वार्षिक प्रतिवेदन
Annual Report
2007-2008

भाकृअनुप
ICAR

भारतीय गन्ना अनुसंधान संस्थान
Indian Institute of Sugarcane Research

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Preface

Sugar cycles are a well known fact and India's sugar production has fluctuated a lot in New Millennium, from 13.8 mln tonnes in 2004-05 to an all time high of 26.4 mln tonnes in 2007-08. It is again expected to fall to a level of 18 mln tonnes in 2008-09. So is the case in sugarcane area switchovers in a sugar cycle. These fluctuations result in uncertainty to the millers and farmers on price front and ultimately lead to dis-incentives to the farmers to follow improved technologies and package of practices. Despite the fluctuations and disincentives, the domestic consumption of sugar has increased to a level of 22-23 mln tonnes. Considering these trends in consumption, the requirement of sugarcane is estimated to be 495 mln tonnes by 2025 to meet the growing sugar and energy demands of the country. The scope for horizontal expansion is limited as the area under sugarcane in India has fluctuated between 4 to 4.5 mln hectares from 1995-96 to 2005-06, and it is expected to stablise around 4.8 mln tonnes in near future, considering India's food security concerns and water availability scenario. It could be increased through vertical increase in yield and sugar recovery and for which sustained research and development backstopping from research institutions is urgently needed.

The Indian Institute of Sugarcane Research, Lucknow has carried out research work in the areas of judicious water management, integrated nutrient management, integrated disease and pest management, bio-technology and mechanization of sugarcane crop. The main research focus during the year was laid on yield ehancement, i.e., through development of high-sugar and high-yielding varieties, improvement in seed cane quality and quantity, mechanization of sugarcane cultivation, and proper management of almost culturally ignored ratoon crop. CoLK 94184 (Birendra), a high sugar, early maturing sugarcane variety, an excellent ratooner and tolerant to both drought and waterlogging stresses, was developed and accepted for release for cultivation in the North Central Zone comprising eastern Indian states. In addition, 7 genotypes accepted for State Varietal Trials were further multiplied. Focus was also given on seed cane quality and quantity enhancement, as response and efficiency of all other inputs rest on the seed. Sugarcane has now come under the fold of Seed Act and it needs suitable checks and balances at different levels of seed production. IISR, Lucknow organised a National Symposium on Seed Cane and revitalised the seed consciousness amongst all stakeholders to harness the potential yield. It also emphasised for prescribed seed standards, seed replacement and varietal replacement as two separate programmes instead of one, value-addition of seed cane with fortification of beneficial microorganisms, and for reducing seed requirement by innovative methods. The Institute also forged a private-public partnership by signing a MoU with 2 local manufacturers by providing them with necessary technical know-how and manufacturing rights of 7 successful prototypes of farm equipments / machinery to ensure the availability of these equipments to the end-users at an affordable cost. Timely operations on the fields of millions of small and marginal cane growers alone can boost cane yield levels. To address the issue of poor ratoon management in India, the research work has been made more focused. A publication on ratoon management in simple language for easy understanding and benefit of the farmers is under preparation. The extenson approach in sugarcane being mill-centred, the concerted effort on the part of researchers, sugar industry, private entrepreneurs, manufacturers and extensitionists is urgently needed for speedy dissemination of improved sugarcane production technology to the farmers.

The present Annual Report carrying the above description in detail, consists of 23 theme-based chapters. The report is a mirror of all Institute activities during the year 2007-08 (April – March). Dr. D.V. Yadav, Principal Scientist & I/C, RCM and Dr. A. K. Sharma, Sr. Scientist (Agril. Econ.), RCM, deserve appreciation of their sincere efforts in the compilation and editing and presenting the information nicely in the report. Thanks are also due to all the Heads of Divisions / Incharges of Sections and scientists for their cooperation in providing the information timely and in the requisite format. The help rendered by Sri G.K. Singh, Technical Officer, RCM in preparing the Hindi version (*saransh*) of the report, Sri Mahendra Singh, and Sri. D.C. Pant in type-setting this manuscript is also acknowledged.

(R.L. Yadav)
Director

Contents

कार्यकारी सारांश

फसल सुधार

संस्थान द्वारा विकसित गन्ने की उच्च शर्करा युक्त, शीघ्र पकने वाली तथा उत्तम पेड़ी क्षमता वाली प्रजाति कोलक 94184 (बीरेन्द्र) को अखिल भारतीय समन्वित अनुसंधान परियोजना (ऐक्रिप) द्वारा उत्तरी-मध्य परिक्षेत्र के लिए चिन्हित किया गया। ऐक्रिप के अन्तर्गत किये गये अग्रिम परीक्षणों में मध्य-देर से पकने वाली प्रजाति कोलक 9705 की नौलख एवं पेड़ी दोनों ही फसलें अच्छी पायी गयीं। गन्ने की एक अगेती प्रजाति कोलक 07201 तथा मध्य-देर से पकने वाली दो प्रजातियों-कोलक 07202 व कोलक 07203 को उत्तर-पश्चिमी परिक्षेत्र के लिए बहुस्थानिक परीक्षण हेतु चुना गया। कोलक 9709 (अगेती), कोलक 05202 तथा मध्य देर से तैयार होने वाली दो प्रजातियों, कोलक 99271 एवं कोलक 07203, को उत्तर प्रदेश राज्य में परीक्षण हेतु स्वीकृत किया गया।

जैव तथा अजैव विषमताओं के लिए उपयुक्त प्रजातियों के विकास हेतु परम्परागत तथा जैव-प्रौद्योगिकी विधियों द्वारा दमदार कृन्तकों (क्लोन्स) को चिन्हित किया गया। लाल-सड़न रोग रोधी अण्विक चिन्हकों की खोज के अन्तर्गत *सैक्रम स्पान्टेनियम* (एसेसन एस.ई.एस 594) के साथ संकरण के प्रयास किये गये। इसी प्रकार शर्करा संग्रहण के लिए अधिक एवं कम शर्करा वाले प्रजनकों को इन गुणों से युक्त मैपिंग-पापुलेशन विकसित करने के लिए प्रयोग किया गया। शीर्ष बेधक कीट के प्रति सहिष्णुता प्राप्त करने के क्रमबद्ध शोध प्रयासों में वांछित विविधता लाने के लिए *इरियेन्थस* जनकों का प्रयोग किया गया जिससे कुछ उत्कृष्ट कृन्तक (क्लोन्स) प्राप्त हुए। इस प्रकार का एक कृन्तक एल जी 2910 (कोलक 07201) को एक्रिप द्वारा परीक्षण हेतु स्वीकृत किया गया है। अपर्याप्त नमी एवं देरी से बुवाई के लिए उपयुक्त जीन प्रारूपों की पहचान की गयी है। विभिन्न प्रजनन शोधों से निर्गमित वाणिज्यिक गुणों से युक्त तथा लाल सड़न रोग रोधी नौ प्रतिभावान वरण जीन रूपों की पहचान करके स्थानिक परीक्षण (स्टेशन परीक्षण) में शामिल किया गया है।

आनुवांशिक विविधता वाले समूहों की पहचान करने के लिए 46 गन्ना प्रजातियों का आर.ए.पी.डी., एस.एस.आर. तथा आई.आई.एस.आर. चिन्हकों द्वारा आण्विक चिन्हन् किया गया। कोशा 767 की लाल सड़न रोग के पैथोटाइप सी एफ 9 के प्रति अत्यधिक सुग्राहिता होने के विपरीत इस प्रजाति के चार सोमाक्लोन्स में साधारण रोग रोधिता पायी गयी। गन्ने की सूक्ष्मप्रवर्धित पौध की मूल्य वृद्धि के लिए इनकी जड़ में *ग्लूकानएसिटोबैक्टर डायसोट्राफिकस* द्वारा जड़ में संचारण के उत्साहजनक प्रारम्भिक निष्कर्ष प्राप्त हुए हैं।

संसाधन उपयोग वाले अधिक सक्षम जीन प्रारूप

बसन्त काल में बोये गये जीन प्रारूप कोशा 96275 की गन्ना उपज (68.7 टन हे.$^{-1}$) अन्य दो जीन प्रारूपों कोशा 96257 (64.4 टन हे.$^{-1}$) एवं कोशा 99192 (58.7 टन हे.$^{-1}$) की तुलना में सार्थक अन्तर से अधिक पायी गयी। कोशा 96275 द्वारा सर्वाधिक चीनी उपज (7.96 टन हे.$^{-1}$) प्राप्त हुयी।

एक अन्य प्रयोग में कोलक 94184 में सर्वाधिक मिलयोग्य गन्ने (136400 हे.$^{-1}$), गन्ना उपज, सीसीएस मात्रा (12.22) तथा सीसीएस उपज (7.91 टन हे.$^{-1}$) ऑके गये। बी ओ 128 तथा कोशा 95270 में उपरोक्त गुणों में क्रमशः कम ऑके गये। मध्य देर से पकने वाली प्रजातियों में, सीओएच 110 में सर्वाधिक मिल योग्य गन्ने (110,000 हे.$^{-1}$) एवं गन्ना उपज (60.2 टन हे.$^{-1}$) ऑके गये।

कोलक 94184 का जमाव (44.4%), जुलाई माह में कुल पौधे (205200 हे.$^{-1}$) मिल योग्य गन्ने (103700 हे.$^{-1}$) तथा गन्ना उपज (68.8 टन हे.$^{-1}$) कोलक 97147 की अपेक्षा सार्थक अन्तर से अधिक पाया गया। नत्रजन का 150 तथा 225 किग्रा प्रति हे. की दर से प्रयोग करने पर मिल योग्य गन्ने एवं उपज में सार्थक वृद्धि ऑकी गयी। कोलक 94184 की 90 सेमी के पंक्ति अंतराल पर 225 किग्रा नत्रजन प्रति हे. प्रयोग करने से सर्वाधिक (93.84 टन प्रति हे.$^{-1}$) उपज ऑकी गयी। कोलक 97147 की 60 सेमी पर बुवाई करने एवं नत्रजन की वही मात्रा (225 किग्रा प्रति हे.$^{-1}$) प्रयोग करने से सर्वाधिक उपज (84.53 टन प्रति हे.$^{-1}$) प्राप्त हुई।

पेड़ी प्रबंधन

गन्ना प्रजाति कोसे 92423 की परम्परागत विधि (पंक्ति से पंक्ति अंतराल 90 सेमी) के अन्तर्गत उगाई गयी द्वितीय पेड़ी से दोहरी पंक्ति विधि (30:120 सेमी) वाली द्वितीय पेड़ी उत्कृष्ट पायी गयी। संदर्भित दोहरी पंक्ति विधि से रिक्त स्थान 15.5 प्रतिशत कम आँके गये तथा मिलयोग्य गन्नों की संख्या (108000 हे.$^{-1}$) व गन्ना उपज (71.6 टन हे.$^{-1}$) में सार्थक अन्तर पाया गया। पेड़ी गन्ने की उपज वृद्धि के लिए सामान्य बीज दर से 25 प्रतिशत अधिक बीज दर के साथ दोहरी पंक्ति विधि (30:120 सेमी) अथवा सामान्य बीज दर से बुवाई करने पर प्रथम सिंचाई के समय रिक्त स्थानों की भराई, दोनों ही समान रूप से प्रभावी सिद्ध हुयीं। यद्यपि इन विधियों का गन्ने के रस में शर्करा प्रतिशत पर कोई प्रभाव नहीं पाया गया।

नौलख तथा पेड़ी दोनों में ईष्टतम् पौध सघनता प्राप्त करने के उद्देश्य से किये गये शोध निष्कर्ष में पाया गया कि तीन आँख वाले 30 हजार टुकड़े हे.$^{-1}$ बोने पर 45 दिन बाद सर्वाधिक (21.78%) रिक्त स्थान थे जबकि 40 हजार, 50 हजार तथा 60 हजार हे.$^{-1}$ वाले उपचारों में रिक्त स्थानों का प्रतिशत क्रमशः 80.1, 73.1, व 65.1 टन हे.$^{-1}$ पाया गया। सर्वाधिक गन्ना उपज (86.3 टन हे.$^{-1}$) तीन आँख वाले 60 हजार टुकड़े हे.$^{-1}$ की बुवाई से प्राप्त हुयी।

गन्ने की कटाई से पूर्व इथ्रेल तथा कटाई उपरान्त पोटैसियम तथा जिंक के प्रयोग से नियंत्रित स्थिति में 50 तथा 100 सेल्सियस तापमान पर आँखों का अंकुरण अधिक पाया गया। कम तापमान पर पोटैसियम का प्रयोग, जिंक तथा इथ्रेल से अधिक प्रभावी पाया गया। शरद्कालीन पेड़ी की अंकुरित आँखों में बिना अंकुरण वाली आँखों की अपेक्षा प्रहासन शर्करा, घुलनशील प्रोटीन, प्रोलिन, हाइड्रोजन पेराक्साइड की मात्रा तथा एसिड इनवर्टेज एवं एटीपेज इन्ज़ाइम्स की क्रियाशीलता अधिक पायी गयी जबकि एमडीए, कुल फिनाल, इन्डोल एसिटिक एसिड, कैटेलेज की क्रियाशीलता, पेराक्सिडेज तथा एसओडी इन्ज़ाइम्स कम पाये गये।

गन्ना आधारित फसल पद्धति में पोषक तत्व प्रबंधन

द्वितीय पेड़ी में जैव उर्वरक (गोबर की खाद 10 टन हे.$^{-1}$ तथा *ट्राइकोडरमा विरिडि* 25 किग्रा हे.$^{-1}$) प्रयोग करने पर सर्वाधिक किल्ले (265930 हे.$^{-1}$), मिल योग्य गन्ने (112950 हे.$^{-1}$) तथा गन्ना उपज (71.73 टन हे.$^{-1}$) पाये गये। नत्रजन की 200 किग्रा. हे.$^{-1}$ मात्रा डालने पर सर्वाधिक किल्ले (268340 हे.$^{-1}$), मिल योग्य गन्ने (114290 हे.$^{-1}$) तथा गन्ना उपज (7311 टन हे.$^{-1}$) प्राप्त किये गये। इस प्रकार जैव-कार्बनिक खाद (गोबर की खाद 10 टन हे.$^{-1}$ + *ट्राइकोडरमा विरडि* 25 किग्रा हे.$^{-1}$) तथा अकार्बनिक नत्रजन खाद (200 किग्रा हे$^{-1}$) द्वितीय पेड़ी में अधिकतम पौध संख्या, मिल योग्य गन्ने तथा गन्ना उपज के लिए सर्वोत्तम पाया गया।

वेलग्रो कार्बनिक उर्वरक को एनपीके के साथ प्रयोग करके गन्ने की उपज एवं गुणवत्ता के अध्ययन में पाया गया कि फास्फोरस व पोटैसियम की संस्तुत मात्रा के साथ वेलग्रो की 400 किग्रा हे.$^{-1}$ आधारभूत मात्रा (बेसल डोज) के रूप में तथा नत्रजन 150 किग्रा हे.$^{-1}$ खड़ी फसल में प्रयोग करने से मिल योग्य गन्ने (78,500 हे.$^{-1}$), गन्ने की लम्बाई (179 सेमी), गन्ना बजन (798 ग्रा.), गन्ना उपज (69 टन हे.$^{-1}$) तथा चीनी उपज (8.13 टन हे.$^{-1}$), सार्थक अन्तर से अधिक पाये गये।

एक अन्य प्रयोग में नत्रजन, फास्फोरस, पोटैसियम तथा सल्फर के विभिन्न ग्रेड वाली खाद के मिश्रण (12-16-16-06, 14-20-10-06 तथा 15-17-11-07) समान तत्व के आधार पर प्रयोग करने पर उपज एवं गुणवत्ता के लिए सम प्रभावी पाये गये। इन खाद मिश्रणों का विशेष रूप से सल्फर की कमी वाली मृदाओं में गन्ने में संतुलित मात्रा में पोषक तत्व देने के लिए प्रयोग किया जाना श्रेष्ठकर रहेगा।

गन्ने के लिए कार्बनिक पोषक मोड्यूल

गन्ना पेड़ी फसल पद्धति के अन्तर्गत गन्ने की उपज एवं गुणवत्ता में विभिन्न जैव उर्वरकों को परखने के लिए सन् 2003 में एक प्रक्षेत्र प्रयोग किया गया। इसमें मृदा की भौतिक-रासायनिक तथा सूक्ष्मजैविक गुणों का भी अध्ययन किया गया। चतुर्थ पेड़ी में एसपीएमसी + *एसिटोबैक्टर* के प्रयोग से सर्वाधिक गन्ना उपज (69.5 टन हे.$^{-1}$) प्राप्त हुई। इससे कम गन्ना उपज (67.3 टन हे.$^{-1}$) एसपीएमसी के प्रयोग से तथा 65.6 टन हे.$^{-1}$ वर्मीकम्पोस्ट + *एसिटोबैक्टर* के प्रयोग से प्राप्त हुई। पौध एवं उपज वृद्धि वाले पौध गुण जैसे पौध शुष्क भार, किल्लों की संख्या, गन्ने की लम्बाई, मिल योग्य गन्ने, गन्ना मोटाई एवं वजन आदि भी इसी क्रम में उन्नत पाये गये, जबकि रस की गुणवत्ता में उल्लेखनीय अन्तर नहीं आया।

विभिन्न जैव-उर्वरक उपचारों से मृदा का कार्बनिक कार्बन 0.63 से 0.68 प्रतिशत के मध्य रहा जबकि मृदा में इसकी प्रारम्भिक मात्रा 0.32 प्रतिशत थी। विभिन्न जैव उर्वरकों के प्रयोग से मृदा की जैवाणुविक क्रियाशीलता में वृद्धि आँकी गयी। एसपीएमसी + *एसिटोबैक्टर* के प्रयोग से क्रमशः सर्वाधिक मृदा जैवाणुविक बायोमास कार्बन 278.21 मिग्रा. CO_2-C प्रति किग्रा मृदा प्रति दिन एवं 273.75 मिग्रा CO_2-C प्रति किग्रा मृदा आँके गये जो कि मृदा की प्रारम्भिक मात्रा 47.60 मिग्रा CO_2-C प्रति किग्रा. मृदा प्रति दिन से अधिक थी।

अन्य प्रयोग में कार्बनिक पोषण मोड्यूल जिसमें एसपीएमसी 10 टन हे.$^{-1}$ + गोबर की खाद 10 टन हे.$^{-1}$ या एसपीएमसी 10 टन हे$^{-1}$ + *एजोटोबैक्टर* का प्रयोग किया गया, जड़-मूल परिवेश में जैवाणुविक मात्रा, मृदा स्वास्थ्य सुधार, गन्ना उपज वृद्धि तथा धान-शरद्कालीन पेड़ी-गेहूँ तथा धान-बरसीम-बसन्तकालीन गन्ना-पेड़ी-गेहूँ पद्धतियों में नौलख पेड़ी पद्धति के लिए आर्थिक दृष्टिकोण से आदर्श पाया गया।

सन् 2006 में बसन्तकाल मे प्रारम्भ किये गये एक अन्य प्रयोग में नत्रजन की 75% संस्तुत मात्रा अकार्बनिक स्रोतों से +25% मात्रा कार्बनिक उर्वरकों + जैव खादों + जैव कीटनाशी के प्रयोग से सर्वाधिक गन्ना (नौलख) उपज (90 टन हे.$^{-1}$) तथा पेड़ी उपज (76 टन हे.$^{-1}$) प्राप्त हुई जबकि 75% संस्तुत नत्रजन कार्बनिक श्रोतों से + जैव खाद + 25% संस्तुत एनपीके की मात्रा अकार्बनिक श्रोतों से + जैव कीटनाशी के प्रयोग से नौलख एवं पेड़ी की कम गन्ना उपज क्रमशः 87.7 तथा 75.4 टन हे.$^{-1}$ प्राप्त की गयी। रस की गुणवत्ता इन उपचारों से अप्रभावित आँकी गयी। कार्बनिक खेती मोड्यूल्स के अन्तर्गत उगाई गयी पेड़ी की कटाई उपरान्त मृदा कार्बनिक कार्बन की मात्रा में सुधार पाया गया यद्यपि मृदा नत्रजन, फास्फोरस व पोटास की मात्रा में कोई स्थायी रुझान नहीं पाया गया।

सूखा प्रबंधन के लिए उपयुक्त सस्य तकनीकी

सस्य प्रबंधन की विभिन्न विधाओं द्वारा सूखा के कुप्रभाव को कम करने के प्रयोग के अन्तर्गत बुवाई की गड्ढा विधि में सर्वाधिक जमाव प्रतिशत (47%) आँका गया। नाली विधि द्वारा बोये गन्नों का जमाव इससे कम रहा। गन्ने की 60 सेमी के पंक्ति अंतराल पर की गयी बुवाई से सर्वाधिक मिलयोग्य गन्ने (130,000 हे.$^{-1}$) पाये गये। इस विधि द्वारा गन्ने की उपज वृद्धि वाले कारकों जैसे गन्ने की

लम्बाई (252.1 सेमी.), मोटाई (2.61 सेमी), वजन (1.3 किग्रा.) में उल्लेखनीय वृद्धि पायी गयी। परिणामतः गड्ढा विधि द्वारा बुवाई से प्राप्त गन्ना उपज (86.3 टन हे.$^{-1}$) तथा चीनी उपज (9.02 टन हे.$^{-1}$) में सार्थक अन्तर से वृद्धि पायी गयी। गन्ने के टुकड़ों को संतृप्त चूना पानी में भिगोकर बोने, यूरिया तथा पोटैसियम क्लोराइड के 2.5% सान्द्रता वाले घोल को बुवाई के 90, 105 एवं 120 दिन बाद छिड़काव करने + बुवाई के 60 दिन बाद पताव बिछाने तथा बुवाई से पहले कूँड़ों में 10 टन हे.$^{-1}$ की दर से गोबर की खाद डालने की अपेक्षा बुवाई के 170 दिन बाद 60 किग्रा. हे.$^{-1}$ की दर से पोटैशियम डालने पर गन्ना उपज में उल्लेखनीय वृद्धि (82.5 टन हे.$^{-1}$) आँकी गयी तथा इसकी गुणवत्ता में वृद्धि भी दर्ज की गयी।

समन्वित खरपतवार नियंत्रण

गन्ने की कोसे 92423 प्रजाति की पेड़ी में खरपतवारों के कारण गन्ना उपज में 36% की कमी आयी। गन्ने में तीन गुड़ाइयॉ (पेड़ी प्रारम्भ करने के बाद क्रमशः प्रथम, चतुर्थ व सातवें सप्ताह बाद) करने से खरपतवारों के शुष्क पदार्थ में उल्लेखनीय कमी (20 ग्रा मी.$^{-1}$) आयी तथा गन्ना उपज (63.3 टन हे.$^{-1}$) में वृद्धि ऑकी गयी जो कि एट्राजीन/मेट्रीब्यूजीन/ग्लायसेल से उपचार के बाद 2, 4-डी का प्रयोग या एक गुड़ाई करने से प्राप्त गन्ना उपज के लगभग समान थी। इसी प्रकार एकान्तर पंक्तियों या सम्पूर्ण खेत में एक समान पताव बिछावन से खरपतवार में प्रभावी ढंग से नियंत्रण पाया गया तथा तीन गुड़ाइयों के समान गन्ना उपज प्राप्त हुई। इससे स्पष्ट है कि समन्वित खरपतवार नियंत्रण विधि (शाकनाशी+गुड़ाई/पतवार बिछाना + गुड़ाई) को अपनाकर तीन गुड़ाईयाँ करने वाले परम्परागत ढंग को बदला जा सकता है।

समन्वित ब्याधि प्रबंधन

ट्राईकोडर्मा हरजिएनम (टी 37 तथा टी 38) की स्टरलाइज़्ड एवं अनस्टरलाइज़्ड प्रेसमड पर वृहद् स्तर पर संख्या वृद्धि करने में सफलता प्राप्त हुयी। इनकी 32^0 से. तापमान तथा 30% नमी पर 21 दिनों की वृद्धि से $7.66x10^6$ सीएफयूजी ग्रा$^{-1}$ प्राप्त हुए। स्टरलाइज़्ड प्रेसमड या सब्स्ट्रेट पर दो किग्रा न्यूक्लियस कल्चर को पुनः 200 किग्रा. अन्स्टरलाइज़्ड प्रेसमड पर बहुगुणित करके बुवाई के समय प्रयोग किया गया। लाल सड़न रोग सुग्राही प्रजाति कोलक 7701 की बावक फसल में टी 37 + सैलिसिलिक अम्ल के उपचार से इस रोग के फैलाव में उल्लेखनीय कमी (86.67%) आयी। इससे जमाव में 9.44%, किल्लों की संख्या में 18.52%, मिलयोग्य गन्नों की संख्या में 13.21% तथा उपज में 34.64% की वृद्धि ऑकी गयी। पेड़ी में टीएमसी, बीजाणु घोल, बीजाणु घोल+ मेटाबोलाइट्स, मेटाबोलाइट्स, बीजाणु घोल + टीएमसी तथा टीएमसी + मेटाबोलाइट्स के साथ टी 37 से उपचार करने पर क्रमशः 50.6, 53.1, 60.0, 65.6, 63.0 एवं 63% गन्ने तथा टी 38 से 59.0, 62.9, 65.0, 66.3, 67.0 एवं 73.6% गन्नों में लाल सड़न को रोकने में सहायता मिली। पेड़ी में ठूँठों के फुटाव में वृद्धि (5.37%) पायी गई। पौधों के शिरों में इन्डोल एसिटिक एसिड की मात्रा (67.87 माइक्रोग्राम प्रति 100 ग्राम ताजा भार) में वृद्धि ऑकी गयी। किल्लों की संख्या, मिलयोग्य गन्ने, लम्बाई, मोटाई, गाँठो के बीच की लम्बाई में वृद्धि हुयी तथा अनुपचारित रखी गई फसल की अपेक्षा 18.54 टन हे. अधिक उपज प्राप्त हुयी।

सी. फैल्केटम की अंतरण प्रणाली स्पष्ट करने के लिए 14 गन्ना प्रजातियों में प्लग विधि तथा सीसीटी में तुलना की गयी। सामान्यतया, सी सी टी में ब्याधि दरें प्लग विधि की अपेक्षा अधिक पायी गयीं। प्लग विधि में तमाम रोग रोधी प्रजाति प्रभेदों ने सीसीटी में सीमित (माडरेट) एवं सुग्राही आचरण दर्शाए। संभवतः सी सी टी में अधिक आर्द्रता तथा स्थिर तापमान के कारण गन्ना प्रभेदों में सुग्राहिता बढ़ गयी।

गन्ना, प्रजाति को 7717, के उकठा रोग ग्रस्त पौधों की जड़ से अलग करने पर *फ्यूजेरियम, पिथियम, राइजोक्टोनिया, निग्रोस्पोरा, ट्राइकोडर्मा* तथा *कीटोमियम* वंश के फँफूद पाये गये। *फ्यूजेरियम, पिथियम* या *निग्रोस्पेरा* से अकेले या एक साथ संरोपण से चीरा लगाई गई जड़ों में प्रयोगशाला परिस्थिति के अन्तर्गत आँशिक जड़ सड़न देखा गया। गमलों तथा प्रक्षेत्र में संरोपित एवं असंरोपित ठूठों में उल्लेखनीय अन्तर नहीं आया। इसी प्रकार ऊष्मोपचारित स्वस्थ तथा ऊष्मोचारित रोग ग्रस्त सेट्स (बीज) बोने पर उनके प्रोजनीज में अपने कन्ट्रोल की अपेक्षा रोग ग्रसिता में उल्लेखनीय अन्तर नहीं आया ।

कुल 14 गन्ना प्रजातियों में तीन आइसोलेट्स, आई आर 6, आई आर 7, आई आर 8 तथा प्रभेद सीएफ 11 (कोसा 64) को प्लग विधि से परीक्षण किया गया। आइसोलेट आईआर 6 ने, को 975, को 62399 तथा को 7717 में अलग-अलग तथा शेष में समान प्रतिक्रिया दर्शायी और इस प्रकार सी एफ 8 के रूप में चिन्हित किया गया। प्रभेद सीएफ-11, उत्तर-पश्चिम परिक्षेत्र में मौजूद प्रभेद से भिन्न था।

विभिन्न प्रजातियों में रोग रोधिता मूल्यांकन सम्बन्धी एक अन्य प्रयोग में कोशा 03279, कोह 130, को 0122, कोलक 99271 तथा कोशा 03222 ने *सी. फैल्केट्म* के प्रति सीमित (माडरेट्ली) रोगरोधिता, कोशा 03192, कोलक 9902, को 0116, कोलक 9709, को पन्त 02217, को शा 03252 तथा को पन्त 02218 कँडुआ के प्रति सुग्राही जबकि कोशा 01256, कोशा 01268, को 0327 व कोह 118 ने उकठा रोग के प्रति सुग्राही प्रदर्शित की तथा शेष प्रजातियाँ सहनशील पायी गयीं।

सी. फैल्केटम के आण्विक चिन्हन प्रयोग के अन्तर्गत 6 प्रभेदों सी. एफ 01, सी.एफ. 02, सी. एफ. 03, सी.एफ. 07, सी. एफ 08 तथा सी.एफ.09 का सी.टी.ए.वी. इक्स्ट्रैक्टेड कुल जिनोमिक डी.एन.ए. को 85 रैन्डम डिकैन्यूक्लियोटाइड प्राइमर (ओ.वी.ए., ओ.पी.आई.,ओ.पी.ओ., ओ.पी.टी. तथा एम.ए.पी. श्रेणियाँ) से

प्रवर्धन किया गया। कुल 483 पी.सी.आर. प्रवर्धित जीनोमिक डी.एन.ए. पट् हासिल किये गये जिन्होंने उच्च दर्जे के बहुरूप (पालीमार्फिज़्म) (70%) दर्शाया। प्रभेदों में आर.ए.सी.डी. आँकड़ों के आधारित विश्लेषण से जेनेटिक (पैतृक) समानता 0.32 से 0.97 आँकी गयी। 60% से अधिक आनुंवशिक विचलन दर्शाने वाले सभी 6 प्रमेदों को 2 समूहों में रखा गया है।

पीड़क कीट प्रबन्धन

यूरिया का 75 किलोग्राम प्रति हेक्टेयर की दर से चोटी बेधक (तृतीय वंश) के निकलते समय छिड़काव करने से चोटी बेधक (तृतीय एवं चतुर्थ वंश) के प्रकोप में कमी पाई गई, साथ में प्रति हेक्टेयर उपज में भी वृद्धि हुई।

मध्य उत्तर प्रदेश में पायरिला का अत्यधिक प्रकोप अप्रैल से सितम्बर 2007 में देखा गया, जिसको सफलतापूर्वक *इपीरिकेनिया मेलानोल्यूका* के 10000 कोकून अथवा 5000 कोकून और 5 लाख अण्डे को छोड़ने से नियंत्रण किया गया। एक अन्य प्रयोग में चोटी बेधक (तृतीय एवं चतुर्थ वंश) का प्रकोप 10.11 से 15.26 प्रतिशत था, जो कि पिछले वर्ष की तुलना में कम था। लाल माइट का अधिक प्रकोप अप्रैल से जून तक था जो कि बरसात के दिनों में कम हो गई।

प्रयोगशाला में तापमान सहनशील प्रभेद उत्पन्न करने के लिए *टी. किलोनिस* को 2 डिग्री अधिक सेंटीग्रेड तापमान पर यानि 30 डिग्री सेंटीग्रेड तक *कोरसायरा सिफेलोनिका* के अण्डों पर 5 पीढ़ी तक पाला गया। 30-32 डिग्री सेंटीग्रेड में इनकी प्रजनन क्षमता कम पायी गई। *ट्राइकोग्रामा जपोनिकम* को 26^0 सेन्टीग्रेड पर 10 पीढ़ियाँ एवं 28 डिग्री सेंटीग्रेड पर 5 पीढ़ियों तक पाला गया। इसकी प्रजनन क्षमता प्रारम्भिक पीढ़ियों में बाद की पीढ़ियों की तुलना में ज़्यादा पाई गई।

पताव-विछोना, पताव का जलाना और बिना पताव की, तीनों विधियों की पेड़ी गन्ने में तुलना से यह पाया गया कि पताव-बिछौना के कारण कीटों का प्रकोप बढ़ गया तथा परजीवियों की संख्या में वृद्धि पायी गयी। पताव जलाने से तना बेधक, पोरी बेधक और जड़ बेधक का प्रकोप कम पाया गया तथा लाभ : लागत अनुपात 2.45 प्राप्त हुआ। क्लोरीपाइरिफास और कार्बोफ्यूरान का 1 किलो ग्राम सक्रिय तत्व प्रति हेक्टेयर के प्रयोग से गन्ना की उपज 68.47 टन हे.$^{-1}$ आँकी गई। दो परजीवी *रेकोनोटस रोसलेन्सिस* और *स्टेनोब्रेकान* को प्रयोगशाला में गुलाबी बेधक एवं मक्का बेधक सुंडियों पर बृद्धि के लिए अनुकूल पाया गया।

कोटेसिया लेविप्स परजीवी को प्रयोगशाला में तना बेधक सुंडियों पर वृद्धि के लिए अनुकूल पाया गया। *बीबेरिया वेसियाना* एवं *मेटराइजियम एनीसोपली* फफूंदी को पीडीए एवं तीन कार्बनिक माध्यम (चावल, मक्का और ज्वार) पर वृद्धि किया गया और यह पाया गया कि कृत्रिम (सिन्थैटिक) मेडिया पर *बीबेरिया बेसियाना* की अधिक वृद्धि हुई।

चोटी बेधक की विभिन्न पीढ़ियों (प्रथम, द्वितीय, तृतीय एवं चतुर्थ) में कुल नर पतंगों की संख्या 1124, 5238, 3968, 616 और 403 आँकी गयी। लुभावी ट्रैप द्वारा चोटी बेधक के निकलने के समय को सफलतापूर्वक नियंत्रित किया जा सकता है।

गन्ना के ऊनी माहू की संख्या वातावरण की आर्द्रता एवं वर्षा के बढ़ने के साथ बढ़ती है एवं इनके परजीवियों की संख्या भी बढ़ती है।

थायोमेथोक्सम नामक रसायन 12.5-50.0 ग्राम प्रति हेक्टेयर प्रयोग करने से चुकन्दर के माहू का 15 दिन में नियंत्रण पाया गया। इमामेक्टिन बेन्जोओट 5-10 ग्राम प्रति हेक्टेयर और लुफेनुरान 25-60 ग्राम प्रति हेक्टेयर प्रयोग से *स्पाइलोसोमा आवलिक्वा* एवं *स्पोडोप्टेरा लिटूरा* को नियंत्रण किया गया।

ई 2 वाई 45, 0.4 जीआर के दानेदार मिश्रण से दीमक एवं चोटी बेधक को नियंत्रित किया गया। बोने के समय वाईफेन्थ्रिन 100 ग्राम प्रति हेक्टेयर नाली में प्रयोग करने से दीमक को नियंत्रित किया गया जिससे अधिक उपज पायी गयी।

गन्ना खेती में यंत्रीकरण

ट्रैक्टर चालित गन्ने की दो पंक्तियों को एक साथ काटने वाला यंत्र विकसित किया गया। जिसका ढाँचा पिटवा लोहे से निर्मित है तथा यंत्र को ऊपर नीचे करने के लिए प्रावधान, विद्युत शक्ति संचारण तथा कटाई ईकाइयाँ लगी है। मुख्य ढांचे में काटने वाले ब्लेड्स की तरफ गन्ने को लाने एवं गिरे हुए गन्ने को भी ऊपर उठाने का प्रावधान किया गया। संस्थान प्रक्षेत्र में किये गये ट्रायल अध्ययन में बिना गिरे हुए गन्ने की कटाई तथा विन्डरोविंग संतोषजनक पायी गयी।

अँगौले की कटाई एवं पत्ती सफाई के लिए एक पावर चालित डिट्रैसर का परीक्षण किया गया। यंत्र द्वारा तीन गन्नों की एक साथ पत्ती सफाई की कार्य विधि संतोषजनक पायी गयी। अँगौला सफाई क्षमता (2 गन्ने) 90-99% तथा अँगौला पताव सफाई क्षमता 80-90% पायी गयी।

वर्तमान पेड़ी प्रबंधन यंत्र से भिन्न पेड़ी प्रमोटर यंत्र का प्रारूप तैयार किया गया जिसमें ठूँठ कटाई एवं ऊर्जा चालित प्रणाली के अतिरिक्त अन्य उप-इकाईयाँ पूर्ववत समान रखी गयीं। खाद /उर्वरक को पंक्तियों में डालने के लिए प्रत्येक पंक्ति की मीटरिंग डिवाइस को चलायमान रखने हेतु इस प्रारूप में एक फ्लोएटिंग टाइप लग्ड ग्राउन्ड व्हील लगाया गया है।

एक ट्रैक्टर चालित गन्ना बुवाई-एवं-विजाई यंत्र का 55 एच.पी. ट्रैक्टर द्वारा किसानों के खेतों पर परीक्षण किया गया। इसमें गन्ने की दो पंक्तियों की बुवाई, बेड बनाना, इसमें गेंहूँ की दो पंक्तियों में विजाई तथा खाद डालना एक साथ सम्पादित हो जाते हैं।

इंजिन चालित बहुउद्देशीय निकाई गुड़ाई यंत्र (रिवर्सिबल

शावेल्स टाइप 3-टाइन इन्टर कल्चरल टूल) को विकसित व परीक्षित किया गया। प्रक्षेत्र में 75 सेमी पंक्ति अन्तराल पर बोये गये गन्ने में प्रभावी प्रक्षेत्र क्षमता 0.2 हे घंटा.$^{-1}$ तथा खरपतवार निवारण क्षमता 70-80% आंकी गयी। यंत्र 10-15 सेमी गहनी कर्षण क्रिया करने में सक्षम है। यंत्र की क्षमता 10 घंटा हे.$^{-1}$ की दर से आंकी गयी।

गन्ना आलू की अन्तः फसली खेती को बढ़ावा देने के उद्देश्य से एक ट्रैक्टर चालित संयुक्त भूपरिष्करण यंत्र विकसित किया गया तथा आलू की बुवाई के लिए खेत की तैयारी हेतु परीक्षण किया गया। इस यंत्र द्वारा डीजल की बचत हुयी तथा परम्परागत भूपरिष्करण यंत्रों की अपेक्षा खेत ज़्यादा अच्छा तैयार हुआ। इस यंत्र में आलू की बिजाई हेतु एक अतिरिक्त प्रावधान भी पूर्ण कर लिया गया है।

कटाई उपरान्त तकनीक

गन्ना कटाई से 5 दिन पूर्व जिंक सल्फेट विलयन (1000 पी.पी.एम.) का छिड़काव करने से कटाई के बाद 7 दिनों तक गन्ना रखे रहने पर भी सुक्रोष में 6%, शुद्धता में 6.4% की वृद्धि आंकी गयी जिससे सी.सी.एस.में 10.2% की वृद्धि दर्ज की गयी। जबकि मैगंनस शल्फेट के उपचार से अनुपचारित गन्नों की अपेक्षा 5.7% की वृद्धि दर्ज की गयी। एसिड इन्वर्टेज की कम क्रियाशीलता के कारण ऐसे परिणाम प्राप्त हुए। कटाई पूर्व जिंक सल्फेट का मृदा में प्रयोग से अनुपचारित गन्ने की अपेक्षा सुक्रोज (10.5%), शुद्धता (1.9%) में वृद्धि तथा प्रहासन शर्करा (48.3%) में कमी आंकी गयी।

देरी से गन्ना पेराई सत्र में गन्ने की पोरी में एसिड इनवर्टेज की क्रियाशीलता प्रारम्भिक पेराई सत्र के समय बाले गन्ने की अपेक्षा अधिक पायी गयी। क्यू यू एटी उपचारित गन्नों की अनुपचारित गन्नों की अपेक्षा एसिड इनवर्टेज की क्रियाशीलता कम हुयी तथा चीनी मिल स्तर पर बासी (स्टेल्ड) गन्नों में चीनी परता की 0.4 यूनिट की वृद्धि आँकी गयी।

गुड़ बनाने, भंडारण करने तथा मूल्यवर्धन के अध्ययन के अन्तर्गत गन्ना छिलाई यंत्र, गन्ना रस छनाई की मशीनीकृत इकाई, खुली कड़ाही में रस मंथन डिवाइस, गुड़ को धूप से सुखाने का यंत्र (सोलर ड्रायर) तथा गुड़ में विटामिन सी मिलाकर उसके मूल्य वृद्धि आदि के प्रयोग किये गये। मूल्यांकन अध्ययनों में आई आई एस आर जैगेरी ड्रायर तथा टी एन ए यू गन्ना कोल्हू का परीक्षण किया गया।

तकनीकी हस्तान्तरण

गन्ना प्रजाति कोलक 94184 को ब्यावसायिक स्तर पर उगाने के लिए चिन्हित किया गया। इसके साथ 7 जीन प्रारूपों को राज्य स्तरीय प्रजाति अध्ययनों के लिए स्वीकृत किया गया। इन जीन प्रारूपों का बीज चीनी मिलों को बहुगुणित करने के लिए दिया गया। संस्थान ने 7 कृषि यंत्रों के निर्माण करने की तकनीकी जानकारी एवं उनके तैयार करने के अधिकार (मैनुफैक्चरिंग राइट्स) 2 कम्पनियों को निर्माण के लिए प्रदान किये गये। गन्ना उत्पादन की उन्नत जानकरी किसानों को डाक्यूमेन्टरी फिल्म, टी वी तथा रेडियो वार्ताओं द्वारा भी दी गयी।

गन्ने की उत्पादन लागत

देश के छः प्रमुख गन्ना उत्पादक राज्यों महाराष्ट्र, तमिलनाडु, कर्नाटक, आन्ध्र प्रदेश, गुजरात तथा उत्तर प्रदेश में उत्पादकता एवं उत्पादन लागत के दीर्घकालीन (1971-72 से 2005-06) विश्लेषण से स्पष्ट होता है कि उत्पादकता स्तर में वृद्धि दर गन्ना उत्पादन लागत में वृद्धि दर के अनुरूप नहीं हुई है। गन्ने की उत्पादन लागत में मुख्यतः सिंचाई लागत तथा मजदूरी लागत के अंश में आशातीत वृद्धि हुई है जिसके फलस्वरूप गन्ना खेती से कुल आय में लाभ के अंश में वर्ष दर वर्ष कमी आंकी गई है। महाराष्ट्र, तमिलनाडु एवं आन्ध्र प्रदेश राज्यों में यह कमी स्पष्ट रूप से विदित हुई है।

चुकन्दर शोध एवं विकास

संस्थान द्वारा चुकन्दर की प्रजाति एल एक-6 तथा सिन्जेंटा प्रा. लि. की प्रजाति एच आई. 0064 (शुभ्रा) को ए पी सेस नेटवर्क परियोजना (चुकन्दर) के अन्तर्गत उष्ण-कटिबन्धीय परिस्थितियों में उगाने के लिए चिन्हित किया गया है।

विविध

फसल एवं मौसम सम्बन्धी दीर्घकालीन (1980-99) ऑकड़ा बेस पर आधारित उत्तर प्रदेश में गन्ना फसल की उत्पादकता के आंकलन हेतु एक मौसम आधारित (सक्रिय) मॉडल तैयार किया गया तथा उसके उपयोग से वर्ष 2000 से 2006 तक की गन्ना फसल की उत्पादकता स्तर का ऑकलन किया गया जो कि वास्तविक उत्पादकता स्तर के करीब पाई गई। संस्थान स्तर पर कृषि-मौसम, गन्ना उत्पादन एवं चीनी उद्योग के विभिन्न पहलुओं पर एक ऑकड़ा वेयर हाऊस बनाने का कार्य प्रारम्भ किया गया है। इस वर्ष भारतीय शोध पत्रिकाओं में 36 एवं विदेशी शोध पत्रिकाओं (जनरल) में 6 शोध पत्रों के माध्यम से संस्थान के शोध परिणाम प्रकाशित हुए हैं। लगभग हर वैज्ञानिक ने कम से कम एक राष्ट्रीय स्तर के समिनार/कार्यशाला में भाग लिया है।

Executive Summary

Crop Improvement

CoLk 94184 (Birendra), an early maturing, high sugar variety with excellent ratooning was identified for the North Central Zone by the AICRP on Sugarcane. Mid-late maturing variety CoLk 9705 did well in the plant and ratoon crop in the advance trials of AICRP(S). One early (CoLk 07201) and two mid-late maturing varieties (CoLk 07202 and CoLk 07203) were accepted for multilocation testing for NW zone. CoLk 05202 and CoLk 9709 (Early) and two mid-late varieties (CoLk 99271 and CoLk 07203) were accepted for the UP State trials.

With regards to breeding for biotic and abiotic stresses involving conventional and biotechnological techniques, promising clones were identified. In the ongoing search for molecular markers for resistance to red rot, suitable crosses involving *Saccharum spontaneum* (accession SES 594) were attempted. Similarly, for sugar accumulation, parents with high and low sugar were used to develop mapping populations for these traits. Research on breeding for tolerance to top borer utilized *Erianthus* parents to introgress the desirable variability and has led to some elite clones. One such selection LG 2910 (CoLk 07201) has been accepted for AICRP testing. Genotypes have also been identified for suitability under moisture deficit conditions and late planting condition. Nine promising selections showing commercial merit and resistance to red rot have been included in the Station Trial.

To identify genetically diverse groups, a set of 46 sugarcane varieties were subjected to molecular characterization by RAPD, SSR and ISSR markers. Some somaclones were analyzed with polymorphic SSR markers for differentiating these from their source varieties. Four somaclones of CoS 767 have been found to possess moderate resistance to red rot as opposed to the highly susceptible reaction of CoS 767 to pathotype Cf 09. The initial result from root inoculation with *Gluconacetoabacter diazotrophicus* appeared encouraging for value addition of micropropagated plantlets of sugarcane.

Efficient input use sugarcane genotypes

In spring season, significantly higher cane yield (68.7 t ha^{-1}) was harvested with genotype, CoS 96275 as compared to CoJ 99192 (58.7 t ha^{-1}) and CoS 94257 (64.6 t ha^{-1}). The maximum sugar yield (7.96 t ha^{-1}) was also obtained with genotype, CoS 96275.

In another experiment, early maturing sugarcane genotype CoLk 94184 produced the highest number of millable cane (136.4 t ha^{-1}), cane yield (59.2 t ha^{-1}), CCS content (12.22%) and CCS yield (7.99 t ha^{-1}) and was followed by BO 128 and CoS 95270. Application of 150 kg N ha^{-1} + 10 t FYM ha^{-1} gave the highest NMC (125.6 t ha^{-1}) and cane yield (67.1 t ha^{-1}). Amongst mid-late maturing sugarcane genotypes, significantly highest number of millable cane (130.1 t ha^{-1}) and cane yield (60.2 t ha^{-1}) were record for CoH 110, which was however, at par with CoLk 9616. But genotype CoH 110 produced the highest CCS (7.51 t ha^{-1}). Newly developed sugarcane genotype CoLk 94184 recoded significantly higher germination (44.4%), number of tillers in July (205.2 t ha^{-1}), number of millable cane (103.7 t ha^{-1}) and cane yield (68.8 t ha^{-1}) as compared to CoLk 97147. This genotype also produced higher commercial cane sugar (9.30 t ha^{-1}). There was no significant variation in cane yields due to different spacings. Application of 150 and 225 kg N ha^{-1} significantly improved NMC and yield. Genotype CoLk 94184 produced highest cane yield (93.84 t ha^{-1}) at 90 cm spacing and 225 kg N ha^{-1}, while CoLk 97147 produced maximum cane of 84.53 t ha^{-1} at 60 cm spacing fertilized with 225 kg N ha^{-1}.

Ratoon management

The second ratoon crop (2nd cycle) of sugarcane (Cv. CoSe 92423) raised under paired row planting system (30:120 cm) proved superior over conventional planting system (90 cm) by significantly lowering the gaps (15.5%) and producing higher number of millable canes (108 t ha^{-1}) and cane yield (71.6 t ha^{-1}). Sugarcane planted under paired row system (30:120 cm) with higher seed rate (25%) or planted with normal seed rate with gap filling at 1st irrigation proved equally good in increasing ratoon yield. This practice also curtailed the gap filling operation in ratoons. None of the practice could affect the pol % in juice.

Experiment on optimizing plant population density in sugarcane plant-ratoon system indicated that the percentage of gaps observed at 45 days after planting was the maximum (21.78%) under planting density of 30,000 three-bud setts ha^{-1}, followed by 10.94%, 5.35% and 2.32% with 40000, 50000 and 60000

three-bud setts ha^{-1}, respectively. The highest cane yield (86.3 t ha^{-1}) was recorded with planting density of 60000 three-bud setts ha^{-1} followed by 80.1, 73.1 and 65.1 tha^{-1} under 50000, 40000 and 30000 three-bud setts ha^{-1}, respectively.

Application of Ethrel (Pre-harvest), K and Zn (Post-harvest) improved the sprouting of buds at 5°C and 10°C under controlled conditions. Application of K led to maximum improvement in bud sprouting at sub-optimal temperatures followed by Zn and Ethrel. In winter initiated ratoons, sprouted buds showed relatively higher reducing sugars, soluble protein, proline, H_2O_2 contents and activity of acid invertase and ATPase enzymes and lower content of MDA, total phenols, IAA and activity of catalase, peroxidase and SOD enzymes as compared to the unsprouted ones.

Nutrient management in sugarcane based cropping systems

Application of N (150 kg ha^{-1}) resulted in significantly higher (73.0%) increase in cane yield of second ratoon crop. Integration of P, K and S could not result in further significant incease of cane yield over N application. Application of other nutrients with NPK also did not increase the yield significantly over NPK use. The higher response of N may be due to the deficiency of available N in the soil. The content of other nutrients was not deficient in the soil. Juice quality parameters remained unaffected by the treatments.

One experiment conducted with different grades of NPKS mixed fertilizers (12-16-16-06, 14-20-10-06 and 15-17-11-07) found them equally effective source, if applied on equal nutrient basis for the yield and quality of ratoon crop also. Application of these may be a good step for basal and balanced application for sugarcane, in general for the all soils and, in particular for S-deficient soils.

Application of bio-manure (FYM @ 10 t ha^{-1} & *Trichoderma viride* @ 25 kg ha^{-1}) produced the maximum umber of shoots (265930 ha^{-1}) and millable canes (112950 ha^{-1}) resulting in the highest yield (71.73 t ha^{-1}) of second ratoon crop of sugarcane. Nitrogen applied @ 200 kg ha^{-1} recorded maximum shoot population (268340 ha^{-1}), millable canes (114290 ha^{-1}) and cane yield (73.11 t ha^{-1}) as compared to other N doses. Hence, the application of bio-organics (FYM @ 10 t ha^{-1} + *Trichoderm viride* @ 25 kg ha^{-1}) and inorganic nitrogen fertilizer (200 kg ha^{-1}) found superior than other treatments in terms of producing maximum shoot population, millable canes and highest cane yield in the second ratoon crop of sugarcane.

In an experiment, effect of wellgro organic manure with NPK on yield and quality was studied. Application of recommended dose of P and K (basal) mixed with 400 kg wellgro manure ha^{-1} and top dressing of recommended nitrogen (150 kg ha^{-1}) improved number of millable canes (78500 ha^{-1}), individual cane length (179 cm), cane weight (798 g), (69 t ha^{-1}) and sugar yields (8.13 t ha^{-1}), significantly.

Organic nutrition modules for sugarcane

Field experiment was started in spring, 2003 with the objectives to evaluate the efficacy of different biomanures on yield and quality of sugarcane under plant and subsequent ratoons and to study the changes in physico- chemical and microbial properties of soil on long term basis. The highest cane yield (69.5 t ha^{-1}) in 4th ratoon was recorded with SPMC + *Acetobacter*). This was followed by SPMC (67.3 tha^{-1}) and vermicompost + *Acetobacter* (65.6 tha^{-1}). The growth and yield attributing characters viz. dry matter production, number of tillers, plant height, number of millable cane, cane length, cane thickness and weight also exhibited similar trend. Juice quality did not differ significantly by the different treatments however, the highest brix of ^{0}19.8 was recorded with FYM +Acetobacter and closely followed by SPMC + Acetobacter (19.4).

Soil organic carbon ranged between 0.63 to 0.68 under different treatments of bio manuring, over its initial value of 0.32 %. Soil microbial activity enhanced due to different biomanurial treatments. The highest value of soil microbial biomass carbon (SMBC) of 278.21 mg CO_2-C Kg^{-1} soil day^{-1} was recorded under plots receiving SPMC + Acetobacter.and closely followed by vermicompost + Acetobacter (273.75 mg CO_2 - C / kg soil^{-1} day^{-1}) against initial value of 47.60 mg CO_2-C kg soil^{-1} day^{-1}.

Another experiment highlighted that organic nutrition module comprising SPM 10 t ha^{-1}+ FYM 10 t ha^{-1}or SPM 10 t ha^{-1}+ *Azotobacter* proved ideal organic farming module for enriching rhizospheric microbial pool, maintaining soil health, enhancing cane productivity and making plant-ratoon system economically viable in two distinct diversified cropping system viz., rice-autumn sugarcane-ratoon-wheat, rice-berseem-spring sugarcane-ratoon-wheat.

In yet another experiment initiated during spring 2006, highest cane yield of plant crop (90 t ha^{-1})

and ratoon cane (76.0 t ha^{-1}) were recorded with 75% recommended N through inorganics + 25% through organic manures + biofertilizers + biopesticides and closely followed by 75% of recommended N through organics + biofertilizers + 25% of recommended NPK through inorganics + biopesticides (87.7 and 75.4 t ha^{-1} in plant and ratoon crop, respectively). Juice quality remained unaffected by these treatments. There was an improvement in soil organic carbon under different organic farming modules at the harvest of ratoon crop. However, no definite trend could be observed for available N, P & K in relation to different modules.

Agro-techniques for management of summer drought

In an experiment on drought management conducted with different methods and different management practices, highest germination of 47.0% was recorded under pit planting method closely followed by trench method. Planting of sugarcane at 60 cm spacing produced significantly highest number of tillers as well as number of millable cane (130.1 t ha^{-1}). The yield attributes like cane length (252.1 cm), girth (2.61 cm) and weight per cane (1.30 kg) were significantly higher under pit method of planting. Consequently, Pit planting produced significantly higher cane (86.3 t ha^{-1}) as well as sugar (9.02 t ha^{-1}) yield. Significantly highest cane (82.5 tha^{-1}) as well as sugar (8.9 tha^{-1}) yield was recorded by additional 60 kg K_2O ha^{-1} at 170 DAP over and above soaking setts in saturated lime water + foliar spray of urea and KCl @ 2.5 % at 90, 105 and 120 DAP + trash mulch after 60 DAP + application of FYM @ 10 t ha^{-1} in the furrows before planting. Additional 60 kg K_2O ha^{-1} significantly improved the juice quality.

Integrated weed management

The weed infestation reduced the ratoon cane yield of CoSe 92423 by 36%. Three hoeings (at 1st, 4th and 7th week after ratoon initiation) reduced the weed infestation to the maximum with the lowest dry matter production (20 g m^{-2}). It resulted in the highest number of millable canes (113.4 t ha^{-1}) and cane yield (63.3 t ha^{-1}) which were comparable with the herbicidal treatments (atrazine / metribuzin / glycel) followed by either 2, 4-D application or one hoeing (post emergence). Similarly, trash mulching either in alternate rows or in all the rows of cane effectively controlled the weeds and produced cane yield at par with three hoeings. This clearly indicates that an integrated weed management (herbicide + hoeing / mulching + hoeing) may replace the traditional method of weed control (3 hoeings).

Integrated disease management

Mass multiplication of *T. harzianum* potent strains (T37 & T38) on sterilized and un-sterilized press mud was successful. A growth of 21 days (at 32^0C and 30% moisture) resulted $7.66x10^6$ CFU g^{-1}. Two kg nucleus culture on sterilized pressmud / substrate was further multiplied on the 200 kg un-sterilized pressmud and applied at the time of planting. In the plant crop, the treatment with metabolites of T 37 + salicylic acid checked (86.67%) red rot development in canes of the susceptible variety CoLk 7701. It also improved germination (9.44%), no. of tillers (18.52 %), NMC (13.21%) and yield (34.64%). In ratoon crop, the development of red rot was checked in 50.6, 53.1, 60.0, 65.6, 63.0 and 63.0 per cent canes by T 37, and 59.0, 62.9, 65.0, 66.3, 67.0 and 73.6 per cent canes by T 38 with TMC, spore suspension, spore suspension + metabolites, metabolites, spore suspension + TMC and TMC + metabolite treatments respectively. Stubble sprouting was enhanced by 5.37%. IAA content was higher in shoot tips (67. 87 µg 100^{-1} g fresh weight) of ratoon cane. Improvement in number of tillers, NMC, height, girth and internodes length were observed and it resulted in higher yield by 18.54 t ha^{-1} over control.

A comparison of plug method and CCT was made on a set of 14 cane differentials to find out the mechanism of variability in *C. falcatum*. In general, disease ratings increased in CCT in comparison to plug method. Several resistant differentials (plug method) showed moderate to susceptible reaction (CCT method). Probably the high humidity and constant temperature maintained CCT enhanced the susceptibility of cane differentials.

Further investigations on the spread of red rot, it was found that in *C. falcatum*, a spore / conidia concentration of one million was effective in producing 100 per cent infection. The success of infection gradually tapered up to the concentration of 10,000 conidia ml^{-1}. thereafter, the reduction in successful infection was quite drastic. However, even 100 conidia ml^{-1} could produce the disease, though success rate was around 10%.

Isolations from roots of wilt affected sugarcane variety Co 7717 yielded fungi belonging to genera of *Fusarium, Pythium, Rhizoctonia, Nigrospora, Trichoderma* and *Chaetomium*. Inoculation of sett roots with isolates of *Fusarium, Pythium* and *Nigrospora,*

alone or in combinations inflicted partial rotting of excised roots in laboratory condition. In pot and field inoculations there was no significant difference in the incidence of wilt between inoculated clumps and un-inoculated controls. Similarly, no difference in the incidence of disease was observed in the progenies raised from heat-treated healthy and heat-treated diseased setts with corresponding controls.

Three isolates viz., IR-6, IR-7, IR-8 and pathotype Cf 11 (CoJ 64) were tested on a set of 14 differentials by plug method. Isolate IR-6 exhibited different reaction in Co 975, Co 62399 and Co 7717 and in rest eleven differentials showed same reaction and thus identified as Cf 08. Pathotype Cf 11 was different from the existing pathotypes of North-West Zone.

In an experiment on evaluation of 44 genotypes against red rot, smut and wilt, genotypes, CoS 03279, CoH 130, Co 0122, CoLk 99271 and CoS 03222 showed moderately resistant reaction against *C. falcatum*. Genotypes CoJ 03192, CoLk 9902, Co 0116, CoLk 9709, CoPant 02217, CoS 03252 and CoPant 02218 were susceptible to smut. Four genotypes viz., CoS 01256, CoS 01268, Co 0327 and CoH118 were susceptible to wilt and remaining genotypes were found tolerant.

In an experiment on molecular characterization of pathotypes of *C. falcatum*, CTAB extracted total genomic DNA of six different pathotypes viz., Cf 01 Cf 02, Cf 03, Cf 07, Cf 08 and Cf 09 of *C. falcatum* were amplified using 85 random decanucleotide primers (series OPA, OPI, OPO, OPT and MAP). A total of 483 PCR – amplified genomic DNA bands were scored and showed high degree of polymorphism (> 70%). The genetic similarity based on analysis of RAPD data among pathotypes showing more than 60 % genetic divergence varied from 0.32 to 0.97. All the six pathotypes showing more than 60% genetic divergence were grouped into 2 groups.

Bio-ecology and insect-pest management

The top dressing of urea @ 75 kg N ha^{-1} coinciding with the emergence of IIIrd brood of top borer significantly reduced the incidence of top borer IIIrd and IVth brood and yielded higher cane yield over untreated check.

An outbreak of Pyrilla was noticed in central Uttar Pradesh from April to September, 2007 which was successfully controlled by augmented release of *Epiricania melanoleuca* @10000 cocoons or 5000 cocoons + 5 lakh eggs ha^{-1}. In another study, the incidence of top borer IIIrd and IVth brood ranged from 10.11 to 15.26 %, which was quite low in comparison to previous years. Red Mite had severe infestation from April till June but diminished during rainy season.

Trichogramma chilonis (reared from F_1 to F_{10} generations at 28 ± 2°C) was further maintained at 2°C higher temperature (30 ± 2°C) on the eggs of *Corcyra cephalonica* for five generations. The longevity, fecundity and female sex ratio were affected adversely at 30 – 32 °C. *Trichogramma japonicum* was maintained in the laboratory for 10 successive generations at 26 ± 2°C and for five generations at 28 ± 2°C. The longevity and fecundity of *T. japonicum* were more in early generations than the later ones.

The pest complex of sugarcane studied under 3 conditions of ratooning revealed that mulched condition had significantly higher infestation besides having more parasitization. The burning of trash reduced the incidence of stalk borer, internode borer and root borer. The cost benefit ratio was worked out to be 1:2.45.The treatment which included application of chlorpyriphos + carbofuran @ 1.0 kg a. i. ha^{-1} was found effective for the control of IIIrd brood of top borer and also gave higher cane yield.

Studies on acceptance of some alternative insect hosts by two parasitoids viz., *Rhaconotus rosiliensis* and *Stenobracon spp.* revealed that the larvae of pink borer (*Sesamia inferens*) and maize stem borer (*Chilo partellus*) are suitable for rearing these parasitoids.

Host preference of *Cotesia flavipes* was studied by offering larvae of three lepidopterous pests viz., *Chilo auricilius, Sesamia inferens* and *Chilo sacchariphagus indicus* by exposing grown-up healthy larvae to gravid females of the parasitoid in the laboratory at 25 ± 2 °C and 60-70 % RH. *Cotesia flavipes* preferred to *C. auricilius* over *C. s. indicus* and *S. inferens*. Also, *Beauveria bassiana* and *Metarhizium anisopliae* were multiplied on synthetic medium (PDA) and on three organic media such as broken rice, maize and jowar. It was found that development of *B. bassiana* was more rapid on PDA followed by rice in terms of germination, colony development and spore formation. Among the organic media, rice and jowar responded similar reaction.

Top borer sex pheromone lure, traps, which were used to catch male moths, have been most successfully used for monitoring the emergence and activity of each brood of top borer.

Sugarcane woolly aphid population was found positively correlated with relative humidity and rainfall, however its correlation with the population of *D. aphidivora* and *M. igorotus* was observed highly

significant. Mass multiplication of *D. aphidivora* and *M. igorotus* was done in separate shade nets on natural food.

Studies on evaluation of new insecticides revealed that Thiamethoxam (Actara 25 G) when sprayed @ 12.5 -50.0 g a.i.ha^{-1} against aphids in sugarbeet provided significant reduction for 15 days. Emamectin Benzoate (Proclaim 5 SG) @ 5-10 g a. i. ha^{-1} and Lufenuron (Signa 5 EC) @ 25-60 g a. i. ha^{-1} proved quite effective against *Spilosoma obliqua* and *Spodoptera litura*. The granular formulation of E2Y 45 0.4 GR was evaluated @ 50 -150 g a.i. ha^{-1} against termites and top borer of sugarcane provided significant control. Soil application of Bifenthrin @ 100 g a. i. ha^{-1} responded significantly higher germination, low sett damage, low bud damage, higher millable cane and yield over other treatments and untreated check.

Mechanization of sugarcane cultivation

A front mounted tractor operated harvester was developed for cutting two rows of sugarcane. It consists of M.S. frame, an attachment for raising and lowering of equipment during transportation as well as during the field operations, power transmission and cutting units. Attachments were also provided with the main frame of the equipment for guiding the cane towards the cutting blades during harvesting operation and up to some extent for raising the partially lodged canes. Field trials were also conducted at institute farm and it was found that the cutting and windrowing was satisfactory for cane crops which were not lodged and where the canopy of one row of cane was not intermingled with the other rows.

A power operated de-trasher for removal of green top as well as dry trash from the harvested sugarcane was tested in the field for its performance in respect of different varieties of sugarcane. The performance of the de-trasher was satisfactory for de-trashing up to 3 cane stalks at a time. The green top removal efficiency (using 2 cane stalks at a time) varied from 90 to 99 per cent whereas overall trash removal (green + dry trash) efficiency varied from 80 to 90 per cent.

An equipment viz., Ratoon Promoter, consisting of a customized version of various sub-units of the RMD (like rippers, manure / granular fertilizer dispensing unit including its metering mechanism, containers for application of pesticide / chemicals in liquid form and soil covering unit), but excluding the unit for stubble shaving and its power driving mechanism, was designed. The prototype was provided with one floating type lugged ground wheel for each row to drive metering system of the manure / fertilizer disbursing unit. Further fabrication work related to the seeding attachment for inter-cropping is in progress.

One FIRB: T.O. Sugarcane Planter-cum-seeder was developed and successfully test-operated at farmers' fields with 55 HP tractor for planting of sugarcane in two rows, making raised beds, drilling wheat seeds in two rows on each bed, and drilling fertilizers for each row of sugarcane and wheat in a single pass.

An engine operated walking type multi-purpose equipment (reversible shovels type 3-tyne intercultural tool) was developed and field tested for intercultural operations in sugarcane crop planted at 75 cm spacing at the institute farm. The effective field capacity of the equipment was observed as 0.2 ha hr^{-1}. The manpower requirement was worked out as 10 man-hr ha^{-1}. The working depth of the equipment was 10-15 cm and weeding efficiency was 70 to 80%. The problems faced due to ridges formed during planting, in the gauge wheel mounted in front of the prime mover, are further being explored.

For encouraging sugarcane+potato inter-cropping system, one tractor drawn combined tillage implement was developed and tested for the preparation of field for planting potato crop. The implement saved diesel and prepared field better than the conventional tillage implements like harrow and cultivator. A metering system also perfected and tested to meter potato seed revealed that the dropping of seed size tubers was perfect without any gap.

Post-harvest technology

A pre-harvest foliar application of zinc sulphate solution (1000 ppm) five days prior to harvest recorded an increase in sucrose per cent (6%) and Purity (6.4%) in 7 days stale cane resulting into higher CCS (10.2%). Whereas in manganous sulphate treated cane, gain in CCS was 5.7% compared to untreated trash covered control. This affect was attributed to relatively low activity of acid invertase. Pre-harvest soil application of zinc sulphate revealed an increase in sucrose content (10.5%) and purity (1.9%) of cane

juice and decrease in total reducing sugars (48.3%) in juice under zinc treatment in comparison to control.

The expression of internodal acid invertase activity in the harvested cane during late milling season was relatively higher compared to early season. There was considerable suppression of acid invertase activity in stale cane treated with QUAT based formulation. A factory level trial showed around 0.4 unit improvement in sugar recovery from stale cane.

Studies on manufactouring and storage of jaggery consisted of the development of a sugarcane peeler, a mechanical filteration unit for sugarcane juice, a device for churning of sugarcane juice in an open pan furnance, efficiency improvement in jaggery making furnance, development of a solar drier for jaggery drying and the value addition of jaggery through natural source of Vitamin C (aonla). Under testing and evaluation studies, IISR jaggery Drier and TNAU cane crusher were tested and the performance was evaluated.

Transfer of technology

Sugarcane variety CoLk 94184 was identified for commerical release. In addition 7 genotypes were accepted for state varietal trials. The seed of these genotypes was supplied to many sugar-mills for multiplication. The institute has also provided the necessary tecnhical know-how of 7 farm equipments / machinery to 2 firms and provided them with the manufacturing rights. The knowledge about improved sugarcane production technology was disseminated through documentary films, TV & Radio talks newspapers, exhibitions, Kisan Call Centre, KVK, visits, and demonstrations. In addition, surveys of insect-pests and diseases of sugarcane were carried out and the farmers were suggested the effective management practices to control them.

A survey was made in sugar-mill zone in Barabanki district, of U.P. to assess the increase in knowledge of sugarcane farmers as a result of ICS implementation. The maximum increase in knowledge was recorded in post-harvest management followed by ratoon management, insect-pest management, mechanization and the planting methods.

Economics and statistics

Analysis of sugar production in India revealed that amongst major sugar producing states the production of sugar in new Millenium was more stable in UP, AP and Gujarat but highly instable in Maharashtra.

Analysis of long term (1971-72 to 2005-06) trends in yield and economics of sugarcane cultivation in 6 major cane growing states revealed that the yield levels were not consistent with the rise in the cost of cultivation of sugarcane. The operational cost of cultivation, mainly because of increasing proportion of irrigation and labour cost has increased signficantly over the years. The profit margins as percentage of the gross returns has followed a declining trend, particularly in respect of Maharashtra, TN and AP. In another study, it was found that the composition of Indian sugar exports has gone under change during the last 10 years. The exports of refined sugar have increased varying from 67-73% of the total sugar exports. In value terms, the sugar exports have been less than 1% of the total exports of all commodities. These were above 3 mln tonnes in 2007-08 valuing about 4000 crores.

Sugarbeet development

The IISR sugarbeet variety, LS-6 along with a Syngenta variety HI 0064 (Shubhra) was identified for cultivation under the tropical conditions under the AP Cess Network Project on Sugarbeet.

Miscellaneous

A weather interactive model was developed for estimating sugarcane productivity in the state of Uttar Pradesh using long-term crop and weather database (1980-1999). The model predictions for the productivity were fairly close to observed cane productivity in the state. Data Warehouse work has been undertaken to have a better insight into the dynamics of sugarcane production and sugar industry using historical data generated on sugarcane production, sugar industry and agro-met data. About 36 research papers were published in national journals and 6 in foreign journals. Almost every scientist participated in at least one or more seminars / workshop etc.

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, along with other central agricultural research institutes. The Institute is located in Lucknow, the capital city of Uttar Pradesh and conveniently situated at about 12 kms from Lucknow's Amousi Airport and about 5 kms each from Lucknow Railway station and Charbagh 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 sugarane 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 as 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, consultancy and other 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 efficiency through rhizosphere 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 the 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 programmes
		• Molecular breeding programmes
		• 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 diseases / 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 equipment 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 programmes
		• Molecular breeding programme
		• Varietal development programmes
		• Identification of early maturing red rot resistant variety
		• 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. Factor productivity declining	1) Crop residue recycling 2) Introduction of legumes in cropping system 3) Rhizo-sphere bio-engineering	
D. Reducing cost of cane cultivation	1) Mechanising sugarcane cultivation	• Mechanization of various operations in sugarcane cultivation
	2) Enhancing input use efficiency & reduce 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 and water use efficiency
		• Improving water use efficiency
	3) Enhancing productivity of ratoon cane	• Developing agro-techniques to improve
		• Plant protection measures for ratoon
		• Improving sprouting of stubble buds
		• Equipment for increasing ratoon productivity
E. Making cultivation of sugar beet 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 man power 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 relating 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, shown in the flow chart on the next page is as under:

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

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 queries 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. The unit also coordinated the technical audit of the Institute carried out by the CAG of India.

Library and reprography

The IISR Library is well established and has a rich collection of books, journals, annual reports, reference materials, CD ROMs, etc. The library offers reference and reprographic services to its readers / clientele. During this year, the library budget was Rs. 13.88 lakh, out of which Rs. 1.12 lakh was spent on purchase / acquisition of 32 books and Rs. 12.76 spent towards subscription of Indian, International journals, Newspapers and Hindi / English magazines. Total number of books in the library has reached to 9850 and the total titles of Indian and foreign journals 390, comprising 18500 set / volumes. During the year, 560 issues of Indian and International journals and 130 Annual Reports were received. There are 28 Indian, 31 International Journals, 10 Newspapers and 9 Hindi / English magazines on the current subscription list. Some of the journals date back as early as 1913. About 2200 readers were provided reference service during the year.

For modernization / digitalization, 20 CD ROMs were acquired and steps to provide on-line data access to the readers are being taken in the form of e-resource journals.

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

Indian Institute of Sugarcane Research Lucknow

QRT
Quinquennial Review Team

Director

RAC
Research Advisory Committee

IMC
Institute Management Committee

IRC
Institute Research Council

RCM
Research Coordination & Management
- Institute RCM unit
- Training unit
- ARIS cell
- AICRP(S)

EXTENSION
Agri. Extension
KVK

DIVISIONS
- Crop Production
- Crop Improvement
- Crop Protection
- Plant Physiology & Biochemistry
- Agricultural Engineering

CENTRES

A. Institute
- Motipur (Bihar)

B. Divisional Bio-Control
- Pravaranagar (Maharashtra)

SECTIONS
- Ag. Econ/Stat
- Agrometeorology
- Radio-Tracer lab

CENTRALIZED LABORATORIES
- Tissue culture
- Central lab I&II
- Juice Analysis

SUPPORT UNITS
- Library
- Farm
- Guest House
- Dispensary
- Hindi
- Arts & Photography
- Administration
- Finance

Organizational set-up

automatic weather station. Long term data base 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 in the year 2007-08.

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 soil, plant, etc. samples. The laboratory also provides facilities for soil physical parameters like aggregate size distribution, bulk density and infiltration rate.

Bio-technology 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 micro propagation aspects.

ARIS Cell

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 cell 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 cell 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, ARIS Cell compiled information for Institute Information Bank (Institute Profile and Crop Profile), updated the Web Site 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 cell 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. Smt. Sunita Lal, Pr. Scientist is the chairperson of the cell. Smt. Radha Jain, Sr. Scientist; Smt. S.L. Barjo, Assistant; Smt. Anita Sawnani T-5, Technical Officer and Shri Rajeev Lal, Sr. Administrative Officer are the members of the Women Cell.

Regional Centre, Motipur

The research activities at the centre included 48 trials for North Central and Eastern zones of AICRP (Sugarcane), breeder seed multiplication programme in 6.5 acres of land, raising of nursery from the fluff of 20 crosses, maintenance of 7 promising entries, planting of 32 entries for testing and screening against red rot, and other pathological dimensions, station trials, 27 frontline entries in demonstration trials, multiplication of 6 water logging tolerant entries supplied from Jaggery Research Station, Kolhapur. About 10 tons of breeder seed of CoLk 94184 was supplied to sugar-mills, SAUs, KVK and to progressive farmers. The civil works carried out at the centre were the renovation and repair of the office building, installation of weigh bridge and of deep borewell.

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.

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 (2007-08)

Budget allocation (RE) and expenditure of the main Institute and AICRP on Sugarcane during 2007-2008 are furnished below:

A. Institute

(Rs. in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Estt. Charges	825.00	847.86	-	-
T.A.	3.00	2.55	-	2.63
HRD	-	-	-	-
Other charges	91.5 5	69.52	-	175.8
Works	43.45	43.45	-	15.04
Other items	-	-	-	-
OTA	-	-	-	-
Total	**963.00**	**963.38**	**190.00**	**193.47**

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

(Rs. in Lacs)

Particulars	Estt. Charges	T.A.	Other Charges (RC)	NRC	Grant in aid to centres	Total
Revised Estimate	334.83	18.12	44.05	-	-	397.0
Expenditure	336.11	16.62	44.00	-	-	396.73

Note : RC- Recurring contingency, NRC- Non-recurring contingency

C. Externally Funded Projects

Sl. No.	Projects	Funding agency	Duration	Amount (Rs.in lacs)
1	UPCAR 1/03 : Evaluation and standardization of organic farming techniques for sugarcane production system	UPCAR, Lucknow	03-07	13.18
2	UPCAR 1/06 : Enhancing field water use efficiency in sugarcane cropping system through FIRBs	UPCAR, Lucknow	06-09	1.60
3	Farmer's participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane	Central Water Commission, Ministry of Water Resources, Govt. of India	2008-11	50.00
		Total (over the years)		**64.78**

D. Revenue Generation

Sl. No.	Realisation of Revenue Receipt	Amount (Rs. In lac)
1.	Farm Produce	31.00
2.	Miscellaneous	11.69
	Total	**42.69**

Staff Position

A. Scientists

i) IISR, Lucknow

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Agricultural Chemistry	0	0	1	0	2	0	3	0
Agricultural Entomology	1	1	2	0	5	5	8	6
Agronomy	2	0	2	3	8	8	12	11
Bio-Chemistry (Plant Science)	0	0	1	0	2	2	3	2
Bio-Technology (Plant Science)	1	0	1	10	2	0	4	0
Microbiology (Agriculture)	0	0	1	0	2	1	3	1
Nematology (Agriculture)	0	0	1	0	1	0	2	0
Plant Breeding	1	0	2	2	6	4	9	6
Plant Pathology	1	0	2	2	5	5	8	7
Plant Physiology (Ag/Hort. Corps)	1	1	1	0	2	2	4	3

Soil Science-Soil Chemistry / Fertility / Microbiology	1	1	1	1	3	1	5	3
Soil Science-Soil Physics / Soil & Water Conservation	0	0	1	0	0	1	1	1
Agricultural Structure & Process Engineering	1	1	2	0	0	1	3	2
Electronics & Instrumentation	0	0	0	1	0	0	0	1
Farm Machinery & Power	1	1	1	2	3	3	5	6
Soil & Water Conservation Engineering	0	0	1	0	1	1	2	1
Organic Chemistry	0	0	0	0	0	1	0	1
Agricultural Economics	0	0	1	1	1	0	2	1
Agricultural Extension	1	1	1	0	3	3	5	4
Agricultural Statistics	0	0	1	0	1	2	2	2
Computer Application in Agriculture	0	0	0	0	1	1	1	1
Genetics & Cytogenetics	0	0	1	1	2	3	3	4
Sub Total	**11**	**6**	**24**	**13**	**50**	**44**	**85**	**63**

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	1	1	0	0	1	1
Plant Breeding	0	0	1	1	0	0	1	1
Agricultural Entomology	0	0	1	1	0	0	1	1
Sub Total	**1**	**1**	**3**	**3**	**0**	**0**	**4**	**4**

iii) IISR Regional Station, Motipur

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	1	1	0	1	1
Sub Total	0	0	1	2	1	0	2	2

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

B. Technicals

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	31	4	5	5	0	0	0	0	45
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	49	25	31	19	1	2	0	0	127
Field / Farm Technicians (Motipur)	1	0	1	0	0	0	0	0	2
Total	50	25	32	19	1	2	0	0	129

Functional Group	T-1	T-2	T-3	T-4	T-5	T-6	T(7-8)	T-9	Total
	CSP								
Field / Farm Technicians	13	18	20	10	1	1	0	0	63
Workshop Staff including Engineering Workshop	28	4	5	5	0	0	0	0	42
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	46	25	29	18	1	2	0	0	118
Field / Farm Technicians (Motipur)	1	0	1	0	0	0	0	0	2
Total	47	25	30	18	1	2	0	0	120

C. Administrative Staff

Designation	SCS	CSP
Asst. Director (Official Languages)	1	0
Senior Administrative Officer	1	1
Asst. Administrative Officer	4	4
Asst. Finance & Accounts Officer	1	1
Personal Assistant Grade II	2	2
Assistant	14	14
Upper Division Clerk	15	15
Lower Division Clerk	13	12
Private Secretary	1	0
Steno Grade III	7	6
Security Officer	1	1
Subordinate Staff Grade I	22	16
Subordinate Staff Grade II	31	31
Subordinate Staff Grade III	18	18
Subordinate Staff Grade IV	9	9
Sub Total	**140**	**130**
Upper Division Clerk (Motipur)	1	1
Subordinate Staff Grade 1 (Motipur)	1	1
Total	**142**	**132**

2

Crop management for high cane productivity under different environments

2.1 Sugarcane based production system

Intercropping studies of linseed with autumn planted sugarcane (AL – 1)

Field experiment was conducted to explore the possibility of intercropping linseed with autumn planted sugarcane (CoSe 92423). The treatments consisted of 6 intercropping systems along with 3 sole stands viz., T_1-Sugarcane at 90 cm row spacing + linseed-Parvati (1:3 row ratio); T_2-Sugarcane + linseed-Garima (1:3); T_3-Sugarcane + linseed-Parvati (1:4); T4-Sugarcnae + linseed-Garima (1:4); T_5-Sugarcane + linseed-Parvati (broadcast); T_6-Sugarcane + linseed-Garima (broadcast), T_7-Sole sugarcane (90 cm row spacing); T_8- Sole linseed-Parvati 20 cm row spacing with 45 kg seed ha^{-1}) and T_9- Sole linseed-Garima (25 cm row spacing with 30 kg seed ha^{-1}). Sugarcane was planted in mid October 2005 followed by sowing of linseed as per the treatments. The recommended fertilizer doses included 150:60:60 kg NPK ha^{-1} for sugarcane and 60:40:40:30 NPKS kg ha^{-1} for linseed. Sugarcane intercropped with linseed Cv. Parvati (1:3 row ratio) produced number of millable canes (112.7 thousand ha^{-1}) and cane yield (76.5 t ha^{-1}) *at par* with sole sugarcane (Table 2.1). This was closely followed by sugarcane + linseed Cv. Garima (1:3) intercropping system. Significantly highest cane equivalent yield (97.5 t ha^{-1}) was recorded under sugarcane + linseed Cv. Parvati (1:3) intercropping system. This system also recorded the highest Land Equivalent Ratio (LER) at 1.81. The quality parameters of sugarcane were not affected by different intercropping systems and commercial cane sugar (CCS) yield followed the some trend as that of cane production (Table 2.2). Thus, autumn planted sugarcane (Cv. CoSe 92423) may be intercropped with linseed (Cv. Parvati) in 1:3 row ratio for enhancing vertical land productivity, harnessing the benefit of crop associability and increasing economic profitability of sugarcane based production system.

Table 2.1: Growth and yield of component crops in Sugarcane + linseed intercropping systems

Cropping Systems	Germination (%)	Nos. of tillers (000 ha^{-1})			NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Linseed plant population (000 ha^{-1}	Linseed yield (kg ha^{-1})	Cane equivalent yield (t ha^{-1})
		Mar.	May	July					
S + L P (1:3)	41.6	76.9	175.9	167.8	112.7	76.5	493.7	960.7	97.5
S + L G (1:3)	39.7	71.6	163.8	146.2	104.6	73.7	479.8	776.9	90.7
S + L P (1:4)	38.8	65.9	146.0	115.9	96.7	64.2	779.4	813.9	81.9
S + L G (1:4)	40.2	71.6	149.0	106.8	102.3	67.6	673.8	800.6	85.1
S + L P (B)	38.9	76.7	126.0	102.9	95.6	66.9	794.6	668.7	81.5
S + L G (B)	38.5	73.9	106.5	101.3	89.7	59.7	659.7	574.6	72.2
S (Sole)	36.6	179.8	208.7	220.8	121.3	80.8	-	-	80.8
LP (Sole)	-	-	-	-	-	-	1029.7	1110.6	24.2
LG (Sole)	-	-	-	-	-	-	824.6	905.7	19.8
CD (P = 0.05)	NS	24.56	35.68	16.17	14.56	9.25	116.4	205.7	11.57

Abbr., S = Sugarcane, LP = Linseed Cv. Parvati, LG = Linseed Cv. Garima,
Note: The price of sugarcane was Rs. 1200 per tonne and that of Linseed was Rs. 2400 per quintal

Table 2.2 : Sugarcane quality and land productivity under Sugarcane + linseed intercropping system

Cropping systems	^{0}Brix	Pol %	Purity (%)	CCS		SEY (t ha^{-1})	LER
				(%)	(t ha^{-1})		
S + L P (1:3)	18.56	16.08	86.6	11.01	8.43	10.73	1.81
S + L G (1:3)	18.56	16.08	86.6	11.01	8.12	9.98	1.77
S + L P (1:4)	18.61	16.40	88.1	11.33	7.27	9.28	1.53
S + L G (1:4)	18.46	16.26	88.1	11.23	7.59	9.55	1.72
S + L P (B)	18.35	16.26	88.6	11.26	7.53	9.18	1.43
S + L G (B)	18.21	15.83	86.9	10.86	6.48	7.85	1.37
S (Sole)	18.11	16.26	89.8	11.33	9.15	9.15	1.00
LP (Sole)	-	-	-	-	-	-	1.00
LG (Sole)	-	-	-	-	-	-	1.00
CD (P = 0.05)	NS	NS	3.56	NS	0.95	0.97	-

Abbr., SEY=Sugar Equivalent Yield, LER =Land Equivalent Ratio.

Agronomic evaluation of promising genotypes of sugarcane (AS 42)

An experiment was conducted to evaluate three sugarcane genotypes (CoJ 99192, CoS 96275 and CoS 94257) under three NPK levels (112.5,45,45; 150,60,60 and 187.5,75,75 kg ha^{-1}) with a view to identify suitable genotype under various fertiliser schedules in different cropping seasons. Initial soil chemical analysis indicated that soil was low in organic carbon (0.42%) and available nitrogen (190 kg ha^{-1}); medium in phosphorus (34.2 kg P_2O_5 ha^{-1}) and potassium (220 kg K_2O ha^{-1}) contents.

Spring season crop: In spring planting situation, genotype, CoS 96275 produced the highest number of millable cane (89900 ha^{-1}) but it was at par with CoS 94257. There was no significant difference in individual cane length between the genotypes CoS 96275 and CoS 94257 (Table 2.3). Genotype, CoJ 99192

Table 2.3: Effect of genotypes and different fertility levels on growth, yield and quality of sugarcane

Treatments	Millable canes (000 ha^{-1})	Cane length (cm)	Cane diameter (cm.)	Cane weight (g)	Cane yield (t ha^{-1})	Sugar yield (t ha^{-1})
Spring crop*						
Genotypes						
V_1- CoJ 99192	82.4	170.6	2.38	811.1	58.0	7.19
V_2- CoS 96275	89.9	185.6	2.32	828.9	68.7	7.96
V_3- CoS 94257	88.9	186.2	2.19	815.5	64.6	7.30
CD (P=0.05)	4.86	9.69	0.13	NS	4.60	0.48
Fertility levels (NPK kg ha^{-1})						
D_1- 112.5, 45, 45	83.4	175.8	2.22	762.2	57.2	6.63
D_2- 150, 60, 60	88.1	183.1	2.32	840.0	63.8	7.53
D_3- 187.5, 75, 75	89.6	183.5	2.35	813.3	61.4	7.31
CD (P=0.05)	4.86	9.69	0.13	42.6	4.15	0.48
Summer crop*						
Genotypes						
V_1- CoJ 99192	72.6	128.8	2.43	543.3	45.5	5.46
V_2- _CoS 96275	85.7	150.2	2.28	658.9	56.8	6.93
V_3- CoS 94257	80.0	127.3	2.34	673.3	53.3	6.02
CD (P=0.05)	4.55	10.56	NS	39.2	4.35	0.42
Fertility levels (NPK kg ha^{-1})						
D_1- 112.5, 45, 45	74.4	132.1	2.29	595.6	48.39	5.56
D_2- 150, 60, 60	81.3	137.1	2.35	641.7	52.7	6.43
D_3- 187.5, 75, 75	83.4	137.1	2.40	638.3	54.5	6.43
CD (P=0.05)	4.55	10.56	NS	39.2	4.35	0.42

Note:-* For spring crop, the planting date was 12-02-2007and the harvesting date was 08—3-2008. For summer crop, the planting date was 10-04-2007 and the harvesting date was 10-3-2008

produced thicker canes (2.38 cm diameter) as compared to CoS 96275 and CoS 94257. Mean individual cane weight was the product of length and diameter and did not differ significantly. Thus, cane yield increased due to higher number of millable canes. Significantly higher cane yield (68.7 t ha^{-1}) was harvested with genotype, CoS 96275. It was 18.4 % higher as compared to CoJ 99192 and 6.3% higher than CoS 94257. The maximum sugar yield (7.96 t ha^{-1}) was obtained with genotype, CoS 96275. Almost similar results were obtained in respect of number of millable canes, individual cane length, diameter, weight, cane and sugar yields with 150, 60, 60 and 187.5, 75, 75 kg NPK ha^{-1}. Thus, recommended level of NPK i.e., 150, 60 and 60 kg ha^{-1} fetched significantly higher cane (63.8 t ha^{-1}) and sugar yields (7.53 t ha^{-1}) over 75% of recommended NPK.

Summer season crop: Higher number of millable canes (85700 ha^{-1}) were counted with sugarcane genotype, CoS 96275. Individual cane length (150.2 cm) was also significantly higher with genotype, CoS 96275 as compared to CoJ 99192 and CoS 94257. Individual cane diameter of different genotypes did not differ significantly. Single cane weight was the highest with CoS 96275 (658.9 g). It was due to higher cane length (150.2 cm) with CoS 96275 as compared to other genotypes. Thus, genotype, CoS 96275 produced significantly highest cane (56.8 t ha^{-1}) and sugar yields (6.93 t ha^{-1}). Number of millable canes (81300 ha^{-1}) at 150:60:60 kg NPK ha^{-1} was significantly higher than 75% of recommended level (112.5: 45: 45 kg NPK ha^{-1}). Significant increase in cane length, diameter and weight was observed up to recommended level of NPK. Various treatments could not produce tangible differences in juice quality. Significant increase in cane (52.7 t ha^{-1}) and sugar (6.43 t ha^{-1}) yields were obtained up to recommended NPK levels (150, 60, 60 kg NPK ha^{-1}).

Drought management in sugarcane (AS 56)

The experimental treatment consists of 4 planting methods (planting at 60 cm row spacing, 90 cm row spacing; trench planting at 120 cm apart and pit planting) and 4 drought management practices, viz.(i) (control-(recommended practices), (ii) soaking cane setts in saturated lime water + foliar spray of urea and KCl @ 2.5 % at 90, 105 and 120 days after planting, (DAP) + trash mulch after 60 DAP + addition of FYM @ 10 t ha^{-1} in the furrows before planting; (iii) treatment + additional 60 kg K_2O ha^{-1} at last irrigation, (iv) treatment + additional 60 kg K_2O ha^{-1} at 170 DAP) in thrice replicated strip-plot design. Sugarcane (CoSe 92423) was planted in the last week of February with pre-planting irrigation (*Palewa*). The crop received 150 kg N + 60 kg P_2O_5 + 60 kg K_2O ha^{-1} in addition to treatmental K. Three irrigations were applied before the onset of monsoon . No irrigation was given during rainy months and post-rainy period.

Significantly highest germination of 47.0% was recorded under pit planting method closely followed by trench method. Planting of sugarcane at 60 cm spacing produced significantly highest number of tillers as well as number of millable cane, 130.1 thousand ha^{-1} (Table-2.4). However, the yield attributes like cane length (252.1 cm), girth (2.61 cm)

Table 2.4: Effect of treatments on growth and yield attributes of sugarcane

Treatments	Germination (%)		Nos. of tillers (000 ha^{-1})			NMC (000 ha^{-1})	Cane length (cm)	Cane girth (cm)	Weight per cane (kg)
	30 DAP	45 DAP	Jun.	Aug.	Oct.				
Planting Methods									
60 cm row spacing	29.9	42.5	189.8	210.2	161.8	130.1	220.8	2.30	0.79
90 cm row spacing	31.2	41.9	166.9	166.2	124.5	112.7	230.8	2.36	0.90
Trench planting	38.7	48.5	175.9	183.2	150.5	121.9	235.9	2.38	1.09
Pit planting	42.5	49.5	169.0	148.3	143.5	122.7	252.1	2.61	1.30
CD (P = 0.05)	2.26	3.20	8.25	11.73	9.68	12.30	12.16	0.35	0.44
Drought Management Practices									
Control	29.9	40.9	140.3	161.0	132.9	114.3	220.1	2.29	0.88
Lime soaking + FYM + KCl & Urea spray	36.9	47.7	186.9	181.6	141.7	114.5	233.1	2.40	0.98
Additional 60 kg K_2O ha^{-1} at last irrigation	37.2	46.9	186.5	182.0	147.2	125.3	239.9	2.45	1.08
Additional 60 kg K_2O ha^{-1} at 170 DAP	38.2	47.0	187.9	183.3	158.5	133.4	246.5	2.51	1.14
CD (P = 0.05)	3.72	4.29	12.37	16.39	12.30	16.16	14.68	0.22	0.23

Abbr., DAP: Days after Planting

Table 2.5: Effect of treatments on yield and quality of sugarcane

Treatments	Brix	Pol % Juice	Purity Coefficient (%)	CCS %	CCS (t ha^{-1})	Cane yield (t ha^{-1})
Planting Methods						
60 cm row spacing	18.16	15.03	82.78	10.06	7.07	70.10
90 cm row spacing	18.27	15.20	83.14	10.20	6.57	63.9
Trench planting	18.21	15.21	83.50	10.23	7.74	75.6
Pit planting	18.66	15.54	83.27	10.43	9.02	86.3
CD (P = 0.05)	0.21	0.20	NS	0.19	1.10	4.86
Drought Management Practices						
Control	17.63	14.34	81.36	9.51	6.37	66.8
Lime soaking+ FYM + KCl & Urea spray	18.36	15.20	82.79	10.17	7.21	70.9
Additional 60 kg K_2O ha^{-1} at last irrigation	18.72	15.57	83.16	10.44	7.92	75.7
Additional 60 kg K_2O ha^{-1} at 170 DAP	1.60	15.87	85.39	10.79	8.90	82.5
CD (P = 0.05)	0.33	0.31	NS	0.28	1.69	6.35

and weight per cane (1.30 kg) were significantly higher under pit method of planting. Consequently, the pit planting produced significantly higher cane (86.3 t ha^{-1}) as well as sugar (9.02 t ha^{-1}) yield (Table 2.5).

Sett soaking in saturated lime water gave significantly higher percentage of germination (42.5%). The number of tillers at various crop growth stages and number of millable canes increased significantly under the treatment involving lime water soaking of setts + Urea and KCL spray + FYM. This treatment also produced significantly higher individual cane weight.

Significantly highest cane (82.5 t ha^{-1}) as well as sugar (8.9 t ha^{-1}) yield were recorded by additional 60 kg K_2O ha^{-1} at 170 DAP over and above soaking setts in saturated lime water + foliar spray of urea and KCl @ 2.5 % at 90, 105 and 120 DAP + trash mulch after 60 DAP + application of FYM @ 10 t ha^{-1}in the furrows before planting. Additional 60 kg K_2O ha^{-1} significantly improved the juice quality.

Developing organic farming module for sugarcane crop (AS 57)

Field experiment was started during spring 2006 with an objective to study the effect of organic farming module on sustainability of crop productivity and soil health. Five treatments were laid out in RBD with four replications. Sugarcane (Cv. CoS 94257) was planted in first week of March 2006.

Plant-ratoon system (1st cycle) : In first cycle of the crop (plant-ratoon system), the highest number of millable cane in plant and ratoon (131.0 and 98.8 thousand ha^{-1}) were recorded under T_2, i.e. recommended N through organics (vermicompost) + biofertilizers+ intercropping of legume (Rhizobium inoculated) + control of pests/ diseases through chemical mode and was closely followed by T_3, i.e. recommended N through organics (vermicompost) + biofertilizers +intercropping of legume with rhizobium + biopesticides (Trichoderma/ Pseudomonas/ neem cake) + cultural mode + detrashing of dry leaves at 127.0 and 98.3 thousand ha^{-1}, respectively. The highest cane yield of plant crop (90 t ha^{-1}) and ratoon cane (76.0 t ha^{-1} t ha^{-1}) were recorded with T_5, i.e. 75% recommended N through inorganics + 25% through organic manures + biofertilizers + biopesticides and closely followed by 75% of recommended N through organics + biofertilizers + 25% of recommended NPK through inorganics + biopesticides (87.7 and 75.4 t ha^{-1} in plant and ratoon crop, respectively).

Soil fertility status in terms of available N, P and K was maintained in all the organic nutrition modules at the end of the first cycle after harvest of sugarcane plant-ratoon crop.

In plant crop of 2nd cycle, the highest number of millable canes (108.0 thousand ha^{-1}) was recorded under T_3 closely followed by T_2 (107.6 thousand ha^{-1}). The highest cane yield of plant crop (79.0 t ha^{-1}) was recorded with T_5 closely followed by T_4 (77.5 t ha^{-1}). Juice quality remained unaffected by these treatments in first as well as in second cycle.

There was an improvement in soil organic carbon under different organic farming modules at the harvest of ratoon crop of first cycle and the plant crop of the second cycle. The magnitude of increase

in organic carbon was highest under T_2 and T_3(0.65%) against the initial value of 0.45% in first cycle of the crop and 0.55% against the initial value of 0.46% in the second cycle. However, no definite trend could be observed for available N, P & K in soil in relation to different treatments in 2nd cycle after the harvest of the plant crop.

Table: 2.6: NMC, cane yield and soil organic carbon as influenced by different organic farming modules.

Treatments	NMC (000 ha^{-1})		Cane yield (t ha^{-1})		Soil organic carbon (%)
	Plant	Ratoon	Plant	Ratoon	Plant
T_1	101.0	93.0	85.3	72.0	0.55
T_2	131.0	98.8	84.6	74.8	0.65
T_3	127.0	99.3	85.2	74.5	0.65
T_4	122.0	96.2	87.7	75.4	0.64
T_5	114.0	95.4	90.0	76.0	0.62
C.D. (P=0.05)	11.00	5.67	2.30	2.15	0.45

Note: T_1 = Recommended NPK + micronutrients through inorganics + control of pests / diseases through chemical mode; T_2 = Recommended N through organic (vermicompost) +biofertilizers + intercropping of legumes (*Rhizobium* inoculated) with sugarcane + control of pests / diseases through chemical mode; T_3 = Recommended N through organics (vermicompost) + biofertilizers + intercropping of legume with *rhizobium* + biopesticides (*Trichoderma/ Pseudomonas*/ neem cake)+ cultural mode + detrashing of dry leaves; T_4 = 75% of Recommended N through organics + biofertilizers + 25% of recommended NPK through inorganics + biopesticides; T_5 = 75% recommended NPK through inorganics + 25% through organic manures + biofertilizers + biopesticides (Pseudomonas + Trichoderma / neemcake).

Evaluation and standardization of organic farming techniques for sugarcane production system (UPCAR Project)

Organic nutrition module consisting of SPM 10 t ha^{-1} + FYM 10 t ha^{-1}proved highly productive for plant-ratoon system under both autumn and spring planting. SPM 10 t ha^{-1} + *Azotobacter* and FYM 20 t ha^{-1} + *Trichoderma viride*+ legume (lentil) intercropping were reckoned next in order for autumn sugarcane. However, in spring planted sugarcane, FYM 20 t ha^{-1}+ *Acetobacter* had an edge over legume (mung) intercropping. Cane quality was maintained with these organic nutrition modules under both the seasons.

Soil organic matter was enhanced in all the organic nutrition modules. Microbial biomass turnover (SMBC / Org. C) was high in spring season in all organic nutrition modules. Soil fertility status in terms of available N, P and K was maintained in all the organic nutrition modules after harvest of sugarcane plant-ratoon crop. On the basis of benefit : cost ratio, SPM 10 t ha^{-1}+ FYM10 t ha^{-1}and FYM 20 t ha^{-1}+ *Trichoderma viride* + legume intercropping could be rated as equally economical propositions for both autumn as well as spring planted sugarcane. Thus, it could be recommended that organic nutrition module comprising SPM 10 t ha^{-1} + FYM 10 t ha^{-1}or SPM 10 t ha^{-1}+ Azotobacter proved ideal organic farming module for enriching rhizospheric microbial pool, maintaining soil health, enhancing cane productivity and making plant-ratoon system economically viable in two distinct diversified cropping system viz., rice-autumn sugarcane-ratoon-wheat and rice-berseem-spring sugarcane-ratoon-wheat.

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

With the objective to economise the use of seed cane through sett size and sett treatment, sugarcane was planted in February 2008. The treatments, consisting of 3-sett sizes (three, two and single-bud sett), 2-seed rates (1,20,000 and 80,000 buds ha^{-1}) and 2-sett treatments (dipping of setts in fungicide, carbendazime (0.01%) for 15 minutes, and dipping of setts in fungicide, carbendazime (0.01%) + Gibberellic acid (100 ppm) were arranged in factorial RBD with three replications for sugarcane variety CoSe 92423. Results are awaited.

2.2 Ratoon management in sugarcane

Optimizing plant population of ratoon crop for minimizing gaps (A 3.20)

The second ratoon crop (2nd cycle) of sugarcane (Cv. CoSe 92423) raised under paired row planting system (30:120 cm) proved superior over conventional planting system (90 cm) by significantly lowering the gaps (15.5%) and producing higher number of millable canes (108 thousand ha^{-1}) and cane yield at 71.6 t ha^{-1} (Table 2.7).

Treatments of higher seed rates (25 & 50%) and gap filling (plant cane) at first irrigation under normal seed rate lowered the intensity of gaps in second ratoon (14.0–16.0%) as compared to normal seed rate

Table 2.7: Effect of row spacing and seed rate on second ratoon crop of sugarcane

Treatments	Ratoon 2007-08					
	Clumps (000 ha^{-1})	Gaps (%)	Maximum shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
Row spacing						
i) 90 cm. (single)	23.9	20.3	261.0	99.3	67.2	16.3
ii) 30:120 cm (paired)	25.4	15.5	276.6	108.3	71.6	16.8
C.D. at 5%	NS	3.15	10.3	3.80	2.58	NS
Seed rate (setts ha^{-1})						
i) Normal (40000 ha^{-1})	22.3	25.6	248.9	94.6	60.5	16.6
ii) 25% higher (50000 ha^{-1})	25.6	14.4	275.9	108.1	70.6	16.4
iii) 50 % higher (60000 ha^{-1})	25.5	14.7	278.3	107.9	71.0	16.7
iv) Normal + gap filling at 1st irrigation in plant crop	25.1	16.2	272.0	104.7	70.0	16.8
C.D. (P=0.05)	2.35	6.30	14.6	5.30	3.23	NS

without gap filling where it was 25.6%. An increase in seed rate by 25% in plant crop not only reduced the gaps but also produced significantly higher number of millable canes (108 thousand ha^{-1}) and cane yield (70.6 t ha^{-1}) over normal seed rate (60.5 t ha^{-1}). However, gap filling at first irrigation under normal seed rate proved equally effective and produced cane yield (90.3 t ha^{-1}) at par with those obtained under higher seed rates by 25 & 50%. It suggests that sugarcane planted under paired row system (30:120 cm) with higher seed rate (25%) or planted with normal seed rate with gap filling at 1st irrigation proved equally good in increasing ratoon yield. This practice also curtailed the gap filling operation in ratoons. None of the practice could affect the pol % in juice.

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

Sugarcane (CoSe 92423) was planted in the first week of March, 2007 and its ratoon was initiated during February, 2008 with the aim to minimize the intra-row gaps in subsequent ratoon crop by increasing initial plant population in plant crop, through manipulation in seed rates (30,000; 40,000; 50,000 and 60,000 three bud setts ha^{-1}), gap filling in plant cane with 3-bud setts at 45 days after planting and application of potassium @ 80 kg ha^{-1} through irrigation water one month before plant cane harvesting.

In the plant cane crop, germination of cane buds did not differ (Table 2.8) significantly due to planting

Table 2.8: Effect of seed rate, gap filling and K application on plant crop of sugarcane.

Treatments	Germination % at 45 DAP	No. of shoots (000 ha^{-1})	No. of millable canes (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
Seed rate (3-bud setts ha^{-1})					
S_1 : 30,000	32.66	134	103	65.07	17.08
S_2 : 40,000	32.69	157	110	73.09	17.05
S_3 : 50,000	34.09	181	116	80.05	17.15
S_4 : 60,000	35.21	198	125	86.30	17.13
CD (P=0.05)	NS	15.9	5.23	5.54	NS
Gap filling					
G_1 : No gap filling	33.71	161	109	72.78	17.04
G_2 : Gap filling with 3-bud setts at 45 DAP	33.58	174	118	79.58	17.16
CD (P=0.05)	NS	11.7	4.83	3.99	NS
Application of K (kg ha^{-1})					
K_1: No K	34.11	168	113	75.43	17.20
K_2: 80 kg (through irrigation water one month the before the plant cane harvesting	33.20	167	114	76.83	17.00
CD (P=0.05)	NS	NS	NS	NS	NS

with four levels of seed rates (30,000 to 60,000 three-bud setts ha^{-1}). The percentage of gaps observed at 45 days was the maximum (21.78% under planting with 30,000 three-bud setts ha^{-1}, followed by 10.94%, 5.35% and 2.32% with 40000 (recommended rate), 50000 and 60000 three-bud setts ha^{-1}, respectively. However, the number of shoots, millable canes and cane yield differed significantly due to variation in planting densities at each level and accordingly these characters showed increasing trend with every increase in the level of planting density from 30,000 to 60,000 three-bud setts per ha. The highest cane yield (86.3 t ha^{-1}) was recorded with the planting density of 60,000 three-bud setts ha^{-1} followed by 80.1, 73.1 and 65.1 t ha^{-1} under the corresponding density of 50000, 40000 and 30000 three-bud setts ha^{-1}, respectively. Gap filling with 3-bud setts at 45 days produced the cane yield of 79.6 t ha^{-1} which was 9.04% more than that obtained without gap filling (73.0 t ha^{-1}). Application of K @ 80 kg ha^{-1} through irrigation water, one month before plant cane harvesting did not produce any significant difference in the yield of sugarcane plant crop. Pol % juice was more or less similar in different treatments.

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

Application of Ethrel (Pre-harvest), K and Zn (Post-harvest) improved the sprouting of buds at 5^0C and 10^0C under controlled conditions. Application of K led to maximum improvement in bud sprouting at sub optimal temperatures followed by Zn and Ethrel (Table 2.9). The reasons for this improvement were ascertained by analyzing the buds and root band zone of single bud setts kept in the incubator at 5^0C and 10 ^{0}C with four treatments: Control, Ethrel (500 ppm), K (80 kgK_2O ha^{-1}) and Zn (25 kg ha^{-1}).

The reasons for improvement in bud sprouting due to application of Ethrel, K and Zn appeared to be due to decrease in total phenolic content (TPC), super oxide dismutase (SOD), IAA and sucrose and increase in reducing sugars (RS), acid invertase activity (AI), moisture %, IAA oxidase (IAAO) and Nitrate reductase activity (NRA). Intensity of increase was more in potassium treated setts at both the temperatures of 5 ^{0}C and 10 ^{0}C.

Thirty six different treatments were given to the freshly harvested stubbles in winter initiated ratoon of sugarcane variety CoS 92423 to improve stubble bud sprouting. Initial results showed perceptible improvement in number of shoots produced.

Biochemical analysis of sprouted and unsprouted buds of lower and upper half of winter initiated ratoon revealed higher fresh weight and moisture content of sprouted buds as compared to unsprouted ones. Sprouted buds showed relatively higher reducing sugars, soluble protein, proline, H_2O_2 contents and activity of acid invertase and ATPase enzymes and lower content of MDA, total phenols, IAA and activity of catalase, peroxidase and SOD enzymes.

These findings suggested that in sprouted buds, higher moisture content enhances the activity of hydrolytic enzymes and consequently increases the

Table-2.9 : Influence of Ethrel, K and Zn application on various parameters (Per cent increase or decrease over control, in buds)

Parameters	Temperature					
	5 °C			10 °C		
	Ethrel	Potassium	Zinc	Ethrel	Potassium	Zinc
Reducing sugars (mg g^{-1} fwt)	65.41	78.90	96.99	32.94	120	68.42
Sucrose (mg g^{-1} wt)	(-)13.14	(-)41.64	(-)31.69	(-) 27.11	-20.43	-42.62
Acid Invertase (mmol min^{-1} mg^{-1} protein)	300	600	300	233.3	500	300
Bud wt (g)	45.19	101.92	53.84	35.06	83.5	45.20
Moisture %	59.57	92.67	61.93	40.69	89.12	53.48
TPC %	38.75	-69.53	-11.39	18.90	-36.44	-87.87
IAA(µg g^{-1} fwt)	-63.07	-54.29	-25.06	(-)30.07	-52.57	-13.40
NRA(nM NO_2 g^{-1} fwt hr^{-1})	35.32	180.35	76.60	66.21	182.71	84.46
AT Pase (µg Pi liberated mg^{-1} protein (10 min^{-1})	200	226.6	371.3	75.6	217.03	71.11
SOD (Units mg^{-1} protein)	(-)62.88	(-)68.16	(-)70.49	(-)40.3	(-)95.93	(-) 78.11
IAAO (µg mg^{-1} protein)	38.32	129.07	107.04	132.67	320.79	58.41

availability of hexoses and other metabolites which provides energy for sprouting of buds. In unsprouted buds, higher content of IAA together with an accumulation of total phenols may be responsible for the induction of dormancy in unsprouted buds due to low temperature conditions. Higher activity of catalase, peroxidase and superoxide dismutase may protect unsprouted stubble buds from oxidative damage during low temperature conditions. Higher MDA content and lower bud moisture in unsprouted buds could be due to mortality of a few bud cells which checks the uptake of water.

2.3 Integrated weed management in sugarcane based cropping system

Weed management in sugarcane ratoon (AS 55)

The weed infestation reduced the ratoon (Cv. CoSe 92423) cane yield by 36% under weedy condition (control). Among the weed control treatments, three hoeings (at 1st, 4th and 7th week after ratoon initiation) reduced the weed infestation to the maximum with the lowest dry matter production (20 g m^{-2}). This treatment recorded the highest number of millable canes (113.4 thousand ha^{-1}) and cane yield (63.3 t ha^{-1}) which were comparable with the herbicidal treatments (atrazine / metribuzin / glycel) followed by either 2,4-D application or one hoeing (post emergence) (Table 2.10). Similarly, trash mulching either in alternate rows or in all the rows of cane effectively controlled the weeds and produced cane yield at par with that at the three hoeings. This clearly indicates that an integrated weed management (herbicide + hoeing / mulching + hoeing) may replace the traditional method of weed control (3 hoeing). None of the control measures could affect the pol % juice.

Evaluation of Velpar K4 60 WP herbicide for control of sugarcane weeds as post-emergence application (CR 6/06)

Unchecked growth of weeds viz., *Cyprus rotundus, Dactyloctenium aegyptium* and *Panicum* sp. caused reduction to the tune of 33.2% in millable cane population and 22.6% in cane height which finally resulted in cane yield loss by 52.1 per cent. Post-emergence application of weedicides (Velpar, Hexazinone and Diuron) applied at 75 days of sugarcane planting after second interculture operation proved effective as it resulted in cane yield at par with the standard check (three hoeings done at 40, 60 and 80 days after planting). Among the weedicides tried, velpar proved more effective in comparison to diuron and hexazinone (Table 2.11). Application of weedicides alone without interculture remained significantly inferior to treatments where weedicides were applied after two interculture operations, in controlling these weeds as well as in increasing the cane yield. Cane juice quality did not differ significantly due to different weed control treatments.

Table 2.10. Effect of weed control treatments on weed number, weed dry weight, NMC and yield of ratoon

Treatment	Number of weeds m^{-2}	Weed dry weight (g m^{-2})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})
T1 – Weedy check (control)	153.0	82.8	89.1	40.2
T2 – Three hoeings (1st week, 4th week and 7th week after ratoon initiation)	38.0	20.5	113.4	63.3
T3 – Atrazine 2.0 kg ha^{-1} (PE) + 2, 4-D 1.0 kg ha^{-1} at 45 DARI	43.3	2.4	107.3	56.9
T4 – Atrazine 2.0 kg ha^{-1} (PE) + one hoeing at 45 DARI	40.6	22.0	108.2	60.6
T5– Metribuzin 1.0 kg ha^{-1} (PE)+2, 4-D 1.0 kg ha^{-1} at 45 DARI	51.6	26.8	105.3	55.7
T6– Metribuzin 1.0 kg ha^{-1} (PE) + one hoeing at 45 DARI	43.3	23.7	106.1	58.6
T7 – Glycel 0.4 kg ha^{-1} after 3 weeks of ratoon initiation	49.3	26.5	105.1	57.3
T8– Glycel 0.4 kg ha^{-1} (at 3 weeks)+one hoeing at 60 DARI	41.6	24.4	108.3	61.2
T9 – Trash mulching in alternate rows+hoeings at 1st and 6th week	40.3	23.8	107.2	62.3
T10 – Trash mulching between all the rows	45.0	25.5	100.6	59.7
C.D. at 5 %	10.5	8.96	6.58	5.17

Abbr., PE = Pre-emergence, DARI = Days after ratoon initiation

Table 2.11. Effect of weed control treatments on weed dry weight, weed control efficiency (WCE), millable canes, cane yield and juice quality

Treatments	Weed dry wt * (qha^{-1})	WCE	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Cane juice quality		
					Brix	Pol	Purity
Post-em application without interculture							
T1 – Velpar 1.0 kg ai ha^{-1}	22.2	39.6	78.4	54.5	20.1	18.2	90.5
T2 – Velpar 1.2 kg ai ha^{-1}	18.5	49.7	79.2	56.4	20.6	18.6	90.3
T3 – Velpar 1.4 kg ai ha^{-1}	20.5	41.2	81.0	55.7	20.9	18.8	89.9
T4 – Hexazinone 0.3 kg ai ha^{-1}	22.7	38.2	75.3	49.2	20.1	18.2	90.5
T5 – Diuron 1.6 kg ai ha^{-1}	23.5	35.7	76.1	50.4	19.9	18.1	90.9
Post-em application after second interculture							
T6 – Velpar 1.0 kg ai ha^{-1}	8.0	78.1	92.1	65.8	20.6	18.7	90.7
17 – Velpar 1.2 kg ai ha^{-1}	9.3	74.6	91.8	67.4	20.6	18.3	88.8
T8 – Velpar 1.4 kg ai ha^{-1}	7.7	79.2	93.0	66.8	20.4	18.5	90.7
T9 – Hexazinone 0.3 kg ai ha^{-1}	11.2	69.3	90.2	64.6	20.9	18.7	89.5
T 10 – Diuron 1.6 kg ai ha^{-1}	12.9	64.7	92.4	65.0	20.6	18.5	89.8
T11 – Standard check (three hoeings)	7.8	78.9	94.2	68.0	20.8	18.5	88.9
T12 – Untreated	36.7	-	62.9	32.6	20.2	18.3	90.6
C.D. (0.05)	-	-	5.6	4.3	NS	NS	NS

Note : *At 135 days after sugarcane planting

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

A general plant crop of early maturing variety (CoS 96268) of sugarcane was raised during 2006-07 for ratooning. Ratoon was initiated in the first week of January 2008. Treatments were applied to ratoon crop as per the technical programme and the crop is in good progress. Results are awaited.

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

Field experiment is under progress to study the effect of sub-soiling treatments on soil physico-chemical conditions and sugarcane yield. The 5 treatments consisted of 5 sub-soiling treatments viz., No sub-soiling (NSS), sub-soiling at 1.0 m distance (SS-1.0), sub-soiling at 1.5 m distance (SS-1.5), cross sub-soiling at 1.0 m distance (CSS-1.0) and cross sub-soiling at 1.5 m distance (CSS-1.5) and two preparatory tillage viz., four harrowing (4H) and two harrowing (2H). The crop sugarcane, variety CoSe 92423, was planted during spring season of 2008 by following the strip-plot experiment design with three replications. Sub-soiling was done with tractor-mounted sub-soiler up to dept of 35-40 cm. Results are awaited.

3

Resource management in sugarcane based cropping system

3.1 Nutrient management in sugarcane based cropping system

Identification of sugarcane genotypes for high nitrogen use efficiency (A 1.1.26)

In an experiment, eight early maturing and eight mid-late maturing sugarcane genotypes were spring planted under flat system to evaluate their performance with respect to their nitrogen use efficiency. Out of eight early maturing sugarcane genotypes, CoLk 94184 produced the highest number of millable cane (136.4 thousand ha^{-1}), cane yield (59.1 t ha^{-1}), CCS content (12.22%) and CCS yield (7.99 t ha^{-1}) and was followed by BO 128 and CoS 95270 (Table 3.1). Application of 150 kg N ha^{-1}+ 10 t FYM

Table 3.1: Productivity and nitrogen use efficiency of sugarcane genotypes (2007-08)

Treatment	Germination (%)	No. of tillers in May (000 ha^{-1})	NMC (000 ha^{-1})	Yield (t ha^{-1})	CCS (%)	CCS (t ha^{-1})	Nitrogen Use Efficiency (kg cane kg^{-1} N)	
							150 kg N ha^{-1}	FYM + 150 kg N ha^{-1}
Early maturing sugarcane genotypes								
CoS 95270	37.1	84.3	94.9	57.3	12.41	7.11	134.8	188.8
CoS 96258	39.9	109.3	86.9	57.3	12.23	5.51	168.9	210.4
CoH 92201	25.3	74.2	81.6	45.0	11.75	5.19	109.6	171.8
BO 130	29.9	77.6	76.0	44.3	11.82	5.87	134.8	165.9
CoS 96268	33.6	123.2	98.2	49.5	11.84	6.81	157.0	220.8
CoPt 98224	38.5	116.1	101.3	58.1	11.87	5.97	134.8	149.6
BO 128	35.6	83.2	117.8	50.3	11.47	6.80	84.5	122.9
CoLk 94184	48.1	128.4	136.4	59.2	12.22	7.99	189.1	259.9
CD (P=0.05)	3.65	14.61	12.85	7.21	0.76	1.97	-	-
Nitrogen levels								
0-Control	35.3	77.1	76.1	40.8	11.84	4.82	-	-
150 kg N ha^{-1}	33.7	113.8	108.1	60.1	11.50	6.93	-	-
10 t FYM ha^{-1}	36.7	83.6	86.8	48.1	12.33	5.94	-	-
150 kg N+10 t FYM ha^{-1}	34.9	123.6	125.6	67.1	12.13	8.13	-	-
CD (P=0.05)	NS	8.33	7.93	5.63	NS	1.12	-	-
Mid-late sugarcane genotypes								
CoJ 20193	33.5	99.6	103.1	47.7	12.13	5.80	140.5	167.3
CoS 99259	29.1	91.6	94.2	42.6	12.48	5.31	104.7	142.7
CoS 96275	34.5	98.7	101.5	58.2	12.79	7.41	180.7	207.3
CoPt 99214	31.4	100.3	96.6	52.7	12.00	6.19	168.00	188.7
CoH 110	34.2	115.8	130.1	60.2	12.47	7.51	233.3	287.3
CoH 119	34.2	115.8	130.1	60.2	12.47	7.51	233.3	287.3
CoLk 9616	41.2	126.8	131.8	59.6	12.34	7.30	235.3	283.3
CoJ 99192	27.9	105.5	102.8	53.0	12.35	6.44	178.7	220.0
CD (P=0.05)	5.27	8.63	11.29	7.32	0.88	1.12	-	-
Nitrogen levels								
0-Control	32.4	88.5	87.3	35.8	12.62	4.53	-	-
150 kg N ha^{-1}	32.1	111.7	115.3	61.9	12.22	7.57	-	-
10 t FYM ha^{-1}	32.7	96.6	98.1	48.2	12.64	6.10	-	-
150kg N+ 10 t FYM ha^{-1}	33.4	123.6	128.1	67.3	12.31	8.28	-	-
CD (P=0.05)	NS	4.96	6.95	4.69	NS	2.61	-	-

ha^{-1}gave the highest NMC (125.6 thousand ha^{-1}) and cane yield (67.1 t ha^{-1}). CoLk 94184 was observed to be the most efficient genotype for nitrogen use both with FYM (259.9 kg cane kg^{-1} N) and without FYM (189.1 kg cane kg^{-1} N). The genotype CoS 96268 and CoS 96258 were also identified efficient ones with NUE of 220.8 and 210.4 kg cane kg^{-1} N, respectively.

Amongst 8 mid-late sugarcane genotypes, CoH 110 and CoH 119 recorded significantly highest number of millable cane and cane yield which was however, at par with CoLk 9616. The genotype CoH 110 produced the highest CCS. The nitrogen use efficiency of these two genotypes was higher than other genotypes. Genotype CoH 110 and CoH 119 were identified as most nitrogen use efficient at 150 kg N + 10 t FYM ha^{-1}. The nitrogen use efficiency of CoLk 9616 worked out to be 283.3 kg cane kg N^{-1}at 150 kg N^{-1} + 10 t FYM ha^{-1}. Similar to early group, mid-late genotypes produced highest tillers (123.6thousand ha^{-1}) and yield (67.3 t ha^{-1}) at FYM + 150 kg N ha^{-1}

Evaluation of sugarcane genotypes for high nitrogen use efficiency under ring-pit planting system (Expl. Trial)

Another set of field experiments was conducted consisting of (8 early maturing genotypes: CoS 95270, CoS 96258, CoH 92201, BO 130, CoS 96268, CoPt 98224BO 128, CoLk 94184 and 8 mid-late genotypes : CoJ 20193, CoS 99259, CoS 96275, CoPt 99214, CoH 110, CoH 119, CoLk 9616, CoJ 99192) under ring-pit planting system with 4 N levels (0, 150 kg ha^{-1}, 10 t ha^{-1}FYM and 150 kg N + 10 t FYM) in split-plot design replicated. Ratoon initiated in January for early genotypes and February for mid-late genotypes and supplied with the treatments as applied to plant crop revealed that the highest NUE was worked out for BO 130 followed by CoLk 94184 amongst early genotypes. Among mid-late group, genotypes, CoPt 99214 recorded the highest NUE in first ratoon followed by CoS 96275 at 150 kg N ha^{-1}+ 10 t FYM.

Agronomy of new sugarcane genotypes (Expl. Trial)

The treatments consisted of 2 sugarcane genotypes (CoLk 94184 and CoLk 97147) planted at 3 row spacings (60, 75 and 90 cm) and fertilized with 4 nitrogen doses (0, 75, 150 and 225 kg ha^{-1}). The main plot treatments included the combinations of genotypes spacing while. The sub plots included the nitrogen levels in split-plot design replicated thrice. Sugarcane was planted in the first week of November. The recommended doses of phosphorus (60 kg P_2O_5 ha^{-1}) and potassium (60 kg K_2O ha^{-1}) and one third of treatmental N were applied at the time of sugarcane planting. The remaining amount of N was scheduled as per the treatments. Sugarcane genotype CoLk 94184 recoded significantly higher germination (44.4%), number of tillers in July (205.2 thousand ha^{-1}), number of millable cane (103.7 thousand ha^{-1}) and cane yield (68.8 t ha^{-1}) as compared to CoLk 97147 (Table 3.2). Genotype CoLK 94184 also produced higher commercial cane sugar (9.30 t ha^{-1}). There was no significant variation in cane yields due to different spacing. Application of 150 and 225 kg N ha^{-1}

Table: 3.2. Effect of treatments on growth yield and quality of sugarcane genotypes

Treatments	Germination (%)	No. of Tillers in July (000 ha^{-1})	NMC (000 ha^{-1})	Yield (t ha^{-1})	CCS (%)	CCS (t ha^{-1})	NUE (kg cane kg^{-1} N)	
							CoLk 94184	CoLk 97147
Genotypes								
CoLk 94184	44.4	205.2	103.7	68.8	13.50	9.30	-	-
CoLk 97147	33.6	173.1	95.5	57.4	12.52	7.17	-	-
CD (P=0.05)	4.21	10.61	6.31	5.96	0.57	1.35		
Spacing								
60 cm	39.6	219.4	101.1	65.3	13.28	8.97	-	-
75 cm	39.7	181.0	93.5	62.3	13.27	8.26	-	-
90 cm	37.7	152.0	87.6	61.8	12.92	8.05	-	-
CD (P=0.05)	NS	13.23	8.36	NS	NS	NS	-	-
N levels (kg N ha^{-1})								
0 kg ha^{-1}	39.4	99.6	89.3	43.5	13.13	5.74	-	-
75 kg ha^{-1}	37.3	186.1	90.6	56.9	12.89	7.36	154.8	203.7
150 kg ha^{-1}	40.1	221.2	109.7	70.3	13.04	9.19	167.9	189.4
225 kg ha^{-1}	39.2	249.7	113.7	81.7	13.00	10.65	158.8	180.7
CD (P=0.05)	NS	16.30	10.21	7.54	NS	2.36	-	-

significantly improved NMC and yield. Genotype CoLk 94184 produced highest cane yield (93.84 t ha^{-1}) at 90 cm spacing and 225 kg N ha^{-1}, while CoLk 97147 produced maximum cane of 84.53 t ha^{-1} at 60 cm spacing fertilized with 225 kg N ha^{-1}. The nitrogen use efficiency worked out to be higher at 75 kg N, the values being 128.1 kg cane kg^{-1} N for CoLk 94184 and 199.3 kg cane kg^{-1} N for CoLk 97147. The variation in spacings and nitrogen levels did not influence the juice quality of test genotypes and sugar yield remained a function of cane yield.

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

Field experiment was started in spring, 2003 with the objectives to evaluate the efficacy of different biomanures on yield and quality of sugarcane under plant and subsequent ratoons and to study the changes in physico-chemical and microbial properties of soil on long term basis. The highest cane yield (69.5 t ha^{-1}) in 4th ratoon was recorded with SPMC + *Acetobacter* (Table 3.3). This was followed by SPMC (67.3 t ha^{-1}) and vermicompost + *Acetobacter (* 65.6 t ha^{-1}). The growth and yield attributing characters viz. dry matter production, number of tillers, plant height, number of millable canes, cane length, cane thickness and weight also exhibited similar trend. Juice quality viz., brix and sucrose % did not differ significantly by the different treatments, however, the highest brix of ^{0}19.8 was recorded with *FYM +Acetobacter* and closely followed by SPMC + *Acetobacter* (^{0}19.4).

Soil organic carbon ranged between 0.63 to 0.68 under different treatments of bio-manuring, over its initial value of 0.32%. Soil microbial activity enhanced due to different biomanurial treatments. The highest value of soil microbial biomass carbon (SMBC) of 278.21 mg CO_2-C kg^{-1} soil day^{-1} was recorded under plots receiving SPMC + *Acetobacter* and closely followed by vermicompost + *Acetobacter* (273.75 mg CO_2 - C kg^{-1} soil day^{-1}) against initial value of 47.60 mg CO_2-C kg^{-1} soil day^{-1}.

Enhancing nitrogen use efficiency through integrated nutrient management under multi-ratooning system (C 6.4)

The experiment was started with spring planted sugarcane variety CoSe 92423 (February 2005) as an uniform crop with an objective to find out the effective combination of biomanure with N fertilizer for enhancing nitrogen use efficiency and sustaining cane productivity under multi-ratooning system. Six organic manurial treatments, viz. i) FYM, ii) Trash iii) FYM+ *Trichoderma viride* iv) Trash+ *Trichoderma viride* v) FYM+*Gluconacetobacter vi)* Trash + *Gluconacetobacter* and three N doses, viz. 0, 100 and 200 kg ha^{-1}, were laid out in RBD with three replications, and imposed in first and second ratoon.

The results obtained from second ratoon crop revealed that the maximum yield of 71.73 t ha^{-1} was recorded with 10 t FYM ha^{-1}+ *Trichoderma viride* which was significantly higher than that obtained with 7.5 t

Table 3.3. NMC, cane yield, juice quality, soil organic carbon and microbial biomass carbon (SMBC) of 4th ratoon under different biomanurial treatments

Treatments	NMC (000 ha^{-1})	Cane Length (cm)	Cane Yield (t ha^{-1})	Juice quality		Organic C (%)	SMBC (mg CO_2-C kg^{-1} soil day^{-1})
				^{0}Brix	pol (%)		
T_0 - Control	70.0	125.4	35.0	19.3	17.15	0.36	146.87
T_1-Trash 10 t ha^{-1} +*Trichodarma*	81.0	150.3	53.2	18.5	16.14	0.64	246.65
T_2-Vermicompost @ 10 t ha^{-1}	92.2	156.7	63.2	19.1	16.88	0.63	224.86
T_3– FYM @ 10 t ha^{-1}	91.2	154.8	63.0	19.2	17.76	0.65	215.68
T_4- Biogas slurry @ 10 t ha^{-1}	91.1	154.5	63.2	18.8	16.06	0.65	195.53
T_5– SPMC @ 10 t ha^{-1}	95.6	163.6	67.3	18.9	16.66	0.67	244.42
T_6- T_1+ *Acetobacter*	81.7	155.0	55.0	19.0	16.54	0.65	273.75
T_7- T_2+ *Acetobacter*	92.8	162.8	65.6	19.1	16.44	0.64	244.42
T_8- T_3+ *Acetobacter*	91.3	163.4	64.3	19.8	16.53	0.66	207.54
T_9- T_4+ *Acetobacter*	91.2	163.2	64.0	19.0	16.65	0.64	206.00
T_{10}- T_5+ *Acetobacter*	96.5	170.0	69.5	19.4	17.35	0.68	278.21
T_{11}– Dhaincha+*Acetobacter*	90.7	154.8	61.5	19.2	17.05	0.65	146.65
T_{12}– NPK (120:60:60 kg ha^{-1})	91.9	164.0	64.3	19.1	16.89	0.50	136.87
C.D. (P= 0.05) / Initial	3.77	12.50	4.26	-	-	0.32	47.60

Table: 3.4. Influence of organics and inorganic nitrogen fertilizer application on second ratoon crop.

Treatments	Max. Shoot Population (000 ha^{-1})	No. of Millable Canes (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
A. Organics				
F_1 - FYM @ 10 t ha^{-1}	256.43	108.20	69.92	17.12
F_2 - Trash @ 7.5 t ha^{-1}	244.49	103.96	67.12	16.71
F_3 – F_1 + *Trichoderma viride*	265.93	112.95	71.73	*16.60*
F_4 – F_1 +*Gluconacetobacter*	261.27	111.06	70.71	16.51
F_5 – **F_2** + *Trichoderma viride*	249.53	105.83	67.56	*16.94*
F_6 – **F_2** + *Gluconacetobacter*	246.49	105.18	66.58	16.29
CD (P = 0.05)	6.12	3.23	2.81	NS
B. Nitrogen doses (kg ha^{-1})				
N_0 – 0	233.42	99.02	63.55	17.15
N_1 – 100	260.08	110.29	70.15	16.70
N_2 - 200	268.34	114.29	73.11	16.23
CD (P=0.05)	4.22	2.28	2.30	NS

Abbr. N.S. – Not significant

trash ha^{-1}+*Trichoderma viride* (67.56 t ha^{-1}) (Table-3.4). FYM (10 t ha^{-1}) alone or with *Trichoderma* / Gluconac*etobacter* gave significantly higher cane yield as compared to trash (7.5 t ha^{-1}) alone or with *Trichoderma* / Gluconac*etobacter*. However, differences in cane yield under FYM alone, FYM+ *Trichoderma* and FYM+*Gluconacetobacter* were not significant. Likewise, the differences in cane yield due to trash (7.5 t ha^{-1}) alone or with *Trichoderma* / *Gluconacetobacter* were also not significant. Highest cane yield of 73.11t ha^{-1}was recorded with 200 kg N ha^{-1}which was significantly higher than 100 kg N ha^{-1} (70.15 t ha^{-1}). Control plots (no nitrogen) resulted in lowest cane yield (63.55 t ha^{-1}). The interaction between organics and nitrogen levels on the cane yield was not significant. The maximum number of shoot population and millable canes exhibited the similar results as that of ratoon yield. Juice quality (Pol%) was unaffected due to various treatments.

Optimising nitrogen use through integrated nutrient management under sugarcane plant and ratoon system (C 6.5)

An experiment was started with spring planted sugarcane (February 2007) with an objective to find out the optimum proportion of inorganic and organic source of nitrogen to sugarcane plant and ratoon system for enhancing nitrogen use efficiency and sustaining cane productivity. Six treatments consisting combinations of different inorganic (urea) and organic (sulphitation pressmud cake) and three nitrogen doses were laid out in factorial RBD with three replications.

The first year results revealed that maximum cane yield and yield attributing characters e.g. millable canes, cane height, cane girth and cane weight were recorded in M_1 (Table 3.5) treatment

Table: 3.5. Influence of different treatments on yield and yield attributes of sugarcane plant crop

Treatments/Sources	Millable cane (000 ha^{-1})	Cane Yield (t ha^{-1})	Cane length (cm)	Cane girth (cm)	Cane wt (g)	Sugar Yield (t ha^{-1})
M_1 = 100 % N (TIS)	111.9	70.6	166.9	2.54	910.0	8.58
M_2 =90 % N (TIS) + 10 % (TOS)	110.6	69.2	168.0	2.50	900.0	8.43
M_3 =80 % N (TIS) + 20 % (TOS)	107.5	67.2	167.0	2.60	900.0	8.08
M_4 =70 % N (TIS) + 30 % (TOS)	105.2	66.5	163.9	2.54	861.0	8.04
M_5 =60 % N (TIS) + 40 % (TOS)	104.2	64.2	160.0	2.59	850.0	7.81
M_6 =50 % N (TIS) + 50 % (TOS)	99.5	66.5	161.0	2.63	873.0	7.96
CD (P=0.05)	6.90	5.60	8.36	0.086	64.8	0.68
Nitrogen Doses (kg ha^{-1}**)**						
N_1 =75	98.5	63.5	155.0	2.53	825.0	7.65
N_2 =150	108.2	67.2	165.0	2.58	900.0	8.09
N_3 =225	112.8	71.4	173.4	2.60	922.0	8.64
CD (P=0.05)	5.65	4.80	5.91	0.06	38.9	0.46

Abbr. TIS - N through inorganic sources, TOS - N through organic sources

where 100% N dose was applied through inorganic source. The differences in yield and yield attributing characters were not significant in various organic & inorganic combinations. Maximum cane yield and yield attributing characters were observed in treatment N_3, applying 200 kg N ha^{-1}, which was significantly higher than N_1 (75 kg N ha^{-1}). The soil organic carbon content was observed to be high with M_6 indicating an improvement in soil fertility level due to increase in the organic source of nitrogen application as compared to inorganic source.

Management of macro- and micronutrients in sugarcane based cropping system (C 18.2)

In second ratoon crop of sugarcane under plant cane-first ratoon-second ratoon-wheat-paddy cropping system with treatments of control, N,P,K,PK, NP,NK,NS, NPK, NPK+S, NPK+Zn, NPK+Cu, NPK+Mn, NPK+ Fe, NPK+S+Zn, and NPK+micronutrients (Zn, Cu, Mn+Fe) replicated four times in a RBD design, the application of N (150 kg ha^{-1}) resulted in a significant increase (73.0%) of yield over control. Application of other nutrients (P, K, PK and S) with N could not result in any significant increase of yield over N application. (Table 3.6) Integration of micronutrients with NPK also did not increase the yield significantly over NPK use. The higher and significant response of N may be due to deficiency of available N content and not that of other nutrients in the soil. Juice quality parameters remained unaffected by the treatments.

Table 3.6: Cane yield (t ha^{-1}) of second ratoon crop under different treatments

Treatments	Cane yield	Treatments	Cane yield
C (No-fertilizer)	38.2	NPK	67.2
N	66.1	NPK+S	67.7
P	34.6	NPK+Zn	67.5
K	34.2	NPK+Cu	67.2
PK	35.2	NPK+Mn	67.2
NP	66.5	NPK+Fe	67.6
NK	65.2	NPK+S+Zn	67.8
NS	66.7	NPK+Micronutrients	67.8
C.D. (P=0.05)	4.3	-	4.3

Comparative performance of sugarcane in wheat + sugarcane cropping under flat and FIRB system (Field Testing)

A field trial was conducted to see the performance of sugarcane in wheat + sugarcane intercropping under different planting methods. The planting methods viz., manual planting of sugarcane in wheat + sugarcane under FIRB system, wheat + sugarcane planting by raised bed seeder-cum-planter, wheat + sugarcane planting by planter-cum-seed drill in flat beds and wheat – sugarcane conventional system were and the sole sugarcane (Table 3.7). Under FIRB system, two rows of wheat were sown on raised beds and sugarcane was planted in furrows spaced at 60 cm in the month of November. In wheat + sugarcane (flat) system, both the crops were sown / planted using cane planter cum wheat drill keeping four rows of wheat in between two rows of sugarcane (90 cm). Sole sugarcane was planted at 90 cm spacing, whereas, in wheat–sugarcane system, sugarcane was planted at 60 cm.

Wheat grain yield was almost equal in all the cropping systems. The highest cane yield was obtained in sole sugarcane (87.7 t ha^{-1}) and was almost equal to that obtained under wheat + sugarcane (manual planting) under FIRB system (86.5 t ha^{-1}). The lowest cane yield of 62.3 t ha^{-1} was recorded under wheat + sugarcane in Flat method. The cane yield was higher in sole sugarcane and wheat + sugarcane under FIRB system due to higher and heavier millable canes compared to that under wheat–sugarcane sequential system. The cane equivalent yield in wheat + sugarcane (manual planting) under FIRB system was the highest (121.0 t ha^{-1}) with the net profit of Rs. 26758 over sole sugarcane. Wheat + sugarcane (manual planting) under FIRB system produced higher cane yield and the net profit over sole sugarcane as compared to wheat + sugarcane planted by raised bed seeder cum planter due to higher number of millable cane in the former system.

Table: 3.7. Performance of sugarcane in wheat + sugarcane intercropping under different planting methods

Cropping systems	Wheat grain yield (q ha^{-1})	Sugarcane				Profit over sole sugarcane (Rs. ha^{-1})
		NMC (000 ha^{-1})	Cane weight (kg)	Yield (t ha^{-1})	CEY (t ha^{-1})	
Wheat + sugarcane (manually) under FIRB	45.3	106.7	0.921	86.5	121.0	26758
Wheat + sugarcane under FIRB (raised bed seeder cum planter)	45.1	90.0	0.928	74.3	108.6	15553
Wheat + sugarcane under flat method	47.6	70.0	0.913	62.3	98.5	4240
Wheat – sugarcane Conventional	48.4	98.3	0.776	68.4	105.2	8455
Sole sugarcane	-	96.7	1.024	87.7	87.7	-

Effect of covered pit planting (CPP) and covered trench planting (CTP) on productivity and quality of sugarcane (Expl. Trial)

An experiment is under progress to find out the effect of CPP and CTP on yield and juice quality of sugarcane. The treatment consisted of five planting methods viz., Ring pit planting (RPP), covered pit planting (CPP), trench planting (TP), covered trench planting (CTP), furrow planting after deep disk (DDP) and normal furrow planting. The experiment was laid out in randomized block design with four replications. The planting of experiment was done in February.

Comparative performance of different grades of NPKS mixed fertilizers on yield and quality of sugarcane (CR – 2/06)

A field experiment was conducted on ratoon crop of sugarcane during 2007-08 in order to compare the agronomic performance of different grades of NPKS mixed fertilizers supplied by Shriram Chemicals and Fertilizers, New Delhi. The grades were 12-16, 16-06, 14-20-10-06 and 15-17-11-07. The treatments made on these grades were replicated three times in a RBD design. The experimental crop was raised as per local cultural practices. Full P, K was given at ratooning and N (150 kg ha^{-1}) was given in two equal splits i.e. 50% at ratooning and rest 50% at the onset of monsoon. Different grades of NPKS mixed fertilizers were found equally effective source for the yield and the quality of ratoon crop also if applied on equal nutrient basis (Table 3.8). The results suggested the that application of these NPKS mixed fertilizers may be a good step for basal and balanced application in sugarcane for all soils in general and for S-deficient soils in particular.

Table: 3.8. Yield and quality parameters of ratoon crop under different grades of NPKS fertilizers

Treatments	Tiller No. (' 000ha^{-1})	NMS ('000ha^{-1})	Cane Yield (t ha^{-1})	Juice parameters (%)		
				Brix	Pol	Purity
T_1 N_{150} P_{60} K_{60}	271.7	99.2	68.7	18.8	16.2	86.2
T_2 N_{150} P_{60} K_{60}	265.7	93.7	69.7	18.7	16.2	86.6
T_3 N_{150} P_{60} K_{60}	268.3	93.9	67.8	19.5	16.5	84.7
T_4 N_{150} P_{60} K_{30}	273.3	98.9	70.0	18.7	16.2	86.6
T_5 N_{150} P_{60} K39	266.7	96.6	69.3	19.1	16.1	84.3
T_6 N_{150} P_{80} K_{80}	267.0	94.7	69.7	19.2	16.4	85.4
T_7 N_{150} P_{80} K_{40}	262.0	93.8	69.7	19.1	16.7	87.4
T_8 N_{150} P_{80} K52	263.3	98.6	70.9	19.4	16.7	86.0
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS

Effect of Wellgro organic manure with NPK on yield and quality of sugarcane (CR-1/06)

An experiment was conducted with "wellgro" organic manure and NPK fertilization to assess the best combination of organic and inorganic in increasing the ratoon cane yield as well as for sustaining soil health. Application of recommended dose of P and K (basal) mixed with 400 kg wellgro manure ha^{-1} and top dressing of recommended nitrogen (150 kg ha^{-1} = T_8) improved significantly, the number of millable canes (78500 ha^{-1}), individual cane length (179 cm) and weight (798 g) (Table 3.9). The number of millable canes increased by 11.7% and the mean cane weight increased by 9.9% over control. Juice quality (brix, pol and purity) did not register tangible difference among various treatments. The highest cane (69 t ha^{-1}) and sugar yield (8.13 t ha^{-1}) were observed at T_8. The increase in cane and sugar yields with T_8 was 15 and 16.6%, respectively over control or recommended NPK application (T_1). The highest agronomic efficiency (102.5 kg cane kg^{-1} N applied) was also observed with T_8. It indicated improved nutrient use under integration of organic with inorganic fertilizers. Soil health also improved with the application of wellgro manure integrated with inorganic fertilizers.

Effect of mode of *Gluconacetobacter* inoculation with various nitrogen levels on sugarcane (Expl.Trial)

An exploratory trial was conducted with three levels of inoculation of *Gluconacetobacter* viz., sett

Table 3.9: Effect of various treatments on yield attributes, ratoon cane and sugar yields

Treatments	Millable canes (000 ha^{-1})	Cane length (cm)	Cane dia-meter (cm.)	Cane weight (g)	Cane yield (t ha^{-1})	Agronomic efficiency (kg cane/ kg N^{-1} applied)	Sugar yield (t ha^{-1})
T_1 Control : Basal application of P and K and top dressing of N as normal practice	70.3	164	2.2	726	60	57.5	6.97
T_2 RD basal P & K mixed with 200 kg wellgro soil ha^{-1} and top dressing N as recommended	74.5	168	2.24	766	64	77.5	7.14
T_3 RD basal P & K mixed with 300 kg wellgro soil ha^{-1} and top dressing N as recommended	76.0	172	2.26	780	65.2	83.5	7.63
T_4 RD basal P & K mixed with 400 kg wellgro soil ha^{-1} and top dressing N as recommended	78.0	176	2.27	790	66.5	90	7.91
T_5 RD basal P & K mixed with 500 kg wellgro soil ha^{-1} and top dressing N as recommended	75.6	176	2.26	804	66	87.5	7.77
T_6 RD basal P & K and 200 kg wellgro soil mixed with N dose	75.0	171	2.25	772	65	82.5	7.70
T_7 RD basal P & K and 300 kg wellgro soil mixed with N dose	76.5	175	2.27	785	67	92.5	7.93
T_8 RD basal P & K and 400 kg wellgro soil mixed with N dose	**78.5**	**179**	**2.29**	**798**	**69**	**102.5**	**8.13**
T_9 RD basal P & K and 500 kg wellgro soil mixed with N wellgro dose	78.2	177	2.27	815	68.5	100	7.94
T_{10} RD basal P&K mixed with 200 kg wellgro soil and N dose mixed with 200 kg wellgro soil ha^{-1}	77.5	178	2.28	794	67	92.5	7.66
T_{11} 50% RD basal P & K mixed in 200 kg wellgro soil ha^{-1} and N dose and 50% N mixed in 200 kg wellgro soil ha^{-1}	76.6	179	2.27	798	67.5	95	8.03
T_{12} No fertiliser application	58.0	156	2.09	593	48.5	-	5.93
C.D. (P=0.05)	7.20	10.45	0.03	45.6	6.40	-	0.52

Note: *Treatments = 12, Design = RBD, Plot size = 7.5 m x 4.5 m, Sugarcane variety = CoS 94257, Planting time = 24.03. 2006, Ratoon initiation = 14-03-2007; Row to row spacing = 75 cm Recommended N in ratoon cane = 200 kg N ha^{-1}, N application period in ratoon cane= ½ in March and ½ in May, Organic Source (wellgro soil) = as indicated in treatments.

Table 3.10: Effect of mode of inoculation of *Gluconacetobacter* and different N levels on growth, yield and quality of sugarcane

Treatment	Millable canes (000 ha^{-1})	Cane length (cm)	Cane diameter (cm.)	Cane weight (g)	Cane yield (t ha^{-1})	CCS (t ha^{-1})
Mode of application of *Gluconacetobacter*						
Sett treatment	100.9	156.9	2.89	891.1	62.6	7.82
Soil treatment	95.4	152.1	2.85	856.6	59.1	7.38
Foliar application	85.3	144.9	2.72	773.3	55.7	6.88
CD (P=0.05)	6.50	8.56	0.16	45.60	4.62	0.52
N levels (kg ha^{-1})						
0	81.1	140.1	2.76	704.4	55.7	6.96
75	95.8	151.3	2.83	873.3	65.3	8.12
150	104.8	162.5	2.87	933.3	69.5	8.61
CD (P=0.05)	6.50	8.56	0.16	45.60	4.62	0.52

treatment (during planting), soil treatment (basal) and foliar application (at maximum tillering stage) with three nitrogen levels (0, 75 and 150 kg N ha^{-1}) through inorganic fertilizers to sugarcane. High sugar genotype, CoS 8436 was taken in the experiment. Thus, 9 treatment combinations were tried under RBD with three replications. Sett treatment with *Gluconacetobacter* produced the highest number of millable canes (100.9 thousands ha^{-1}) (Table 3.10). It also improved individual cane length (156 9 cm), diameter (2.89 cm) and weight (891.1 g). It was followed by soil treatment with *Gluconacetobacter* in increasing growth and yield of sugarcane. Significantly higher cane weight (12.4 %) was observed with sett treatment (891.1 g) compared to foliar application. Sugar yield (7.82 t ha^{-1}) increased with sett treatment by 13.7% over foliar application. Increasing levels of nitrogen increased growth parameters, cane and sugar yields. There was increase of 24.8% in sugarcane yield with application of 150 kg N ha^{-1}as compared to no N (55.7 t ha^{-1}). Sugar yield increased by 23.7% (8.61 t ha^{-1}) with the similar N level. Thus, it could be concluded that sett treatment by *Gluconacetobacter diazotrophicus* with the application of 150 kg N ha^{-1} simultaneously improved growth, yield attributes and yield in sugarcane.

Sett treatment of *Gluconacetobacter diazotrophicus* application was found to be the best in terms of colonizing population of *G. diazoytrpjhicus* in shoot and root of sugarcane variety, CoS 8436. Foliar application could not induce colonization of inoculated strain, as the population level was comparable with the natural incidence of *G diazotrophicus*, as observed in control plants. Overall the response of inoculation was better at N_{75} kg ha^{-1} (Table 3.11).

3.2 Water management in sugarcane based cropping system

Optimization of irrigation water requirement of plant and ratoon crop of sugarcane in sub-tropical India (A.E. 6.7)

Autumn and spring planted and spring initiated ratoon crops of sugarcane were irrigated with 6, 8 and 10 cm depth of water. Autumn planted crop received five irrigations while spring planted crop and spring initiated ratoon received three irrigations each. Highest cane yield (69.78 t ha^{-1}) was observed in autumn planted crop irrigated with 10 cm depth of water while lowest cane yield (52.75 t ha^{-1}) was observed in spring initiated ratoon crop irrigated with 6 cm depth of water. However, irrigation water use

Table: 3.11: Population of *Gluconacetobacter diazotrophiscus* (counts g^{-1}) in sugarcane shoot/root

Treatments	N_0		N_{75}		N_{150}	
	Root	Shoot	Root	Shoot	Root	Shoot
Sett treatment	2.7x 10^3	2.4X10^2	1.9X10^4	8.7x10^2	6.4x 10^3	4.3 x10^2
Soil treatment	1.7x10^2	80	2.9x10^2	1.3x10^2	6.4x10^2	1.4 x10^2
Foliar spray	20	10	40	35	60	30
Control	25	10	35	35	50	35

efficiency was the highest (3138.89 kg ha^{-1}-cm) in spring planted sugarcane irrigated with 6 cm depth of irrigation water. The lowest irrigation water use efficiency (1395.6 kg ha^{-1}cm) was observed in autumn planted crop irrigated with 10 cm depth of irrigation water.

Enhancing field water use efficiency for sugarcane cropping system through FIRBS (UPCAR Funded project)

Sugarcane crop planted in October, 2006 and March 2007 have been harvested in February, 2008. Potato crop planted in October 2007 have been harvested in March, 2008. Results indicate that highest potato yield (45.85 t ha^{-1}) was observed when two rows of potato were planted on raised beds made between two sugarcane rows spaced at 90 cm and the crop was fertilized through organic fertilizers and irrigated with 5.0 cm depth of irrigation water. However, the highest sugarcane yield (65.1 t ha^{-1}) was observed when the sugarcane was planted in furrows spaced at 75 cm in raised bed system and fertilized through organic fertilizers and irrigated with 7.5 cm depth of irrigation water. Highest irrigation water use efficiency for potato and sugarcane crops was observed in FIRB system with furrows spaced at 90 and 75 cm apart, respectively.

3.3 Heavy metal toxicity management in sugarcane based cropping system

Physiological and molecular approaches to study heavy metal toxicity in Sugarcane (APC 1/05/NS-80)

Effect of foliar spray of chromium, nickel, cadmium and lead (30 ppm) was observed on NR activity *in vivo* in fourteen sugarcane varieties. It was found that induction of NR activity was more than control in varieties viz., UP 0091, CoS 96268 and CoLk 94184 when lead was used as heavy metal. Similarly the spray of nickel decreased the NR activity except variety CoLk 94184. The spray of cadmium induced NR activity more than control in CoS 96268, CoLk 94184 and CoP 9702. With chromium spray, induction was more than control in varieties CoS 94259, CoS 96268 and CoLk 94184. It showed that variety CoLk 94184 had relatively more induction with tested metals, while in other cases, it decreased in comparison with control.

Soil application of nickel (0, 60 and 90 ppm) had shown less deterioration in juice quality (^{o}Brix, Pol % juice and purity), with lesser reducing sugar and acid invertase activity in variety CoLk 94184 compared with CoS 99269 and UP 0097.

4

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)

The collection of 225 genotypes consisting of *S. officinarum*, *S. barberi*, *S. sinense*, ISH lines, commercial hybrids, *S. spontaneum*, etc. was maintained and the required materials were supplied to various on- going projects of the Institute.

For identifying genotypes suitable for high biomass production, 10 IkshuISH genotypes with *Saccharum officinarum* and *Saccharum spontaneum* as immediate parents in the interspecific hybridization programme were grown under normal and moisture deficit conditions during 2006-07 and 2007-08 seasons and observed for cane yield, yield parameters and juice quality. IkshuISH-22 and IkshuISH-4 (Table 4.1) recorded very high cane yield (170.0 and 164.2 t ha^{-1} respectively) and shoot biomass, coupled with optimum brix percent (17.52 and 13.31%, respectively) for ethanol production. Further, these also performed well under moisture deficit conditions, wherein, no irrigation was provided after complete germination (cane yield 95.93 and 90.21 t ha^{-1}respectively) and were MR against prevalent red rot races thereby proving their suitability for cultivation under wider range of areas.

Observations on 12 commercial varieties were recorded for precise sett weight of their seed cane. It was observed that great variability exists for sett weight among varieties. The mean sett weight for three, two and single bud setts was 98.92 g (range 45.22 – 136.65 g), 71.88 g (range 35.69 – 107.49 g) and 36.70 g (range 22.35 – 54.53 g), respectively (Table 4.2).

Table 4.1: Performance of IkshuISH-4 and IkshuISH-22 for biomass production

Genotypes	NMC (000 per ha)	Cane Length (in m)	No. of Inter-nodes	Inter-node Length (cm)	Cane Girth (cm)	Brix% (in Feb)	Total Fresh Leaf production (t ha^{-1})	Cane Yield under normal conditions (t ha^{-1})	Cane Yield (t ha^{-1}) under Moisture Deficit Condition
IkshuISH-4	369	1.63	16.8	12.6	1.90	13.31	47.6	164.2	90.2
IkshuISH-22	304	1.68	15.9	13.8	1.69	17.52	43.6	170.0	95.9

Note : Year 2006-07 & 2007-08.

Table 4.2: Seed Cane Sett weight of commercial varieties (in g)

Varieties	3-bud setts	2-bud setts	Single bud setts
CoJ 64	74.35	59.85	31.51
CoS 94257	102.82	73.08	47.59
CoSe 92423	136.65	96.20	49.25
CoSe 95422	77.40	60.03	28.53
CoS 95270	105.56	87.16	48.35
CoPant 90223	111.54	82.14	54.53
CoLk 8102	75.10	53.65	22.35
CoS 8436	124.71	107.49	52.66
CoS 96275	110.86	63.78	30.07
CoS 96268	132.55	79.26	23.36
CoLk 94184	90.25	64.26	29.45
CoS 767	45.22	35.69	22.75
Mean sett weight	98.92	71.88	36.70
SE	7.87	5.71	3.64
Range (Min)	45.22	35.69	22.35
Range (Max)	136.65	107.49	54.53

This indicates that for commercial packaging of requisite number of buds to be planted in a unit area, the weight of the packets will differ with varieties and there exists a scope for seed cane saving in varieties with lower sett weights.

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

CoLk 94184 sugarcane variety developed by the Institute was evaluated for its performance in North Central Zone of AICRP(S). It was mostly ranked first in cane yield, CCS and pol % juice amongst the 3 varieties, viz., CoLk 94184, BO 120 and CoSe 95422 (Table 4.3). Its second position was in terms of CCS for plant I and in terms of Pol % juice at harvest in plant II. Four sugarcane genotypes, two each of early and Mid-late group, have also been proposed for U.P. State Varietal Trials during 2008-09 (Table 4.4)

Evaluation of elite clones under Station Trials 2007-08 (Plant Crop)

A trial comprising nine sugarcane clones viz. LG 03058, LG 01012, LG 02321, LG 03002, LG 03001, LG 99118, LG 01170, LG 02327, LG 02314 with three checks CoJ 64, CoS 96268 and CoS 767 was conducted in RCBD with three replications. Two genotypes LG 02327 and LG 03058 (Table 4.5) were accepted for AICRP(S) with the names CoLk 07203 and CoLk 07202 respectively, as mid-late varieties. Several genotypes were found to be better than the checks for different characters and will be proposed for AICRP(S) and State Varietal Trials. LG 03001 recorded best CCS yield (11.30 t ha^{-1}) followed by LG 02321 (11.10 t ha^{-1}).

Table 4.3 : Performance of CoLk 94184 over locations in North Central Zone

AICRP(S) AVT	Cane yield (t ha^{-1})			CCS (t ha^{-1})			Pol % juice at harvest		
	CoLk 94184	BO 120	CoSe 95422	CoLk 94184	BO 120	CoSe 95422	CoLk 94184	BO 120	CoSe 95422
Plant I	76.43	64.76	76.12	9.28	7.76	9.76	17.91	17.28	17.38
Plant II	80.72	59.36	71.66	9.74	7.19	8.88	17.75	17.20	17.82
Ratoon	70.75	57.54	68.39	8.82	6.93	8.44	18.26	17.57	18.00
Mean	75.97	60.55	72.06	9.28	7.29	9.03	17.97	17.35	17.73

Note: Identified by AICRP (S) in 2007.

Table 4.4 Sugarcane genotypes proposed for U.P. State Varietal Trials (Year 2008-09)

Genotype	Parentage	NMC ('000 ha^{-1})	Single Cane Weight (kg)	Cane yield (t ha^{-1})	CCS (t ha^{-1})	Pol % in Juice		Reaction to Red Rot
						8 M*	10 M**	
Early Group								
CoLk 05202	CoS 92263 x ISH 69	95	0.89	84.9	10.7	16.8	19.3	MR
CoLk 9709	LG 7230 GC	92	0.80	77.1	10.4	16.3	19.5	MR
Mid Late Group								
CoLk 99271	CoPant 90223 x Co 1148	128	0.70	90.0	11.7	16.1	19.0	R
CoLk 07203	CoLk 8102 x Co 62198	94	0.91	85.2	10.4	17.9	18.2	MR

Note: For mid late group, * and ** are 10 M & 12 M, resepctively.

Table 4.5: Mean performance of elite clones in Station Trial (2007-08)

Variety	Tiller Count ha^{-1} (June)	Cane Dia (cm)	NMC $^{-1}$ ('000) (Dec)	pol% in juice (Oct)	pol% in juice (Dec)	pol% in juice (Feb)	Yield t ha^{-1} (Feb)	CCS t ha^{-1}
LG 03058	203.5	2.2	85.7	12.2	17.1	18.0	81.8	10.10
LG 02321	172.6	2.1	84.3	12.9	19.0	19.3	83.3	11.10
LG 03001	173.7	2.3	77.1	11.2	17.2	18.5	89.3	11.30
LG 02327	125.7	2.4	68.5	11.8	18.0	18.5	70.9	9.00
CoJ 64	127.6	2.1	64.2	13.2	19.4	19.7	52.9	7.20
CoS 767	141.5	2.1	61.5	13.1	18.0	19.2	57.6	7.70
GM	151.40	2.18	70.53	12.41	17.93	18.67	67.41	8.67
SEM	15.19	0.1	4.97	0.56	0.67	0.29	2.90	0.44
CV %	17.38	7.56	12.21	7.82	6.49	2.66	7.45	8.75
CD(0.5)	44.55	0.29	14.58	1.64	1.97	0.85	8.51	1.29

Evaluation for ratoonability of promising advance genotypes under Station Trial

Twelve genotypes developed under different projects along with three checks CoJ 64, CoS 676 and CoS 96268 were evaluated for ratooning potential during 2007-08. Analysis of variance for characters under observations indicated significant variability among the traits except purity percent. The highest cane yield (62.7 t ha^{-1}) was recorded in clone CoLk 99271, followed by CoLk 9709 (58.3 t ha^{-1}), CoLk 05202 (57.8 t ha^{-1}) and CoLk 94184 (56.0 t ha^{-1}) as compared to check CoS 767 (48.8 t ha^{-1}). Commercial variety CoLk 94184 exhibited highest sugar (19.2%).

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

This project is being carried out with the aim to enrich breeding population in the National Hybridization Garden at Sugarcane Breeding Institute, Coimbatore so as to lend precision to economic breeding. Apart from incorporating the genetic complement from suitable accessions of *S. officinarum*, the high sugar ISH clones and commercial varieties have been utilized in enhancing the genetic potential for early sugar accumulation. Till date, 42 breeding stock have been sent to SBI, Coimbatore and over 30 that are already in the 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. Besides, occasionally, desirable recombinants with commercial attributes are also obtained in the progeny. Over the years, 3 clones were proposed for evaluation under AICRP on Sugarcane. One in particular, CoLk 94184 (Birendra) was identified for cultivation in the North Central zone. Twenty Four biparental matings (8 at Coimbatore and 16 at Agali), 5 selfs and 7 GCs were attempted involving predominantly the LG breeding stock in 2007-08. Over 3000 seedlings raised from the fluff of 2006 crosses were transplanted in the field. From the ratoon crop of C_0 population, 250 selections were made based on early sugar in October (with reference to the high sugar standard, CoJ 64). The high population mean is indicative of the efficacy of recurrent selection for sugar accumulation potential. In C_1 clonal generation, 56 selections were advanced for desirable level of sugar, (some selections possessed other good commercial attributes as well). LG 97050 x Co 775, LG 95123 x Co 86002 and LG 94184 x Co 86011 were the crosses giving high proportion of selections in C_1. Evaluation of various clonal generations in replicated trials in plant and ratoon crop showed that LG 01030 and LG 01282 had commercial merit and moderate resistance to red rot. These were promoted to the station trial at the Institute. A mid-maturing clone, CoLk 7202 (LG 03058/ Selection No IV-4-4), was accepted for evaluation in AICRP North West Zone.

Genetic evaluation of sugarcane genotypes and crosses for their suitability under late-planted conditions (B 2.6)

One hundred four C_1 selections were evaluated for their suitability under late planted conditions, especially after wheat harvest. Thirty-four selections exhibited superiority and were advanced to C_2 stage. The progenies derived from CoLk 8102 x CoS 88216, CoLk 8102 x LG 72120 and LG 94184 x CoS 8436 were advanced to C_3 stage on the basis of performance under late planted conditions. Ten advanced stage clones were evaluated for their suitability to late planting condition. LG 2616, LG 2618 and LG 2619 were found superior in sugar yield over standards CoS 767 & CoJ 64.

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

Under the project, CoLk 7201(LG2910) was included as an early entry in multilocation testing for north western zone under AICRP(S) . CoLk 04238 has been promoted to advanced varietal trial after evaluation in initial varietal trial.

During the year, two biparental crosses viz., Co1148 x NCo 310 and BO 91 x CoS 8436 were attempted at SBI, Coimbatore and fourteen crosses viz., CoLK 8102 x (Co 7201 x IMP 84-446), 97-304 x CoLk 8102, BO 91 x CoS 95255; 97-239 x Co 1158, CoLk 8901 x Co 775, CoC 671 x Co 86011, Co 7704 x ISH 41, Co 8371 x CoS 90265, Co 8371 x Co 1148, Loakona-15 x CoS 8436, 81V48 x CoS 8436, CoV 92102 x Co 1148, CoS 90265 x CoT 8201 and 81V48 x CoS 89003 were attempted at Distant hybridization facility at Agali.

Three thousand Co seedlings derived from 15 biparental crosses, involving 4 intergeneric hybrids with *Erianthus* sp. as the male parent, 10 GCs and 4 self made in 2005, were evaluated for initial vigor and cane forming ability.

The ratooned Co seedlings numbering 3298 derived from four biparental crosses, and 12 GCs made in 2004 were evaluated for ratooning potential, top borer tolerance, HR brix and growth habit. The

highest brix during Nov. 07 was observed in progenies of CoT 8201 GC. For clonal evaluation, 106 clones at C_1 stage were evaluated for growth, quality parameter and top borer tolerance. The lowest range of cumulative top borer infestation was observed in progenies derived from BO 91 x CoS 90260 (4.8-6.4%). Fifty eight promising clones were advanced to C_2 stage. Forty clones were evaluated at C_2 stage and 24 clones advanced to C_3 stage. Eleven clones at advance stage were evaluated for top borer tolerance and sugar yield. Four clones possessed superiority in traits of economic importance.

The clonal evaluation reveals that the progenies derived from biparental hybrids viz., CD-264 x Co 86002, CoLK 8102 x 99-109, LG 94114 x I K 76-81 and 97-128 x BO 91 exhibited less than 2.90 percent of top borer infestation in Ist and IInd brood, while 3.1 to 3.9 percent in IVrd to Vth brood, indicating the importance of *Erianthus sp.* in breeding for top borer tolerance, as the parentage of these progenies has a component of *Erianthus.*

The top borer tolerance was influenced by carbohydrate content, reducing sugars and protein content in leaves. Third brood infestation was negatively correlated with total carbohydrate content in leaves, while reducing sugar and protein content were positively correlated with top borer tolerance.

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

A total of 22 biparental crosses were attempted at National Hybridization Garden, SBI, Coimbatore in 2007. The fluff received for the crosses along with 15 GCs was sown in the glass-house to raise the seedlings for evaluation.

Twelve sugarcane crosses with equal number of seedlings were transplanted in a replicated trial to evaluate the family performance for the prediction of future crosses. Observations were recorded on survival percent, early growth, vigour and the number of shoots per clump in each plot of seedlings.

Based on the yield, quality, suitability under moisture deficit condition and red rot resistance, 2 clones of early group (LG 03701 and LG 03702) and one of mid-late group (LG 03706) were promoted to the station trial. LG 03706 was also sent to the IISR Regional Centre, Motipur (Bihar) for testing under water logging conditions.

Nine sugarcane genotypes of CoLk series along with BO 91 were evaluated under both normal as well as moisture deficit conditions for yield and quality parameters. There were significant differences amongst the genotypes for cane and sugar yield and in their component traits. The genotype CoLk 9902 exhibited significant higher cane and CCS yield under normal conditions. The genotype CoLk 99271 recorded highest cane and sugar yield under drought conditions, followed by CoLk 04238. The maximum reduction in cane yield and CCS yield under moisture deficit condition was noticed in CoLk 05202, followed by CoLk 9412. Genotype BO 91 was the least affected genotype under moisture deficit for cane and sugar yield. Genotype CoLk 94184 showed the highest sucrose percent under both the conditions.

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

Nineteen bi-parental crosses viz. LG 95053 x ISH 69, Co 1158 x CoLk 8002, CoLk 8102 x CoH 15, CoLk 8102 x CoS 8436, CoS 92263 x ISH 69, CoLk 94184 x Co 62198, CoLk 8002 x CoSe 92423, CP52-1 x Co 86002, 87A298 x CoS 8436, 81V48 x CoH 70, ISH-1 x CoSe 96436, Co 7201 x CoC 671, CoPant 88220 x CoT 8201, Co 94012 x ISH 176, Co 88025 x CoPant 92227, CoJ 83 x Co 62198, CoLk 9412 x Co 86011, UP 9530 x Co 86002 and Co 89003 x ISH 41 were attempted at National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore during October - November 2007. In addition, fluff of 11 zonal crosses CoS 8436 x Co 89003, Co 88025 x Co 775, CoSe 92423 x CoS 8436, CoS 8436 x CoPant 97222, Co 98008 x Co 775, Co 98010 x Co1148, CoJ 99122 x CoS 8436, MS 68/47 x Co 1148 and Co 7314 x Co 1148, CoS 8436 PC (with Co 89003, Co 8347 and ISH 9) and Co 7201PC (with Co 89003, Co 7314 and CoS 8436) along with 10 GCs was also received. The fluff was tested for germination in BOD at 30^{0}C and crosses with good germination were sown in glass house to raise seedlings.

The seedlings obtained from biparental crosses attempted during 2006 crossing season viz. LG 99122 x NCo 310, CoLk 8102 x HR 83-65, Co 1158 x Co 62198, CoLk 94184 x CoLk 8102, UP 9530 x Co 86002, CoLk 94184 x ISH 176, CoLk 8102 x CoJn 862072, LG 95053 x Co 775, CP 52-1 x CoH 70, ISH 100 x CoS 88216, CoJ 64 x Co 94008 and 81 V 48 x Co 1148 along with of 11 zonal crosses (8 bi-parental and 3 poly crosses) and 20 GCs were transplanted in the field for evaluation and were ratooned during March 2008 for further observation.

Out of 257 selected progenies from 11 crosses planted in the field for multiplication and evaluation (C_1 stage) during spring 2007 along with standards

(CoS 8436, CoJ 64 and CoPant 84211), 51 selections were made based on the yield and juice quality parameters. The selected clones were planted during autumn and spring of 2007-08 for further evaluation.

A total of 28 clones (C_2 clones) selected and planted during autumn season of 2006, were evaluated along with CoS 767, CoS 8436 and CoJ 64 as standards. Selection was done on the basis of HR Brix%, cane diameter, cane top colour, NMC and other morphological features along with juice quality parameters. Five clones with high biomass and early sugar accumulation were selected and advanced for further evaluation and planted during autumn 2007.

In a trial, comprising 12 advanced clones (elite clones) along with three standards (CoS 767, CoJ 64 and CoS 8436) planted in RCBD for evaluation, observations were recorded for germination percentage yield and its attributes, juice quality parameters (October 07 and January 08). A total of 8 clones were found to be promising and advanced for further evaluation. Out of 20 clones planted in augmented design, 6 clones were advanced for multiplication and further evaluation.

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

In order to select the resistant parents for the breeding programme, 35 clones comprising of Inter-specific hybrids (ISH), *S. spontaneum* accessions and commercial hybrid varieties were inoculated by plug method using pathotypes (Cf 09) of *Colletotrichum falcatum*. Commercial varieties namely, CoLk 8102, CoLk 8001, CoLk 94194, CoS 96268, CoSe 92423, CoSe 95422 and BO 91 exhibited MR reaction to red rot. Interspecific hybrids ISH 7, ISH 135, ISH 150, ISH 288 and the elite genotypes CoLk 9412 and CoLk 05202 also showed MR reaction.

For hybridization programme, 10 bi-parental crosses viz. Co 7201 x CoC 671, CoS 96268 x CoLk 8002, CoLk 8102 x Co 86002, CoJ 83 x Co 62198, ISH 100 x Co 86002, CoLk 8002 x Co 62198, ISH-1 x CoSe 96436, Co 88025 x ISH 41 and CoC 671 x ISH 147, one self of CoS 96268 and five general crosses were attempted at National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore and fluff received was sown in glass-house to raise and evaluate seedling population during 2008-09.

Evaluation and selection of progenies and clones was carried out. Observations on number of tillers per clump, shoots per clump, number of millable cane, visual performance (score very good =1, good = 3, poor = 5 and very poor = 7), weight of single cane and HR Brix in December and February were recorded and individual progenies with more than 16% HR Brix were selected for evaluation in first clonal generation against red rot. A total of 235 progenies were selected from four families, in which cane formation was complete, namely, Co7717 x SES 594, CoLk 8102 x ISH 176, CoLk 8102 x HR 83-65, CoLk 9412 x BO91, CoC 671 x ISH 147 and CoLk 94196 x HR 83-65. Progenies of other families viz. Co1158 x CoLk 8002, Co1158 x BO91, CoLk 9412 x Co86011, ISH 100 x Co1148, ISH 100 x Co 62198 and LG 95053 x ISH 153 which did not show formation of millable canes were ratooned for further selection. Progenies of the cross CoC 671 x ISH 147 exhibited HR Brix in the range of 14 to 23 %, followed by CoLk 9412 x BO 91 (13.0 to 22.6 %).

For evaluation and selection of clones from the first clonal generation, 126 clones out of 285 progenies (from 12 crosses selected in 2006-07) showed moderately resistant to moderately susceptible reaction to red rot pathotype Cf 09 under plug method of inoculation. These clones also out performed in HR brix recorded in November and February. Selections were made from ratoon of seedling generation based on the visual performance, NMC and HR brix during November 07 and February 2008.

At C_2 stage, 2 A trial comprising of 26 clones was conducted to validate the red rot reaction and to assess their yield and quality performance along with two checks, namely CoJ 64 and CoS 767. Three clones LG 05810, LG 05817 and LG 05828 showed moderately resistant (MR) reaction to three virulent pathotypes viz, Cf 08 and Cf 09 with more than 80 t ha^{-1} cane yield, while LG 05823 showed the highest cane yield (92.0 t ha^{-1}) and sugar yield (12.0 t ha^{-1}) with MR reaction to Cf 08 and Cf 11.

Four promising clones viz., LG 05828, LG 05823, LG 05817 and LG 05810 also showed better ratoonability in first clonal generation.

Varietal Trials of AICRP on Sugarcane (B.1)

Zonal Varietal Trials, North West Zone, Lucknow Centre

Advance Varietal Trial (Early) II Plant: Ten early maturing entries viz. Co 0116, Co 0118, Co 0237, Co

0238, Co 0239 CoS 02258, CoS 03252, CoH 118, CoLk 9709, CoPant 02217 with two checks viz. CoJ 64 and CoPant 84211 were evaluated for their performance in plant crop. Genotype CoLk 9709 was found to be significantly superior in cane and sugar yield (86.1 t ha^{-1}) and (12.20 t ha^{-1}), respectively over the best check CoJ 64, followed by Co 0239 in cane yield (78.3 t ha^{-1}).

Advance Varietal Trial (Early) Ratoon: A trial comprising of nine early maturing entries viz., Co 0116, Co 0118, Co 0237, Co 0238, CoH 118, CoS 02258, CoLk 9709, CoS 03252 and CoPant 02217 with two checks viz. CoJ 64 and Co Pant 84211 ratooned. The best entry was CoLk 9709 with cane yield (59.1 t ha^{-1}) and sugar yield (8.40 t ha^{-1}). This genotype also exhibited better ratoonability.

Advance Varietal Trial (Early) I Plant: Eight entries viz. CoH 127, CoJ 03191, CoJ 03192 , CoLk 9902, CoS 03251, CoS 03279, CoPant 03219 and CoPant 03220 including two checks viz. CoJ 64 and CoPant 84211 were planted to assess their performance for yield and juice quality. CoPant 03220 gave the highest cane yield (91.3 t ha^{-1}), followed by CoPant 03219 (85.8 t ha^{-1}). CoPant 03220 also gave higher sugar yield (10.75 t ha^{-1}) over both checks.

Initial Varietal Trial (Mid late): Six genotypes *viz.*, Co 0327, Co 0424, CoLk 99271, CoLk 04238, CoS 03222 and CoPant 04222, along with three standard varieties Co 1148, CoS 767 and CoS 8436 were evaluated for yield and quality parameters. The genotype CoLk 99271 recorded highest cane yield (93.85 t ha^{-1}) as well as CCS yield (12.25 t ha^{-1}) which was significantly superior to the best check CoS 8436. The genotypes CoS 03222 and CoLk 04238 had also shown higher cane and CCS yield than CoS 8436. Genotype Co 0327 exhibited highest sucrose % at 12 months (19.34%) followed by Co 0424 (19.01%) and CoLk 99271 (18.65 %). Among the standard varieties, CoS 8436 was the best with highest cane yield (68.52 t ha^{-1}) and CCS yield (8.88 t ha^{-1}).

Advance Varietal Trial (Midlate) I Plant Crop: Six genotypes i.e. Co 0331, CoH 128, CoH 129, CoH 130, CoLk 9910 and CoS 03261 along with three standard varieties, i.e., Co 1148, CoS 767 and CoS 8436 were tested. CoH 129 exhibited significantly superior cane yield (95.53 t ha^{-1}) and CCS yield (11.11 t ha^{-1}) as compared with the best respective checks. However, CoH 128 had significantly higher cane yield (91.18 tha^{-1}) than the best standard. CoS 03261 was also promising with cane yield (81.61 t ha^{-1}) and sugar yield (10.09 t ha^{-1}). Among the test genotypes, CoLk 9910 showed highest sucrose % (18.40%), followed by Co 0331 (18.36 %) and CoH 130 (17.95%). Among the standard varieties, Cos 8436 was the best for cane yield (67.57 t ha^{-1}) and Co 1148 for CCS yield (8.40 t ha^{-1}).

Advanced Varietal Trial (Mid-late) II Plant and Ratoon crop: Seventeen entries viz., Co 0121, Co 0122, Co 0123, Co 0124, Co 0240, Co 0241, CoH 115, CoH 117, CoLk 9705, CoLk 9710, CoPant 01215, CoPant 01218, CoPk 59, CoPk 112, CoS 98259, CoS 01256 and CoS 1268 along with three standards viz., Co 1148, CoS767 and CoS 8436 were evaluated for their performance in plant and ratoon crop. CoLk 9705, followed by CoH 115 were significantly superior in cane yield and sugar yield over the best standards, CoS 8436 for sugar yield and CoS 767 for cane yield in plant crop. In ratoon CoLk 9705, followed by Co 0124 was superior over the best standard, CoS 8436.

Inter-Zonal Varietal Trial, NWZ, Lucknow Centre

Inter zonal initial varietal trial (Early): Fourteen entries viz., CoM 0254, CoM 0259, CoH 125, CoH 126, CoH 127, CoJ 03191, CoLk 94184, CoLk 9902, CoS 03272, CoS 03279, , CoS 03251, CoPant 03219, CoPant 03220 and CoSe 03421 along with two standards were evaluated with three replications. Only CoPant 03219 was significantly superior in sugar yield over the best check, CoJ 64. Under Mid late group, 10 entries viz., CoH 128, CoH 129, CoH 130, CoJ 03193, Co 0331, CoS 03261, CoPant 03221, CoSe 03422, CoSe 02231, and CoP 03182 along with three standards were evaluated in RBD with three replications. CoH 128, Co 0331 and CoS 03261 were superior in cane yield over the best standard (CoS 767). CoSe 03422 and CoSe 2231 were superior in pol per cent over the standard CoS 8436. CoH 128 was superior in sugar yield.

Zonal varietal Trial, North Central Zone, Motipur, Bihar

Eight trials namely, Initial Varietal Trial, Advance Varietal Trial I, Advance Varietal Trial II, and Advance Varietal Trial ratoon crop for the early (E) and the mid-late (ML) maturity groups were conducted at the centre during 2007-08. Entries from Buralikson centre (Assam) were highly susceptible to wilt and were not included in trials due to insufficient seed cane. Except Advance Varietal Trial (Early) ratoon, all trials were severely affected by water-logging from July to September'07 and top borer.

Early Maturing Group

Initial Varietal Trial: None of 6 evaluated sugarcane genotypes viz., BO150, Co 0418, Co 0419, Co 0420, CoP 04181 and CoSe 04231, was significantly superior to two standard varieties BO 130 and CoSe 95422 in respect of yield and quality parameters. *Advance Varietal Trial I plant crop:* None of the four sugarcane genotypes viz., BO 138, CoP 03181, CoP 04181 and CoSe 03421, along with three standard varieties BO 130, CoSe 95422 and CoS 687 was significantly superior to the chekcs in respect of yield and quality parameters. *Advance Varietal Trial II plant crop:* Out of eleven sugarcane genotypes viz., BO145, Co 0229, Co 0230, Co 0231, Co 0232, CoLk 9411, CoLk 9412, CoP 02181, CoSe 01421, CoSe 02235 and UP 0090 along with three standard varieties BO 130, CoSe 95422 and CoS 687 evaluated, genotype Co 0232 was significantly superior over checks in CCS yield (8.10 t ha^{-1}), followed by Co 0231 (5.70 t ha^{-1}). None of the genotypes was significantly better in pol % juice than the checks. *Advance Varietal Trial Ratoon crop:* Twelve sugarcane genotypes viz., Co 0229, Co 0230, Co 0231, Co 0232, CoLk 9411, CoLk 9412, BO145, CoP 02181, CoSe 01421, CoSe 02235, UP 01104 and UP 0090 along with three standard varieties BO 130, CoSe 95422 and CoS 687 were evaluated for yield and quality parameters. Genotype Co 0230 was significantly superior over checks in cane yield (67.40 t ha^{-1}) and CCS (7.2 t ha^{-1}), followed by Co 0231 in cane yield (56.00 t ha^{-1}) and Co 0232 in CCS (6.3 t ha^{-1}).

Mid-late Group

Initial Varietal Trial : Four sugarcane genotypes viz., Co 0421, Co 0422, CoP 04182 and CoSe 01423 along with three standard varieties BO 91, CoP 9301 and CoSe 92423 were evaluated for yield and quality parameters. Co 0422 gave significantly higher cane yield (50.4 t ha^{-1}) and CCS yield (6.25 t ha^{-1}) than the best standard variety. Co 0421 recorded significant superiority for sucrose and CCS percent at 10 months of crop age compared to standard variety. Among the standard varieties, CoP 9301 had the best performance for CCS yield (5.52 tha^{-1}) as well as cane yield (44.4 tha^{-1}). Under *advanced varietal trial for Ist Plant crop,* 7 genotypes, i.e., BO 141, CoP 03182, CoSe 02231, CoSe 03422 including three checks viz., BO 91, CoP 9301 and CoSe 92423 were evaluated. Genotype BO 141 was numerically superior over the best check CoSe 92423 for both cane and sugar yield (68.5 and 7.72 tha^{-1}). None of the genotypes were better than the checks for pol percent in juice. For *IInd Plant crop,* 12 genotypes viz., BO 146, BO 147, Co 0236, Co 0235, Co 0233, CoSe 01424, CoSe 01434, CoP 02182, UP 0098, UP 0097, UP 01105 and UP 01108 along with three standard varieties BO 91, CoP 9301 and CoSe 92423 were evaluated for yield and quality parameters. BO 147 showed the highest CCS yield (7.33 t ha^{-1}) and cane yield (64.5 t ha^{-1}), followed by genotypes Co 0235 (57.0 t ha^{-1}), Co 0236 (54.8 t ha^{-1}) and BO 146(53.2 t ha^{-1}) in cane yield. Among the standard varieties, CoP 9301 had shown the best performance for both sugar and cane yield. For *Ratoon crop,* 15 genotypes i.e. BO 146, BO 147, CoSe 01424, Co 0236, Co 0235, Co 0233, CoSe 01434, CoP 02182, UP 0098, UP 0097, UP 01105, UP 01108, including three checks viz., BO 91, BO 128 and CoSe 92423 were evaluated. Genotype BO 147 was significantly superior over best check CoSe 92423 for both cane and sugar yield (62.8 and 7.49 t ha^{-1}). None of the genotypes was better than the checks for pol per cent in juice.

Fluff Supply Programme (B 2)

Under this programme which deals with the development of sugarcane varieties for subtropical region from the fluff of zonal crosses at Sugarcane Breeding Institute, Coimbatore. 58 genotypes (Table 4.6) were selected for further evaluation from C_1 to C_2 based on hand refractometer brix in November and January, and other agronomic traits in 2006-07. Out of this 9 genotypes were directly advanced to a replicated trial. The crosses that yielded good number of clones having agronomic merit were BO 91 x CoLk 8002, CoPant 90214 GC, CoS 92263 GC, CoH 70 GC, CoH 98 GC and CoLk 8102 x Co 1148. Based on the ratoon performance, 8 entries were included in the advance varietal trial, while nine

Table 4.6: Identification of desirable crosses for economic breeding

S. No.	Cross	No. of selections from C_1 to C_2	Per cent selection
1.	CoLk 8102 x Co 1148	10	34.5
2.	CoLk 8102 x CoS 96260	1	33.3
3.	BO 91 x CoLk 8102	4	80.0
4.	BO 97 x CoJ 46	2	50.0
5.	Co 94012 GC	1	100.0
6.	CoH 70 GC	4	80.0
7.	CoH 98 GC	8	53.3
8.	CoN 85134 GC	1	20.0
9.	CoPant 90214 GC	6	60.0
10.	CoS 88216 GC	2	50.0
11.	CoS 92263 GC	7	58.3
12.	CoS 96260 GC	12	60.0
Total clones promoted		58	

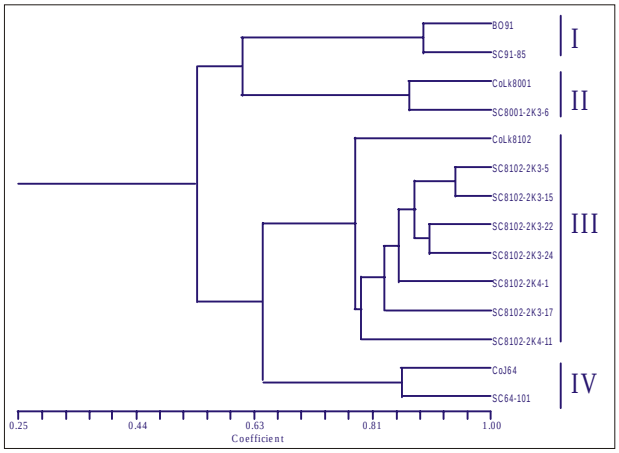
genotypes found a place from the plant crop trial. Two clones, LG 04360 and LG 02325 were selected for inclusion in the station trial 2008-09. CoLk 07203 (Selection No LG 02327) was accepted for testing in the NWZ as a mid-maturing variety under the auspices of AICRP on Sugarcane. This genotype has also been included in the state varietal trials and its seed was supplied to many sugar factories for multiplication and subsequent conduct of state trial. Another clone selection 1-14-7 (LG 02314), though did not make it as a variety, has shown high sugar content early in the season, comparable with CoJ 64. This has been marked as a potential parent in high sugar breeding.This selection has shown moderately susceptible reaction to Cf 08 and Cf 09.

4.3 Cytogenetic and biotechnological approaches for sugarcane improvement

Genetic Improvement of sugarcane through tissue culture (B 3.7)

Sugarcane on account of its genetic complexities and polyploid nature is not readily amenable to standard breeding techniques for cross pollinated crops, in that, modifying an otherwise desirable genotype for minor shortcomings through conventional breeding techniques is not feasible. On the other hand, any genetic modification by sexual or asexual means gets fixed and can be carried forward due to its vegetative propagation. Tissue culture particularly somaclonal variation arising from callus cultures is one such technique to achieve this goal. This project was aimed to assess its efficacy in sugarcane and met with mixed success. During 2007 ratoon crop of nearly 300 R_1 somaclones from seven varieties was subjected to red rot inoculation with appropriate pathotypes to verify the reaction obtained in the previous year in the plant crop. The success rate in the change of reaction from susceptible to resistant on rescreening was very low, the most responsive being somaclones of CoS 767 (4 out 40 somaclones gave MR reaction in both the years against Cf 09 as compared with HS reaction of CoS 767).

Another set of 98 somaclones, selected on the basis of morphology, vigour and hand refractometer brix in R_0 and planted in autumn season, was evaluated in plant to row R_1 generation. An excellent crop was obtained but selection was primarily based on brix data in October '07 and January '08 as compared with the source varieties that served as checks. Twenty-eight selections resulted from somaclones of six varieties, viz. CoLk 8001, CoLk 8102, BO 91, Co 87263, Co 7717 and CoJ 64. These have been planted in spring for further evaluation. Apart from this, a few somaclones in advance clonal generations were marked for desirable attributes in the plant and ratoon crops. In laboratory, molecular characterization of the same set of somaclones (taken in 2006-07) with forty SSR markers confirmed the differentiation among somaclones and source varieties (Fig. 4.1).

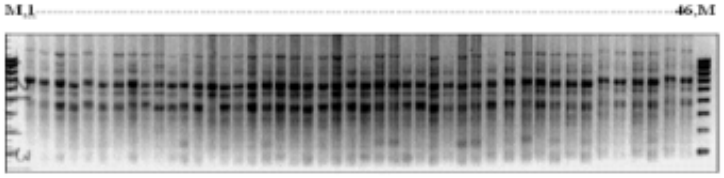


Note : The horizontal scale is Jaccard's coefficient of similarity. The clusters are indicated on the right margin

Fig 4.1: Dendrogram of somaclones and their parent cultivars of sugarcane constructed using UPGMA based on 25 polymorphic SSR primers.

Cyto-morphological and molecular characterization of some sugarcane genotypes (B 3.8)

In order to understand the molecular genetic diversity within the commercial cultivars and species level germplasm of the genus *Saccharum*, 46 sugarcane genotypes of sub-tropical India were used for molecular characterization in 2006-07 using three marker systems *viz.* RAPD, microsatellites and ISSR markers. Flanking sequences of 32 microsatellites of EST and genomic DNA region were used as primers. 72 random decamers from operon kits A, B, C, D, E, F, G, H, I, J, K, AA, AB and AK were used for RAPD. Twenty anchored and unanchored simple sequence repeats of di-, tri-, tetra- and penta-oligonucleotide motifs were used as primers for ISSR analysis. These primers were able to produce sufficient polymorphism (Fig.4.2). Using these primers, 898 markers were resolved for RAPD, 158 for microsatellites and 118 for ISSR primers. All the data



M-marker, Lane 1-46 : Co 975, Co 453, CoJ 85, BO 120, CoBln 9605, BO 130, CoS 8118, CoBln 9102, Co 6308, BO 129, BO 99, Co 89029, CoS 109, Co 1336, CoBln 9103, CoC 671, CoLk 7901, CoBln 9101, Co 846, Co 1111, CoS 514, CoS 510, CoB 94164, Co 312, Co 331, Co 213, Lohit 9104, CoS 88230, CoP 9301, CoS 245, CoS 8315, CoSe 1235, CoS 443, CoJ 83, CoS 687, CoJ 88, CoS 541, Co 87263, CoSe 96436, CoP 9206, BO 137, CoLk 05202, Co 87268, Co 1007, Co 0233, UP 0097.

Fig 4.2: PCR amplification profile of Inter Simple Sequence Repeat marker in 46 genotypes of sugarcane

were transformed into binary matrix and the similarity matrices were obtained for molecular diversity analysis. Among these genotypes, the genetic similarity coefficients ranged from 0.25 to 0.99 for RAPD, from 0.53 to 0.91 for ISSR markers and from 0.40-0.91 for the microsatellites. Based on the similarity indices, UPGMA based cluster analysis placed these sugarcane varieties into different clusters.

Identification of biochemical and molecular markers for sugar genes in sugarcane (B 3.13)

In order to identify biochemical and molecular markers for sugar genes in sugarcane with the long-term aim of utilizing these markers for marker-assisted selection, a few sugarcane clones with varying sugar content were used for field studies. Pol% of the different clones ranged from 14 to 20 during peak period. Ten more selections were evaluated out of which, 8 having 12-14% pol during peak period were advanced to the next generation. PCR and electrophoretic studies were continued using random and specific sequences to identify variations among high and low sugar clones. Primers designed from EST sequences along with other known primer sequences were used for laboratory studies. Unigene sequences from sorghum and sugarcane were also used for primer designing. Six polymorphic markers were identified for further validation.

A population (ratoon crop) derived from selfing CoS 96268 was evaluated for HR brix in December 2007. A total of 220 individual clumps were advanced to C_1 generation. Seedling population (plant crop) derived from 6 crosses of 2006 crossings was evaluated for HR brix. These were also advanced to C_1 generation. Seven matings – six crosses and one self- were attempted at NHG, Sugarcane Breeding Institute, Coimbatore. The fluff obtained has been sown in the glass house to utilise for further validation studies.

Molecular Diversity Analysis for biotic stresses of *Saccharum* germplasm (B 3.14)

DNA was isolated from sixty genotypes of sugarcane differing in reaction to red rot. These genotypes were fingerprinted using 20 SSR primer pairs. Out of 20 primers, 15 (75%) were polymorphic. The number of alleles per primer ranged from 2 to 8 while the allele size ranged from 75 bp to 310 bp. DNA profiling of 15 genotypes generated by primer pair NKS 40 is given in Fig. 4.3. These genotypes will be analyzed using more number of SSR primer pairs. The information generated would help in the identification of linked marker using association-mapping approach.

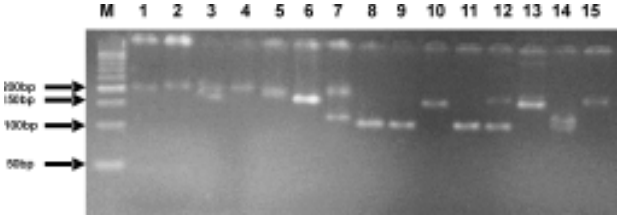


Fig. 4.3: A representative DNA profile of 15 genotypes of sugarcane by primer pair NKS 40

Parental polymorphism was carried out between the highly susceptible (CoC 671 and Co7717) and resistant parents (ISH 147 and SES 594) and was used for development of the mapping population, using 60 SSR markers. Out of 60 SSR markers, 25 (41.7%) were polymorphic for the cross Co 7717 and SES 594 while 20 (33.3%) SSR markers showed polymorphism between CoC 671 and ISH 147 parents.

A total of 167 and 200 seedlings of two promising crosses Co 7717 x SES 594 (interspecific) and CoC 671 x ISH 147 (intraspecific), respectively were transplanted in the field for development of mapping populations. DNA was isolated from each individual plant of the cross Co 7717 x SES 594 for genotyping, using polymorphic SSR markers. These populations have been advanced in C_1 generation for phenotyping.

Genetic Transformation in Sugarcane for resistance against Borers (B 3.15)

For development of a suitable protocol for genetic transformation in sugarcane, the biolistic gun approach was used. The gold particle was coated with plasmids (NBRI-100 with GUS as reporter gene and NPT-III as kanamycine resistance gene) at first. The callus of CoJ 64 was arranged on media plate in the centre containing MS medium and bombarded using biolistic PDS-1000 / He particle delivery system under following conditions: rupture disc macro carrier gap 3 mm; macro carrier travel distance 8 mm; chamber vacuum 28 in Hg; helium pressure 1100 psi and target distance at 6 cm. After bombardment, the calli were placed in culture room for 48 hrs. following which the calli were assayed histochemically for GUS expression by staining overnight with X-Gluc at 37^{0}C. A number of blue loci were observed on the surface of transformed calli under dissecting microscope (Fig. 4.4) while control callus did not show blue loci.

Fig. 4.4: Transient genetic transformation in sugarcane callus of CoJ 64 using biolistic gun

The procured four Bt gene constructs (Cry 1Ab, Cry 1Aa, Cry 1F, Cry IA5) and pB1 121 with GUS are being maintained in yeast extract manitol (YEM) medium and preserved in equal volume of 40% glycerol at 70^{0}C for their utilization. Further, for the development of transgenic in sugarcane infection was given in callus of variety CoJ 64 using Bt gene construct Cry 1Ab through *Agrobacterium*.

Optimizing standards for sugarcane seed production through micro propagation (B 3.16)

Gluconacetoabacter diazotrophicus substantially contributes towards nitrogen nutrition of sugarcane by fixing nitrogen and in general improves plant health by producing plant growth hormones. Therefore, a protocol for inoculating *G. diazotrophicus* in micro-propagated plantlets of sugarcane was developed so that value added sugarcane plantlets may be produced. An efficient isolate of *G. diazotrophicus* (IS 100) was used to inoculate plantlets of variety CoS 96268. The plantlets of variety CoS 96268 with intact and incised roots were dipped in *G. diazotrophicus* suspension ($4.7x10^8$ cells ml^{-1}) for 10 minutes and the treated plantlets were transferred in the new rooting medium under aseptic conditions. Un-inoculated controls of intact and incised root plantlets were maintained separately. Each flask containing 10 plantlets and 5 replicates were used for sampling. At initial stage and subsequently at 7 days interval, sampled roots were observed using light microscopy and were analyzed for endophytic *G. diazotrophicus* colonization after surface cleaning. Most Probable Number (MPN) technique was used for enumerating bacterial population. After thorough washing with saline buffer, roots were macerated and serial dilutions of it were used to inoculate semi solid LGI tubes. Five tubes were used for each dilution and were incubated at 30^{0}C for 10 days. Development of yellow pellicle and subsequently acetylene reduction assay confirmed the presence of *G. diazotrophicus*.

The presence of *G. diazotrophicus* near the root branching points, surface and tips was confirmed by light microscopy and *G. diazotrophicus* population data of surface clean roots confirmed the endophytic presence in inoculated plantlets. Exposure of incised roots to *G. diazotrophicus* suspension was found to be the best (Fig. 4.5) as the roots contained approximately 3.9×10^3 cells g^{-1} of root as compared to non-detectable *G. diazotrophicus* cells in control, while it was 7.8×10^2 cells g^{-1} in intact roots. The experiment was repeated twice. The developed healthy plantlets were transferred in the field after hardening for their further evaluation.

A field experiment was also conducted to find

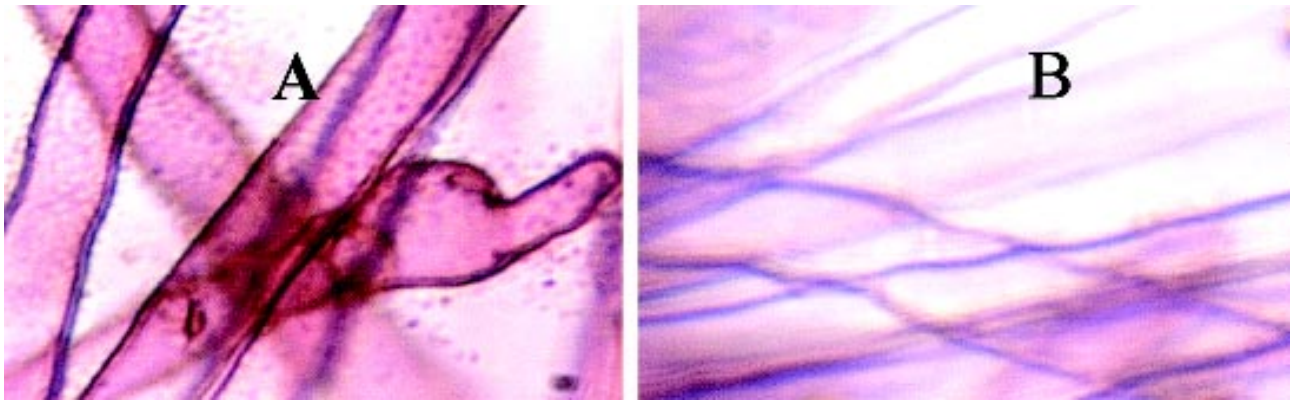


Fig. 4.5: Inoculation of *Gluconacetobacter diazotrophicus* in micropropagated plantlets (A) Root hair of treated plantlet (B) Root hair of control plantlet

out the effect of planting on growth, yield and quality of micro-propagated plantlets in sugarcane. Micro-propagated plantlets of CoS 96268 were planted at three intra-row spacings viz. 90x30, 90x45 and 90x60 cm along with control (conventional method of planting). Significantly highest number of millable canes (160.5 thousand ha^{-1}) was recorded at 90 x 30 cm spacing (Table 4.7), which was however, at par with 90 x 45 cm. Significantly highest cane yield (67.2 t ha^{-1}) was recorded with 90 x 45 cm planting geometry. Although the observed cane length was significantly higher at 90 x 60 cm as compared to others, but the number of millable canes and cane yield was significantly lower at this spacing. The quality parameters viz. brix %, pol % in juice and CCS (%) was not affected by different planting geometries.

About 1500 plantlets of cultivars CoS 96268 and CoSe 01235 were produced from the explants collected from nursery seed plot grown after MHAT. These explants were found disease-free after testing for red rot, wilt, smut and mosaic. Genetic purity of these plantlets was also tested using SSR markers. Further validation work is going on.

Table 4.7: Effect of planting geometry on growth, yield and quality of micro-propagated plantlets in sugarcane cultivar CoS 96268

Treatments	NMC (000 ha^{-1})	Cane Length (m)	Cane yield (t/ha^{-1})	Brix (%)	Pol (%)	Purity (%)	CCS (%)
Planting geometry							
90 x 30 cm	160.0	1.45	64.9	21.41	18.30	84.73	12.46
90 x 45 cm	150.8	1.47	67.2	21.40	18.50	86.77	12.66
90 x 60 cm	110.9	1.70	57.5	20.85	17.86	85.87	12.17
Control	98.5	1.57	53.6	21.08	18.28	86.02	12.53
CD(P=0.05)	**10.46**	**0.12**	**11.89**	**NS**	**NS**	**NS**	**NS**

Abbr. : NMC = Number of millable canes; CCS = Commercial cane sugar

5 Epidemiology and integrated disease management

5.1 Epidemiology of diseases of sugarcane

Survey and surveillance of insect-pests and diseases of sugarcane in subtropical area (EM 01)

Incidence of red rot (5-10%) was observed in predominant cane cultivar CoS 8436 in Unnao district under Haidergarh Sugar Factory zone. Incidence of red rot in the factory zone of Sakseria Sugar Mill, Biswan, Sitapur was also observed in the variety CoS 8436 in low lying areas (20-30%) and in uplands (2-5%). Leaf scald incidence (2-5%) was noticed in CoS 767 and CoS 8436 in Ghatampur (Kanpur) under the command area of Ghatampur sugar mill, Kanpur.

Mechanism of variability in *Colletotrichum falcatum* causing red rot in sugarcane (M 2.13)

A set of 14 differentials *viz.*, Co 419, Co 975, Co 997, Co 1148, Co 62399, CoJ 64, CoS 767, CoS 8436, CoC 671, BO 91, Khakai (*S. sinense*), Baragua (*S. officinarum*) and SES-594 (*S. spontaneum*) were inoculated with spore suspension (10^6 spores ml^{-1}) of Cf 08 (CoJ 64) and Cf 09 (CoS 767) by plug method under both conditions, i.e. field and controlled condition testing (CCT) to find out the mechanism of variability in *Colletotrichum falcatum* causing red rot in sugarcane. It was observed that the disease severity in test differentials was increased under CCT as compared to field testing. Co 419 and CoS 767 showed intermediate reactions against Cf 08 under field condition whereas they showed susceptible reactions under CCT. Similarly, BO 91 and Baragua were resistant under field, while they exhibited intermediate and susceptible reactions under CCT. Co 975, Co 7717, Co 62399, BO 91 and Baragua (*S. officinarum*) were found resistant under field conditions with pathotype Cf 09 but they showed susceptible reactions in CCT. Similarly, Co 419 and CoC 671 showed intermediate reactions in the field, while susceptible reaction under CCT. Thus, it appeared that the constant temperature (25 ± 2^0C) and RH (>90%) maintained under CCT were mainly responsible for enhancing the disease susceptibility of some differentials against test pathotypes.

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

Determination of causal organism(s) of wilt disease of sugarcane (M 3.5)

Isolations from roots of wilt affected sugarcane variety Co 7717 yielded fungi belonging to genera, namely *Fusarium, Pythium, Rhizoctonia, Nigrospora, Trichoderma* and *Chaetomium*. Inoculation of sett roots with selected isolates of *Fusarium*, *Pythium* and *Nigrospora*, alone or in combinations, inflicted partial rotting of excised roots in laboratory condition. In pot and field inoculations, there was no significant difference in the incidence of wilt between inoculated clumps and un-inoculated controls. Similarly, no difference in the incidence of disease was observed in the progenies raised from heat-treated healthy and heat-treated diseased setts with corresponding controls. The planting of setts beyond the period of conventional spring (Feb.-March) and late-planting (summer) showed variation in the incidence of disease. Planting in June recorded highest disease incidence (100%) and least incidence was observed in the plantings of August (65%).

Identification of pathotypes of red rot pathogen (PP 14)

Three isolates i.e. IR6 (CoLk 8102), IR7 (CoS 98231), IR-8 (Co 58436) and pathotype Cf 11 (CoJ 64) were tested on fourteen set of differentials viz., BO 91, Co 997, Co 975, Co 1148, CoJ 64, CoS 8436, Co 62399, CoC 671, Co 7717, Co 419, CoS 767, Khakai (*S. sinense)*, Baragua (*S. officinarum)* and SES 594 (*S. spontaneum*) by plug method.

Isolate IR-6 exhibited different reaction in Co 975, Co 62399 and Co 7717 but the rest eleven differentials showed the same reaction. Hence these isolates belong to one group of pathotype i.e. Cf 08. Pathotype Cf 11 is different from the existing pathotype i.e. Cf 01, Cf 02, Cf 03, Cf 07, Cf 08 and Cf 09 found in North-West Zone.

Maintenance of isolates of red rot pathogen (PP14a)

Seven pathotypes viz., Cf 01, Cf 02 , Cf 03, Cf 07, Cf 08, Cf 09 and Cf 11 of North-West Zone, four pathotypes viz., Cf 04, Cf 05, Cf 06 and Cf 10 of East-Coast Zone and four local isolates viz., IR-5, IR-6, IR-7 and IR-8 of IISR, Lucknow were maintained *in vivo* and *in vitro*.

Molecular characterization of isolates / pathotypes of *Colletotrichum falcatum* (PP29)

The total genomic DNA was extracted from six different pathotypes viz., Cf 01 Cf 02, Cf 03, Cf 07, Cf 08 and Cf 09 of *Colletotrichum falcatum* using CTAB extraction. A total of 85 random decanucleotide primers belonging to series OPA, OPI, OPO, OPT and MAP were used for amplification of genomic DNA. Genetic similarity index for each combination was used for constructing graphical phenogram using UPGMA cluster analysis.

A total of 483 PCR – amplified genomic DNA bands were scored and showed high degree of polymorphism (> 70%). The genetic similarity based on the analysis of RAPD data among pathotypes varied from 0.32 to 0.97. All the six pathotypes were grouped into two major groups showing more than 60 % genetic divergence.

5.3 Integrated disease management in sugarcane

Management of red rot disease of sugarcane through bio-agents (M 15.3)

Ten new isolates of *Trichoderma* spp. (T 61-T 80) were collected and tested against *C. falcatum*. These isolates produced control of red rot in fewer plants and were adjudged as non-potent. T 1 – T 80 isolates of *Trichoderma* spp. were purified by single spore, multiplied in culture tubes and kept in deep freeze for further evaluation. Mass-multiplication of potent strains of *T. harzianum* indicated higher number of CFU g soil^{-1} (7.66) when subjected to dilution by 10^6 in 21 days at 32^{0}C and at 30% moisture. Nucleus culture was developed in sterilized substrate / press mud and further developed in un-sterilized fresh press mud. Nucleus culture of *T. harzianum* may be mixed with fresh mud and utilized at the time of planting.

In plant crop, the treatment of metabolites of T 37 + salicylic acid produced red rot control in 86.67% canes of susceptible variety CoLk 7701 and 90% in resistance variety CoS 96268. The treatment was also effective in CoLk 7701 to improve the germination (9.44%), tiller population (18.52%), NMC (13.21%) and yield (34.64%). In resistant variety, CoS 96268, the germination was improved (11.11%), tiller (36.06%), NMC (30.25%) and yield (47.13%).

In ratoon crop, the different formulations were super imposed at the stubble sprouting stage and control of red rot was tested in July-August in rainy season. The disease was controlled in 50.6, 53.1, 60.0, 65.6, 63.0 per cent canes by T 37, respectively with TMC, spore suspension, spore suspension + metabolites, metabolites, spore suspension + TMC and TMC + metabolites treatments. The control by T 38 was in 59.0, 62.9, 65.0, 66.3, 67.0 and 73.6% canes in the above mentioned treatments, respectively.

Stubble sprouting was enhanced with the application of *T. harzianum* in ratoon by 5.37%, IAA content was higher in shoots (67.87 mg 100 g^{-1} fresh weight), number of tillers were higher by 10.01 t ha^{-1}, more height of cane by 0.44 m, girth by 0.36 cm, number of internodes were higher by 5, length of internodes by 2.07 cm, single cane weight by 0.14 kg, NMC by 5.75 t ha^{-1} and yield by 18.54 t ha^{-1}.

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

Fifty sugarcane genotypes were screened against red rot and smut diseases. Somaclones of CoS 767 (40), CoJ 64 (91) and CoLk 8001 (66) were also tested against red rot. Genotypes, namely LG 02039, LG 01030, LG 01170, LG 04008 and LG 04360 were found moderately resistant to both the pathotypes (Cf 08 and Cf 09) of *C. falcatum*. All the somaclones of CoS 767, CoJ 64 and CoLk 8001 were found moderate to highly susceptible against both the pathotypes of red rot. Four genotypes, i.e. LG 02325, LG 03065, LG 04435 and LG 04456 were susceptible to smut.

Evaluation of genotypes / varieties against red rot, smut and wilt (PP 17)

Forty four (AVT & IVT) early and mid late genotypes were tested against red rot, smut and wilt. The disease reaction of genotypes against red rot (Cf 08 and Cf 09) pathotypes was evaluated by plug method of inoculation. Genotypes viz., CoS 03279, CoH 130, Co 0122, CoLk 99271 and CoS 03222 showed

moderately resistant reaction and the rest of the genotypes showed moderately susceptible to susceptible reaction. Genotypes CoJ 03192, CoLk 9902, Co 0116, CoLk 9709, CoPant 02217, CoS 03252 and CoPant 02218 were susceptible to smut. Four genotypes viz., CoS 01256, CoS 01268, Co 0327 and CoH118 were susceptible to wilt while the remaining genotypes were found tolerant to it.

Investigation on spread of red rot (*C. falcatum*) of sugarcane (Expl. trial)

An exploratory trial was conducted to find out the critical level of inoculum (conidia) load required for successful initiation and the development of red rot. Parafilm method, standing cane variety Co 1148 in August and race Cf 01 were used for this study. *C. falcatum* conidia (Cf 01), from one week growth were harvested in sterile distilled water. Spore concentration was adjusted to about 10^6 viable conidia ml^{-1}. This conidial suspension was further diluted four times in a factor of 10 and other dilutions (10^5, 10^4, 10^3 and 10^2 conidia ml^{-1}) were prepared. All the inoculations were done at one go to avoid any variation. It was observed that a spore concentration of one million was effective in producing 100 per cent infection. The success of infection gradually tapered up to the concentration of 10,000 conidia ml^{-1}. Thereafter, the reduction in successful infection was quite drastic. However, even 100 conidia ml^{-1}can produce the disease, though the success rate was around 10%.

Cellular and molecular interaction of the bacterial isolates with pathogens causing major diseases of sugarcane (C 15.7)

A microbial consortium, for management of red rot disease caused by *Colletotrichum falcatum* in sugarcane, has been developed and demonstrated at field level. The red-rot disease in highly sensitive and mild red rot sensitive sugarcane varieties like CoJ64, CoLK 9707, CoLK 9617 has been checked by prophylactic treatment of sugarcane setts with the developed microbial consortium. A field experiment with 10 treatments (9 bioagents + Control) in three replications was laid with randomized block design, one each of varieties CoJ64, CoLK 9707, CoLK 9617. Biocontrol treatment was given by dipping three buded sets overnight in bioagent suspension (10^{8-9} counts ml^{-1}) and also followed by its application at 90 days at the tillering stage. Later for disease induction plug method of pathogen inoculation was followed using spore suspension of virulent isolate of *C. falcatum*. Data recorded after 60 days of inoculation on red rot disease development indicated that among the bacterial isolates *Serratia marcescens*, *Pseudomonas fluorescens* (mutant) and *Acetobacter diazotrophicus* were successful up to 70% in checking the red rot disease in varieties CoLK 9707 and CoLK 9617 (Fig. 5.1), whereas it could be checked up to 50% in CoJ 64. Among fungal isolates *Trichoderma* and *Penicillium spp.* could check red rot spread up to 65% in CoLK 9707 and CoLK 9617 and 50% in CoJ 64.

Developed "Microbial consortium" of potent bacterial and fungal biocontrol agents against *C falcatum* could check the disease spread up to 80% in CoLK 9707 and CoLK 9617 and 60% in CoJ 64. Thus the application of microbial consortium proved to be better than the individual bacterial and fungal treatments. Apart from disease management, bioagents promoted plant growth as observed by more cane weight, height, total millable canes and yield.

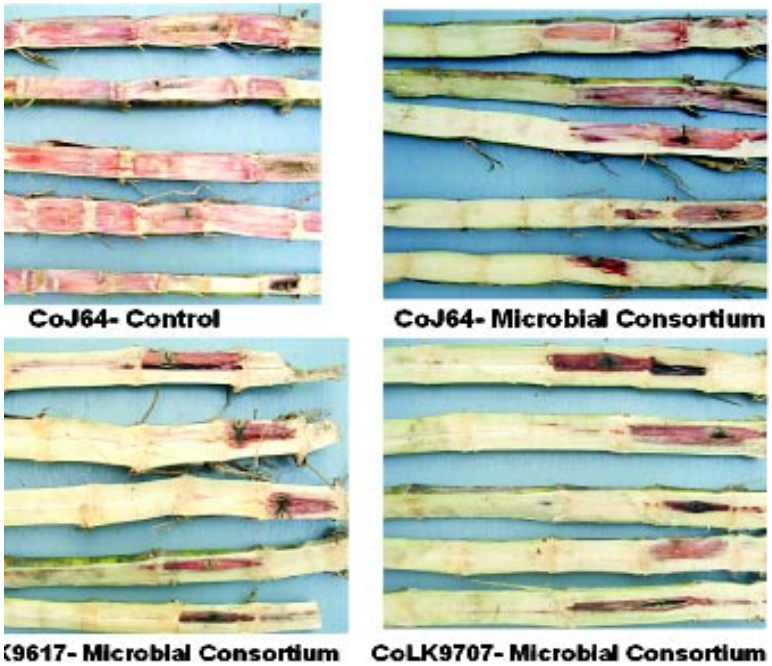


Fig. 5.1. Efect of Microbial consortium in red rot management in sensitive sugarcane varieties

6

Bio-ecology and integrated management of insect-pests

6.1. Bio-ecology of insect pests of sugarcane

Bio-intensive management of top borer of sugarcane (E 4.2 i)

CoLk 8102 was planted on March 23, 2007. All recommended package of practices were adopted to raise a good crop. The germination ranged from 27.71 to 38.02 %. The incidence of top borer IIIrd brood started from the first week of June 2007. The top dressing of urea was coincided with the emergence of moth of top borer during June. All the treatments were based on top dressing of urea @ 75 kg N ha^{-1}. Treatment T_4 (collection and destruction of infested shoots (IInd brood of top borer) + top dressing of urea at the time of moth emergence + augmented release of parasitoids), T_5 (Pestoneem + conserve release and augmented release of bio-agents + top dressing of urea at the time of moth emergence + augmented releases of parasitoids), T_6 (Amogh+ conserve release of naturally occurring bio-agents+ top dressing of urea at the time of moth emergence + augmented release of parasitoids), T_7 (Amogh+ conserve release of naturally occurring bio-agents + top dressing of neem coated urea at moth emergence) and T_8 (collection of destruction of infested shoots (IInd brood of top borer) + top dressing of neem coated urea at moth emergence + augmented release of parasitoids) significantly reduced the incidence of top borer IIIrd brood and IVth brood. The significantly higher yield was recorded in T_5 (89.65 t ha^{-1}) followed by T_1 (spray of neem based insecticides and conserve releases of naturally occurring bio-agents), T_9 (conservation release of parasitoids).

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

Periodic surveys were undertaken in the command areas of K.M. Sugar Mills, Faizabad, Bajaj Hindustan Ltd., Gola Gokaran Nath (Lakhimpur Kheri) and, Haidergarh Chini Mill, Barabanki from April to September, 2007. Some sugarcane varieties were examined for the occurrence of *Pyrilla* and observed that the egg mass ranged from 2 to 11 and nymphs and adults of *Pyrilla* varied from 40 to 150 per leaf in mature standing crop. Different stages of ecto-parasitoid, *Epiricania melanoleuca* were also recorded. The cocoons of *Epiricania* varied from 0 -5 per leaf. In the crop planted during autumn, spring and recently initiated ratoon, the population of *Pyrilla* varied from 20 to 60 per leaf whereas the cocoons of *Epiricania* varied from 0 to 1 per leaf.

Due to continuous desapping by hoppers, top leaves in the affected plants dry up and the lateral buds germinate. The younger crop, which has been attacked by the *Pyrilla* ultimately, resulted into poor yield and low recovery. Consequent upon outbreak of *Pyrilla*, the loss in yield was estimated to be 28.0 per cent, with a decrease of 1.5-2.0 units of sucrose in juice.

The egg period of *Epiricania* varies from 7 - 11 days, larval period from 9-15 days, pupal period 4-6 days, adult period 2-6 days and fecundity 400-950 eggs per female. The life cycle of this parasitoid is very short in comparison to that of *Pyrilla*. When *Pyrilla* completes one life cycle, the *Epiricania* completes 2-3 life cycles.

Monitoring of insect pests and bio-agents in sugarcane agro-ecosystem (E.30: AICRP)

The periodic observations on pest incidence and occurrence of parasitoids were recorded in respect of Cv. CoSe 92423 planted on March 23, 2007. The incidence of top borer IInd brood, IIIrd brood, IVth brood and Vth brood was recorded on an average 4.42, 10.11, 15.26, and 28.69 percent, respectively. The infestation of pink borer during May was 3.75 percent. Red mite (*Oligonychus indicus*) severely infested the leaves during June, which diminished on the onset of monsoon. Mealy bug (*Saccharicoccus sacchari*) was noticed after September and continued till harvest with an average incidence of 6.37 percent. The incidence of internode borer was 11.88 percent and Stalk borer had negligible incidence at harvest.

The epidemic of *Pyrilla* was noticed from April onwards till September. The entire crop was found to be covered by egg masses, nymphs and adults. The pest was successfully controlled by augmented release of *Epiricania melanoleuca* (a nymphal and adult parasitoid). Termite was observed damaging buds to the extent 16.67 after 60 days.

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

Trichogramma chilonis (reared from F_1 to F_{10} generations at 28 ± 2^{0}C) was further maintained at 2^{0}C higher temperature (30 ± 2^{0}C) on the eggs of *Corcyra cephalonica* for five generations. The longevity and fecundity was found to be reduced at this temperature and in higher temperature (30 to 32^0 C). Higher temperature shock affected the female ratio.

Trichogramma japonicum was maintained on the eggs of *Corcyra cephalonica* for 10 successive generations (F_1 -F_{10}) at 26 ± 2^{0}C and 70 ± 5% relative humidity and at 28 ± 2^{0}C for five generations in the laboratory. The longevity and fecundity of *T. japonicum* was more in early generations than the later generations. Between the two species, *T.chilonis* withstands heat shock better than *T. japonicum*.

Succession of insect-pests in multiple ratoons of sugarcane and their management (E 6.03)

Under 3 different management practices in ratoons viz., trash mulching, trash Burning and no trash, it was observed that trash mulching reduced the sprouting of clumps and found to be attacked significantly by termites. The incidence of stalk borer and internode borer was found be reduced drastically due to burning. However, the incidence of top borer was not affected due to different treatments. The effect on parasitisation was not found to be conspicuous. The NMC were significantly low in trash mulching but higher yield was obtained under no trash condition. Burning was found to reduce the incidence of many pests. The maximum protection gave cost benefit ratio of 1:2.45. The application of chlorpyriphos @ 1 kg a.i.ha^{-1} at the initiation of ratooning + soil application of carbofuran @ 1 kg a. i.ha^{-1} against IIIrd brood of top borer was found superior and gave highest yield.

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

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

Eight sugarcane genotypes of early group were evaluated against major insect-pests. Highest incidence of top borer (IIIrd brood) was recorded in CoJ 64 (7.33%) and lowest in CoLk 9905 (below 1.00%). In case of termites, highest infestation was found in CoS 03251 (2.86%) followed by CoH 127 (2.65%) and lowest in CoS 03279 (0.5%) and CoLk 9902 (0.77%). Among 24 genotype of mid late group, the highest incidence of top borer and termite was recorded in CoPt 84211 (21.94%) followed by Co 0122 (14.14%) and lowest in Co 0240, CoPk 112, CoS 01268 and CoS 98259 (below 1.00%).

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

For the mass multiplication of parasitoids of top borer of sugarcane, host insects are needed. Therefore, some lepidopterus larvae were screened to get alternative hosts for rearing of some bio-agents of top borer such as *Rhaconotus rosiliensis* and *Stenobracon* spp. *Seasmia inferens* (Pink borer), *Chilo partellus* (maize stem borer), *Tryporyza incertulus* (Paddy stem borer) and *Corcyra cephalonia* (Rice moth) were evaluated for their suitability for two parasitoids *viz., Rhaconotus rosiliensis* and *Stenobracon spp.* Healthy larvae were used for parsitization. Twenty pairs of parasitoids were kept in a glass jar (5"x5") with honey solution in cotton swab. Mouth of jar was covered with a thinly woven muslin cloth and held in position with the help of rubber bands. Healthy larvae were placed on upper surface of the cloth and covered by a plastic seat to check their movement and kept for over night. Parsitized larvae were shifted to the natural food for further development at 27^{o}C and 80% RH. Larvae of pink borer and maize stem borer were parasitised by both the parasitoids.

Mass multiplication of potential bio-agents of sugarcane insect pests (E.27 AICRP)

Studies were conducted to evaluate the host preference *Cotesia flavipes* by exposing laboratory reared healthy larvae of *Chilo auricilius* (sugarcane stalk borer) and field collected larvae of *Sesamia inferens* (Pink borer) and *Chilo sacchariphagus indicus* (internode borer) to gravid female wasp at 25 ± 2 ^{0} C and 60-70 % RH. *Cotesia flavipes* preferred *C.auricilius* to other larvae with 32.87% parasitisation. While parasitisation of internode borer and pink borer larvae were 27.65% and 23.31%, respectively. Emergence of parasitoid was 86.42%, 82.13% and 69.24% in

C.s.indicus, *C.auricilius* and *S.inferens*, respectively. Two entomopathogenic fungi *viz.*, *Beauveria bassiana* and *Metarhizium anisopliae* were multiplied on PDA and on three natural media such as broken rice, maize and *jowar*. It was found that development of *B. bassiana* was more rapid on PDA followed by rice in terms of germination, colony development and spore formation. Among the organic media, rice and *jowar* responded similar reaction. The growth rate of *B. bassiana* was slow than *M. anisopliae*. Development of *M. anisopliae* was at par on all organic media and PDA.

Field evaluation of synthetic sex pheromone lure of sugarcane top borer (CR-4/06)

In an experiment repeated in approximately 5 ha area of sugarcane crop at IISR farm, with pheromone lure of top borer put in 125 water traps, placed at an inter-trap distance of 20x20 m, the catches were recorded daily. The lures were changed when the catch showed decline. The brood wise incidence of the borer was recorded out of 25 samples of 6 m row length ha^{-1} and compared with similar fields having no trapping. The number of trapped male moth revealed good trappability of the pheromone lure and the water trap. The lure could also reveal the earliest emergence of the male moth in all the broods, which indicated the beginning of the particular brood. The emergence continued for a period of 24 to 46 days but 55.19 to 92.61 per cent of the total male moth emerged only in half period of the total duration. The catch was lowest during 5^{th} brood. The brood wise incidence, yield of cane and sugar recorded no significant difference over the check, the untrapped area.

Bionomics and management of sugarcane woolly aphid (NS-5)

Population of sugarcane woolly aphid, *Ceratovacuna lanigera* was recorded maximum in November (225.86 nymph + adults per $(2.5)^2$ sq. cm leaf area), where as it was negligible during May and June. Population of *Dipha aphidivora* was observed maximum during December -January (5.80 larvae per leaf), whereas its was minimum during June-July. Population of *Micromus igorotus* (Nymph and adults per leaf) was recorded maximum during October (4.20 per leaf). During March to July, its population remained minimum. Sugarcane woolly aphid population was found positively correlated with relative humidity (r = 0.36) and rainfall (r = 0.002), however its correlation with the population of *D. aphidivora* and *M. igorotus* was observed highly significant (r = 0.96, r = 0.97 and r = 0.90). Mass multiplication of *D. aphidivora* and *M. igorotus* was done in separate shade nets at Khatauli, Muzaffarnagar, U. P. Multiplication rate of both the predators was at the peak in the month of January and February. After mass multiplication, these predators were distributed in the farmers' fields having severe *C. lanigera* infestation to suppress the pest population. Spraying of Dichlorvos (0.05%) proved most effective in suppressing the woolly aphid population.

Evaluation of bio-efficacy of Bifenthrin 10EC against termite in sugarcane (CRE.3.2.3 (iv))

For evaluating the bio-efficacy of Bifenthrin 10EC against termites, sugarcane variety CoPant 84212 was planted at IISR farm on March 13, 2007 in plots measuring 45 m^2. The insecticide was mixed in sand + soil mixture and applied in furrows. Eleven treatments were arranged in RBD having three replications. Insecticidal application of Bifenthrin @ 100g a. i. ha^{-1} provided significantly higher germination, lowest sett damage & bud damage, higher millable canes, and higher yield over other treatments and untreated check.

Evaluation of E2Y 45 0.4 GR against termites and top borer of sugarcane (CR-3/06)

The granular formulation of E2Y 45 0.4 GR was evaluated against *Odontotermes obesus* and *Scirpophaga excerptalis* in sugarcane at IISR Farm. All the doses ranging from 50 g a.i. to 150 g a.i. ha^{-1} provided significant control of termites and top borer. There was no adverse effect of insecticidal treatment on parasitoids and predators. The phytotoxicity was also not observed.

Biological control of sugarcane moth borers, pyrilla and scale through exotic and indigenous parasitoids and predators (E.4.2)

At IISR bio-control centre, Pravaranagar, maximum incidence and intensity of scale insect,

Melanaspis glomerata in adsali crop was recorded during December where as maximum parasitisation was observed during October. The maximum *Pyrilla* was observed during August (28-34 adults and 49-105 nymphs per 100 clumps). Fresh cocoons of *Epiricania melanoleuca* were noticed from June to October. A total of 10,000 cocoons and 15000 larvae of pyralid predator, *Dipha aphidivora* were released in farmer's fields against sugarcane woolly aphid around Pravaranagar (Maharashtra) area for its colonization. The release of *Trichogramma chilonis* @50,000 adults ha^{-1} was done in 408 ha sugarcane area of 330 farmers against shoot borer from April 2007 to March 2008.

Evaluation of insecticides against insect-pests in sugarbeet (CRE.3.2.4)

All the treatments based on Actara were found significantly superior over check to control aphids till 15 days after treatment. However, Actara @100 g and 200g a. i ha^{-1} was significantly superior over other treatments. There was no adverse effect of insecticides on naturally occurring parasitoids and predators. *Coccinella* spp. was most prevalent predators in the field. All the treatments based on Emamectin benzoate (Proclaim 5SG) and Lifenuron (Cigna 5% EC) are significantly superior over control. Lufenuron 5% EC (Cigna) 60.0 g a. i. ha^{-1} was superior over other treatments 1 DAT to reduce the population of larvae *Spilosoma obliqua* and *Spodoptera litura.*

Demonstration of IPM and IDM technology against key pests and diseases

The technology developed for the management of insect –pests and diseases was demonstrated in block trial with variety CoSe 92423 (ratoon) under recommended agronomical practices. The IPM plot received chlorpyriphos @ 1 kg a.i. ha^{-1} at ratoon initiation to prevent damage by termites; removal of top borer egg masses (IInd brood); conservation of natural egg parasitoid emerged from field collected egg masses for top borer; application of carbofuran 3G @ 1 kg a.i. ha^{-1} during last week of June against IIIrd brood; release of *Trichograma chilonis* @ 50000 adults ha^{-1} at 10 days interval from July to October and larval parasitoid, *Cotesia flavipes* @ 500 gravid females $week^{-1}$ ha^{-1} from July to November against stem borer and removal of dry leaves and late shoots / water shoot was done at 30 days interval from September onwards. The incidence of top borer (IIIrd & IVth brood) was 9.29 in IPM in comparison to check (16.26%). The incidence of termite, SB and INB was 5.35%, 6.12%, 9.23%, respectively while in check the respective incidence was 10.81%, 8.38%, 13.64%. The IPM block recorded 13.5 % higher cane yield over the check.

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 has been developed for cutting of two rows of sugarcane. It consists of M.S. frame, an attachment for raising and lowering of equipment, power transmission and cutting units. Frame supports the cutting and power transmission unit. Attachments were developed for raising and lowering of harvester during transportation as well as for field operation. Attachments consisted of a M.S. frame and hydraulically controlled arms through hydraulic cylinders. Hydraulic fluid of tractor hydraulic assembly has been used for obtaining hydraulic power for raising and lowering of equipment. Power to the cutting blades was provided through tractor PTO. Power train consisted of chain, sprockets, straight m.s. shaft, universal joints, PTO pulley gear box and double grooved V-belt pulleys and belts. The rotation of both the cutting blades were kept clockwise. The right hand side (RHS) cutting blades are intended to throw the cut canes towards right hand side. It means free space is needed towards the RHS of the equipment. The left hand side (LHS) cutting blades cut and place the harvested cane in between the wheal base of the tractor. Attachments were also provided with the main frame of the equipment for guiding the cane towards the cutting blades during harvesting operation and up to some extent for raising the partially lodged canes. Field trials were conducted at IISR farm during the month of January, February and March, 2008 and it was found that the cutting and windrowing was satisfactory for crops which are not lodged and where the canopy of one row of cane was not intermingled with the other rows. However, the crops which was lodged heavily and having intermingled canopy, the windrowing was a problem due to which there was a tendency of clogging of the equipment causing breakdown in the power transmission system of the equipment.

Design refinement of a power operated equipment for detrashing of harvested sugarcane (AE 1.18A)

A power operated detrasher for removal of green top as well as dry trash from the harvested sugarcane was developed during 2006-07. During 2007-08, the equipment was tested in the field by transporting and operating it with the help of a tractor. During its testing, different varieties of sugarcane were fed from the topside through the feeding chute. Different components of the equipment viz. feeding, detrashing and delivery units worked satisfactorily. Performance of the detrasher was satisfactory when one, two or three cane stalks were fed. However, for feeding of more than three cane stalks simultaneously, the slippage of belt was observed causing slippage of detrashing roller belt resulting into poor detrashing efficiency. For feeding of one or two cane stalks at a time, green top removal efficiency varied from 90 to 99 percent whereas overall trash removal (green + dry trash) efficiency varied from 80 to 90 percent depending upon the variety. The trash percentage left in the cleaned cane varied from 1.5 to 6.5 percent on cleaned cane weight basis.

Development of a tractor operated mounted type two-row ratoon management device (AE 1.19A)

Equipment named Ratoon Promoter was designed consisting of customized version of various sub units of the RMD excluding the unit for stubble shaving and its power driving mechanism. A rugged frame was developed with mounting arrangement to encompass other subunits like rippers, manure/ granular fertilizer dispensing unit including its metering mechanism, containers for application of pesticide/ chemicals in liquid form and soil covering unit as also called earthing-up unit. The prototype has been provided with one floating type lugged ground wheel for each row to drive metering system of the manure/fertilizer disbursing unit. Further fabrication work related to the seeding attachment for intercropping is in progress.

Development of FIRB: T.O. Sugarcane Planter-cum-seeder (AE 1.32)

The equipment has been developed and commercialized. It is able to plant sugarcane in two rows, makes two raised beds (one full and two half beds) and drills wheat seeds in two rows on each bed, along with fertilizer drilling for each row of sugarcane and wheat in single pass. The equipment has been operated successfully at farmers field with 55 hp tractor.

Development of an engine operated walking type multipurpose equipment for sugarcane cultivation (AE 1.33)

Reversible shovels type 3-tyne intercultural tool was developed as an attachment to the engine operated walking type prime mover. The equipment was tested in the field of IISR farm for intercultural operations in sugarcane crop planted at 75 cm spacing. The equipment in general worked satisfactorily. The gauge wheel mounted in front of the prime mover was creating problems in the actual field conditions due to ridges formed during planting. This needs further probing. The equipment was operated in the field by removing the front wheel. The effective field capacity of the equipment was observed as 0.2 ha hr^{-1}. One operator is needed to operate the equipment. However, two operators were employed under actual field conditions in order to ascertain continuous operation of equipment and providing sufficient rest to the operator. The manpower requirement was worked out as 10 man-h ha^{-1}. The working depth of the equipment was 10-15 cm and weeding efficiency was 70 to 80%.

Development of a moist hot air unit for treatment of seed cane on bulk scale (AE 3.6)

Moist hot air treatment (MHAT) unit for treatment of seed cane on bulk scale has been designed which shall have the capacity of treating 25 quintal of seed cane in one go. It shall take around four hours time to treat this quantity. In fact four units of approximately 6.25 quintals capacity MHATs of movable type have been integrated to make bulk scale fixed concrete structure unit. These 4 sub units will be on trolleys which can be taken directly to the fields after treatment of seed cane. Accordingly, the room size has been increased and instead of movable type, a pucca structure has been designed. No. of heaters, and the steam generation capacity has been increased. The moitoring and control circuits along with automatic thermostats have been provided in the design.

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

The frame, residue chopping system and drive mechanism have been fabricated.

Enhancing field water use efficiency for sugarcane cropping system through FIRBS (UPCAR Funded project)

For sugarcane + potato intercropping system, a metering system to meter potato seed has been perfected. Testing of the metering system revealed that dropping of seed size tubers was perfect without any gap. For preparation of field for planting potato crop, one tractor drawn combined tillage implement has also been developed and tested. The implement saves diesel and prepares field better than the conventional tillage implements *i.e.* harrow and cultivator.

8

Development of suitable post-harvest technology

8.1 Post-harvest losses in sugarcane

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

Effect of pre-harvest foliar spray of divalent cations (Zn & Mn) on post-harvest sucrose losses in sugarcane : Field experiments were conducted during March, 2008 for studying the effect of pre-harvest foliar application of zinc sulphate solution (1000 ppm) five days prior to harvest on post harvest deterioration of sucrose in sugarcane after 7 days of staling of mid- late maturing cane (CoSe 92423). Minimum and maximum temperature during the experimental period ranged from 14.5°C and 32.3°C while relative humidity varied from 25 to 100%. Results showed an increase in sucrose percent (6%) and purity (6.4%) in juice of trash covered canes from zinc sulphate treated plants in comparison to trash covered cane from water treated plants (control) after 7 days of staling. Consequently, higher CCS (10.2%) under zinc sulphate treatment as compared to trash covered cane from water treated control plants was recorded (Table 8.1). This effect was probably due to lower activity of internodal acid invertase (5.3%) in zinc sulphate treated cane compared to untreated control as zinc has been reported to have an inhibitory effect on acid invertase activity. The distribution of zinc content in different plant parts after 3 days of foliar spray of zinc sulphate solution (zinc, 1000 ppm) revealed that there was increase in zinc in roots (132%), sheath (870%), stalk (46%) and leaf (541%) in comparison to foliar application of water (control).

To study the effect of manganous sulphate, the pre-harvest foliar application of manganous sulphate solution (1000 ppm) under similar conditions as mentioned above showed increase in sucrose percent (2%), purity (5.9%) in juice and higher CCS (5.7%) as compared to 'trash covered and water sprayed cane' (control). This was perhaps due to suppression of internodal acid invertase activity (37.2%) in manganous sulphate treatment in comparison to control. Manganese has been found to inhibit acid invertase activity and the increment in sucrose content in treated cane may be due to the inhibitory effect of Mn. Manganese content of different plant parts after 3 days of foliar spray of manganous sulphate solution (manganese,1000 ppm) revealed that there was increase in manganese in roots (94%), sheath(137%) and leaf (145%) in comparison to foliar application of water (contol), while there was no change in manganese content in cane stalk.

Effect of pre-harvest soil application of zinc sulphate on improvement of sucrose in sugarcane juice: Preliminary field experiment was conducted in December to study the effect of pre-harvest soil application of zinc sulphate (25 kg ha^{-1}), two weeks prior to harvest, on juice quality of early maturing cane variety CoS 95255. Results revealed an increase in sucrose content (10.5%) and purity (1.9%) of cane juice, and decrease in total reducing sugars (48.3%) in juice under zinc treatment in comparison to control (Table 8.2).

Table 8.1: Effect of pre-harvest foliar spray of zinc sulphate and manganous sulphate on deterioration of sugarcane juice quality in mid-late maturing variety CoSe 92423

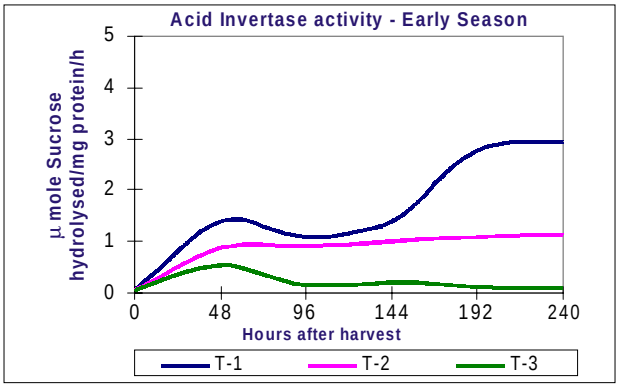
Days after harvest	Control			Zinc sulphate			Manganous sulphate		
	Sucrose %	Purity%	CCS	Sucrose %	Purity %	CCS	Sucrose%	Purity%	CCS
0	17.4±0.33 (3)	90.4±0.32 (3)	12.1±0.25 (3)	18.5±0.47 (3)	90.2±0.49 (3)	12.9±0.33 (3)	17.9±0.18 (3)	89.8±0.62 (3)	12.5±0.09 (3)
7	14.9±0.58 (3)	67.4±2.19 (3)	8.8±0.54 (3)	15.8±0.16 (3)	71.7±0.78 (3)	9.7±0.16 (3)	15.2±0.29 (3)	71.4±0.61 (3)	9.3±0.23 (3)

Table 8.2: Effect of pre-harvest soil application of zinc sulphate on improvement of sucrose in sugarcane juice

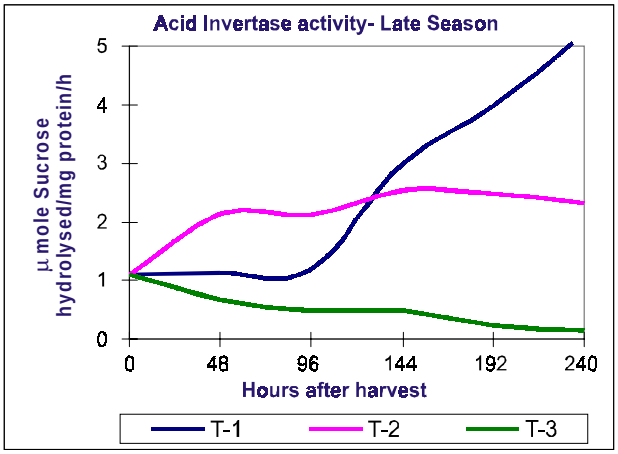
Control			Zinc sulphate		
Sucrose%	Purity%	Reducing sugars %	Sucrose%	Purity%	Reducing sugars %
17.2±1.18 (3)	88.1±1.10 (3)	0.29±0.006 (3)	19.0±0.59 (3)	89.8±0.39 (3)	0.15±0.014 (3)

Effect of post-harvest treatment of chemicals in minimizing sucrose losses

Studies carried out in January and April using QUAT based formulations showed appreciable reduction in post harvest sucrose losses (Var. CoSe 92423). The effect was evaluated on the expression of acid invertase activity in the harvested cane stored in open field, cane covered with trash & sprinkled with water and harvested cane treated with QUAT based formulation and covered with trash. The study was carried out for 10 days during early and crushing seasons. The results indicated considerable suppression of acid invertase activity in chemically treated cane and less formation of reducing sugars compared to trash covered cane or cane stored in open field conditions (Fig. 8.1 a &b).



(a) Early season



(b) Late season

Note : (T-1= Harvested cane stored in open field ;T-2= harvested cane covered with trash ; T-3= harvested cane treated with QUAT based formulation and covered with trash)

Fig. 8.1 (a) & (b). Change in acid invertase activity during post-harvest storage during early and late-crushing seasons

A large scale factory level trial with QUAT based formulation was carried out during late crushing season. The results show considerable improvement in recovery percent cane from stale cane compared to water sprinkled trash covered control. The values for pol% cane and recovery % are shown in Fig. 8.2 & Fig. 8.3. Sugar recovery % in QUAT treated nine days stale cane was 0.4 unit higher compared to untreated control.

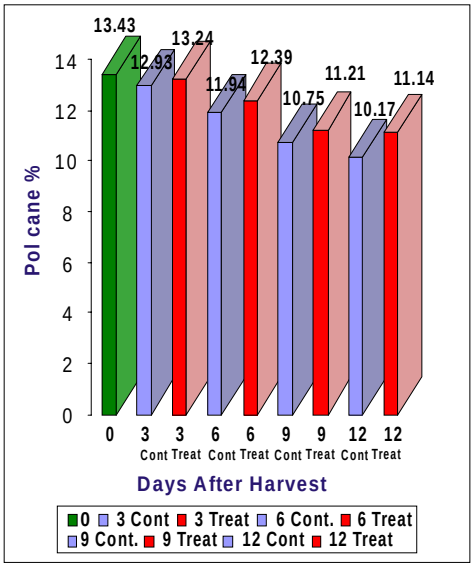


Fig. 8.2. Change in Pol% cane following treatment of QUAT based formulation during post-harvest storage

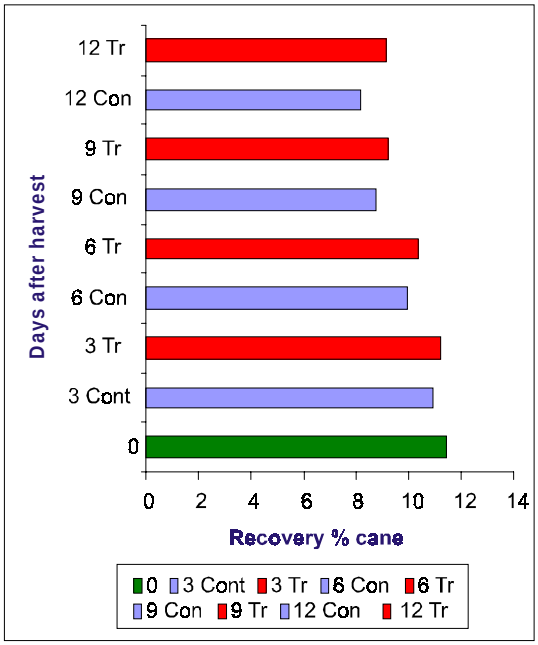


Fig.8.3. Improvement in sugar recovery from stale cane after treatment with QUAT based formulation

8.2 Manufacturing and storage of jaggery

Development of sugarcane peeler (LKO/JKS/07/01)

Peeling unit of sugarcane peeler was designed and developed. It consists of four sigmoid shaped spring loaded saw tooth blades arranged on a circular frame diverging from inlet towards exit/outlet. It rotates at a speed of about 1200 rpm.

Development of mechanical filtration unit for sugarcane juice (LKO/PHTS/05/3)

A mechanical filtration unit has been developed. It consists of one pre filter, four filters in series and a pump of 800 lh^{-1}. It has a backwash facility also. The pre filter consists of a slotted plastic cylinder body of diameter 150mm and length 608 mm, end cap, plastic flange, submersible motor and plastic cloth of 1 mm mesh size. This filter will be used to separate coarse impurities like trash, bagasse particles, and fibre, sand other large insoluble impurities, present in the juice. The first filter consists of woven plastic cloth of 0.5mm mesh size to separate fine particles of bagasilo. The second filter consists of a woven synthetic candle capable of removing imputities of size 0.5-0.1mm. The third unit consists of another synthetic candle capable of removing impurities of size 0.1- 0.08mm. All the above three filters have candle of 70 mm diameter having synthetic material as a filter medium and the size of the cartridge was of diameter 80mm and length 260mm. The fourth unit was active charcoal filter. It consisted of aluminum casing, inlet-outlet valve, active charcoal granules and a small plastic mesh filter. The filter will be used to absorb the colour compounds of the juice. A pump of 800 lh^{-1} capacity was used to pump the juice to the filter.

Development of a device for churning of sugarcane juice in an open pan furnace (LKO/PHTS/07/3)

A manually operated churning device consisting of rotary system in vertical plane was designed and developed. It consists of three sets of rotors provided at an angle of 120° each on the main shaft and an handle for rotating the churner. The preliminary test results depicted uniformity in mixing of boiling clarified juice in the open pan on the furnace.

Optimization of fins provided to the pan bottom for improved efficiency of jaggery making furnace (LKO/PHT/07/04)

Experiments were conducted with smaller pans having different fin size and spacing. In one set of experiment, size of fin was kept constant and the area of heat receiving surface was varied by increasing number of fins. In second set of experiment, per cent increase in area of heat receiving surface was kept constant (100 per cent) and the fin size and the numbers were varied according to the area. The effect of per cent increase in area of heat receiving surface on heat utilization efficiency is shown in Fig. 8.4

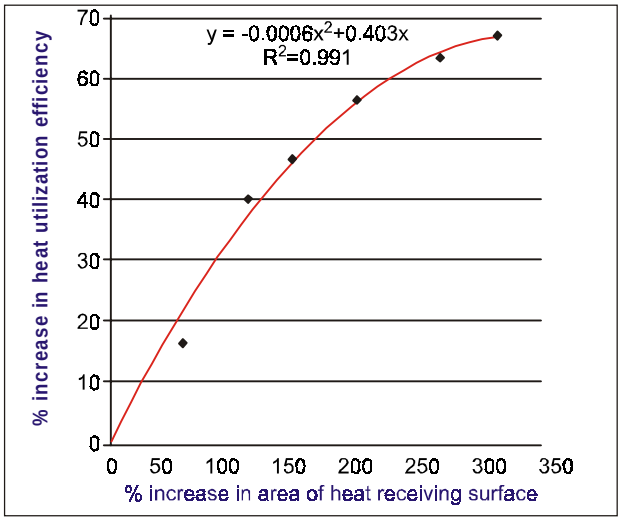


Fig. 8.4. Percent increase in heat utilization efficiency based on percent increase in area of heat receiving surface of pan

The percent increase in heat utilization efficiency increases with increase in per cent increase in area of heat receiving surface and goes as high as 65 with the increase in area upto 311%. The increase in heat utilization efficiency due to different fin size and numbers for 100 per cent increase in area of heat receiving surface is depicted in Fig. 8.5. More numbers

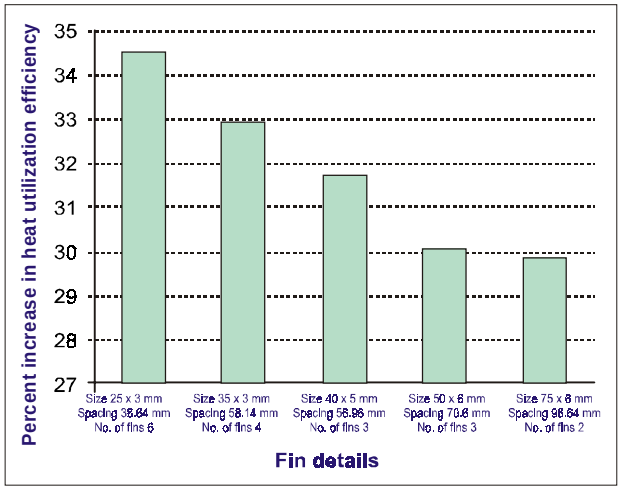


Fig. 8.5. Percent increase in heat utilization efficiency due to different fin size (for 100% increase in area of heat receiving surface)

of smaller fins are better than larger and less number of fins for a particular increase in area of heat receiving surface.

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

A 100 kg per batch capacity solar jaggery drier has been designed. It consists of a insulated drying chamber, inlet and exhaust. The solar heat is trapped for heating purpose with the help of flat plate collector and at an angle equal to latitude of Lucknow.

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

A compact and closed mini cane crusher was designed which consists of three horizontal rollers driven by 0.25 hp motor through sprocket chain transmission system.

Value addition of jaggery through natural source of vitamin C (LKO/PHTS/05/4)

Indian gooseberry (*Aonla*) in identified quantity and form was successfully added in jaggery in its process of manufacture enriching jaggery with vitamin C (75.4 mg 100 g^{-1}). Storability of samples over a period of six months showed retention of vitamin C in substantial quantity (72 mg 100 g^{-1}). The concept could be utilized for the manufacture of more nutritious jaggery, which may become a part of mid-day meal being given to rural school goers.

A concept of spicy jaggery was also tried by adding turmeric, black pepper and cinnamon powder in jaggery in suitable quantity and at a proper stage of jaggery manufacturing. Jaggery samples with turmeric and black pepper tasted good.

Testing and evaluation of IISR jaggery drier (LKO/PHT/07/06)

The IISR jaggery drier was tested under no load conditions. The functioning of all the components viz. air blower, heating device and drying chamber, were satisfactory. The heating device was able to heat the forced air up to 50 C and able to sustain the supplied air temperature. The thermostat functioned well and was able to regulate the temperature of the supplied air. The overall performance of the drier was satisfactory.

Testing and evaluation of TNAU cane crusher (LKO/PHTS/05/2)

TNAU four roller sugarcane crusher was tested at 2.5, 4.0 and 5.0 mm gap between crushing and extraction roller. During the test, the speed of the crusher was 166 rpm. It was found that maximum juice extraction was 63.6% (on the basis of available juice in the cane).The cane crushing capacity was found as 392 kg h^{-1} with power consumption of 4.990 kW.

Assessment of post harvest losses in crops/ commodities (LKO/PHTS/05/1)

The survey was conducted for assessment of post harvest losses in ten crops/ commodities viz. wheat, paddy, pigeon pea, mustard, bajara, mango, guava, potato, green pea, sugarcane, jaggery, khandsari in 5 districts of Uttar Pradesh namely Chandauli, Deoria, Kanpur (Dehat), Etawah, and Unnao.

8.3 Diversification of sugarcane based by-products

Development of pre-treatment and hydrolysis process for conversion of sugarcane biomass to alcohol (A.P. Cess Fund Project)

The bench scale chemical and biological pre-treatment, saccharification and fermentation processes have been standardized for conversion of sugarcane lignocellulosic biomass to ethanol. The saccharification of acid pre-treated bagasse, trash and stubble with cellulase enzyme (120 FPU g^{-1} cellulose) yielded 17.76, 39.9 and 13.8% reducing sugars after 168 h. However with 60 FPU/g cellulose, bagasse, trash and stubble yielded 6.4, 22.9 and 8.2% of reducing sugars. Microbial saccharification yielded higher sugar yields (27-51%). Fermentation of this pre-treated-saccharified biomass yielded ethanol from 12-13 ml 100 g^{-1} biomass.

9

Sugar beet improvement and its seed production

Sugarbeet appears to be on the threshold of a long-awaited and well-deserved commercial breakthrough. This temperate crop has shown considerable genetic versatility to adapt to subtropical climates, and now to even the tropical growing conditions. In fact, tropical environments are proving much less stressful on account of narrower temperature extremes and proving more productive as a result. The bio-fuel scenario in the country has brought the potential of sugarbeet much closer to realization. It opens new vistas for alternate industrial uses other than the traditional sugar. This is definitely more feasible, less capital intensive and holds greater promise.

Results obtained in the *AP Cess Network Project on Sugarbeet Research (ICAR)* for the past three years reveal the agricultural feasibility of sugarbeet under tropical conditions too. The crop has also thrown new challenges. The growing conditions in the tropical environments allow continuous growth of sugarbeet resulting in much larger roots and per plant foliage, and the total biomass is much more than that in the subtropical conditions which, of course, is not good for sugar build-up. Hence, one of the objectives of the project is to produce reasonably good root yield (60-80 t ha^{-1}) in half the time as that required by the sugarcane crop and that too at a much higher economy of irrigation water. Another challenge is with regard to the pests that a luxuriantly growing sugarbeet crop attracts. While the lush green succulent foliage is a feast to the defoliators, the sweet and soft root is a ready host to many soil pathogens. Fortunately, no new pest has been observed under tropical conditions and the prophylactic and control measures established earlier and validated in this project have worked well and shown good efficacy. The bio-agents and pheromone traps also hold promise of containing the insect pests and have given good results. There is, however, going to be a need to be vigilant and to keep looking for the natural predators of these pests. This is an area requiring continuous monitoring and refinement.

The performance of 6 sugarbeet varieties was evaluated for root yield, sucrose content, gross sugar yield (t ha^{-1}) and per cent incidence of root rot at 4 centers all over the country (Table 9.1). The variety LS-6 was found better and has been identified for release (Fig. 9.1).

Research work at IISR, Lucknow

Under the project, the research work pertaining to breeding, crop protection, mechanization and seed production was carried out at IISR Lucknow Centre. The details are as follows :

Breeding: Three experiments were conducted. The first one was a repetition of the advance varietal trial carried out with the objective of confirmation of

Fig. 9.1. Root yield performance of sugarbeet variety LS-6 and shubhra

Table 9.1: Root yield, sucrose content, gross sugar yield (t ha^{-1}) and per cent incidence of root rot in sugar beet varieties at different locations

Centres	Varieties						
	Shubhra (HI 0064)	Cauvery (Dorotea)	Indus (Pasoda)	IISR Comp-1	LS-6	R-06	CD at 5%
Root Yield (t ha^{-1})							
Lucknow	71.2	62.3	47.5	67.1	62.3	62.1	8.14
Pune	91.5	69	66.3	64	88.9	61	NS
K. Digraj	85.1	82.6	77	69.7	69.5	71.5	9.71
Sriganganagar	92.7	85.4	89.9	86.6	63.2	80	6.34
Overall mean	85.1	74.8	70.2	71.8	71	68.6	
Mean for Pune and K. Digraj	88.3	75.8	71.7	66.9	79.2	66.3	
Sucrose %							
Lucknow	17.19	16.25	15.2	14.8	16.04	15	0.8
Pune	16.1	14.3	14.2	14	15.3	12.2	1
K. Digraj	13.9	14.6	15	12.7	15.7	14.3	0.4
Sriganganagar	16.6	16.2	14.6	15.2	16.2	16.1	1.5
Overall mean	15.95	15.34	14.74	14.16	15.81	14.39	
Mean for Pune and K. Digraj	15	14.45	14.6	13.35	15.5	13.25	
Gross sugar yield (t ha^{-1})							
Lucknow	12.27	10.1	7.19	9.89	9.73	9.3	1.47
Pune	11.29	9.61	7.84	9.64	9.77	8.35	NS
K. Digraj	11.83	12.06	11.55	8.852	10.91	10.22	NS
Sriganganagar	15.39	13.84	13.13	13.15	10.23	12.88	1.62
Overall mean	12.69	11.4	9.93	10.38	10.16	10.19	
Mean for Pune & K. Digraj	11.56	10.84	9.7	9.25	10.34	9.29	
Incidence of root rot (%)							
Lucknow	18.6	34.1	45.1	17.9	20.2	17.2	8.2
Pune	5.8	22.8	29.5	16.7	10.7	-	5.9
K. Digraj	17.5	25.7	15.8	22.5	14.1	-	2.2
Sriganganagar	9	21.4	24.2	12.8	12.9	10.2	
Overall mean	12.7	26	28.6	17.5	14.5	13.7	
Mean for Pune & K. Digraj	11.6	24.2	22.7	19.6	12.4	-	

varietal performance. The second was 'preliminary varietal trial' with entries from five sources, namely, IISR, Syngenta, Iran and SES Vanderhave (Belgium). The third, 'initial varietal trial' was aimed at screening the entries mainly from Syngenta for natural incidence of root rot. Data were recorded on plant vigour and the plant population was recorded at regular intervals towards crop maturity to assess the tolerance of varieties to heat and root rots in April, May and June 2007. Root weight was on the higher side considering Lucknow conditions (Table 9.2). On the basis of root performance across the season, Syngenta varieties need to be harvested before June, while the indigenous varieties can give satisfactory yield up to early June. With regard to quality, measured as sugar content as percent of root weight, Shubhra was the best variety, as also in the earlier trials, and significantly better than the other varieties under test.

In the PVT, LKC-95, LK-27, Rasoul, LKS-10, LKC-2000, IN-06, IN-07 and IN-16 appeared promising. In the IVT with 25 Syngenta entries,

Table 9.2: Mean data on yield and quality parameters of sugarbeet varieties for entries in the Advance Varietal Trial (2006-07)

Variety	Root weight (kg)			Root yield (t ha^{-1})			Sucrose content (Pol %)			Gross sugar (t ha^{-1})		
	Apr	May	Jun	Apr	May	Jun	Apr	May	Jun	Apr	May	Jun
IISR Comp-1	1.02	0.84	1.07	92.16	67.07	68.2	15.13	14.75	14.95	13.9	9.89	10.22
Shubhra (HI 0064)	0.81	0.87	0.72	78.86	71.24	39.34	17.62	17.19	17.89	13.86	12.27	7.04
LS-6	0.97	0.78	0.88	90.46	62.29	56.63	15.6	16.04	15.74	14.01	9.73	8.95
Cauvery (Dorotea)	1.18	0.86	0.83	106.5	62.3	29.08	16.57	16.25	16.43	18.71	10.1	4.78
R-06	0.94	0.86	0.84	78.39	62.08	50.53	14.3	14.96	15.02	11.08	9.3	7.55
Indus (Posada)	1.21	0.79	0.85	99.88	47.51	17.29	15.31	15.17	15.89	15.3	7.19	2.72
CD at 5%	**0.22**	**NS**	**0.18**	**17.5**	**8.14**	**10.21**	**1.02**	**0.8**	**1.28**	**2.59**	**1.47**	**1.84**
CV %	**13.98**	**7.69**	**13.91**	**12.6**	**8.7**	**15.57**	**4.28**	**3.38**	**5.31**	**11.9**	**13.6**	**17.7**

SYT06-1, SYT06-07, SYT06-10, SYT06-13, SYT06-21 and SYT06-24 showed better tolerance to root rots.

Plant Pathology: The natural incidence of root rot was observed in all types of varietal trials. In AVT, the maximum disease incidence was recorded in Indus (58.9%) and minimum in R-06 (26.2 %). In general, less incidence of root rot was recorded with IISR varieties than Syngenta varieties. In IVT, Shubhra (HI-0064) recorded the minimum incidence of root rot (15.1%), while 1N-01 recorded the maximum incidence (49.8%). In IVT, Felicita, IISR Comp-1 and Shubhra recorded incidence of up to 9.6% and the maximum was observed in IN–06 (44.6%). Overall, the performance of Shubhra and LS-6 was found superior in respect of disease incidence. With regard to the seedling disease caused predominately by *Rhizoctonia bataticola*, fungicidal treatment or the inoculation with *Trichoderma viride* were equally effective in managing seedling diseases. An experiment on IDM showed that the combined use of soil application of bioagent (prior to sowing) and drenching of Thiram or Bavistin in the last week of February were effective in reducing root rot incidence and increasing root yield significantly.

Entomology: Only one major insect pest, *Spodoptera litura* was observed in the crop. A single spray of quinalphos of 0.05% or endosulfan at 0.1 % has been found effective. Among different varieties, Indus was affected the most, followed by Cauvery, while minimum number of larvae plant^{-1} was observed in Shubhra, IISR Comp-1 and LS-6. Pheromone traps @ 5 traps ha^{-1} and release of bio-agents @ 50,000 adults ha^{-1} also reduced larval population of *Spodoptera litura*. Other insect pests were observed to be of minor importance.

Agricultural Engineering: The seed drill that can sow two rows of sugarbeet 40 cm apart on a raised bed was developed and tested at Pune in Saamarth sugar factory area. Besides, hand dibblers were also designed.

Seed production: Seed Production activities carried out at Mukteswar involved bulk production of LS-6 and IISR Comp-1, while other breeding material was maintained. New germplasm and varieties were also procured from USDA, including one CMS line. Nearly 50 kg of seed was produced. The selection for sugar was made at Lucknow and the selections were transplanted at Mukteswar for breeding purposes. A few experimental hybrids have been made and studied for root crop performance. New locations for seed production are being explored and the sugarbeet seed was sown *in situ* at Shimla and Srinagar.

10

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

10.1 Technology adoption and analysis of constraints

Integrated Communication Strategy (ICS) for accelerating the adoption of sugarcane production technology (ET1.10)

Integrated Communication Strategy (ICS) was implemented in BCM Sugar Mill, Rauzagaon in Barabanki district of Uttar Pradesh. The identification and segmentation of clientele targets (viz., sugar-mill personnel, development personnel and sugarcane farmers) was done for effective dissemination of information in sugarcane technology under ICS. Messages on different sugarcane production technology were developed and disseminated through print and electronic media. A survey was carried out in sugar-mill zone to assess the increase in knowledge of sugarcane farmers as a result of ICS implementation. Data on knowledge of farmers in component sugarcane technologies such as variety, seed, planting method and plant growth, integrated nutrient management, integrated weed management, intercultural operation, intercropping, water management, insect-pests management, disease management, ratoon management, mechanisation and post - harvest management were recorded on structured questionnaire. The maximum increase in knowledge was recorded in post-harvest management followed by ratoon management, insect-pest management, mechanisation and planting methods.

Development of a scale to measure the attitude of extension personnel towards sugarcane production technology (ET 1.11)

The study was initiated to assess the attitudinal changes of sugarcane development personnel after imparting training. Following Likert Methods, an attitude scale was constituted. The scale contains 66 statements from different areas of sugarcane cultivation. Minimum and maximum scores of the scale are 66 and 198, respectively. Split-Half Method was used to analyze the reliability of the scale. Two sets were prepared by putting even numbered statements in first set and odd numbered statement in the second set. Both the sets were administered to the 30 judges. The co-efficient of correlation between the two sets of scores of the scale was calculated. The value of the co-efficient of correlation was 0.83. It indicates that the scale is reliable and more dependable for measuring attitude. The validity of the scale was examined with the help of the Content Validity Method to determine how well the contents of the scale represented the subject matter. During one month training conducted at IISR, Lucknow, the data were collected from 10 sugarcane development personnel before initiation of training and at the end of it. Pre & post training attitude score were 161.33 and 142.67, respectively. This shows that training could make positive change in the attitude of sugarcane development personnel.

10.2 Socio-economics and policy analysis

Analysis of sugarcane area, production and yield in different sugarcane growing states of the country (AES 4.7)

During last six years, all tropical states except Gujarat registered negative or nearly zero compound growth rates for cane yield and area. The maximum instability was observed in Maharashtra and Karnataka for cane area, production and yield. The high negative growth rates in cane area in Maharashtra, Karnataka and Tamil Nadu, resulted in drastic reduction in sugar production. This picture was emerged due to drought and outbreak of woolly aphid and other natural calamities in major cane producing states in tropical region of the country. The annual compound growth for different decades during the last fifty six years (1951-2006) was estimated to measure growth in sugar production also in different states of India. During 2001-06, the country as a whole and most of the sugar producing states registered negative compound growth rates except Uttar Pradesh and Tamil Nadu (Table 10.1) .

Table 10.1: Annual compound growth rate (%) and coefficient of variation (%) of sugar production in different states of India.

States	Growth rate (%)		CV (%)	
	1991-00	2001-06	1991-00	2001-06
Uttar Pradesh	4.24	2.35	17.29	11.06
Bihar	-2.01	2.44	20.57	21.49
Haryana	1.80	-7.66	14.00	19.78
Punjab	2.25	-10.19	31.48	27.14
Madhya Pradesh	-0.70	1.12	33.61	14.65
Rajasthan	-3.08	2.68	29.27	48.45
West Bengal	-1.28	2.70	32.27	34.91
Assam	-6.30	-	29.25	0
Maharashtra	5.28	-12.59	26.06	36.56
Andhra Pradesh	6.33	1.53	23.61	12.70
Gujarat	4.29	-1.30	16.62	14.34
Karnataka	5.39	-1.28	23.28	24.65
Orissa	9.38	6.9	43.51	18.28
Tamil Nadu	4.30	-2.35	23.77	29.61
Kerala	4.54	-	44.80	70.50
India	4.37	-3.51	19.04	18.49

Highest negative growth was recorded in Maharashtra (-12.59%) followed by Punjab (-10.19%) and Haryana (-7.16%). The coefficient of variation (CV) of sugar production reveals that, during 2001-2006, the production was more stable in Uttar Pradesh, MP, AP and Gujarat. However, it was highly instable in Kerala (70.5 %) followed by Rajathan (48.45 %) and Maharashtra (36.56 %).

Analysis of long term trends in yield and economics of sugarcane cultivation in important cane growing states of India (AES 4.9)

The yield and cost analysis was carried out based on the current prices for the input use in the most prevalent agronomic scenario of sugarcane cultivation in each of the 6 major cane growing states for the last 35 years. The yield levels have not been consistent with the rise in the cost of cultivation, on the contrary, these have observed decreasing trends over the years in some states. The average gross returns per hectare from sugarcane cultivation were highest in TN and lowest in UP, mainly on account of differences in yield levels, as well as in price levels. The operational cost is lowest in UP at about 30 thousands and highest in TN at about 54 thousands. In all other states, it ranged from 36 to 44 thousands. Over the years, the operational cost of cultivation ha^{-1} has increased significantly in almost all the states. The differences in the operational costs in different states are mainly on account of number of irrigations, quantum of fertilizers used as well as in the labour use. The proportion of the labour cost and that of irrigation cost in the total operation cost has increased significantly over the years (Table 10.2). In TN, the

Table 10.2 Proportion of labour and irrigation cost components in total operational cost of cultivation in major cane growing states in India

States	QE Year	Share of different cost components in total operational cost in sugarcane	
		Irrigation (%)	Labour (%)
Maharashtra	1975-76	14.04	17.90
	2005-06	23.62	26.26
Tamil Nadu	1975-76	16.65	29.90
	2005-06	19.97	52.13
Uttar Pradesh	1975-76	4.28	34.96
	2005-06	5.75	47.14

proportion of labour cost has risen up to 52% whereas in Maharashtra, the proportion of irrigation cost has increased to about 24% of the total operation cost of cane cultivation. Though, the profit margin per ha was highest in Maharashtra closely followed by TN, the analysis of the data over the years reveals that the profit margin as the percentage of the gross returns has decreased over the years in these major cane growing tropical states, particularly in Maharashtra, TN and AP (Fig. 10.1).

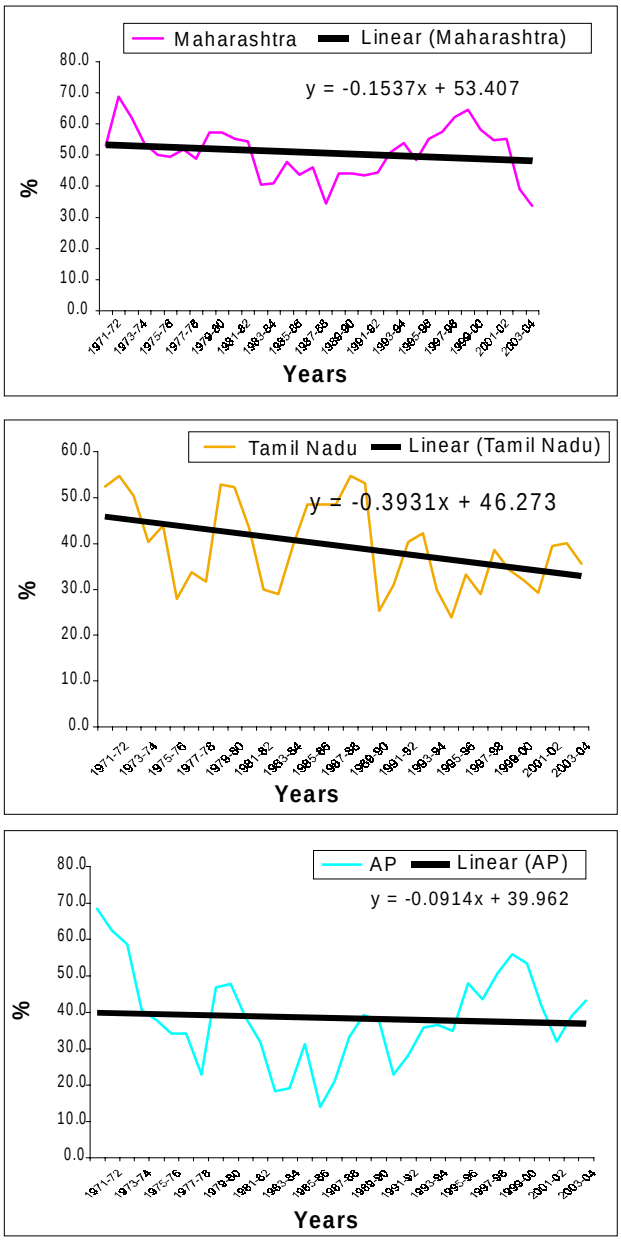


Fig. 10.1. Profit margin as per cent of gross returns in sugarcane cultivation in different states

Developing a database and analyzing contribution of sugarcane in Indian Economy (AES 4.11)

The project was undertaken to analyse the trends in Indian sugar export and foreign exchange earnings and the trends in contribution to the fiscal income of the country, *inter alia*. Indian sugar exports are covered under Harmonized System (HS) code no. 17 and the heading entitled "sugar and sugar confectionery" comprising 38 different categories of exports. Universely, the sugar exports are covered under 4 headings: cane sugar raw, beet sugar raw, sugar refined with coloring matter, and cane sugar refined without coloring matter. In this millennium, the composition of Indian sugar exports has gone under change. The exports of refined sugar have increased (Fig. 10.2). The raw sugar exports were below 33% for all the years up to 2006-07 while the refined sugar exports have increased up to 67% to about 73% of total sugar exports.

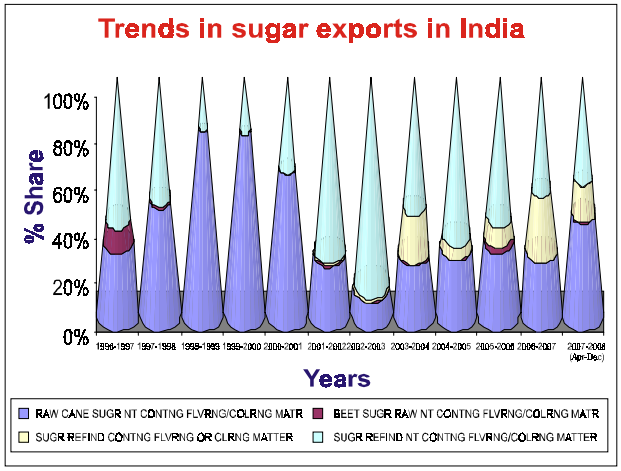


Fig. 10.2 Composition of Indian sugar exports

Analysis of data on total sugar and sugar confectionery exports and its major components for the period 1997-98 to 2007-08 reveals that, in value terms, the Indian sugar exports have been less than 1% of the total exports of all commodities during this period. The value of sugar exports was fluctuating during the last 11 years, being quite low by the turn of the century at Rs. 132.57 crores in TE Year 1999-00 to Rs. 1480.81 crores by TE year 2006-07. Of late, the sugar exports have been at Rs. 3441 crores in 2006-07 and more than Rs. 4000 crores in 2007-08 (Fig. 10.3). In 2006-07, about 91.22 per cent of the sugar &

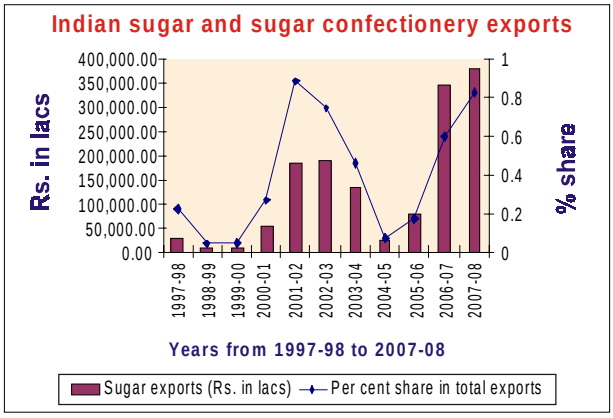


Fig. 10.3. Value of Indian sugar exports

confectionery exports were from cane sugar, 1.90% from other sugars, 3.87% from molasses, and 3.43% from sugar confectionery. In years when the total sugar exports were lower, the share of cane sugar export value also fell to as low as 24% in 1999-00. In physical terms, the cane sugar exports fluctuated between 12 thousand tons in 1998-99 to 1642 thousand tonnes in 2006-07, and even more than 3000 thousand tonnes (3 mln tonnes) in 2007-08. The respective share of cane sugar export was 81.08%, other sugars 1.91%, molasses 16.14%, and of sugar confectionery 0.87% in 2006-07.

10.3 Development of statistical models/ procedures

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

A weather interactive model was developed for estimating sugarcane productivity in Uttar Pradesh using long-term crop and weather database (1980-1999). The model is based on monthly average weather data on maximum temperature, minimum temperature, morning and afternoon relative humidity and rainfall from April to September. The predictor variables are given weightage as per their correlation with average cane productivity. The weightage system is used to generate composite weather variables which are regressed with cane productivity. The model was updated each year from 2000 to 2006 and predictions were made for each year. The model predictions for the productivity were fairly close to observed productivity in the state.

Energy and water balance and crop growth monitoring using satellite data (SAC-IISR Programme)

On-station trial comprising spring crop of sugarcane, variety CoSe 92423, planted on 7th November 06 with recommended package and practices was conducted and the observations on crop parameters and NDVI data during crop cycle were also recorded. Since, there is practically no crop growth in terms of foliage development during winter season due to very low temperature, the crop starts tillering and foliage development is much faster as temperature rises during spring. The NDVI recorded during early May to end November was related to crop biophysical attributes such as shoot population, plant height and crop biomass (Table 10. 3).

Table 10.3. Correlation between NDVI and crop biophysical attributes

Crop Attributes	Correlation coefficient (r)	Period of crop cycle
Shoot Population	0.129ns	For the entire crop cycle from early May to end November
	0.91***	From early May to 3rd week of August
Plant height	0.786***	For the entire crop cycle from early May to end November
	0.868*	From early May to 3rd week August
Total biomass	0.793***	For the entire crop cycle from early May to end November
	0.749***	From early May to 3rd week of August

*** - Significant at 1%, *- Significant at 5%, ns – not significant

The NDVI-LAI relationship (Y = 0.0813*e 5.3244X with R^2= 0.9014, where Y is LAI and X is NDVI) developed during last crop cycle (2006-07) for the same variety (CoSe 92423) planted in spring season was used to estimate the LAI in autumn planted cane in crop cycle (2006-08). The estimated and observed LAI are given in Fig. 10.4.

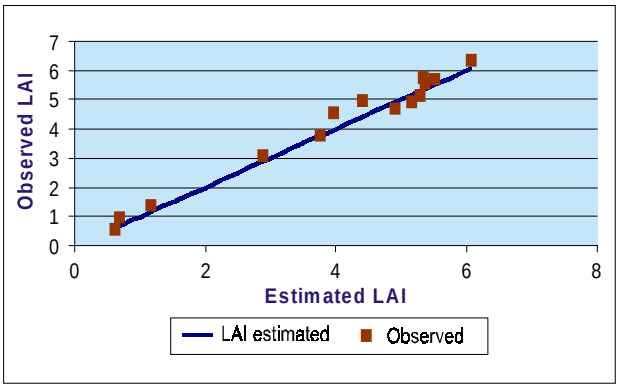


Fig 10.4. Observed and estimated LAI in autumn planted sugarcane

Development of a precision N application technology based on NDVI index using green seeker sensors for intercropping of sugarcane and wheat (CIMMYT/RWC-USAID Programme)

In the second cycle of the experimental trial, the wheat (PBW-343) was sown on raised beds using RWC raised bed planter at nitrogen doses @ 0, 30, 60, 90, 120, 150, 180 and 210 kg ha^{-1} applied as basal before sowing of wheat as per technical programme. Sugarcane (CoSe 92423) was planted in furrows at 1.34 m inter row distance on 7th November, 06. Observations of NDVI were recorded at satellite pass dates provided by RWC for wheat crop during November 06 to April 07. The biophysical parameters of sugarcane crop were recorded after wheat harvest in April, 07. The average productivity of wheat was 5.96 t ha^{-1} on raised beds as compared to conventional wheat (4.66 t ha^{-1}) and conventional wheat intercropped with sugarcane (4.85 t ha^{-1}) at 120 kg N ha^{-1}. The INSEY (in season estimate of yield) for wheat grown on raised beds was developed from crop yield data and maximum NDVI recorded during the wheat crop cycle. The relationship developed is shown in Fig. 10.5.

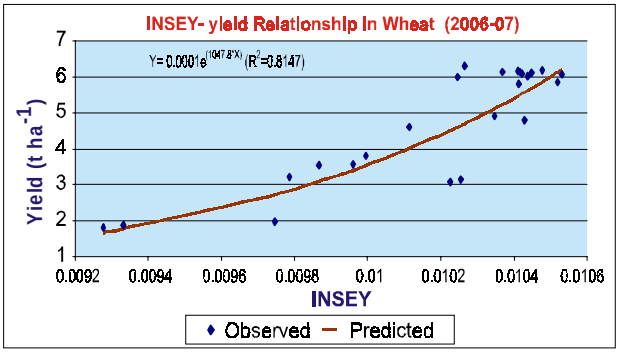


Fig 10.5 INSEY- Yield relationship in wheat

Sharp increase in cane productivity was observed from 90 kg ha^{-1} to 150 kg N ha^{-1} (Fig. 10.6) from amongst different nitrogen levels (from 0 to 210 kg N ha^{-1}) at wider row spacing of 1.38 m. and with the entire nitrogen through urea provided after harvest of wheat. The NDVI recorded in July (25.07.07) was used to compute INSEY index (= NDVI / crop age), in sugarcane grown with wider row spacing which was correlated with cane productivity (harvest time, February 08). The INSEY –yield relationship in autumn planted sugarcane in wheat sugarcane intercropping was developed under subtropical conditions prevailing at Lucknow (Fig. 10.7).

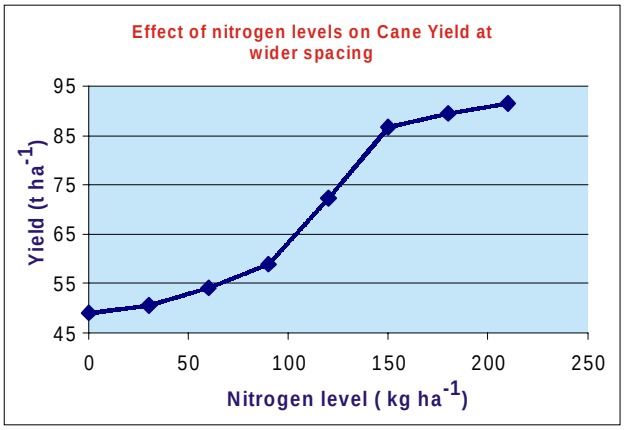


Fig. 10.6 Effect of nitrogen levels on cane yield

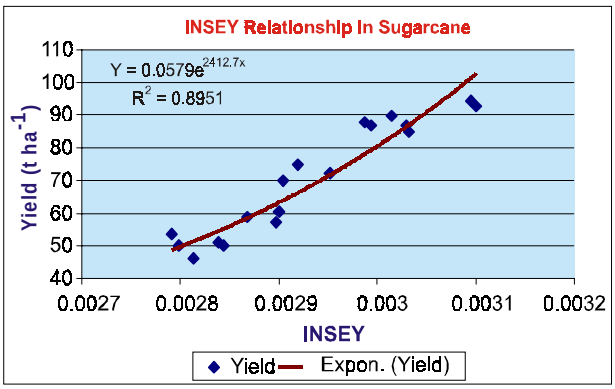


Fig. 10.7. INSEY – relationship in sugarcane

10.4 Development of database and information systems

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

The weather data during the crop season 2007-2008 was analysed. The long–term (1980-2006)

weather data on maximum and minimum temperature, morning and afternoon relative humidity, duration of bright sunshine, total annual and monsoon rainfall, number of rainy days and wind speed collected at station analyzed for monthly trends. In general, coefficient of variability was lower for maximum temperature as compared to minimum temperature and range of temperature. The maximum temperature reflected declining trends except in February to April and August. The highest CV of 8.8 % (indicating fluctuations) was noticed for January and lowest CV of 2.8 % (indicating stabilized trend) in the September. The minimum temperature showed inclining trends except in January, April, May and November with highest CV of 13.9 % in December and lowest CV of 3.4 % in August. The range of temperature reflected declining trends except in March and April with highest CV of 17.7 % in August and lowest CV of 7.8 % in April. In general the range of temperature appears to be compressed. The morning relative humidity shows inclining trends all through the year with highest CV of 13.7 % in May and lowest CV of 3.2 % in January and August. The afternoon relative humidity showed variable trends with highest CV of 27.7 % in April and lowest CV of 7.7 % in August. The mean relative humidity reflected inclining trends except in April, May, July, August, September and November with highest CV of 17. 3% in the month of May and lowest CV of 4.8 % in August. The duration of bright sunshine showed declining trends in most of the months except in March where an inclining trend was observed. The highest CV of 26.9 % was noticed in January and lowest CV of 14.3 % was observed in February. The rainfall reflected declining trend in most of the months except in January where an inclining trend is reflected. Except in the month of June, declining trends were reflected in the monsoon season with highest CV of 70.3 % in September and lowest CV 60.5 % in June. The number of rainy days reflected declining trends all through the year except in April and November. During monsoon activity period from June to September, highest CV of 45.3 % was noticed in June and lowest CV of 35.7 % was found in August. The annual rainfall shows a sharp decline with mean value of 898.7 mm and a range of 507.1- 2113.7 mm. with a CV of 34.1 %. The monsoon rainfall also reflected sharp decline with a mean value of 781.8 mm and range of 445. 2 – 2037.1 mm with a CV of 34.1 %. A sharp decline was observed in total number of rainy days both in the annual (with mean value of 55 and CV of 20.6 %) and monsoon season (with mean value of 43 and CV of 23.2 %).

Data Warehouse on sugarcane production System (AES 4.8)

Data Warehouse work has been undertaken to have a better insight into the dynamics of sugarcane production and sugar industry using historical data generated on sugarcane production, sugar industry, agro-met data generated by government department and agencies. District level information of various states of India has been recorded in the system to identify sugarcane-growing regions of the country. Meteorological information of these districts was extracted from various government web sites. These data were either available in worksheet format or printed journals / reports. Further, Sugar Mills addresses and their crushing record have been obtained from published information of sugar mills.

Dimension Modeling technique has been applied in which two types of entities are used viz. Fact and Dimension. Two dimensions taken into consideration were Place and Time. Place dimension corresponds to the administrative hierarchy of a state. It starts with the State, which is divided into districts. Time dimension consists of temporal intervals such as day, week, month and year. It plays an important role in analyzing temporal data of sugarcane production facts. Facts are the metrics associated with and reported for dimensions, e.g. Sugarcane Area, Production, Productivity, etc. are facts recorded for Place and Time dimension. The architecture of the Data Warehouse is shown in Fig. 10.8.

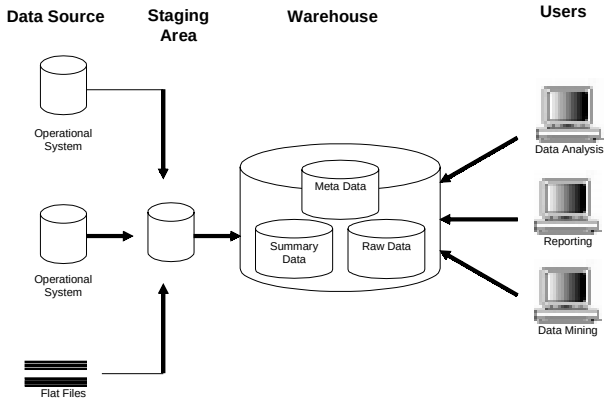


Fig. 10.8 Data Warehouse Architecture

Certain analytical operations using standard SQL commands have been performed for the testing of data warehouse implementation. Algorithmic approach has been applied to carry out analytical operations. Two case studies were performed to analyze complex queries on the data warehouse.

Decision Support Tools in Sugarcane Cultivation (AES 4.10)

Decision Support Tools in sugarcane cultivation were under active development in order to disseminate knowledge of sugarcane technologies in highly interactive way. Information on fifty sugarcane crop disorders has been collected from domain experts and literature. KADS methodology has been applied in knowledge acquisition. Various categories of information viz. disorder name, its concept & properties, and symptoms related to disorder diagnosis were collected. The developed system will be able to identify the disorder in sugarcane crop on selecting one or more symptoms by the user based on present status of the crop. The system is being evaluated.

Development of atlas for sugarcane cultivation in India (AM4)

The district-wise information on population below poverty line, mechanization status (number of tractors and advanced harrow and cultivators) and number of sugarcane crushers were collected. The GIS maps for tractors and advanced harrow and cultivators, area under canal, government and private tube well irrigation, coverage under early and mid-late varieties of sugarcane, waterlogged area, number of agricultural laborers and marginal farmers using district level data were generated for the state of Uttar Pradesh.

Transfer of technology

Sugarcane variety CoLK 94184 identified for commercial release

CoLK 94184 (Birendra), a high sugar early maturing sugarcane variety developed by IISR was identified for cultivation in the North Central Zone comprising eastern Uttar Pradesh, Bihar, Jharkhand and West Bengal. It is an excellent ratooner and tolerant to both drought and waterlogging stresses. The variety has recorded a yield of 75.97 t ha^{-1}, CCS 9.28 t ha^{-1} and sucrose 17.97%.

Sugarcane genotypes viz., LG 03001, LG 03701, LG 03702, LG 04061 and LG 02321 were found suitable for multi location testing based on their performance in the trials. Main characteristics of these identified genotypes are as follows:

Variety	Pol % in juice		Yield (t ha^{-1}) (February)	CCS (t ha^{-1})	Reaction to Red Rot
	(10 months)	(12 months)			
Early					
LG 03702	18.40	19.20	92.6	12.20	MR
LG 03701	18.30	19.10	82.1	11.60	MR
LG 02321	19.00	19.30	83.3	11.10	
Mid-late					
LG 03001	17.20	18.50	89.3	11.30	MR
LG 04061	17.80	18.60	89.3	11.50	MR

In addition, genotypes such as CoLk 07201, CoLk 07202, CoLk 07203, CoLk 9709, CoLk 94184, CoLk 99271 and CoLk 05202 have already been accepted for state varietal trials by Indian Sugar Mills Association (ISMA) and All India's Coordinated Research Project for multi-location trial. The seed of these genotypes was supplied to many sugar factories for multiplication and subsequent conduct of state trials.

Implements for sugarcane cultivation: commercialized

IISR, with its limited capacity, is striving hard to increase the production of the successful prototypes and to meet the ever increasing demands of end users. To increase the availability of sugarcane cultivation equipments, IISR has gone ahead with forging private-public partnership for the mass production of these equipments. In this direction, willing and reputed agricultural equipment manufacturer have roped-in by signing a memorandum of understanding (MOU) with them. The willing manufactures were provided with necessary technical know-how of these equipments. Manufacturing rights of identified equipments were given (through signing of MOU) to 2 firms Msrs. Govinda Industries, Barabanki (U.P.) and Msrs Sunlight Foundaries, Barabanki (UP) for exploiting the commercial use of 7 technologies (farm machinery / equipments) developed at the Institute, and accordingly these manufacturers have taken up the manufacturing of these equipments. Rs. 20,000 per technology was charged from the manufacturers as fee while signing the MoU. The farm machinery / equipments identified for the purpose along with the tentative price are as follows:

1. Two row pit digger, Rs. 53000
2. Ratoon management device, Rs. 73000
3. Raised bed seeder, Rs 15000
4. Ridger type sugarcane cutter planter, PTO drive, Rs. 39000
5. Raised bed seeder cum planter, Rs 38000
6. Multipurpose sugarcane cutter planter, Rs 43000
7. Modified two row sugarcane cutter planter (Ground wheel drive), Rs 30000

Dissemination of management practices

Farmers' visits

Technical guidance to numbers of farmers/ extension workers / students/ development personnel was provided during their visits to the experimental farm of the institute. Twenty three groups of farmers (766 in number) from different states under ATMA scheme who visited KVK Lucknow under the auspices of the institute, were shown different technologies of sugarcane crop, jaggery and khandsari processing unit, vermicompost unit and the improved implements developed at the institute.

Field Visits and days

The scientists of the institute are visiting the farmers' fields under their research projects to demonstrate technology to the farmers. A farmers' participatory research project is also being carried out by the institute under which experiments have been laid out in farmers fields. The Director of the institute also visited Rauzagaon sugar factory on 15.03.2008 under FPARP programme.

Management practices for disease and insect-pest outbreaks

Surveys were carried out in sugar mill areas in UP state and appropriate management strategies were advocated during the year. A rapid appraisal in cane command area of K.M. Sugar Mills Ltd, Faizabad, Bajaj Hundusthan Ltd, Gola and Balrampur Chini Mill, Haidergarh to assess the incidence and damage done by Pyrilla was conducted during April, 2007. It was observed that nymphs and adults of Pyrilla varied from 40 to 150 per leaf in mature standing crop. Along with Pyrilla, the different stages of ecto-parasitoid, *Epiricania melanoleuca*, was also recorded (upto 5 per leaf) in the crop planted during autumn, spring and recently initiated ratoon The population of pyrilla varied from 20-60 per leaf. Conservation and augmented releases of *Epiricania* was advocated to contain Pyrlla flare up. The strategy for the management of the outbreak of *Pyrilla perpusilla* as given below was advocated in the survey areas.

Harvest as early as possible the mature standing canes from the fields. The cane leaves containing viable cocoons and egg masses of *Epiricania melanoleuca* may be clipped off in 8-10 cm size from older and these may be stapled on under side of leaves in younger crop having severe infestation of Pyrilla. In heavily infested fields *Epiricania* may be released @10000 cocoons or 5000 cocoons + 5 lakh eggs ha^{-1}. Remove the egg masses of Pyrilla along with leaf bits and keep them in fine mesh net bags for emergence of parasitoids in Pyrilla infested fields and destroy the nymphs of Pyrilla emerging in bags. In ratoon, the lower leaves may be stripped off, as Pyrilla prefers these for egg laying. Remove dry leaves from August onwards to reduce infestation.

For the control of shoot borer, the management practice advised to the farmers was "Pull out the 'Dead Hearts' from the plants and subsequently kill the larvae inside plant by poking the pointed wire/ spokes. Also remove the infested plants or cut the plants from the base and destroy the infested shoots".

Incidence of red rot was also observed in the variety CoS 8436 in low lying areas (20-30%) and in uplands (2-5%) in the factory zone of Sakseria Sugar Mill, Biswan, Sitapur. Leaf scald incidence (2-5%) was noticed in CoS 767 and CoS 8436 in Ghatampur (Kanpur) under the command area of Ghatampur sugar mill, Kanpur.

Mass Multiplication of effective predators of sugarcane woolly aphid and their release in farmer's fields.

Dipha aphidivora (pyralid predator) and *Micromees igorotus* (Hemero predator) are very effective components of bio-control of sugarcane woolly aphid, *Cerafovacuna lanigera*. Mass multiplication of *D. aphidivora* and *M. igorotus* was done under separate shade nets (5x5x4m size). Field release of these predators was done at farmer's fields with variety Co 5767 having moderate to severe infestation of sugarcane woolly aphid in village Bhaledi, Jansath, Rathore and Khatauli of district Muzaffarnagar (U.P), for controlling the burgeoning population of woolly aphid. *D. aphidivora* was released @ 1000 larvae ha^{-1} during the month of September when the crop was about six months old. After 15 days 63% population was reduced due to the predator. The predator was released in village Khatauli and Jansath in 10 fields with a total area of

1.88 ha. *M. Igorotus* was released @ 2000 larvae ha^{-1} twice in a month during September/ October, 2007 in 10 farmer's fields having CoS 767 variety comprising 2.10 ha area in two villages viz. Ratoon and Bhaledi near Khatauli Sugar mills in district Muzaffernagar. About 40 per cent reduction in population of woolly aphid was recorded due to this predator. D. Aphidivora proved more effective in containing the woolly aphid population.

Spraying of Dichlorvos (0.05%) proved most effective in suppressing the woolly aphid population. At IISR bio-control centre, Pravaranagar, (Maharashtra), a total of 10,000 cocoons and 15000 larvae of pyralid predator, *Dipha aphidivora* were released in farmers' fields against sugarcane woolly aphid around Pravaranagar area for its colonization. *Trichogramma chilonis* @ 50,000 adults ha^{-1} was also released against shoot borer in an area of 408 ha of sugarcane area benefiting 330 farmers of the area.

Exhibitions

IISR was the venue for the National Level Agri-Expo 2008, organised jointly by the Centre for Agriculture and Rural Development (CARD), New Delhi and ASSOCHAM, New Delhi from February 16-19, 2008. Hon'ble Minister for Food Processing, Govt. of India, Shri Subodh Kant Sahay visited each and every stall and lauded the efforts. During this exhibition, IISR showcased sugarcane production and protection technologies, various implements including cutter planters, ratoon management device (RMD), etc. to the visitors. About 5000 farmers from all over the country visited the IISR stall during Agri-Expo-2008 and got abreast of new and emerging technologies in sugarcane farming. Besides six institutes of ICAR, several other reputed institutions of both public and private domains participated in this Agri-Expo. Every aspect of agriculture from seed, fertilizers, implements, irrigation management, pesticides, harvesting and post harvest processing and management, management of animals, crop insurance and crop loans were well represented in this Expo. This Expo provided a window to the farmers for looking beyond the traditional farming, ways of storing the produce in a better way and value addition to the farm produce to generate more income in a sustainable manner.

Agri Expo 2008 at IISR, Lucknow

Farmers' Fair (Kisan Mela) and Exhibition was organized by KVK, IISR, Lucknow at Beniganj village in the block of Mohanlalganj, district Lucknow on March 26, 2008. A stall of IISR, Lucknow on sugarcane production technologies was installed at the fair ground and 350 farmers visited the stall and acquired latest know-how in sugarcane production technology

An exhibition on 'Sugarcane Production Technology' was organised at Northern Regional Agriculture Fair-cum regional Mango show organized by CISH, Lucknow during June 16-17, 2007.

Documentary Films

The three documentary films on *Bhartiya Ganna Anusandhan Sansthan: Ek Jhalak, Ganna Buwai Vidhiyan* and *Pedi Prabandhan* were made for its widespread dissemination.

Press Releases/ dissemination through print media

in *Hindi*

1. विशेषज्ञ स्वस्थ गन्ना बीज के लिए रणनीति तैयार करें। दैनिक जागरण, लखनऊ, 28 सितम्बर, 2007।
2. स्वस्थ बीज ही उत्तम फसल का आधारः चन्द्रिका। राष्ट्रीय सहारा लखनऊ, 28 सितम्बर, 2007।

3. स्वस्थ गन्ना बीज के लिए रणनीति बनाएंगे गन्ना विशेषज्ञ। स्वतंत्र भारत, लखनऊ, 28 सितम्बर, 2007।
4. गन्ने के स्वस्थ बीज के उत्पादन की रणनीति बनाएँ। स्वतंत्र भारत, लखनऊ, 29 सितम्बर, 2007।
5. गन्ना अनुसंधान संस्थान ने दिया गुड़ बनानें का प्रशिक्षण। राष्ट्रीय सहारा, लखनऊ, 30 दिसम्बर, 2007।

in English

1. Workshop on Jaggery Processing. The Hindustan Times, Lucknow, December 15, 2007.
2. Training Programme, The Hindustan Times, Lucknow, December 30, 2007.

Websites

IISR Website is regularly updated for IISR research projects, technologies, achievements, and other related activities. The Institute Information Bank is updated regularly in E-Book form.

A document of frequently asked questions (FAQs) on sugarcane cultivation and their answers was prepared and submitted to ICAR for its inclusion in the ICAR website.

Information dissemination through correspondence

Letters received from the farmers and extension workers of various states were replied giving them details of sugarcane production technologies.

Krishi Vigyan Kendra & Kisan Call Centre

Under SUBACS programme, 10 FLDs in one ha area each were conducted to transfer the sugarcane production technology such as ring-pit planting, intercropping of moong and urd, mustard, and ratoon management.

Seed Production and distribution

Breeder Seed of varieties CoS 96275, CoS 94257, CoS 97264, CoS 95270, CoS 95222, CoS 96268, CoS 8436 was produced in approximately 10 ha area and the seed cane was supplied to various sugar factories, progressive sugarcane farmers etc. Seed production of newly released variety CoLk 94184 has been taken up on priority for 2008-09. For the purpose, STP and polybags nursery methods have been adopted for rapid multiplication.

About 35 quintal of Breeder Seedcane of a newly developed variety CoLk 94184 was supplied to Riga Sugar-mill and 10 quintals to sugarcane research institute, RAU, Pusa and 10 quintal to a progressive farmer in Bihar state by the institute's Regional Research Station, Motipur, Bihar.

Sugarbeet : About 50 kg of sugar beet seed was produced at Mukteshwar, mainly of LS-6, and IISR Comp-1 variety.

TV Talks

Name of Scientist	Topic	TV Channel/Programme	Date and Time of Broadcasting
Dr. R. L. Yadav, Director	गड्ढा विधि द्धारा गन्ने की बुआई का महत्व एवं प्रबन्धन।	" अन्नदाता " e-tv (UP / Uttaranchal)	Jan. 22, 2008 (6.30 am)
Dr. Menhi Lal	शरदकालीन गन्ने के साथ सहफसली खेती का महत्व।	" अन्नदाता " e-tv (UP / Uttaranchal)	Jan. 12, 2008 (6.30 am)
Dr.S.R. Prasad	पेड़ी प्रबन्धन।	" अन्नदाता " e-tv (UP / Uttaranchal)	Jun. 01, 2007
Dr.A.K.Sah	ग्न्ना कटाई उपरान्त आवश्यक प्रबन्धन।	" अन्नदाता " e-tv (UP / Uttaranchal)	Jan. 16, 2008
Dr.A.K.Sah	शरदकालीन गन्ने में सामयिक कृषि कार्य।	" अन्नदाता " e-tv (UP / Uttaranchal)	Jan.19, 2008

Two TV talks were also delivered on *Navjat Pasuo Ki Dekhbhal and Dudharu Pasuo Ki Garmi me Dekhbhal* by KVK, Lucknow .

12

Education and training

The institute regularly conducts a one-month training programme to the cane development officials of the sugar-mills. In addition, it also provides various short-term trainings as per need. The Institute also offers 3 international training programmes on sugarcane related aspects. The scientists of the institute are professionally well recognised and are invited in various scientific and planning forums. In addition, the scientists also train students from the nearby colleges in some frontier areas and thus assist them in building their academic capability.

International Training Programmes

The institute developed following 3 International Training Programmes on sugarcane related aspects which also appeared in ICAR International Training Programmes manual.

1. Agro-technology for Maximizing Sugarcane Production
2. Protection Technology for Sustaining Sugarcane Productivity
3. Manufacturing and Storage of Jaggery

In order to meet the requirements of new emerging challenges, one new training programme on mechanization of sugarcane cultivation is being developed.

Training for Sugarcane Development Personnel

IISR is regularly organising one-month training (July1-31) on cane management and development in sugar mill reserved areas for sugarcane development personnel to keep them abreast with the current knowledge of sugarcane farming. During this year, 10 trainees participated and attended the training programme, 6 trainees from Haryana, 3 from U.P. and one trainee from Egypt. The course contents of the training programme comprising of 74 lectures, both theory and practical, were appreciated by the trainees. In order to make this training programme an effective and an efficient means for the transfer of improved sugarcane production technology in sugar mill command areas, the institute also receives feedback from the participants to further improve upon as per the needs of the clients. Resource generation to the extent of Rs. 64,875 was generated from the fee prescribed this training programme.

Winter School on Jaggery

Jaggery, popularly known as 'gur' is manufactured mostly in unorganised sectors of small-scale industries and by village craftsmen employing traditional methods and equipments. This sector lacks trained manpower, adequate knowledge of new equipments and technology and thus poses a major bottleneck in improving the quality of jaggery and its availability round the year. To improve this knowledge gap, IISR, Lucknow with the help of ICAR New Delhi., CIPHET, Ludhiana and SAUs organised a 21-days winter school from 10-30 December, 2007. Twenty participants from eight states viz. U.P. A.P. Maharashtra , Karnataka, Kerala, Rajasthan, Uttarakhand and West Bengal were enrolled. The training was inaugurated by the Director, IISR, Lucknow. Dr. Nawab Ali, DDG (Agri. Engg.), ICAR, New Delhi was the Chief Guest in the valedictory function.

Training to Students

Short-term trainings varying from 45 days to 90 days duration were imparted on biotechnology and microbiology, to the B.Tech. (Biotech.)/M.Tech. (Biotech.) students from public as well as private academic institutions in Zharkhand and Uttar Pradesh state. Fifteen students (11 in Biotechnology and 4 in Microbiology) from different institutes and universities like BIT, Ranchi; DG and DAV College, Kanpur; A B College of Engineering and Management, AMITY University, Rai Foundation, Lucknow; Allahabad Agricultural Institute, Deemed University, Allahabad and Dr. B. R. Ambedkar University, Agra were provided training as a part of their academic requirements.

Three students were also enrolled for 90- days training in Biotechnology. Under an IASc-INSA-NASI summer fellowship programme, a 3-month training on enhancing sugarcane trash decomposition using combined approach of chemical N, SPMC and bio-agent was provided to a lecturer Dr. K. Ponmurugan from T.N.

A sum of Rs 3.80 lacs was generated from trainings provided to students.

Training visits

Training to staff of fertilizer companies on nutrient management of sugarane was also provided as per their needs.

Training to newly recruited staff from IFFCO, Lucknow

The trainees of 10-weeks short-term certificate course on "PVP and Related Issues" organized by DSST, IARI, New Delhi on October 16-19, 2007 visited the Institute. The visitors were provided with training lectures & practicals.

Trainings to administrative staff on information management

The administrative staff of the institute was provided training on Intelligent Reporting System Software, its features, application and how to use the software on November 7, 2007. The computor scientist of the institute, Sh. S.S. Hasan coordinated the training programme.

Trainings to farmers at KVK, Lucknow

KVK, Lucknow, located at IISR, Lucknow also organized a total of 53 training programmes during which 1459 trainees were provided technical know-how on various agricultural activities during 2007-08. KVK, Lucknow, under the institute management also coordinated different sponsored training programmes to progressive farmers on pump- sets, boring mechanics, animal husbandry and dairying under Farmers' Field School programme, 2 training programmes pertaining to IPM in mustard and one pertaining to IPM in Mango.

Title of training	Period (Days)	Partici-pants	Sponsored agency
Pump- set, Boring mechanics, Animal Husbandry and Dairying	7	64	Deputy Director, Agrl., Lucknow
Integrated Pest Management in mustard (Dhanuasand Village).	14	36	CIPMC, Lucknow
Integrated Pest Management in mustard (Beniganj, Village)	14	36	CIPMC, Lucknow
Integrated Pest Management in Mango (Mangtaiya Village).	14	36	CIPMC, Lucknow
Total	**-**	**172**	**-**

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Awards and recognition

Recognitions

Dr. R. L.Yadav, Director of the institute was co-opted as a member of Group of Experts" set up by the Government of India to examine various options available for the growth and development of the sugar economy.

Dr. Archna Suman, Senior Scientist nominated as Reviewer for 3 International Journals, viz., World J Microbiology and Biotechnology, Springer Verlag; Letters in Applied Microbiology, Society for Applied Microbiology; Soil and Tillage Research, Elsevier.

Dr. R. K. Singh, Senior Scientist nominated as member of the Editorial Board of the journal 'Physiology and Molecular Biology of Plants' published by Springer.

Dr. Sangeeta Srivastava selected as consulting editor of the journal 'Sugar Tech' for the year 2007-08.

Dr. S. Solomon, Principal Scientist nominated as a fellow of the Sugar Technologists Association of India, New Delhi.

Drs. R.L.Yadav, D.V. Yadav and Rajesh Kumar were President, Chairman, Poster Session and organising secretary of 10th National Scientists Conference in Hindi *"Vaishvikaran ke paripakhsa mein krishi evam sambandit utpaadan ke gunatmak vridhhi evam sanrakhsan hetu bhavi shod dishayan"* at IISR, Lucknow.

Prizes

Dr. Ashok K. Shrivastava, Principal Scientist received Consolation prize in Oral literature category of the "Indian Literature Golden jubilee Literary Translation Prize Competition" organised by Sahitya Academy, New Delhi.

14

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.

(i) Collaboration with International Research Institutions

At International level, the institute intends to strengthen institutional linkages with International Bureau of Plant Genetic Resources and International Society of Sugarcane Technologists to participate in the sugarcane genetic resources programme. The institute also intends to explore collaboration with different foreign universities and Governments dealing with sugarcane like, USA, Brazil, Cuba, Australia. The Institute is also exploring areas of common interest in sugarcane research with Japan and Australia. A three-member Australian team of scientists visited IISR in summer this year and has interacted with IISR scientists to explore the opportunities of a joint venture in sugarcane breeding and other areas of collaborative research.

IISR Scientists interacting with Australian delegation

A Collaboration research project on Development of a Precision N Application Technology based NDVI index using Green Seeker sensors for intercropping of sugarcane and wheat is in operation in the Institute as CIMMYT/ RWC-USAID Programme.

(ii) Collaboration with National Research Institute

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, 42 high sugar LG selections so far have been sent to the National Hybridization Garden (NHG), SBI, Coimbatore 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. The crossing attempted by the institute scientists (breeders) under different research projects at National Hybridization Garden, SBI, Coimbatore are as follows:

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. From 2006 onwards, the fluff received under the programme is being grown under different institute research projects to cater to the needs of varietal development. At present, the work done under this programme involves the identification of promising genotypes in different clonal generations and not from the seedling population

Maintenance of genes : The procured four Bt gene constructs (Cry 1Ab, Cry 1Aa, Cry 1F, Cry IA5) and pB1 121 with GUS are being maintained in yeast extract manitol (YEM) medium and preserved in equal volume of 40% glycerol at 70^0C for their utilization.

Crosses made under IISR on-going research projects at National Hybridization Garden, SBI, Coimbatore

On-going research project	Linkages/Crosses attempted
Development of sugarcane breeding stocks for high sugar (B 2.3)	Till date, 42 breeding stock have been sent to SBI, Coimbatore and over 30 that are already in the NHG after quarantine are being increasingly used in crossing.
Development of top borer tolerant genetic stocks of sugarcane (B 2.9)	Two biparental crosses were attempted at SBI, Coimbatore and 14 crosses were attempted at Distant hybridization facility at Agali.
Development of sugarcane varieties for moisture deficit environment (B.2.10)	A total of 22 biparental crosses were attempted at NHG, SBI, Coimbatore.
Development of sugarcane varieties for sub-tropics (B.2.13)	Nineteen bi-parental crosses were attempted Fluff of 11 zonal crosses along with 10 GCs was received.
Development of breeding stocks of sugarcane for durable resistance to red rot (B 2.14)	Ten bi-parental, one self and five general crosses were attempted and fluff received
Identification of biochemical and molecular markers for sugar genes in sugarcane (B 3.13)	A total of seven matings – six crosses and one self- were attempted and the fluff obtained.

Seed multiplication of genotypes

The seed of thirteen genotypes was multiplied for the next year's Initial Varietal Trial. Seed Cane of 13 early maturing clones (received from SBI, RC Karnal) to be tested in initial varietal trial (Early) during 2008-09 was multiplied. Observations on general growth performance and juice quality were recorded.

Maintenance of varieties as preparedness for plant variety protection & DUS testing

A total of 100 varieties from various centres of sub-tropical India were maintained at institute farm. The details are given in Box below :

Co 312, Co 331, Co 419, Co 453, CoS 109, CoS 245, CoS 443, CoS 510, CoS 514, CoS 541, Co 1148, Co 1158, Co 1336, Co 6811, Co 6308, Co 6425, Co 1157, Co 6613, CoS 109, CoS 730, CoS 687, CoS 770, CoS 767, CoS 797, CoS 7918, CoS 8118, CoS 8315, UP 5, UP 9530, UP 0097, CoS 8432, CoS 8436, CoS 8207, CoS 88230, CoS 90265, CoS 90269, CoS 91230, CoS 91269, CoSe 92423, CoS 93259, CoS 95255, CoS 94270, CoS 95222, CoS 96258, CoS 01256, CoSe 95436, CoS 95270, CoSe 96436, CoSe 00235, CoS 96268, CoS 97264, CoSe 98231, CoSe 95422, CoS 96275, CoS 96269, CoS 97261, CoS 99259, CoSe 01235, CoSe 01424, CoS 97258, CoS 02258, CoS 02264, CoS 94257, CoS 03279, CoLk 8001, CoLk 8102, CoPant 84211, CoPant 84212, CoPant 90223, CoPant 96219, CoPant 97222, CoH 35, CoH 56, CoH 99, CoH 110, CoH 119, CoH 92201, CoJ 64, CoJ 83, CoJ 85, CoJ 88, CoJ 89, CoB 94164, Co 87263, Co 87268, Co 89029, BO 120, BO 128, BO 91, BO 99, BO 109, BO 110, BO 129, BO 130, BO 136, BO 137, BO 138, CoP 9206, CoP 9301, CoP 9302, CoP 9702.

Note : 1. Varieties CoBln 9101, CoBln 9102, CoBln 9103, CoBln 9104, CoBln 9605 are being maintained at SBI Regional Centre, Karnal. 2. Out of varieties in collection, 68 varieties were characterized as per the existing DUS Guidelines. Twenty varieties have been planted with STP method by utilizing polybags raised nurseries as per the guidelines finalized by the Task Force II for characterization of varieties.

The Institute strengthened its linkages with national research organization like NBRI, Lucknow, CDRI, Lucknow, and CIMAP Lucknow, and NSI, Kanpur.

Collaborations with national/ state level sugarcane research organizations in the country have also been made through inviting the scientists / officers in the seminar/ brainstorming sessions organized at the institute.

(iii) Collaboration with Central Line Departments

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

pertaining to SDF funding for research, and with the President, STAI on the strategies to improve sugar recovery and sugarcane yield in India with special reference to UP & Bihar.

- The Directorate of Sugarcane Development sponsored short-term training and one national seminar to the Institute.
- One Collaboration research project on energy and water balance and crop growth monitoring using satellite data is in operation as a programme of Space Applications Centre (ISRO), Govt. of India.
- The Deptt. of Biotechnology, Govt. of India., New Delhi sponsored two projects, viz., i) Development of ESTs, gene identification and ransformation in sugarcane, and ii) Development of PCR- based diagnostic kits for red rot and smut disease of sugarcane which were concluded during the year.
- A farmers' participatory action research project has been funded by Central Water Commission, Ministry of Water Resources, Govt. of India with a budgetary provision of Rs. 50 lacs.

(iv) Collaboration with State Agencies state research organizations

The institute has linkages with Sugarcane Research Stations and State Agricultural Universities for testing of technologies developed by the Institute and quick dissemination of viable technologies 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 20 different co-operating centres located in different states in 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, (GAU, 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); Thirvella, KAU, Trichur); Uchani, CCSHAU, Hissar); Lucknow, (IISR, Lucknow)

In addition, the institute has cooperating centres of 3 other AICRPs, viz AICRP (FIM) AICRP (BC) AICRP (PHT).The Institute is also coordinating a Network project on Sugar beet.

- U.P. Council of Agricultural Research Lucknow: Institute scientists were invited in various state level meetings / committee and seminars organized by the Council. In addition, the Institute scientists are carrying out research on following three projects funded by UPCAR, Lucknow.

i) Screening of sugarcane varieties for sodicity tolerance as sole and intercrops.

ii) Evaluation and standardization of organic farming technology.

iii) Enhancing field water use efficiency in sugarcane cropping system through FIRBS.

- State Cane Department: U.P. State Department of Cane Development collaborated in extension programmes and provided the feedback for refinement of the technology. The Institute also sends its Newsletters / Annual Reports to cane federations of various states as well as to the Departments of Cane Development. Efforts are on to increase its mailing list.

- Local IMD, Lucknow: The Institute record metrological data at its observatory and share with local IMD, Lucknow. The institute also shares its data on weather variables to Weather Watch Group, constituted by the Govt. of UP. The institute sponsors its scientists regularly to the Weather Watch Group meetings at UP Council of Agriculture Research, Lucknow.

(iv)Collaboration with Private Organizations

Collaboration with industries has also been made through contact research programmes. Out of eight contract research projects, five research projects have been undertaken with 3 agencies in private sector viz, M/s pest control India Pvt. Ltd., Banglore, M/s EI Dupont India Limited, Gurgoan and M/s FMC India Pvt. Ltd. Banglore on field evaluation of new insecticides against termites and shoot borer in sugarcane. Collaborations with Shriram Fertilizers & Chemicals for testing their product on sugarcane and with ITC Ltd, Guntur for testing of Wallgro manure have been made. Memorandum of Understanding (MoU) has also been signed with private entrepreneures and provided them the manufacturing rights of equipments for their further commercial exploitation.

(v) Collaboration with Sugar Mills:

- In an attempt to have linkages with the sugar-mills of the country the Institute conducted a one month training programme exclusively for the cane development officers of the sugar-mills. In addition, meetings organized by Indian Sugar Mill Association (ISMA) were represented by the Director of the Institute. The Institute also sends its newsletter to some sugar-mills in the country. The institute also helps the sugar industry through contract research projects and consultancies.
- The Extension educationists of the Institute participated in group meetings attended by the cane development staff of the sugar-mills of U.P.
- Surveys were carried out in the cane commend area of sugar-mills in nerby districts of U.P.
- The farmers were linked through Front line Demonstrations, on-farm trials, advisory services, Kisan gosthi, Field Day, etc as a regular programme of KVK, IISR , Lucknow. Some of the experimental trials were conducted in various sugar-mills cane command areas.

vi) 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 & CSSRI regional centre, Lucknow. Directors of the other ICAR institutes are also invited to the institute on important occasions.

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Technical programme during 2007-08

Crop management for high cane productivity under different environments

Sugarcane based production system

AL-1 : Intercropping studies of linseed with autumn planted sugarcane (A.K. Singh and Menhi Lal)

AS 42 : Agronomic evaluation of promising genotypes of sugarcane (S.K. Shukla and Ishwar Singh)

AS 56 : Drought management in sugarcane (A.K. Singh, Menhi Lal and Ishwar Singh)

AS 57 : Developing organic farming module for sugarcane crop (K.P. Singh and Archna Suman)

AS 60 : Studies on seed cane economy in sugarcane cultivation

UPCAR–1/03 : Evaluation and standardization of organic farming techniques for sugarcane production system (Menhi Lal, K.P. Singh, Archna Suman and Arun Baitha)

Expl. Trial : Evaluation of sugarcane genotypes for high nitrogen use efficiency under ring-pit planting system (A.K. Singh and Menhi Lal)

Expl. Trial : Agronomy of new sugarcane genotypes (A.K. Singh, R.L. Yadav and A.D. Pathak)

Ratoon management in sugarcane

A 3.20 : Optimizing plant population of ratoon crop for minimizing gaps (R.S. Chauhan and Sheo Naik Singh)

A 3.23 : Optimizing plant population density in sugarcane plant-ratoon system (S.N. Singh, Todi Singh, S.K. Shukla and S. Pandey)

PB 18 : Improving juice quality and stubble bud sprouting in sugarcane under low temperature (A.K. Shrivastava, S. Solomon, R.K. Rai, Pushpa Singh, Ishwar Singh, Radha Jain and Rajesh Kumar)

Integrated weed management in sugarcane based cropping system

AS 55 : Weed management in sugarcane ratoon (R.S. Chauhan)

AS.58 : Improving productivity of winter initiated ratoon of sugarcane in sub-tropical India (R.S. Chauhan)

AS 59 : On-going effect of sub-soiling on soil physico-chemical characteristics and sugarcane productivity (A.K. Singh, P.N. Singh & A.K. Singh)

CR 6/06 : Evaluation of Velpar K4 60 WP herbicide for control of sugarcane weeds as post-emergence application (R.S. Verma and R.L. Yadav).

Resource management in sugarcane based cropping system

Nutrient management in sugarcane based cropping system

A 1.1.26 : Identification of sugarcane genotypes for high nitrogen use efficiency (A.K. Singh, R.L. Yadav, A.D.Pathak and Archna Suman)

A 2.31 : Effect of bio-manuring on sugarcane productivity and soil properties under Plant and subsequent ratoon (K.P. Singh, P.N. Singh and Archna Suman)

C 6.4 : Enhancing nitrogen use efficiency through integrated nutrient management under multi-ratooning system (P.N. Singh and R.S. Chauhan)

C 6.5 : Optimising nitrogen use through Integrated Nutrient Management under sugarcane plant and ratoon system (P.N. Singh, S.K. Shukla and R.S. Chauhan)

C 18.2 : Management of macro- and micro-nutrients in sugarcane based cropping system (T. Singh and P.N. Singh)

Expl. Trial: Effect of covered pit planting (CPP) and covered trench planting (CTP) on productivity and quality of sugarcane (A.K. Singh, P.N. Singh and A.K. Singh)

CR-2/06 : Agronomic evaluation of different new grades of N P K on Sugarcane (D.V. Yadav and Todi Singh)

CR-1/06 : Evaluation of wellgrow – an organic manure with NPK on yield and quality of sugarcane (R.L. Yadav, D.V. Yadav, S.K. Shukla)

Expl.Trial: Effect of mode of *Gluconacetobacter* inoculation with various nitrogen levels on sugarcane

Long term effect of conventional (non-organic) and organic cultivation of sugarcane on soil properties and cane yield (R.L. Yadav, D.V. Yadav, D.K Sharma, A.K. Nayak and Archna Suman)

Population dynamics of *Arbuscular mycorhiza* and its role in Microbial consortia for sugarcane (Dr. Archna Suman)

Water management in sugarcane based cropping system:

A.E. 6.7 : Optimization of irrigation water requirement of plant and ratoon crop of sugarcane in sub-tropical India (R. Gupta)

UPCAR Funded project : Enhancing field water use efficiency for sugarcane cropping system through FIRBS. (Rajendra Gupta, P.R. Singh, Archna Suman and Ishwar Singh)

Ext. aided project : Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane (D.V. Yadav, R.P. Verma, Kamta Prasad, A.K. Sah, Rajendra Gupta and K.P. Singh)

Heavy Metal Toxicity management in sugarcane based cropping system

APC 1/05/NS-80 : Physiological and molecular approaches to study heavy metal toxicity in Sugarcane (R.K. Rai & B.K. Dube)

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 (P.K. Singh, J. Singh and Sanjeev Kumar)

Development of sugarcane varieties and breeding stocks for sub-tropics

Expl. Trial : Evaluation of elite clones under Station Trial 2007-08 (P.K. Singh and Sanjeev Kumar)

B 2.3: Development of sugarcane breeding stocks for high sugar (Raman Kapur and S.K. Duttamajumder)

B 2.6: Genetic evaluation of sugarcane genotypes and crosses for their suitability under late planted conditions (A.D. Pathak)

B 2.9: Development of top borer tolerant genetic stocks of sugarcane (A.D. Pathak, R.K. Rai, R.K. Tewari and Rajesh Kumar)

B.2.10: Development of sugarcane varieties for moisture deficit environment (Sanjeev Kumar, J. Singh, P.K. Singh and Ishwar Singh)

B.2.13: Development of sugarcane varieties for sub-tropics (J. Singh, D.K. Pandey, P.K. Singh and Sanjeev Kumar)

B 2.14: Development of breeding stocks of sugarcane for durable resistance to red rot (D.K. Pandey, P.K. Singh, Sunita Lal and J. Singh)

B 1: Zonal Varietal Trials (North West Zone) of AICRP on Sugarcane (Raman Kapur, A.D. Pathak, D.K. Pandey, J. Singh and Sanjeev Kumar)

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

Cytogenetic and biochnological approaches for sugarcane improvement

B 3.7: Genetic improvement of sugarcane through tissue culture (Raman Kapur and R.K. Singh)

B 3.8: Cyto-morphological and molecular characterization of some sugarcane genotypes (Sangeeta Srivastava)

B 3.13 Identification of biochemical and molecular markers for sugar genes in sugarcane (M. Swapna, Sangeeta Srivastava and D.K. Pandey)

B 3.14: Molecular Diversity Analysis for biotic stresses of Saccharum germplasm (R. K. Singh, D. K. Pandey, M. Swapna)

B 3.15: Genetic Transformation in Sugarcane for resistance against Borers (R.K. Singh, Raman Kapur, Sangeeta Srivastava, M. R. Singh)

B3.16: Optimizing standards for sugarcane seed production through micro propagation (R.K. Singh, Vijai Singh, J. Singh, Archana Suman, A.K. Singh)

Others

i) Seed Production in Sugarcane

ii) Preparedness for Plant Variety Protection and DUS Testing through ICAR-SAU System

Epidemiology and integrated disease management

Epidemiology of diseases of sugarcane

EM 01 A : Survey and surveillance of insect-pests and diseases of sugarcane in subtropical area (HOD, Crop protection and all scientists of the division)

M 2.13 : Mechanism of variability in *Colletotrichum falcatum* causing red rot in sugarcane (A.P. Singh, Vijay Singh, Ramji Lal and Sumita Lal)

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

M 3.5 : Determination of causal organism(s) of wilt disease of sugarcane (S.K. Dattamajumder & S.C. Mishra)

PP 14 : Identification of pathotypes of red rot pathogen (Ramj Lal and Sunita Lal)

PP14a : Maintenance of isolates of red rot pathogen (Sunita Lal & Ramji Lal)

PP29 : Molecular characterization of isolates / pathotypes of *Colletotrichum falcatum* (Sunita La, Ramji Lal and Archna Suman)

Integrated disease management in sugarcane

M 15.3 : Management of red rot disease of sugarcane through bio-agents (Vijay Singh, S.N. Srivastava and Ramji Lal)

M 17 : Evaluation / screening of sugarcane germplasm / genotypes against red rot and smut (S.K. Gangwar, Ramji Lal, Sunita Lal and Vijay Singh)

PP17 : Evaluation of genotypes / varieties against red rot, smut and wilt (S.K. Gangwar, Ramji Lal, Sunita Lal, A.P. Singh and Vijay Singh)

Exploratory trial : Investigation on spread of red rot (*C. falcatum*) of sugarcane

C 15.7 : Cellular and molecular interaction of the bacterial isolates with pathogens causing major diseases of sugarcane (Archna Suman, Sunita Lal and Pushpa Singh)

Bio-ecology and Integrated Management of Insect-pests

Bio-ecology of insect –pests of sugarcane

E.4.2.1(iv): Development of high temperature tolerant strain of *Trichogramma chilonis* and *Trichogramma japonicum* (A. Baitha and D. C. Srivastava)

E 6.03: Succession of insect-pests in multiple ratoons of sugarcane and their management (S. K. Gangwar, M. R. Singh and A. Baitha)

E 4.2 (I): Biointensive management of top borer of sugarcane (S. K. Gangwar, D. C. Srivastava, R. Tewari, M. R. Singh and A. Baitha)

E.11.1: Development of techniques for laboratory mass multiplication of top borer and its parasitoids (M. R. Singh)

EM 01 : Survey and surveillance of insect-pests and diseases of sugarcane in sub-tropical area (Head, crop protection and all scientists of the division)

E.27 : AICRP (S): Mass multiplication of potential bioagents of sugarcane insect pests (M. R. Singh and A. Baitha)

E.30 : AICRP (S): Monitoring of insect pests and bio-agents in sugarcane agro-ecosystem (S. K. Gangwar, D. C. Srivastava, M. R. Singh and A. Baitha)

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

E.4.2. : Biological control of sugarcane moth borers, pyrilla and scale through exotic and indigenous parasitoids and predators (R. B. Jadhav)

E 4.1 : AICRP (S): Evaluation of varieties / genotypes for their reaction against major insect-pests (R. K. Tewari and G. M. Tripathi).

CR-4 / 06: Field evaluation of synthetic sex pheromone lure of sugarcane top borer (D. C. Srivastava, M. R. Singh, S. K. Gangwar and R. L. Yadav)

NS-5: Bionomics and management of sugarcane woolly aphid (G. M. Tripathi and M. R. Singh)

CRE.3.2.3 (iv): Evaluation of bio-efficacy of Bifenthrin 10EC against termite in sugarcane (S. K. Gangwar, A. Baitha and R. L. Yadav)

CR-3 / 06: Evaluation of E2Y 45 0.4 GR against termites and top borer of sugarcane (S. K. Gangwar, M. R. Singh, D. C. Srivastava, and R. L. Yadav)

CRE. 3.2.4 (EM). Evaluation of insecticides and fungicides against insect-pests and diseases of sub tropical sugarbeet crop (S. K. Gangwar, S. N. Srivastava, Sunita Lal, R. K. Tewari and R. L. Yadav)

Expl.Trial: Demonstration of IPM and IDM technology against key pests and diseases at Institute's farm (S.K. Gangwar, A. Baitha and A. P. Singh)

Development of appropriate farm machinery for mechanization of sugarcane cultivation

Design and development of equipment

AE 1.9E: Development of sugarcane harvester (A.K. Singh, M.P. Sharma and Jaswant Singh)

AE 1.18A: Design refinement of a power operated equipment for detrashing of harvested sugarcane (A.K. Singh and M.P. Sharma)

AE 1.19A: Development of a tractor operated mounted type two row ratoon management device (A.C. Srivastava)

AE 1.32: Development of FIRB : Tractor operated Sugarcane Planter-cum-seeder (P.R. Singh, A.C. Srivastava and R.L. Yadav)

AE 1.33: Development of an engine operated walking type multipurpose equipment for sugarcane cultivation (M.P. Sharma and A.K. Singh)

AE 3.6: Development of a moist hot air unit for treatment of seed cane on bulk scale (R.K. Pangasa, M.P. Sharma and M.H. Ansari)

AE 8.1: Design and development of residue mutator-cum-bio applicator (P.R. Singh, Archana Suman and A.C. Srivastava)

Development of suitable post-harvest technology

Post-harvest losses in sugarcane

PB 19: Management of post-harvest deterioration of sucrose in sugarcane (S. Solomon, R. Banerji, Pushpa Singh and Ishwar Singh)

Manufacturing and storage of Jaggery

LKO / PHTS / 05 / 1: Assessment of post harvest losses in crops / commodities (Jaswant Singh, S.I. Anwar, R.D. Singh and Dilip Kumar)

LKO / PHTS / 05 / 2: Testing and evaluation of TNAU cane crusher (Jaswant Singh, and R.D. Singh)

LKO / PHTS / 05 / 3: Development of mechanical filtration unit for sugarcane juice (R.D. Singh and Dilip Kumar)

LKO / PHTS / 05 / 4: Value addition of jaggery through natural source of vitamin C (S.I. Anwar, and R.D. Singh)

LKO / JKS / 07 / 01 : Development of sugarcane peeler (Dilip Kumar, Jaswant Singh and P.R. Singh)

LKO / PHTS / 07 / 2: Design and development of a small capacity cane crushing unit for house hold purpose (Jaswant Singh and Dilip Kumar)

LKO / PHTS / 07 / 3: Development of a device for churning of sugarcane juice in an open pan furnace (Jaswant Singh and A. K. Singh)

LKO / PHT / 07 / 04: Optimization of fins provided to the pan bottom for improved efficiency of jaggery making furnace. (S.I. Anwar)

LKO/PHT/07/05: Refinement of 3-roller horizontal power driven crusher developed at IISR. (S.I. Anwar and Jaswant Singh)

LKO/PHT/07/06: Testing and evaluation of IISR jaggery drier (A. K. Singh, Jaswant Singh and R. D. Singh)

LKO/PHT/07/07: Development of a solar drier for jaggery drying (Jaswant Singh, R.D. Singh and Dilip Kumar)

Diversification of sugarcane based by-products

A.P. Cess Fund Project: Development of pre-treatment and hydrolysis process for conversion of sugarcane biomass to ethanol (Pushpa Singh, Archna Suman and A.K. Shrivastava)

New Identification of inhibitors in sugarcane biomass hydrolyzates and their effect on ethanol yields (Pushpa Singh, Archna Suman and A.K. Shrivastava)

Sugarbeet Improvement and its Seed Production

NWP 2/04: AP Cess Network Project on Sugarbeet Research (ICAR): Developing Agro-techniques for Tropicalized Sugar beet in India.

Technology adoption, socio-economics, statistical modelling, computer applications

Technology adoption and analysis of constraints

ET 1.10 : Integrated Communication Strategy (ICS) for accelerating the adoption of sugarcane production technology. (A.K. Sah and R.P. Verma)

ET 1.11 : Development of a scale to measure the attitude of extension personnel towards sugarcane production technology (R.P. Verma, A.K. Sah & Kamta Prasad)

Socio-economics and policy analysis

AES 4.7 : Analysis of Sugarcane area, Production and Yield in Different Sugarcane Growing States and the Country (Rajesh Kumar, P.K. Bajpai and S.S. Hassan)

AES 4.9 : Analysis of Long Term Trends in Yield and Economics of Sugarcane cultivation in Important Cane Growing States of India (A.K. Sharma & R.L. Yadav)

AES 4.11 : Developing a database and analyzing contribution of sugarcane in Indian Economy (A.K. Sharma, R.L. Yadav, D.V. Yadav and Hema Pandey)

Development of statistical models/ procedures

AM3 : 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)

CIMMYT/RWC-USAID: Programme (05/1): Development of a Precision N Application Technology Based on NDVI index using Green Seeker Sensors for intercropping of Sugarcane and Wheat (Arun K. Srivastava and Ishwar Singh)

SAC-IISR Programme (05/1) : Energy -Water Balance and Growth Monitoring in Sugarcane Using Satellite Data (Arun K. Srivastava, Ishwar Singh and Todi Singh)

Development of database and information systems

AM3 : 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)

AES 4.8 : Data Warehouse on Sugarcane Production System

AS 4.10 : Decision support tools in sugarcane cultivaiton (S.S. Hassan, Rajesh Kumar, S.N. Shukla, Arun Baitha and A.K. Singh)

AM4 : Development of Atlas for Sugarcane Cultivation in India (Arun K. Srivastava, A.K. Sharma, R.L. Yadav and D.V. Yadav)

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Consultancy, contract research and patents

Contract Research Projects

During the year, the following contract research projects on evaluating the efficacy of fertilizers, weedicides and pesticides were carried out after signing a Memorandum of Understanding (MOU) with the manufacturers/companies. The details are as follows.

Title	Period	Concerned Scientists	Amount (Rs. In Lacs)	Firm/company
Evaluation of wellgrow – an organic manure of sugarcane	Apr. 06 – Mar. 08	R.L. Yadav, D.V. Yadav, S.K. Shukla	2.0	ITC Ltd., Guntur
Agronomic evaluation of different new grades of N P K S on sugarcane	Mar. 06 – Feb. 08	D.V. Yadav and Todi Singh	1.5	Shriram Chemicals and Fertilizers, New Delhi
Evaluation of Velpar K4 60 WP herbicide for control of sugarcane weeds as post emergence application	2005- 06 & 2006- 07	R.S. Verma and R.L. Yadav	3.0	M/s EI Du Point India Pvt. Ltd. Gurgaon
Field evaluation of E 2Y 45 20 SC against termite and top borer of sugarcane	Mar. 05 – Feb. 07	M.R. Singh and S.K. Gangwar	3.0	M/s EI Du Point India Pvt. Ltd. Gurgaon
Evaluation of E2Y 45 0.4% GR against top borer and termites in sugarcane	2006-07 & 2007-08	S.K.Gangwar, M. R. Singh, D. C. Srivastava and R. L. Yadav	3.0	M/s EI Du Point India Pvt. Ltd. Gurgaon
Field evaluation of synthetic sex pheromone lures of top borer of sugarcane	2006-07 & 2007-08	D.C.Srivastava, M.R. Singh, S.K.Gangwar, R.L.Yadav	2.0	M/S Pest Control India Pvt. Ltd. Bangalore
Evaluation of bio-efficacy of Bifenthrin in 10 EC against Termites in sugarcane	Mar. 06 – Feb. 08	S.K. Gangwar, Arun Baitha and R. L. Yadav	3.0	FMC India Pvt. Ltd. Bangalore
Field evaluation of synthetic sex pheromone lures of top borer of sugarcane	2006-07 & 2007-08	D.C.Srivastava, M.R. Singh, S.K.Gangwar, R.L.Yadav	2.0	M/S Pest Control India Pvt. Ltd., Bangalore

Patents

Following five patents, as complete applications, have been filed with the patent authority.

Application No.	Date	Patent	Concerned Scientists
3454 / DEL / 2005	December 23, 2005	An improved method of storing harvested sugarcane to minimize sucrose losses	Drs. S. Solomon, R.L. Yadav and Ashok Kumar. Shrivastava
3457 / DEL / 2005	December 23, 2005	Improving heat utilization in jaggery / khandsari making furnaces through modified pans	Dr. S.I. Anwar
3460 / DEL / 2005	December 23, 2005	Zero Tell furrower with guider for sugarcane planting. An attachment for sugarcane cutter planter	Dr. A.C. Srivastava
41 / DEL / 2005	January 04, 2006	Seeder cutter planter	Dr. A.C. Srivastava
141 / DEL / 2005	January 19, 2006	Ratoon Management Device (RMD)	Dr. A.C. Srivastava, Dr. R.L. Yadav, Er. M.P. Sharma, Dr. P.R. Singh and Er. Rajendra Gupta

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Monitoring and evaluation

Research Advisory Committee (RAC)

The composition of the Research Advisory Committee of the Indian Institute of Sugarcane Research, Lucknow as per ICAR letter F. No. 4(10)/07-IA.III dated Feb. 4, 2008, is as follows:

1.	Dr. H.K. Jain, Ex-Director, IARI, New Delhi	Chairman
2.	Dr. B.L. Jalali	Member
3.	Dr. D.G. Hapse	Member
4.	Dr. D.N. Yadav	Member
5.	Dr. N. Balasundaram	Member
6.	Dr. T.C. Thakur	Member
7.	Dr. K.C. Jain	Member
8.	Dr. R.L. Yadav	Member
9.	Shri Krishnapal Singh Rathore	Member
10.	Shri Anil Chowdhary	Member
11.	Dr. D.V. Yadav	Member-Secretary

The committee met on July 8-9, 2008 and initiated the discussions from a paper entitled "Sugarcane Research and Development in India in Global Perspective" highlighting sugarcane production scenario in the country, the future concerns and the research priorities *inter alia* prepared exclusively for the meeting as desired by the Chairman, RAC, and also emailed / posted to the all the members of RAC well in advance (about 2 months) of the meeting. The committee appreciated the concern highlighted in the paper. All the Heads of Divisions also took part in the meeting. The ATR pertaining to the previous RAC meeting recommendations was presented by Dr. D.V. Yadav, Member Secretary, RAC. The proceedings of the previous XIII RAC meeting were confirmed. These were duly approved earlier by the ICAR vide letter F.No. 4-6/06-IA.III dated March 13, 2007.

Based on the critical review of the presentations, agenda papers and visit to the field and laboratories, the RAC made division-specific following observations / recommendations:

Division of Crop Improvement

i) The RAC noted that in the last 90 years no major breakthrough has been achieved in increasing the genetic potential of the sugarcane crop. The Institute should intensify its research programme for a major advance of this kind through greater exploitation of genetic diversity available worldwide. The institute should plan a large number of new inter-varietal and inter-generic crosses to mobilize genes for high yields which have not been trapped so far. Also Somaclonal variation should be exploited for this purpose.

ii) The genetic stocks of sugarcane should be augmented through germplasm collections from different parts of the world. The institute should not be dependent on Coimbatore for this purpose.

iii) Bring all diversity in sugarcane (*Spontaneum*, *Erianthus*, *Barberi* etc) and plan accordingly.

iv) The germ-plasm collection of sugar beet should be strengthened. It may be obtained from Israel, USA, Japan and other European countries. The institute should become much more proactive in making a success of sugar beet in India. It is too important a crop in India for its future need to be left out.

v) Set linkages with industrial units processing sugar beet. Set goal to make cultivation of sugar beet a success.

vi) On the recommendation of previous RAC, "Work on molecular cytogenetics should be taken up to elucidate chromosomal composition of different species in sugarcane varieties to help sugarcane breeding. This may employ techniques such as Fluorescent *in situ* Hybridization (FISH) and Genomic *in situ* Hybridization (GISH)". Based on the useful information generated on molecular cytogenetics of sugarcane, a research project should go to DBT / NAIP for funding.

vii) DNA coming from other species should be marked.

viii) Main Research on QTLs should be on disease resistance, earliness in maturity, abiotic stress etc. Root characters to be taken up for moisture stress condition.

ix) Genetic base be widened in close association with SBI, Coimbatore.

x) Collaborations for biotechnology work may be strengthened with IARI, New Delhi.

Division of Crop Production

i) Soil preparation aspect needs to be looked seriously as roots cannot go to deeper depths due to hardpan beneath. There is a need for exploiting the lower layers of the soil.

ii) More intensive research on Nutrient Management is required. Balanced and integrated use of nutrients be emphasized to sustain soil health.

iii) Make it a mission to increase N use efficiency from 40 to 50% at farmers' fields during next 5 years.

iv) Dynamics of rhizosphere be studied and quantified.

v) The institute should have a mission to increase ratoon cane productivity and extension bulletin should be published on the efficient management of ratoon crop for wide distribution to farmers, extension departments, NGOs and KVKs. The title should be "Make more money from your Ratoon Crop".

vi) Attempts be made to reduce the cost of sugarcane production.

vii) A breakthrough and not a small gradual change in sugarcane yield is desired. For this, the technologies need to become widely adopted. A mechanism for this be envisaged and get institutionalized.

viii) Also make contract farmers / progressive farmers to spread the technologies of the Institute. Technology is not reaching to the farmers at a desired extent and speed. There is a need to develop and demonstrate a one acre model farm for high yields with all the improved- package of practices.

ix) Select 10 sugarcane districts in UP and make one National Demonstration in each of 10 selected sugarcane districts in U.P.

x) Develop a sugarcane model village with IISR technologies in Western Uttar Pradesh. Adopt a village linked to a sugar factory.

Division of Crop Protection

i) Bring out a publication on biological control of insect-pests and diseases in sugarcane.

ii) Quantification of parasitic population be carried out.

iii) Termites in sandy soil and white grubs are the problem. The eco-friendly control measures be developed.

iv) There is an urgent need for strengthening service units for biological control. The techniques for *Trichogramma* multiplication should reach the farmers.

v) Rearing of bioagents should be on natural field conditions to make these hardy.

vi) Microbial Consortium developed for red-rot control be tested under field conditions.

vii) Red-rot mapping w.e.f. 2000 may be done in Uttar Pradesh.

viii) Diagnostic kit developed for early diagnosis of red-rot and smut in sugarcane be validated.

Division of Plant Physiology and Bio-Chemistry

i) Use setts for planting and then try to improve germination using chemicals including harmones.

ii) Try to develop a nutritional supplement rich in minerals from by-products of sugarcane with the collaboration of CDRI and other research organizations.

iii) Converting bagasse for ethanol production and not for cogeneration should get priority.

iv) Convert usable technology for cane growers to reduce post-harvest losses.

v) The water requirement for sugarcane crop is very high. The new conservation technology should be applied to reduce the amount of water requirement to produce a good crop of sugarcane. The conservation agronomy should be more fully recognized for the developed of improved packages of practices.

vi) There are a number of by-products starting with sugarcane and ending with crystalised white sugar. The institute should focus on value addition and greater efficiency in the production and utilization of these by products. The institute should develop collaboration with the Sugar Research Institute at Kanpur for this purpose.

Division of Agril. Engineering

i) Efforts be made for mechanization of sugarcane farming at the level of cane growers.

ii) Cane planters should reach to the farmers.

iii) Implements be developed considering the small holdings and economic conditions of the cane growers.

Agrometeorology

i) Effect of climate change on phenology of sugarcane be studied.

ii) Climate change at IISR be documented.

Socio-economics

i) The yield growth rates are negative in some states in recent years. Its reasons need to be analysed.

ii) Develop collaboration with other agencies to carry out impact analysis of production technologies of sugarcane.

KVK

i) One publication on yield gaps should be made out of FLD work on yield gaps.

ii) Explore possibilities on the role of KVK under the institute in the transfer of sugarcane production technology in other districts.

Policy issues

i) There is a need for a national level body such as Sugarcane Development Council consisting of researchers, sugar-mills, planners, cane departments, extensionists, farmers' organizations and farmers to coordinate all the research and development efforts.

ii) Sugar-beet need to be included in the institute research mandate, goals and objectives of the Institute. Research programmes on sugar- beet need to be strongly strengthened. The Institute should have a section on sugar-beet. A proposal could be made in 11th Five Year Plan or under NAIP.

iii) Incentives to farmers are not coming and in this year, about 30% less area has been devoted to sugarcane in Western U.P. Efforts be made to stabilize sugarcane area.

iv) For strengthening biotechnological work in the Institute, the Post Doctoral Fellowship programme be encouraged in the Institute. Ph.D students may also be enrolled.

v) A breakthrough and not a small gradual change in sugarcane yield is desired. For this, the technologies need to become widely adopted. A mechanism for this be envisaged and get institutionalised.

Review by DDG (Crop Science), ICAR, New Delhi

The overall review of the research programmes was carried out by Dr. P.L. Gautam, DDG (Crop Science), ICAR, New Delhi on Nov. 4, 2007. He also presided over a meeting of the all the scientists of the institute. Dr. Gautam emphasized that IISR, Lucknow is a national institute and it has the national agenda. The research outputs of the institute must be available

and applicable across the country. The system / network created for sugarcane development in India be made better use of. Investment in India is being emphasized for technologies which results in cutting down on natural resources. Interaction studies are needed to understand the whole system. Technologies are also needed which take lesser time in screening for diseases. Experiments on precision farming with precise application of scarce resources, chemicals etc. are to be taken. Time series data on micro fauna and flora, i.e. biological, physical and chemical properties of soil be obtained. There is also a need to form the long term organic farming experiment, and to take data after every 5 years on developed organic farming sites. There is also a need to take data on disease causing germplasm. He emphasized that it is also a new research area. The countries like Japan has established Genome bank in this direction. He also emphasized that protection is needed for the varieties developed, so Colk 94184 developed at IISR, Lucknow be maintained in proper perspective. While commenting on research work on tissue culture, he emphasized that with a change in climate, new viruses are coming up, so research has to be geared up accordingly. Tissue culture seedlings require special care and the farmers would not be able to raise the crop from these seedlings. Hence these seedlings, be raised first in the institute farm and then distributed to the farmers. He also emphasized to study trade, market and policy issues, such as cost of cultivation of the crop (fixed / per qt. of cane), profit and prices. He also expressed concern that why sucrose percentage is low in India and very high in other countries. Whether it is due to false reporting or a fact, it needs to be explored scientifically?

Dr. Gautam also exhorted the scientists to be choosy in taking the projects from outside and the projects be taken according to the ICAR guidelines. He also emphasized to take large projects in collaboration with the private sector. He also expressed his concern that the institute must have best possible facilities in labs, electronic items, latest technology in the workshop, and overall good infrastructure.

Institute Research Council (IRC)

Institute Research Council (IRC) comprising all the scientists of the institute met twice on November 1-4, 2007 and January 25, 2008 under the chairmanship of Dr. R.L. Yadav, Director, IISR. While reviewing the progress of the research programmes / projects of the institute, the Chairman desired that the review of the research projects in the meeting be made focused on deliverable outputs / outcomes of the research projects. He clarified the difference between research output and outcome at the start of the meeting by citing relevant examples. He exhorted the scientists to present the specific deliverables / outputs as well as outcome of his research work during the project period under reference. He also desired that total research work load (as PI and Co-PI of the projects) and the contribution made as Co-PIs of the projects be presented by every scientist during his presentation. The Chairman emphasized the need for enhancing the visibility of Institute at the national / international level and towards this endeavour he exhorted the members / scientists to be professionally recognized by publishing books, papers in journals of repute, winning awards, prizes and fellowships, and also by proper documentation and publication of technologies. He also desired that the books on topics such as "enhancing ratoon management, post harvest losses management, mechanization of sugarcane cultivation, biological control of insect-pests, seed cane production technology, soil health and ethanol production from sugarcane residues" be written within 6 months. As better management of ratoon crop is one of the mission of the Institute, the Chairman advised HOD of the Plant Physiology and Bio Chemistry Division to focus the research activities of the division on physiological and biochemical processes which may provide answers to questions related to poor physiological efficiency of the ratoon.

Dr. R.L. Yadav, Director exhorted the scientists to be all rounder in their activities. He advised them not to waste their time and energy in trivial activities but to focus it for the generation of quality research papers. He exhorted the scientists that it is the quality publication work which will help them in their carrier advancement.

In IRC meeting, 2 research projects on crop production, 3 research projects on plant physiological aspects, one on sugarcane economics, one on computor applications and one on agricultural engineering aspect was approved. In addition, one

externally funded farmers' participatory action research project was presented for information of the house. The IRC also carried out a mid-term review of the research projects and approved the modifications in terms of change in the name(s) of PIs & Co-PIs and the extension in the project time period as per need.

a) Review of research progress at division/programme level

The performance indicators for monitoring and reviewing the research output/ performance at the divisional level were suggested in IRC meeting. For Crop Improvement Division, four performance indicators for monitoring yearly research work of the division were suggested. These are i) Quantum of seedlings grown, ii) Number of clones accepted for AICRP trials, iii) Varieties released, and iv) Quantum of the seed production carried out.

In order to prioritise the research work of Plant Physiology and Biochemistry Division, the chairman, IRC advised that the physiological efficiency of ratoon crop vis-à-vis plant crop be studied and as the first step towards it, the available / published data on this aspect be compiled and analyzed to spot gaps for proper management of the ratoon. He also exhorted the scientists of the division to carry out systematic studies as done in Kalai Experiments. The chairman advised to collate data on the subject to provide answer to the question "How plant and ratoon crops are different physiologically?" The parameters on which the data are to be obtained on monthly basis are: plant height, internodal length (no. of internodes), leaf area index (LAI), dry matter, number of leaves, nutrient concentration & their uptake, hormonal level, and root proliferation, if available. If data are available, the other parameters such as number of tillers, specific leaf weight, retentivity of photosynthates, sugar accumulation, and percentage of cell wall in cell constitution, etc., may also be considered important for inclusion. For monitoring the research output of the Economics and Statistics section, the targets specified were: Databases developed on all aspects of sugarcane and sugar, Sampling sizes defined and sampling procedures developed, analytical sampling techniques decided, and capacity building of scientists on advanced statistical softwares.

b) Review of research output/outcomes

As emphasized by the Chairman, IRC in every successive meeting, the IRC this year went a step ahead to refine the raw research results into specific deliverables or research outputs / outcomes so that the yearly outcome of a research programme or of a divison could be reviewed and the research programme could be made well focused. Based on the presentations of the HODs, the deliverables / research outputs / outcomes emerged at the divisional level review along with the comments of IRC are as follows:.

Research Outputs/Outcomes	IRC Comments
Division of Crop Improvement	
• Two varieties were accepted for AICRP(S) Multi-location trials. • Twelve breeding stocks (high sugar selections) were sent to SBI for inclusion in NHG. • Two inter-specific hybrid genetic stocks were sent to gene bank for registering • Package of practices of sugarbeet cultivation for sub-tropical region was developed.	• Information / data be compiled on the utilization of the breeding stocks of sugarcane sent to NHG (i.e. out of total breeding stocks sent to NHG, how many are being used in breeding) programme. • Seed Multiplication of the promising IISR varieties promoted from IVT to AVT-I should be carried out at the institute by the proposing breeders. • The quantum of seedlings raised by all the breeders in the Crop Improvement Division be increased to about 40000 seedlings. • All work / projects of Biotechnology is to be brought under one Umbrella for reporting. Possibilities of sharing facilities with NBRI, Lucknow may also be explored in order to further improve biotechnology work in the Institute. • Co-PIs of the projects of Crop Improvement division need to be from other divisions / disciplines rather than from the same division / discipline. • Technical Bulletin on Seed Cane Production Technology be prepared

Division of Crop Production	IRC Comments
• SPM 10t ha^{-1} + FYM 10t/ha proved productive and economical organic farming module for plant-ratoon system of both autumn and spring planted sugarcane • Application of 10 t ha^{-1} sulphitation pressmud cake + *Acetobactor* every year meet the nutritional requirement of crop and also maintain soil health under multi-ratooning of sugarcane. (It registered highest NMC and cane yield in 3rd ratoon)	• For strengthening extension research work/transfer of technology in the institute, there should be one demonstration of each division near the institute. One scientist be assigned the job of monitoring it. • Extension wing will bring out package of practices for control and management of root borer. • The results of Contract Research Projects be communicated only to the sponsoring agency/party. These may be included in the Institute recommendations if the IRC feels so.
• Sugarcane planted in paired row system (30:120 cm) significantly reduced the gaps (9.5%), produced highest NMC (120.5 thousand ha^{-1}) and cane yield (92.9 t ha^{-1}) over conventional planting at 90 cm spacing. • K application @ 80 kg ha^{-1} with last irrigation in plant cane, Inoculation of trash mulch in alternate rows with *Trichoderma viride*, use of NPK @ 200, 60, 80 kg ha^{-1} for increasing ratoon yield. • Increasing 25% seed rate through sett overlapping or gap filling at 1st irrigation in plant crop proved applicable practice for enhancing ratoon productivity. • Application of 75 kg K_2O ha^{-1} in plant crop increased yield of ratoon cane and CCS by over 10%. Similarly inoculation of seed cane with *Trichoderma viride* improved individual cane weight and cane as well as CCS yield of ratoon crop. • Five bio-agents were identified against red-rot. • Ninety five kilograms of bio-fertilizers were prepared.	• One Technical bulletin of research work undertaken on ratoon management be prepared. • Research papers on ratoon management must be published. • Reporting of research outputs be made programme-wise.
Division of Crop Protection	
• One technical bulletin on red rot management was developed (first draft). • Sett treatment with 10% leaf extract of *Solanum nigrum* **or** Spore suspension of *Trichoderma viride* (10^6 spores ml^{-1}) were found effective in reducing the smut incidence and improving cane yield. • Application of 20 kg. *Trichodarma* in 2 quintal FYM in furrows followed by planting the setts was found effective to protect red rot infection.	• Research on Biological control of white grub & termites emphasized. Motipur Centre (Hari Nagar area) is an ideal side for such research work. The detailed technical programme be submitted for approval of the Director for carrying out visits of the area. • Demonstrations be made on control of Top-Borer in about 0.5 ha 2 ha area.

Division of Plant Physiology and Bio-Chemistry	IRC Comments
• Physio-biochemical causes for poor sprouting of buds at low temperature investigated. • A pre-harvest foliar spray of $ZnSO_4$ showed reduction in post-harvest sucrose loss.	• The cost of chemicals used as post harvest spray also to be considered. • The response of the spray of K also need to be observed. • Project on increasing the viability of bud chip to be undertaken for observing physiological aspects. • Scientists should do all filler trials associated with the approved project and for this approval of HOD is sufficient.
Division of Agricultural Engineering	
• The prototype of an engine operated walking type multipurpose equipment for sugarcane cultivation was functionally tested. • Power operated improved detrasher developed. • Value addition in gur by addition of Aonla was carried out.	• The De-trasher designed at the division be further improved. • Engine operated interculture operator developed at the institute may also be taken up for public-private partnership with the firms located nearby. • Study and simulate village conditions also for research on gur storage.
Agrometeorology Section	
• Data were compiled for preparing sugarcane atlas in India.	• Climatological database of all the major sugarcane growing states be developed.

C) Review of IISR Regional Centre, Motipur, Bihar

The review of IISR Regional Centre, Motipur, Bihar was also carried out in the IRC meeting. The Chairman made the following observations while reviewing the progress of the Centre.

- Work on seed multiplication be taken up at the centre. Seed Multiplication of suitable variety CoLk 94184 be carried out at the centre. Breeder should start seed multiplication when the variety enters in AVT of the AICRP(S).
- HOD, Crop Improvement will be the nodal officer at the institute level for supporting the research work at Motipur centre.
- Research work on screening of varieties for water logging and red rot be given priority at the centre. The seed of variety obtained from Kolhapur, (Maharashtra) which is suitable for water logging conditions be planted at Motipur.
- Research work on Biological Control of white grub & termites be taken up at the centre. Harinagar area is an ideal site to do the research work.
- Demonstrations be made at the centre and All HODs to help I/c Motipur in this regard. I/c Motipur centre also needs to maintain liaison with all HODs.

d) Review of transfer of technology activities

The progress on the transfer of technology activities was also reviewed in IRC meeting. The chairman expressed the need for publishing extension pamphlets by the institute. The chairman also desired that the press clippings be put in the institute website.

A system for disseminating information be made at the institute and the terms and conditions for this may be developed. As the institute is generating valuable information, there need be a nominal price tag associated with the dissemination of such information. The institutions / private firms desirous of information about the institute / institute technologies first be asked to register themselves with the institute and a suitable registration fee be decided.

Review visits of field Experiments and Research Laboratories

The review visits of field experiments and Research Laboratories of the institute were carried out by reviewing bodies such as RAC members and by other dignitaries from ICAR, New Delhi. Dr. Mangala Rai, Secretary, DARE and Director General, ICAR, New Delhi also paid a review visit to institute experiments on June 23, 2007. He critically observed the ongoing trials in the field. He stressed the need of organic recycling, vermicompost, in-situ decomposition of sugarcane trash and to ban any form of burning of sugarcane residues. Dr. P.L. Gautam, DDG (Crop Science), ICAR, New Delhi also visited the field experiments and the laboratories in the institute on Nov. 4, 2007. The RAC members also visited the technology demonstration block, labs and workshops.

Dr. Mangala Rai, Secretary, DARE and DG, ICAR, New Delhi inspecting IISR research experiments

Review by Heads of Divisions

Individual on-going research projects are reviewed and discussed threadbare at divisional level prior to the IRC/RAC meeting under the chairmanship of respective Heads of Divisions. The Divisional level progress during the year 2006-07 and Action Taken Report on the recommendations of IRC-2006 were presented by respective HODs. The Action Taken Report (ATR) on the recommendations of the previous RAC meeting, pertaining to the division, was also prepared by respective Heads of Divisions for presentation in the meetings. In addition, HODs also help scientists in fine-tuning and providing a brief write-up on output/outcome of each research project for IRC/RAC meetings as well as to facilitate reporting, both internal and external.

Research Project File Review

The individual research project files are maintained in RCM unit of the institute and an overview of all the research projects is prepared and presented at the outset of IRC meeting for the information of the house. The institute as on March 31, 2008 was having a total scientific strength of 71 scientists (32 Pr. Scientist including Director, 32 Sr. Scientists, 1 Scientist (SG), 5 Scientist (SS) and 1 Programme Coordinator) and they were working on 94 research projects. Out of these 94 research projects, 53 were institute projects, 24 AICRP projects, 8 Externally-aided projects, 2 Network projects and 7 contract research projects as per details below:

Division	Institute Projects	AICRP Projects	Externally Aided	Network	Contractual	Total
Crop Improvement	13	2	1	1	-	17
Crop Production	10	7	1	-	3	21
Plant Phy. & Biochem	3	-	2	-	-	5
Crop Protection	11	9	1	1	4	26
Agril. Engineering	8	6	1	-	-	15
Eco/stat/com.	6	-	-	-	-	6
Ag. Meteorolgy	2	-	2	-	-	4
Total	53	24	8	2	7	94

Institute Management Committee (IMC)

The Institute management committe with the following composition met on September 21, 2007 for its 28th meeting. The regular agenda pertaining to annual budget and other administrative activities. In addition, the construction of Administrative Building and sub-station building of KVK, Lucknow, repair and maintenance of R&T lab were also discussed.

Representation	Name	Designation
Director the Institute	Dr. R.L. Yadav	*ex-officio* Chairman
Representative of U.P. Govt.* (Cane Commissioner)	-	Member
Representative of other State Govt.*	-	Member
SAU representative **	-	Member
Non-official members	1. Sri Krishna Pal Singh Rathi 2. Sri Anil Chowdhary	Member Member
Scientists of ICAR Institutes nominated by DG, ICAR	1. Dr. Ashok Kumar Shrivastava, (IISR, Lucknow) 2. Dr. S. Sundra, SBI, Coimbatore 3. Dr. Raman Kapur, IISR, Lucknow 4. Dr. Shive Kumar, IIPR, Kanpur	Member
ICAR representative	–	Member
Financial Advisor / Account officer nominated by President	Smt Neelum Chandra, FAO, IVRI, Izatnagar Bareilly (U.P.)	Member
Others	1. Dr. D.V. Yadav, Head, Crop Production 2. Dr. S.K. Gangwar, I/c Head, Crop Protection 3. Dr. Jaswant Singh, Head, Agri. Engg. 4. Dr. R.K. Singh, Programme Coordinator, KVK	Special Invitees
Administrative Officer of the Institute	Sr. Administrative Officer	*ex-officio* Member-Secretary

*Cane Commissioner, Uttarakhand, ** Director of Research, NDUA&T, Kumarganj, Faizabad

Institute Joint Staff Council (IJSC) Meeting

The IJSC met twice on 25.07.2007 and 14.12.2007 with the following composition.

Dr. R.L. Yadav, Director,	Chairman
Members Selected	**Members Nominated**
Sh. Someshwar Mishra, T-5	Sr. A.O.
Sh. A. M. Srivastava, Asstt.	AF&AO
Sh. Ashrit Kumar Singh, T-3	Dr. A.K. Sharma, Sr. Scientist
Sh. Shiv Kumar Soni, Grade-II	Smt. Sneh Lata Barjo, Asstt.
–	Sh. Hans Raj, SS Grade-III
Sh. Rajender Kumar, SS Grade-I (Member-Secretary)	Sh. G.K. Singh, T-6 (Member-Secretary)

The main emphasis in the meeting was laid on the revival and reconstitution of Institute Co-operative committee. The modalities ensuring adequate drinking water supply in official premises was also discussed. Some matters pertaining to administration were also discussed.

Institute Technology Management Committee (ITMC).

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 constituted on Jan 12, 2007 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. Archna Suman, Sr. Scientist (Microbiology)- Member

4. Dr. A.K. Shrivastava HOD(PPB)- Member
5. Dr. A.C. Srivastava, Pr. Scientist- Member
6. Dr. A.K. Sharma, Sr. Scientist (Ag. Econ.)- Member
7. Dr. D.V. Yadav, Pr. Scientist & I/c RCM, I/c HOD (Crop Production)- Member-Secretary

Monitoring of Seed Production Activities

Review meeting under the Chairmanship of the Director were held to October 19, 2007 and December 5, 2007 to monitor seed cane production activities in the institute farm. The ways to fast multiplication of the seed cane of CoLk 94184 sugarcane variety through improved methods such as STP was emphasized. It was also decided that 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, Motipur (Bihar) was also emphasized.

Review of information management system

The importance of an efficient information management system for a research institute hardly needs any emphasis. The information management system of the institute is gradually being improved upon. IISR Website is regularly updated for IISR research projects, technologies, achievements, tender notifications, Seminar / Symposia, staff list and cadre strength, RTI replies, etc. The Institute Information Bank is updated regularly in E-Book form. The bio-data of employees and staff position is also updated on regular basis every month. During the year, a Hit Counter program has been added on the institute website to have day to day visit information of the site. Information KIOSK software on Touch Screen Information KIOSK system has also been test configured.

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 2007-08 were constituted / reconstituted on May 10, 2007. The meetings of these committees were held as per need of the task.

Policy, Planning & Expenditure

1. Dr. D.V. Yadav – Chairman
2. Dr. P.K. Singh
3. Dr. R.P. Verma
4. I/c KVK
5. SAO
6. AFAO

Purchase Advisory Committee

1. Dr. D.V. Yadav - Chairman
2. Er. M.P. Sharma
3. Dr. (Mrs.) Archna Suman
4. Dr. D.K. Pandey
5. SAO
6. AFAO

Farm Advisory Committee

1. Dr. Menhi Lal – Chairman (upto 31.01.2008)
2. D.V. Yadav- Chairman (w.e.f. 1.2.2008)
3. Shri. M.P. Sharma
4. Dr. R.S. Chauhan
5. Sri S.C. Mishra
6. Dr. J. Singh
7. SAO
8. AFAO
9. Farm Manager

Human Resource Development

1. Dr. A.C. Srivastava – Chairman
2. Dr. S. Solomon
3. Dr. (Ms) Pushpa Singh
4. Dr. Arun Baitha
5. SAO
6. AFAO
7. AAO (Adm.I)

IISR Publication & Library Committee

1. Dr. D.V. Yadav – Chairman
2. Dr. S.K. Sharma
3. Incharge, Library
4. Dr. S.K. Duttamajumder
5. SAO
6. AFAO

Works Committee

1. Dr. Jaswant Singh– Chairman
2. Dr. S.R. Prasad
3. Dr. R.S. Chauhan
4. SAO
5. AFAO
6. Sh. M.H. Ansari

Security & Vigilance Committee

1. Dr. Sukhraj Prasad – Chairman
2. Dr. A.K. Singh (Agron)
3. Capt. RAS Yadav
4. SAO
5. AFAO

Transfer of Technology

1. Dr. Menhi Lal – Chairman (up to 31.1.2008)
2. Dr. D.V. Yadav (w.e.f. 1.2. 2008)
3. Dr. R.P. Verma
4. Dr. S.N. Singh
5. All HODs
6. I/C, KVK
7. I/C RCM

Staff Welfare Committee

1. Dr. Sukhraj Prasad – Chairman
2. I/C Maintenance
3. Dr. M.R. Singh
4. Dr. K.P. Singh
5. Capt. R.A.S. Yadav
6. Dr. S.K. Sethi
7. Secretary, IJSC
8. SAO
9. AFAO

Grievances Cell

1. Dr. O.K. Sinha – Chairman
2. Dr. Todi Singh
3. Dr. Sangeeta Srivastava
4. SAO
5. AFAO

Women Cell

1. Dr. Sunita Lal – Chairman
2. Dr. Radha Jain
3. Smt. S.L. Barjo
4. Smt. Anita Sawnani
5. SAO

Contract Research Consultancy

1. Incharge, RCM – Chairman
2. Dr. A.D. Pathak
3. Dr. P.K. Singh
4. Dr. Archna Suman
5. AFAO

Event Coordination Committee

Er. M.P. Sharma – Chairman
Dr. D.V. Yadav
Dr. Ishwar Singh (Physiology)
Dr. J. Singh
SAO

Sports Committee

Dr. Raman Kapoor – Chairman
Dr. R.S. Chauhan
Dr. P.R. Singh
Dr. Pushpa Singh
SAO
Secretary, IJSC
Secretary, Recreation Club

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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, national seminars, and interfaces with the industry were also organized in the institute to help the scientists in developing better communication, skills interactions and also in focusing their research efforts in the priority areas.

Dr. R.L. Yadav, Director of the Institute himself took keen interest in initiating a number of activities on varied aspects ranging from personality development, spiritualism which may lead to an improvement in the work culture of the Institute. One exclusive human resource development committee has also been constituted to encourage and streamline HRD activities in the Institute. The participation of scientists / staff during the year is given below :

A) Mass participation of scientists at Lucknow

Name of Scientists	Topic/Subject	Place	Date
All scientist	Interaction Meeting with Australian Delegation visiting IISR, Lucknow	IISR, Lucknow	Apr.19-20, 2007
Drs. R.L. Yadav, O.K. Sinha, Raman Kapur, J. Singh and P.K. Singh	VIII Meeting of Task Force II for 'Finalization of DUS test guidelines, special tests and agronomic practices of sugarcane, linseed and sesame	IISR, Lucknow	Sep.11-12, 2007
All scientists of the institute	National Symposium on Seed Cane. Organised by Association of Sugarcane Tchnologists of India and The Indian Institute of Sugarcane Research, Lucknow.	Indian Institute of Sugarcane Research, (IISR), Lucknow.	Sep. 27-28, 2007
Drs. O.K. Sinha, Dr. B.L. Singh and Dr. Om Prakash and all scientists working on AICRP(s) projects	Group Meeting of AICRP on Sugarcane	College of Agriculture (MPKV), Pune	Oct. 9-11, 2007
Drs. R.L. Yadav, R.L. Yadav, D.V. Yadav, R.L. Yadav, R. P. Verma, A.K. Sah, Kamta Prasad, S.N. Singh, A.D. Pathak, Sanjeev Kumar, Jaswant Singh, S.I. Anwar, P.K. Bajpai, Rajesh Kumar, S.R. Prasad, Om Prakash, S.S. Hasan, Er. Rajendra Gupta and Er. Dilip Kumar	Bhartiya Krishi Anusandhan Samiti's 10th National Scientific Symposium on "Vashvikaran ke Paripreksh ya mein Krishi evam Sambandhit Utpadon ki Gunatmak Vradhi evam Sanrakshan hetu Bhavi Sodh Dikshayein.	IISR, Luknow	Oct. 26-28, 2007
Dr R.K. Singh, V.K. Singh, Ms. R.K. Singh & Om Prakash	Farmers-Scientist Interaction workshop	UPCAR, Lucknow	Feb. 17, 2008

B) Individual participations of the scientists

Dr. R.L. Yadav	Review and planning meeting under USAID/ USDA	NAS Complex, New Delhi	Apr. 5-8, 2007
	National seminar on organic agriculture scopeof posterity	UPCAR, Lucknow	Jul. 13-14, 2007
	National Symposium on Pulses	IIPR, Kanpur	Nov. 3-6, 2007
	South Conference 2008 Science based agricultural transformation towards alleviation of hunger and poverty in SAARC countries	NAS Complex, New Delhi	Mar. 5-7 2008

Division of crop Production

Dr. D.V. Yadav	National Seminar on Organic agriculture: Hope of Posterity	U.P. Council of Agricultural Research, Lucknow	Jul. 13-14, 2007
	Schreening-cum-Technical Committee for National Awards for R&D efforts in Industry-2007	Ministry of Science & Technology, Technology Bhavan, New Delhi	Aug. 7, 2007
	Workshop on Rajbhasha Hindi	NAARM, Hyderabad	Sep. 4-6, 2007
	National Seminar on Sustaining Soil Health for Higher Crop Productivity	UPCAR, Lucknow	Oct. 30-31, 2007
	National seminar on Varietal Planning for Improving productivity and Sugar Recovery in sugarcane	GBPUA&T, Pantnagar	Feb. 14-15, 2008
Dr. S.K. Shukla	National Seminar on Organic agriculture: Hope of Posterity	U.P. Council of Agricultural Research, Lucknow	Jul. 13-14, 2007
	National Seminar on “Sustaining Soil Health for Higher Crop Productivity” organized by Krishi Evam Gramin Vikas Sewa and KRIBHCO	UPCAR, Lucknow,	Oct. 30-31, 2007
	National seminar on Varietal Planning for Improving productivity and Sugar Recovery in sugarcane	GBPUA&T, Pantnagar	Feb. 14-15, 2008
Dr. S.N. Singh	National Seminar on “Sustaining Soil Health for Higher Crop Productivity” organized by Krishi Evam Gramin Vikas Sewa and KRIBHCO.	UPCAR, Lucknow,	Oct. 30-31, 2007
	Group discussion on “Management of agricultural informations and dissemination”	NBFGR, Lucknow	Aug. 18, 2008
Dr. R.P. Verma	Scientific Advisory Committee Meeting of KVK, Hydergarh, Barabanki	KVK, Hydergrah	May 21, 2007

Division of Crop Improvement

Dr. Raman Kapur	Horticulture Summit- 2007	CISH, Lucknow (at CMS, Lucknow)	Jun. 16, 2007
	Group Meeting of All India Coordinated Research Project on Sugarcane	Agriculture College, MPKV, Pune	Oct. 9-11, 2007
	Annual Review Meeting of AP Cess Network Project on "Developing Agro-techniques for Tropicalized Sugarbeet in India	VSI, Pune	Oct. 12, 2007
Dr. A.D. Pathak	Annual Review Meeting of AP Cess Network Project on "Developing Agro-techniques for Tropicalized Sugarbeet in India	VSI, Pune	Oct. 12, 2007
Dr. J. Singh	Zonal Breeders' Meet'	Sugarcane Research Institute, RAU, Pusa, Samastipur, Bihar	Jan. 22, 2008
Dr. P.K. Singh	Management of Agricultural Information and Dissemination – Role of DIPA'	NBFGR, Lucknow	Aug. 18, 2007
	Round Table Discussion on 'Annual Fee part of Gene Fund'	GBPUA&T, Pantnagar	Sep. 7-8, 2007
	VIII Meeting of Task Force II for 'Finalization of DUS Test Guidelines, Special Tests and Agronomic Practices of Sugarcane, Linseed & Sesame'	Indian Institute of Sugarcane Research, Lucknow	Sep. 11-12, 2007
	Brainstorming Session on 'R & D Priorities for Transformation of Indian Agriculture'	Institute of Agricultural Sciences, B.H.U., Varanasi	Jan. 5-6, 2008
Dr. R.K. Singh	Workshop on sensitization on DST's Women Scientist Scheme (WOS-A)	Gorakhpur	Jun. 20-21, 2007

Division of Crop Protection

S. K. Gangwar	Insect pests of sugarcane and their control to cane development and marketing management	L.B.Shastri Ganna Kisan Sansthan, UP	Jun. 27 & 30, 2007
Arun Baitha	Vth QRT Meeting of Project Director on Biological Control, Bangalore on AICRP on Biological Control of Crop Pests and Weeds	GBPAU&T, Pantnagar	Nov. 19, 2007

Agrometerology

Arun K. Srivastava	Global Climate Change and Sustainable Environment (GCCSE-08),	Babasaheb Bheemrao Ambedkar University, Lucknow	Mar. 4-5, 2008
	Review and Planning Meeting of USAID/ USDA project	RWC office, NASC Complex New Delhi	Apr. 6, 2007
	Review-cum-planning meeting on on "Energy-Water Balance and Crop Growth Monitoring Using Satellite Data" Project	Space Applications Centre (ISRO), Ahmedabad	Apr. 25, 2007
	Workshop Meeting on CAPE/ FASAL Programme	Space Applications Centre (ISRO), Ahmedabad	Aug. 22, 2007

Economics and Statistics

Dr. P.K. Bajpai	61st Annual conference of the Indian Society of Agricultural Statistics	Birsa Agricultural University, Ranchi	November 30 to December 2, 2007
Dr. Rajesh Kumar	61st Annual conference of the Indian Society of Agricultural Statistics	Birsa Agricultural University, Ranchi	November 30 to December 2, 2007
Dr. A.K. Sharma	National Seminar on "Sustaining Soil Health for Higher Crop Productivity" organized by Krishi Evam Gramin Vikas Sewa and KRIBHCO	UPCAR, Lucknow,	Oct. 30-31, 2007
Dr. S.S. Hasan	Two days training programme on "Intelligent Reporting System (IRS)"	IASRI, New Delhi	Sept. 10-11, 2007
	CAS Training Programme on "Spatial and Non-Spatial Information Management and Mining in Agriculture"	IASRI, New Delhi	Nov 13, 2007 to Dec 3, 2007

Project Co-ordinating Unit of AICRP on Sugarcane

Dr. O.K. Sinha	2nd Asian Congress on Mycology & Plant Pathology	Osmania University, Hyderabad	Dec. 19-22, 2007
	National Seminar on Varietal Planning for improving productivity and sugar recovery in sugarcane	GBPUAT, Pantnagar	Feb. 14-15, 2008

KVK, Lucknow

Dr. R.K Singh	Mid term review workshop of KVKs	Zonal Coordination unit, Zone IV, CSAUA&T, Kanpur	May 9- 10, 2007
	Horticulture summit-2007	Confederation of Indian Horticulture and Central institute of subtropical horticulture	Jun. 16-19, 2007
	Zonal workshop of KVKs	Zonal Coordination unit, Zone IV and GBPUA&T, Pantnagar, US Nagar	Oct. 26-28, 2007
	Institute Management Committee	IISR, Lucknow	
Dr. V K Singh	Mid term review workshop of KVKs	Zonal Coordination unit, Zone IV, CSAUA&T, Kanpur	May 9- 10, 2007
	Zonal workshop of KVKs	Zonal Coordination unit, Zone IV and GBPUA&T, Pantnagar, US Nagar	Oct. 26-28, 2007
Dr. Om Prakash	Recent Advances in soil & Water Resource Management for Sustainable Management of Degraded Land	Central Soil & Water Conservation Research & Training Institute, Research Centre, Chhalesar, Agra (UP)	Feb. 27-29, 2008

Participation in Refresher Courses

Name of Scientist	Title of the Course	Name of the Organizing Institution	Duration
Kamta Prasad (SS)	Processing, Handling and Storage of Jaggery from Sugarcane	IISR, Luknow	Dec. 10-30, 2007
Er Dilip Kumar	Wnter School on "Processing, Handling and Storage of Jaggery from Sugarcane"	IISR Lucknow	Dec. 10-30, 2007
Dr.V.K.Singh	Winter School on Processing, Handling and Storage of Jaggery from Sugarcane	IISR, Lucknow	Dec. 10-30, 2007

Participation of other staff members

Sri K.P. Yadav, AAO	Training course 'Improving Administrative Efficiency & Financial Management'	NAARM, Hyderabad	Jun. 12-19, 2007

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Workshop, seminars, symposia organized

National symposium on Seed Cane

IISR, Lucknow and Association of Sugarcane Technologists of India (ASTI), Lucknow jointly organised the symposium on Seed Cane from 27-28 September 2007. The symposium was attended by more than 150 delegates. Deep and focused deliberations werer held under 5 technical sessions. Dr. R.K. Chowdhury, ex OSD, DSR& PC (NSP), IARI, New Delhi chaired the session of Seed Act, Seed Standards and Certification; Dr. S.B. Singh, Director, UPCSR, Shahjahanpur chaired the second session on Seed Cane Quality. The session on Seed production technoques was chaired by Dr. D.V. Yadav, PS & I/c RCM, and the session on Management of seed nurseries was chaired by Dr. O.K. Sinha, PC (Sugarcane). Dr. M.L. Agrawal, ex-Addl Director, UPCSR, Shahjahanpur chaired the Session seed multiplication and replacement. In addition to these technical sessions, Poster session was also held under the chairmanship of Dr. A.C. Srivastava.

Dr R.L.Yadav, Director, IISR presenting Memento to chief guest

In his opening remarks, Dr. R.L.Yadav, Director of the Institute outlined the importance of seed cane with the saying "Morning shows the day", so does the seed and emphasised that response and efficiency of all other inputs rest on the seed. Sugarcane has now come under the fold of Seed Act and needs suitable checks and balances at different levels from the production of nucleus seed to the actual use of certified seeds by the farmers. A concept of seed packaging with fortification of plantlets with beneficial microorganisms was visualized.

Form the deliberations, it emerged that seed consciousness has to be revitalized to harness the potential yield. Agribusiness of seed cane has to follow the prescribed seed standards. The methodology for certification and seed testing of sugarcane should be worked out along with the training of manpower. Value addition of seed cane with the fortification of beneficial microorganisms like *gluconacetobactor* (for nitrogen economy) and *Trichoderma* (for increasing tolerance to diseases) should be part of the seed production and distribution scheme. Heat treatment, being the most eco-friendly and effective against several diseases, should invariably be used at nucleus or breeder seed production level. Innovative methods should come to reduce the seed requirement, faster multiplication of seed and to keep the pests and diseases at bay. It also emerged that seed replacement and varietal replacement should be treated as two separate programmes so that apppropriate strategy could be followed locally. It was emphasized that some centrally sponsored scheme should be initiated to coordinate the seed cane production activities in an organised manner throughout the country and a need for active participation of research institutes, cane development departments and the sugar-mills, besides the involvement of farmers was required.

Workshop of AICRP on Sugarcane

The workshop of AICRP on Sugarcane was held at the College of Agriculture (Mahatma Phule Krishi Vidyapeeth), Pune from October 9-11, 2007. The Opening Session was chaired by Dr. R.B. Deshmukh, Vice-Chancellor, MPKV, Rahuri and Dr. D.G. Hapase, Ex-Director (Agri.), Vasantdada Sugar Institute, Pune was the Chief Guest. About 140 delegates were present on the occasion. Dr. S.S. Mehtre, Director of Research, MPKV welcomed the delegates. Dr. O.K. Sinha presented the Annual Progress Report for 2006-07. Dr. K.C. Jain, ADG(CC), ICAR, Dr. R.L. Yadav, Director, IISR, Lucknow and Dr. N. Vijayan Nair, Director, SBI, Coimbatore offered Introductory Remarks. Dr. Lavekar gave special remarks. Inaugural address was presented by Dr. D.G. Hapase and finally Dr. R.B. Deshmukh, Chairman, offered chairman's remarks.

Four technical sessions of Crop Improvement, Crop Production, Pathology and Entomology were held concurrently and concluded on October 10-11, 2007. In Crop Improvement discipline, the session was chaired by Dr. K.C. Jain. Dr. N. Vijayan Nair presented the summary of achievements. Under Fluff Supply Programme, 32.84 kg of fluff was supplied to AICRP centres for raising of seedlings. A total of 27 genotypes were found promising in all the 5 agro-climatic zones. For evaluation in zonal varietal trial, 34 early and 38 mid-late entries were accepted.

A meeting of Varietal Identification Committee was held under the chairmanship of Dr. K.C. Jain, ADG(CC). Four proposals for variety identification were considered. Only one early maturing variety, CoLk 94184 (Birendra) was identified for cultivation in North Central Zone. The variety has recorded cane yield of 75.97 t ha^{-1}, commercial cane sugar (CCS) of 9.28 t ha^{-1} and sucrose of 17.97%. It is moderately resistant to red rot, smut and wilt.

In Crop Production discipline, the session was chaired by Dr. R.L. Yadav. The progress report was presented by Dr. S.K. Saini, P.I. It was found that sugarcane production can be sustained through Integrated Nutrient Management. SSP and DAP were equally effective as sources of phosphorus @ 60-80 kg P_2O_5 ha^{-1} and is compatible with $ZnSO_4$ applied @ 20-30 kg ha^{-1}. Pre-planting tillage operations can be economized to the extent of 50% by using rotavator twice over conventional tillage in late planted crop. Two new experiments viz., Effect of sub-soiling on cane productivity and economy of seed cane in sugarcane culitivation were formulated.

In Pathology discipline, the session was chaired by Dr. P. Padmanabhan, Head, Crop Protection Division, SBI, Coimbatore. The progress report was presented by the P.I. Varieties resistant to red rot, smut and wilt were identified. Molecular characterization of eleven pathotypes of red rot pathogen indicated that these can be grouped in three clusters. For rust management, propineb (0.25%) was found effective.

In Entomology discipline, the session was chaired by Dr. A.S. Patil, VSI, Pune. Progress report was presented by Dr. M.B. Patel. Varieties were evaluated against major insect pests. Technology for mass multiplication of bioagents was developed. Mass multiplication and release of *Dipha aphidivora* effectively controlled woolly aphid. White fly incidence is on increase in some states. New project on 'Population dynamics of sugarcane borers through pheromone trap' was formulated.

Under SUBACS Scheme, a Technical Session on Review of Frontline demonstration and Breeder Seed Production was held under the chairmanship of Shri Virendra Singh, Director I/C, Directorate of Sugarcane Development, Lucknow. Frontline demonstrations of several technologies were conducted in 130 ha at AICRP centres. A total of 2500.81 tonnes and 39.98 lakh setts of seed cane were produced under Breeder Seed Production.

Plenary session was chaired by Dr. K.C. Jain, ADG(CC), ICAR. He laid emphasis on advance planning of cross combinations and more efforts on seedling survival. He urged for developing water-logging resistant varieties and low cost technology. The meeting ended with a vote of thanks proposed by the Project Coordinator.

Group meeting on red rot management

A group meeting was organised at IISR, Lucknow on May 5, 2007 to discuss the management of red rot in relation to the use of *Trichoderma* as the key agent of biological control. Prof.U.S. Singh GBPAU&T, Pantnagar and Dr. Pratibha Sharma, Principal Scientist, IARI, New Delhi were invited to share their rich experience in this regard. The meeting was attended by 16 scientists. Dr. S.K. Duttamajumder presented a brief outline of red rot disease cycle and Dr. Vijay Singh presented the progress of ongoing

experiments on bio-control of red rot. In depth discussion ensued to improve upon the management strategy and how to increase the efficiency of bicontrol system. It was proposed to follow a consortium approach using *Trichoderma* as the main constituent and other antagonistic micro-organisms against red rot like *Pseudomonas*, *Bacillus*, etc. to increase the overall efficiency. Similarly, it was also suggested that a mass multiplication and delivery system of *Trichoderma* and *Pseudomonas* should be developed and evaluated, taking due account of the available resources at the disposal of a marginal farmer.

Annual Review Meeting of AP Cess Network Project on Sugar-beet

Annual Review Meeting of AP Cess Network Project on "Developing Agro-techniques for Tropicalized Sugarbeet in India" was held at VSI, Pune on October 12, 2007. The project has been extended up to July 2008 to fine-tune the package of practices for sugarbeet cultivation for the tropical agro-climate.

DUS Task Force meeting

VIII Meeting of Task Force II for 'Finalization of DUS Test Guidelines, Special Tests and Agronomic Practices of Sugarcane, Linseed & Sesame' was held at Indian Institute of Sugarcane Research, Lucknow on September 11-12, 2007, under the Chairmanship of Dr. Y.S. Nerkar, Ex-Director (Agril Research & Extension), Vasantdada Sugar Institute, Pune.

Panel Discussion on Contract and Corporate farming

A panel discussion was organized on contract and corporate farming under the Chairmanship of Dr. R.L. Yadav on July 11 2007. Panel of experts were Dr. R.S. Verma, Dr. Ashwani K. Sharma, Dr. R. K. Singh and Dr. A.K. Sah. With the globalization and commercialization of agriculture, contractual farming has become the talk of the day. More and more farmers are getting attracted to these new opportunities without understanding the pitfalls and long term effect on the soil and biosphere. A general consensus emerged that a balanced approach towards contract and corporate farming has to be followed to guard the larger interest of majority of Indian farmers who are either small or marginal.

Pustak Lekhan Paricharcha

A discussion on how to write a scientific book was organised at IISR, Lucknow on 15 May, 2007. Prof. A. N. Mukhopadhayay, an Ex.-VC. AAU, Jorhat chaired the meeting. Prof. C.P.S. Yadav, DG, UPCAR, Lucknow was the Chief Guest. Scientists from IISR and other Institutes based in Lucknow participated in the discussion.

On this occasion, a book written in Hindi entitled *'vaigannik vidhi se ganne ki kheti'* by Dr. R.L. Yadav, published by ICAR, New Delhi was also released. This book deals with scientific method of sugarcane farming in a lucid way and in the common language of the farmer. This book is divided into seven chapters dealing with the importance of sugarcane farming, post harvest management, cane quality, cane purchase system including the system of cane pricing, future policies and management.

Hindi Saptah / Pakhwara

"Hindi Saptah" was observed from 14-21 September, 2007 during which various programmes were organised to encourage use of Hindi in day- to-day office working and scientific communications. Several competitions involving the staff members across the categories were held. Director, IISR distributed the prizes. In his address, he urged that one should get oneself totally involved to increase the use of Hindi in different spheres of life.

Hindi Week Celebrations at IISR, Lucknow

Farmer's Visits

Farmers in groups regularly visit IISR to acquaint themselves with the latest technologies of

sugarcane farming and to identify possible solutions of their immediate problems. During this period, 190 farmers visited IISR from different parts of UP State / India

Vigilance Week

Vigilance week was observed at the Institute with the aim to be vigilant and to work for the growth and reputation of the Institute.

Events

Independence Day and Republic Day were celebrated by the staff along with their family members. Intra-institutional games were held to mark these occasions. Dr. R.L. Yadav, Director of the Institute distributed prizes to the winners of games and felicitated them. Saplings of trees were planted to celebrate Independence Day.

Dr. R.L.Yadav, Director participating in tree plantation drive carried out on Independence Day

Felicitation of Meritorious children of staff.

The wards of institute employees topped UP Board Senior Secondary Examination for the year 2005-06 and 2007-08 and third position in 2006-07. These children and their parents were felicitated.

Dr. R.L. Yadav, Director along with UP Senior Secondary Board Exam Topper wards of Institute Staff Members

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Distinguished visitors

Dr. Mangala Rai, DG, ICAR and Secretary, DARE visited the Institute on June 23, 2007. He critically observed the ongoing trials and other research activities. He reviewed the ongoing renovation works and addressed all the staff members of the Institute. He provided important guidance and other suggestions on the direction of the research, new challenges and their solutions, human resource development and value addition of outputs and services.

Dr. Mangala Rai, Secretary, DARE & DG, ICAR, New Delhi addressing IISR scientists and staff members

Dr. C.D. Mayee, Chairman, ASRB, New Delhi, visited different laboratories and engineering workshop on July 14, 2007. He interacted with scientists and made an address to them regarding ICAR/ASRB recruitment policies and career advancement policies.

Dr. C.D. Mayee, Chairman, ASRB interacting on farm equipments developed by the Institute.

A three-member Australian team of scientists headed by Dr. Nils Berding of Crop Improvement Division, BSES Limited, Meringa, Dr. Philip Jackson, Plant Industry, CSIRO and Dr. Prakash Lakshmanan, BSES Limited, Gordonvale visited IISR from 19-20 April, 2007. The delegation made presentation on Australian Sugar Industry Biotechnology Research, and interacted with IISR Scientists and suggested a framework for Australia-India sugarcane research collaboration. The team was on a study visit to explore the opportunities of a joint venture in sugarcane breeding and other areas of collaborative research.

Dr. P.L. Gautam, DDG (Crop Science), ICAR, New Delhi visited the institute on November 4, 2007 and addressed the scientists.While lauding the efforts made by the Institute, he cautioned the scientists of

the ensuing challenges and emphasized to work by following a very systematic research strategy.

Dr. Chandrika Prasad, Director General, UP Council of Agriculture Research visited on May 15, 2007. He released a book in Hindi "Vaigayanic Vidhi Se Ganne Ki Kheti" by Dr. R. L. Yadav.

Dr Basant Ram, Vice Chancellor, RAU, PUSA, Bihar visited on July 26, 2007 along with other scientists from the University to better and interacted to frame appropriate research programmes for the University.

Mr. Subodh Kant Sahay, Minister of Food Processing, Govt. of India on February 19, 2008.

Prof D.P.S. Verma, Chairman, Technical Advisory Committee (TAC) on September 22, 2007

Prof. D.P.S. Verma & Smt. Vandana Dwivedi at IISR, Lucknow

Ms. Vandana Dwivedi, Joint Advisor (Agri.), Planning Commission, Government of India on September 22, 2007

Sri A.K. Upadhaya, Secretary, ICAR visited the Institute on September 6, 2007 and addressed all the employees of the Institute

Dr. V.J. Verghese, Director, CPCRI : June 1-8, 2007

Dr. Nawab Ali, DDG, Agriculture Engineering, ICAR, New Delhi, August 11, 2007

Dr. R. T. Patil, Director, CIPHET, Ludhiana, August, 11, 2007

Dr. Pitam Chandra, ADG (Processing Engineering), ICAR, New Delhi, June 16, 2007

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Infrastructure development

The infrastructure created during the year 2007-08 consists of the works as follows :

Sl. No.	Work item	Amount * (Rs. in Lacs)	Agency to whom work allotted
1.	Renovation of Guest House (Replacement of wiring and fittings)	6.00	CPWD
2.	Renovation of Guest House (Kitchen & related works)	10.44	CPWD
3.	Renovation of Agronomy building	(i) 5.00 (ii) 2.69	CPWD
4.	Renovation of Soil Science labs.	5.00	CPWD
5.	Renovation of first floor of Administrative Building	5.00	CPWD
6.	Construction / fabrication of net house	11.19	Other party
7.	Other items		
	a) Electirc wiring of main office at Regional Centre, Motipur (Bihar)	1.49	CPWD
	b) Face lifting (granite flooring)	2.49	CPWD
	c) Renovation of Pathology Building	3.92	CPWD
	d) Repair of broken Boundary wall	0.68	CPWD
	e) Repair of roof of glass-house	3.85	CPWD
	f) Repair of roof of fertilizer / pesticide farm store	0.75	Other party.
	g) Pre fabricated labs**	3.49	Other party

Note: * The expenditure has been met out of Non-Plan Budget. ** The source of funding is other than Non-Plan Budget.

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Personnel (as on March 31, 2008)

Director	:	Dr. R.L. Yadav
Administration		
Senior Administrative Officer	:	Sri Rajeev Lal
I/c, Asstt. Finance & Accounts Officer	:	Sri Shatruhan Kumar
Drawing & Disbursing Officer	:	Sri Manna Lal
Asstt. Administrative Officer	:	Sri Manna Lal
	:	Sri R.K. Khanna
	:	Sri Shatruhan Kumar
	:	Sri K.P. Yadav
Security Officer	:	Capt R.A.S. Yadav
Research Coordination and Management		
Principal Scientist & Incharge	:	Dr. D.V. Yadav
Senior Scientist (Ag. Econ.)	:	Dr. Ashwani K. Sharma
Technical Officer	:	Sri Mahendra Singh
	:	Sri G.K. Singh
Crop Production		
Principal Scientist & I/c, Head	:	Dr. D.V. Yadav
Principal Scientist (Soil Chem./Fer./	:	Dr. D.V. Yadav
Microbiology)	:	Dr. P.N. Singh
Principal Scientist (Agronomy)	:	Dr. S.R. Prasad
	:	Dr. R.S. Verma
	:	Dr. R.S. Chauhan
	:	Dr. Arjun Prasad
		Dr. S.N. Singh
Principal Scientist (Agril. Extension)	:	Dr. Ram Pal Verma
	:	Dr. (Mrs.) Hem Pandey
Senior Scientist (Agronomy)	:	Dr. K.P. Singh
	:	Dr. S.K. Shukla
	:	Dr. A.K. Singh
	:	Dr. Ishwar Singh
Senior Scientist (Soil Chem./Fer./Microbiology)	:	Dr. Todi Singh
Senior Scientist (Microbiology PS)	:	Dr. (Smt.) Archna Suman
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 & I/c, Head	:	Dr. Ashok K. Shrivastava
Principal Scientist (Biochemistry PS)	:	Dr. S. Solomon
Senior Scientist (Plant Physiology)	:	Dr. R.K. Rai
	:	Dr. (Smt.) Radha Jain
Senior Scientist (Biochemistry PS)	:	Sri Raman Banerjee
Senior Scientist (Organic Chemistry)	:	Dr. Pushpa Singh
Technical Officer	:	Dr. (Smt.) Namita Arya

	:	Smt. Anita Sawnani
	:	Sri Ram Darash
	:	Sri S.P. Shukla
Crop Improvement		
Principal Scientist & Head	:	Dr. Raman Kapur
Principal Scientist (Plant Breeding)	:	Dr. R. Kumar
Senior Scientist (Plant Breeding)	:	Dr. D.K. Pandey
	:	Dr. Jyotsendra Singh
	:	Dr. A.D. Pathak
	:	Dr. P.K. Singh
	:	Dr. Sanjeev Kumar
Senior Scientist (Gen. & Cytogenetics)	:	Dr. (Smt.) Sangeeta Srivastava
	:	Dr. R.K. Singh
Scientist SS (Genetics)	:	Dr. M. Swapna
Technical Officer	:	Smt. Hem Lata Madhok
	:	Sri Ram Hit
	:	Sri V.K. Saxena
	:	Sri Ram Kumar
	:	Smt. Pramila Lal
		Sri L.K.Lama
	:	Sri Ram Sewak
Crop Protection		
Principal Scientist & I/c, Head	:	Dr. S.K. Gangwar
Principal Scientist (Plant Pathology)	:	Dr. Vijay Singh
	:	Dr. S.N. Srivastava
	:	Dr. A.P. Singh
	:	Dr. Ram Ji Lal
	:	Smt. Sunita Lal
Principal Scientist (Agril. Entomology)	:	Dr. D.C. Srivastava
	:	Dr. R.K. Tewari
Senior Scientist (Plant Pathology)	:	Dr. S.K. Duttamajumder
Senior Scientist (Agril. Entomology)	:	Dr. G.M. Tripathi
	:	Dr. Maharam Singh
	:	Dr. Arun Baitha
Scientist S.G (Plant Pathology)	:	Sri S.C. Misra
Technical Officer	:	Sri R.B. Jadhav
	:	Dr. S.K. Awasthi
	:	Dr. D.C. Rajak
	:	Sri Sanjay Bhatnagar
	:	Sh. B.B. Joshi
	:	Sri Amar Nath
	:	Sri Niranjan Lal
	:	Sri M.P. Sharma
	:	Sri I.P. Maurya
Agril. Engineering		
Principal Scientist & Head	:	Dr. Jaswant Singh

Principal Scientist (Farm Mach. & Power)	:	Er. M.P. Sharma
	:	Dr. A.C. Srivastava
	:	Dr. P.R. Singh
Principal Scientist (Elec. & Instr.)	:	Sri R.K. Pangasa
Senior Scientist (Soil Water Con. Engg.)	:	Er. Rajendra Gupta
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 Sharif Ahmad
	:	Sri Rajendra Singh
Economics/Statistics/ARIS Cell		
Principal Scientist & I/c	:	Dr. P.K. Bajpai
Senior Scientist (Agril. Statistics)	:	Dr. Rajesh Kumar
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	:	Mrs. Archna Suman
Training Unit		
Principal Scientist and I/c	:	Dr. D.V. Yadav
Principal Scientist (Agril. Extension)	:	Dr. R.P. Verma
Technical Officer	:	Sri A.K. Singh
AICRP on Sugarcane		
Project Coordinator	:	Dr. O.K. Sinha
Principal Scientist (Agronomy)	:	Dr. B.L. Singh
Senior Scientist (Agril. Entomology)	:	Dr. Om Prakash
Technical Officer	:	Dr. J.K.S. Gautam
	:	Sri Adil Zubair
Farm		
Scientist Incharge	:	Dr. D.V. Yadav
Farm Manager	:	Sri S.K. Pal
Technical Officer	:	Sri Nar Singh

	:	Sri Ramayan Singh
	:	Sri Raghvendra Kumar
	:	Sri Jiyawan Ram
	:	Sri Satya Narayan
	:	Sri B.B. Singh
Krishi Vigyan Kendra		
Principal Scientist & Incharge	:	Dr. S.R. Prasad
Programme Coordinator	:	Dr. R.K. Singh
Technical Officer	:	Dr. V.K. Singh
	:	Dr. Om Prakash
	:	Smt. Mithilesh Tiwari
Hindi Unit		
Principal Scientist & I/c	:	Dr. D.V. Yadav
Arts & Photography		
Scientist Incharge	:	Dr. D.V. Yadav
Technical Officer	:	Sri Vipin Dhawan
	:	Sri Y.M. Singh
	:	Sri J. Ganguli
Dispensary		
Principal Scientist & I/c	:	Dr. S.R. Prasad
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. Archna Suman / Dr. Pushpa Singh
Technical Officer	:	Smt. Asha Gaur
	:	Smt. Meena Nigam
Incharge, Vehicles	:	Sri K.P. Yadav
Consultancy Cell		
Scientist Incharge	:	Dr. D.V. Yadav
Member	:	Dr. S.R. Prasad
Guest House		
Manager	:	Dr. S.K. Awasthi
Estate		
Officer-In-Charge	:	Dr. Jaswant Singh
Technical Officer	:	Shri M.H. Ansari
IISR Regional Centre, Motipur		
Scientist Incharge	:	Dr. Devender Kumar
Senior Scientist (Agronomy)	:	Dr. V.P. Jaiswal
Senior Scientist (Plant Breeding)	:	Dr. Devender Kumar

STAFF NEWS

Joining

Dr. (Mrs.) Hema pandey, Principal Scientist (Agril Extension) joined IISR Lucknow on transfer from NRC for Women in Agriculture, Bhubaneshwar or 27.11.2007.

Dr. S.N. Singh Principal Scientist joined IISR, Lucknow on transfer from IISR Regional Centre, Motipur , Bihar on 05.11.2007.

Dr. Devendra Kumar, Senior Scientist (Plant Breeding) joined IISR Regional Centre, Motipur , Bihar, on 04.08.2007.

Mr. Rajeev Lal, Sr. A.O. joined on 20.08.2007 after completeting the course work for post Graduation Diploma in Public Policy and Management from MDI, Gurgaon.

Superannuation

During this period the following persons were superannuated from their respective services.

Scientists:

The following scientific manpower superannuated during the period under reference and left the Institute

Dr. Abdul Rashid, Principal Scientist (Agril. Entomology) on 31.7.2007.

Dr. A.N. Singh, Principal Scientist (Plant Breeding) on 31.7.2007

Dr. Mehni Lal, Principal Scientist (Agronomy)and I/C Head , Crop Production on 31.01.2008

Dr. Satrughan Pandey, Principal scientist (Plant Pathology) on 29. 02.2008

Others:

Mr. Hari Lal, Technical Officer on 31.07.2007

Mr. Sajeevan Lal, T3 on 30.11.2007

Transfers/ Relievings

Dr. Ishwar Singh, Senior Scientist (Plant Physiology) transferred to Directorate of Maize Research, ICAR, New Delhi on 28.02.2008

Career Advancement

During this period, the following persons got promotion in their respective service careers w.e.f.:

From Scientist to Scientist(SS)

Er. Dilip Kumar	01.11.2005

From Scientist (SS) to Sr. Scientist, w.e.f.

Dr. Ishwar Singh (Agronomy)	21.05.2005.
Dr. A.K. Sah	12.12.2006.
Dr. M.R Singh	17.12.2006.
Dr. Arun Baitha	20.12.2006.
Dr. Sanjeev Kumar	22.12.2006.

Upgradation of pay scale under ACP scheme , w.e.f.

Km. Maya Agarwal, UDC	03.07.2007.
Smt. Raj Shankar, UDC	15.11.2007.
Sh. Bikram Singh , LDC	09.10.2007.
Sh. Ganesh Prasad Jr. Steno.	18.10.2007

Promoted to Personal Assistant

Smt. Veena Sharma	w.e.f. 16.02.2008

Promoted to Personal Secretary

Shri Rajiv Kumar Arora	w.e.f. 16.02.2008

Promoted to T-4

Shri Anil Kumar Singh	w.e.f. 03.07.2006
Shri C. P. Prajapati	w.e.f. 05.09.2006

Promoted to T-5

Shri Fauzdar Singh	w.e.f. 01.01.2006
Smt. Neelam Singh	w.e.f. 15.10.2006
Smt. Meena Nigam	w.e.f. 01.01.2007
Shri R. K. Singh	w.e.f. 13.03.2007
Shri Umesh Kumar	w.e.f. 18.08.2007
Shri Chaman Singh	w.e.f. 29.09.2007
Shri Surya Deo Singh	w.e.f. 01.01.2008

Promoted to T-6

Shri M. H. Ansari	w.e.f. 24.11.2006
Smt. Anita Sawanani	w.e.f. 27.09.2006
Shri Ram Darash	w.e.f. 01.01.2007
Dr. Om Prakash	w.e.f. 16.12.2007
Shri Vijay Bahadur Singh	w.e.f. 01.01.2008
Shri Surendra Singh	w.e.f. 02.01.2008
Shri L. K. Lama	w.e.f. 14.06.2006

Promoted to T-(7-8)

Shri R. K. Shukla	w.e.f. 01.01.2005
Smt. Hem Lata Madhok	w.e.f. 03.02.2005
Dr. S. K. Awasthi	w.e.f. 03.02.2005
Dr. H. P. Pande	w.e.f. 03.02.2005
Shri Sanjay Bhatnagar	w.e.f. 27.09.2005
Dr. Mani Ram Verma	w.e.f. 01.01.2006
Shri V. K. Singh	w.e.f. 16.03.2007

Promoted to Principal Scientist

Dr. Om Prakash	w.e.f. 01.07.2004
Dr. S. K. Duttamajumder	w.e.f. 27.07.2006
Dr. Rajesh Kumar	w.e.f. 27.07.2006

Necrology

Shri Suraj Singh Yadav, T-5, working in the Division of Crop Protection passed away on 13.05.2007 after prolonged illness.

Dr. Shyama Charan Srivastava, ex Director, IISR, Lucknow left for his heavenly abode on 30.05.2007. He had joined IISR on 14 August, 1962 as Soil Scientist. He was appointed the first Project Co-ordinator (Sugarcane) on 21 October, 1971. He became Director of this Institute on 7 June, 1989. He was a soil science expert of International fame. He devoted his entire career for the betterment of sugarcane and its culture. He was known for his wit, comprehension and razor sharp analytical mind.

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Meteorological data

(Year 2007-08)

Months	Temperature (°C)		RH (%)		Rainfall (mm)	Rainy days	Wind velocity (km/hr)	Duration of Sunshine (h/day)
	Tmax	Tmin	07 Hrs	14 hrs				
Apr. 07	37.9	22.6	56	25	0.0	0	4.8	3.6
May. 07	37.6	24.3	59	36	18.3	2	3.5	4.2
Jun. 07	37.7	27.0	73	47	73.9	3	4.1	4.0
Jul. 07	33.5	26.1	86	69	184.9	10	3.8	2.4
Aug. 07	33.0	25.8	90	73	261.2	9	3.0	2.4
Sep. 07	32.6	24.5	90	66	130.6	8	2.4	3.9
Oct. 07	32.2	18.3	85	41	0.0	0	2.2	4.1
Nov. 07	28.7	12.7	94	42	0.0	0	0.8	0.9
Dec. 07	23.7	8.2	90	39	0.2	0	2.4	1.8
Jan. 08	22.3	7.2	88	38	0.2	0	3.1	2.2
Feb. 08	23.9	8.6	83	34	5.4	1	3.8	4.6
Mar 08	32.4	16.2	72	30	0.0	0	3.9	2.2
Total						33		674.7

Glossary

Abbreviation	Full Form
AAO	Assistant Administrative Officer
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
ATR	Action Taken Report
AVT	Advance Varietal Trial
AWS	Automatic Weather Station
CCS	Commercial Cane Sugar
CEY	Cane Equivalent Yield
CFU	Colony Forming Units
CMA	Corn Meal Agar
CMS	Cytoplasmic Male Stariltiy
Co	Sugarcane Var. Hybridisation & Testing at Coimbatore
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
CoPk	Sugarcane Var. Hybridisation at Coimbatore & Testing at Pratap Kota
Co Pant	Sugarcane Var. Hybridisation at Coimbatore & Testing at Pantnagar
CoS	Sugarcane Var. Hybridisation at Coimbatore Testing at Shahjahanpur
CoSe	Sugarcane Var. Hybridisation at Coimbatore Testing at Seohari
CCT	Controlled Condition Testing
CPP	Covered Pit Planting
CTP	Covered Trench Planting
CSP	Cadre Strength in Position
CTAB	Catyltrimethyl ammonium bromide
CV	Coefficient of Variation
Cv	Cultivar
DAH	Days after Harvest
DAP	Days after planting
DAS	Days after Sowing
DARI	Days after ratoon initiation
DBT	Department of Biotechnology
DDP	Furrow planting after deep disc
DUS	Distinctiveness, Uniformity and Stability
ESTs	Expressed Sequence Tags
Expl.	Exploratory
FIMS	Farm Information Management System
FIRB	Furrow Irrigated Raised Bed
FISH	Fluorescent *in situ* hybridization
FMD	Foot Mouth Disease (Cattle)
FP	Farmers' Practice
FPU	Filter Paper Unit

FSF	Flame Spreader Fins
FYM	Farm Yard Manure
GC	General Cross
GISH	Genomic *in situ* hybridization
HOD	Head of Division
HR Brix	Hand Refractrometer Brix
HRD	Human Resource Development
HS	Highly Susceptible
IAA	Indole Acetic Acid
IAAO	Indole Acetic Acid Oxidase
IAPSIT	International Association of Professionals in Sugar and Integrated Technologies
ICS	Integrated Communication Strategy
IDM	International Department of Meteorology
IDM	Integrated Disease Management
IE(I)	Institute of Engineers (India)
IISR	Indian Institute of Sugarcane Research
IMC	Institute Management Committee
INM	Integrated Nutrient Management
INSEY	In Season Estimate of Yield
IPM	Integrated Pest Management
IRC	Institute Research Council
ISAE	Indian Society of Agricultural Engineering
ISEE	Indian Society of Extension Education
ISEP	Indian Society of Extension Professionals
ISSR	Inter Simple Sequence Repeat
IVLP	Institute Village Linkage Programme
IVT	Initital Varietal Trial
IZVT	Inter Zonal Varietal Trial
KADS	Knowledge Analyis & Design Support
KVK	Krishi Vigyan Kendra
LAI	Leaf Area Index
LAN	Local Area Network
LCC	Leaf Colour Chart
LER	Land Equivalent Ratio
LG	Linkage Group
MHAT	Moist Hot Air Treatment
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPN	Most Probable Number
MR	Moderately Resistant
MS	Moderately Susceptible
MTA	Material Transfer Agreement
NDVI	Normalized Difference Vegetation Index
NAIP	National Agricultural Innovative Programme
NAR	Net Assimilation Rate
NFOA	Nitrogen Fertilization Optimization Algorithm

NHG	National Hybridization Garden
NMC	Number of Millable Canes
NPK	Nitrogen, phosphorus and Potassium
NRA	Nitrate Reductase Activity
NRC	Non-Recurring Contingency
NSI	National Sugar Institute
NUE	Nitrogen Use Efficiency
NR	Nitrate Reductase
NS	Non signficant
NWZ	North West Zone
NCZ	North Central Zone
OMA	Oat Meal Agar
Palewa	Pre-planting or pre-sowing irrigation (local term)
PCR	Polymerase Chain Reaction
PDA	Potato Dextrose Agar
PF	Parallel Fins
PHT	Post-Harvest Technology
Pi	Phoshorus inorganic
PI	Principal Investigator
PLER	Partial Land Equivalent Ratio
PMC	Press Mud Cake
PTO	Power Take Off
QUAT	Quaternary
QTL	Quantitative Trait Loci
PSB	Phosphate Solubilising Bacteria
PVT	Primary Varietal Trial
PT	Preparatory Tillage
R	Resistant
RAC	Research Advisory Committee
RAPD	Randon Amplified Polymorphic DNA
RBD	Randomised Block Design
RC	Recurring Contingency
RCBD	Randomized Complete Block Design
RCM	Research Coordination and Management
RDF	Recommended Dose of Fertilizers
RE	Revised Estimate (Budget)
RF	Radial Fins
RGR	Relative Growth Rate
RH	Relative Humidity
RMD	Ratoon Management Device
RPP	Ring pit planting
RWC	Rice-Wheat Consortium
S	Susceptible
SAI	Soluble Acid Invertase
SMBC	Soil Microbial Biomass Carbon
SOD	Super Oxide Dismutase

SCMV	Sugar Cane Mosaic Virus
SPAD	Soil Plant Analysis Development (Chlorophyll Meter)
SPM	Sulphitation Press Mud
SPMC	Sulphitation Press Mud Cake
SQL	Structural Query Language
SSF	Simultaneous Saccharification and Fermentation
SSP	Single Super Phosphate
SSR	Simple Sequence repeat
STAI	Sugar Technologists' Association of India
STP	Spaced Transplanting
SWA	Sugarcane Woolly Aphid
SCS	Sanctioned Cadre Strength
TA	Traveling Allowance
TMC	Trichoderma mixed culture
TO	Tractor Operated
TOT	Transfer of Technology
TP	Trench Planting
TPC	Total Phenolic Content
UPCAR	Uttar Pradesh Council of Agricultural Research, Lucknow
UPCSR	Uttar Pradesh Council of Sugarcane Research, Shahjahanpur
UPGMA	Unweighted pair-group method of Arithmatic mean
VSI	Vasantdada Sugar Institute, Pune
VC	Vermi Compost
VPN	Vitrual Private Network
WSI	Wilt Severity Index
WHRS	Waste Heat Release System
WCE	Weed Control Efficiency
RAPD	Randomly Amplified Polymorphic DNA
YEM	Yeast extract Mannitol
UDSC	University of Delhi, South Campus

भाकृअनुप
ICAR

भारतीय गन्ना अनुसंधान संस्थान

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