done at Regional Sugarcane Research Station, Navsari; Central Sugarcane Research Station, Padegaon; Regional Sugarcane and Jaggary Research Station, Kolhapur; Zonal Agricultural Research Station, Powarkhera; Vasant Dada Sugar Institute, Pune, and Sugarcane Research Station, Akola. The last meeting of QRT was held at IISR, Lucknow on December 14-16, 2010 with the scientists of IISR, Lucknow for finalization of the report.

The observations of QRT were presented by Dr. N.N. Singh, Chairman, QRT in the 31st meeting of the Institute Management Committee held at IISR,

Lucknow on February 26, 2011. Thereafter, the recommendations were presented at ICAR, New Delhi on March 16, 2011.

Recommendations

While taking in depth information by visiting labs and field experiments and delibrating with

Scientists as well as other staff members, the QRT made its observations as follows:

Observations

1. Factor productivity is going down, with a consequent impact on the cost of production. There is a need to improve factor productivity.
2. Holdings are becoming smaller and smaller with time and increasing population. Technology is needed for smaller and marginal holdings.
3. Plateau in yield (cane yield and sugar recovery) may be caused by a variety of factors such as ground water depletion, soil salinity, nutrient imbalance and unfavourable input-output prices. Necessary steps may be taken up to break the plateau in yield.
4. The sugarcane acreage may decline in times to come. Thus to meet the sweeteners needs of burgeoning population, besides improving yield and sucrose content, we should also look into the sugarcane cultivation on waste lands. Efforts may be given to reclamation of such lands and improving their biological potential so as to cultivate sugarcane.
5. Cultivation of denotified sugarcane varieties-need to be replaced with high yielding and high sugar varieties.
6. The technological gains already made have to be defended to face the challenges arising from climate change, marginalization of arable land, diminishing water resources, *etc*.
7. Prevailing invasive insect-pests and diseases and weeds are affecting productivity. Emerging new insect-pests and diseases will also augment this.
8. Cultivation has to be made more lucrative to overcome farmers tendency to quit cane cultivation. More emphasis has to be given on jaggery/ *gur* and value-added products.
9. In order to have stability in sugar production in the country and to meet the rising demand for ethanol, sugarbeet will have to be given greater importance in the Indian agricultural scenario. The Institute has been very active in research on sugarbeet and is maintaining a skeletal sugarbeet research activity confined to breeding for the last three decades.
10. To be able to better utilize the scientific expertise, equipment and infrastructure, it would be desirable to enter in to MoU's with reputed universities for a regular flow of postgraduate students for their research projects under the guidance of IISR scientists. In ICAR also, a mechanism similar to CSIR may be devised, whereby each Institute gets a share of junior and senior research fellows, who can register for M.Sc. or Ph.D.
11. There is a need to constantly enhance the working skills of scientists in the new laboratory techniques and research frontiers, particularly in molecular biology/ biotechnology. For this, training at national and international level for the human resource development must be facilitated on a regular basis.

Technical Recommendations

Crop Improvement

1. Genetic base broadening of sugarcane varieties is to be done by utilizing wild related species in crosses and pre-breeding material are to be developed for different agronomic traits.
2. Trait specific gene pools may be developed utilizing diverse sources for progressive improvement in quality, yield and resistance

to diseases in the breeding stocks. Recurrent selection may be done to improve sugar content, disease resistance and yield contributing traits.

3. Molecular marker studies are to be strengthened for identifying markers for important traits to assist in early stage for marker aided selection.

4. Tissue culture facility is to be augmented for periodic rejuvenation of varieties under cultivation for sustaining productivity levels. The supply of pure and disease free breeder seed in sufficient quantities are to be ensured.

5. The Institute is to take up research in some emerging areas, such as RNAi technology, novel methods *in vitro* regeneration for genetic transformation, gene identification, *etc*.

Plant Physiology & Biochemistry

1. Find out a plant type which can mature within short duration and with high sugar content. This requires screening of germplasm, both cultivated and wild types, for physiological efficiency.

2. In order to break the yield barrier in sugarcane, a better plant type with optimum morpho-physiological and biochemical characters should be looked in to.

3. There is need to work on induction of flowering for breeding purposes at locations other than Coimbatore also.

4. The post-harvest deterioration of cane is a major cause for reduced sugar recovery. The research on methods to prevent post-harvest deterioration is to be strengthened.

5. Studies should be conducted on extending the shelf life of juice.

Crop Production

1. Enhancing Nutrient Use Efficiency.

2. Enhancing Ratoon Cane Productivity.

3. Management of drought in sugarcane for enhancing yield and quality.

4. Enhancing input (nutrient and water) use efficiency in sugarcane –based intercropping systems through Furrow Irrigated Raised Bed method of planting.

5. Accelerating the adoption of sugarcane production technology.

6. For dissemination of technology and mitigation of the problems arising for sugar farmers, there is a need to strengthen the linkages with sugar factories, farmers and KVKs. Relevant training programme should also be chalked out for all the stakeholders. Adoption of profit proven, high yielding and profitable technologies will help in enhancing TFP growth in the long-run and increasing the sugar supply.

Crop Protection

(i) Plant Pathology

1. Developing molecular diagnostic tools: This will help in efficient and reliable detection and diagnosis of diseases which will be helpful in strengthening breeding and related programmes.

2. Emerging diseases like Yellow Leaf Disease also needs immediate attention and extensive studies should be initiated in this aspect.

(ii) Entomology

1. Studies should be done on biodiversity, geographical distribution and seasonal abundance of all the species of top borers for development of suitable management module against the insect pests.

2. Parasitizing efficiency of parasitoids should be enhanced against major insect pests of sugarcane through habitat management and also through kairomones.

3. Effective utilization of *Trichogramma* spp. against borer complex in sugarcane must be standardized.

4. Maintenance and promotion of potential bio-agents of pests of sugarcane, their multiplication on host diet as well as semi-synthetic diet should be standardized.

5. Deployment of pheromones' technology should be taken up for monitoring and mass trapping of insect pests of sugarcane. Isolation and characterization of pheromones from associated borer pests must be attempted.

6. Biodiversity of *Bacillus thuringiensis* associated with borer complex of sugarcane and their utilization for insect management must be attended.

7. Eco-friendly technologies for the management of white grubs in sugarcane agro-ecosystem should be developed. Side by side, a database of all the species of white grub associated with sugarcane from different ecologies may be studied and documented.

8. Work on bioprospecting entomopathogens against termites in sugarcane may be initiated.

Agricultural Engineering

1. Standardization of parts of implements/ machinery developed and their interchangeability with ease- their ISO certification must be obtained for the products released. Before this, the test certification for the performance of implement/ machinery should be done.

2. Selective mechanization for conditions like hard pan below the soil surface, waterlogged conditions, heavy soils, light sandy soils, saline soils, *etc.*, should be attempted.

3. Efforts for making a low cost harvester for green cane harvest should be intensified as harvesting sugarcane is a labour intensive process.

4. Machinery for small and marginal farmers should be developed.

Administrative

1. Manpower in the terms of SRF/JRF must be increased in various disciplines of the Institute. To ensure the continuity of SRF/JRF, they should be encouraged to register for Ph.D. in the Universities near by the Institute. To make it functional, the Institute must enter into MoU with the Universities.

2. At present, 34 scientists positions are vacant. These need to be filled over time in the next five years. It is recommended that at least 7 scientist positions at the initial stage to be recruited by ASRB in the following disciplines:

   (i) Soil Science
   (ii) Pathology
   (iii) Entomology
   (iv) Microbiology
   (v) Agrometeorlogy/ Environmental Science
   (vi) Biotechnology
   (vii) Molecular Plant Pathology

However there are some positions of scientists which are going to be vacated on account of retirement during 2010-11 and these positions must be filled in the following disciplines, on priority:

   (i) Soil Science-2
   (ii) Microbiology-1
   (iii) Agrometeorlogy/Environmental Science-1
   (iv) Plant Pathology-1
   (v) Biotechnology-1

3. Problem of nematodes is now negligible in sugarcane. To tackle the problem of sugarcane diseases, it is urgently required to concentrate on molecular aspects. It is, therefore, strongly recommended that the two positions in the discipline of Nematology should be converted to that of Molecular Plant Pathology in the Division of Crop Protection.

4. Regular staff is needed exclusively for sugarbeet research and one scientist (breeding) and two each of technical and supporting staff may be earmarked for it.

5. The manpower and resources in different divisions of the Institute may be pooled/ consolidated for developing transgenics with appropriate genes for high sugar content and biotic and abiotic stress factors.

6. Subject Matter Specialists (SMS) appointed in *Krishi Vigyan Kendra* (KVK) are placed from the Technical cadre and they may not cater to the needs of knowledge empowerment to farmers and conducting the field demonstrations. It is recommended that SMS should come from the scientific cadre.

The Governing body of the ICAR in its 220th meeting held on April 6, 2011 at New Delhi has accepted the recommendations made by QRT of IISR, Lucknow and AICRP(S) for the period 2005-2009.

18.2 Research Advisory Committee

The Research Advisory Committee (RAC) of the Indian Institute of Sugarcane Research, Lucknow was constituted by the Council vide its office order no. 4(10)/07-IA.III dated March 11, 2011 for a period of three years *w.e.f.* March 9, 2011.

S.No.	Name, Designation & Address	Position
1.	Dr. S. Nagarajan, Former Director, IARI & Former Chairperson, PPV&FR Authority	Chairman
2.	Dr. V.P. Singh, Directorate of Research, Rajendra Agriculture University, Pusa, Samastipur (Bihar)	Member
3.	Dr. Bushan L. Jalali, Ex. Director of Research, CCS Haryana Agricultural University, Hisar (Haryana)	Member
4.	Dr. J.P. Mishra, Ex. ADG (ESM), ICAR	Member
5.	Prof. R.P. Sharma, Former Director, NRC on Plant Biotechnology, New Delhi	Member
6.	Prof. Bachchan Singh, Ex. Dean, College of Technology, GBPUA&T, Pantnagar	Member
7.	Dr. N. Gopalakrishnan, ADG (CC), ICAR, New Delhi	Member
8.	Dr. R.L. Yadav, Director, IISR, Lucknow	Member
9.	Shri Kunwar Ajay Singh, Distt. Siddhart Nagar (UP) - IMC Member	Member
10.	Shri Dattatrey Bhavane, Pune - IMC Member	Member
11.	Dr. A.K. Sharma, Principal Scientist & I/c Research Coordination & Management, IISR, Lucknow	Member Secretary

18.3 Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) meeting of the Indian Institute of Sugarcane Research, Lucknow was held under the Chairmanship of Dr. R.L. Yadav, Director of the Institute during August 16-19, 2010 to review and discuss the on-going research projects. In this meeting, 53 scientists and 8 technical officers of the Institute participated and discussed the research findings of 54 Institute research projects going-on in the Institute. The Chairman in his opening remarks emphasized that the presentations be made brief and focused highlighting the workload of the scientist and the deliverables in the research projects. He also emphasized the need for the quality research projects in the Institute.

Dr. R.L Yadav, the Chairman, IRC and the Director of the Institute apprised the members that the information on the Institute technologies ready for commercialization or to be commercialized is being asked by CTMC/ZTMC/ITMUs in four areas *viz.*, 'seed and planting material', "diagnostic vaccines and biotechnological products', 'farm implements and machinery" and "post harvest technology and value addition' on specified formats for ICAR-Industry Meet. In this connection, the Chairman mentioned about an ICAR letter requiring information on varieties CoLk 8102, CoLk 8001 and CoLk 94184 for 'seed and planting

material session' during ICAR-Industry meet. The Chairman desired that such information in desired format be prepared by the Crop Improvement Division for sending it to the ICAR, New Delhi/ CTMC. He also exhorted the scientists to prepare projects for external funding.

The Chairman, while reviewing the 54 Institute research projects and 48 other research projects as given in the table below, made some specific observations that are applicable to all the Divisions/ sections. These are as follows:

Number of research projects/activities during 2009-10 discussed in the IRC Meeting

Division/ Section	Institute projects	Network/ Contract research	Externally funded projects	Total	AICRP trials	Exploratory Studies	Grand Total
Crop Improvement	15	1	3	19	3	-	**22**
Crop Production	9	-	-	9	7	2	**18**
Plant Physiology & Biochemistry	6	-	1	7	-	-	**7**
Crop Protection	12	2	-	14	11	-	**25**
Agril. Engineering	6	-	1	7	16	-	**23**
Economics/ Statistics/ Computers	5	-	-	5	-	-	**5**
Agril. Meteorology	1	-	1	2	-	-	**2**
Total	**54**	**3**	**6**	**63**	**37**	**2**	**102**

- There is a need for transparency and accountability in research. The methodology chosen for any research project must have justification and it must be capable of proving/ disapproving some selected hypotheses. Hence, prioritize the research work, set time-bound targeted goals & activities, and plan accordingly, as ICAR is also pressing hard to review all the on-going projects critically.
- While discussing the ICAR Vision 2030 document, it was emphasized that Vision document must be on a statement of efforts to reach at number one and not to be complacent anything less than that. The IRC felt that there should be a vision for each Division of the Institute, and the Chairman agreed to have a vision for each Division. The Chairman also emphasized that the Vision should be discussed/taken up to activity level in a time bound scale, stressed to take up new research project proposals on the lines of the vision of the Division /Section.
- All the scientists, particularly the Principal Scientists should submit papers for publication in high impact journals (with NAAS ranking more than 7.5). They should not give preference to the quantity but should concentrate on quality of the paper. The papers published in journals of impact factor of 7 and above be discussed in the Institute. A presentation may be made on such papers for the information of other scientists and also for further improving the quality of research work in the Institute.
- The scientific manpower is reducing year after year. Five scientists of the Institute will also retire before next IRC Meeting. Hence, the scientists should try to undertake externally funded projects or contract research projects with more than Rs. 5.00 lacs as project outlay. It will provide additional manpower to the Institute to undertake different types of research activities.
- Keeping in view, the declining scientific strength of the Institute which is going to be still shorter in future, the use of technical personnel may be made in survey and surveillance work in the Institute. Qualified and competent technical personnel be used for this purpose.
- While reporting/disseminating any research information to the farmers, researchers, industrialists and planners, the information,

if happens to be the same, need to be provided/ explained as per their specific requirement so that it could be easily grasped by the people of diverse interests/ the end-users.

- Observations /results from exploratory trials should be well verified before being sent to ICAR or for any other external communication.
- There is a need to develop a proper system for give and take of the germplasm/variety within the Institute. All indents for seed of the germplasm/ variety from other divisions should be routed through the Head, Crop Improvement Division.
- The use of paired-row-cutter-planter be made for sowing sugarcane at IISR farm. Ten ha area be planted by the paired-row-sugarcane-cutter-planter during this season.
- The Heads of the Divisions while making presentations should present the main issues and not the results of each and individual research projects.
- Prioritise, plan and be focused in taking up research projects.

Division-wise observations and recommendations of IRC

i) Crop Improvement

- Possibilities be explored to test the IISR entries (clones/varieties) in the Institute's level system with the help of sugar mills in view of limited entries being included in AICRP (S).
- An already identified nomenclature for the varieties/ clones should be used while giving clones for the state evaluation trials. CoLk series should be used in place of LG series to avoid any objection from any quarter.
- Efforts should be made to include more number of Institute (IISR) entries in the AICRP trials.
- Include sugarcane variety CoPT 97222 replacing CoS 767 as the check in experiments.
- The justification for taking pol% in cane during November and January (at two points) be discussed in Breeders' Meet.
- Possibilities of associating Dr. Amaresh Chandra, Principal Scientist and Head, Division of Plant Physiology and Biochemistry in the biotechnological work be explored.
- Target to surpass variety CoJ 64 in respect of sucrose content.

ii) Crop Production

- The Division must give priority to demonstrate the developed technologies on the farmers' fields. At least 50 demonstrations on farmers' fields should be conducted for demonstrating the potentialities of the use of *Trichoderma* in the form of TMC, RMD and raised bed seeder cum planter. A write up in this regard containing technical programmes, area/mill zone selected, persons associated and review aspects be prepared well in advance. RMDs will be provided by the Division of Agricultural Engineering. *Trichoderma* @ 20 kg/ha should also be used along with farmyard manure/press mud.
- Highly adaptive (Standard) variety be taken up for general agronomic trials, unless otherwise desired. The indent for the demand of the seed cane of any variety for agronomic evaluation in the Division be institutionalized for betterment and be routed through the Head, Division of Crop Improvement.
- Although 150 kg N/ha is recommended, but most of the varieties do not respond beyond 75 kg N/ha. Nutrient uptake of nitrogen application to be reviewed in the Division as to why there is less response beyond 75 kg N/ha. The reasons need to be explored. Dr. A.K. Singh, Sr. Scientist (Agronomy) in the Division may take up the experiment (C 6.5) on reviewing the nutrient use efficiency. The characters of varieties responsible for high nutrient-use efficiency should be identified.
- Under extension programmes, the reasons for non-adoption of technology may be viewed from the farmers' perspective, as unawareness about the technology is not the only cause on a number of occasions.

iii) Crop Protection

- IRC comments should be taken seriously and revised ATR be submitted. Compliance to the points made by the previous IRC be presented in next IRC meeting.

- Main highlights of the research work be presented by the HOD while presenting the progress of the Division, not the results of all the research projects.
- An effective mechanism of survey be developed and the personnel from the sugar Industry and Cane Development Departments be also involved in survey and surveillance work. The matter may also be discussed in the ensuing Bi-annual workshop of AICRP on Sugarcane to be held at Navsari Agricultural University, Navsari.
- Role of endophytes should be reviewed, and a paper be prepared and sent for publication in a reputed journal.
- A brouchure of success story of Biological Control Centre, Pravaranagar (Maharashtra) be published at the earliest.

iv) Plant Physiology and Biochemistry

The Chairman desired to know from IRC that 'What should be done in sugarcane research now for bringing a breakthrough in yield and sugar content"? He emphasized that though sugarcane is known as highly efficient C_4 plant but it takes 45 days for germination causing underutilization of land and light resources. Hence, he suggested that one thing to do is to increase the physiological efficiency of sugarcane for having increased levels of yield and sucrose content to ensure efficient use of resources used. Hence, he emphasized to direct the research work towards reducing the germination period of sugarcane from 45 days to 15-20 days.

v) Agril. Engineering

- Action be ensured to sort out patent issues related to the development of sugarcane harvester through discussion with the scientists of the division in Divisional Meeting. The matter may be taken up on urgent basis as considerable time has already been lost.
- There is a problem of giving equipment free of cost for FLD by research organizations, as it is costly and it needs to be taken back for accounting and auditing purpose. A system in this regard needs to be thought of and developed.
- Three sets of RMD without stubble shavers and three sets of raised bed seeder cum planter be provided to the Head, Division of Crop Production for carrying out demonstrations. Also one set of each be provided to IISR Regional Centre, Motipur. These should be made available by December 2010.
- There is an urgent need to study the feed back of different machines developed by the Division. Also, there is an urgent need to take a systematic study on sugarcane + potato interculturing machine.
- Prioritise and accordingly plan the research work in the Division. It is better for the scientists of Division of Agricultural Engineering, if they emphasize on sugarcane harvestor rather than other machines.
- Planting by the paired row sugarcane cutter planter be facilitated in 10 ha area of the Institute farm.
- The tractor drivers of the Institute farm be trained for operating RMD/cutter planter with greater accuracy.

vi) Agrometeorology

- Impact of climate change on sugarcane productivity be thoroughly studied.

vii) Ag. Economics and Statistics

- Plan and prioritise the research work, and take up research projects accordingly.
- A system for developing database on sugarcane be developed so that a minimum dataset is available on continuing basis.

viii) Regional Centre, Motipur

- Scientists should be careful in writing name of the varieties. A leaflet on efforts made by IISR Regional Centre, Motipur for spreading seed cane be published at the earliest.

18.4 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 January 6, 2011 to decide on all issues of IP Management and technology transfer/ commercialization.

1. Dr. R.L. Yadav, Director- Chairman
2. Dr. Jaswant Singh, HOD (Ag. Eng.)- Member
3. Dr. Raman Kapur, HOD (Crop Improvement) – Member
4. Dr. Amaresh Chandra, HOD (Pl. Physiology & Biochemistry) – Member
5. Dr. S.K. Duttamajumder, HOD (Crop Protection)-Member
6. Dr. T. K. Srivastava, HOD (Crop Prduction)-Member
7. Dr. (Mrs.) Shashi Rana, Scientific Officer & I/c IPR, CST, Lucknow
8. Dr. N.S. Nagpure, Pr. Scientist, NBFGR, Lucknow
9. Dr. A.K. Sharma, Pr. Scientist & I/c, RCM-Member Secretary

The ITMC met from time to time to discuss the issues pertaining to commercialization of technologies. The ITMU was made more efficient and the post of RA was filled up.

18.5 Institutional Bio-safety Committee

Institutional Bio-safety Committee (IBC) was constituted as per the guidelines of ICAR.

1. Dr. R.L. Yadav - Chairman
2. Dr. Raman Kapur
3. Dr. A.K. Shrivastava
4. Dr. Pravendra Nath (NBRI)
5. Dr. Mukul Das (IITR)
6. Dr. Sangeeta Srivastava – Member Secretary

The IBC met from time to time to discuss the various issues involved in the ongoing projects related to biotechnology at the Institute and the need of bio-safety measures in these projects.

18.6 Institute Management Committee Meeting

The Institute Management Committee (IMC) was constituted by the Council vide its letter no. 4-2/93-IA.III dated Aug. 16, 2010 for a period of 3 years. The constitution of the IMC is given below:

Representation	Name	Designation
Director of the Institute	Dr. R.L. Yadav	*ex-officio* Chairman
Representative of U.P. Govt.	Cane Commissioner, U.P. Government	Member
Representative of other State Govt.	Cane Commissioner, Government of Bihar	Member
SAU representative	Director (Research), SVBPUA&T, Meerut	Member
Non-official members	Sri. Kunwar Ajay Singh	Member
	Sri. Dattatray Bhavane	Member
ICAR representative	Asstt. Director General (CC), ICAR	Member
Financial Advisor/Accounts Officer nominated by President	Sr. FAO, IGFRI, Jhansi	Member
Eminent Scientists	Dr. O.K. Sinha, PC, AICRP (S)	Member
	Dr. S.K. Duttamajumder Head, Crop Protection, IISR	Member
	Dr. (Mrs.) Sangeeta Srivastava Principal Scientist, IISR	Member
	Dr. R.K. Khetrapal, Head, Division of Plant Quarantine, NBPGR, New Delhi	Member
Sr. Administrative Officer of the Institute	Sri Ratnesh Kumar	*Ex-officio* Member-Secretary

The 31st meeting of the Institute Management Committee IMC) was held on February 26, 2011 under the chairmanship of Dr. R.L. Yadav, Director of the Institute at IISR, Lucknow. Additional Cane Commissioner, Govt. of U.P, Lucknow; Shri Kunwar Ajay Singh, Village & Post Seorahi, District Siddhart Nagar (U.P.); Dr. O.K. Sinha, Project Coordinator (Sugarcane); Dr. S.K. Duttamajumdar, HOD, Crop Protection, IISR; Dr (Smt.) Sangeeta Srivastava, Principal Scientist (Crop Improvement); Shri Ratnesh Kumar, Senior Administrative Officer were other members of IMC who were present in the meeting. Dr. N.N. Singh, Chairman, QRT and V.C., Birsa Agricultural University, Ranchi; Dr. A.K. Shrivastava, Principal Secretary (Plant Physiology) & Member Secretary, QRT; Dr. Raman Kapur, HOD, Crop Improvement; Dr. Amaresh Chandra, HOD, Plant Physiology & Biochemistry; Dr. Jaswant Singh, HOD, Agrcultural Engineering; Dr. T.K. Srivastava, HOD, Crop Production; Dr. A.K. Sharma, I/c R.C.M.; Dr. R.K. Singh, Programme Coordinator & I/c KVK; Shri Shatruhan Kumar, AAO & I/c F. & A.O also participated in the meeting as special invitees.

The regular agenda of the meeting pertained to annual budget and other administrative activities. Dr. N.N. Singh, the Chairman, QRT and the Vice Chancellor, Birsa Agricultural University, Ranchi presented the QRT Report and its recommendations through a PowerPoint presentation. The Management Committee noted the challenges for the production of sugarcane. Dr. Jaswant Singh, HOD, Agril. Engineering made a presentation on the Mechanization of Sugarcane Cultivation-Status, Constraints & Prospects. Salient Research Findings/ Activities of the Institute were highlighted by Dr. A.K. Sharma, Principal Scientist & I/c R.C.M. All the HODs of the Institute apprised the IMC of the research activities of their divisions. Committee appreciated the progress made by the Institute and highlighted that there is a need for the state government to help in the dissemination of sugarcane production technology to the farmers in a more vigorous way.

The status of purchase of equipments and works undertaken under Plan during 2010-11, the Annual Budget of IISR, Lucknow & its progress upto 31st January, 2011 was presented before the Management Committee. The Committee showed its satisfaction. The Member Secretary also assured the committee that the budget released under Plan and Non Plan scheme would be utilized in full by 31st March, 2011.

18.7 Institute Joint Staff Council (IJSC)

The IJSC with the following composition met on September 3, 2010 and discussed matters pertaining to staff welfare.

Dr. R.L. Yadav, Director, IISR - Chairman

Members Elected

Sh. Someshwar Mishra, T-5

Sh. Niranjan Lal, T-5

Sh. Anand Mohan Srivastava, Asstt.

Sh. Raj Kumar Yadav, Asstt.

Sh. Shiv Kumar Soni, SS Grade-II

Sh. Rajender Kumar, SS Grade-I, Member Secretary

Members Nominated

Dr. S.N.Sushil, Sr. Scientist (Entomology)

Sh. Ratnesh Kumar, Sr. A.O.

Sh. S. Kumar, AF&AO

Sh. P.K. Srivastava, Asstt.

Sh. Inder Singh, SS Grade-I

Dr. G.K. Singh, T 7-8, Member Secretary

18.8 Monitoring of Seed Production Activities

Review meeting under the Chairmanship of the Director was held to monitor seed cane production activities in the Institute farm. It was decided that the Cane Commissioner, Uttar Pradesh be informed about the availability of seed cane on the Institute farm for its further dissemination to farmers through sugar factories. The regular review of seed production activities at the Institute Regional Centre at Motipur (Bihar) was also emphasized. It was emphasized that the area allocated for seed cane production is less, and this aspect may be considered seriously. The information pertaining to the availability of seed cane was also hoisted in the Institute website.

18.9 Review of Other Functions

For smooth conduct and functioning of the Institute and to provide advice to the Director on diverse matters, the following committees for the financial year 2010-11 were constituted/ reconstituted on April 29, 2010. The meetings of these committees were held as per need of the task.

Policy, Planning & Expenditure
1. Dr. A.K. Shrivastava – Chairman
2. Dr. Sangeeta Srivastava
3. Dr. R.K. Singh, KVK
4. Incharge, RCM
5. AFAO
6. SAO – Member Secretary

Purchase Advisory Committee
1. Dr. S.K. Duttamajumder – Chairman
2. Dr. A.K. Singh (Engg)
3. Dr. D.K. Pandey
4. Dr. Pushpa Singh
5. AF&AO
6. SAO – Member Secretary

Farm Advisory Committee
1. Dr. T.K. Srivastava – Chairman
2. Dr. R.S. Chauhan
3. Dr. S.C. Mishra
4. Dr. J. Singh
5. Er. Rajendra Gupta
6. AFAO
7. SAO
8. Farm Manager – Member Secretary

Human Resource Development
1. Dr. O.K. Sinha – Chairman
2. Dr. S. Solomon
3. Dr. R.K. Rai
4. I/c RCM
5. AFAO
6. SAO

IISR Publication & Library Committee
1. Dr. A.K. Srivastava – Chairman
2. Dr. S.K. Duttamajumder
3. Dr. Ashwani K. Sharma
4. SAO
5. FAO
6. I/c, RCM – Member Secretary

Works Committee
1. Dr. Jaswant Singh– Chairman
2. Dr. Ram Ji Lal
3. Dr. S.N. Sushil
4. AFAO
5. SAO
6. Mr. K.N. Singh
7. Mr. M.H. Ansari – Member Secretary

Security & Vigilance Committee
1. Dr. S.K. Shukla – Chairman
2. Dr. M.R. Singh
3. Mr. S. Bhatnagar (I/c Security)
4. Farm Manager
5. AFAO
6. SAO – Member Secretary

Transfer of Technology
1. Dr. R.S. Verma – Chairman
2. Dr. S.N. Singh
3. All HODs
4. I/c RCM – Member Secretary

Staff Welfare Committee
1. Dr. A.K. Singh (Agro.) – Chairman
2. Dr. M.R. Singh
3. Dr. S.K. Sethi
4. Dr. Deeksha Joshi
5. Dr. G.K. Singh
6. Mr. M.H. Ansari
7. Secretary, IJSC
8. SAO – Member Secretary

Grievance Cell
1. Dr. Amresh Chandra – Chairman
2. Dr. Todi Singh
3. Mr. S.S. Hassan
4. AFAO
5. SAO – Member Secretary

Women Cell 1. Dr. Sunita Lal – Chairman 2. Dr. M. Swapna 3. Mrs. Anita Sawnani 4. Mrs. S.L. Barjo 5. SAO – Member Secretary	**Residence Allotment Committee** 1. Dr. Raman Kapur – Chairman 2. Dr. Ram Ji Lal 3. Dr. R.K. Singh (Biotech.) 4. Dr. K.P. Singh 5. I/c Maintenance 6. SAO – Member Secretary
Event Coordination Committee 1. Dr. A.C. Srivastava – Chairman 2. Dr. S. Soloman 3. Dr. S.N. Sushil 4. Dr. S.K. Shukla 5. SAO – Member Secretary	**Sports Committee** 1. Dr. P.R. Singh – Chairman 2. Dr. Sanjeev Kumar 3. Dr. Radha Jain 4. SAO 5. Secretary, IJSC 6. Secretary, Recreation Club – Member Secretary

18.10 Result Framework Document (RFD)

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.

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Human resource development

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.

The Director, IISR participated in number of high level meetings at ICAR, New Delhi as well as other offices of National importance. After each such meetings attended by the Director, meetings of all the scientists were convened to make them abreast of latest developments and also of ICAR concerns. The details of the meetings are as follows:

1. FAI-IZA Symposium"Zinc, Crops and Human Health" on April 26, 2010 held at New Delhi.
2. The 4th Council Meeting of the STAI on April 27, 2010 held at New Delhi.
3. QRT meeting from May 7-8, 2010 at New Delhi.
4. Annual Day Celebrations of NAAS, New Delhi from June 04-05, 2010 held at New Delhi.
5. Launching Workshop of a NAIP Project, ARS Net online examination and to discuss Sugarcane-wheat cropping system from June 30 - July 07, 2010 held at IRRI & CIMMYT Office, New Delhi.
6. Delivered a lecture at National Sugar Institute, Kanpur on August 5, 2010.
7. Workshop on "Approved uses of pesticide in agriculture" from August 29-30, 2010 at New Delhi.
8. Screening Committee Meeting to consider cane development proposals for SDF loan on Sept. 23, 2010 held at New Delhi.
9. Assessment Committee Meeting on Sept. 29, 2010 at ASRB, New Delhi.
10. National Symposium on "Potassium for improving soil health and crop productivity" on Sept. 30, 2010 held at Amity University, Noida.
11. ICAR Regional Committee Meeting (Zone - IV) on October 07-08, 2010 at Ranchi.
12. KVK Review Meeting of North Zone on October 09, 2010 at Ranchi.
13. Selection Committee Meeting on Oct. 27, 2010 at ASRB, New Delhi.
14. Brain Storming Session on "Carrying Capacity of Indian Agriculture" on Oct. 28, 2010 at New Delhi.
15. ARS Exam. Online Review Meeting with D.G., ICAR, New Delhi on Nov.16, 2010 held at New Delhi.
16. Interactive Meeting on Issues of Data Sharing and Strengthening from Nov. 23 -24, 2010 at New Delhi.
17. Executive Council Meeting of the STAI on Jan. 05, 2011 at New Delhi.
18. SDF Screening Committee Meeting and discussion with DDG (CS) on Jan. 12, 2011 at New Delhi.
19. X Agricultural Science Congress on February 10-12, 2011 held at Lucknow.
20. ICAR Director's Conference from February 23-24, 2011 at New Delhi.

Conference/Seminar/Workshop/Training Attended

A) Mass group participation of the scientists

Name of Scientists	Topic/Subject	Place	Date
Fourty one scientists and technical officers. (Drs. Raman Kapur, J. Singh, A.D. Pathak, D.K. Pandey, Sangeeta Srivastava, R.K. Singh, Sanjeev Kumar, M. Swapna, Sonia Yadav, T.K. Srivastava, R.S. Chauhan, S.K. Shukla, K.P. Singh, Todi Singh, S.N. Singh, A.K. Singh, Ishwar Singh, A.K. Sah, Amaresh Chandra, A.K. Shrivastava, R.K.Rai, Radha Jain, Raman Banerji, Pushpa Singh, Priyanka Singh, S.K. Duttamajumder, Ram Ji Lal, Sunita Lal, G.M. Tripathi, S.N. Sushil, M.R. Singh, Sunita Lal, G.M. Tripathi, S.N. Sushil, M.R. Singh, Jaswant Singh, A.C. Srivastava, P.K. Bajpai, Rajesh Kumar, S.S. Hasan, Arun K. Srivatava, Ashwani K. Sharma, Brahm Prakash, G.K. Singh, R.K. Singh, Om Prakash and Rakesh K. Singh)	X Agricultural Science Congress on "Soil, Plant and Animal Health for Enhanced and Sustainable Productivity"	National Bureau of Fish Genetic Resources, Lucknow	February 10-12, 2011
Drs. R.S. Chauhan, S.K. Shukla, K.P. Singh, A.K. Singh, S.N. Singh and Ishwar Singh	XIX National Symposium on "Resource Management Approaches towards Livelihood Security" organized by the Indian Society of Agronomy	University of Agricultural Sciences, Bengaluru	December 2-4, 2010
Drs. R.S. Chauhan, S.N. Singh, J. Singh, A.D. Pathak and Sanjeev Kumar, Ramji Lal, G.M.Tripathi and M.R.Singh	28th Biennial Workshop of All India Coordinated Research Project on Sugarcane	Navsari Agricultural University, Navsari	October 27-29, 2010
Drs. R. Kapur, J. Singh, D.K. Pandey, A.D. Pathak and Sanjeev Kumar	Zonal Breeder's Meet	IISR, Lucknow	February 26, 2011
Drs. J. Singh, D.K. Pandey, R.K. Singh and Sanjeev Kumar	National Conference on "Biodiversity Development and Poverty Alleviation"	Lucknow	May 22, 2010

B) Individual participation of the scientists in Seminars/ Conferences

Name of Scientists	Topic/Subject	Place	Date
Crop Production			
Dr. S.K. Shukla	National Seminar on the occasion of International Biodiversity Day	RML Law University, Lucknow.	May 22, 2010
	Seminar on *Krishi Vikas Mela and Agro Industrial Alternatives* organized by *Gramin Krishi Vikas Seva Samiti*, Lucknow.	Lucknow	Oct. 13, 2010
	Seminar on Management and Development Programme on Agricultural Research	IIM, Lucknow	Jan. 13, 2011
Crop Improvement			
Dr. Raman Kapur	Consultation of Biotechnology Research in India	NASC Complex, New Delhi	July 26 - 27, 2011
	MDP training	Indian Institute of Management, Lucknow	Oct. 25-29, 2011
Dr. S. Srivastava	Consultation of Biotechnology Research in India" organized by ICAR	NASC Complex, New Delhi	July 26 - 27, 2011
Dr.A.D.Pathak	Seminar on sugarbeet and fodder beet introduction in India	University of Agricultural Sciences, Dharwad (Karnataka)	July 15, 2010
	Training on Statistical Analysis Systems (S.A.S.)	IASRI, New Delhi	October 25-30, 2010
	Institute Bio- safety Committee of UP Council of Sugarcane Research, Shahjahanpur	UP Council of Sugarcane Research, Shahjahanpur	February 2, 2011
	"Data Analysis Using SAS" under NAIP Consortium Strengthening Statistical Computing for NARS	Indian Agricultural Statistics Research Institute, New Delhi	January 10-15, 2011
Dr Sanjeev Kumar	Annual Review Meeting of 'Mega Seed Project'	NASC, New Delhi	July 19-20, 2010
Dr J. Singh	Workshop to Review the Conduct of DUS Tests	NAARM, Hyderabad	August 11-12, 2010
	Review Meeting of DUS	NASC, New Delhi	February 25, 2011
Dr. D.K. Pandey	*Khalihan Mein Vigyan Sangoshthi*	Basti, U.P	February 21, 2011
Dr. M. Swapna	NAIP sponsored training on Data Analysis using SAS under NAIP Consortium Strengthening Statistical Computing for NARS	IASRI, New Delhi	January 31- February 5, 2011
Crop Protection			
Dr Arun Baitha	XIX Bio-Control Worker's Group Meeting on "Biological Control of Crop Pests and Weeds	Sher-e-Kashmir, University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar	May 28-29, 2010
Dr. S. K. Duttamajumder	Workshop on "Approved uses of pesticides in Agriculture"	NASC Complex, Pusa, New Delhi	August 30, 2010

Plant Physiology & Biochemistry			
Dr. Amaresh Chandra	Annual day celebration of NAAS and received Fellowship of NAAS	NASC Complex, New Delhi	June 4-5, 2010
	ICAR foundation day and received ICAR Team Award	NASC Complex, New Delhi	July 16, 2010
	15th Management Development Programme in Agricultural Research (ICAR sponsored)	NAARM, Hyderabad	December 2-7, 2010
	IMC meeting of IGFRI, Jhansi	IGFRI, Jhansi	Feb.02, 2011 & March 04, 2011
	A adviser for the promotion of Senior Scientist to Principal Scientist for the disciplines of Plant Physiology, Plant Biochemistry and Plant Biotechnology	ASRB, New Delhi	April 07, 2010
	As selection committee member for SRF/RA	CISH, Lucknow	July 22 & 24, 2010
	PAC, DST meeting	IIT, Mumbai	Sept. 20, 2010
Dr. A.K. Shrivastava	Acted as Member Secretary of QRT	Different centres	2010-2011
Dr. S. Solomon	IMC meeting of SBI, Coimbatore	SBI, Coimbatore	
	Acted as Member of Evaluation Committee, National Fund for Basic, Strategic and Frontier Application Researches in Agriculture: Sweet sorghum for efficient ethanol production	DSR, Hyderabad	
Dr. Radha Jain	National Conference of Plant Physiology	BHU, Varanasi	Nov. 25-27, 2010
Agricultural Engineering			
Dr Jaswant Singh	Brain Storming Meeting on "Post Harvest Technology and Value Addition of Agricultural Produce : Scenario, Issues and Strategy"	CIPHET, Ludhiana	May 01-02, 2010
	Interaction Meet on Agricultural Mechanization	CIAE, Bhopal	July 23-24, 2010
	IMC meeting	CIPHET, Ludhiana	March 25, 2011
Dr Jaswant Singh and Dr R.D. Singh	28th Annual Workshop of AICRP on Post –Harvest Technology	Central Institute of Agricultural Engg, Bhopal	October 28-31, 2010
Dr R.D. Singh	All India Seminar on "Engineering Interventions to Enhance Income of Small and Marginal Farmers"	Institution of Engineers (India), Delhi State Centre, New Delhi	Sept 29-30, 2010
Agricultural Knowledge Management Unit (ARIS Cell) and Computer Application			
Dr. P.K.Bajpai	Training on Statistical Analysis Systems (S.A.S.)	IASRI, New Delhi	October 25-30, 2010
	Sensitization cum training workshop on Project Management System	CIAE, Bhopal	November 11, 2010
Dr Rajesh Kumar	Zonal Breeders Meet of All India Coordinated Research Project on Sugarcane of North West Zone, North Central and North Eastern Zone	IISR, Lucknow	February 26, 2011

Sh. S.S. Hasan	Interactive Meet on Information and Communication Technology Applications in ICAR	NASC, New Delhi	Nov 3-4, 2010
	Workshop on "Strengthening Statistical Computing for NARS"	IASRI, New Delhi	June 7-8, 2010
Agromet			
Dr. Arun K. Srivastava	Annual workshop of Network Project on Climate Change	AAU, Anand	September 20-24, 2010
	Farmers meet on Climate Change Awareness	IISR, Lucknow	January 7 & 10, and March, 24 & 30, 2011
RCM			
Dr. A.K. Sharma	State Level Sugarcane Price Fixation Committee Meeting	Yojana Bhawan, Lucknow	October 29, 2010
	Workshop on "Result-Framework-Document : An effective tool for the improvement of the performance of Govt. work"	Vigyan Bhawan, New Delhi	February 22, 2011
	Workshop on "Result-Framework-Document"	NASC Complex, New Delhi	March 12-15, 2011
AICRP on Sugarcane			
Dr. O.K. Sinha	Workshop of AICRP on Sugarcane	Navsari Agricultural University, Navsari	October 27-29, 2010
	Meeting of ICAR Regional Committee (Zone IV)	Birsa Agricultural University, Kanke, Ranchi	October 7-9, 2010
Dr. O.P. Dubey	Workshop of AICRP on Sugarcane	Navsari Agricultural University, Navsari	October 27-29, 2010
KVK			
Dr. R K Singh	Mid-term review workshop of KVKs	CSAUA&T, Kanpur	April 29-30, 2010
	ICAR Regional Committee Meeting	Birsa Agricultural University, Kanke, Ranchi	October 8-9, 2010
	Annual Zonal Workshop of KVKs Zone 4	IIVR, Varanasi	December 10-11, 2010
	National Conference on KVKs	MPUA&T, Udaipur (Rajsthan)	December 22-24, 2010

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

Name of Scientists	Topic/Subject	Place	Date
Sh. Rajendra Singh and Sh. S.K. Savita	Training on "Maintenance on Machines"	Tamil Nadu Agricultural University, Coimbatore	October 11-20, 2010
Dr. Mani Ram Verma	Training on Statistical Analysis Systems (S.A.S.)	IASRI, New Delhi	October 25-30, 2010

Dr. G.K. Singh	Winter School on "System based integrated nutrient management to sustain crop productivity and soil health"	Project Directorate on Farming Systems Research, Modipuram, Meerut	October 1-21, 2010
	XIX National Symposium on "Resource Management Approaches towards Livelihood Security" organized by the Indian Society of Agronomy	University of Agricultural Sciences, Bengaluru	December 2-4, 2010
Mr. Brahm Prakash	State Level Sugarcane Price Fixation Committee Meeting	Yojana Bhawan, Lucknow	October 29, 2010
	Inter Media Publicity Coordination Committee Meeting	Akashwani Bhawan, Lucknow	November 3, 2010
	13th *Rashitrya Krishi Vigyan Sangoshti* on "*Barani Evam Seemit Sinchai Chhetron Mein Krishi, Vaniki Tatha Pashupalan- Samasya Va Samadhan*"	NRC on Agroforestry, Jhansi & Bundelkhand University, Jhansi	January 21-23, 2011
Dr. V K Singh	Mid-term review workshop of KVKs	CSAUA&T, Kanpur	April 29-30, 2010
Dr. Om Prakash	7th Advanced Level training in Soil testing, Plant analysis and Water Quality assessment	Division of Soil Science, IARI, New Delhi	September 21-October 11, 2010
	75th Annual Conference of Indian Society of Soil Science	IISS, Bhopal	November 14-17, 2010
	13th *Rashitrya Krishi Vigyan Sangoshti* on "*Barani Evam Seemit Sinchai Chhetron Mein Krishi, Vaniki Tatha Pashupalan- Samasya Va Samadhan*"	NRC on Agroforestry, Jhansi & Bundelkhand University, Jhansi	January 21-23, 2011
Mrs. Mithlesh Tewari, and Mrs. Neelam Singh	13th *Rashitrya Krishi Vigyan Sangoshti* on "*Barani Evam Seemit Sinchai Chhetron Mein Krishi, Vaniki Tatha Pashupalan- Samasya Va Samadhan*"	NRC on Agroforestry, Jhansi & Bundelkhand University, Jhansi	January 21-23, 2011

20 Workshops, seminars and symposia organized

Foundation Day of the Institute

The 59th Foundation Day of the Institute was celebrated on Februrary 16, 2011 with great fevour and gaiety. Dr. A.N. Mukhopadhyay, former Vice-Chancellor, Assam Agricultural University, Jorhat was the Chief Guest and Dr. G.C. Tewari, Vice Chancellor, CSAUA&T, Kanpur was the Guest of Honour.

Delivering the Foundation day lecture on "*Trichoderma* and Sugarcane disease management", Dr. Mukhopadhyay highlighted the importance of *Trichoderma* in effective management of the diseases of sugarcane. Chairing the session,

Dr. G.B. Singh, Former Director General, Uttar Pradesh Council of Agricultural Research, appreciated the achievements of the Institute in sugarcane research and also urged the scientists to address emerging challenges amidst changing scenario.

Dr. R.L. Yadav, Director, IISR, Lucknow mentioned accomplishments of Indian Institute of Sugarcane Research, namely healthy seed production technique, development of MHAT, improved sugarcane varieties, planting methods, INM, ID&PM, sugarcane machines, jaggery making technique *etc*. The adoption of these technologies by the cane growers enhanced their income from cane cultivation and also helped sugar industry to grow. The contributions of ex-Directors and Scientists of the Institute were also remembered. added that the efforts of Indian Institute of Sugarcane Research in disseminating bio-control technology for managing sugarcane diseases and pests through Memorandum of Understanding with DSCL group of industry in Uttar Pradesh will help in managing the diseases of sugarcane in the state.

28th Biennial Workshop of AICRP on Sugarcane

The 28th Biennial Workshop of AICRP on Sugarcane was organized at the Navsari Agricultural University (NAU), Navsari from October 27-29, 2010. The concurrent Technical Sessions of Crop Improvement, Crop Production, Pathology and Entomology were held on October 27, 2010. The Opening Session was inaugurated by Dr. A.R. Pathak, the Vice-Chancellor of N.A.U., Navsari on October 28, 2010. Dr. A.R. Pathak, as Chief Guest, highlighted the need for cane improvement in Gujarat state. He emphasised on developing varieties resistant to biotic and abiotic stresses through molecular biological work. The tissue culture techniques should be effectively employed for the seed multiplication and the soil carbon content be increased and the use of biofertilizers needs to enhanced. He apprised that the improved technologies extended to the farmers in the state had shown remarkable improvement in the cane productivity. Dr. K.C. Jain, Asstt. Director General (CC), ICAR, New Delhi chaired the session. He highlighted that the extremes of temperature and abiotic stresses are the major constraints in increasing cane productivity. He stressed for increasing soil productivity, adoption of new varieties and other technologies by the growers. He also laid emphasis on the efficient use of water and on mechanizing cane cultivation. For achieving these, he also advocated that there is a need for full cooperation from State Cane Departments. The session ended with vote of thanks by Dr. D.U. Patel, Unit Head (Sugarcane), N.A.U., Navsari. Dr. H.C. Pathak, Director of Research & Dean, P.G. Studies, N.A.U., Navsari, while welcoming the delegates, also presented the scenario of sugarcane production in Gujarat State. Dr. O.K. Sinha, Project Coordinator (Sugarcane)

presented the annual progress of the Coordinated Project and highlighted the major achievements. Dr. N. Vijayan Nair, Director, Sugarcane Breeding Institute, Coimbatore stated that the fluctuations in sugarcane production in the country is cyclic in nature and is likely to increase in the current year also. There is a need to increase soil productivity for increasing cane productivity. Prof. J.B. Patel, the Chairman, National Federation of Cooperative Sugar Factories Ltd., New Delhi urged for increasing sugar production through increasing cane productivity and laid emphasis on management of soil health, development of high yielding varieties and machanization of sugarcane cultivation, *etc*.

In Crop Improvement discipline, the session was chaired by Dr. K.C. Jain, ADG (CC). Dr. N. Vijayan Nair, Director, SBI, Coimbatore presented the summary of research achievements. Under fluff supply programme, 34.72 kg of fluff was supplied to AICRP centres for raising seedlings. A total of 24 entries under early and 30 under mid-late group were found promising. Due to two distinct environments in tropical and subtropical India which demand varieties specific to a particular condition, it was decided not to continue with the Inter Zonal Varietal Trials. For conducting Zonal Varietal Trial during 2011-12, 16 entries in early group and 31 entries in mid-late group were accepted.

A meeting of Varietal Identification Committee was held under the Chairmanship of Dr. K.C. Jain, ADG (CC). Out of 12 proposals, the following four varieties were identified for release in the country. These are CoH 128 (Mid-late) and Co 0237 (Early) for North West Zone, Co 0403 (Early) for Peninsular Zone, and CoA 05322 (Mid-late) for East Coast Zone.

In Crop Production discipline, the session was chaired by Dr. C.L. Patel, Principal & Dean, N.M. College of Agriculture, N.A.U., Navsari and Co-Chaired by Dr. A.M. Bafna, Professor & Head, Department of Agril. Chemistry and Soil Science, NMCA, Navsari. The progress report was presented by Dr. S.K. Saini, P.I. The recommendations made were:

- There is a great deal of genetic variations in cane yield and quality across the zone. Hence, superior clones be recommended to substitute old/inferior varieties. In NWZ/NEZ/NCZ/ECZ, the sugarcane crop be fertilized with 100% recommended dose of fertilizer whereas in peninsular zone, sugarcane crop be fertilized with 25% more of the recommended dose of fertilizers.
- For sustaining higher sugarcane yield and better soil health, sugarcane plant and ratoon crops be fertilized with 75% of recommended NPK through inorganics + 25% of recommended N through organics (FYM/PSM) along with furrow application of Azotobacter + PSB @ 2.5 kg/ha each and biopesticide (*Trichoderma*) inoculated @ 1 kg/ha mixed with one quintal FYM; apart from trash mulching and green manure of legumes (*Sesbania*) in alternate rows in ratoon crop.

In Pathology discipline, the session was chaired by Dr. A.N. Sabalpara, Associate Director of Research, NAU, Navsari. The progress report was presented by Dr. P Padmanaban, P.I. The varieties resistant to red rot, smut and wilt were identified. The recommendations made were as follows:

- Since CoLk 8102, CoS 8436 and CoSe 95422 have been affected by red rot in Haryana, Punjab, Uttar Pradesh and Bihar, suitable replacement with red rot resistant varieties are required.
- The emergence of new pathotype isolated from CoS 8436 needs further confirmation by Lucknow and Karnal centres and in peninsular zone at Coimbatore, Navsari and Thiruvalla centres.
- Since Pokkah boeng though a minor disease, has been reported in several varieties at various locations, studies on its epidemiology, varietal screening and management should be taken up.
- Yellow leaf disease (YLD) has been found in different states. Hence, critical observations should be made on the disease, its occurrence, severity and yield loss in order to strategically manage the disease.
- The incidence of bacterial top rot has been reported by Ludhiana and Uchani centres. These centres are advised to isolate the pathogen and confirm the pathogenicity through Koch's postulates for further studies on the disease, if needed.

In Entomology discipline, the session was chaired by Dr. C.B. Patel, Ex-Director of Campus and Retd. Professor of Entomology. The progress report was presented by Dr. M.B. Patel, Professor, Navsari Agril. University, Navsari and P.I. A technology for the management of white woolly aphid was recommended which is as follows:

- For management of sugarcane woolly aphid, *Ceratovacuna lanigera* imidacloprid @ 100 g a.i./ha, chlorpyriphos 1 kg a.i./ha, oxydemeton methyl @ 1 kg a.i./ha, and thiamethoxam @ 50 g a.i./ha were found most effective.

Under Macro-management scheme sponsored by DAC, Ministry of Agriculture, Govt. of India, the progress of Frontline Demonstrations and Breeder Seed Production was reviewed. The session was chaired by Dr. H.C. Pathak, Director of Research, NAU, Navsari and Co-Chaired by Dr. Virendra Singh, Joint Director, DSD, Lucknow. A total of 105 FLDs were conducted and 28132.73 quintals of breeder seed of sugarcane were produced in the country at AICRP centres.

Plenary session was chaired by Dr. K.C. Jain, ADG(CC). He expressed his satisfaction on the deliberations of the Workshop.

ICAR Inter-Institutional (North Zone) Sports Meet

The Institute participated in the Inter Institutional Zonal Sports Meet (North Zone) held at IIPR, Kanpur during 06-09 April, 2010. The following employees of the Institute won the Medals in different categories in the Sports Meet.

Carom Board (Men)	Shri. A.M. Srivastava	Winner
Carom Board (Women)	Smt. Neelam Singh	Runner
Table Tennis (Men)	Shri A.M. Srivastava	Runner
	Shri R.K. Yadav	
	Shri Sartaj Ali	
	Shri Pankaj Arora	
	Shri V.P. Tewari	
Table Tennis (Women)	Smt. Manju Srivastava	Winner
Table Tennis (Women Double)	Smt. Manju Srivastava	Winner
	Smt. U.K. Sharma	Winner
Athletic-Relay Race 4 x 100 Meters	Shri Sudhir Yadav	Runner
	Shri Inder Singh	
	Shri Taruk Nath	
	Shri Dhamendra	

Events organized

Independence Day

Independence Day was celebrated on August 15, 2010 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

Institute contingent at IIPR, Kanpur

Recitation of National Anthem

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, 2011. All the scientists, officers and staff members participated in an event organized in front of the main Institute building. Dr. R.L. Yadav, Director of the Institute hoisted the National tricolour and addressed the participants to mark the occasion. The sweets were also distributed to mark the occasion by the Staff Recreation Club, IISR, Lucknow.

Shahid Day (Martyr Day)

Martyr Day was observed on January 30, 2011 by observing a 2-minute silence by all the officers and staff members in front of the main building. The contributions of martyrs were also remembered on this day.

Climate Change Awareness Programme

The climate change awareness programme among farmers was continued in 2010-11 with 150 sugarcane farmers from sub-tropical states of Bihar, Haryana, Punjab, Uttarakhand and Uttar Pradesh.

Welcome/farewell functions

The scientific strength that joined the institute was welcomed in the IRC meeting. The staff members who superannuated during the years were bid farewell by organizing farewell functions by Staff Welfare Committee on behalf of the staff of the Institute.

Exams conducted

The Institute conducted following examination during the year.

- ICAR's 15th All India Entrance Examination for UG Admission by ICAR for Admission to 15 seats in Under Graduate Programme for Admission to Agriculture and allied subjects on April 17, 2010 at Lucknow.
- ICAR's 15th All India Entrance Examination for Post Graduate Admission on April 18, 2010.
- ARS/NET Examination, 2010 by ASRB on September 29, 2010.

गन्ना शोध एवं प्रसार क्रियाकलापों में राजभाषा के बढ़ते चरण

भारतीय गन्ना अनुसंधान संस्थान, लखनऊ मूलतः गन्ना खेती एवं गन्ना आधारित सस्य-पद्धतियों पर शोध कार्यों में विगत छः दशकों से कार्यरत है। उपोष्ण कटिबंधीय परिक्षेत्र के गन्ना उत्पादकों को नवीनतम गन्ना उत्पादन तकनीक, प्रजातियाँ, कृषि यंत्र तथा फसल सुरक्षा आदि की तकनीकी जानकारी उपलब्ध कराने के लिए भारतीय कृषि अनुसंधान परिषद का यह एक मात्र संस्थान है। गन्ना उत्पादन का सर्वाधिक भूभाग उत्तरी भारत में अवस्थित है जहाँ की व्यावहारिक आम-भाषा हिंदी है। कृषकों के लिए विकसित की गयी तकनीक को सरल एवं सुग्राह्य भाषा में प्रचार-प्रसार करना संस्थान का एक महत्वपूर्ण पहलू रहा है। संस्थान ने न केवल तकनीक हस्तान्तरण के लिए विभिन्न ग्रामों में कृषकों के खेतों पर शोध की योजनाएं चलायीं अपितु राजभाषा के उन्नयन एवं प्रगति के क्षेत्र में भी अनेक कदम उठाये हैं। इसका संक्षिप्त विवरण इस प्रकार है:

राजभाषा के उन्नयन के लिए भारतीय गन्ना अनुसंधान संस्थान में परिषद के नियमानुसार राजभाषा कार्यान्वयन समिति का इस वर्ष पुर्नगठन किया गया जिसका विवरण इस प्रकार है।

पदाधिकारी का नाम	पद
डा. रतन लाल यादव, निदेशक	अध्यक्ष
डा. हेमा पाण्डे	सदस्या
डा. सुधीर कुमार शुक्ल, प्रधान वैज्ञानिक एवं प्रभारी राजभाषा	सदस्य
डा. राजेश कुमार सिंह, कार्यक्रम समन्वयक, कृषि विज्ञान केन्द्र	सदस्य
वरिष्ठ प्रशासनिक अधिकारी	सदस्य
डा. गया करन सिंह, तकनीकी अधिकारी, टी 7-8	सदस्य
श्री धर्मेन्द्र चन्द्र पन्त, अवर श्रेणी लिपिक	सदस्य
डा. (कुमारी) वन्दना गुप्ता, हिन्दी अनुवादक, टी 5	सदस्य सचिव

समिति की नियमित तिमाही बैठकों में समय-समय पर परिषद से प्राप्त दिशा-निर्देशों के अनुपालनार्थ आवश्यक कार्यवाही की गयी।

हिन्दी प्रकाशन

संस्थान द्वारा हिन्दी भाषा में 'किसान ज्योति' पत्रिका तथा इक्षु समाचार पत्र का नियमित रूप से षट्मासिक प्रकाशन हो रहा है तथा इस वर्ष इन प्रकाशनों की क्रमशः 1100 एवं 500 प्रतियाँ प्रकाशित की गयी। नवीनतम् ज्ञान-विज्ञान के लौकिक-लेखों एवं सफल कहानियों को सरल हिन्दी भाषा में लेकर 'किसान-ज्योति' पत्रिका कृषकों एवं ग्रामीणांचल के सुदूर भागों में ज्ञान-विज्ञान का प्रकाश फैलाने में सक्रिय है।

संस्थान द्वारा इस वर्ष 2011 में हिन्दी में निम्नलिखित प्रसार पत्र प्रकाशित किये गये एवं किसानो को वितरित किये गये।

- गड्ढ़ा बुवाई विधि अपनाकर सिंचाई जल की बचत करें
- गन्ने की क्रान्तिक वृद्धि अवस्थाओं पर सिंचाई कर पानी बचाएं
- एकान्तर नाली सिंचाई विधि अपनाकर गन्ने में पानी बचाएं
- गन्ने की पेड़ी में पताई बिछाकर सिंचाई जल की बचत करें

प्रशिक्षण कार्यक्रम

संस्थान द्वारा आयोजित सभी प्रशिक्षण कार्यक्रमों में तकनीकी व्याख्यान, किसान मेले में कृषक गोष्ठी, प्रश्नोत्तरी, संस्थान स्थापना दिवस तथा वैज्ञानिकों के संवाद भाषण, प्रशिक्षण सामग्री आदि सभी हिन्दी भाषा में किये गये। इसके अतिरिक्त, कृषकों एवं विस्तार कार्यकर्ताओं के लिए तकनीकी विषयों की जानकारी हिन्दी पत्राचार के माध्यम से दी गयी।

संस्थान ने जन कल्याण संस्थान, हरिद्वार द्वारा प्रायोजित 23 किसानों के लिए "गन्ना उत्पादन की उन्नत कृषि तकनीक" विषय पर जनवरी 18-22, 2011 तक का पाँच दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया। प्रशिक्षण के दौरान गन्ना उत्पादन से संबंधित

विभिन्न विषयों जैसे उन्नत प्रजातियाँ, बुवाई विधियाँ, स्वस्थ बीज उत्पादन, पोषक तत्व प्रबंधन, सिंचाई प्रबंधन, समेकित कीट प्रबंधन, तथा अन्य उत्पादन तकनीक जैसे उन्नत यंत्र एवं गुड़ उत्पादन विधि पर किसानों को सरल हिन्दी भाषा में जानकारी दी गई।

गन्ने की उन्नत कृषि तकनीक विषय पर संस्थान में आत्मा संस्था, समस्तीपुर, बिहार द्वारा प्रायोजित 18 से 22 मई, 2010 तक का पाँच दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया गया। इस प्रशिक्षण में बिहार से आये हुए 20 कृषकों ने हिन्दी भाषा में तकनीकी ज्ञान अर्जित किया। संस्थान के कृषि विज्ञान केन्द्र द्वारा आयोजित गृह विज्ञान, पशु पालन, उद्यानिकी, मृदा विज्ञान एवं सस्य विज्ञान आदि में कुल 22 प्रशिक्षण कार्यक्रम आयोजित किये गये जिसमें 527 प्रशिक्षणार्थियों को हिन्दी भाषा में ही जानकारी प्रदान की गयी। उपरोक्त उन्नत गन्ना उत्पादन तकनीक की जानकारी प्राप्त करने के उद्देश्य से जो कृषक संस्थान भ्रमण पर आये उन्हें भी हिन्दी भाषा में तकनीकी जानकारी उपलब्ध करायी गयी।

किसान मेले का आयोजन

भारतीय गन्ना अनुसंधान संस्थान, लखनऊ के 59वें स्थापना दिवस के अवसर पर संस्थान परिसर में 16 फरवरी, 2011 को किसान मेले का आयोजन किया गया जिसमें उत्तर प्रदेश तथा अन्य प्रदेशों के लगभग 1000 किसानों ने भाग लिया। इस अवसर पर आयोजित कृषि प्रदर्शनी, विभिन्न कृषि शोध संस्थाओं, कृषि मशीन निर्माताओं, कृषि विज्ञान केन्द्रों, राज्य विकास विभागों, कृषि निवेश संस्थाओं द्वारा उन्नत तकनीकों/उत्पादों/सेवाओं का प्रदर्शन किया गया तथा समस्त स्टालों के बैनर हिन्दी भाषा में तैयार किये गये। नवोन्मेषी कृषक सम्मेलन में वैज्ञानिकों के तकनीकी व्याख्यान का माध्यम भी हिन्दी रखा गया। इसके अतिरिक्त, हिन्दी भाषा में ही प्रसार-सामग्री भी तैयार की गयी।

हिन्दी पखवाड़े का आयोजन

संस्थान में हिन्दी पखवाड़ा समारोह 14-30 सितम्बर, 2010 के मध्य आयोजित किया गया। जिसके अन्तर्गत कवि सम्मेलन के अतिरिक्त टिप्पणी अनुवाद, आशुभाषण, अन्त्याक्षरी, श्रुतलेख, प्रकाशित शोध लेखों की समीक्षा, वर्षभर के हिन्दी भाषा में किये गये कार्यालय कार्य की समीक्षा एवं स्टाफ के बच्चों हेतु काव्य- पाठ प्रतियोगिताओं का आयोजन किया गया। इन प्रतियोगिताओं में लगभग 100 प्रतिभागियों ने भाग लिया जिसमें 62 उत्कृष्ट प्रतिभागियों को पुरस्कार एवं प्रमाण पत्र प्रदान किये गये। सफल प्रतिभागियों में 12 को प्रथम पुरस्कार,

11 को द्वितीय पुरस्कार, 12 को तृतीय पुरस्कार एवं 24 प्रतिभागियों को सांत्वना पुरस्कार वितरित किये गये।

व्याख्यान

संस्थान में गठित वैज्ञानिक विचार मंच द्वारा समय-समय पर विभिन्न सम-सामयिक विषयों पर व्याख्यान आयोजित किये गये। सितम्बर माह में हिन्दी समारोह के दौरान डा. जितेन्द्र नाथ पाण्डेय, भूतपूर्व आचार्य, हिन्दी विभाग, लखनऊ विश्वविद्यालय, लखनऊ ने ''हिन्दी शब्द रचना एवं वर्तनी व तुलसी का समसामायिक महत्व'' विषय पर दिनांक 30.09.10 को अपना व्याख्यान उद्बोधित किया। संस्थान के निदेशक, डा. रतन लाल यादव ने ''वैज्ञानिक एवं तकनीकी लेखन'' विषय पर फरवरी 2011 को अपना व्याख्यान हिन्दी भाषा में प्रस्तुत किया। संस्थान के वैज्ञानिकों एवं कर्मचारियों के हितार्थ एक गैर -सरकारी संस्थान 'संजीवनी' द्वारा दवामुक्त एवं तनावरहित जीवन पर 13 दिसम्बर 2010 को गोष्ठी भी हिन्दी में आयोजित की गयी।

द्विभाषी प्रयोग

भारतीय गन्ना अनुसंधान संस्थान के कार्यालय प्रयोग में आने वाली सभी रबड़ की मोहरें, नाम पट्टिकाएं, सूचनापट्ट, फाइल कवर, आवेदन प्रपत्र एवं माँग पत्र आदि परिषद के नियमानुसार द्विभाषी हैं। संस्थान के अधिकांश परिपत्र हिन्दी में परिचालित होते हैं। इसके अतिरिक्त सभी कम्प्यूटरों में हिन्दी/अंग्रेजी टंकण सुविधा उपलब्ध है।

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Distinguished visitors

Dr. N.N. Singh, Vice Chancellor, Birsa Agriculture University, Ranchi (Jharkhand) on June 11, 2010 and March 26, 2011.

Dr. Dharmender Rathore, Ex. Vice Chancellor, CSKKV, Palampur (H.P.) on August 6, 2010.

Dr. J.S. Samra, CEO, National Rainfed Area Authority, Govt. of India, New Delhi on October 29, 2010.

Sri Ajeet Sriram, MD & Chairman DSCL Group of Sugars alongwith Sri Sunil Radha Krishna, Sr. Executive Director of DSCL Group on November 12, 2010.

Sri Chaman Kumar, Additional Secretary & Financial Advisor, DARE, ICAR on January 1, 2011.

Dr. G.B. Singh, Ex. Director General, U.P. Council of Agricultural Research, Lucknow, Dr. G.C. Tewari, Vice Chancellor, C.S. Azad University of Agriculture and Technology, Kanpur, Dr. A.N. Mukhopadhyay, Ex. Vice Chancellor, Assam Agricultural University, Jorhat and Dr. V.P. Agnihotri and Dr. S.R. Mishra, Ex. Directors of the IISR, Lucknow on February 16, 2011.

Dr. N. Gopalakrishnan, Assistant Director General (CC), ICAR on March 25-26, 2011.

An Ethiopian delegation comprising five members *viz.*, H.E. Ato Abay Tsehaye, Director General of a rank of a Cabinet Union Minister, Mr. Ato Deroje Gutema, Deputy Director General, Factory Projects and Operations, Mr. Ato Shimelis Kebede, Deputy Director General, Corporate

Planning and Monitoring, Mr. Ato Ambachew Damtie, Deputy Director General, Research and Training and Mr. Ato Zewdu Nigate, Director, Factory Projects on March 31, 2011.

Infrastructure development

The infrastructure created/civil works carried out during the year 2010-11 consisted of the following work items:

S. No.	Item	Amount (₹ in lacs)	Agency to whom work allotted
1	Providing & fixing of false ceiling in Director's committee room	1.34	CPWD
2	Boundary wall around KVK at G Block, IISR, Lucknow	30.00	CPWD
3	Redevelopment of Tube well No. 10	3.51	U.P. Jal Nigam
4	Fabrication & fixing of steel ladder in the Ist floor of Adm. Builing at IISR, Lucknow	0.47	CPWD
5	Providing street lighting on the farm of IISR Regional Centre, Motipur	7.25	CPWD
6	Installation of high water dischanging capacity tube well at IISR Regional Centre, Motipur	6.50	Water Resources, Tube well wing, Patna
7	Boundary wall of IISR Regional Centre, Motipur	20.00	CPWD
8	Recarpeting of colony road at Ikshupuri Colony	7.76	CPWD
9	White-washing & painting of IISR Community Centre	2.46	Other Agency
10	Replacement of existing AMF penel 200 KVA KEC make KVA, AUR necessary cabling *etc*.	2.37	Other Agency
11	Re-plastering (ii) repainting (iii) minor brick work(iv) civil work of 2 ft height of boundary wall of Ikshupuri Colony from Colony Gate to Butchery Ground, and (v) construction/minor repair of broken part of farm building gate and portion of boundary wall	4.68	Other Agency
12	Replacement of MS Doors in mist chamber No. 02 and transparent filer glass roofing in Polyhouse no.02 at IISR, Lucknow	5.63	Other Agency
13	Power cable laying and connection between feeder piller (near Bank) and Feeder Pillar (near Biocontrol) for electricity supply to Guest House, Bio-control, KVK building, drinking water, tube well No. 11 at IISR, Lucknow	0.95	Other Agency
14	Re- plastering (ii) repainting (iii) minor brick work and (iv) Civil work at 2 ft height on the entire stretch of boundary wall at Ikshupuri colony 450 mt. on Jail Road and construction/minor repairs at broken part of boundary wall	4.69	Other Agency
15	Repair & painting *gur* godown at IISR, Lucknow	0.47	Other Agency
16	Replacement of MS doors in Mist chamber No. 01 and transparent fibre glass roofing in Polyhouse No. 01 at IISR, Lucknow	5.63	Other Agency
17	Replacement of existing AMF panel 200 KVA, KEC Make 200 KVA, AUR necessary calling etc.	3.34	Other Agency
18	Replacement at AMF panel and AVR (Automatic Voltage Regulator at 110 KVA DG set installed near dispensary).	1.60	Other Agency
19	Repair at farm road street light (phase-1) at IISR, Lucknow	4.99	Other Agency
20	Repairing and painting at Jaggery Complex at IISR, Lucknow	1.46	Other Agency

Personnel (as on March 31, 2011)

Director	:	Dr. R.L. Yadav
Administration		
Senior Administrative Officer	:	Sri Ratnesh Kumar
Administrative Officer	:	Sri Shatruhan Kumar
Finance & Accounts Officer	:	Sri A.K. Srivastava
Asstt. Finance & Accounts Officer	:	Sri T.S.N. Murthy (on study leave)
Drawing & Disbursing Officer	:	Sri K.P. Yadav
Asstt. Administrative Officer	:	Sri R.K. Khanna
	:	Sri K.P. Yadav
	:	Smt. S.L. Barjoo
I/C, Security Officer	:	Sri Sanjay Bhatnagar
Research Coordination and Management		
Principal Scientist & Incharge	:	Dr. A.K. Sharma
Technical Officer	:	Sri Mahendra Singh
	:	Sri Brahm Prakash
	:	Dr. G.K. Singh
Crop Production		
Principal Scientist & Head	:	Dr. T.K. Srivastava
Principal Scientist (Agronomy)	:	Dr. R.S. Verma
	:	Dr. R.S. Chauhan
	:	Dr. S.K. Shukla
	:	Dr. K.P. Singh
Principal Scientist (Agril. Extension)	:	Dr. (Mrs.) Hema Pandey
Senior Scienist (Agronomy)	:	Dr. S.N. Singh
	:	Dr. A.K. Singh
	:	Dr. Ishwar Singh
Senior Scientist (Soil Chem./ Fer./ Microbiology)	:	Dr. Todi Singh
Senior Scientist (Soil Water Con. Engg.)	:	Er. Rajendra Gupta
Senior Scientist (Agril. Extension)	:	Dr. A.K. Sah
Scientist SS	:	Sri Kamta Prasad
Technical Officer	:	Sri Ram Singh
	:	Sri S.N. Srivastava
	:	Dr. R.K. Singh
Plant Physiology & Biochemistry		
Principal Scientist & Head	:	Dr. Amaresh Chandra
Principal Scientist (Plant Physiology)	:	Dr. Ashok Kumar Shrivastava
Principal Scientist (Biochemistry)	:	Dr. S. Solomon
	:	Dr. R.K. Rai
Principal Scientist (Organic Chemistry)	:	Dr. Pushpa Singh

Senior Scientist (Plant Physiology)	:	Dr. (Smt.) Radha Jain
Senior Scientist (Biochemistry PS)	:	Sri Raman Banerjee
Technical Officer	:	Dr. (Smt.) Namita Arya
	:	Smt. Anita Sawnani
	:	Sri Ram Darash
	:	Sri S.P. Shukla

Crop Improvement

Principal Scientist & I/c, Head	:	Dr. Raman Kapur
Principal Scientist (Plant Breeding)	:	Dr. Jyotsendra Singh
	:	Dr. A.D. Pathak
	:	Dr. D.K. Pandey
Principal Scientist (Gen. & Cytogenetics)	:	Dr. (Smt.) Sangeeta Srivastava
Principal Scientist (Biotechnology)	:	Dr. R.K. Singh
Senior Scientist (Plant Breeding)	:	Dr. P.K. Singh (on deputation)
	:	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

Crop Protection

Principal Scientist & Head	:	Dr. S.K. Duttamajumder
Principal Scientist (Plant Pathology)	:	Dr. Ram ji Lal
	:	Smt. Sunita Lal
	:	Dr. G.M. Tripathi
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
Technical Officer	:	Sri R.B. Yadav
	:	Dr. S.K. Awasthi
	:	Dr. D.C. Rajak
	:	Sri Sanjay Bhatnangar
	:	Sri B.B. Joshi
	:	Sri Amar Nath
	:	Sri Niranjan Lal
	:	Sri M.P. Sharma
	:	Sri I.P. Maurya
	:	Smt. Pramila Lal

Agril. Engineering

Principal Scientist & I/c, Head	:	Dr. Jaswant Singh

Prinicipal Scientist (Farm Mach.& Power)	:	Dr. A.C. Srivastava
	:	Dr. P.R. Singh
Prinicipal Scientist (Elec.& Instr.)	:	Sri R.K. Pangasa
Senior Scientist (Farm Mach.& Power)	:	Dr. A.K. Singh
	:	Dr. S.I. Anwar
	:	Dr. R.D. Singh
Scientist (Ag.Str./Proc.Engg.)	:	Er. Dilip Kumar
Technical Officer	:	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

Economics & Statistics/ ARIS Cell

Principal Scientist (Statistics) & I/C	:	Dr. P.K. Bajpai
Principal Scientist (Ag. Economics)	:	Dr. A. K. Sharma
Scientist SS (Computer Science)	:	Sri S.S. Hasan
Technical Officer	:	Dr. Mani Ram Verma

Agrometeorology

Principal Scientist & I/C	:	Sri Arun Kumar Srivastava
Technical Officer	:	Sri Surendra Singh

Radio Tracer Laboratory

Principal Scientist & Incharge	:	Dr. S.K. Shukla

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. Entomology)	:	Dr. Om Prakash
Principal Scientist (Agril. Statistics)	:	Dr. Rajesh Kumar
Technical Officer	:	Dr. J.K.S. Gautam
	:	Sri Adil Zubair

Farm

Scientist Incharge	:	Dr. T.K. Srivastava
Farm Manager	:	Sri S.K. Pal
Technical Officer	:	Sri Nar Singh
	:	Sri C.P. Singh

	:	Sri Raghvendra Kumar
	:	Sri Jiyawan Ram
	:	Sri Satya Narayan
	:	Sri B.B. Singh
ITMU/PME Cell		
Nodal Officer & Scientist Incharge	:	Dr. A.K. Sharma
Krishi Vigyan Kendra		
Programme Coordinator& Incharge	:	Dr. R.K. Singh
Technical Officer	:	Dr. Om Prakash
	:	Smt. Mithilesh Tiwari
	:	Dr. R.K. Singh
	:	Smt. Neelam Singh
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
	:	Sri Avadhesh Kumar Yadav
Dispensary		
Incharge	:	Sri Ratnesh Kumar
Senior Medical Officer	:	Dr. S.K. Sethi
Library		
Scientist Incharge	:	Dr. Ashok K. Shrivastava
Technical Officer	:	Sri G.K. Gupta
	:	Sri G.D. Dhariyal
	:	Sri Ghanshyam Ram
Incharge, Seed Production Unit	:	Dr. J. Singh
Incharge, Central Laboratory	:	Dr. Pushpa Singh
Technical Officer	:	Smt. Asha Gaur
	:	Smt. Meena Nigam
Incharge, Vehicles	:	Sri K.P. Yadav
Consultancy Cell		
Scientist Incharge		Dr. A.K. Sharma
Guest House		
Manager	:	Dr. S.K. Awasthi
Estate		
Officer-in-charge	:	Dr. Jaswant 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)

STAFF NEWS

New joinings on transfer

Technical

Sri Brahm Prakash, T 7-8 joined at this Institute on August 4, 2010 on transfer from IIPR, Kanpur.

Sri C.P. Singh, T 7-8 joined at this Institute on August 16, 2010 on transfer from Directorate of Groundnut Research, Junagadh.

Sri Ram Murti, T-5 joined at this Institute on August 16, 2010 on transfer from V P K A S, Almora.

Administrative

Sri Sunil Kumar joined as Administrative Officer on December 20, 2010.

Sri Ratnesh Kumar joined as Senior Administrative Officer on January 31, 2011.

Sri A.K. Srivastava joined as Finance and Accounts Officer on March 10, 2011.

Appointments

Scientist

Dr. T.K. Srivastava joined IISR as Head, Division of Crop Production on December 1, 2010.

Others

Sri Kulpreet Singh joined as T-1 (Driver) KVK on September 7, 2010.

Sri Nand Kishore joined as T-1 (Driver) on September 8, 2010.

Sri Santosh Kumar joined as SSS at KVK on September 9, 2010.

Sri Sambhu Kumar joined as Driver (T-1) KVK on September 10, 2010.

Sri Dhirendra Pratap Singh joined as Steno-III at KVK joined on September 16, 2010.

Sri Anoop Chand Kol joined as SSS at KVK September 16, 2010.

Sri Rakesh Kumar Srivastava joined as T-1 (Electricals) on October 13, 2010.

Sri Kuldeep joined as T-1 (Tubewell Operator) on November 2, 2010.

Sri Amar Kumar joined on November 9, 2010 as Lower Division Clerk.

Km. Rupam Rani joined on December 8, 2010 as Lower Division Clerk.

Transfers

Sri Rajeev Lal, Senior Administrative Officer relived on October 12, 2010 to join at CIFRI, Barackpur as Chief Administrative Officer on promotion.

Sri A.M. Srivastava, Assistant relived on October 19, 2010 to join at CISH, Lucknow as Assistant Administrative Officer (on deputation)

Sri Sunil Kumar Administrative Officer relived on February 4, 2011 to join at NBFGR, Lucknow.

Promotions

Name	Promoted to the post	w.e.f.
Scientist		
Dr. R.K. Rai	Principal Scientist	August 4, 2007
Dr. A.K. Sharma	Principal Scientist	April 1, 2008
Dr. G.M. Tripathi	Principal Scientist	April 27, 2008
Dr. D.K. Pandey	Principal Scientist	April 7, 2007
Dr. (Ms) Pushpa Singh	Principal Scientist	June 11, 2008
Dr. K.P. Singh	Principal Scientist	November 29, 2008
Dr. R.K. Singh	Principal Scientist	February 14, 2008
Technical		
Dr. J.K.S. Gautam	T 9	January 1, 2001
Sri Mahaendra Singh	T 9	May 21, 2009
Dr. (Mrs) Namita Arya	T 7-8	February 3, 2005
Dr. G.K. Singh	T 7-8	July 19, 2008
Smt. Asha Gaur	T 7-8	January 1, 2010
Smt. Mithilesh Tewari	T 7-8	January 1, 2010

Dr. D.C. Rajak	T 7-8	February 16, 2005
Dr. (Ms) Bandana Gupta	T-5	June 29, 2006
Sri Dasha Ram	T 1	June 1, 2010
Sri Suresh Chandra	T 1	June 1, 2010
Administration		
Sri Sunder Lal	Assistant	October 12, 2010
Sri Nageshwar Lal	Assistant	October 12, 2010
Sri Prem Chandra	P.S.	October 12, 2010
Sri Tarukh Nath Saini	UDC	August 1, 2010
Sri L.P. Singh	LDC	June 30, 2010
Smt S.L. Barjoo	AAO	June 1, 2010
Supporting		
Sri Deepak Kumar	LDC	August 17, 2010
Sri Makrand Singh	T-1	June 1, 2010

Superannuation

Sri Shrawan Kumar, SSS retired on Feb. 28, 2011.

Sri Ram Nath, SSS retired on Jan. 31, 2011.

Dr. P.N. Singh, Principal Scientist (Soil Science) retired on Dec. 31, 2010.

Smt Ram Kumari SSS retired on Nov. 30, 2010.

Sri Sunder Lal, Assistant retired on Oct. 31, 2010.

Sri Gopal Singh, T-1-3 retired on Sept. 30, 2010.

Sri Mohd. Israil, T-1-3 retired on Aug. 31, 2010.

Dr. D.V. Yadav, Principal Scientist and Head, Division of Crop Production retired on July 31, 2010.

Smt. Pushpa Srivastava, UDC retired on July 31, 2010.

Dr. Ram Pal Verma, Principal Scientist retired on June 30, 2010.

Sri Sartaj Ali, AAO retired on May 31, 2010.

Necrology

Shri Mewa Lal, SSS expired on Dec. 17, 2010.

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Meteorological data

(Year 2010-11)

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Rainy days (No.)	Wind velocity (km/h)	Duration of sunshine (h/day)
	Max	Min	07 H	14 H				
Apr. 10	40.8	23.0	43	17	0.0	0	4.2	4.2
May 10	39.2	25.3	58	33	32.2	1	3.6	3.6
Jun. 10	39.5	27.2	61	36	2.8	0	4.2	4.2
Jul. 10	34.2	26.5	87	70	314.6	11	2.8	2.8
Aug. 10	33.2	25.8	91	74	151.0	9	2.0	2.0
Sep. 10	32.2	24.4	92	72	129.6	12	2.1	2.1
Oct. 10	32.2	20.3	90	51	26.4	2	1.5	1.5
Nov. 10	28.1	15.0	91	48	10.6	1	1.6	1.6
Dec. 10	24.3	7.6	89	35	0.8	0	2.1	2.1
Jan. 11	19.5	6.4	89	46	2.8	1	3.3	3.3
Feb. 11	25.5	10.1	88	38	6.8	1	4.1	4.1
Mar. 11	31.7	15.4	75	27	8.0	1	4.9	4.9
Average	31.7	18.9	80	45			3.0	3.0
Total					**685.6**	**39**		

Glossary

Abbreviation	Full Form
AAO	Assistant Administrative Officer
ADG	Assistant Director General
AFS	Apparent Free Space
AICRP (BC)	All India Coordinated Research Project on Biological Control
AICRP (S)	All India Coordinated Research Project on Sugarcane
ARIS	Agricultural Research Information System
ASTI	The Association of Sugarcane Technologists of India
ATMA	Agriculture Technology Management Agency
AVT	Advance Varietal Trial
BOD	Biochemical Oxygen Demand
Bt	*Bacillus thuringiensis*
CC	Commercial Crops
CCS	Commercial Cane Sugar
cDNA	Complementary Deoxyribose Nucleic Acid
CDRI	Central Drug Research Institute
CeRA	Consortium of e Resources in Agriculture
CICR	Central Institute for Cotton Research
CIMAP	Central Institute for Medicinal and Aromatic Plants
CIMMYT	International Maize & Wheat Improvement Centre
CISH	Central Institute for Subtropical Horticulture
CMS	Cytoplasmic Male Stariltiy
Co Pant	Sugarcane Var. Hybridisation at Coimbatore & Testing at Pantnagar
Co	Sugarcane Var. Hybridisation & Testing at Coimbatore
CoA	Sugarcane Var. Hybridisation at Coimbatore & Testing at Anakapalle
CoBln	Sugarcane Var. Hybridisation at Coimbatore & Testing at Buralikson
CoH	Sugarcane Var. Hybrisation at Coimbatore & Testing at Hisar
CoJ	Sugarcane Var. Hybridisation at Coimbatore & Testing at Jallandhar
CoLk	Sugarcane Var. Hybridisation at Coimbatore, Testing at Lucknow
CoOr	Sugarcane Var. Hybridisation at Coimbatore & Testing at Orrisa
CoPk	Sugarcane Var. Hybridisation at Coimbatore & Testing at Pratap Kota
CoS	Sugarcane Var. Hybridisation at Coimbatore & Testing at Shahjahanpur
CoSe	Sugarcane Var. Hybridisation at Coimbatore & Testing at Seorahi
CSIR	Council of Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSP	Cadre Strength in Position
CSSRI	Central Soil Salinity Research Institute
CTAB	Catyltrimethyl Ammonium Bromide
CV	Coefficient of Variation
Cv	Cultivar
DAP	Days after Planting
DBT	Department of Biotechnology
DNA	Deoxyribose Nucleic Acid
DUS	Distinctiveness, Uniformity and Stability

ELISA	Enzyme – Linked Immunosorbent Assay
ESTs	Expressed Sequence Tags
EW	Electrolyzed Water
Expl.	Exploratory
FIRB	Furrow Irrigated Raised Bed
FYM	Farmyard Manure
GA	Gibbrelic Acid
GC	General Cross
GUS	Beta – glucouronidase
h	Hours
HR Brix	Hand Refractrometer Brix
HRD	Human Resource Development
HS	Highly Susceptible
LDC	Lower Division Clerk
IAA	Indole Acetic Acid
IASRI	Indian Agricultural Statistics Research Institute
ICAR	Indian Council of Agricultural Research
IDM	Integrated Disease Management
IIPR	Indian Institute of Pulses Research
IISR	Indian Institute of Sugarcane Research
IITR	Indian Institute of Toxicology Research
IMC	Institute Management Committee
INM	Integrated Nutrient Management
IPM	Integrated Pest Management
IRC	Institute Research Council
ISMA	Indian Sugar Mill Association
ISSR	Inter Simple Sequence Repeat
ITS	Internal Transcribed Spaces
IVRI	Indian Veterinary Research Institute
IVT	Initital Varietal Trial
KVK	*Krishi Vigyan Kendra*
LAI	Leaf Area Index
LAN	Local Area Network
LER	Land Equivalent Ratio
MAS	Marker Added Selection
MHAT	Moist Hot Air Treatment
min	Minutes
MoU	Memorandum of Understanding
MR	Moderately Resistant
MS	Moderately Susceptible
NBFGR	National Bureau of Fish Genetic Resources
NBRI	National Botanical Research Institute
NCBI	National Centre for Biotechnological Information
NHG	National Hybridization Garden
NMC	Number of Millable Canes
NPK	Nitrogen, Phosphorus and Potassium

NRC	Non-Recurring Contingency
NS	Non signficant
NSI	National Sugar Institute
NSKE	Neem Seed Kernel Extract
PCR	Polymerase Chain Reaction
PDA	Potato Dextrose Agar
PHT	Post-Harvest Technology
PPO	Polyphenol Oxidase
PTO	Power Take Off
PVP	Polyvinyl Pyrrolidone
PVT	Primary Varietal Trial
QRT	Quinquennial Review Team
R	Resistant
RAC	Research Advisory Committee
RBD	Randomised Block Design
RC	Recurring Contingency
RCBD	Randomized Complete Block Design
RCM	Research Coordination and Management
RDF	Recommended Dose of Fertilizers
RH	Relative Humidity
RMD	Ratoon Management Device
RT – PCR	Real Time/Reverse Transcriptase - Polymerase Chain Reaction
RWC	Rice-Wheat Consortium
S	Susceptible
SAI	Soluble Acid Invertase
SAU	State Agriculture University
SBI	Sugarcane Breeding Institute
SCS	Sanctioned Cadre Strength
SNP(s)	Single Nucleotide Polymorphism(s)
SPM	Sulphitation Press Mud
SPMC	Sulphitation Press Mud Cake
SSR	Simple Sequence Repeat
STAI	Sugar Technologists' Association of India
TA	Traveling Allowance
TAE	Tris – Acetate – EDTA
TMC	*Trichoderma* mixed culture
TO	Tractor Operated
UDC	Upper Division Clerk
UPCAR	Uttar Pradesh Council of Agricultural Research, Lucknow
UPCSR	Uttar Pradesh Council of Sugarcane Research, Shahjahanpur
USAID	United States Agency for International Development
VPKAS	Vivekananda *Parvatiya Krishi Anusandhan Sansthan*, Almora
VSI	Vasantdada Sugar Institute, Pune
WCE	Weed Control Efficiency
WUE	Water Use Efficiency
YLD	Yellow Leaf Disease

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