वार्षिक प्रतिवेदन
Annual Report

2008-2009

भाकृअनुप
ICAR

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Preface

India's sugar production was at an all time high level of 28.4 mln tonnes in 2006-07, after 4 years of previous peak production of 20.1 mln tonnes achieved in 2002-03. Sugar production dropped by 2 mln tonnes in 2007-08 and then by more than 10 mln tonnes to 15.5 mln tonnes in 2008-09 by registering an unprecedented fall in any single year. It is, thus, evident that sugar production in India is characterized by ups and downs or the operation of a sugar cycle. Sugar cycle in India typically lasts 2-3 years, as production adjusts to fall in price and which in turn leads to lower supplies, price increase and higher production. The present time sugar cycle in India is moving from excess production in the last couple of years to lower production as there was no significant increase in minimum support price to farmers when compared to other food crops. This excess supply also led to erosion of margins for mill owners leading to delay in payment to farmers thereby providing no incentive to farmers to raise sugarcane cultivation. Though all the producing countries of the world face such situations but Indian sugar cycle is quite violent and it creates instability in a short span of 4 to 5 years. Such unprecedented drop in sugar production in India coupled with an ever rising sugar consumption demand at about 22.5 mln tonnes per year has resulted in making India a net sugar importer from a sugar exporter last year. Managing such unprecedented drops in sugar production and stabilizing its production is the utmost priority of the country at present.

Sugar production in India has a direct correspondence with sugarcane production in India and hence one way to stabilize sugar production is to have vertical increase in sugarcane yield and sugar content in cane from the reduced cane area when downward phase of the sugar cycle is in operation. The Indian Institute of Sugarcane Research, Lucknow has carried out research work in the area of high-sugar varietal development, judicious water management, integrated nutrient management, integrated disease and pest management, biotechnology and mechanization of cultural operations of sugarcane crop in India. The Institute's varietal development efforts culminated this year, into the release of one high-yielding, high-sugar CoLk 94184 variety, best suitable even for risk prone areas. The Institute also gave emphasis on farmers' participatory action orientated research and demonstrated its improved technologies on planting techniques, crop geometry & planting methods, quality seed cane, better ratoon management, nutrient and water management and crop mechanization on farmers' fields. In its mechanization drive, the institute carried out further improvements in its earlier developed equipments & machines. A holistic approach for stabilizing cane and sugar production would require better focus not only in research programmes but also in policy planning and management. In this front, the institute also organized a high-level brainstorming discussion-comprising participants from sugar industry, research organizations and cane/sugar departments to establish reasons for low cane and sugar production in 2008-09, and identified researchable, developmental and policy issues for taking appropriate measures.

The present Annual Report 2008-09, carrying the above description in detail, consists of 23 theme-based chapters. This report is a mirror of all the Institute activities during the year 2008-09 (April-March). Dr. D.V. Yadav, Head, Crop Production Division & I/c, RCM, Dr. Ashwani Kumar Sharma, Sr. Scientist (Agril. Economics), Sri Mahendra Singh, Technical Officer, and Sri D.C. Pant, LDC, RCM deserve appreciation of their sincere efforts in presenting the information nicely and in bringing out this report in time. Thanks are also due to all the Heads of Divisions/Incharges of Sections, and all scientists who provided the information for this report in requisite format.

(R.L. Yadav)
Director

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कार्यकारी सारांश

फसल सुधार शोध

एस. ओफिसिनेरम, एस. बारबरी, एस. साईनेन्स, आई.एस. एच. क्लोन, व्यावसायिक शंकर प्रजातियाँ एवं एस. स्पान्टेनियम के लगभग 230 जीन प्रारूपों का संस्थान में प्रजाति विकास के लिए रखरखाव किया जा रहा है। नये विकसित जीन प्रारूपों को प्रजनन में जनक के रूप में चिन्हित करने के लिए 24 एल.जी. तथा इक्षु आई.एस. जीन प्रारूपों के पौध एवं रस के गुणों का मूल्यांकन किया गया जिसमें से एल.जी. 99114, एल जी 97009 तथा एल.जी. 01118 बेहतर पाये गये।

केन्द्रीय प्रजाति रीलीज समिति ने संस्थान द्वारा विकसित प्रजाति कोलख 94184 (बीरेन्द्र) को उत्तर मध्य क्षेत्र में खेती करने के लिए अधिसूचित कर दिया है। पाँच उच्च शर्करा युक्त अभिजनकों जैसे एल.जी. 02057, एल.जी. 05433, एल.जी. 05434, एल.जी. 05460 तथा एल.जी. 05493 को राष्ट्रीय संकरण उद्यान में सम्मिलित करने एवं उनके प्रजनन गुणों के अध्ययन हेतु भेजा गया है।

वाणिज्यिक गुणों से युक्त तथा लालसड़न रोग रोधी चिन्हित तीन जीन प्रारूपों एल.जी. 02039, एल.जी. 02057, एल.जी. 05447 को स्थानीय परीक्षणों में शामिल किया गया है। इस वर्ष (2008-09) में चिन्हित जीन प्रारूप एल.जी. 01030 ने स्थानीय परीक्षणों में अच्छा प्रदर्शन किया है। कृन्तकों के मूल्यांकन से लगभग 140 का चुनाव किया गया जिनका अगेती उच्च शर्करा संचय अथवा प्रजाति विकास में उपयोग हेतु पुनः आँकलन किया जायेगा।

अग्रिम अवस्था के 10 कृन्तकों का आँकलन किया गया। इनमें से (एल.जी. 2616, एल.जी. 2618 तथा एल.जी. 2619) देरी से बुआई की स्थिति में मानक प्रजाति की तुलना में ज्यादा चीनी का उत्पादन देने में बेहतर पाये गये।

नौ में से दो ह्वैत-जनक शंकरों की सन्तति में यरियन्थस का अंश होने के कारण, चोटी बेधक कीट का तृतीय एवं चतुर्थ अंडसमूह (ब्रूड) में 3.1 से 4.2 प्रतिशत ही प्रकोप पाया गया। कीट के तृतीय अंडसमूह (ब्रूड) के प्रकोप का गन्ने की पत्तियों में कुल कार्बोहाईड्रेट की मात्रा से ऋणात्मक सहसम्बन्ध तथा अवकारक शर्करा तथा प्रोटीन की मात्रा से घनात्मक सहसम्बन्ध पाया गया। एक अन्य अध्ययन में एक कृन्तक एल.जी. 04-043 को स्थानीय परीक्षण में शामिल किया गया। उत्तरी पश्चिमी क्षेत्र के लिए शीघ्र पकने वाली 8 प्रजातियों के अग्रिम प्रजाति परीक्षण के मूल्यांकन में दो प्रजातियाँ, कोपन्त 03220 (गन्ना एवं चीनी उत्पादकता क्रमशः 72.9 एवं 9.29 टन प्रति हेक्टेयर) तथा कोलक 9902 (गन्ना एवं चीनी उत्पादकता क्रमशः 66.9 एवं 9.05 टन प्रति हेक्टेयर) क्रमशः बेहतर पायी गयीं। पेड़ी फसल के 13 प्रजातियों के परीक्षणों में, कोह 05265 एवं कोह 05262 ने प्रारम्भिक प्रजाति परीक्षण (शीघ्र) में मानक प्रजातियों, कोपन्त 84211 एवं कोजे 64 से बेहतर प्रदर्शन किया।

मध्यम देरी से पकने वाली अग्रिम प्रजातियों (पहली बावक) के परीक्षण में 6 जीन प्रारूपों में से कोलक 99271 जीन प्रारूप, मानक प्रजातियों की तुलना में, सबसे ज्यादा गन्ना उपज (89.5 टन प्रति हेक्टेयर) तथा चीनी उत्पादन (10.62 टन प्रति हेक्टेयर) वाला आंका गया है। एक अन्य द्वितीय पौध फसल परीक्षण में मानक प्रजाति कोशा. 767 की तुलना में कोह 130 जीन प्रारूप, तथा पेड़ी फसल के परीक्षण में कोशा. 03261 ने बेहतर प्रदर्शन किया। संस्थान द्वारा विकसित जीन प्रारूप कोलक 08201 को अखिल भारतीय समन्वित गन्ना शोध परियोजना की द्विवार्षिक कार्यशाला में उत्तरी पश्चिमी क्षेत्र में बहु-स्थानीय परीक्षणों के लिए स्वीकृत किया गया। एक उच्च शर्करा युक्त जीन प्रारूप एल.जी. 99270 जो कि लाल सड़न रोग के दो प्रभेदों, सी.एफ. 08 तथा सी.एफ. 09 के लिए सामान्य प्रतिरोधी पाया गया, को एक आनुवंशिक सकन्ध के रूप में चिन्हित कर राष्ट्रीय संकरण उद्यान में प्रयोग हेतु भेजा गया।

गन्ने में प्रौद्योगिकी तरीकों से सुधार

तीन डीएनए आधारित मार्कर प्रणालियों (आरएपीडी, माइक्रोसेटेलाईटस तथा आईएसएसआर) द्वारा 46 सेकरम वर्ग के कृन्तकों तथा 86 गन्ना जीन प्रारूपों का परमाणु सम्बन्धी गुणों का निर्धारण किया गया। दस बहुरूपी प्राइमरों को आगे सप्रमाणता हेतु चिन्हित किया गया। शर्करा जीन्स हेतु ई एस टी सीक्वेन्स से 60 से अधिक बहुरूप प्राइमर तैयार किये गये। चार संकर तथा एक स्वयं सप्रंथकन जनसंख्या विकसित की गयी है। दो कम शर्करा (10-13 प्रतिशत) युक्त प्रवेशकों को प्रसिद्ध पैतृक पंक्तियों के रूप में प्रयोग किया जा सकता है।

गन्ने में 40 ई एस टी-एस एस आर मार्करों को विकसित किया एवं उनकी सप्रमाणता देखी गयी। बत्तीस एसएस मार्करों द्वारा लाल सड़न रोग के प्रति भिन्न-भिन्न प्रतिरोधी क्षमता वाले 30 गन्ना जीन प्रारूपों का अध्ययन विश्लेषण किया जिसमें से एसईएस 594 तथा आईएसएच 150 को लालसड़न रोग रोधी पहचाना गया। ऊतक संवर्धन द्वारा गन्ने में फसल सुधार शोध के लिए लाभदायक सोमाक्लोन्स का प्रजनन में उपयोग प्रारम्भ किया गया है। संस्थान द्वारा हाल ही में विकसित की गई प्रजाति कोलख 94184 की सूक्ष्म-प्रवर्धन द्वारा पौध तैयार करने की तकनीक विकसित की गयी।

पोषक तत्व प्रबन्धन

गन्ना की खेती में नत्रजन की 50 प्रतिशत मात्रा कार्बनिक तथा 50 प्रतिशत मात्रा अकार्बनिक स्रोतों से प्रयोग करने पर 65.2 टन प्रति हे. गन्ना एवं 7.49 टन प्रति हे. चीनी उत्पादकता आँकी गयी जो कि अकार्बनिक स्रोतों से ही 100 प्रतिशत नत्रजन की मात्रा प्रयोग करने की तुलना में काफी ज्यादा पायी गयी। कार्बनिक स्रोतों से नत्रजन की मात्रा की पूर्ति करने से सीधे तौर पर मृदा उत्पादकता में वृद्धि आँकी गयी।

गन्ना आधारित बावक फसल-पेड़ी-पेड़ी गेहूँ-धान के फसल चक्र में, केवल नत्रजन के प्रयोग मात्र से ही गेहूँ उत्पादकता में 271 प्रतिशत तथा धान उत्पादकता में 59.2 प्रतिशत की वृद्धि आँकी गयी। नत्रजन के साथ फास्फोरस, पोटाश और गन्धक के प्रयोग से उत्पादकता में कोई खास वृद्धि नहीं हुई। गन्धक एवं सूक्ष्म पोषक तत्वों का नत्रजन, फास्फोरस एवं पोटाश के साथ उपयोग से भी उत्पादकता में आशाजनक वृद्धि नहीं आँकी गयी। मृदा में इन तत्वों की संतोषजनक मात्रा होने के कारण ऐसे परिणाम प्राप्त हुए।

पेड़ी प्रबन्धन

गन्ना की फसल में 20 टन प्रति हे. सल्फीटेशन प्रेसमड या 10 टन प्रति हे. सल्फीटेशन प्रेसमड + 25 किग्रा. जिंक सल्फेट प्रति हे. के प्रयोग करने से ठूँठों के प्रस्फुटन में बढौत्तरी आँकी गयी। ऐसे उपचार करने से प्ररोहों/कल्लों की संख्या अधिकतम पायी गयी। पेरने योग्य गन्नों की संख्या, इन उपचारों में क्रमशः 99900 एवं 99600 प्रति हे. पाई गयी। दस टन सल्फीटेशन प्रेसमड प्रति हे. तथा 25 किग्रा. जिंक सल्फेट प्रति हे. के सयुंक्त उपयोग से सबसे ज़्यादा 70 टन प्रति हे. गन्ना की उपज प्राप्त की गई। अतः इस प्रकार सल्फीटेशन प्रेसमड के एकल या जिंक सल्फेट के साथ संयुक्त प्रयोग से शरद्कालीन पेड़ी की उत्पादकता बढ़ाई जा सकती है।

गन्ना फसल के द्वितीय चक्र की बावक फसल में 30 हजार तीन-आँख वाले गन्ना-टुकड़ों के साथ बुआई करने से संस्तुत बीज मात्रा (40 हजार तीन-आँख वाले बीज टुकड़े) की तुलना में बुआई के 45 दिन बाद लगभग 22 प्रतिशत अधिक रिक्त स्थान पाये गये। गन्ने की बुआई में 60 हजार तीन आँख वाले बीज टुकड़े प्रयोग करने से, इससे प्राप्त प्रथम पेड़ी में अधिकतम पैदावार 86.09 टन प्रति हे. तथा न्यूनतम 910 रिक्त स्थान प्रति हे. पाये गये जबकि 30 हजार बीज टुकड़ों के प्रयोग से बुआई करने पर 3560 रिक्त स्थान प्रति हे. पाये गये। कटाई से एक माह पूर्व, सिंचाई के साथ 80 किग्रा. प्रति हे. पोटाश के प्रयोग से लगभग 12.73 प्रतिशत ज़्यादा सक्षम ठूंठ पाये गये जिसके कारण ठूंठ प्रस्फुटन में वृद्धि आँकी गयी।

विटामिन तथा खनिज तत्वों के मिलान के सूत्रीकरण के प्रयोग से शरद्कालीन पेड़ी फसल में ठूंठ प्रस्फुटन एवं उसकी बढ़वार में सुधार आँका गया। प्रजातियों के पकने में भिन्नता के कारण उनके ठूंठ प्रस्फुटन में भी भिन्नता पायी गयी। दस दिनों तक कलिकाओं को 6 ± 1^0 सेंटीग्रेड तापमान में रखने से किसी भी प्रजाति में उनका प्रस्फुटन नहीं पाया गया। जब इन्हें 25 ± 1^0 सेन्टीग्रेड तापमान पर लाया गया तो मध्यम देरी से पकने वाली प्रजातियों में शीघ्र पकने वाली प्रजातियों की तुलना में शीघ्र प्रस्फुटन पाया गया। पोटाश, जिंक तथा ईथरेल के प्रयोग से गन्ना टुकड़ों के कल्लों तथा रूट बैण्ड परिक्षेत्र में कम तापमान द्वारा प्रभावित जैव-रासायनिक क्रियाओं को प्रभावित किया जिनके कारण कल्लों में प्रस्फुटन में सुधार हुआ। मैंगनीज, कैल्शियम एवं पोटाशियम के 0.5 प्रतिशत घोल का प्रयोग करने से कम तापमान में कल्लों के प्रस्फुटन में सुधार आँका गया।

जल प्रबन्धन

फरवरी में बुआई की गयी गन्ना फसल में आई डब्लू/सी.पी. ई., के एक अनुपात पर 8 सेमी. सिंचाई देने से सबसे ज़्यादा 61.55 टन प्रति हे. गन्ना उपज आँकी गयी, जबकि इसके 0.5 अनुपात पर 6 सेमी. सिंचाई के प्रयोग करने से सबसे अधिक 1439.3 किग्रा. प्रति हे.-सेमी जल उपयोग दक्षता आँकी गयी। बसन्तकालीन पेड़ी फसल में आई डब्लू/सीपीई. के एक अनुपात पर दी गयी 8 सेमी की सिंचाई से सबसे अधिक 60.87 टन प्रति हे. गन्ना उपज तथा इसी के 0.5 अनुपात पर सिंचाई देने पर सबसे अधिक (1407.7 किग्रा. प्रति हे. सेमी.) सिंचाई जल उपयोग दक्षता आँकी गयी है।

गन्ना की सहफसली खेती में गन्ना फसल की 90 सेमी. की दूरी पर दो पंक्तियों के मध्य उठी हुई क्यारी में आलू की दो पंक्तियाँ उगाने से, 5 सेमी. सिंचाई देने तथा पोषक तत्वों की पूर्ति कार्बनिक स्रोतों से करने पर 36.5 टन प्रति हे. आलू उपज प्राप्त की गयी। लेकिन गन्ना फसल की दो पंक्तियों के मध्य समतल क्यारी पर आलू की दो पंक्तियाँ उगाने एवं ज़्यादा पानी (7.5 सेमी.) देने पर कम (21.4 टन प्रति हे.) आलू की उपज प्राप्त हुई। इन उपचारों में 1216.67 किग्रा प्रति हे. सेमी. तथा 570.67 किग्रा. प्रति हे. सेमी. की क्रमशः सबसे ज़्यादा एवं सबसे कम सिंचाई जल उपयोग दक्षता पायी गयी।

भौतर-जैव रसायनिक अध्ययन

अंकुरिका-चिप बीज स्टाक ने मृदा में 20 प्रतिशत नमी की मात्रा पर सबसे ज्यादा (88 प्रतिशत) प्रस्फुटन प्रदर्शित किया जो कि मृदा में नमी की घटती मात्रा के साथ घटता हुआ पाया गया। अंकुरिका-चिप को फफूंदनाशी से उपचार के उपरान्त पोलीथीन के थैले में डालकर कम तापमान (10 ± 1^0 सेंटीग्रेट) पर 10 दिनों तक रखने के उपरान्त भी 80 प्रतिशत प्रस्फुटन पाया गया जबकि अंकुरिका-चिप को कमरे के साधारणतया तापमान में रखने पर बहुत कम (40 प्रतिशत) प्रस्फुटन ही आँका गया। ऐथिफोन (200 मिग्रा. प्रति लीटर) के उपचार से कल्लों में प्रस्फुटन, जड़ निकलने की प्रक्रिया, पौधों की बढ़ने की क्षमता, तथा अंकुरिका से प्राप्त पौध में फुटाव में सुधार पाया गया। इस उपचार से पत्तों में क्लोरोफिल, केराटीनोएड, घुलनशील प्रोटीन, और प्रोलीन की मात्रा तथा केटालेज और परौक्सीडेज की गतिविधियों में सुधार पाया गया। विभिन्न वृद्धि नियामक रसायनों जैसे कैल्शियम क्लोराइड, पोटाशियम फास्फेट, नेफथोलएसिटिक एसिड, इथ्रेल, मैंगनीज, क्लोराइड, जिंक सल्फेट तथा थायोयूरिया में अंकुरिका-चिप को बोने से पूर्व डुबोने से अंकुरिका के प्रस्फुटन में तथा पौध की ओज में वृद्धि आँकी गयी। नेफथोल एसिटिक एसिड के उपचार से जड़ें अच्छी एवं जल्दी आ गई। कूण्डों में गोबर की खाद का प्रयोग करने से 23 प्रतिशत अंकुरिका-चिप के जमाव में वृद्धि पायी गयी।

एकीकृत रोग एवं कीट प्रबन्धन

पूर्वी उत्तर-प्रदेश के कई चीनी मिल क्षेत्रों में सर्वेक्षण के आधार पर पाया गया कि बलरामपुर, अकबरपुर तथा हैदरगढ़ चीनी मिल वाले जल भराव के क्षेत्रों में कोलक 8102 तथा कोशा 8436 प्रजातियों में

लालसड़न रोग का प्रकोप 40 से 50 प्रतिशत तक पाया गया। प्रजाति को. 87263 तथा को. 90023 में भी इस रोग का 10 से 20 प्रतिशत तक का प्रकोप आँका गया। क्षेत्रीय केन्द्र, मोतीपुर (बिहार) में प्रजाति एम एस 0202 तथा एम 0254 में घासी प्ररोह रोग तथा कोएम 316 में गन्ना मोजेक वायरस का प्रकोप भी देखा गया। गोण्डा जनपद में स्थित बलरामपुर चीनी मिल समूह की मैजापुर चीनी मिल के फार्म पर कोशा 767 पर रतुआ रोग का भी काफी प्रकोप देखा गया।

अखिल भारतीय समन्वित गन्ना शोध परियोजना से प्रजाति कोजे. 64 के चार चिन्हित रोगाणु प्रभेदों (सीएफ 03, 07, 08 एवं सीएफ 11) की चिन्हित 13 विभेदकों पर नियंत्रित परिस्थितियों (25-27^0 सेंटीग्रेड तापमान तथा 90 प्रतिशत से ज़्यादा आर्द्रता) में प्रतिक्रियाओं की जाँच की गई तथा इनका खेत में प्राप्त प्रतिक्रियाओं से तुलना की गई। सेकरम स्पोनटेनियम (एसई एस 594) उप्रयुक्त चारों रोगाणु प्रभेदों के लिए प्रतिरोधी था, लेकिन नियंत्रित परिस्थितियों में इसने इन चारों प्रभेदों के प्रति संवेदनशील से सामान्य प्रतिरोधिता प्रदर्शित की। उत्तर पश्चिमी क्षेत्र में उगाई जा रही प्रजातियों से सम्बन्धित 7 रोगाणु प्रभेदों जैसे सी एफ 01, 03, 07, 08, 09 एवं 11 को पात्रे तथा जीवे दोनों परिस्थितियों में रखरखाव किया गया। इसके अतिरिक्त पूर्वी तटीय क्षेत्र में उगाई जा रही प्रजातियों से सम्बन्धित 4 रोगाणु प्रभेदों जैसे सीएफ 04, 05, 06 तथा 10 का भी रखरखाव किया गया। उष्मनम वायु उपचार (2.5 घंटों तक 54^0 सेंटीग्रेड) के उपरान्त 20 किग्रा. प्रति हे. मिश्रित संवर्धन ट्राईकोडर्मा के प्रयोग से अन्य उपचारों (68-75 टन गन्ना प्रति हे.) की तुलना में अधिक फुटाव, पेरने योग्य गन्नों की संख्या तथा उत्पादकता (81 टन गन्ना प्रति हे.) आँकी गयी।

पीड़क कीट के प्रकोप के सर्वेक्षण से विदित हुआ कि पूर्वी उत्तरप्रदेश में (मैजापुर चीनी मिल क्षेत्र) में दीमक, चोटी बेधक कीट तथा काला चिटका का प्रकोप 7 प्रतिशत से कम था। संस्थान प्रक्षेत्र में प्रजाति कोसे 92423 की पेड़ी फसल में चोटी बेधक कीट का प्रकोप (15.2 प्रतिशत) पाया गया। पश्चिमी उत्तरी प्रदेश के गाजियाबाद जनपद में प्रजाति कोशा 8436 की पेड़ी फसल में गुवरैला/सफेद लट का 10 प्रतिशत प्रकोप पाया गया।

गन्ना खेती में मशीनीकरण

संस्थान द्वारा वर्ष 2007-08 में विकसित गन्ना कटाई यन्त्रों पर प्रक्षेत्र में कटाई परीक्षण किए गये। यह मशीन, गन्ने के तने को काट कर फसल को पंक्ति से रख देती है, लेकिन तने से हरी एवं सूखी पत्तियों का अलगाव अलग से करना पड़ता है।

गन्ने के तने से सूखे एवं हरे पत्ते निकालने की एक शक्ति चलित मशीन का विकास किया गया है। इस मशीन की पत्ते हटाने की क्षमता, प्रजाति पर निर्भर होने के कारण, 77.5 से 99.5 प्रतिशत आँकी गयी है। यह मशीन एक घंटे में 2.4 टन के लगभग पत्ते निकाल सकती है। पेड़ी प्रबंधन यंत्र (आर एम डी) के एक अन्य मॉडल रैटून प्रोमोटर में खोदने, खाद/उर्वरक डालने की एक नियमित यूनिट, तरल पदार्थ (जैसे कीटनाशक इत्यादि) के लिए दो कन्टेनर तथा मिट्टी चढ़ाने की एक प्रणाली विकसित की गयी तथा खासतौर से डिजाईन की गई फ्रेम में इन्हें लगाया गया। इस मशीन में अन्तः फसल की बुआई की सुविधा के लिए एक बीज इकाई भी लगाई गयी ताकि अन्तः फसल जैसे मसूर, बरसीम इत्यादि की बुआई भी की जा सके। इस मशीन की बीज इकाई में भिन्न-भिन्न आकारों के बीज को भिन्न-भिन्न गहराई पर बोने हेतु नियंत्रण करने की सुविधा बनाई गयी है।

बहुउद्देशीय मशीन "रिवरसिबल शोवल टाईप 3 टाइन इन्टरकल्चर टूल" का वृहद पैमाने पर आँकलन किया गया। विभिन्न गन्ना कर्त्तन बुआई यन्त्रों जैसे कि आई आई एस आर पहला मॉडल, खालसा टाईप, आई आई एस आर रीजर टाईप, आई आई एस आर बहुउद्देशीय तथा वी एस आई प्लान्टर में वर्तमान में लगे चार प्रकार के ब्लेडों का गठन किया गया। इस नमूना इकाई की बीज टुकड़ों के काटने की विभिन्न प्रक्रियाओं के परीक्षण के लिए एक सेट तैयार किया गया है।

कटाई उपरान्त तकनीकी

सितम्बर माह के प्रथम सप्ताह में तथा कटाई से लगभग 6 सप्ताह पूर्व, जिंक सल्फेट तथा मैंगनीज सल्फेट के 25 किग्रा. प्रति हे. की दर से मृदा में प्रयोग करने से कटाई उपरान्त शर्करा (शुक्रोज) में कमी/नुकसान को काफी कम किया गया। जिंक सल्फेट उपचारित गन्ने को सूखी पत्तियों से 14 दिनों तक ढके रखने से, पानी के छिड़काव तथा सूखी पत्तियों से ढके रखने की, तुलना में गन्ने के रस में शुक्रोज की मात्रा में 3.6 प्रतिशत तथा सीसीएस में 9 प्रतिशत की वृद्धि आँकी गयी है। मैंगनीज सल्फेट उपचारित गन्ने में 6.3 प्रतिशत अधिक सीसीएस आँकी गयी है।

पिछड़े पेराई सत्र में बैन्जालकोनियम क्लोराइड तथा सोडियम मेटासिलिकेट के एक सूत्रीकरण से कटाई उपरान्त गन्ने या सुक्रोज के नुकसान में आशातीत कमी आँकी गयी है। अप्रैल माह में अनुपचारित गन्ने में सीसीएस में 0.021 यूनिट प्रति घंटा नुकसान आँका गया जबकि पानी के छिड़काव, सूखी पत्ती से ढकने पर एवं के सी सूत्रीकरण से उपचार करने पर सीसीएस में क्रमशः 0.020 तथा 0.06 यूनिट प्रति घंटा नुकसान आँका गया। उप्रयुक्त रसायन सूत्रीकरण का गन्ने के ऊपरी मध्यम एवं नीचले हिस्से के टुकड़ों (विलेट) पर प्रयोग करने से क्रमशः 0.031, 0.012 एवं 0.011 यूनिट प्रति घंटा सीसीएस के नुकसान में कमी आँकी गयी।

अखिल भारतीय समन्वित कटाई उपरान्त प्रौद्योगिकी की शोध परियोजना के अन्तर्गत एक छोटे कोल्हू का प्रारूप तैयार किया गया जिसमें तीन किंग, पेरने एवं निचोड़ने वाले बेलनों की अभिकल्पना तैयार की गयी। गुड़ का मूल्य-संवर्धन करते हुए गुड़ को लगभग 30 ग्राम की 75x25x12.5 मिमी. की सिल्ली के आकार के रूप में तैयार किया गया। गुड़ की प्रत्येक ऐसी सिल्ली में लगभग 25 मिग्रा. विटामिन सी की मात्रा होने के साथ इसका स्वाद भी अच्छा पाया गया। आँवला के रेसे से गुड़ में साधारण गुड़ की तुलना में वान्छित कठोरता भी हासिल की गयी।

सहउत्पाद (ईथनोल) उत्पादन

सूक्ष्म सेकरिफिकेशन तथा ईथनोल उत्पादन के लिए लिग्नोसेलोसिक जैव पदार्थ का पूर्व उपचार करना आवश्यक है क्योंकि अनुपचारित सह-उत्पादों में क्रतिपय कम मात्रा में कुछ ऐसे रसायन होते हैं जिनके कारण ईथनोल उत्पादन में अवरूद्धता उत्पन्न होती है। गन्ने के जैव पदार्थ को अनुकूलतम स्थितियों (4 मिनटों तक 165^0 सेंटीग्रेड) में हल्के तेजाब से उपचारित कर प्रीहाइड्रोलाईजेट का विघटित योगिकों तथा चीनी की मात्रा ज्ञात करने हेतु विश्लेशण किया गया। इस प्रक्रिया में विघटित यौगिकों में से मुख्यतः कार्बनिक अम्ल जैसे कि ऐसिटेट, फ्यूरोन, वैनीलिन तथा सीरिंगऐल्डिहाईड पाए गये। पूर्व उपचार के दौरान, जाइलोज के विघटन से उपलब्ध फरफुरल की मात्रा तापमान बढ़ने के साथ बढ़ते हुए क्रम में (135^0 से 165^0 सेंटीग्रेड प्रति लीटर) पायी गयी। फरफुरल के विघटन के कारण, ऐसिटिक अम्ल में 0.2 से 1 ग्रा. तथा फोरमिक अम्लता में 0.5 से 1.5 ग्रा. प्रति लीटर की वृद्धि आँकी गयी। यह सह-उत्पाद सेकरिफिकेशन प्रक्रिया में मुख्य अवरोधक पाये गये। परिणामों से विदित हुआ है कि प्री-हाइड्रोलाजेटस में उप्रयुक्त यौगिकों की उपस्थिति काफी हद तक जल अपघटन प्रक्रिया को प्रभावित करती है, जिससे सेलूलेज रूपान्तरण में 25 प्रतिशत की कटौती हो जाती है।

चुकन्दर शोध एवं विकास

चुकन्दर की शुभ्रा एवं एल एस-6 प्रजातियों की तुलना में ईरान की रसुल, भारत की एल के सी-95 तथा एल के-27, सिन्जेन्टा की एस वायी टी-06-13, एस ई एस वान्डरहेव की पीएसी-60002 एवं 60006 तथा के डब्लू एस की फेलिसिटा ने अच्छा प्रदर्शन कर इन प्रजातियों की भारतीय स्थितियों में खेती करने की सम्भावनाओं को उजागर किया है। चुकन्दर फसल रोग प्रबन्धन के अन्तर्गत यह पाया गया कि फसल बुआई से पहले *टी विरडी* के प्रयोग एवं फफूंदीनाशक थीरम से डरेन्चिंग करने से *स्क्लेरोसियल* जड़सड़न रोग की रोकथाम एवं फसल उत्पादकता बढ़ाने में काफी प्रभावी पाए गये। बावस्टिन का छिड़काव करने से *सरकोस्पोरा* पर्णदाग रोग को काफी हद तक कम किया जा सकता है। शुभ्रा प्रजाति में बायोइन्टेन्शिव पेस्ट मैनेजमेंट पैकेज अपनाने से प्रति पौधा *स्पीलोसोमा ओबलिका* कीट की सुंडियों की संख्या को प्रभावी ढंग से कम किया जा सकता है। फसल मशीनीकरण से सम्बन्धित शोध से यह विदित हुआ कि पंक्ति से पंक्ति की 60 सेमी. या अधिक की दूरी पर बुआई करने से टैक्टर चलित शुगरबीट डिगर मशीन सतोषजनक ढंग से काम करती है। संस्थान के अतिरिक्त मुक्तेश्वर (उत्तराखंड) में भी चुकन्दर की प्रजाति विकास हेतु जर्मप्लाज़्म उपयोग एवं बीज उत्पादन पर शोध कार्य किया जा रहा है।

प्रौद्योगिकी हस्तान्तरण

उत्तर प्रदेश के दो जनपदों, सीतापुर एवं बाराबंकी में संस्थान द्वारा गन्ना फसल की 4 उन्नत तकनीकों पर किसानों के खेतों में 35 प्रदर्शन करवाये गये। प्रदर्शन से स्पष्ट है कि किसानों द्वारा अपनायी जा रही तकनीक के मुकाबले प्रदर्शित तकनीकों में फसल उत्पादकता एवं सिंचाई के पानी की उपयोग दक्षता में आशातीत वृद्धि आँकी गयी। साथ ही फसल उत्पादन में प्रयुक्त पानी की मात्रा में बचत भी प्रदर्शित की गयी। किसानों द्वारा अपनायी जा रही तकनीक की तुलना में गोल गड्डा विधि द्वारा बुआई करने से फसल उत्पादकता में 66% वृद्धि तथा प्रयुक्त पानी में 129% बचत आँकी गयी। अन्य उन्नत तकनीकों जैसे पताव-बिछाव, बढ़वार की क्रान्तिक अवस्थाओं में सिंचाई एवं एकान्तर नाली सिंचाई विधि से फसल उत्पादकता में 30-38% तथा पानी उपयोग दक्षता में 57-93% की वृद्धि आँकी गयी। इन विधियों से गन्ने की खेती में प्रयुक्त किये पानी में 17-39% तक की बचत भी आँकी गयी है। प्रदर्शित पताव-बिछावन तकनीक में सबसे ज़्यादा लाभःलागत अनुपात (2.47) आँका गया जबकि एकान्तर नाली सिंचाई विधि, बढ़वार की क्रान्तिक अवस्थाओं पर सिंचाई एवं गोल गड्डा विधि में घटते क्रम में क्रमशः 2.11, 1.97 एवं 1.85 आँका गया।

गन्ने का भारतीय अर्थव्यवस्था में योगदान

गन्ने का भारतीय अर्थव्यवस्था में योगदान के विश्लेषण से विदित हुआ है कि चीनी उत्पादन की कुल कीमत का 5.4 प्रतिशत हिस्सा चीनी उत्पादक शुल्क के रूप में भारत सरकार को प्रतिवर्ष उपलब्ध होता है। विगत तीन वर्षों में औसतन प्रतिवर्ष 2076 करोड़ रुपये चीनी उत्पादन शुल्क के रूप में उपलब्ध हुए हैं। देश में चीनी उत्पादक शुल्क सभी वस्तुओं से संग्रहित उत्पाद शुल्क का मात्र 1.73 प्रतिशत हिस्से का योगदान करता है। गन्ना खेती से किसानों की आय के रूप में विगत तीन वर्षों में औसतन प्रतिवर्ष 17675 करोड़ रुपये किसानों के गन्ना मूल्य के रूप में दिये गये जिसमें से प्रतिवर्ष 7157 करोड़ रुपये दैनिक मजदूरी के रूप में वितरित किये गये।

अन्य

मुख्य चीनी उत्पादक राज्यों की चीनी मिलों में औसत चीनी परता के स्तर में दीर्घकालीन (1951-2008) वृद्धि दर के आंकलन से विदित होता है कि मुख्य चीनी उत्पादक राज्यों उत्तर प्रदेश एवं महाराष्ट्र में औसत चीनी परता में ह्रास हुआ है जबकि हरियाणा, गुजरात, तमिलनाडू, आन्ध्रप्रदेश, पंजाब एवं कर्नाटक राज्यों में चीनी परता की दर में वृद्धि पाई गयी है।

गन्ना उत्पादन में फसल विविधीकरण पर सितम्बर माह में विभिन्न राज्यों के गन्ना विकास अधिकारियों के लिए आठ दिवसीय प्रशिक्षण आयोजित किया गया। चीनी मिलों के गन्ना विकास अधिकारियों के लिए गन्ना विकास एवं प्रबन्धन पर एक माह का प्रशिक्षण आयोजित किया। इसके अतिरिक्त, अक्तूबर माह में बिहार के किसानों के लिए, दो अन्य प्रशिक्षण भी आयोजित किये गये।

वर्ष 2008-09 में गन्ने के क्षेत्रफल, उपज एवं चीनी परता में आई कमी के कारणों पर गहरा विचार मंथन करने के लिए, संस्थान ने 24 मार्च 2009 को एक ब्रेन स्टार्मिंग बैठक का आयोजन किया जिसमें विभिन्न प्रदेशों के शोध कर्त्ताओं, चीनी मिलों के प्रतिनिधियों तथा भारतीय कृषि अनुसंधान परिषद् के वरिष्ठ अधिकारियों ने भाग लिया।

Executive summary

Collection, maintenance and evaluation of germplasm

A collection of 230 genotypes consisting of *S. officinarum*, *S. barberi*, *S. sinense*, ISH clones, commercial hybrid varieties, *S. spontaneum*, etc. was maintained. For identifying newly evolved genotypes to be used as parents in the hybridization programme, twenty-four LG and Ikshu ISH genotypes were evaluated for cane and juice characteristics. The maximum sucrose% in January was recorded in LG 99114, followed by LG 97009, and LG 01118.

CoLk 94184 (Birendra) was notified by the CVRC for cultivation in the North Central Zone. Five high sugar breeding stocks, viz. LG 02057, LG 05433, LG 05434, LG 05460 and LG 05493 were sent to Sugarcane Breeding Institute, Coimbatore for inclusion in the National Hybridization Garden and study their breeding behaviour. Three selections with commercial merit and resistance to red rot (LG 02039, LG 02057 and LG 05447) were included in the station trial (2009-10). One entry (LG 01030) in the station trial (2008-09) has done well. Clonal evaluation resulted in about 140 selections for further evaluation for early high sugar accumulation or varietal candidature.

Ten advanced stage clones were evaluated for their suitability to late planting conditions. LG 2616, LG 2618 and LG 2619 were found superior in sugar yield over standards.

In clonal evaluation, for top borer tolerance, quality and vigour, 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 3.1 to 4.2 per cent of top borer infestation in IIIrd to IVth brood indicating the importance of *Erianthus sp.* in top borer tolerance, as one of the parent has component from *Erianthus*. Two out of 11 clones viz., LG 2907 and LG 2923 possessing superiority in traits of economic importance were advanced to station trial. 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 was positively correlated with top borer tolerance.

Six promising C_2 clones, namely LG 04006, LG 05003, LG 05004, LG 05016, LG 05020 and LG 05029 were selected and advanced for further evaluation. A promising clone LG 04-043 was promoted for evaluation in station trial out of nine selected clones under PVT.

Thirty-five clones from second clonal generation (from 103 C_1 progenies from eleven crosses) were tested by plug method using two pathotypes of red rot and advanced to third clonal generation. Red rot resistant clone LG 05823 yielded the highest cane (90.8 t ha^{-1}) and sugar (11.8 t ha^{-1}) followed by LG 05817 (86.4 t ha^{-1}, 11.4 t ha^{-1}). Other clones namely LG 05809, LG 05810, LG 05828 and LG 05890 were identified as red rot resistant clones. Two Clones LG 05817 and LG 05823 are being evaluated in station trial as pre multi-locational testing.

Evaluation of early maturing sugarcane clones for North West Zone was carried out. CoPant 03220 with cane yield (72.9 t ha^{-1}) and sugar yield (9.29 t ha^{-1}) followed by CoLk 9902 (66.9 t ha^{-1}, 9.05 t ha^{-1}) were better entries out of 8 entries in Advance Varietal Trial (Early) Ratoon. Genotype CoH 05265 followed by CoH 05262 from 13 entries gave the higher cane yield over checks (CoPant 84211 and CoJ 64) in Initial Varietal Trial (Early).

Genotype CoH 05267, out of 13 genotypes recorded highest cane yield (95.1 t ha^{-1}) as well as CCS yield (13.26 t ha^{-1}) which was significantly superior to 3 standards, Co 1148, CoS 767 and CoS 8436 in Initial Varietal (Midlate) Trials. The genotypes Co 05011, CoPant 05224, Co Pant 05223, CoH 05269, and CoH 05266 also had higher cane and CCS yield than the best standard.

The genotype CoLk 99271, out of 6 genotypes recorded highest cane yield (89.5 t ha^{-1}) as well as CCS yield (10.62 t ha^{-1}) in Advance Varietal Trial (Midlate) Ist Plant over the best check. In another Advance Varietal Trial (Midlate) IInd Plant comprising of six test genotypes, the genotype CoH 130 showed highest sucrose % (19.2) followed by CoS 03261and Co 0331 over the standard check, CoS 767. In Advance Varietal Trial (Midlate) Ratoon, the genotype CoS 03261 showed best ratooning ability with significant higher cane yield (70.2 t ha^{-1}) and CCS yield (8.33 t ha^{-1}) over the best standard CoS 767.

Genotype CoLk 08201 was proposed during Biennial Workshop of AICRP(S) held at AP University, Vishakhapattanam and accepted for multilocation evaluation in North West Zone.

A high sugar clone LG 99270 possessing moderately resistance reaction against two prevalent pathotypes Cf 08 and Cf 09 of red rot was identified as genetic stock and sent to NHG at Coimbatore for utilization.

Cytogenetic and biotechnological techniques for sugarcane improvement

Molecular characterization of eighty-six sugarcane genotypes and forty-six *Saccharum* species level clones has been done using three DNA based marker systems *viz.* RAPD, microsatellites and ISSR. Ten polymorphic primers were identified for further validation. More than 60 polymorphic primers were designed from EST sequences for sugar genes. Segregating population from 4 crosses and one self has been developed. Two low sugar entries (10-13% sucrose at peak) can serve as putative parental lines.

Developed and validated 40 EST-SSR markers in sugarcane. After analysis of 30 sugarcane genotypes differing in response to red rot with 32 SSR markers, SES 594 and ISH 150 were identified as red rot resistant.

Immersion of callus in *Agrobacterium* suspension for 15 min and co-cultivation for 4 days increased the gene expression efficiency up to 70 % in sugarcane. The procured four Bt gene constructs (Cry 1Ab, Cry 1Aa, Cry 1F, Cry IA5) and pB1 121 with GUS are being maintained at IISR, Lucknow as Bt gene resource for development of transgenics in sugarcane against borer.

Significantly higher yield of sugarcane variety CoSe 01235 (88.1 t ha^{-1}) was recorded with 90x45 cm planting geometry in comparison to other planting geometry. An average of 16.6 per cent (range 15.4-17. 8%) increase in ultimate sugar yield was observed in the crop raised using sets obtained through micropropagated plantlets over conventional method. Techniques for development of micropropagated plantlets in the newly released variety of sugarcane CoLk 94184 were standardized.

Nutrient management in sugarcane based cropping systems

Maximum cane (65.2 t ha^{-1}) and sugar yield (7.49 t ha^{-1}) were recorded in treatment having 50% N through inorganic source and 50% N through organic source which were significantly higher (57.1 t ha^{-1}, 6.20 t ha^{-1}) than treatment having 100% N through inorganic source. However, higher cane yield was found to be associated with higher nitrogen dose irrespective of the source. The higher soil organic carbon content (0.55%) was observed with increasing rate of organic source of N application compared to inorganic source.

The grain yield of wheat and paddy crops grown in the plant cane-first ratoon-second ratoon-wheat-paddy cropping system, increased over control, by 272% in wheat and 59.2% in paddy due to N application. Application of P, K and S with N could not increase the yield further significantly over N application. Application of S and micronutrients with NPK also could not show a marked and significant increase over NPK application. It highlights that N is the only nutrient, which was deficient and its application increased the yield of wheat and paddy considerably. The application of other nutrients could not result in increase of yield because of their sufficient content in the soil.

Ratoon management

Application of 20 t ha^{-1} SPM or 10 t ha^{-1} SPM + 25 kg zinc sulphate ha^{-1} improved the bud sprouting and significantly produced maximum number of shoots. Increase in number of millable canes was noticed with the application of 20 t ha^{-1} SPM (99900 ha^{-1}) and 10 t ha^{-1} SPM + 25 kg $ZnSO_4$ ha^{-1} (99600 ha^{-1}). Highest cane yield (70 t ha^{-1}) was also recorded with application of 10 t ha^{-1} SPM + 25 kg $ZnSO_4$ ha^{-1} (68.5 t ha^{-1}). Thus, it clearly suggests that productivity of winter ratoon can be enhanced through application of 20 t ha^{-1} SPM or 10 t ha^{-1} SPM + 25 kg $ZnSO_4$ ha^{-1}. Juice quality remained unchanged.

The gaps observed at 45 DAP in 2nd crop cycle of plant cane were higher (22.01%) under planting with 30,000 three-bud setts ha^{-1}, compared to planting with 40,000 (recommended rate), 50,000 and 60,000 three-bud setts ha^{-1}. Sugarcane planting by 60,000 three-bud setts ha^{-1} produced the highest ratoon cane yield (86.09 t ha^{-1}) and also exhibited minimum number of gaps (910 ha^{-1}) as against 3560 ha^{-1} under sugarcane planting with 30,000 three-bud setts ha^{-1}. Application of potassium @ 80 kg ha^{-1} with irrigation water before one month of plant cane harvesting improved the sprouting of stubble buds and thus, produced 12.73% more number of viable stubbles than that observed under no K application.

A formulation containing mixture of vitamins and minerals was made which improved sprouting of winter-initiated ratoon and its performance. Varieties with different ripening behavior differed in their sprouting response to shift from low to high temperatures. Buds did not germinate when setts of early as well as mid-late ripening varieties were kept at 6±1 °C for 10 days. When these were shifted to 25± 1 °C, buds of early ripening varieties germinated rather slowly as compared to the mid-late ripening varieties. Application of K, Zn and Ethrel modulated low temperature-induced biochemical changes in bud and root band zones of sugarcane setts, which improved sprouting of buds. Application of calcium (as $CaCl_2$), potassium (as KCl) and manganese (as $MnCl_2$) each at the rate of 0.5% solution improved sprouting under low temperature conditions.

Water management

For February planted sugarcane, highest yield (61.55 t ha^{-1}) was recorded with 8 cm depth of irrigation water applied at 1.00 IW/CPE ratio and Irrigation Water Use Efficiency was the highest (1439.3 kg ha^{-1} cm) with 6 cm depth of irrigation water applied at 0.5 IW/CPE ratio. For spring initiated ratoon crop, highest yield (60.87 t ha^{-1}) was recorded with 8 cm depth of irrigation water applied at 1.00 IW/CPE ratio. However, Irrigation water use efficiency was the highest (1404.7 kg ha^{-1}cm) with 6 cm depth of irrigation water applied at 0.5 IW/CPE ratios.

In another inter-cropping based experiment, the highest yield of potato (36.5 t ha^{-1}) was recorded when two rows of potato were planted on raised beds made in between two sugarcane rows planted at 90 cm row spacing, irrigated with 5 cm depth of irrigation water and fertilized organically. However, the lowest potato yield (21.4 t ha^{-1}) was observed when two rows of potato were planted on flat bed in between sugarcane rows at 90 cm row to row spacing, irrigated with 7.5 cm depth of irrigation water and fertilized inorganically. Potato yields were higher when the crops were fertilized with organic fertilizers. The highest (1216.67 kg ha^{-1} cm) and the lowest (570.67 kg ha^{-1} cm) irrigation water use efficiencies were also recorded in the same treatments, respectively.

Physio-biochemical studies concerning survival and establishment of bud chips

Bud chip seed stocks showed the highest germination (88%) at 20% soil moisture and it reduced gradually with decrease in soil moisture level. The bud chips after fungicide treatment stored in polyethylene bags at 10 ± 1°C exhibited about 80% bud germination 10 days after storage than one (about 40%) stored at room temperature. In bud chips, moisture content was within the range of 70-77% during storage similar to 0 day moisture content. Treatment with 200 mg l^{-1} Ethephon helped in improving bud sprouting, rooting activity, plant vigour and tillering of bud chip raised settlings. In leaves, chlorophyll, carotenoids, soluble protein, proline contents and activity of catalase and peroxidase increased due to Ethephon treatment. Pre-soaking bud chips in different growth regulating chemicals *viz*., calcium chloride, KH_2PO_4, NAA, ethrel, $MnCl_2$, $ZnSO_4$, and thiourea showed an improvement in bud sprouting and plant vigour. Rooting activity was the highest with NAA treatment. Among different varieties tested, variety BO 91 exhibited the highest germination (80%) using bud chip seed material. Bud chips planted in rows filled with farmyard manure improved germination by 23%.

Integrated disease management

Survey and surveillance of diseases of sugarcane carried out in eastern UP observed severe red rot incidence (40 – 50%) in CoLk 8102 and CoS 8436 in waterlogged areas of Balrampur, Akbarpur and Haidergarh factory zones. Red rot incidence (10-20%) was also observed in Co 87263 and Co 90023. The SCMV in CoM 316 and GSD in MS 0202 and CoM 0254 were also noticed at IISR Regional Station, Motipur (Bihar). Severe incidence of rust was also noticed on CoS 767 at factory farm of Balrampur Chini Mill unit, Maizapur (Gonda).

Reactions of 4 pathotypes (Cf 03, 07, 08 and Cf 11) identified in AICRP programme from CoJ 64 were tested on identified 13 differentials under controlled condition (CCT) (25-27 ^{0} C and > 90% humidity) and compared with reactions recorded in field. *Saccharum spontaneum* (SES 594) was resistant to all the above 4 pathotypes but the same produced susceptible to MR reactions to these pathotypes under CCT.

Seven pathotypes viz., Cf 01, 02, 03, 07, 08, 09 and 11 belonging to the varieties grown in north-western zone were maintained both *in-vivo* and *in-vitro* conditions. In addition, 4 pathotypes viz., Cf 04, 05, 06 and 10 belonging to the varieties grown in east coast zone were also maintained.

MHAT (54 ^{0}C for 2.5 hr) followed by application of 20 kg ha^{-1} TMC (Trichoderma mixed culture) was significantly better for increasing tillers, NMC and yield (81 t ha^{-1}) than the other treatments (68-75 t ha^{-1}).

Bio-ecology and insect-pest management

Survey and surveillance of insect-pests of sugarcane in command area of Indogulf India Ltd. Maizapur (Gonda) and at Modinagar (Ghaziabad). revealed that the incidence of termite, top borer and black bug was less than 7%. Top borer incidence was higher (15.2%) in ratoon crop of CoSe 92423 at the institute farm. Incidence of white grub was 10% in ratoon crop of CoS 8436 at Modinagar (Ghaziabad).

Mechanization of sugarcane cultivation

Field trials of front mounted sugarcane harvester, developed during 2007-08, were conducted at Indian Institute of Sugarcane Research, Lucknow farm. The equipment cuts and windrows the whole cane stalks flush with the ground. Removal of green tops and dry trash from the harvested cane needed to be done separately.

A power-operated detrasher was developed for removal of green top as well as dry trash from the harvested sugarcane. Performance of the equipment was evaluated by feeding harvested canes of different varieties from their green tops side through the feeding chute to the detrashing rollers. Trash removal efficiency varied from 77.5 to 94.5% depending upon the variety. The output of the detrasher was 2.4 t h^{-1}.

In a model of RMD named as Ratoon Promoter, rippers, fertilizer /manure container with metering unit, two number of liquid containers for dispensing pesticide, fertilizer etc in liquid form through gravity and a pair of earthing units were developed and were affixed to a specially designed sturdy frame. The equipment was also provided with a seeding unit for raising intercrops like lentils, berseem etc. It contained adjustments for proper metering of various grades of seed and its depth placement.

The large scale testing of the multipurpose equipment "reversible shovels type 3-tyne intercultural tool developed as an attachment to the engine operated walking type prime mover" was conducted at IISR farm. The effective field capacity of the equipment was observed as 0.2 ha h^{-1}.

Post-harvest technology

Soil application of zinc sulphate and manganese sulphate @ 25 kg ha^{-1}in the first week of September, six weeks prior to harvest showed appreciable reduction in post-harvest sucrose losses. The zinc sulphate treated cane covered with trash showed about 3.6% increase in juice sucrose and 9.0% increase in CCS 14 days after staling, compared to water sprayed trash covered cane (untreated control). The manganese sulphate treated cane recorded 6.3% higher CCS.

Post-harvest treatment of whole cane and billets with a formulation consisting of benzalkonium chloride and sodium metasilicate recorded an appreciable reduction in sucrose losses during late crushing period. The CCS loss per hour in the untreated whole stalk during the month of April was around 0.021 units compared to 0.020 units in water sprayed+ trash covered & 0.015 units in BKC treated formulation. The average CCS loss in billets was about 0.060 units per hour. Application of chemical formulation on billets from upper, middle and lower portions of cane stalk showed perceptible reduction in CCS loss and the values were 0.031, 0.012 and 0.011 unit per hour, respectively.

Sugar bye-product (ethanol) studies

Sugarcane biomass was pre-treated with dilute acid at optimal conditions (165°C for 4 min). Prehydrolysates were analyzed for degradation compounds and sugars content. The major degradation by-products released during the process included organic acids such as acetate, furans (furfural and 5-hydroxymethylfurfural) and phenols such as 4-hydroxybenzaldehyde (4-HB), vanillin, and syringaldehyde. The concentration of furfural obtained during the pre-treatment process increased with temperature from 50 mg l^{-1} at 135°C to 900 mg l^{-1} at 165°C as a result of xylose degradation. Acetic acid concentration increased by 0.2–1 g l^{-1} during the process while formic acid concentration increased by 0.5–1.5 g l^{-1} probably due to degradation of furfural. These by products were found to be potent inhibitors during the saccharification process. Results showed that these compounds contained in prehydrolysates strongly affected the hydrolysis step, a 25% decrease in cellulose conversion compared with control.

Sugar beet production

Sugar beet entries, Rasoul from Iran, LKC-95 and LK-27 from India, SYT-06-13 from Syngenta, PAC-60002 and PAC-60006 from SES Vanderhave and, Felicita from KWS performed well as compared with the check varieties Shubhra and LS-6. Entries, PAC 60006, Felicita and SYT-06-13 hold promise under Indian conditions. Soil application of *T. viride* (before sowing) and drenching of thiram (before appearance of disease) have been found quite effective for managing *Sclerotial* root rot of sugar beet under field conditions as well as enhancing root yield. *Cercospora* leaf spot under natural conditions could be minimized effectively by spraying of Bavistin. The bio-intensive pest management package was effective in reducing the larval population of *Spilosoma obliqua* to 0.63 larvae per plant as against 2.23 larvae per plant in farmers' practice in variety HI 0064 (Shubhra) at IISR, Lucknow field conditions. Testing of a tractor drawn sugar beet digger revealed that the digger may work satisfactorily in a field having row spacing of 60 cm or more.

Transfer of technology

Thirty-five demonstrations conducted at farmers' fields revealed that the highest increase (65.71%) in yield was recorded for ring-pit method of planting over the conventional method followed by trash mulching (38.20%), irrigation at critical growth stages (30.60%) and skip furrow method of irrigation (30%). Saving in irrigation water varied from 16.81 to 38.52 per cent. The highest increase in irrigation water use efficiency was recorded in ring-pit method of planting (128.90%) over the conventional method followed by trash mulching (93.90%), skip furrow method of irrigation (70.60%) and irrigation at critical growth stages (57.00%).

The cost of cultivation was highest in case of ring-pit method; the highest return accrued for this technology well compensated the increased cost. The highest net return (Rs.74363 ha^{-1}) was recorded in case of ring- pit method; followed by trash mulching (Rs.63254 ha^{-1}), skip furrow method of irrigation (Rs.61089 ha^{-1}) and ICGS (Rs.57130 ha^{-1}). Among the demonstrated technologies, the highest B/C ratio was observed for trash mulching technology (2.47) followed by skip furrow method of irrigation (2.11), ICGS (1.97) and ring-pit method of planting (1.85).

Economics and statistics

Long-term trends of last fifty-eight years (1951-2008) to measure growth in sugar recovery in India highlights that UP, Maharashtra, Karnataka and Bihar registered negative annual compound growth while Haryana (0.35%), Gujarat followed by Tamil Nadu, Andhra Pradesh, Punjab registered positive annual compound growth rate.

In an agro-economic analysis based on secondary data on the contribution of sugarcane in Indian economy, the excise duty including cess from sugar was worked out at 5.4% of the value of sugar produced. The sugar industry, on an average, contributed about 2076 crore per year in terms of excise duty to Central Exchequer. Excise collections from sugar constituted about 1.73% of the total excise duty collection from all commodities in India. In addition, the cane price payments to farmers by sugar mills, on an average, amounted to Rs. 17675 crore per year. The cane growers paid about Rs. 7157 crore to casual labourers as their wage income.

A data-mining software tool having 3 components viz. User Interface, Search Engine and Data Warehouse was developed to explore and analyze the data stored in the data warehouse of sugarcane production at IISR, Lucknow. The web-oriented nature of the tool provides a web-browser based user interface to search the data from data warehouse.

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 Amousi Airport and about 5 kms each from Lucknow Railway station and Alambagh Bus station. The climate of the area is sub-tropical semi-arid type. Monthly average maximum temperature during April to June ranges from 36^0 C to 40^0 C and minimum temperature during November to February ranges from 7^0C to 11.5^0C. The annual average rainfall is around 880 mm.

Vision

An efficient, globally competitive and vibrant 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, and consultancy to end users at regional, national and international levels.

Issues and strategies

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

Issues

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

Strategies

Increasing the levels of cane yield and sugar recovery

a. Introgression of untapped genes in the parental gene pool

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

c. Improving sink strength and source efficiency

d. Enhancing productivity of ratoon cane

Reducing the cost of cane cultivation

a. Nutrient 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 :

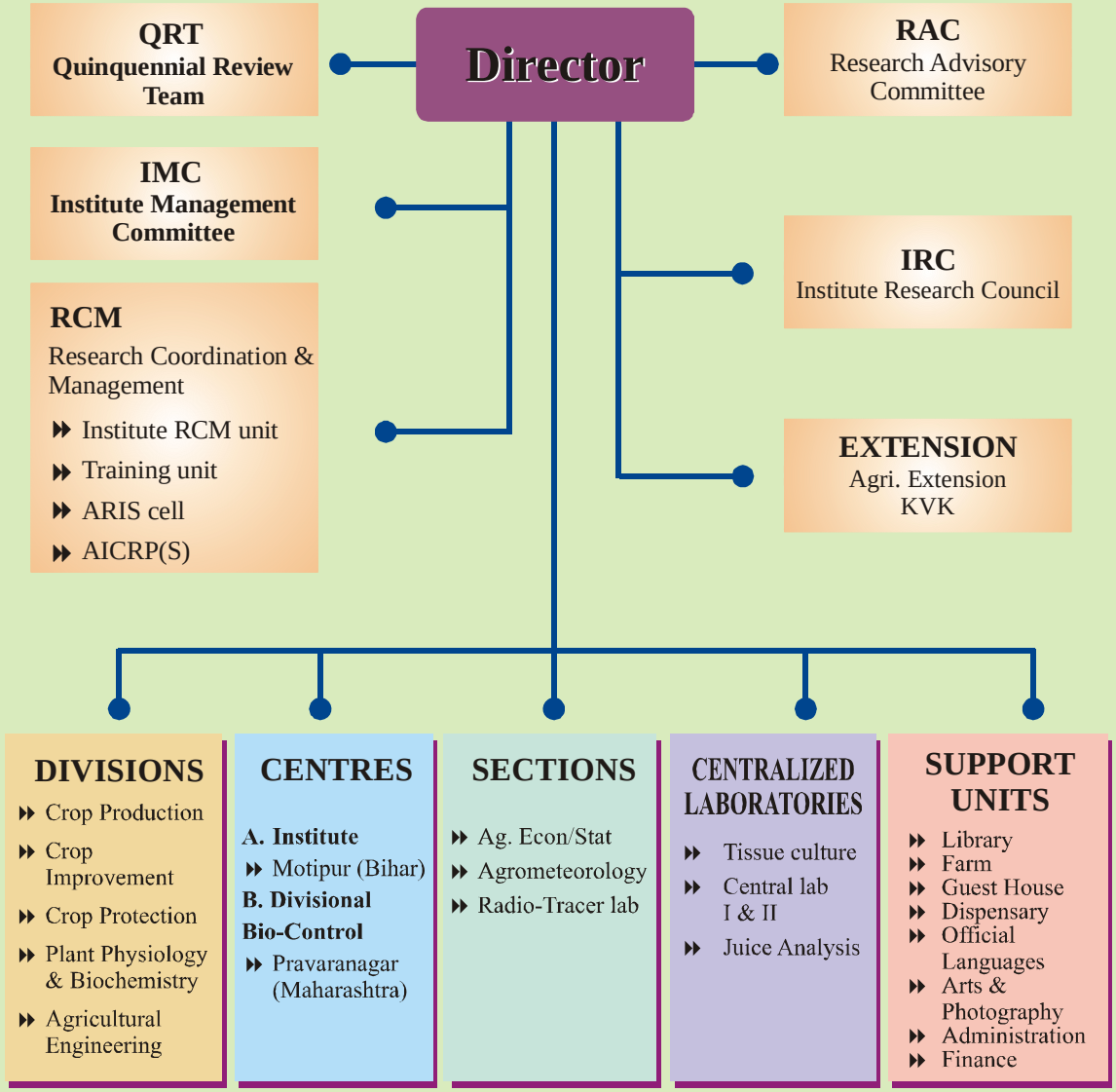
Issues	Strategies	Programmes
A. Increasing levels of cane yield	1) Developing high yielding, disease resistant and pest tolerant, good ratooning varieties	• Pre-breeding programmes
		• Molecular breeding programmes
		• Varietal development programme
		• Mapping the virulence and population diversity 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 is shown in the flow chart on the next page:

Indian Institute of Sugarcane Research Lucknow



Organizational set-up

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/ clientle. During the year, the library budget was 23.73 lakh, out of which Rs. 1.27 lakh was spent on purchase/acquistion of 23 books and Rs. 20,825 spent on subscription of Indian journals, Rs. 22.20 lakh on foreign journals and Rs. 4312 on Hindi/English magazines and newspapers. Total number of titles of Indian/foreign journals reached to 386 comprising 20,000 set/volumes. During the year, 741 issues of Indian/foreign journals and 22 CDs were received. There are 47 Indian and 35 foreign journals; 10 newspapers and 9 Hindi/English magazines on the current subscription list. Total number of books in the library has reached to 9944. Some of the journals in the library date back as early as 1913.

About 2450 readers/users were provided reference services. During the year, 103 Annual Reports were received in libarary. Through CeRA, journals/serial publications of Springer and Annual Reviews Inc. are being made available by ICAR as a centralized service.

Sugarcane literature (Books relating to sugarcane and available in the IISR Library, New Research 2008 (Research papers published on sugarcane during 2008, and Holding List (List of serial publications available at IISR Libarary) were also made available to institute scientists during this year as shared document.

Radio tracer laboratory

The Radio Tracer Laboratory of the Institute houses sophisticated instruments like Liquid Scintillation Counter, Advanced Gamma Counting

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

Agrometeorology laboratory

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

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.

Regional Centre, Motipur

The research activities at the centre included 8 trials for North Central and Eastern zones of AICRP (Sugarcane), breeder seed multiplication programme in 5 ha of land, raising of nursery from the fluff of 20 crosses, maintenance of 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 113.5t tons of breeder seed of CoLk 94184, Co 89029 and BO137 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. Centre has generate the revenue Rs. 3.21 Lakh during the year.

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 (2008-09)

A. Institute

(Rs. in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Estt. Charges	1420.00	1420.16	0.00	0.00
T.A.	3.00	3.00	7.00	6.71
HRD	0.00	0.00	0.00	0.00
Other Charges	114.00	112.30	208.00	207.87
Works	87.00	87.00	35.00	35.00
Others items	0.00	0.00	0.00	0.00
OTA	0.15	0.15	0.00	0.00
Total	**1624.00**	**1622.61**	**250.00**	**249.58**

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

(Rs. in Lacs)

Particulars	Estt. Charges	T.A.	Other Charges (RC)	NRC	Total
Revised Estimate	301.58	20.12	45.55	-	367.25
Expenditure	303.65	17.11	44.24	-	365.00

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

C. Externally Funded Projects

S. No.	Projects	Funding agency	Duration	Amount (Rs. in lacs)
1	UPCAR 1/06: Enhancing field water use efficiency in sugarcane cropping system through FIRBs	UPCAR, Lucknow	2006-09	2.13
2	Farmer's participatory action research on water use efficency technologies for improving productivity and sustainability of sugarcane	Central Water Commission, Ministry of Water Resources, Govt. of India	2008-11	34.93

D. Other ICAR Projects/schemes at IISR Lucknow

Proj.No./ Abbr.	Project title	Funding Agency	Duration	Amount (Rs. in Lacs)
OP-1/09	Outreach programme in network mode on diagnosis and management of leaf spot diseases of field and horticultural crops. (IISR Centre component, mandated crop sugarcane, pathogen: *Colletotrichum)*	ICAR, New Delhi	11th Five Yr Plan (2007-12)	33.10
Mega seed project	Seed production in agricultural crops and fisheries (IISR Centre component)	-do-	-do-	203.50*
FIM	AICRP on Farm Implements and Machinery (IISR Centre component)	-do-	-do-	996.602
PHT	AICRP on Post-harvest Technology (IISR Centre component)	-do-	-do-	39.00
Climate	Network project on impact adoption and vulnerability of Indian agriculture to climate change	-do-	-do-	28.29
ITMU	Intellectual property management and transfer, commercialization of agril technology scheme (up-scaling of existing component i.e., IPR under ICAR Hqs. schemes on management of information services	-do-	-do-	23.52

*Budget demand.

E. Revenue Generation

S. No.	Realisation of Revenue Receipt	Amount (Rs. in lacs)
1	Farm Produce	34.29
2	Miscellaneous	17.92
	Total	**52.21**

F. Revolving Fund: KVK, Lucknow

Rs. 84586 revenue was generated through seed production of wheat, vermicompost, potato seed, pickles and murrabba of different fruits and vegetables in KVK, Lucknow.

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	0	2	0	5	5	8	5
Agronomy	2	0	2	2	8	6	12	8
Bio-Chemistry (Plant Science)	0	0	1	0	2	2	3	2
Bio-Technology (Plant Science)	1	0	1	0	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	1	2	2	6	4	9	7
Plant Pathology	1	0	2	2	5	4	8	6
Plant Physiology (Ag/Hort. Corps)	1	2	1	0	2	2	4	4
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	1	0	1	1	3	2
Electronics & Instrumentation	0	0	0	1	0	0	0	1
Farm Machinery & Power	1	1	2	2	2	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	2	3	3
Sub Total	**11**	**7**	**24**	**12**	**50**	**40**	**85**	**59**

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	0	1	0	2	0
Plant Breeding	0	0	0	0	1	0	1	0
Agricultural Entomology	0	0	0	1	1	1	1	1
Sub Total	**1**	**1**	**1**	**1**	**3**	**1**	**5**	**2**

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. Technical staff

Functional Group	T-1	T-2	T-3	T-4	T-5	T-6	T(7-8)	T-9	Total
SCS									
Field/Farm Technicians	16	18	21	11	1	1	0	0	68
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	30	19	1	2	0	0	126
Field/Farm Technicians (Motipur)	1	0	1	0	0	0	0	0	2
Total	50	25	31	19	1	2	0	0	128

Functional Group	T-1	T-2	T-3	T-4	T-5	T-6	T(7-8)	T-9	Total
CSP									
Field/Farm Technicians	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	43	25	29	18	1	2	0	0	118
Field/Farm Technicians (Motipur)	1	0	1	0	0	0	0	0	2
Total	44	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	12	10
Private Secretary	1	1
Steno Grade III	7	4
Security Officer	1	0
Subordinate Staff Grade I	16	16
Subordinate Staff Grade II	31	28
Subordinate Staff Grade III	18	18
Subordinate Staff Grade IV	9	8
Sub Total	**133**	**122**
Upper Division Clerk (Motipur)	1	1
Subordinate Staff Grade 1 (Motipur)	1	1
Total	**135**	**124**

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)

Ratoon was initiated after harvesting autumn planted sugarcane (CoSe 92423) that was intercropped with linseed. The plant crop consisted of 6 intercrop treatments viz. T_1-Sugarcane at 90 cm row spacing + linseed cv Parvati (1:3 row ratio); T_2-Sugarcane + linseed cv Garima (1:3); T_3-Sugarcane + linseed cv Parvati (1:4); T4-Sugarcnae + linseed cv Garima (1:4); T_5-Sugarcane + linseed cv Parvati (broadcast); T_6-Sugarcane + linseed cv Garima (broadcast), T_7-Sole sugarcane (90 cm row spacing); T_8- Sole linseed cv Parvati (20 cm row spacing with 45 kg seed ha^{-1}) and T9- Sole linseed cv Garima (25 cm row spacing with 30 kg seed ha^{-1}).

Ratoon initiated from autumn planted sugarcane sole crop produced highest number of millable canes and cane yield (74.4 t ha^{-1}). This was closely followed by sugarcane + linseed cv. Parvati (1:3) intercropping system (71.3 t ha^{-1}). Thus, the autumn planted sugarcane (cv. CoSe 92423) may be intercropped with linseed (cv. Parvati) in 1:3 row ratio for enhancing vertical land productivity, without much loss in successive ratoon yield.

Agronomic evaluation of promising genotypes of sugarcane (AS 42)

An experiment was conducted to evaluate three sugarcane genotypes (CoLk 9709, CoPant 02217 and CoLk 5202) 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 fertilizer schedules in different cropping seasons. Initial analysis indicated that soil was low in organic carbon (0.45%), and available nitrogen (215 kg ha^{-1}) and medium in phosphorus (32.2 kg P_2O_5 ha^{-1}) and potassium (210 kg K_2O ha^{-1}) contents.

Spring season crop

In spring planting situation, genotype, CoPant 02217 produced the highest number of millable cane (103700 ha^{-1}) but it was at *par* with genotype CoLk 9709 (99830 ha^{-1}). There was no significant difference in individual cane length between these two genotypes. However, the highest cane length (238 cm) was measured with CoLk 5202. Genotype, CoLk 5202 produced thicker (2.34 cm mean cane diameter) and heavier canes (1163 g individual cane weight) as compared to other genotypes. Significantly higher cane yield (82.91 t ha^{-1}) was harvested with genotype, CoLk 9709. The maximum sugar yield (10.42 t ha^{-1}) was also obtained with genotype, CoLk 9709. Growth parameters and yield increased up to 150, 60, 60 kg NPK ha^{-1}. Recommended level of NPK i.e., 150, 60 and 60 kg ha^{-1} fetched significantly higher cane (81.2 t ha^{-1}) and sugar yields (9.59 t ha^{-1}) over 75% of recommended NPK.

Summer season crop

Significantly higher number of millable cane (85080 ha^{-1}) was counted with sugarcane genotype, CoPant 02217. Individual cane length (159.4 cm) was significantly higher with genotype, CoLk 9709 compared to other genotypes. The highest individual cane diameter (2.32 cm) was measured with CoLk 5202. The single cane weight (772.2 g) was also highest with CoLk 5202. Genotype, CoLk 9709 produced significantly highest cane (54.34 t ha^{-1}) and sugar yields (7.68 t ha^{-1}). Number of millable canes (77110 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. Juice quality could not produce tangible differences among various treatments. Significant increase in cane (50.92 t ha^{-1}) and sugar yields (6.78 t ha^{-1}) were obtained up to recommended NPK levels (150, 60, 60 kg NPK ha^{-1}).

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

The effect of soil moisture on germination and growth of shoot and roots of bud chip raised seed stocks was studied using different soil moisture levels (7, 10, 15 and 20%) in soil tray culture conditions.

Germination of bud chip raised seed material was very early (8 days after planting) and maximum (88%) at 20% soil moisture. It was greatly reduced to 64% and 4% at 10 and 7% soil moisture, respectively. A significant reduction in germination was at 10% soil moisture and near total inhibition in sprouting and growth of shoot and root was noted at 7% soil moisture. Plant vigour, plant height and shoot weight were maximum at 15% soil moisture. These parameters were reduced markedly at 10% soil moisture level as compared to 15 and 20% soil moisture conditions. It suggests that 15-20% soil moisture is sufficient for higher rate of germination, rooting activity, plant vigour and early growth of bud chips.

Bud chips stored in polyethylene bags after fungicide treatment and maintained at 10 ±1°C (low temperature conditions) exhibited about 80% bud germination 10 days after storage than ones (about 40%) stored at room temperature. Plant vigour remained unchanged if stored at low temperature conditions. With time of storage from 0 day to 10 days, growth attributes viz., fresh weight of shoot and root, root number, shoot length and leaf area decreased after six days if stored at ambient condition (25°C) as compared to one which was stored at low temperature conditions (10°C). The results indicate that if bud chip seed material stored at low temperature conditions, it will remain viable even for 10 days. In bud chips, moisture content was within the range of 70-75% during storage.

The bud chips of sugarcane variety, CoSe 92423 were soaked in graded concentrations of ethephon *viz*., 50, 100, 200 and 400 mg l^{-1} along with control (water soaked) for 24 hr. Sugarcane bud chips soaked in ethephon solution (50 to 200 mg l^{-1}) recorded higher bud sprouting and early plant vigour. Plant height, root number, leaf area, fresh and dry weight of shoot and roots showed improvement due to ethephon treatment. Treatment with ethephon increased the contents of total phenols, IAA in shoot tips and chlorophyll, carotenoids, soluble protein, proline, catalase and peroxidase activity in leaves. The maximum increase was recorded at 200 mg l^{-1} ethephon level. Results suggest that the treatment with 50-200 mg l^{-1} ethephon helped in improving bud sprouting, rooting activity, plant vigour, tillering and rate of photosynthesis by altering some of the key biochemical activities essential for the early growth which perhaps reflected in their better establishment compared to untreated bud chips.

Pre-soaking bud chips in different growth regulating chemicals *viz*., calcium chloride, KH_2PO_4, NAA, ethrel, $MnCl_2$, $ZnSO_4$, and thiourea showed an improvement in bud sprouting and plant vigour. Rooting weight was the highest with NAA treatment. Different varieties showed variable reaction to ethephon application for germination of bud chip seed stocks. Among different varieties tested, variety BO 91 exhibited the highest germination (80%) using bud chip seed material. Variety Co 1148 showed the highest improvement in germination due to ethephon application. Bud chips planted in rows filled with farm yard manure improved germination by 23%.

Drought management in sugarcane (AS 56)

Ratoons were initiated from the experimental treatments consisted 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 (Control-recommended practices; 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 60 DAP + addition of FYM @ 10 t ha^{-1} in the furrows before planting; 2nd treatment + additional 60 kg K_2O ha^{-1} at last irrigation; 2nd treatment + additional 60 kg K_2O ha^{-1} at 170 DAP) in strip-plot design replicated thrice.

Ratoon initiated from sugarcane at 60 cm spacing produced significantly highest number of millable cane (144.8 thousand ha^{-1}). Ratoon of pit planting produced significantly higher cane (74.9 t ha^{-1}) as well as sugar yield.

Residual effect of drought management treatment involving lime water soaking of setts + Urea and KCl spray + FYM + K application at 170 DAP in plant crop recorded the highest NMC (148.37 thousand ha^{-1}) and cane yield (76.2 t ha^{-1}).

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. Following five treatments were laid out in RBD with four replications. Sugarcane (cv. CoS 94257) was planted in first week of March 2006.

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).

Plant - ratoon system (2nd cycle)

The highest numbers of millable cane in plant (103.6 thousand ha^{-1}) in T_3 and ratoon (104.8 thousand ha^{-1}) in T_2 were recorded (Table 2.1). The highest cane yield of both plant crop (79.0 t ha^{-1}) and ratoon cane (74.2 t ha^{-1} t ha^{-1}) were recorded with T_5 (75% recommended N through inorganics + 25% through organic manures + biofertilizers + biopesticides) and closely followed by 77.5 t ha^{-1} cane in plant crop and 73.5 t ha^{-1} cane in ratoon crop both with T_4 (75% of recommended N through organics + biofertilizers + 25% of recommended NPK through inorganics + biopesticides). Juice quality remained unaffected by these treatments.

There was an improvement in soil organic carbon content under different organic farming modules at the harvest of ratoon crop against its initial value of 0.37%. Soil fertility status in terms of available contents of N, P and K was maintained in all the organic nutrition modules after harvest of sugarcane plant-ratoon crop.

Plant crop(3rd cycle)

The highest number of millable cane (112.0 thousand ha^{-1})was recorded in T_3 (recommended N through organics (vermicompost)+biofertilizers+ intercropping of legume (*Rhizobium* inoculated) + control of pests/ diseases through biopesticides mode) and was closely followed (111.6 thousand ha^{-1}) in T_2 (recommended N through organics (vermicompost) + biofertilizers +intercropping of legume with *Rhizobium*+ control of pests/ diseases through chemical mode). The highest cane yield of plant crop (84.0 t ha^{-1}) was recorded with T_5 (75% recommended N through inorganics + 25% through organic manures + biofertilizers + biopesticides) closely followed by T_4 (75% of recommended N through organics + biofertilizers + 25% of recommended NPK through inorganics + biopesticides). Juice quality remained unaffected due to these treatments.

There was an improvement in soil organic carbon under different organic farming modules at the harvest of plant crop. The magnitude of increase in organic carbon content was highest under T_2 and T_3 against initial value of 0.34%. However, a definite trend for soil available contents of N, P and K in relation to these treatments could not be observed.

Table 2.1: NMC, cane yield and soil organic carbon as influenced by different organic farming modules

Treatment	NMC (000 ha^{-1})		Cane yield (t ha^{-1})		Soil organic C(%)	
	Plant	Ratoon	Plant	Ratoon	Plant	Ratoon
T_1	101.5	97.5	74.0	70.8	0.55	0.55
T_2	102.7	104.8	72.7	69.3	0.65	0.66
T_3	103.6	103.7	73.4	69.5	0.65	0.67
T_4	103.0	101.5	77.5	73.5	0.64	0.65
T_5	102.8	99.7	79.0	74.2	0.62	0.62
C.D. (0.05)	-	-	2.76	2.34	-	-

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

Field experiment was conducted to study the effect of sub-soiling treatments on soil physico-chemical conditions and sugarcane yield. The treatments consisted of 5 sub-soiling treatments viz., No sub-soiling, sub-soiling at 1.0 m distance, sub-soiling at 1.5 m distance, cross sub-soiling at 1.0 m distance and cross sub-soiling at 1.5 m distance and two preparatory tillage viz., four harrowings and two harrowings. The experimental design was strip plot with three replications.

Sugarcane variety CoSe 92423 was taken for the experiment. Sub-soiling was done with tractor-mounted sub-soiler up to a depth of 35-40 cm. Higher infiltration rate (4.77 mm hr^{-1}) and lower bulk density (1.24 M m^{-3}) were recorded under cross sub-soiling at 1.0 m distance. The germination was not affected by tillage treatments. The cross sub-soiling at 1.0 m distance recorded significantly highest shoot population (242.5 thousand ha^{-1} at 180 DAP), numbers of millable cane (172.6 thousand ha^{-1}), cane (82.7 t ha^{-1}) and sugar (9.12 t ha^{-1}) as compared to control. This treatment was followed by cross sub-soiling at 1.5 m distance and sub-soiling at 1.0 m distance. Preparatory tillage did not exhibit any impact on the growth and yield of sugarcane.

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

With an objective to economise the use of seed cane through sett size (three, two and one-bud sett), seed rate (80,000 and 1,20,000 buds ha^{-1}) and seed treatment (dipping of setts in carbendazim (0.01%) for 15 minutes and carbendazim + GA3 (100 ppm), a field experiment was carried out in factorial RBD with three replications using sugarcane variety CoSe 92423 in the study.

The germination of cane buds recorded at 30, 45 and 60 DAP was found significantly higher under 3-bud setts planting as compared to 2 and 1-bud setts (Table 2.2). This trend reflected to growth and yield of cane. Accordingly the cane yield of 3-bud setts planting (70.74 t ha^{-1}) was significantly higher to 2-bud (63.74 t ha^{-1}) and 1-bud (55.47 t ha^{-1}) setts planting. An increased seed rate did not affect germination of cane buds but it had a significant effect on the growth and yield of seed cane. Dipping of cane setts in 100 ppm GA3 solution for 15 minutes exerted significantly adverse effect on germination of cane buds, population of shoots and millable canes and cane yield than that obtained with dipping of setts in carbendazim for 15 minutes.

2.2 Ratoon management in sugarcane

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

The simultaneously initiated plant and ratoon crops grown in same season were compared for nutrient uptake and dry matter accumulation pattern in relation to changes in rhizospheric environment. In spite of well-established root system, advanced sprouting and tillering during the formative phase (till 90 DAP), dry matter accumulation and nutrient uptake were lower in ratoon crop than plant crop. Lower dry matter of ratoon plants was due to decrease in nutrient uptake in ratoon crop at every stage of growth. This behavior however was more apparent during the grand growth phase (120-210 days after planting). An increase in soil respiration, enzymatic activities, total phenol and decline in pH was observed in ratoon rhizosphere. Root cation exchange capacity, membrane leakage and nitrate reductase activities initial vivo decreased by 19.4, 11.2 and 25.9% respectively in

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

Treatments	Germination at 45 DAP (%)	Shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (%)
Sett size					
1-bud	19.57	169	101	55.47	11.37
2-bud	30.47	184	112	63.74	11.55
3-bud	32.28	225	120	70.74	11.58
CD (0.05)	1.64	8.56	7.52	2.04	NS
Seed rate Buds ha^{-1}					
80,000	25.41	185	107	62.04	11.52
1,20,000	23.59	200	115	64.46	11.44
CD (0.05)	NS	8.18	4.82	1.36	NS
Seed treatment					
Carbendazim	29.71	200	114	64.60	11.47
Carbendazim + GA_3	25.17	184	108	62.04	11.48
CD (0.05)	1.34	8.18	4.82	1.36	NS

ratoon cane as compared to plant cane at every stage of growth. These alterations led to decline in uptake of nitrogen, phosphorus and potassium by 26.04, 42.3 and 35.7%, respectively and suppression in development of assimilatory apparatus by 27.4% in ratoon cane affecting dry matter accumulation (15.8%) adversely.

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

A field experiment was initiated in spring 2003 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 physical, chemical and biological properties of soil on long term basis. The highest cane yield of 5th ratoon (60.5 t ha^{-1}) was recorded with SPMC + *Gluconacetobacter* against the planted cane yield of 77.5 t ha^{-1} and 1st ratoon yield of 80.8 t ha^{-1} (Table 2.3). This was followed by SPMC (57.9 t ha^{-1}) and FYM + *Gluconacetobacter* (55.2 t ha^{-1}). The growth and yield attributing characters viz., dry matter production, number of millable cane, cane length, cane thickness and weight also exhibited similar trend. Juice quality viz., brix and sucrose % did not differ significantly by the different treatments.

Soil organic carbon ranged between 0.64% to 0.69% under different treatments of biomanuring, over its initial value of 0.32%. Soil microbial activities enhanced due to different biomanurial treatments. The highest value of soil microbial biomass carbon (SMB-C) of 268.70 mg CO_2-C kg^{-1} soil day^{-1} was recorded under plots receiving SPMC + *Gluconacetobacter* against initial value of 47.60 mg CO_2-C kg^{-1} soil day^{-1}.

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

In the plant cane under 2nd crop cycle, germination of cane buds did not differ (Table 2.4) significantly due to increased seed rates. The gaps observed at 45 days after planting decreased from 22.01% to 1.89% with increasing seed rate from 30,000 three-bud setts ha^{-1} to 60,000 three-bud setts ha^{-1}. However, the number of shoots, millable canes and cane yield increased significantly with increasing planting density from 30,000 to 60,000 three-bud setts ha^{-1} to reach at their maximum level with the planting density of 60,000 three-bud setts ha^{-1}. Gap filling with 3-bud setts at 45 DAP produced 88.34 t ha^{-1} cane being 15.96% more than that obtained without gap filling (74.24 t ha^{-1}). Application of 80 kg ha^{-1} K through irrigation water, one month before plant cane harvesting could not produce any significant difference in the yield of sugarcane plant crop. CCS% cane was more or less similar in different treatments.

The gaps in the first ratoon crop (1st crop cycle) of sugarcane (CoSe 92423) decreased progressively from 35.60% to 9.10% when raised with increasing planting density from 30,000 to 60,000 three-bud setts ha^{-1}

Table 2.3: NMC, cane yield, soil organic carbon content and soil microbial biomass carbon (SMBC) of 5th ratoon under different biomanurial treatments

Treatments	NMC ('000 ha^{-1})	Cane length (cm)	Cane yield (t ha^{-1})	Organic C (%)	SMBC (mg CO_2-C kg^{-1} Soil d^{-1})
T_0 - Control	60.0	105.0	24.8	0.37	160.45
T_1 –Trash @ 10 t ha^{-1} +*Trichodarma*	67.3	125.5	40.0	0.64	267.63
T_2 -Vermicompost @ 10 t ha^{-1}	80.7	136.4	54.5	0.64	246.78
T_3 – FYM @ 10 t ha^{-1}	81.3	135.0	55.0	0.65	247.50
T_4 - Biogas slurry @ 10 t ha^{-1}	80.6	134.8	54.8	0.65	235.91
T_5 – SPMC @ 10 t ha^{-1}	85.4	143.5	57.9	0.69	268.50
T_6 - T_1+ *Acetobacter*	67.0	122.5	42.3	0.64	278.52
T_7 - T_2+ *Acetobacter*	80.8	136.1	54.6	0.65	251.74
T_8 - T_3+ *Acetobacter*	81.9	135.3	55.2	0.65	253.92
T_9 - T_4+ *Acetobacter*	80.8	135.0	54.5	0.65	250.18
T_{10} - T_5+ *Acetobacter*	85.9	144.0	60.5	0.69	268.70
T_{11} – *Dhaincha*+*Acetobacte*r	79.7	136.0	53.0	0.65	161.65
T_{12} – NPK (120:60:60 kg ha^{-1})	81.6	143.8	53.8	0.49	139.76
C.D. (0.05) /Initial	5.50	6.15	4.25	0.32	47.60

(Table 2.5). Consequently, the number of shoots and millable canes and cane yield increased in ratoon cane with every increase in the level of planting density from 30,000 to 60,000 three-bud setts ha^{-1}. Gap filling in plant crop with 3-bud setts at 45 DAP produced 81.74 t ha^{-1} ratoon cane being 16.15% more than that obtained without gap filling (68.54 t ha^{-1}). Application of 80 kg K ha^{-1} through irrigation water in plant cane before one month of harvesting produced significantly higher ratoon cane to the tune of 12.03% over no K application in plant cane (70.33 t ha^{-1}). CCS % cane did not yield any significant difference due to different treatments in the study.

Table 2.4 : Effect of seed rate, gap filling and K application on plant crop of sugarcane

Treatments	Germination (%)	No. of shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (%)
Seed rate (Nos. of 3-bud setts ha^{-1})					
30,000	33.92	155	111	68.08	11.42
40,000	36.74	179	119	79.91	11.67
50,000	34.66	208	126	85.01	11.31
60,000	37.13	229	134	92.15	11.88
CD (5%)	NS	8.94	5.94	4.81	NS
Gap filling					
No gap filling	37.13	181	117	74.24	11.54
Gap filling with 3-bud setts at 45 DAP	34.09	205	128	88.34	11.60
CD (5%)	NS	7.62	4.76	4.25	NS
K application					
No K	34.92	195	124	80.34	11.48
80 kg K ha^{-1} through irrigation water before one month of plant cane harvesting	36.30	191	121	82.24	11.66
CD (5%)	NS	NS	NS	NS	NS

Table 2.5: Effect of seed rate, gap-filling and K application followed in planted sugarcane on growth and yield of sugarcane ratoon

Treatments given in planted sugarcane	Effect on sugarcane ratoon					
	No. of clumps (000 ha^{-1})	Gaps (%)	No. of shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (%)
Seed rate (Nos. of 3-bud setts ha^{-1})						
30,000	20.46	35.60	234	107	63.88	11.30
40,000	23.77	24.90	258	114	72.24	11.25
50,000	27.25	18.50	284	123	78.35	11.40
60,000	31.19	9.10	306	132	86.09	11.45
CD (5%)	3.88	4.82	12.62	5.56	4.66	NS
Gap filling						
No gap filling	22.46	24.65	254	114	68.54	11.25
Gap filling with 3-bud setts at 45 DAP	28.88	19.40	284	124	81.74	11.45
CD (5%)	3.33	3.21	11.03	5.32	4.19	NS
K application						
No K	23.74	23.90	260	115	70.33	11.22
80 kg K ha^{-1} through irrigation water before one month of plant cane harvesting	27.59	20.15	281	123	79.95	11.48
CD (5%)	3.33	3.21	11.03	5.32	4.19	NS

Causes of low physiological efficiency of sugarcane ratoon (Exploratory trial)

The plant and ratoon crops were initiated simultaneously to record their growth, nutrient concentration, dry matter accumulation and growth analysis parameters at each stage. It was observed that in ratoon cane although initial LAI and canopy coverage was more but after 210 days of growth, these parameters along with nutrient loss, growth and dry matter accumulation started to decline. Such decline led to poor yield in ratoon, also because of reduced NAR, LAR, LAD and biomass duration. Intensity of decline of these parameters was more in ratoon compared with plant cane.

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

In order to improve sprouting of stubble buds in winter-initiated ratoons, the first ratoon of sugarcane variety CoSe 92423 was harvested on December 26-28, 2007 and 36 treatments were applied (including one pre-harvest foliar treatment on December 18, 2007). Afterwards, at fortnightly intervals, number of shoots were counted up to June end. In the second fortnight of October, 2008, number of millable canes (NMC) were counted. In the second fortnight of December, 2008, cane yield of individual plot was recorded and average cane weight (ACW) was computed. Based on the initial population (15 days after the treatment when counting started), maximum number of tillers produced (T_{max}), NMC, ACW and cane yield, in all the treatments, cumulative rating for various treatments was worked out. For arriving at a rating for individual character, the range of performance (Table 2.6) was divided into 4 equi-spaced ranges, 1, 2, 3 and 4 . These numbers were added for the above mentioned five characters to arrive at a relative cumulative rating for a particular treatment. Cumulative rating for 8 best treatments is given in Table 2.6.

A study was conducted to work out the influence of low temperature (6±1 °C) incubation of setts of 2 early ripening varieties (CoJ 64 and CoS 96268) and mid-late ripening varieties (CoSe 92423 and CoS 767) for ten days and then shift to 25± 1 °C, for 13 days.

At 6±1 °C, buds in both the varieties did not germinate, however, when shifted to 25± 1 °C, germination in the mid-late ripening varieties was quicker as compared to early ripening ones.

Dry weight of buds did not change when setts were kept at 6±1 °C for 10 days, however when shifted to 25± 1 °C, dry weight of sprouted buds at 25± 1 °C increased. But it could not be observed a group response with respect to early or mid-late ripening varieties. Moisture content in the buds in setts placed at 6±1 °C for 10 days increased in the varieties except for CoS 767. It further increased when the setts were shifted to higher temperatures of 25± 1 °C. Initially early ripening varieties exhibited higher total carbohydrates (Tc) contents than the mid-late ripening varieties. After incubating at 6±1 °C for 10 days, Tc decreased in all the varieties. It further decreased when setts were shifted to 25± 1 °C. Early ripening varieties as a group, always maintained higher Tc as compared to mid-late ripening varieties.

Sucrose content in the buds was higher in the early ripening varieties as compared to mid-late ripening varieties studied. After incubation at 6±1 °C for 10 days, sucrose content decreased in all the varieties. It further decreased in sprouted buds when the setts were placed at higher temperatures of 25± 1 °C. Reducing sugars in the buds were invariably higher in CoJ 64 as compared to all other varieties. After incubating at low temperatures of 6±1 °C for 10 days,

Table 2.6: Efficacy of different formulations on winter initiated ratoon

Treatments	Rating for character					
	Initial population	T_{max}	NMC	ACW	Cane yield	Cumulative rating (out of 20)
Formulation-1	4	3	4	3	4	18
Formulation-2	2	4	4	2	4	16
Formulation-3	3	3	4	2	4	16
Formulation-4	4	3	2	4	3	16
Formulation-5	2	3	2	4	4	15
Formulation-6	2	3	2	4	4	15
Formulation-7	4	2	3	3	3	15
Formulation-8	4	3	3	2	3	15

reducing sugars decreased in all the varieties except for Co J 64, where it increased. In all other varieties at 25± 1 °C, it increased but in CoJ 64, it decreased. It appears therefore, that buds did not germinate when setts of early as well as mid-late ripening varieties were kept at 6±1 °C for 10 days. When these were shifted to 25± 1 °C, buds of early ripening varieties germinated rather slowly as compared to the mid-late ripening varieties.

Low-temperature-induced biochemical changes in bud and root band zone of the sugar cane setts suppress sprouting in ratoon crops. A study was undertaken to modulate these biochemical changes using potassium, zinc, and Ethrel to enhance the sprouting of buds at 5 and 10 °C. Application of potassium, zinc, and Ethrel led to 80, 50 and 40% improvement in bud sprouting at 5 °C, respectively. An increase in reducing sugars and a decrease in sucrose contents were also recorded. Acid invertase, adenosine tri-phosphatase, indoleacetic acid oxidase, and nitrate reductase *in vivo* activities were also enhanced. However, treatments led to a significant decline in indoleacetic acid, total phenols, and superoxide dismutase activity, which rendered the *in situ* toxicity build up in sets at low temperatures.

A study was undertaken to enhance the stubble bud sprouting under low temperature conditions by application of calcium (as $CaCl_2$), potassium (as KCl) and manganese (as $MnCl_2$) each at the rate of 0.5% solution. Stubble bud sprouting under controlled condition was about 64.3%, 73% and 68.7% due to application of calcium, potassium and manganese treatment, respectively, as compared to control (46.0%). The number of tillers per stubble, recorded 60 days after ratoon initiation was 157%, 57% and 85.7% more in the calcium, potassium and manganese treated stubble, respectively. Weight of buds, tillers and roots were maximum with manganese treatment followed by calcium and potassium treatments. Results suggest an improvement in stubble bud sprouting and subsequent re-growth of stubble in winter-initiated ratoon by nutrient application, which may help in enhancing ratoon productivity.

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

The winter ratoon was initiated in the first week of January, 2008. All the treatments were given as per the technical programme (Table 2.7). Application of 20 t ha^{-1} SPM or 10 t ha^{-1} SPM + 25 kg ha^{-1} zinc sulphate improved the bud sprouting and significantly produced maximum number of shoots. A significant increase in number of millable canes was noticed with the application of 20 t ha^{-1} SPM (99900 ha^{-1}) and 10 t ha^{-1} SPM + 25 kg ha^{-1} $ZnSO_4$ (99600 ha^{-1}). Highest cane yield (70 t ha^{-1}) was also recorded with application of 20 t ha^{-1} SPM followed by 10 t ha^{-1} SPM + 25 kg $ZnSO_4$ ha^{-1} (68.5 t ha^{-1}). Thus, it clearly suggests that productivity of winter ratoon can be enhanced through application of 20 t ha^{-1} SPM or 10 t ha^{-1} SPM + 25 kg $ZnSO_4$ ha^{-1}. Juice quality remained unchanged.

Table 2.7: Effect of treatments on number of shoots, NMC, cane yield and pol % juice of winter started ratoon (2008-09)

Treatment	Number of shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
T_1-Recommended practice (control)	248.6	94.4	59.0	16.5
T_2-One irrigation in plant crop 30 days before ratooning followed by irrigations at 15 days interval during winter (up to 1st week of Feb.)	252.3	92.1	60.4	16.5
T_3-Application of sulphitation pressmud cake (fresh) @ 20 t ha^{-1} at ratooning	279.0	99.9	70.0	16.7
T_4-Application of 60 kg K_2O ha^{-1} 30 days before ratooning	254.0	92.5	60.8	16.5
T_5-Intercropping of legume, Senji (*Melilotus alba*), in ratoon for green manure	256.0	92.7	61.6	16.7
T_6-Soil application of $ZnSO_4$ @ 25 kg ha^{-1} 30 days before ratooning	248.0	91.0	59.6	16.3
T_7-Soil application of 60 kg K_2O+ 25 kg $ZnSO_4$ ha^{-1} 30 days before ratooning with irrigation	247.0	92.3	61.0	16.9
T_8-Soil application of 25 kg $ZnSO_4$ ha^{-1} + SPMC (fresh) @ 10 t ha^{-1}	266.3	99.6	68.5	16.8
C.D. (5%)	9.20	5.51	3.95	NS

SPMC – Sulphitation pressmud cake, NMC - Number of millable cane, NS - Not significant

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)

Ratoons were initiated from two separate field experiments conducted on eight early maturing and eight midlate maturing sugarcane genotypes with spring planting under flat system. Early maturing genotypes included CoS 95270, CoS 96258, CoH 92201, BO 130, CoS 96268, CoPt 98224, BO 128 and CoLk 94184; and mid-late genotyes were CoJ 20193, CoS 99259, CoS 96275, CoPt 99214, CoH 110, CoH 119, CoLk 9616 and CoJ 99192.

Early sugarcane genotypes

Ratoon of the sugarcane genotype CoLk 94184 produced the highest number of millable cane (137.1 thousand ha^{-1}), cane yield (61.8 t ha^{-1}), followed by BO 128 (57.5 t ha^{-1}) and CoS 95270 (54.4 t ha^{-1}). Application of 150 kg N ha^{-1} + 10 t FYM ha^{-1} gave the highest NMC (134.1 thousand ha^{-1}) and cane yield (64.5 t ha^{-1}). CoLk 94184 was observed to be the most efficient genotype for nitrogen use both with (219.9 kg cane kg^{-1} N) and without FYM (73.3 kg cane kg^{-1}N). The genotype CoS 96268 and CoS 95270 were also identified efficient ones.

Mid-late sugarcane genotypes

Amongst mid-late sugarcane genotypes, significantly highest number of millable cane (154.8 thousand ha^{-1}) and cane yield (57.9 t ha^{-1}) were recorded for ratoon of CoH 110, which was however, at *par* with CoLk 9616. The nitrogen use efficiency of these two genotypes was higher than others. Ratoon of genotype CoPt 99214 was identified as most efficient with NUE of 286.7 kg cane kg^{-1} N at 150 kg N ha^{-1} + 10 t FYM ha^{-1}. The nitrogen use efficiency of CoLk 9616 worked out to be 237.9 kg cane kg^{-1} N at 150 kg N ha^{-1} + 10 t FYM ha^{-1}. Ratoon of mid-late genotypes produced highest tillers (140.4 thousand ha^{-1}) and yield (64.4 t ha^{-1}) at 10 t ha^{-1} FYM + 150 kg N ha^{-1}.

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

This experiment was started during spring season (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 of inorganic and organic combinations at three nitrogen doses were laid out in factorial RBD with three replications.

The results obtained from first ratoon crop of sugarcane revealed that maximum cane (62.5 t ha^{-1}) and sugar yield (7.49 t ha^{-1}) were recorded in M_6 treatment (50% N through inorganic source and 50% N through organic source) which was significantly higher than M_1 treatment (100% N through inorganic source). The yield attributing characters e.g. millable cane, cane length, cane diameter and cane weight also showed the similar results (Table 3.1). Maximum cane yield (65.06 t ha^{-1}) was observed in N_3 treatment (225 kg N ha^{-1}), which was at *par* with N_2 (150 kg N ha^{-1}) and both were significantly higher than N_1 (75 kg N ha^{-1}) treatment. The higher soil organic carbon content (0.55%) was observed with M_6 treatment compared to M_1 (0.47%) treatment. It indicates the improvement in soil fertility level due to increase of rate of organic source of N application compared to inorganic source above.

Table 3.1: Influence of different treatments on yield and yield attributes of sugarcane ratoon crop

Treatments	Millable cane (000 ha^{-1})	Cane yield (t ha^{-1})	Cane length (cm)	Cane diameter (cm)	Cane wt (g)	Sugar yield (t ha^{-1})
Inorganic and organic combinations						
M_1 100% N through inorganics	83.97	57.10	155.67	2.13	604.67	6.20
M_2 90% N through inorganics + 10% through organics	86.33	58.00	157.67	2.17	615.68	6.45
M_3 80% N through inorganics + 20% through organics	89.65	60.23	163.33	2.27	637.11	6.78
M_4 70% N through inorganics + 30% through organics	92.51	63.10	165.00	2.27	642.35	7.18
M_5 60% N through inorganics + 40% through organics	94.46	64.73	168.33	2.27	653.91	7.42
M_6 50% N through inorganics + 50% through organics	97.22	65.20	175.00	2.33	674.44	7.49
CD (5%)	4.82	4.28	8.44	0.094	24.50	0.88
Nitrogen doses (kg ha^{-1})						
N_1 75	77.44	57.03	146.00	2.10	603.80	6.14
N_2 150	92.72	62.08	165.66	2.30	614.48	7.13
N_3 225	101.89	65.06	180.83	2.40	695.79	7.50
CD (5%)	3.50	3.01	5.96	0.066	16.50	0.64

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

This year, the experiment was conducted to study the effect of nutrient application on the grain yield and nutrients uptake by wheat and paddy grown under the plant cane-first ratoon-second ratoon-wheat-paddy cropping system. The treatments given to both crops included a control (no fertilizer/manure), N, NP, NK, NPK, NPK+S, NPK+Zn, NPK+Cu, NPK+Mn and NPK+Fe. These were replicated four times in a RBD design. The results indicated that the grain yield of both crops increased well over control by the application of nitrogen. The percent increase over control was 272% for wheat yield and 59.2% for paddy yield. The application of other nutrients individually with N resulted in very less magnitude of yield increase and the differences were not significant over N application. Uptake of nutrients by both crops also increased well over control by application of N. Further increase in uptake of nutrients by P and K with N was not observed over N. Integration of micronutrients with NPK also could not increase the uptake over NPK application. Fertility status of the soil remained unaffected by the nutrient management and cropping system.

Agronomy of new sugarcane genotypes (Expl. Trial)

Ratoons were initiated from two 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 and spacings while sub plots contained 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 number of millable cane (122.4 thousand ha^{-1}) and cane yield (62.8 t ha^{-1}) as compared to CoLk 97147. Higher ratoon cane yield was recorded at narrow spacing. Application of 150 and 225 kg N ha^{-1} significantly improved NMC and yield. The nitrogen use efficiency worked out to be higher at 75 kg N ha^{-1}, the values being 161.1 kg cane kg^{-1} N for CoLk 94184 and 210.8 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.

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

Ratoons were initiated from two sets of field experiments consisting of 16 genotypes (8 early : CoS 95270, CoS 96258, CoH 92201, BO 130, CoS 96268, CoPt 98224, BO 128, CoLk 94184 and 8 mid-late: CoJ 20193, CoS 99259, CoS 96275, CoPt 99214, CoH 110, CoH 119, CoLk 9616, CoJ 99192) planted in ring-pit system with 4 N levels (0, 150 kg ha^{-1}, 10 t ha^{-1} FYM and 150 kg N ha^{-1} + 10 t ha^{-1} FYM) in split-plot design replicated thrice.

The treatments as applied to plant crop were also imposed in successive ratoon crop. Among early genotypes, the highest NUE was worked out for BO 130 (239.3 kg cane kg^{-1} N applied) followed by CoS 95270 (209.3 kg cane kg^{-1} N applied). Among mid-late group, genotype CoPt 99214 recorded the highest NUE in third ratoon (264.0 kg cane kg^{-1} N applied) followed by CoS 99259 (253.9 kg cane kg^{-1} N applied) at 150 kg N ha^{-1} + 10 t FYM ha^{-1}.

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

The experiment was conducted to find out the effect of covered pit planting (CPP) and covered trench planting (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 (control). The experiment was laid out in randomized block design with four replications. The planting of experiment was done on 20.2.2008. Significantly higher germination (46.3%) was recorded under CPP over control. Highest number of tillers were recorded under covered trench planting system (150.2 thousand ha^{-1}). However significantly highest cane yield (92.5 t ha^{-1}) was recorded from covered pit planting. The magnitude of increase in yield in CPP was 8.4% compared to not covered (normal) ring-pit planting. The treatment involving planting after deep disc (DDTP) recorded cane yield of 79.2 t ha^{-1}, which was found 22.8% higher than conventional / method of planting.

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

Cane equivalent yield (CEY) in wheat+sugarcane under FIRB system was the highest (121.0 t ha^{-1}) with the net profit of Rs. 26758 over sole sugarcane. However, the CEY and net profit over sole sugarcane were 105.2 t ha^{-1} and Rs. 8455, respectively, in wheat-sugarcane conventional method. Sugarcane ratoon yield was almost equal in sugarcane planted at 60 cm spacing with wheat under FIRB system (87.5 t ha^{-1}) and sugarcane planted at 60 cm spacing after wheat (86.3 t ha^{-1}) and was higher than sugarcane planted with wheat at 90 cm spacing (63.3 t ha^{-1}) and sole sugarcane planted at 90 cm spacing (75.8 t ha^{-1})

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 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. The experiment was done on high sugar genotype, CoS 8436. Thus, 9 treatment combinations were tried under RBD with three replications. Soil treatment with *Gluconacetobacter* produced the highest number of millable cane (72170 ha^{-1}). Other growth attributes of ratoon cane were not affected by *Gluconacetobacter* treatment. Significantly higher cane yield (58.99 t ha^{-1}) was observed with soil treatment compared to sett/ foliar applications. The sugar yield (7.06 t ha^{-1}) also increased with soil treatment of *Gluconacetobacter* by 12% over foliar application. Increasing levels of nitrogen increased millable canes, individual cane length, weight, cane and sugar yields significantly. There was increase of 48.9% in sugar yield with application of 150 kg N ha^{-1} as compared to no N (4.99 t ha^{-1}). Thus, it could be concluded that sett treatment by *Gluconacetobacter diazotrophicus* with application of 150 kg N ha^{-1} simultaneously improved growth, yield attributes and yield in sugarcane.

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 (AE 6.7)

For February planted sugarcane, highest yield (61.55 t ha^{-1}) was recorded with 8 cm depth of irrigation water applied at 1.00 IW/CPE ratio and Irrigation water use efficiency was the highest (1439.3 kg ha^{-1}-cm) with 6 cm depth of irrigation water applied at 0.5 IW/CPE ratio. For spring initiated ratoon crop, highest yield (60.87 t ha^{-1}) was recorded with 8 cm depth of irrigation water applied at 1.00 IW/CPE ratio. However, Irrigation water use efficiency was the highest (1404.7 kg ha^{-1}-cm) with 6 cm depth of irrigation water applied at 0.5 IW/CPE ratio.

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

The highest yield of potato (36.5 t ha^{-1}) was recorded when two rows of potato were planted on raised beds made in between two sugarcane rows planted at 90 cm row spacing, irrigated with 5 cm depth of irrigation water and fertilized organically. However, the lowest potato yield (21.4 t ha^{-1}) was observed when two rows of potato were planted on flat bed in between sugarcane rows at 90 cm row to row spacing, irrigated with 7.5 cm depth of irrigation water and fertilized inorganically. Potato yields were higher when the crops were fertilized with organic fertilizers. The highest (1216.67 kg ha^{-1}-cm) and the lowest (570.67 kg ha^{-1}-cm) irrigation water use efficiencies were recorded in the above raised bed and flat bed planting of potato treatments, respectively.

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 230 genotypes consisting of *S. officinarum, S. barberi, S. sinense*, ISH lines, commercial hybrids, *S. spontaneum*, etc was maintained and the required material was supplied to various on-going projects of the Institute. For identifying newly evolved genotypes to be used as parents in the hybridization programme, twenty-four LG and Ikshu ISH genotypes were evaluated for cane and juice characteristics (Table 4.1). The maximum sucrose (19.51%) in January was recorded in LG 99114, followed by LG 97009 (19.37%) and LG 01118 (19.23%). Maximum juice extraction% was recorded in LG 01016.

Table 4.1: Performance of LG and Ikshu ISH genotypes for cane and quality characters

S. No.	Genotype	Cane length (m)	Cane girth (cm)	Cane weight (kg)	Extraction (%)	Brix % (Jan)	Sucrose (%) (Jan)	Purity (%) (Jan)
1	LG 97147	1.71	2.50	0.88	59.09	20.23	18.00	89.37
2	LG 95053	1.18	2.10	0.40	60.00	17.89	16.27	90.93
3	LG 97050	0.89	1.68	0.40	60.00	18.70	16.70	89.25
4	LG 97032	1.67	1.58	0.40	50.00	18.85	17.02	90.17
5	LG 97009	1.27	2.38	0.58	55.17	21.15	19.37	91.76
6	LG 99164	1.49	2.02	0.62	48.39	19.45	17.46	89.88
7	LG 99001	1.41	2.52	0.64	56.25	19.94	17.99	90.23
8	LG 97022	0.44	1.40	0.10	40.00	18.81	16.31	86.61
9	LG 94126	1.67	2.32	0.80	42.50	19.32	18.27	91.80
10	LG 95056	2.01	2.00	0.60	60.00	18.20	16.22	89.12
11	LG 94114	1.80	1.74	0.64	59.37	20.60	18.10	87.86
12	LG 94001	1.85	1.68	0.46	65.22	19.80	17.82	90.00
13	LG 97023	2.02	1.84	0.58	48.28	20.30	18.33	90.29
14	LG 96115	2.29	2.32	1.04	57.69	20.70	18.39	88.84
15	LG 99114	1.90	2.34	0.88	61.36	21.60	19.51	90.32
16	LG 01118	1.86	2.26	0.74	59.46	21.53	19.23	89.31
17	LG 01016	1.14	1.74	0.21	76.19	19.60	17.51	89.33
18	IkshuISH-4	1.82	1.80	0.52	53.85	17.11	13.38	78.22
19	IkshuISH-1	1.27	1.48	0.28	42.86	16.80	14.99	89.22
20	IkshuISH-22	1.81	2.11	0.42	52.38	18.15	16.05	88.42
21	IkshuISH-23	1.33	1.74	0.60	56.67	17.33	15.23	87.88
22	IkshuISH-24	2.11	1.80	0.62	61.29	16.92	14.62	86.40
23	IkshuISH-21	2.13	1.94	0.70	51.43	15.84	13.74	86.74
24	IkshuISH-16	2.01	2.30	0.78	61.29	18.26	16.27	89.10
Mean		**1.63**	**1.98**	**0.58**	**55.78**	**19.04**	**16.95**	**88.79**
SE		**0.089**	**0.067**	**0.045**	**1.628**	**0.322**	**0.346**	**0.544**
Range	**Max.**	**2.29**	**2.52**	**1.04**	**76.19**	**21.60**	**19.51**	**91.80**
	Min.	**0.44**	**1.40**	**0.10**	**40.00**	**15.84**	**13.38**	**78.22**

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

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

During the year under report, CoLk 94184 (Birendra) was notified by the CVRC for cultivation in the North Central Zone. Five breeding stocks, viz. LG 02057, LG 05433, LG 05434, LG 05460 and LG 05493 were sent to Sugarcane Breeding Institute, Coimbatore for inclusion in the National Hybridization Garden and to study their breeding behaviour. A revised proposal for registration of LG 95053 with the NBPGR was submitted. Three selections with commercial merit and resistance to red rot (LG 02039, LG 02057 and LG 05447) were included in the station trial (2009-10). One of the two entries (LG 01030) from this project in the station trial (2008-09) has done well. Clonal evaluation resulted in about 140 selections being earmarked for further evaluation either for early high sugar accumulation or varietal candidature. Four hundred and sixty-eight selections based on refractometer brix and visual assessment of cane characteristics, were made in the seedling population and planted in the autumn of 2008 for C_1 evaluation. In all, 29 matings were made among breeding stocks developed under this project at NHG, Coimbatore in the 2008 crossing season and the fluff received.

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

Clonal evaluation

Thirty-four C_2 selections were evaluated for their suitability under late-planted condition especially after wheat harvest. Eleven exhibited superiority and advanced to C_3 stage. The progenies derived from CoLk 8102 x LG 72120 and LG 94184 x CoS 8436 biparental hybrids were advanced to C_4 stage on the basis of performance under late planted condition. Ten advanced stage clones were evaluated for their suitability to late planting condition. LG 2618 and LG 2619 were found superior in sugar yield over standards (Table 4.2).

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

Hybridization

Biparental crosses viz., CoLk 8002 x Co 62198, BO 130 x BO 91, Co J 99192 x Co 86002, BO 91 x CoS 8436, BO 91 x (Co 7201 x IND 84-446) and Co 7201 x IK-76-81were attempted at SBI, Coimbatore and the Distant hybridization facility at Agali. In addition, thirteen GCs were collected.

Seedling evaluation

Three thousand ratooned Co seedlings derived from fifteen biparental crosses involving 4 intergeneric hybrids with *Erianthus* sp as male parent, 10 GCs and 4 selfs were evaluated for initial vigour, cane forming ability and HR Brix. The genotypes free from natural infestation of top borer and other diseases and pests and above 21 percent brix during January 2009 were advanced to C_1 stage. Of 360 C_1 genotypes evaluated for top borer tolerance, general vigour and brix, 140 advanced to C_2 stage.

Clonal evaluation

Fifty eight clones derived from 19 biparental crosses, 13 GC and 3 selfs made 2003 of C_2, stage, were evaluated for growth, quality parameter and top borer tolerance. 22 clones advanced to C_3 stage. 24 clones at

Table 4.2: Performance of clones under late-planted condition

S. N.	Variety	Parentage	NMC ('000 ha^{-1})	Yield (t ha^{-1})	Pol% (Feb. 08)	CCS (%)	CCS (t ha^{-1})
1	**LG 2618**	Co S 8436 GC	**98.40**	**79.11**	**19.47**	**13.52**	**10.70**
2	**LG 2619**	Co S 8436 GC	**106.3**	**78.92**	**19.98**	**14.06**	**11.09**
3	CoS 767		84.2	61.8	18.6	12.98	7.92
4	Co 88230		78.3	57.87	18.88	13.38	7.62
5	CoJ 64		119.3	65.24	19.31	13.64	8.90
	CD 5%		**11.0**	**6.82**	**1.04**	**0.98**	**1.43**
	CV %		**13.1**	**9.76**	**4.82**	**3.87**	**8.28**

Table 4.3: Yield and quality attributes of advanced stage clones

Genotype	Germination (%)	Tillers ('000 ha^{-1})	NMC ('000 ha^{-1})	Yield (t ha^{-1})	Pol % Nov.'08	Pol % Feb.'09	CCS %	CCS (t ha^{-1})
LG 2907	60.67	230.67	109.33	93.39	15.56	16.37	10.74	10.03
LG 2923	37.67	149.33	102.67	55.81	15.76	16.56	10.91	11.20
CoJ 64	36.00	91.00	67.33	62.22	17.63	16.36	10.57	6.58
CoS 767	32.00	92.00	72.67	55.66	14.71	17.35	11.59	6.45
CD (5%)	4.63	3.61	17.4	4.69	1.04	1.10	1.53	1.80
CV(%)	11.72	8.65	7.39	9.81	4.79	5.59	6.62	9.74

Table 4.4: Top borer infestation in the advanced stage clones

Genotype	Top borer infestation (%)		Total carbohydrate (mg g^{-1} fwt)	Reducing sugar (mg g^{-1} fwt)	Protein content (mg g^{-1} fwt)
	III rd brood	IV th brood			
LG 2907	4.00	10.00	32.40	8.50	15.30
LG 2923	5.88	9.75	25.6	6.42	13.13
CoJ 64	15.5	10.34	8.3	2.50	3.40
CoS 767	9.09	10.34	20.20	6.46	11.94
CD (5%)	8.38	6.78	2.48	1.49	2.72
CV (%)	12.87	11.98	8.67	5.82	5.72

C_3 stage were evaluated for top borer tolerance, quality and vigour and 18 clones advanced to C_4 stage.

In clonal evaluation, 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 2.70 percent of top borer infestation in Ist and IInd broods, while 3.1 to 4.2 percent in IIIrd to IVth broods indicating the importance of *Erianthus sp.* in top borer tolerance, as one of the parent has component from *Erianthus*.

Eleven clones along with two standards *viz*., CoS 767 and CoJ 64 were evaluated at advanced stage for top borer tolerance and sugar yield. Two clones viz., LG 2907 and LG 2923 possessing superiority in traits of economic importance as above (Table 4.3) were advanced to station trial.

The top borer tolerance was influenced by carbohydrate content, reducing sugars and protein content in leaves as above (Table 4.4). Third brood infestation was negatively correlated with total carbohydrate content in leaves, while reducing sugar and protein content was positively correlated with top borer tolerance. Five genetic stocks (Table 4.5) were sent to Sugarcane Breeding Institute, Coimbatore for inclusion in National Hybridization Garden.

Table 4.5: Genetic stocks for top borer tolerance

Genetic stocks	Cane yield (t ha^{-1})	CCS (%)	CCS (t ha^{-1}) Feb.09	Top borer cumulative infestation (%)
LG 04601	84.2	10.91	9.18	4.38
LG 04602	88.6	10.94	9.69	7.32
LG 04603	74.3	10.70	7.95	6.92
LG 04604	92/3	10.4	9.59	9.42
LG 04605	72.8	9.11	7.99	3.67

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

Hybridization and raising of seedlings

A total of 20 biparental crosses were attempted at National Hybridization Garden, SBI, Coimbatore, during the crossing season 2008. The fluff received for all the crosses along with 10 GCs, was sown in the glass house to raise the seedlings for evaluation. The crosses and GCs recorded good germination.

Seedling evaluation

About 4250 seedlings raised from previous year crosses were transplanted in field condition. Observations were recorded on survival and general growth vigour at early stage.

Evaluation of clonal generation

Based on the HR Brix and general growth performance, ninety-six clones (C_1 clones) were selected from the C_0 population (seedling generation). These clones were planted along with two standards *i.e.* CoJ 64 and CoS 767 in field condition to further evaluate for different traits especially for moisture deficit condition.

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

Proposal of new clone in AICRP (S) for multilocation testing

Genotype CoLk 08201 was proposed during Biennial Workshop of AICRP(S) held at AP University, Vishakhapattanam and accepted for multilocation evaluation in North West Zone.

Identification of high sugar and red rot resistant clone

A high sugar clone LG 99270 possessing moderately resistance reaction against two prevalent pathotypes Cf 08 and Cf 09 of red rot was identified as genetic stock and sent to NHG at Coimbatore for utilization (Fig. 4.1 and Table 4.6).

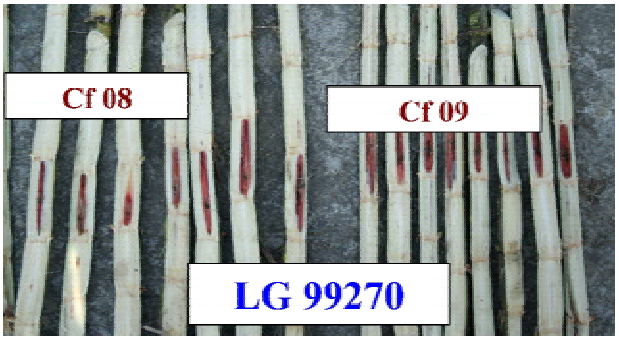


Fig. 4.1 : Reaction of Genotype LG 99270 against red rot pathotypes Cf 08 and Cf 09

Hybridization and raising of seedlings

The crosses viz. CoLk 94184 x Co 62198, Co 1158 x CoLk 8002, Co 1148 x ISH 150, CoLk 7901 x NCo 310,

Table 4.6: Performance of high sugar clone LG 99270

Genotypes	CCS (t ha^{-1})	Cane yield (t ha^{-1})	Sucrose % (October)	Reaction to Red Rot	
				Cf 08	Cf 09
LG 99270 (K 4-8-2)	**11.94**	**87.38**	**18.51**	**MR**	**MR**
CoS 767	9.66	80.53	16.87	S	S
CoS 8436	8.71	82.67	15.08	S	S
CoJ 64	6.87	57.12	17.8	HS	HS

ISH 69 x CoS 88216, CoS 92263 x ISH 69, CoH 76 x Co62198, CoPant 94213 x Co 62198, LG 95053 x ISH 69, CoJ 99192 x Co 86002 CoLk 7901 x CoJ 46 and CoJ 83 x Co 62198 were attempted at NHG, SBI Coimbatore during October - November, 2008. In addition, fluff of 12 zonal crosses containing 9 bi-parental (CoSe 92423 x CoS 8436 Co 7314 x Co 1148 Co 88025 x Co 775 MS 68/47 x Co 1148 CoS 8436 x CoPant 97222 Co 98010 x Co 1148, Co 98008 x Co 775, CoS 8436 x Co 89003 and CoJ 99192 x CoS 8436) and 3 poly crosses (Co 7201 PC, CoS 8436 PC and CoSe 95422 PC) were received for evaluation under this project. The fluff received for these crosses was sown in glass house to raise seedlings. The seedlings will be transplanted during July / August 2009.

Seedling raising and evaluation

A total of 10166 seedlings from 21 crosses were transplanted in July 2008 and February 2009 (seedlings raised in September 2008, part of fluff retained and kept under low temperature).

Evaluation of sugarcane crosses

Observations were recorded on HR Brix%, cane forming tillers and visual score of each stool in ratoon of seedlings raised from 2006 crossing series. A total of 99 clones from 16 crosses (Table 4.7) were selected and planted in the field for multiplication and evaluation along with standards (CoJ 64, CoS 767) during autumn season of 2008.

Evaluation of C_1 clones

A total of 54 clones selected from the ratoon of seedlings from 2005 crossing series on the basis of HR Brix %, cane diameter, green top and yield and other morphological features planted in the field along with three standards (CoS 767, CoS 8436 and CoJ 64) in augmented design for further evaluation. Observations were recorded for germination %, yield and its

Table 4.7: Number of clones selected during 2008 from first clonal generation of different crosses of 2006

S. N.	LG No.	Parentage	No. of selections
1	LG 07001 - LG 07017	CoSe 92423 x CoS 8436 (ZC)	17
2	LG 07018 - LG 07033	UP 9530 x Co 86002	16
3	LG 07034 - LG 07055	81 V 48 x Co 1148	22
4	LG 07056	MS 68/47 x Co 1148 (ZC)	1
5	LG 07057 - LG 07072	CoS 8436 x CoPant 97222 (ZC)	16
6	LG 07073 - LG 07074	CP 52-1 x CoH 70	2
7	LG 07075 - LG 07079	CoS 90265 x CoS 96275 (ZC)	5
8	LG 07080 - LG 07081	CoLk 8102 x HR 83-65	2
9	LG 07082 - LG 07083	LG 95053 x Co 775	2
10	LG 07084 - LG 07086	CoS 8436 PC (ZC)	3
11	LG 07087	CP 61-23 x CoH 70	1
12	LG 07088	CoPant 88220 x Co775	1
13	LG 07089	Co 7201 PC (ZC)	1
14	LG 07090	CoH 56 PC (ZC)	1
15	LG 07091 - LG 07092	CoLk 8002 x ISH 176	2
16	LG 07093 - LG 07099	CoJ 99192 x Co 86002(ZC)	7
		Total	**99**

attributes, HR Brix% (October and December) and juice analysis of selected clones. A total of 22 clones were selected considering morphology of the clones and juice characteristics for further evaluation along with standards.

Evaluation of C_2 clones

A total of 13 selected clones were planted with three standards (CoS 767, CoJ 64 and CoS 8436) in RCBD for further evaluation. Observations were recorded for yield, yield attributes and juice analysis (October). Analysis of variance indicated significant difference among these clones for cane yield, sugar yield and sucrose %. A total of six promising clones, namely LG 04006, LG 05003, LG 05004, LG 05016, LG 05020 and LG 05029 were selected and advanced for further evaluation.

Evaluation of clones under PVT

A trial consisting of nine selected clones viz., LG 04-011, LG 04-043, LG 04-049, LG 04-051, LG 04-059, LG 04-061, LG 04-075, LG 04-090 and LG 03-706 along with three checks CoJ 64, CoS 8436 and CoS 767 were planted in RCBD for agronomic evaluation. Observations were recorded for yield; yield attributes and juice analysis (January). Analysis of variance indicated significant difference among these clones for cane yield, sugar yield and sucrose %. A promising clone LG 04-043 was promoted for evaluation in station trial.

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

Exploitation of interspecific and improved inter-specific hybrid (ISH) parents for widening the genetic base for resistance to red rot

S. spontaneum clone SES 594 and inter specific hybrid ISH 150 (CoC 671 x SES 268), ISH147 (Co 7201 x SES 103), ISH 153 (Kansar x Co 1307), ISH 288 (Oramboo (*S. officinarum*) x SES 275) were used in hybridization to widen the genetic base for resistance to red rot. SES 594 exhibited resistance reaction to red rot pathotypes Cf 08 and Cf 09 while inter specific hybrids showed moderately resistant reaction to these pathotypes. A total of twelve biparental crosses were attempted using commercial varieties namely Co 86002, BO 91, CoLk 8102, Co 62198 and Co7717, CoJ 64, CoJ 83, Co1158 and CoS 96268 at National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore and fluff received was sown in glasshouse to raise and evaluate seedling population during 2009-10.

Evaluation of seedling generation

A total of 3500 seedlings from ten crosses namely ISH 1 x CoSe 96436, CoLk 8102 x Co 86002, Co 7201 x ISH 176, CoS 96268 x CoLk 8002, CoC 671 x ISH 147, Co 7201 x Co 62198, Co 88025 x ISH 41, CoLk 8002 x Co 62198 and BO 91 GC were evaluated and these progenies were ratooned for further evaluation for screening against red rot and juice traits.

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

One hundred three C_1 progenies from eleven crosses (attempted during 2006) namely, CoC 671 x ISH 147(3), CoLk 8102 x ISH 176(20), CoLk 8102 x HR83-65(24), CoLk 94184 x HR 83-65(17), HR 1158 x BO 91(7), CoJ 99192 x Co 86002(3), CoLk 9412 x Co 86011(4), Co 7717 x SES 594(3), CoLk 8002 x ISH 176(5), CoLk 9412 x BO 91(11), ISH 100 x Co 1148(6) were found to be moderately resistant/or moderately susceptible by plug method of inoculation using Cf 09 pathotype of red rot (*Colletotrichum falcatum*). These clones were advanced for further evaluation in second clonal generation.

Evaluation and selection of resistant clones to red rot from second clonal generation

Thirty five clones namely LG 06802, LG 06806, LG 06809, LG 06810A, LG 06811 (CoS 96268 GC), LG 06812 (BO 92 GC), LG 06818, LG 06820, LG 06823, LG 06828 (HR 83-144 GC), LG 06829, LG 06832, LG 06838, LG 06839 (CoSnk 3-44GC), LG 06840, LG 06843, LG 06844 (CoS 96268 x Co 86002), LG 06845 (BO 91 x CoC 8001), LG 06846, LG 06848, LG 06850, LG 06856 (CoLk 7901 GC), LG 06864, LG 06864A, LG 06865, LG 06865A, LG 06867, LG 06874, LG 06879, LG 06885, LG 06891, LG 06893, LG 06894, LG 06898 and LG 06899 (HR 83-65 GC) from second clonal generation were tested by plug method using two pathotypes of in August 2008 by inoculating more 20 canes/clone/ pathotype. 35 clones showing either moderately resistant (19 clones) or moderately susceptible/ resistant (16 clones) reaction to Cf 08 and Cf 09 were further advanced to third clonal generation for red rot testing and evaluation of yield and quality traits. These clones also exhibited HR brix ranging from 18.0 to 22.6 % in January.

Evaluation of advanced clones for resistance to different pathotypes of red rot (Colletotrichum falcatum)

Red rot resistant clone LG 05823 yielded the highest cane (90.8 t ha ^{1}) and sugar yield (11.8 t ha ^{1}) followed by LG 05817 (86.4 t ha ^{1}, 11.4 t ha ^{1}). These two clones also exhibited high Pol in juice in January crushing. Other clones namely LG 05809, LG 05810, LG 05828 and LG 05890 were identified as red rot resistant clones (Table 4.8). Two Clones LG 05817 and LG 05823 are being evaluated in station trial as pre multi-locational testing.

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

Advance varietal trial (Early) ratoon

Eight early maturing entries viz., CoH 127, CoJ 03191, CoJ 03192, CoLk 9902, CoS 03251, CoS 03279, CoPant 03219 and CoPant 03220 with two checks viz. CoJ 64 and CoPant 84211 were ratooned. The best entry was CoPant 03220 with cane yield (72.9 t ha^{-1}) and sugar yield (9.29 t ha ^{1}) followed by CoLk 9902 (66.9 t ha ^{1}, 9.05 t ha ^{1}). Genotype CoLk 9902 also exhibited high sucrose (19.3 %) and better ratoonability.

Table 4.8: Yield and quality attributes of promising red rot resistant genotypes during 2008-09

Genotypes	Red rot reaction			Cane yield (t ha^{-1})	Pol % at 10 M	CCS (%)	Single cane weight (kg)	CCS (t ha^{-1})
	Cf 08	Cf 09	Cf 11					
LG 05823	MR	MS	MR	90.8	19.2	13.00	0.82	11.80
LG 05817	MR	MR	MR	86.4	18.4	13.20	0.64	11.40
LG 05806	MR	MR	MR	72.7	17.8	12.93	0.55	9.40
LG 05821	MR	MR	MS	75.0	16.0	11.10	0.60	8.32
LG 05890	MS	MR	R	70.2	18.6	11.80	0.61	8.28
LG05809	MS	MR	MR	74.3	18.2	12.22	0.80	9.08
LG 05828	MR	MR	MR	79.0	18.7	12.88	0.73	10.18
LG 05810	MR	MR	MR	78.9	18.0	12.84	0.54	10.13
CoS 767	S	S	S	58.3	17.8	12.26	0.70	7.15
CoJ 64	S	S	S	53.1	19.6	13.34	0.54	7.08
CD (5 %)				8.38	1.48	0.57	0.11	0.63
CV (%)				5.30	3.75	2.12	7.4	3.19

Initial varietal trial (Early)

Thirteen entries viz. CoH 05261,CoH 05262, CoH 05263, CoH 05264, CoH 05265, Co 05009, CoPk 05191, CoLk 04237, CoLk 05201, CoLk 05202, CoS 05231 and CoS 05232 including two checks viz. CoJ 64 and CoPant 84211 were planted to assess their performance for yield and juice quality. CoH 05265 (95.24 t ha ^{1}) gave the highest cane yield, followed by CoH 05262 (83.7 t ha^{-1}). CoH 05265 also gave higher sugar yield (12.26 t ha^{-1}) over both checks CoPant 84211 (7.1 t ha^{-1}) and CoJ 64 (6.5 t ha^{-1}).

Seed multiplication

Seed Cane of 5 early maturing clones namely Co 06032, Co 06221, CoH 05261, CoH 06262, CoH 6263, (received from SBI RC, Karnal) to be tested in initial varietal trial (Early) during 2009-10 was multiplied. Observations on general growth performance and juice quality were recorded.

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

Initial varietal trial (Midlate)

Thirteen genotypes *viz.*, Co 05010, Co 05011, CoH 05266, CoH 05267, CoH 05268, CoH 05269, CoLk 05203, CoPant 05222, CoPant 05223, CoPant 05224, CoPb 05211, CoPk 05192 and UP 05233 along with three standards Co 1148, CoS 767 and CoS 8436 were evaluated for yield and quality parameters. The genotype CoH 05267 recorded highest cane yield (95.1 t ha^{-1}) as well as CCS yield (13.26 t ha^{-1}) which was significantly superior to all the three standards. The genotypes Co 05011, CoPant 05224, Co Pant 05223, CoH 05269, CoH 05266 also produced higher cane and CCS than the best standard. Among the genotypes, Co 05011 recorded highest sucrose percentage (20.8%) followed by UP 05233 (20.3%). Among the standard varieties, CoS 767 recorded highest CCS yield (9.45 t ha^{-1}) followed by CoS 8436 and Co 1148.

Advance varietal trial (Midlate) Ist plant

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 under this trial. The genotype CoLk 99271 recorded highest cane yield (89.5 t ha^{-1}) as well as CCS yield (10.62 t ha^{-1}) which was significantly superior to the best check, CoS 767. The genotype CoS 03222 also produced higher cane and CCS than the best standard variety. Co 0424 exhibited highest sucrose % at 12 months (20.1%) followed by Co 0327 (20.0%) and CoPant 04222 (18.0 %). Among the standard varieties, CoS 767 was the best with highest cane yield (69.8 t ha^{-1}) and CCS yield (8.96 t ha^{-1}).

Advance varietal trial (Midlate) IInd plant

A trial comprising of six test genotypes *viz.*, Co 0331, CoH 128, CoH 129, CoH 130, CoLk 9910 and CoS 03261 along with three standard varieties *viz.*, Co 1148, CoS 767 and CoS 8436 was conducted. Genotype CoH 128 exhibited highest cane yield (92.4 t ha^{-1}) and CCS yield (11.2 t ha^{-1}) followed by CoS 03261 and CoH 129. The genotype CoH 130 showed highest sucrose % (19.2 %) followed by CoS 03261and Co 0331. Among the standards, CoS 767 was the best checks for cane yield (66.4 t ha^{-1}) and Co 1148 for CCS yield (8.30 t ha^{-1}).

Advance varietal trial (Midlate) ratoon

Six genotypes i.e. 0331, CoH 128, CoH 129, CoH 130, CoLk 9910 and CoS 03261 along with three standard varieties *viz.*, Co 1148, CoS 767 and CoS 8436 were evaluated for their ratooning ability. The genotype CoS 03261 showed best ratooning ability with significant higher cane yield (70.2 t ha^{-1}) and CCS yield (8.33 t ha^{-1}) over the best standard. CoH 129 was also a good ratooner with high cane yield (68.2 t ha^{-1}) and sugar yield (8.55 t ha^{-1}). Among the standard varieties, CoS 767 was better ratooner with highest cane yield (62.2 t ha^{-1}) and sugar yield (7.58 t ha^{-1}).

Seed multiplication

The seed of fifteen genotypes *viz.*, Co 06033, Co 06034, Co 06035, Co 06037, CoPb 06214, CoPb 06219, CoPant 06223, CoPant 06224, CoPant 06225, CoS 06241, CoS 06246, CoS 06247, CoH 06264, CoH 06265 and CoH 06266 were multiplied for Initial Varietal Trial during the next year.

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

Multiplication

Thirty-five early and twenty-five mid late entries are under multiplication.

Inter zonal varietal trial (Early)

In early group, 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, Co Pant 03219, Co Pant 03220 and CoSe 03421 along with two standards viz., CoJ 64 and Co Pant 84211 were evaluated in second plant and ratoon crops as per technical programme. Co Pant 03220 was superior to CoJ 64 for sugar yield in second plant and ratoon crop.

Inter zonal varietal trial (Mid late)

In Inter zonal initial varietal trial of mid late group, ten entries viz., CoH 128, CoH 129, CoH 130, CoJ 03193, Co 0331, CoS 03261, Co Pant 03221, CoSe 03422, CoSe 02231, and CoP 03182 along with three standards were evaluated in second plant and ratoon crops. CoH 128 and CoS 03261 were superior in cane yield in second plant and ratoon crop, while CoH 128 possessed superiority in sugar yield as well.

Fluff supply programme (B 2)

During the year under report, 52 genotypes were evaluated in the preliminary varietal trial, based on which eighteen were promoted to the Advance Varietal Trial, including the one picked up from ratoon crop evaluation. Based on the ratoon performance, a few genotypes excelling in sugar content but not making the mark agronomically, or excelling agronomically but not having resistance to red rot, have been maintained for possible utilization in breeding.

Based on evaluation in the Advance Varietal Trial in plant crop, LG 02434 has been included in the Station Trial 2009-10.

Evaluation of early and mid-late maturing entries of sugarcane in AICRP(S) North Central Zone at IISR, Regional Centre, Motipur

Advance varietal trial-Early II plant

The trial consisted of 3 entries viz. BO 138, CoP 03181, CoSe 03421 along with 3 standards BO 130, CoS 687 and CoSe 95422. The result indicated that none of the entries exceeded BO 130 (48.12 t ha^{-1}) in cane yield. However, the highest cane yield was recorded by CoP 03181 (42.42 t ha^{-1}).

Advance varietal trial-Early I plant

This trial consisted of 5 entries viz. BO 150, Co 0419, Co 0420, CoP 04181, CoSe 04231 with 2 standards BO 130 and CoSe 95422. The result indicated that the 2 entries viz. Co 0420 (54.38 t ha^{-1}) and BO 150(50.87 t ha^{-1}) showed their superiority over BO 130 (47.89 t ha^{-1}) in cane yield.

Advance varietal trial-Early ratoon

The trial consisted of 3 entries viz. BO 138, CoP 03181, CoSe 03421 with 3 standards, BO 130, CoS 687 and CoSe 95422. The result indicated that all the entries showed better performance in ratoon cane yield over the two standard varieties viz. BO 130 and CoS 687. The entry BO 138 was found the highest yielder in ratoon cane over the other entries and all standards.

Initial varietal trial-Early

This trial consisted of 4 entries and 2 standards BO 130 and CoSe 95422. The result indicated that among the entries CoSe 05451 gave 52.68 t ha^{-1} cane yield and CCS 6.43 t ha^{-1} as compared to BO 130 with cane yield (57.12 t ha^{-1}) and CCS (6.61 t ha^{-1}).

Advance varietal trial-Mid-late II plant

The trial consisted of 4 entries viz. CoSe 02231, CoSe 03422, BO 141 and CoP 03182 with 3 standards BO 91, CoP 9301 and CoSe 92423. The results indicated that CoP 03182 gave its superior performance in cane yield (56.95 t ha^{-1}) and CCS (6.20 t ha^{-1}) over the two standards BO 91 and CoP 9301. However, it was not superior to CoSe 92423 either in cane yield or CCS t ha^{-1}.

Advance varietal trial- Mid-late I plant

This trial consisted of 4 entries viz. CoSe 01423, CoP 04182, Co 0421 and Co 0422 with 3 standards BO 91, CoP 9301 and CoSe 92423. Though the variety Co 422 was the highest cane yielder (71.99 t ha^{-1}), however, it could not show its better performance in CCS (5.79 t ha^{-1}) compared to the standard BO 91 (5.88 t ha^{-1}).

Advance varietal trial- Mid-late ratoon

In this trial, the entries are same as in Advance Varietal Trial-Mid-late II Plant. The entry BO 141 showed superior in ratoon cane yield (42.12 t ha^{-1}) and CCS (5.08 t ha^{-1}) as compared to the best standard BO 91 (ratoon cane yield 28.11 t ha^{-1}) and CCS (3.24 t ha^{-1}).

Initial varietal trial- Mid-late

This trial consisted of 7 entries and 3 standards. The entry CoP 05437 gave the highest cane yield (71.91 t ha^{-1}) and CCS (4.82 t ha^{-1}) as compared to BO 91 (cane yield 47.35 t ha^{-1}) and CCS (3.63 t ha^{-1}).

4.3. Cytogenetic and biotechnological techniques for sugarcane improvement

Genetic improvement of sugarcane through tissue culture (B 3.7)

During the year under report, field experimentation had two trials of five adapted varieties each in plant crop with different sets of somaclones, both in R_2 generation. A ratoon crop trial was also conducted. The plant crop trials have been ratooned for verifying the results in order to identify useful somaclones from varieties CoLk 8102, CoLk 8001, CoJ 64, CoS 767, Co 87263, Co 7717 and BO 91. Two somaclones, CoLk 641 and CoLk 911, sent earlier to National Hybridization Garden, SBI, Coimbatore were involved in crossing and the fluff has been received for study of the progeny.

Cytomorphological and molecular characterization of some sugarcane genotypes (B 3.8)

This project aimed at understanding the molecular genetic diversity within the commercial cultivars and genotypes, and species level germplasm of sugarcane, concluded this year. Molecular characterization of one hundred and fifty genotypes of sugarcane consisting of 41 *Saccharum* species level germplasm (*viz. S. officinarum, S. barberi, S. sinense, S. spontaneum, S. robustum*), 5 interspecific hybrids, 87 commercial sugarcane hybrids and 17 self lines of CoLk 8102 has been completed using biochemical markers and three PCR based marker systems *viz.* RAPD, ISSR and microsatellites. Seventy-two random decamers, twenty di-, tri-, tetra- and penta-oligonucleotide simple sequence repeat motifs and thirty-two SSR primers were used. These primers were able to produce sufficient polymorphism. Among the species level clones, the genetic similarity values ranged from 0.01 to 0.87. The average pair wise similarity among all the *Saccharum species* was 0.25. Among the cultivated genotypes, the genetic similarity coefficients ranged from 0.25 to 0.99.

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

The project aims to identify markers for sugar genes in sugarcane, with the long-term aim of utilizing these markers for marker-assisted selection. Sugarcane clones with varying sugar content and a segregating population from different matings were used for field studies. HR brix observations were recorded from October. Juice analyses were done during November 2008, and also in January 2009, for selected clones. Two putative parental clones with HR brix values ranging from 11.0-14.0 (January) were selected and advanced for further evaluation. PCR and electrophoretic studies were continued for random and specific sequences, to identify variations among high and low sugar clones. Unigene sequences from sorghum and sugarcane, along with other databases for sugar related sequences, were also used for primer designing. Ten polymorphic markers were identified from electrophoretic studies. These will be validated using the population developed.

A population (190 clones in C_1 generation) derived from selfing CoS 96268 was evaluated for sugar content. Pol% values ranged from 10-18 in January. These were advanced to C_2 generation, for DNA studies. C_1 generation from six crosses of 2006 crossings (HR brix values 9.0-23.0) was also advanced to C_2 generation. Four crosses were attempted this year, at NHG, Sugarcane Breeding Institute, Coimbatore, using the parental lines CoJ 64, CoLk 7901, LG 94184, HR-83-65, and ISH 176. The fluff obtained has been sown in the glasshouse and will be used for marker validation.

Molecular diversity analysis for biotic stresses of *Saccharum* germplasm (B 3.14)

SSR based genetic diversity in sugarcane genotypes differing in response to red rot resistance

In the present study, 30 sugarcane cultivars/ genotypes including interspecific hybrids and some basic species of *Saccharum* differing in response to red rot resistance were analyzed using 32 SSR markers. Of 32 SSR primers, 7 were monomorphic generating one allele each and the rest were polymorphic (78.1%). The number of alleles detected by the polymorphic loci varied from 2-7 with an average of 3.46 alleles/locus.

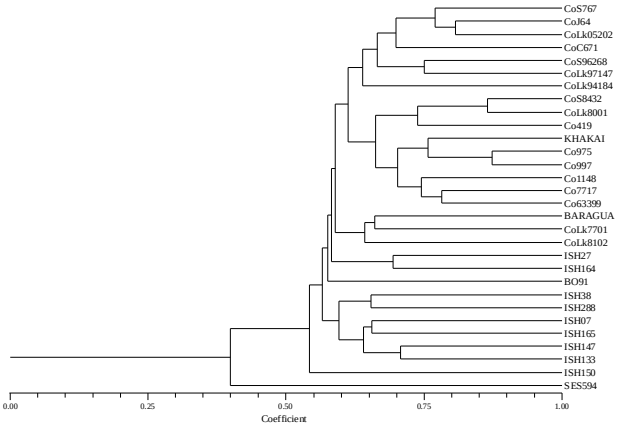


Fig. 4.2: Dendrogram of 30 sugarcane genotypes produced by UPGMA clustering method based on the genetic similarity matrix derived from 32 SSR markers. The major clusters are indicated as I and II at the right side

The average genetic diversity for all possible 435 pairs of genotypes was 42.6% with a range of 12.7% and 66.7%. Dendrogram prepared on the basis of presence or absence of amplified alleles using UPGMA method clearly distinguished all the genotypes from each other (Fig. 4.2). The resistant accessions namely SES 594 and ISH 150 emerged out to be most distinct genotypes whereas the rest of the genotypes could be grouped in two broad clusters separating the moderately resistant and susceptible sugarcane genotypes. The resistant genotypes, ISH 150 and SES 594 showed an average of 47.3% and 61.4% genetic diversity with susceptible sugarcane genotypes. Thus, these two genotypes can be used as germplasm resource for broadening the genetic base of cultivated sugarcane for red rot particularly in sub tropical India. Besides, the genetic diversity information given in the present study can be used in selection of suitable parent generating the mapping population for tagging the red rot resistance gene(s) in sugarcane.

Mapping population

One hundred clones of the cross CoS 7717 and SES 594 are being maintained in the C_1 as mapping population for red rot. To increase the population size of the same mapping population cross was again made between CoS 7717 and SES 594 at NHG and fluff was sown for raising the seedlings. To develop the more sets of mapping population, crosses were made between susceptible and resistant parents (CoJ 64 X SES 594, Co J 64 X BO 91) at NHG, Coimbatore. Fluff was sown in the glass house for raising of seedlings.

Parental polymorphism was carried out between resistant and susceptible parents using 100 SSR markers available in the public domain. Thirty percent markers were found polymorphic in different set of parents used in the crossing for development of mapping population.

Designed and Development of EST-SSR markers

Fifty SSR markers were designed using 397 general EST sequences developed from leaf tissue of sugarcane. Primers were synthesized and validation was carried out. Forty four percent of the EST-SSR primers showed amplification. These primers will be used in molecular diversity studies and tagging and mapping of genes in sugarcane.

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

The four procured Bt gene constructs (Cry 1Ab, Cry 1Aa, Cry 1F, Cry IA5) and pB1 121 with GUS are being maintained at this institute as Bt gene resource for development of transgenics in sugarcane against borer. To increase the efficiency of transient genetic expression of reporter gene (GUS) in sugarcane, treatment of *Agrobacterium (*harboring pBI 121 plasmid) and co-cultivation were studied at different periods. Immersion of callus in *Agrobacterium* suspension for 15 min and co-cultivation for 4 days increased the gene expression efficiency up to 70% in sugarcane. *Agrobacterium* mediated transformation of GUS gene has given good transient genetic expression in sugarcane as compared to biolistic gun approaches. Therefore, for development of transgenic in sugarcane the callus of borer susceptible variety CoLk 8102 was treated with *Agrobacterium* containing Cry 1Ab gene for development of transgenics. Regeneration of plantlets from expected transformed callus is in progress for their further study.

Optimizing standards for sugarcane seed production through micropropagation (B 3.16)

Effect of in vitro inoculated Gluconacetobacter diazotrophicus in micropropagated plantlets in sugarcane

Nitrogen fixing bacteria play a major role in sugarcane production. Therefore, an efficient isolate

of *Gluconacetobacter diazotrophicus* (IS 100) was inoculated *in vitro* in micropropagated plantlets during rooting in the year 2007-08. The treated and hardened plantlets were transferred in three rows of 6 m x 0.75 m at plant to plant distance of 30 cm in the field along with un-inoculated plantlets and conventionally grown plant of variety CoS 96268 to study the population counts of *G. diazotrophicus* and its effect on growth, yield and quality in sugarcane. Data on population of *G. diazotrophicus* was taken at grand growth and maturity period in the root. Maximum cell count was obtained in the *in vitro* treated micropropagated plantlets (5.8 x 10^5 cells g^{-1} fresh weight) followed by untreated micropropagated plantlets (4.7x10^4 cells g^{-1} fresh weight) while it was only 3.7 x10^4 cells g^{-1} fresh weight in conventionally grown plants. However, the cell counts of *G. diazotrophicus* decreased at maturity to 5.4x10^5, 3.9x 10^3, 3.0 x 10^3 cells g^{-1} fresh weight in treated micropropagated plantlets, untreated plantlets and conventionally grown plants, respectively. Results revealed that the highest yield (3.952±0.02 kg $clump^{-1}$) was observed in treated plantlets, followed by untreated plantlets (2.104±0.02 kg $clump^{-1}$) while it was 1.818±0.02 kg $clump^{-1}$ in conventionally grown plants.

Effect of plant geometry on micropropagated plantlets

Micropropagated plantlets of CoSe 01235 were planted at three planting geometries viz. 90x30, 90x45 and 90x60 cm along with control (conventional method of planting). Significantly highest number of millable canes (206.7 thousand ha^{-1}) was recorded at 90x30 cm spacing, followed by 90x 45 cm. Significantly highest yield of sugarcane (88.05 t ha^{-1}) was recorded with 90x45 cm planting geometry (Table 4.9). The quality parameters viz. brix %, pol % in juice and CCS (%) was not affected at different planting geometries.

Effect of tissue culture raised seed cane on growth, yield and quality in sugarcane

A field experiment was conducted to find out the effect of seed cane setts raised from micropropagated plantlets and conventionally grown seed cane on growth, yield and quality of different sugarcane varieties. Three budded setts of three varieties viz., CoS 8432, CoS 97261 and CoS 96268 were obtained (Table 4.10) through conventional grown crop (T-1) and crop raised using micropropagated plantlets (T-2). These setts were planted in four replications following recommended package of practices. Significant impact of source of planting material and varieties was also observed on cane yield and commercial cane sugar (CCS). An average of 16.6 percent increase (range 15.4-17. 8%) was observed in ultimate sugar yield in the crop raised using setts obtained through micropropagated plantlets over conventional method.

Technique for development of micropropagated plantlets in the newly released variety of sugarcane CoLk 94184 was standardized. It was observed that increasing the GA3 concentration from 0.1 mg l^{-1} to 0.2 mg l^{-1} in the multiplication medium gave better result. The developed plantlets were found disease free after testing for red rot, smut and mosaic.

Development of SSR markers for red rot resistance from EST database of sugarcane (DBT Project)

This project has been sanctioned for three years

Table 4.9: Effect of planting geometry on growth, yield and quality of micropropagated plantlets in sugarcane cultivar CoSe 01235

Treatments	NMC (000 ha^{-1})	Cane length (m)	No. of nodes per cane	Cane yield (t ha^{-1})	Pol (%)	Brix (%)	Purity (%)	CCS (%)
Control	109.54	1.62	16.60	63.28	18.71	20.86	89.77	12.92
60x90	147.79	1.98	22.80	80.35	18.82	20.36	88.79	13.10
45x90	177.79	1.85	19.80	88.05	18.88	20.56	89.25	12.68
30x90	206.68	2.17	21.60	83.70	18.85	20.52	89.29	12.76
CD (5%)	**8.25**	**0.17**	**3.52**	**8.96**	**NS**	**NS**	**NS**	**NS**

Table 4.10: Effect of seed cane raised from micropropagated plantlets on growth, yield and quality of sugarcane varieties

Varieties	Treatments	NMC (000 ha^{-1})	Cane length (m)	No. of nodes per cane	Cane yield (t ha^{-1})	Sucrose (%)	Brix (%)	Purity (%)	CCS (t ha^{-1})
CoS 8432	**T-1**	98.3	1.64	20.0	59.6	19.0	18.55	92.13	8.34
	T-2	109.2	1.74	21.3	72.3	18.3	18.7	91.59	9.63
CoS 97261	**T-1**	110.8	1.66	22.8	70.5	18.2	18.8	92.16	9.26
	T-2	146.7	1.68	24.0	80.6	18.7	19.0	91.65	10.91
CoS 96268	**T-1**	77.5	1.32	20.0	42.4	18.3	20.25	90.83	5.41
	T-2	81.7	1.42	15.8	49.5	18.1	19.8	90.81	6.31
CD (P=0.05)									
Varieties (V)		**10.98**	**1.39**	**4.84**	**8.93**	**4.54**	**4.54**	**10.05**	**3.26**
Treatments (T)		**8.96**	**NS**	**NS**	**7.29**	**NS**	**NS**	**NS**	**2.66**
Interaction (VXT)		**15.52**	**NS**	**6.85**	**NS**	**6.42**	**NS**	**NS**	**NS**

NMC=Number of millable cane; CCS= Commercial cane sugar; **Treatments:** Conventionally grown seed cane (T-1), Seed cane raised from micropropagated plantlets (T-2)

starting from 15th Jan 2009 for Rs.38.22 lakhs by Department of Biotechnology, Govt. of India, Ministry of Science and Technology. Work has been initiated as per technical programme. At first, nineteen SSR primers were designed using 121 non-redundant EST sequences specific to red rot of sugarcane. The fluff of three crosses (Co 1148 x BO 91; Co 1158 x BO 91 and Co 1148 x ISH 150) was sown in the glasshouse for development of mapping population.

Equipping and strengthening of designated DUS test centers under central sector scheme for implementation of PVP Legislation

A total of 100 varieties from various centres of sub-tropical India were collected. These varieties are being maintained in the field. The total reference collections were characterized as per the existing DUS Guidelines. The total reference collection was planted in the field. Data after compilation will also be sent to PPV&FRA, New Delhi and SBIRC, Karnal.

5 Epidemiology and integrated disease management

5.1 Epidemiology of diseases of sugarcane

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

Incidence of termite (5-7%), top borer (2-5%) and black bug (mild) was noticed in command area of Indogulf India Ltd. Maizapur (Gonda). Incidence of white grub was 10% in ratoon crop of CoS 8436 at Modinagar (Ghaziabad). Top borer incidence (15.2%) was also noticed in ratoon crop of CoSe 92423 at the institute farm.

Severe red rot incidence (40 – 50%) in CoLk 8102 and CoS 8436 was observed in waterlogged areas of Balrampur, Akbarpur and Haidergarh factory zones. Red rot incidence (10-20%) was also observed in Co 87263 and Co 90023. SCMV in CoM 316 and GSD in MS 0202 and CoM 0254 were also noticed at IISR Regional Station, Motipur (Bihar). Severe incidence of rust was also noticed in CoS 767 at factory farm of Balrampur Chini Mill unit, Maizapur (Gonda).

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

Reactions of 4 pathotypes (Cf 03, 07, 08 and Cf 11) identified in AICRP programme from CoJ 64 were tested on identified 13 differentials under controlled condition (CCT) (25-27 ^{0} C and > 90% humidity) and compared with reactions recorded in field. The susceptibility of several differentials increased in CCT. *Saccharum spontanium* (SES 594) was resistant to all the above 4 pathotypes but the same produced susceptible to MR reactions to these pathotypes under CCT. Similarly, BO 91 was resistant to Cf 03, 07 and 08 in field testing but susceptible under CCT. Baragua was also susceptible under CCT but MR in field conditions. The shift towards susceptibility may be owing to more succulence of the differentials under CCT. Tentatively identified varieties and differentials were found losing resistance. Prolonged cultivation of varieties under most favourable environment may be responsible for breakdown of resistance of the genotype.

5.2 Identification of causal organisms, pathotypes/ strains of sugarcane pathogens for development of resistant genotypes

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

Pythium sp., *Fusarium* sp. and *Rhizoctonia* sp. were frequently isolated from wilt affected cane roots. In such plants, root development was arrested in the monsoon period, coinciding with the grand growth phase of the crop. In the early growth phase, *Fusarium solani* was more pre-dominant than the others and the succulent thick white roots were more damaged than the hard old roots. Root inoculation with the above three parasitic fungi was also carried out in field condition. Wilt incidence was similar between inoculated clumps and un-inoculated check.

Expression of wilt was delayed by application of oatmeal in the root zone of plants probably due to encouraged antibiosis. Wilt like symptoms in sugarcane were produced by application of formaldehyde (1%, 2%, 4%) in the root zone.

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

Two pathotypes, IR 9 and 10 were isolated from Co 0232 and Co 0236 varieties and tested on 13 differentials. Though there were some differences in reaction on Co 7717 and CoS 767, Co 975 and Co 62399 from that of Cf 08 but in general, the reactions of both IR 9 and 10 were similar to Cf 08 existing in north western zone.

Maintenance of isolates of red rot pathogen (AICRP, PP 14 a)

Seven pathotypes viz., Cf 01, 02, 03 07, 08, 09 and 11 belonging to the varieties grown in north- western zone were maintained both *in vivo* and *in vitro* conditions. In addition, 4 pathotypes viz., Cf 04, 05, 06 and 10 belonging to the varieties grown in east coast zone were also maintained.

Molecular characterization of isolates/ pathotypes of *Colletotrichum falcatum* (AICRP, PP 29)

The total genomic DNA extracted from 11 pathotypes of C. falcatum belonging to the varieties of sub-tropical and tropical regions was molecularly characterized by SSR (simple sequence repeat) method. PCR amplification of SSR was performed with (GTG)5, (TCC)5 and (ATA)5 primers. The PCR amplified products were resolved on 1.2% (w/v) agarose gel containing ethidium bromide using 1 x TAE buffer. After scoring band position in comparative SSR profiles for each pathotype and primer combination, a genetic similarity index for each combination was used for constructing graphical phenerograms using UPGMA cluster analysis.

The amplification profile of ISSR using the primers produced variable number of bands in the pathotype. Based on the electrophoretic DNA bands, different pathotypes were found to share 70-90 % genetic homology. Based on similarity coefficient, 11 pathotypes (Cf 01to cf 11) were grouped in 2 major clusters. In the first group, Cf 01, 03, 05 and 06 expressed 90 % genetic similarity among each other. In other group, Cf 08, 09 and Cf 10 ranged75-85 % homology.

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

Two-bud setts were inoculated with different concentrations of *C. falcatum* conidia (10^1 –10^6 ml^{-1}) and planted in micro plots to understand the critical level of inoculum needed for the development of red rot symptoms in standing cane. It was observed that conidia ranging from 10^3 – 10^4 ml^{-1} killed 50% of the buds that resulted failure in germination and also mortality of settlings as compared to control. This level of conidia concentration would be taken for further study.

5.3 Integrated disease management in sugarcane

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

Biotherapy and thermotherapy alone and in combination were tried for the management of red rot. Healthy and inoculated setts of CoS 7701 (HS) were treated with MHAT (54 ^{0}C for 2.5 hr) and TMC applied @ 20 kg ha^{-1}. The emerged canes were later inoculated with red rot pathogen using parafilm technique in July. MHAT followed by TMC application was better for improving germination of healthy (32.83%) and diseased setts (26.29%) as against 24.54% and 18.87% in their respective checks of MHAT + TMC as against 15.5% in check. However, biotherapy alone could protect 70% canes while MHAT alone 35.5% canes only. In case of diseased setts, the control of red rot was also higher by MHAT + TMC (66.6%) as against 8.8% in checks. MHAT followed by TMC application was significantly better for increasing tillers, NMC and yield (81 t ha^{-1}) than the other treatments (68-75 t ha^{-1}).

In a separate experiment on ratoon, TMC metabolites were tried in combination with salicylic acid and agrochemicals against red rot. Application of *T. harzianum* (TMC) alone and in combination with bavistin and salicylic acid were effective to protect 70-79% canes from red rot challenged inoculation in variety CoLk 7701. In remaining treatments, combination of TMC + $ZnSO_4$ was better than $FeSO_4$ and $CuSO_4$. However, the treatment of metabolite + salicylic acid proved most effective (86%). TMC applied on emerging stubbles after pulverizing root zone with deep plough was highly effective for promoting the plant growth and increasing the yield. In addition to red rot management, the plant growth was promoted by the application of different formulations of *T. harzianum* in soil. Availability of different nutrients was estimated after applying *T. harzianum* multiplied culture (TMC) and metabolites (culture filtrates) in soil at plant emergence stage (Feb-March). Availability of nutrients was estimated in August-September.

Availability of N increased from 219.52 kg ha^{-1} to 279.52 kg ha^{-1}, of P increased from 45.96 kg ha^{-1} to 75.88 kg ha^{-1} and of K_2O increased from 190 kg ha^{-1} to 274 kg ha^{-1} by the application of TMC + SA. Availability of Cu increased from 1.33 ppm to 1.41 ppm by the application of TMC + Bavistin, of Zn increased from 0.53 ppm to 0.88 ppm with the application of TMC + Zn SO_4, of Fe increased from 7.32 ppm to 14.68 ppm with the application of TMC + $ZnSO_4$ and of Mn increased from 5.56 ppm to 9.98 ppm with the application of metabolites. Organic carbon increased from 0.36% to 0.56% with the application of TMC + SA. Soil pH reduced (from 7.82 to 7.32) with the application of TMC and metabolites. There was no

effect on EC with or without application of TMC and metabolites.

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

Red rot

Of 91 genotypes screened, 22 genotypes viz., III-20-2, IV-1-9, SC 8102-8, LG 00501, 02039, 02057, 03311, 04601, 04602, 04604, 04605, 04606, 05016, 05023, 05026, 05246, 05319, 05336, 05368, 05385, 05415, 05447 were found resistant to red rot pathotype Cf 08 by plug method.

Smut

Eighty five genotypes were found resistant against smut through sett inoculations in spore suspension. Five genotypes, 1-14-7, 2-15-10, IV-10-9, LG 04456 and CoLk 9617 were found susceptible to smut.

Evaluation/ screening of sugarcane germplasm/ genotypes against red rot, smut and wilt (AICRP, PP 17)

Red rot

Of 30 genotypes evaluated, 10 genotypes viz., Co 05010, Co 05011, CoPant 0522, CoH 128, CoH 05233, CoH 05266, CoH 05269, CoS 03192, CoS 03279 and CoPk 5191 were found moderately resistant against Cf 08 by plug method of inoculation. In addition, CoS 03261, CoH 05265, CoH 052667 and CoLk 04237 were MR with Cf 08 and CoH 129 and Coh 05268 were MR to Cf 09.

Smut

Twenty four genotypes were found resistant to smut.

Wilt

Genotype, CoS 03251, CoH 05261, Co pant 03220 and CoC 671 were found susceptible to wilt with the severity index 3.0-4.0 in 0-4 grade.

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

Developed microbial consortium (Fig. 5.1) of potential bioagents (3 bacterial + 1 fungal cultures) for red rot control and plant growth promotion. It checked the spread of disease under artificially inoculated condition up to 80% in moderately resistant varieties and 50% in highly susceptible variety. Due to plant growth promotion abilities of the bio-agents in terms of N-fixation, production of growth hormones, P-solublization etc, healthy plant growth and higher cane yield was recorded.

A protocol was developed for preparing on-farm intensified bio-agent preparation for which fungal culture and bacterial cultures were mixed sequentially. This bio-agent enriched preparation was used @ 1 ton ha^{-1} by sprinkling it over and around cane setts in the furrows at the time of planting (Fig. 5.2) whereas the same quantity as for plant crop is band placed along the stubble row during off baring operation in a single pass at ratoon initiation (Fig. 5.3). Inoculated bio-agents population in the field was 8.0 x 10^{6-7} counts per bud or per cm row length.

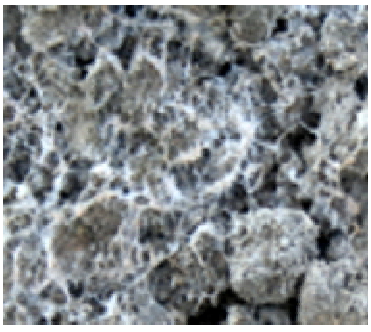


Fig. 5.1: Microbial consortium enriched press mud

Fig. 5.2: Bioagent application in plant crop

Fig. 5.3: Bioagent application in ratoon crop

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)

The application of pestoneem with top borer along with top dressing of urea at 75 kg N ha^{-1} during second week of June coinciding the emergence of moth of top borer III brood and collection and destruction of infested plants due to II brood significantly reduced the incidence of top borer III and IV broods and yielded higher cane over untreated check.

Monitoring of insect-pests and bioagents in sugarcane agro-ecosystem (AICRP, E 30)

The monitoring of the insect-pests throughout the crop season again confirmed top borer as a major pest with increased incidence in 4th brood. Incidence of stalk borer was 4.67 % in ratoon and 18.07% in plant crop. and , incidence of internode borer was 9.88% Incidence of mealy bug was 5.37% and of Black bug and pyrilla was in traces.

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

Trichogramma japonicum (reared from F_1 to F_{10} generations at 34 ± 2 ^{0}C) was further maintained at 56. ±2 ^{0}C on *Corcyra cephalonica* for ten generations. The survival, fecundity and female ratio were reduced at this temperature as compared to early generation at 32 ± 2 ^{0}C.

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

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

Nine varieties of early maturity group were evaluated against major insect-pests. Minimum incidence (0.50%) of top borer (III brood) was recorded in CoS 3279 followed by CoS 03251 (1.58%) and maximum in Co Pant 03219 (9.11%).

Thirteen mid-late varieties were evaluated. Minimum incidence of top borer (III brood) was recorded in CoS 767 (0.50%) followed by CoLk 9910 (1.14%), CoH 129 (2.33%) and maximum in CoLk 99271 (9.30%). Infestation of stalk borer was very low in general (< 4%)

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

Three diet combinations based on different ingredients were tried for rearing of top borer larvae. 2nd and 4th instar larvae were fed on diet for two days. 2nd instar larve survived to the tune of 10 and 20 % in combination of 1st and 2nd diet, respectively for 10 days. Larvae (4th instar) survived for 13 days in 1st and 2nd combination of diet.

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

Beauveria basiana and *Metarhizium anisopliae* were multiplied on PDA and broken rice at large and culture was utilized in Institute Research Projects. *Cotesia flavipes* was multiplied on stalk borer larvae multiplied on artificial diet and natural food. From single larvae, 35 – 36 cocoons were obtained. Parasitic emergence was 61.9 and 56.7% with 64.62% and 68.32 % female population in larvae developed on artificial diets and cane bits, respectively.

Survey and surveillance of sugarcane insect-pests (AICRP, E 28)

Incidence of top borer in CoLk 94184 was 4.74 % in pit method as compared to12.63% in flat method of planting at IISR farm, Lucknow. In variety CoS 96275, the top borer incidence was 2.81 – 12.20% in flat method as compared to 6.75 – 15.645 in FIRB method of planting.

Top borer incidence in different varieties grown at IISR farm ranged between 12.15 – 19.33%. It was minimum in CoS 94257 (5.98% and maximum in CoLk 8102 (47.20%).

Population of Pyrilla (adult & nymphs varied from 2-26 per 20 leaves at IISR farm. The poulation of Pyrilla was parasitized by *E. melanoleuca*.

Stalk and internode borers were recorded > 10% in different varieties during the crop season.

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

With the use of pheromones, the incidence of top borer was observed to be reduced (12.05, 13.39 and 14.27%) in three plots of CoS 94257 as compared to 19.06, 21.09 and 22.345 in check plots).

There was no marked effect on stalk borer because of very low incidence this year.

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

At Pravaranagar (IISR bicontrol centre), the incidence of scale insect (*Melanaspis glomerata*) in *adsali* crop was found to be maximum but the parasitization was observed maximum during October.

Evaluation of E 2Y 45 0.4 GR against termites and top borer of sugarcane (CR 3/06)

The granular formulation of E 2Y 0.4 GR was evaluated against termite and top borer during 2008-09 crop season at IISR, Lucknow. All the doses from 75 - 150 g a.i. ha^{-1} significantly controlled termites and top borer. The tested doses were neither phytotoxic nor left any adverse effects on parasitoids and predators.

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)

Field trials of front mounted sugarcane harvester (Fig. 7.1), developed during 2007-08, were conducted at the IISR farm. The cutting and windrowing was satisfactory for crop which was not lodged heavily. The average effective field capacity of the equipment was 0.15-0.20 ha h^{-1} with field efficiency of 50-60%. The equipment can be used for partially mechanization of sugarcane harvesting. The equipment cuts and windrows the whole cane stalks flush with the ground. Removal of green tops and dry trash from the harvested cane needed to be done manually.

Fig. 7.1: Tractor operated front mounted sugarcane harvester in operation

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

A power operated detrasher was developed for removal of green top as well as dry trash from the harvested sugarcane. Equipment consisted of mechanisms for cane feeding, detrashing and delivery. It separates the top from the cane by breaking it from the natural weak point at the joint of immature top with mature cane stalks. It can be transported on three point linkage of the tractor and operated by an electric motor, diesel engine or tractor PTO. Performance of the equipment was evaluated by feeding harvested canes of different varieties from their green tops side through the feeding chute to the detrashing rollers (Fig. 7.2). The trash left on the cane after passing through the detrasher varied from 1.5% to 6.6%. Trash removal efficiency varied from 77.5% to 94.5% depending upon the variety. The output of the detrasher was 2.4 t ha^{-1}. There was a saving of about 17% in cost of operation and 84% in labour requirement using the detrasher as compared to manual method.

Fig. 7.2: Sugarcane detrasher in operation

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

A model of RMD named as Ratoon Promoter was designed (2007-08). It had no stubble-shaving unit. Power for driving metering units to disburse manure, fertilizer etc was derived not from tractor PTO but from a floating type ground wheel drive mechanism which consisted of a pair of rugged wheels with angled lugs on its periphery, tension springs and appropriate linkages to keep pressing these wheels on to the ground for minimal slippage. Rippers, fertilizer /manure container with metering unit, two number of liquid

containers for dispensing pesticide, fertilizer etc in liquid form through gravity and a pair of earthing units were developed and were affixed to a specially designed sturdy frame in 2008-09. The equipment was also provided with a seeding unit for raising intercrops like lentils, berseem etc. It contained adjustments for proper metering of various grades of seed and its depth placement.

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. Lugged wheels were replaced with pneumatic tyres to improve the manoeuvrability of the equipment. The large scale testing of the equipment was conducted at IISR farm. The effective field capacity of the equipment was 0.2 ha h^{-1}. The manpower requirement was 10 man-h ha^{-1}. The working depth of the equipment was 10-15 cm and weeding efficiency was 70 to 80%.

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

Existing four types of blades which are being used in different sugarcane cutter planters got fabricated. These four types of blades are being used in the planters namely IISR first model and Khalsa type, IISR ridger type, IISR Multipurpose and VSI planter developed under NATP. The test set has been fabricated for evaluation of different sett cutting mechanisms.

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

Design of soil working blades, mounting mechanism and housing device have been finalized. Blade mounting, assembly shaft and first prototype of soil chopping blades have been fabricated.

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)

Pre- harvest soil application of zinc sulphate and manganese sulphate(@ 25 kg ha^{-1} in the first week of September,2008, about six weeks prior to harvest was done to an early maturing cane variety CoS 95255. The zinc sulphate treated cane covered with trash showed about 3.6% increase in juice sucrose content, over 9.0% increase in CCS and recorded 17.2% decline in reducing sugars 14 days after staling, compared to water sprayed trash covered cane (untreated control). This could be due to lower activity of acid invertase (15.9%) following zinc sulphate treatment as Zn^{++} has an inhibitory effects on acid invertase activity. Application of manganese sulphate increased juice sucrose (6%) and purity (1.7%) and decreased the reducing sugars in juice by 20% 14 days after staling. Treated cane covered with trash recorded 6.3% higher CCS compared to water sprayed trash covered (control). Minimum and maximum temperatures during this period were 8.5°C and 28.6°C, respectively, while relative humidity varied from 25% to 96%.

The effect of pre- harvest soil application of zinc sulphate and manganese sulphate (@ 25 kg ha^{-1} in the first week of December,2008, about twelve weeks prior to harvest on post harvest deterioration of sucrose in a mid late maturing cane variety CoSe 92423 was evaluated. The zinc sulphate treated cane covered with trash showed about 2.5% increase in juice sucrose and purity (1.9%) 8 days after staling . The CCS increase in treated cane was around 3.0% as compared to water sprayed trash covered control. Application of manganese sulphate recorded 1.9% increase in juice sucrose and purity (4.3 %) 8 days after staling. The increment in CCS was over 3.3% in treated trash covered cane as compared to water sprayed trash covered control.

The CCS loss per hour in the untreated whole stalks during the month of April was around 0.021 units compared to 0.020 units in water sprayed + trash covered and 0.015 units in BKC treated formulation. Decline in juice sucrose in untreated, water+ trash and BKC treated was 33.19%, 28.53% and 12.63%, respectively, 240 hours after staling. This indicates that BKC based formulation was effective in minimizing sucrose losses in the harvested cane.

Sugarcane billets from top, middle and bottom portions of cane stalk were assessed for the sucrose loss on storage. The CCS loss in the upper, middle and lower billets was 0.067, 0.052 and 0.059 unit $hour^{-1}$, respectively. The CCS loss in billets was over three times higher than the whole cane. Application of BKC formulation showed perceptible reduction in CCS loss in billets and the values were 0.031, 0.012 and 0.011 unit $hour^{-1}$ for upper, middle and lower billets, respectively.

The loss of sucrose was assessed in cut cane at three different temperatures, mimicking early, mid and late-season crushing. The decline in CCS was minimum at 8^0C and maximum at 40^0C. Treatment of cut cane with chemical formulation (BKC+trash) was effective at all the temperatures and minimized CCS loss on storage.

8.2 Manufacturing and storage of jaggery

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

Initial testing indicated 76% filtration efficiency and capacity as 200 l h^{-1}. The unit was modified for higher capacity (300 l h^{-1}) by increasing the opening area of the pre-filter. Modified pre-filter has 600 mm length, 150 mm diameter, 120 holes having 45 mm diameter each. The system is operated with a submersible pump of capacity 800 l h^{-1} and 12 watt power.

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

Value added jaggery in bar shape (75 x 25 x 12.5 mm) weighing about 30 g each was prepared. Each bar is supposed to contain about 25 mg of vitamin C besides having a good taste. It was observed that reinforcement by the *aonla* fibres provide jaggery bar a better strength than the plain jaggery bar of same size and shape.

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.

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

A mini crusher was designed. It has three rollers consisting of king, crushing and extraction rollers. All the three rollers provided with knurlings were fabricated. Fabrication of gears and drive shaft for providing drive to different rollers is in progress.

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

Two types of rotary systems, (i) vertical in horizontal plane and (ii) horizontal in vertical plane, were fabricated and for operation in the open pan of the triple pan furnace. The performance of the horizontal rotary churner / system, operated in vertical plane, was better as compared to vertical rotary churner, operated in horizontal plane, in terms of the mixing of hot juice.

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

The results of experiments with smaller pans having different fin sizes and spacings revealed that fins help in improvement in heat utilization efficiency. Flats having less thickness are better choice than the thick flats of same width.

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

During testing of crusher, it was observed that the canes and bagasse move sideways resulting in choking of cane and slippage of belt. Therefore, rollers with strong thicker (25 mm) collars are to be provided. Looseness of bush socket was also observed which appears to be responsible for frequent breaking of gears.

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

The drier was tested at half load. The temperature of the forced supplied air rose to 40 to 45 ^{0}C within 10 minutes. The temperature was regulated with the help of thermostat provided for the purpose. The air flow rate at the plenum chamber was available at 0.10 $m^3 s^{-1}$ (6.1 $m^3 min^{-1}$). It was found that the moisture content of jaggery reduced from 12%(w.b.) to 9% (w.b.) 3 hours after drying. The dried jaggery stored well for longer duration as compared to fresh stored jaggery.

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

Components of the unit i. .e. drying chamber, plenum chamber, inlet air and exit port , chimney for removal of exit air were designed. The fabrication of the drying chamber was done.

Evaluation of packaging materials for modified atmosphere packaging of jaggery (LKO/PHT/08/01)

Selection of materials was done for packaging of jaggery under modified atmosphere.

8.3 Diversification of sugarcane based by-products

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

The pre-treatment of lignocellulosic biomasses is a necessity for efficient saccharification and ethanol production. Ethanol production gets inhibited in the presence of small concentrations of some of these by-products of pretreatment. Sugarcane biomass was pre-treated with dilute acid at optimal conditions (165°C for 4 min). Prehydrolysates were analyzed for degradation compounds and sugars content. The major degradation by-products released during the process included organic acids such as acetate, furans (furfural and 5-hydroxymethylfurfural) and phenols such as 4-hydroxybenzaldehyde (4-HB), vanillin, and syringaldehyde. The concentration of furfural obtained during the pre-treatment process increased with temperature from 50 mg l^{-1} at 135°C to 900 mg l^{-1} at 165°C as a result of xylose degradation. Acetic acid

concentration increased by 0.2–1 g l^{-1} during the process while formic acid concentration increased by 0.5–1.5 g l^{-1} probably due to degradation of furfural. These by products were found to be potent inhibitors during the saccharification process. Results showed that these compounds contained in prehydrolysates strongly affected the hydrolysis step, a 25% decrease in cellulose conversion compared with control.

9 Sugar beet improvement, its seed production and crop management

The research work conducted at Lucknow was carried out under the AP Cess Network Project on Sugar beet. The project was concluded in July 2008. The discipline-wise report for Lucknow centre is as follows:

Varietal trial

Ten entries, LKC-95, LK-27, RASOUL, FELICITA, PAC 60002, PAC 60006, IN-06, IN-07, SYT 06-7 and SYT 06-13 against two checks, Shubhra and LS-6 were evaluated at Lucknow (Table 9.1).

The experiment was sown on 17.11.2007 in plots containing 6 rows each of 5 m length replicated 4 times in RBD. The recommended package of practices was followed to raise a good crop. Plant population was recorded in June. The natural incidence of *Sclerotium* root rot and *Cercospora* leaf spot and attack of *Spodoptera* and *Spilosoma* remained below the economic threshold. There were rains in April, May and June which lowered the temperatures and resulted in much less root mortality, besides adversely affecting quality late in the season.

On an average, the economic traits such as root weight, sucrose content in roots, root yield and gross sugar showed some variation in April, May and June during 2008 (Table 9.1). The PAC-60006 and PAC-60002 were the highest in sucrose content in May but significantly lower than the high sugar check, Shubhra. In June, only Felicita and PAC 60006 had acceptable sugar, followed by SYT-06-07 while even checks showed substantial reduction from May values. In root yield, Shubhra was the top performer but the differences among varieties were non-significant in May, despite a range of 67.5 to 77.5 t ha^{-1}. For sugar yield, the ultimate economic character, the two check varieties, Shubhra (HI 0064) and LS-6, were among the top five performers. For root weight at three times of observation, besides the two checks, one variety from each group got included. More or less, a similar trend was observed for root yield and gross sugar. For example, Rasoul from Iran, LKC-95 and LK-27 from India, SYT-06-13 from Syngenta, PAC-60002 and PAC-60006 from SES Vanderhave and, Felicita from KWS performed well as compared with the check varieties.

The top five performers for economic traits showed that either or both of the checks did well for most of the characters (Table 9.2). In fact, Shubhra (HI

Table 9.1: Mean data for sugar beet varietal trial at IISR, Lucknow during 2008

S. N.	Varieties	Single root weight (kg)			Sucrose content (%)			Root yield (t ha^{-1})			Gross sugar (t ha^{-1})	Rank based on GS	Purity (%)
		Apr	May	Jun	Apr	May	Jun	Apr	May	Jun	May		
1	LK-27	1.20	1.21	0.72	11.03	14.43	12.08	91.1	74.4	69.7	10.723	8	c
2	LKC-95	1.26	1.40	0.75	11.18	15.59	13.56	79.5	67.5	64.0	10.524	10	c
3	SYT-06-07	1.04	0.97	0.81	10.45	14.83	14.39	80.9	68.7	63.1	10.182	12	c
4	SYT-06-13	1.07	1.14	0.58	10.12	15.80	13.47	90.4	74.1	68.5	11.710	4	b
5	IN-06	1.25	1.23	0.86	10.19	15.55	13.47	85.4	71.0	65.5	11.037	7	b,c
6	IN-07	1.09	1.13	0.70	11.99	15.17	13.26	82.2	68.4	63.0	10.374	11	c
7	PAC-60002	1.11	1.16	0.69	13.49	16.63	12.62	90.9	75.3	70.5	12.532	2	a,b
8	PAC-60006	1.16	1.18	0.90	10.96	16.52	15.20	83.3	72.1	66.7	11.910	3	a,b
9	FELICITA	1.02	1.17	0.81	10.80	14.88	15.21	82.4	76.1	70.5	11.324	6	b
10	RASOUL	1.41	1.19	0.73	11.02	14.96	13.97	95.7	70.9	65.6	10.613	9	c
11	LS-6	1.20	1.29	0.77	11.01	15.95	13.58	85.9	72.8	67.4	11.612	5	b
12	SHUBHRA	1.20	0.88	1.00	12.26	17.30	12.53	96.8	77.5	71.8	13.409	1	a
Mean		1.17	1.16	0.78	11.21	15.64	13.61	87.05	72.40	67.19	11.329		
CD (5%)		0.10	0.14	0.07	0.64	0.38	0.77	10.07	NS	6.39	1.515		
CV (%)		4.44	5.38	4.31	2.61	1.63	2.60	5.31		4.36	6.14		

* The varieties followed by the same letter are statistically at *par*, GS-Gross sugar

0064) was the best for root yield and gross sugar. The other entries at par with Shubhra in gross sugar at 180 days were the SES Vanderhave varieties, PAC-60006 and PAC-60002. However, these two varieties were not statistically superior to LS-6, Felicita, SYT-06-13 and IN-06. The rest of the entries, namely LK-27, Rasoul, LKC-95, IN-07 and SYT-06-07 were comparable with each other for gross sugar in May. In conclusion, it can be said that PAC 60006, Felicita and SYT-06-13 hold promise under Indian conditions. Apart from this, an initial evaluation trial with a set of new entries was also conducted.

breeding lines was harvested.

Germplasm evaluation and initiation of breeding work

The heat tolerant material selected at Lucknow was crossed with high sugar genotypes to develop indigenous varieties of sugarbeet. The indigenous lines were hybridized with exotic lines for introgression of desired genes. Eight such crosses were evaluated for economic traits and adaptation at Lucknow (Table 9.3). The hybrid LK 0503 x LK-27 showed superiority for gross sugar and root yield.

Table 9.2: Comparative performance of five best entries at 150 and 180 days of crop age in the varietal trial (2007-08) at Lucknow

Gross sugar 180	Plant population		Root weight		Sucrose content		Root yield		Rank
	150	180	150	180	150	180	150	180	
Shubhra	Shubhra	LS-6	Rasoul	LKC-95	PAC-60002	Shubhra	Shubhra	Shubhra	I
PAC-60002	Felicita	PAC-60006	LKC-95	LS-6	Shubhra	PAC-60002	Rasoul	Felicita	II
PAC-60006	PAC-60006	Shubhra	IN-06	IN-06	IN-07	PAC-60006	LK-27	PAC-60002	III
SYT 06-13	LS-6	LK-27	LS-6	LK-27	LKC-95	LS-6	PAC-60002	LK-27	IV
LS-6	Rasoul	Felicita	Shubhra	Rasoul	LK-27	SYT 06-13	SYT 06-13	SYT 06-13	V
	NS			NS				NS	

NS : Non-significant

Seed production of indigenous varieties

Two indigenous varieties viz., IISR Comp-1 and LS-6 were multiplied by steckling method. The steckling crop was raised at IISR, Lucknow. The steckling of these varieties were transplanted at Garden Kraal area of IVRI campus, Mukteswar during December 2007 for low temperature induction for flowering. A total of 55.1 kg. of sugar beet seed comprising 52.5 kg of LS-6 having 98% germination and 2.6 kg of IISR comp-1 having 94% germination was produced.

Seed production of breeding lines and germplasm

The twenty-one breeding / germplasm lines were multiplied by steckling method. In addition, seed of nine crosses were also produced for further study. The steckling crop was raised at IISR, Lucknow. The steckling of above mentioned varieties were transplanted at Garden Kraal area of IVRI campus, Mukteswar during December 2006 for low temperature induction for proper flowering. About 25.8 kg seed of

Table 9.3: Performance of germplasm and crosses at Lucknow

S. N.	Varieties	Root weight (kg)	Sucrose (%)		Root yield (t ha^{-1})	Gross sugar (t ha^{-1})
			May '08	Jun '08	May '08	May '08
1	**SR-96**	0.90	18.62	14.34	53.57	9.97
2	**SR-97**	1.05	15.60	13.21	64.87	10.12
3	**SR-96 x LS-6**	1.25	13.86	14.34	73.96	10.25
4	**LK 0503 x LK-27**	1.35	15.50	14.07	82.72	12.82
5	**LK 0502 x LS-6**	1.05	15.60	14.62	57.60	8.99
6	**LK 0503 x LS-6**	1.20	13.28	13.92	72.36	9.61
7	**SR-97 x LS-6**	1.14	16.68	14.88	63.55	10.60
8	**IISR-Comp (HBS)**	1.12	14.42	14.29	63.86	9.21
9	**Cauvery**	1.02	14.42	14.76	59.95	8.65
10	**IISR Comp-1**	1.25	15.36	13.06	77.24	11.87
	CD (5%)	0.14	0.51	0.55	7.32	1.21
	CV (5%)	6.71	1.89	2.24	6.04	6.38

Development of integrated disease management (IDM) for foliar and root diseases of sugar beet

An experiment was conducted for management of *Sclerotium* root rot of sugar beet through soil application of a bio-agent (*T. viride*) and drenching of two fungicides (Carbendazim 0.5% and Thiram 1.0%) and also the spraying of Bavistin for the management of *Cercospora* leaf spot under field conditions with variety Shubhra. The trial was conducted with 12 treatments using randomized block design (RBD) keeping 4 replications. The treatment plots were uniformly inoculated with the pathogen *S. rolfsii* prior to sowing and in the middle of February. At the time of harvest during June, data on disease incidence, root yield, brix % and sucrose % were recorded (Table 9.4).

It is evident (Table 9.4) that all treatments including soil application of *T. viride* alone and in combination with drenching of Bavistin and Thiram significantly reduced the incidence of *Sclerotium* root rot and increased the root yield in comparison to check inoculated with *S. rolfsii*. However, in the inoculated soil with (SR) the treatment of soil application by *Trichoderma viride* before sowing was the best (T5). The next best was another treatment where disease incidence was 20.47% (T11) compared to 36.22% in the check (T3). Regarding root yield, the soil application of *Trichoderma viride* at the time of sowing (T2) and in mid-February treatment (T6) obtained maximum root yield (90.19 t ha^{-1}) under un-inoculated and inoculated conditions, respectively. The next best was with application of *T. viride* at the time of sowing + drenching with thiram obtained (78.42 t ha^{-1}) root yield compared to inoculated check with *S. rolfsii* (27.40 t ha^{-1}). Soil application with bio-agent in normal soil (without pathogen) showed growth promoting activity by enhancing germination, plant growth and yield and reducing root rot incidence. Spraying of Bavistin appeared to be effective for managing leaf spot of *Cercospora* by reducing the disease incidence and enhancing the root yield as well though the incidence of *Cercospora* was very less under natural conditions. Regarding quality attributes, i.e., brix % and pol % the treatmental effects were non significant.

It is concluded that soil application of *T. viride* (before sowing) and drenching of thiram (before appearance of disease) was found quite effective for managing Sclerotial root rot of sugarbeet under field conditions and enhancing root yield. *Cercospora* leaf spot under natural conditions could be minimized effectively by spraying of Bavistin.

Application of bio-control techniques with minimum use of insecticides for the management of major insect-pests

The experiment was designed with an objective to evaluate suitable bio-control measures against major insect-pests of sugar beet in variety Shubhra. In the "Bio Intensive Pest Management Package" (BIMP), as a result of pheromone traps, severe infestation started only 110 days after sowing, while it was more than 4.56 larvae plant^{-1} in other treatments (Table 9.5). At 7

Table 9.4: Management of *Sclerotium* root rot/*Cercospora* leaf spot through bio-agents and fungicides in field conditions

Treatment details		Incidence of root rot disease* (%)	Root yield (t ha^{-1})	Brix (%)*	Sucrose (%)*
T1	Check (without any treatment)	22.50 III	83.05 III	24.85	21.46
T2	Check, with *T. viride* only (TV)	18.43 I	91.52 I	26.25 I	22.46
T3	Check with *S. rolfsii* only (SR)	36.22	27.40	25.50 III	22.25
T4	SR + Rouging + Thiram	24.53 IV	54.70	25.45	22.43
T5	SR + TV (Before sowing)	20.47 II	76.61	25.48	23.14 II
T6	SR + TV (Mid February)	26.19	90.19 II	25.10	22.47
T7	SR + TV (Sowing + February)	28.23	69.73	25.52 II	21.74
T8	SR + Drench Bavistin 45% (Feb.)	29.89	63.51	24.60	22.16
T9	SR + Drench Thiram 1% (Feb.)	28.23	66.98	25.08	21.64
T10	SR + TV (Sow.) Drench. Bavistin	29.89	66.86	25.24	23.47 I
T11	SR + TV (Sow.) Drench Thiram	24.53	78.42	25.14	22.05
T12	Spraying of Bavistin (for *Cercospora* leaf spot)	26.19	75.17	25.19	22.81 III
	CD (5%)	6.03	12.02	NS	NS

* Data transformed as Sin $^{-1}$ for % incidence, brix % & sucrose %

days after treatment, in BIPM package, the lowest population of *S. obliqua* (2.54 larvae plant^{-1}) was recorded, while it was highest in farmers' practices (4.72 larvae plant^{-1}).

All the treatments were effective in reducing the larval population below 1 larva plant^{-1}over the farmers' practices at 28 days after treatment. A minimum larval population of *Spilosoma obliqua* (0.63 larvae plant^{-1}) was recorded in the BIPM Package, followed by the existing package (2.24 larvae plant^{-1}) and farmers' practices (2.23 larvae plant^{-1}) with statistical significance at 28 days after treatment. Spraying was not undertaken in the BIPM package due to low pest population. The variety was less susceptible to hairy caterpillars and armyworm (*Spodoptera litura*). The incidence was very low in all the treatments in general this year.

The bio-intensive pest management package and existing package proved to be effective in reducing the larval population as compared with farmers' practice at IISR, Lucknow in variety Shubhra. In bio-intensive pest management package, 0.63 larvae of *Spilosoma obliqua* plant^{-1} was observed over the season as against 2.23 larvae plant^{-1} in farmers' practice.

Considering the significantly low larval population of *Spilosoma obliqua* and the highest root yield (73.60 t ha^{-1}), the BIPM package was the most effective in reducing the *Spilosoma obliqua* larval population. It was followed by the existing package (72.47 t ha^{-1}), while it was minimum (65.68 t ha^{-1}) in farmers' practice.

Proclaim 5 SG (Emamectinbenzoate) 20 g a.i. ha^{-1} and Cigna 5 EC (Lufenuron) 60g a.i. ha^{-1} were found significantly superior to other treatments against *Spodoptera litura* (80-90%, reduction of population).

Cruiser 35 FS (Thamethoxam) @ 6 g a.i. ha^{-1} was the better treatment to reduce the population of sucking pest (90-100%) up to 15 days after treatment.

The incidence of *Cercospora* leaf spot was recorded ranging from 10.5 to 31.8% in sugar beet. Azoxystrobin and Difenaconazole fungicides were found at *par* with Mancozeb and Hexconazole for the control of *Circospora* leaf spot disease of sugarbeet. The disease was reduced to 75% by the application of fungicides.

Mechanization

In the light of the testing of the planter in Maharashtra, the furrow openers of the tractor raised bed sugar beet planter was modified. A small triangular-shaped m.s. flat was welded at the bottom and side of each furrow opener. These plates were provided to press the soil beneath the furrow openers in order to fill the cracks in the soil in that particular zone. It was observed during trial that at certain places, the sugar beet seeds moved downwards from the desired places through the cracks. This resulted in improper seed placement and sometimes too deep placement, thus adversely affecting the germination. Now with the help of this provision, such problem may be solved in black cotton soils too. Testing of a tractor drawn sugar beet digger in a small area revealed that the digging and lifting of roots were satisfactory. The tractor tyres brushed the sugarbeet roots if planted at 50 cm spacing. The digger may work satisfactorily in a field having row spacing of 60 cm or more.

Tabl 9.5: Evaluation of management practices for *Spilosoma obliqua* in sugar beet at Lucknow

Treatment		Mean larval population of *Spilosoma obliqua*					Root yield (t ha^{-1})	Sugar (%)
		Days after treatment						
		Pre count	7	14	21	28		
T1	BIPM Package	4.55	2.54	1.58	0.52	0.63	73.60	15.17
T2	Cultural and mechanical control	5.42	3.34	3.13	1.11	1.11	69.98	15.46
T3	Existing package	4.28	2.58	1.75	1.33	2.24	72.47	16.50
T4	Farmers' practice	4.56	4.72	2.73	2.51	2.23	65.68	16.18
	CD (5%)	NS	0.52	0.21	0.22	0.23	3.92	1.55

Evaluation of insecticides against insect-pests and diseases of sugarbeet (CR 1/07)

Actara (Thiamethoxam) 25% WG @ 100 and 200 g a.i. ha^{-1} was significantly superior over other treatments to reduce (80-90%) the population of aphids.

10

Technology adoption, constraints analysis, socio-economics, statistical models/procedures, 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 developed and implemented among 100 sugarcane farmers and 20 cane development personnel of the Seksaria Biswan Sugar Mill, Biswan (Sitapur) and Balrampur Chini Mill, Haidergarh (Barabanki) to imitate the knowledge in recommended sugarcane production technology. Another objective of ICS implementation was to enhance the adoption level of sugarcane production technology among sugarcane farmers in mill zone areas. To measure the effect of ICS on increase in knowledge level of selected farmers and development personnel; and increase in adoption level of sugarcane production technology among selected farmers, pre- and post-knowledge and adoption scores were calculated. The mean values of pre- and post-knowledge score for farmers were 52.5 and 70.3 i.e. an increase of 33.90% was recorded in knowledge level of farmers after ICS implementation. The effect of ICS in desirable direction was also reflected by an increase of 38.05% in adoption level of selected farmers as pre- and post-mean values for this particular variable was 45.2 and 62.4, respectively. At the same time, ICS was able to enhance knowledge level of cane development personnel of sugar mills by 30.19% as pre- and post-mean values calculated were 67.9 and 88.1, respectively.

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

An attitude scale was developed. The scale was administered among 37 trainees from sugar mills and agricultural department of different state Governments who undertook different training programmes at IISR, Lucknow. The responses of trainees on pre- and post-attitude were ascertained with the help of developed attitude scale. On the basis of responses, pre- and post-attitude score calculated were 140.22 and 171.46, respectively, with an increase of 22.28 per cent in attitude level of trainees. The increase in attitude level of trainees was achieved as a result of their exposure and learning of recent development in sugarcane production technology during training. This reflects that training imparted to development personnel resulted into change in attitude towards sugarcane production technologies in positive direction.

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

A total of 35 demonstrations were conducted during 2008-09 crop season. The results of demonstrations revealed that there is significant increase in crop yield, irrigation water saving and irrigation water use efficiency. The highest increase in yield was recorded for ring-pit method of planting (65.71%) over the conventional method followed by trash mulching (38.20%), irrigation at critical growth stages (30.60%) and skip furrow method of irrigation (30%). Saving in irrigation water varied from 16.81 to 38.52 per cent (Table 10.1). The highest increase in irrigation water use efficiency (IWUE) was recorded for ring-pit method of planting (128.90%) over the conventional method followed by trash mulching (93.90%), skip furrow method of irrigation (70.60%) and irrigation at critical growth stages (57.00%).

The cost of cultivation was highest in case of ring-pit method, the highest return accrued for this technology well compensated the increased cost. The

highest net return (Rs.74363 ha^{-1}) was recorded in case of ring- pit method, followed by trash mulching (Rs.63254 ha^{-1}), skip furrow method of irrigation (Rs.61089 ha^{-1}) and ICGS (Rs.57130 ha^{-1}). Among the demonstrated technologies, the highest B/C ratio (Table10.2) was observed for trash mulching technology (2.47) followed by skip furrow method of irrigation (2.11), ICGS (1.97) and ring-pit method of planting (1.85).

recovery i.e. UP (-0.034), Maharastra (-0.049), and Karnataka (-0.004) and Bihar (-0.16) (Table 10.3). This is an alarming situation for the country. The situation therefore, warrants serious and immediate effects to minimize losses at the levels of farmers, processors, traders and consumers to improve the sugar recoveries in these states. However, Gujarat registered a positive annual compound growth rate of 0.272 % sugar

Table 10. 1: Effect of technologies on sugarcane yield, irrigation water applied and irrigation water use efficiency

S. No	Name of Technology	Demon-stration (No.)	Average yield (t ha^{-1})			Irrigation water applied (cm)			IWUE* (kg ha^{-1}-cm)		
			Demon-stration	Conven-tional	% increase	Demon-stration	Conven-tional	Saving (%)	Demon-stration	Conven-tional	increase (%)
1	Skip furrow method of irrigation	14	82.80	63.70	30.00	48.70	63.90	31.21	1700.20	996.90	70.60
2	Ring-pit method of planting	2	116.00	70.00	65.71	37.50	61.00	38.52	2626.70	1147.50	128.90
3	Trash mulching	10	75.92	54.92	38.20	42.50	59.60	28.70	1786.40	921.50	93.90
4	ICGS**	9	82.80	63.40	30.60	46.00	55.30	16.81	1800.00	1146.50	57.00

* IWUE – Irrigation water use efficiency ** ICGS – Irrigation at critical growth stages

Table 10.2: Economics of sugarcane production

Particulars	Farmers' practice	Demonstrated technologies			
	Plant cane	Trash mulching	Ring pit	ICGS*	Skip furrow
Cost of production (Rs ha^{-1})	56721	43034	88037	58790	54831
Yield (t ha^{-1})	65.70	75.92	116.00	82.80	82.80
Gross return (Rs ha^{-1})	91980	106288	162400	115920	115920
Net return (Rs ha^{-1})	35259	63254	74363	57130	61089
B:C ratio	1.62	2.47	1.85	1.97	2.11

*ICGS – Irrigation at critical growth stages

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)

The annual compound growth of last fifty eight years (1951-2008) was estimated to measure growth in sugar recovery in different states of India (Table 10.3). The annual compound growth rates of sugar recovery in different states are not uniform during 1951-2008. Important sugar producing states registered negative annual compound growth (%) of sugar

recovery followed by Tamil Nadu (0.13%), Andhra Pradesh (0.13%), Orissa (0.11%), Karnataka (0.018%) and Kerala (0.02%) in tropical India. In sub-tropical India, Haryana (0.35%), Punjab (0.09%), Madhya Pradesh (0.085%) registered positive annual compound growth rate in sugar recovery. If these trends are projected for planning and location of new capacities, the sugar basket is likely to be largely confined to UP, Maharastra, Tamil Nadu, Gujarat, Karnataka, Andhra Pradesh, Punjab and Haryana in order of their importance.

Co-efficient of variation was calculated to measure the stability of sugar recoveries in different states (Table 10.3). The maximum stability in sugar recovery was found in Assam (2.61%) and Rajasthan (4.47%) followed by Madhya Pradesh (4.78%), Uttar Pradesh (5.59%) and Haryana (16.94%). It indicated that there is minimum variation in sugar recoveries between the districts of state in sub-topical India. In contrary, Bihar (17.08 %) registered maximum variability in sugar recoveries of districts. It is due to old sugar factories located in the different parts of state. The variation in sugar recovery was highest in Orissa (19.89%) followed by Kerala (15.74%), Gujarat (9.89%), Tamil Nadu (6.48%), Andhra Pradesh (8.73%), Maharastra (8.23%) and Karnataka (8.17%) within the districts of states.The districts which are giving more than 10% sugar recoveries in the country are Solapur,

Nashik, Aurangabad, Ahmednagar, Beed, Dhule, Pune, Satara, Sangli, Kolhapur, Parbani, Yavatmal of Maharastra, Surat and Valsad in Gujarat, Nizamabad in Andhra Pradesh, Coimbatore and Dharmpuri in Tamil Nadu and Bellary, Mandya and Dharwad in Karnataka.

Table 10.3: Salient features of sugar recovery in different states of India

S. N.	State	Compound growth rate (%) of sugar recovery (1951-2008)	Districts (No.)	Average sugar recovery along with CV (%)	Average sugar recovery(%) of districts in the states
1.	Punjab	0.09	11	9.04 (10.73)	Patiala (9.14), Ludhiana (9.03), Sangrur (9.31), Amritsar (9.01), Faridkot (7.15), Gurdaspur (9.85), Ropar (9.92), Kapurthala (9.81), Jalandhar (9.77), Firozpur (9.21), Mansa (7.26)
2.	Haryana	0.35	10	8.92 (16.94)	Kurukshetra (9.72), Ambala (9.83), Jind (9.36), Karnal (9.93), Rohtak (9.71), Hisar (6.74), Sonipat (9.93), Faridabad (9.29), Panipat (9.14) Kaithal (5.56)
3.	Uttar Pradesh	- 0.034	36	8.90 (5.59)	Ballia (8.63), Azamgarh (8.52), Ghazipur (8.57), Varanasi (9.08), Jaunpur (6.89), Kanpur (8.57), RaeBareli (9.54), Barabanki (8.53), Bahraich (8.59), Faizabad (9.41), Gonda (9.29), Basti (9.27), Gorakhpur (8.58), Deoaria (8.92), Hardoi (8.63), Sultanpur (8.72), Lahimpur (9.51), Shahjahanpur (8.72), Piliphit (8.83), Barelly (8.88), Rampur (8.95), Moradabad(8.68), Bijnour(9.10), Dehradun (8.26), Nainital (9.11), Saharanpur (9.07), Muzaffarnagar (8.92), Bulandshahar (8.68), Meerut (9.34), Aligarh (8.85), Mathura (8.85), Etah (9.10), Sitapur (9.30), Budaun (9.44), Farrukhabad (9.27), Ghaziabad (9.84)
4.	Bihar	- 0.16	15	7.80 (17.08)	Nawada (7.39), Gaya (6.18), Patna (5.75), Vaisali (7.24), Madhubani (7.74), Darbhanga (7.47), Samastipur (10.12), Muzaffarpur (7.25), Sitamarhi (9.64), E.Champaran (8.52), W.Champaran (9.18), Siwan (6.04), Saran (8.83), Gopalganj (8.52), Prnia (7.9)
5.	Madhya Pradesh	0.085	8	9.50 (4.78)	Sehore (9.72), Gwalior (9.93), Indor (9.42), Khandawa (9.35), Ratlam (9.28), Madsaur (8.64), Ujjain (9.45), Morena (9.97)
6.	Rajasthan	- 0.14	3	8.95 (4.47)	Bundi (9.34), Chittaurgarh (8.97), Sriganganagar (8.54)
7.	Assam	- 0.279	2	8.12 (2.61)	Golaghat (7.97), Karimganj (8.27)
8.	Maharastra	- 0.049	22	10.02 (8.23)	Osmanabad (9.69), Solapur (10.31), Nashik (10.69), Aurangabad (10.3), Ahmednagar (10.63), Beed (10.01), Dhule (10.16), Pune (10.45), Satara (11.33), Sangli (11.22), Kolhapur (11.45), Jalna (9.67), Parbhani (10.28), Nanded (9.59), Latur (9.45), Amravati (8.03), Yavatmal (10.49), Buldana (9.38), Jalgaon (9.82), Nagpur (8.98), Wardha (9.49), Akola (8.98)
9.	Gujarat	0.272	7	9.55 (9.89)	Junagadh (8.52), Surat (10.85), Valasad (11.31), Bharuch (9.23), Amreli (9.10), Kheda (9.47), Rajkot (8.79)
10.	Orissa	0.11	5	7.83 (19.89)	Ganjam (8.85), Sambalpur (8.88), Korput (8.85), Badamba (5.34), Nayaganj (7.25)
11.	West Bengal	- 0.788	2	6.715 (0.11)	Birbhum (6.71), Nadia (6.71)
12.	Andhra Pradesh	0.11	17	8.89 (8.73)	Chittoor (9.00), Krishana (9.65), E.Godavari (9.47), W. Godavari (9.57), Nalgoda (7.40), Cuddapath (7.86), Vishakhapatnam (9.12), Srikakulam (8.75), Ananthpuram (8.46), Nellore (7.87), Vizinagaram (8.94), Nizamabad (10.17), Medak (9.56), Karimnagar (9.81), Kurnool (8.66), Guntur (8.06), Khamam (8.87)
13.	Tamil Nadu	0.13	12	9.38 (6.48)	Chengalpattu (8.93), South Arcot (9.30), NorthArcot (9.81), Salem (9.23), Dharampuri (10.31), Coimbatore (10.06), Periyar (9.61), Triuchirapalli (9.55), Thanjour (9.11), Madurai (9.81), Nellikattabomman (8.75) Pasumponmutramlinganam (9.16)
14.	Karnataka	0.018	14	9.52 (8.17)	Kolar (8.76), Bijapur (9.52), Belgaum (10.72), Bellary (10.14), Bidar (9.98), Shimonga (9.40), Uttarkannad (8.12), Hassan (9.37), Mandya (10.58), Maysore (8.83), Raichur (9.52), Chitradunga (9.45), Dharwad (10.38), Gulbarga (8.56)
15.	Kerala	0.02	2	7.43 (15.74)	Palghat(8.26), Pattanamthitta(6.6)

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

In an agro-economic analysis based on secondary data on the contribution of sugarcane in Indian economy in terms of its contribution to fiscal income and labour income was estimated (Table 10.4). The excise duty including cess from sugar was worked out at 5.4% of the value of sugar produced. Total union excise revenue collection from sugar and confectionery was 1.73% of the total excise duty collection from all commodities during 2004-05. The sugar industry contributed about 2076 crores in terms of excise duty to Central Exchequer on an average during TE 2007-08. In addition, it also contributed about 833 crores per year to state income as purchase tax on cane purchase paid by sugar mills. About 28 crores per year were also contributed as commission to societies/cane unions, and about 57 crores as secondary and higher education cess. At an all-India level, there were 59.96 lakh cane-growing holdings in 2000-01, constituting about 5% of all holdings. However, in U.P., Uttarakhand and Punjab, 12-14% of total holding grew sugaracne. The cane price payments to farmers by sugar mills on an average amounted to Rs. 17675 crores per year. Total yearly labour employment in sugarcane was estimated at 816.5 million mandays, of which 44.91 million mandays were the contribution of casual labour. The cane growers paid about Rs. 7157 crores to casual labourers as wage income. It was also observed that sugarcane compared to other crops had lowest demand for female labour despite its high demand for total labour.

Table 10.4: Contribution of sugarcane in Indian economy

TE 2007-08

S. No.	Particulars	Unit	Value
1	Total sugarcane growing holdings (2000-01)	Million	5.99
2	Total labour employment in sugarcane	Million mandays	816.5
3	Total casual labour emploment in sugarcane	Million mandays	449.1
4	Cane price payments to cane growers	Rs. in crores	17675
5	Payments to casual labourers	Rs. in crores	7157
6	Purchase tax from sugarcane	Rs. in crores	833
7	Excise duty including cess	Rs. in crores	2076
8	Excise duty as value of sugar produced	%	5.4

10.3 Development of statistical models/ procedures

Compilation, analysis and documentation of long-term weather database in relation to sugarcane crop culture (AM 3)

Weather during 2008-09 crop season

The weather during the crop season 2008-2009 was characterized by lower average maximum temperature in April, May, June, July, August and November, 2008, respectively by 0.1, 1.0, 4.4, 2.7, 0.7 and 0.2°C as compared to long term (LT) average (1980-2007). It remained relatively higher during September, and December 2008 and January, February and March 2009, respectively by 0.4, 0.7, 1.3, 4.4 and 1.1°C as compared to LT (1980-2008) average.

The minimum temperature exceeded LT average during April, October, November, December, 08, January and February, 09, respectively by 0.1, 0.7, 1.2, 2.7, 2.0, and 2.1°C. It remained lower during May, June, July, August, September 08 and March 09, respectively by 0.3, 0.6, 0.4, 0.2, 0.1 and 0.1°C.

Morning relative humidity remained lower than LT average during April, May and September 08, respectively by 4, 2 and 3%. It exceeded LT normal during June, July, August, December 08 and January, February and March 09, respectively by 15,6,3,5,2,5 and 3%.

Afternoon relative humidity was above LT normal during June, July, August, October, November, December 08, respectively by 20,7,4,3,3 and 10 %. It remained below LT normal during April, and September 08 and January, February and March 09, respectively by 4, 3, 1, 2 and 4%.

The duration of bright sunshine remained lower than LT average during all through the crop season from April, 08 to March, 09 ranging from 0.5 to 5.3 h day^{-1} except in the month of September 08 where it exceeded Lt normal by 0.2 h day^{-1}. The maximum reduction in duration of bright sunshine was observed in November 08 (5.3 h day^{-1}) and minimum in February 09 (0.5 h day^{-1}).

During the crop cycle 2008-09, total rainfall received was 1452.9 mm as against LT normal of 893.0 mm. During monsoon season, the total rainfall received was 1363.1 mm as against LT normal of 780.3 mm. Thus monsoon rainfall was in excess by 582.8 mm.

Long –term variability trends of weather parameters at Lucknow

The annual trend of variability of weather parameters at Lucknow was established from long-term weather database for 30 years (1979-2008) collected at IISR, Lucknow. The annual maximum temperature reflected decreasing trend @ 0.04oC year^{-1} whereas minimum temperature showed increasing trend @ 0.02oC year^{-1}. The morning, afternoon and mean relative humidity reflected increasing trend respectively @ 0.17, 0.04 and 0.10% year^{-1}. The annual and monsoon (June-September) rainfall showed decreasing trend @ 5.67 and 6.04 mm year^{-1} respectively. The annual total duration of bright sunshine reflected a decreasing trend @70.1 hr year^{-1}. The average annual wind speed reflected an increasing trend @ 0.08 km h^{-1} year^{-1}.

Long-term weather variability in sub-tropics

The annual weather variability was also analyzed for Shahajahanpur, Modipuram, Muzaffarnagar and Karnal in sub-tropics from weather database collected from 1996-2006. The annual average maximum temperature reflected an increasing trend at Karnal, Muzaffarnagar and Shahajahanpur respectively @ 0.11, 0.06 and 0.13oC year^{-1} whereas a decreasing trend @ 0.01oC year^{-1} was noticed at Modipuram. The minimum temperature reflected an increasing trend at Karnal and Shahajahanpur, respectively @ 0.14 and 0.5oC year^{-1}. A decreasing trend@ 0.19 and 0.07oC year^{-1} respectively was noticed at Muzaffarnagar and Modipuram. Morning relative humidity reflected an increasing trend @ 0.09% year^{-1} and afternoon relative humidity a decreasing trend @ 0.5% year^{-1} at Karnal. Mean relative humidity showed a decreasing trend @ 0.09 and 0.39% year^{-1} respectively at Shahajahanpur and Muzaffarnagar. The average annual duration of bright sunshine reflected a decreasing trend @ 0.03 h day^{-1} year^{-1} at Karnal. The annual rainfall reflected a decreasing trend @ 56.3, 30.9, 47.6 and 17.1 mm year^{-1} respectively at Karnal, Muzaffarnagar, Modipuram and Shahajahanpur. The monsoon rainfall reflected a decreasing trend @ 46.2, 19.4 and 47.9 mm year^{-1} respectively at Karnal, Muzaffarnagar, and Modipuram. No visible change reflected at Shahajahanpur.

Development of Atlas for Sugarcane Cultivation in India (AM 4)

State level GIS maps on Green House Gas (CO2, CH4 and N2O) emission scenario, mechanization status, average power consumption, edaphic and irrigation resources etc. were developed. Regarding green house gas emission, the methane emission was highest in states of Andhra Pradesh, Orissa and West Bengal and lowest in states of Jammu& Kashmir, Himanchal Pradesh, Rajasthan, Maharashtra and Karnataka. The nitrous oxide emission was highest in the state of Uttar Pradesh and lowest in Jammu& Kashmir and northeastern states. The global warming potential (Gg equivalent of CO_2) was highest in states of Tamil Nadu, Andhra Pradesh and West Bengal and lowest in Himanchal Pradesh and north eastern states.

The average number of tractors (an index of mechanization) was highest in Uttar Pradesh and lowest in Jammu& Kashmir and nort heastern states, Kerala and Orissa The average power availability for agriculture was highest in Punjab and lowest in northeastern states.

SAC-IISR Programme on Energy and Water Balance and Crop Growth Monitoring Using Satellite Data

NDVI- Yield relationship in sugarcane

The NDVI observed in the last week of June was used to estimate crop productivity at harvest. The crop yield at harvest was found to be an exponential function of NDVI (Fig. 10.1).

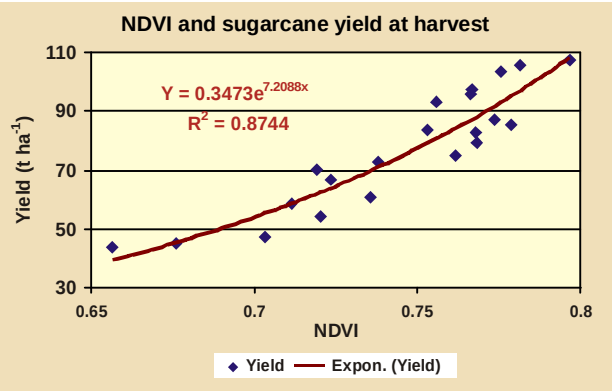
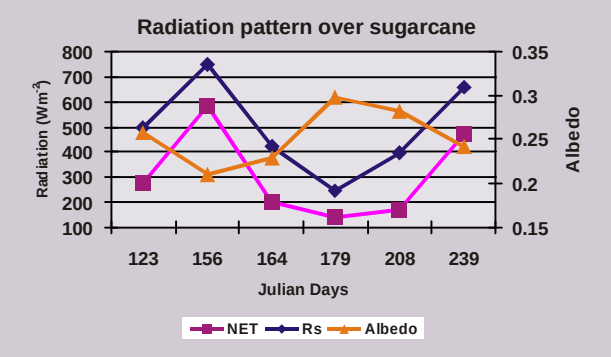


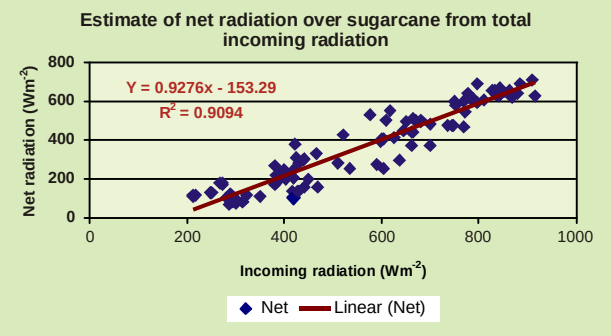
Fig. 10.1: MDVI- Yield relationship in sugarcane

Radiation balance over sugarcane

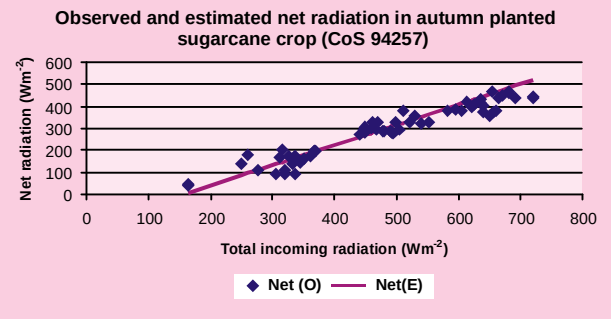
Total incoming radiation and net radiation profile in sugarcane during elongation phase of the crop was recorded and albedo was estimated as shown below:



A linear model was developed for estimating net radiation from total incoming radiation as below:



The relationship was validated in establishment phase of sugarcane (var. CoS 94257) planted on 27th October 2008 in autumn season. The RMSE between observed and estimated net radiation was 13.67 %. The pattern of observed and estimated net radiation is shown below:



10.4 Development of database and information systems

Data warehouse on sugarcane production system (AES 4.8)

Developed a software tool to assist management of field experiments conducted at the institute farm. It provides mechanism for recording information of experiments conducted at the institute farm, daily operation and input provided in the field, project information for which experiments have been conducted. Further reporting modules of the software aid in decision support by providing specific reports on experiments, project, farm operation and input history, etc.

A data mining software tool has been developed to explore and analyze the data stored in the data warehouse of sugarcane production. It has three components viz. User Interface, Search Engine and Data Warehouse. Web-oriented nature of the tool provides a web-browser based user interface to search the data from data warehouse. Software asks for various parameters to be reported along with conditions to be checked for searching the data. Search engine of the software do the job of data searching from data warehouse and provides the results to user through reporting mechanism of the software. Algorithm of the software operates upon two types of data 'Facts' and 'Dimension'. Forty facts related to sugarcane production have been undertaken in the Software. Some of important facts are Sugarcane Area, Production, Productivity, Cane Crushed, Sugar Production, Recovery Percent, No. of Factories, Maximum Temperature, Minimum Temperature, Rainfall, Relative Humidity, etc. Dimension defines the extent of data corresponding to growing regions and duration. Data warehouse is the ultimate repository of sugarcane production data used by the system. Software has been tested with two test cases. It may be implemented on a Web Server with back end database and ASP .NET support in it.

Decision support tools in sugarcane cultivation (AES 4.10)

Common KADS methodology has been applied in acquiring domain knowledge for disorder diagnosis in sugarcane crop. Knowledge of disorder diagnosis consists of Crop Concepts and Symptoms. Crop Concepts are concerned with the properties of sugarcane crop at farmers' field level viz. region where crop stands, crop type (plant / ratoon), crop stage (germination, elongation, maturity, etc). Symptoms are the visible disorder symptoms observed by farmer in the sugarcane crop. Information about major insect / pest & diseases of sugarcane along with textual & visual symptoms has been collected. Images of symptoms have been rectified for optimum quality and size using Microsoft Picture Manager. Crop concepts to identify field conditions where symptoms of particular disorder appear in sugarcane have been collected for Uttar Pradesh. Domain knowledge acquired is represented in the form of domain ontology and domain model. Ontology defines the terms used in particular domain. Domain model defines the rules based on domain ontology for problem solution.

11 Transfer of technology

11.1 Technologies developed and demonstrated

Technologies on the following aspects were developed, and demonstrations were carried out to evaluate their performance as well as their dissemination to the farmers.

Sugarcane varieties

Sugarcane variety CoLk 94184 (Birendra), an early maturing high sugar variety developed by the Institute was released for cultivation north-central zone comprises Bihar, West Bengal and east Uttar Pradesh, in Feb-March planting season. It has the cane yield potential of 80 t ha^{-1} with 17.5% sucrose content in juice. It has good ratooning ability also.

Nutrient and water management

Wheat + sugarcane intercropping under FIRB system is profitable over wheat + sugarcane intercropping under flat method, wheat – sugarcane sequential system and sole sugarcane.

Ring-pit planting of sugarcane and sett soaking in saturated lime water followed by adequate K nutrition (60 kg K_2O ha^{-1} at 170 DAP) impart endurance characteristics to sugarcane plants under drought spells during grand growth period of the crop and enhances cane productivity and quality.

In areas with limited irrigation facilities, cane setts should be soaked in saturated lime water {80 kg lime in 1000 L of water ha^{-1}} for two hours one day before planting to improve germination by 5 percent and cane yield up to 4 tonnes per hectare.

Ratoon management

For enhancing sprouting of stubble bud to raise subsequent good ratoon crop, it is recommended to apply 60 kg K ha^{-1} with irrigation water in standing sugarcane one month prior to its harvest.

Farm machinery

For off-baring, deep tilling and fertilizer placement in ratoon crop, it is recommended to use ratoon management device (RMD)-a machine developed by the institute, which performs all these operations simultaneously in one pass of the tractor. The operation of RMD in one ha of ratoon crop saves 8-10 tractor hours, 200-250 man-hours, and an approximate cost saving Rs. 6000 ha^{-1}.

Disease management

Technology of mass multiplication of *Trichoderma* in press mud cake was developed. It is recommended to apply an IISR-Microbial formulation inoculated in farmyard manure/press mud cake @ 20 kg ha^{-1} in the furrows above seed cane setts at the time of planting. This practice helps in management of red rot disease and improves sugarcane productivity up to 5 tonnes ha^{-1}. Technology of *Trichoderma* application on sprouting stubbles in ratoon was also developed to protect against red rot.

Mass multiplication technique of *Cotesia flavipes* was also developed.

11.2 On-station demonstrations and technical guidance to farmer-visitors

Demonstrations on sugarcane production technologies *viz* planting methods (ring pit and flat planting), Varieties (CoLk 94184, CoS 96275 & CoS 8436), Intercropping of wheat, lentil and linseed with sugarcane under FIRB and Flat planting methods, IPM and Bio-therapy for red rot management were laid out at Institute's farm to demonstrate the yield and economic return potential of improved technologies to the visiting farmers and cane development personnel of sugar mills. About 600 farmers/extension workers/cane development personnel/students were provided technical guidance on these demonstrations during their visits to the experimental farm at the institute. The yield levels under demonstrated technologies were quite high (Table 11.2).

Table 11.2: Yield levels of demonstrated technologies at IISR research farm

S. No.	Technology	Variety	Cane yield (t ha^{-1})	Intercrop	
				Variety	Yield (t ha^{-1})
1	Ring-pit planting method	CoLk - 94184	199.80		
		CoS-96275	175.13		
		CoS-8436	160.20		
2	Flat method of planting	CoLk - 94184	89.00		
		CoS-96275	78.56		
		CoS-8436	70.50		
3	FIRB: Cane +Wheat	CoS-96275	69.13	PBW-343	4.23
4	FIRB: Cane + Linseed	CoS-96275	60.08	Garima	1.01
5	FIRB: Cane + Lentil	CoS-96275	78.31	K-75	2.10
6	Flat: Cane +Wheat	Cos-96275	54.32	PBW-343	3.39
7	Flat: Cane + Linseed	CoS-96275	55.80	Garima	0.85
8	Flat: Cane + Lentil	CoS-96275	62.01	K-75	1.65
9	IPM	CoS-96275	60.20		
10	Bio-therapy for red rot management	CoS-96275	6.13		

Farmers' visits coordinated by KVK, Lucknow: Under ATMA scheme, 24 groups of farmers (494 farmers) from different states visited KVK (IISR), Lucknow. These farmers were shown different technologies of sugarcane crop, the implements (developed by the institute) for sugarcane cultivation, the *jaggery* and *khandsari* processing unit, and the vermicompost unit during their visit.

Farmers visiting IISR field experiments

11.3 Technologies transferred

Resource bacterial cultures: Pure cultures of efficient N-fixer *Gluconacetobacter diazotrophicus* (isolate IS100) were provided to Director, Sugarcane Research Institute, Rajendra Agricultural University, Samastipur (Pusa), Bihar for its multiplication and demonstrations. The technology for its multiplication and application in the sugarcane plant and ratoon crop was also provided.

Seed production and distribution

Sugarcane: More than 8000 quintals of seed cane of eight sugarcane varieties was produced.

Sugar beet: IISR sugarbeet breeding outpost at IVRI, Mukteswar produced seed of IISR bred sugar beet varieties and supplied it to the end users. About 50 kg of very costly seed was produced and supplied to different growers/factories for local evaluation/ feasibility trials. Sugar beet got acceptance as cattle feed in Central UP. In bhuj area of Kutch district of Gujarat, sugar beet has grown quite well in the problem soils (high salinity) and is also able to meet the cattle green fodder demand.

11.4 Knowledge dissemination

Field day on mechanization of sugarcane cultivation: A field day on mechanization of sugarcane cultivation was organized on October 06, 2008 at the Institute premises in order to popularize the farm machines and equipments developed by the institute. About 100 officials from different sugar mills, progressive farmers, ICAR officials, scientists from UPCSR, Shahjahanpur, and GBPAU&T, Pantnagar, manufactures of farm

Live demonstration on sugarcane cutter planter on Field Day

equipments and machinery were present on the Field Day. Live demonstrations on the use of machines developed and being commercialized by the institute, namely Ridger type Sugarcane Cutter Planter (PTO operated), Raised-bed Seeder (RBS) cum Cane Planter, and Ratoon Management Device (RMD) were conducted at sugarcane fields at the IISR farm.

Dissemination through Mass Media

a) T.V. news coverage

Ring-pit planting. In programme "Rajdhani se" telecast by e-tv on 16-05-2008 and 19-05-2008 at 8:00 PM.

Bite of Dr. R.L. Yadav on Sugarcane new variety CoLk 94184 telecasted in e-tv News on 24-05-2008.

Press briefing on CoLk 94184 was telecasted in programme "Khabren kheti ki", Krishi Darshan of Lucknow Doordarshan on 31-07-2008.

b) Press releases

English

- Field Day. The Hindustan Times, Lucknow, October 7, 2008.
- Intercropping is the way for sugarcane industry. Indian Express, Lucknow, September 26, 2008.
- Sweeter sugarcane. The Hindustan Times, Lucknow, August 1, 2008.
- New variety of sugarcane developed. The Pioneer, Lucknow, August 1, 2008.

Hindi

1. समय की बचत के लिए गन्ने की खेती का मशीनीकरण हो। राष्ट्रीय सहारा, लखनऊ, 7 अक्टूबर 2008 ।
2. मशीन एक, काम अनेक। दैनिक जागरण, लखनऊ, 7 अक्टूबर 2008।
3. बुवाई की जानकारी दी। हिन्दुस्तान, लखनऊ, 7 अक्टूबर 2008।
4. गन्ने के साथ सहखेती कर उत्पादन बढ़ाएँ किसान। राष्ट्रीय सहारा, लखनऊ, 24 सितम्बर 2008।
5. गन्ने के साथ लगायें दलहन फसलें। अमर उजाला, लखनऊ, 24 सितम्बर 2008।
6. गन्ने पर प्रशिक्षण कार्यक्रम का समापन। स्वतंत्र भारत, लखनऊ 24 सितम्बर 2008।
7. दूसरी फसल लगाने का प्रशिक्षण कार्यक्रम का समापन। राष्ट्रीय सहारा, लखनऊ 24 सितम्बर 2008।
8. उत्पादन के साथ फसल विविधीकरण पर प्रशिक्षण आज। दैनिक जागरण, लखनऊ, 16 सितम्बर 2008।
9. गोबर की खाद डालिए गन्ना उत्पादन बढ़ाइए। राष्ट्रीय सहारा, लखनऊ, 27 अगस्त 2008।
10. अब चुकन्दर से बनेगी चीनी। अमर उजाला, लखनऊ, 13 अक्टूबर 2008।
11. ज्यादा मिठास वाला गन्ना। राष्ट्रीय सहारा, लखनऊ, 1 अगस्त 2008।
12. जलभराव और सूखे में उगेगा 'कोलख' गन्ना। दैनिक जागरण, लखनऊ, 1 अगस्त 2008।
13. वैज्ञानिकों ने विकसित की उन्नत प्रजाति। स्वतंत्र भारत, लखनऊ, 1 अगस्त 2008।
14. यूपी, बिहार के गन्ने में घुलेगी शहद सी मिठास। दैनिक जागरण, लखनऊ, 30 जुलाई 2008।

टीवी वार्ताएँ

विषय	कार्यक्रम	तिथि	नाम
गन्ना बुवाई के लिए खेत की तैयारी, बीज व प्रजाति का चुनाव एवं बुवाई विधियाँ	अन्नदाता ई.टी.वी (उत्तर प्रदेश/ उत्तरांचल)	11 मार्च, 2009	डा. ए.के. शाह
पेड़ी गन्ना प्रबन्धन	तदैव	10 मार्च, 2009	श्री कामता प्रसाद
बसन्तकालीन गन्ने के साथ सहफसली खेती	कृषि दर्शन प्रसार भारती दूरदर्शन केन्द्र, लखनऊ	27 फरवरी, 2009	श्री जी.के. सिंह
हरी खाद के लिए ढैंचा की खेती	तदैव	25 मार्च, 2009	डा. डी.वी. यादव
पेड़ी गन्ना की उन्नतशील खेती	तदैव	18 मार्च, 2009	श्री जी.के. सिंह

In addition, TV and radio talks were also given by the KVK Lucknow on topics other than sugarcane, such as on horticulture and animal husbandary

Kisan Call Centre and correspondence with sugarcane growers: Letters received from the farmers and extension workers of various states were replied giving them details of sugarcane production technologies.

Website: Information on technologies generated is also hosted on the institute website www.iisr.nic.in

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 4 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.

12.1 International training programme

The institute has developed following 4 International Training Programmes on sugarcane related aspects. These are:

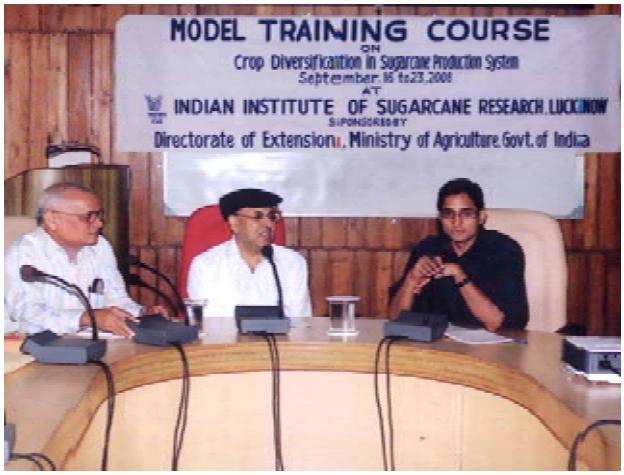
1. Mechanization of sugarcane cultivation
2. Agro-technology for maximizing sugarcane production
3. Protection technology for sustaining sugarcane productivity
4. Manufacturing and storage of jaggery.

12.2 Training of sugarcane development personnel

IISR regularly organizes one one-month (July 1-31) training programme for sugarcane development personnel from sugar mills to update them with the latest knowledge of sugarcane farming. This training is becoming popular and gradually drawing attention of the sugar Industries. During the year, 17 trainees from different states of India participated and got acquainted with the latest technical know-how in sugarcane cultivation. Under this training, 74 lectures, theory and practical, were delivered.

Trainee participants in one month training programme at IISR

Eight days Model Training Course on Crop Diversification in Sugarcane Production System sponsored by the Directorate of Extension, Ministry of Agriculture, Govt. of India was organized from September 16-23, 2008. In this training, 20 development officers from sugar mills/state cane/ agriculture departments of states such as Uttar Pradesh, Bihar, Haryana, Maharashtra, Gujarat, Karnatka, Madhya Pradesh, Andhra Pradesh, Jharkand, Orissa and Nagaland participated. In-depth training was provided in the area of remunerated technologies of intercropping with sugarcane and mechanization of cane cultivation.



Model Training Course in session

12.3 Trainings to farmers

Two-days training was conducted on "Sugarcane production technology" for the farmers from Bihar on September 25-26, 2008. In this training programme, 28 farmers participated and provided with the information on the latest developments in sugarcane production technology.

Farmers' Training in progress

Interactive Session during training for farmers from Bihar

Farmers being explained about improved technologies

Demonstration of sugarcane cutter planter to farmers

A six-days training for farmers from Bihar on "Ganne ki Unnat Krishi Taknik" sponsored by ATMA, Samastipur, Bihar was organized from March 16-21, 2009.

Trainings to the farmers of Lucknow district were also organized in all the areas of agriculture by KVK, Lucknow, housed at the Institute. In all, 57 trainings were organized, of which, 43 were for practising farmers, 3 for rural youths, and 3 for in-service personnel, and 8 sponsored trainings for upgrading knowledge and skill of the participants. A total of 1181 farmer trainees were trained during the year 2008-09.

12.4 Training to students

During the year, 13 students from different institutes and universities like Beehive College, Garhwal, Uttarakhand; Jaipur National University, Rajasthan; VIT university, Vellore, Tamil-Nadu; Allahabad Agriculture Institute (Deemed University), Allahabad; Chaudhary Charan Singh University, Meerut; AMITY University; Lucknow and IILM, Greater Noida were trained in Bio-Technology, Biochemistry and Microbiology.

13

Awards and recognition

Awards

Dr. R.L. Yadav, Director, IISR, Lucknow was awarded ISA Gold Medal 2006 by the Indian Society of Agronomy, New Delhi for his outstanding contribution to Agronomy.

Dr. R.L. Yadav, Director, IISR receiving ISA Gold Medal 2006

Recognition

Dr. R.L. Yadav, Director, IISR, Lucknow was elected as Vice-President (Technical Council) of Indian Society of Agronomy, New Delhi for his outstanding contribution to Agronomy.

Dr. Archna Suman, Principal Scientist (Microbiology) was selected as Member, National Academy of Sciences, India (NASI) and elected as Member, Executive Council, Indian Society of Soil Science, Lucknow Chapter.

Editorial board members/reviewers/ referees of Journals

Dr. Sangeeta Srivastava served as member, Editorial Board of the journal "Plant Cell Biotechnology and Molecular Biology".

Dr. Archna Suman, Principal Scientist (Microbiology) acted as reviewer for the following International Journals :

- World J. Microbiol. & Biotechnol.
- Letters in Applied Microbiology
- Current Microbiology
- Soil and Tillage Research
- African J Agronomy

Dr. Sangeeta Srivastava, Principal Scientist (Gen.& Cytogenetics) acted as referee for the following 2 foreign and 3 national Journals :

- Annals of Applied Biology
- Journal of Plant Breeding and Crop Science
- Indian J. of Genetics and Plant Breeding
- Nucleus
- Indian J. of Sugarcane Technology

Dr. Archna Suman, Principal Scientist (Microbiology) and Dr. Sangeeta Srivastava, Principal Scientist (Gen.& Cytogenetics) served as consulting editors of the Journal "Sugar Tech".

Dr. M. Swapna served as referee for, 1. Indian Journal of Genetics and Plant Breeding, and, 2 the Journal of Tropical Agriculture.

Others

Dr. A. D. Pathak nominated to act as DBT representative in Institute Bio-safety Committe of U.P. Council of Sugarcane Research, Shahjahanpur for a period of 3 years by the Department of Biotechnology, Ministry of Science and Technology, Government of India.

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 as detailed below.

14.1 Collaboration with International Research Institutions

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

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

14.2 Collaboration with National Research Institutions

The institute has developed linkages with National level research organisations such as SBI, Coimbatore on effecting matings/ hybridization (crossing) involving proposed parents and supply of viable fluff for raising sufficient seedling populations; and the supply of germplasm for evaluation in a phased manner, *inter alia*. For the development of improved parental clones for subtropical agro-climate with high sugar accumulation potential and to enrich breeding population in the National Hybridization Garden at Sugarcane Breeding Institute, Coimbatore, 42 high sugar LG selection so far have been sent to the Sugarcane Breeding Institute for enriching the breeding populations in the National Hybridization Garden (NHG), SBI, Coimbalore as part of institute research projects. Over thirty selections that are already in NHG after quarantine are being increasingly used in crossing in order to identify parents transmitting the genes for high sugar content in juice, particularly early in the season. During the year 2008-09, the institute scientists (breeders) under different research projects also attempted crossings at National Hybridization Garden, SBI, Coimbatore.

The Fluff Supply Programme is also carried out in the institute under the auspices of the AICRP on Sugarcane. The programme deals with the development of sugarcane varieties for subtropical region from the fluff of zonal crosses sent from Sugarcane Breeding Institute, Coimbatore. At present, the work done under this programme involves the identification of promising genotypes in different clonal generations and not from the seedling population

The seed cane of many genotypes, and the early maturing clones (received from SBI, RC, Karnal) to be tested in initial varietal trial (Early) has been multiplied. Observations on general growth performance and juice quality were recorded in the institute.

Maintenance of Bt genes: The procured four Bt gene constructs (Cry 1Ab, Cry 1Aa, Cry 1F, Cry IA5) and pB1 121 with GUS are being maintained in the institute as Bt gene resource for development of transgenics in sugarcane against borer.

IISR has also established linkages with IVRI, Mukteswar as institute's sugarbeet breeding outpost which is active in producing seed of IISR bred sugarbeet varieties and supplying the seed to the end users. About 50 kg costly seed was produced and supplied during the year to different growers/factories for local evaluation/feasibility trials.

The Institute has also strengthened its linkages with national research organization like NBRI, Lucknow, CDRI, Lucknow, CIMAP Lucknow, and

NSI, Kanpur. Collaboration with national/ state level sugarcane research organizations in the country has also been made through inviting the scientists/officers in the seminar/ brain storming sessions organized at the institute.

14.3 Collaboration with Central Line Departments

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

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

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

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

14.4 Collaboration with State Agencies/ state research organizations

The institute has linkages with Sugarcane Research Stations and State Agricultural Universities 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 22 different co-operating centres located in different states in the country as shown below, In this way, the Institute its strengthening is 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); Thiruvella, (KAU, Trichur); Uchani, CCSHAU, Hisar); Lucknow, (IISR, Lucknow)

In addition, the institute liasions as cooperating centre of 3 other AICRPs, viz AICRP (FIM), AICRP (BC), and AICRP (PHT). The Institute is also coordinating a Network Project on Sugar beet.

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

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

Local IMD, Lucknow: The Institute records

metrological data at its observolary and share with local IMD, Lucknow. The institute also shares its data on weather variables to Weather Watch Group, constituted by the Govt. of U.P.

14.5 Collaboration with private Organizations

Collaboration with private seed/ fertilizer/ pesticide companies/ industries has also been made through contract research programmes. The institute has 3 contract research projects out of which one is on evaluation of sugarbeet hybrids, and 2 are on evaluation of insecticides. In order to commercialize the equipments/ machinery developed at IISR, Lucknow, meets/ field days were also organized with the manufacturers of farm machinery and equipments.

Inaugural Session of NEFORD sponsored Inception Workshop on Poverty Alleviation through Rice Innovation on Nov. 7, 2008

14.6 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, the meetings organized by Indian Sugar Mill Association (ISMA) were represented by the Director of the Institute. The Institute also sends its newsletters to some sugar mills in the country. The institute also provides consultancy services to the sugar mills. During the year, the consultancy was provided to Balrampur Chini Mills Ltd. For its sugar mill zones in East UP.
- Under one externally funded programme on Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane (FPARP), the institute carryied out field demonstrations on 4 different water efficient and high yielding sugarcane production technologies. Thirty-five demonstrations were conducted during 2008-09 crop season on farmers's fields in sugar mill areas of Biswan, Rauzagaon and Haidergarh under this project.

14.7 Linkage with NGOs

Institute provided its facilities of auditorium in organising a workshop on poverty alleviation through rice innovation system.

14.8 Collaboration with local ICAR 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.

14.9 Linkages with farmers

The farmers in Lucknow district were linked through Front line Demonstrations, on-farm trials, advisory services, kisan gosthi, Field Day, etc as a regular programme of KVK, IISR, Lucknow. The KVK, housed at IISR, regularly imparts both on-campus and off-campus trainings to farmers, farm families and rural youth of Lucknow district in diverse fields of agriculture, animal husbandry and home science. During the period, the KVK of the institute carried out the following activities as shown in Box below:

KVK (IISR), Lucknow

Front Line Demonstrations: Eighty front line demonstrations on various technologies pertaining to newly released varieties of wheat, potato, mentha, berseem, potato seed treatment with boric acid, wheat shown with zero tilled cum fertiseed drill, System of Rice Intensification etc. The increase in yield ranged from 10.8% to 44.17%.

Field days: Three field days were organized, in boosting of rice yield through SRI technique, set box on single page on Zero-tillage technology and, field days, newly released variety of wheat (Shatabdi). An in the 193 farmers participated.

Animal Camps: An animal camp was organized at Bachankhera, Lucknow on February 27,2009. About 215 animals got checked for causes of infertility. About 90 kg mineral-mixture, 45 bolus dewormer and heat inductive capsules were distributed among the farmers during the camp. The representatives of NABARD, National Dairy Development Board and Provincial Cooperative Dairy Federation and Lucknow milk Union also participated in the camp. TV talks on different aspects of animal husbandary were also delivered as given below.

TV talks delivered

Date	Topic	Programme
26.05.2008	Green fodder production round the year	KrishiDarshan
13.08.2008	Feeding and Management of lactating animals	KrishiDarshan
29.09.2008	Green fodder production round the year	KrishiDarshan
25.11.2008	Balance ration for animals	KrishiDarshan
14.01.2009	Balance ration for lactating animals	KrishiDarshan
04.02.2009	Afara disease in animals	KrishiDarshan
18.03.2009	How to get maximum milk production	KrishiDarshan

Field day organized by KVK, IISR, Lucknow

Conducting of On-Farm Testing/Trials: Six on-farm trials were conducted pertaining to various disciplines as per identified major thrust areas.

Performance of inter crops in autumn planted sugarcane: Performance of inter crops in autumn planted sugarcane studied at five locations on farmers' fields revealed that sugarcane + potato (140 t ha^{-1}) with profit of Rs. 1.15 lakhs was found most profitable compared to the intercropping with coriander, mustard and the sole crop.

Improving quality of potato seed: OFT on reduction of virus and virus like symptoms was carried out at 5 farmers' field. Spraying of imidacloprid 30 and 60 days after planting reduced the aphid population, white flies' population, and incidence of mosaic by 69%, 85.5% and 75%, respectively as compared to farmers' practice. Yield of potato tuber was increased by 11%.

Effect of foliar spray of mango special on mango trees: Foliar spray of mango special (combination of Fe, B, Mn, Mb & Zn) was tested at five mango orchards. It was found effective for fruit yield and average fruit weight compared to farmers' practice.

The other OFTs were conducted on 'Performance of weedicide to increase mentha yield and reduce the cost of weed control', 'Evaluation of mentha cultivars at farmers' field', and 'Introduction of processing varieties of potato at farmers' field'.

15

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National Journals

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Technical programme
(2008-09)

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 Duration : 10/05 – 9/08)

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

AS 56 Drought management in sugarcane (A.K. Singh; Duration : 3/05 – 3/09)

AS 57 Developing organic farming module for sugarcane crop (K.P. Singh and Archna Suman; Duration : 2/06 – 3/10)

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

AS 60 Studies on seed cane economy in sugarcane cultivation. (S.N. Singh, Radha Jain and Todi Singh; Duration : 2/08 – 4/10)

PB-22 Physio-biochemical studies concerning survival and establishment of bud chip under normal and encapsulated condition. (Radha Jain, S. Solomon and A. K. Shrivastava; Duration 4/08-3/11)

Ratoon management in sugarcane

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

A 3.20 Optimizing plant population of ratoon crop for minimizing gaps (R.S. Chauhan and Sheo Naik Singh ; Duration : 2/04 – 4/08)

A 3.23 Optimizing plant population density in sugarcane plant-ratoon system (S.N. Singh, R. L. Yadav and Todi Singh; Duration 2/07–4/11)

C 15.8 Studies on rhizospheric environment of plant and ratoon crop of sugarcane. (R. L. Yadav, Archna Sumnan, R. K. Rai and Pushpa Singh; Duration : 2008–11)

PB 18 Improving juice quality and stubble bud sprouting in sugarcane under low temperature (A.K. Shrivastava, S. Solomon, R.K. Rai, Pushpa Singh, Radha Jain and Rajesh Kumar; Duration 3/04-3/09)

Expl. Trial Causes of low physiological efficiency of sugarcane ratoon

AS 58 Improving productivity of winter initiated ratoon of sugarcane in sub-tropical India. (R.S. Chauhan and S.N. Singh; Duration 2/07 – 4/10)

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 ; Duration : 2/05 –3/09)

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; Duration : 03/07-03/10)

C 18.2 Management of macro- and micro-nutrients in sugarcane based cropping system (T. Singh and P.N. Singh; Duration : 3/01-12/08)

Expl. Trial Agronomy of new sugarcane genotypes (A.K. Singh; Duration 10/06 – 03/08)

Expl. Trial Evaluation of sugarcane genotypes for high nitrogen use efficiency-NUE under ring-pit planting system. (A.K. Singh, R.L.

Yadav and A.D. Pathak; Duration 02/05 – 01/10)

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 Akhiles K. Singh; Duration 2008-11)

Field Testing — Comparative performance of sugarcane in wheat + sugarcane cropping under flat and FIRB system. (Ishwar Singh; Duration 2005-09)

Expl. Trial — Effect of mode of Gluconacetobacter inoculation with various nitrogen levels on sugarcane. (S.K. Shukla, R.L. Yadav and Archna Suman; Duration 2007-08)

UPCAR 1/06 — Enhancing field water use efficiency in sugarcane cropping system through FIRBS (Rajendra Gupta; Duration 9/06-9/09)

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; Duration 01/1995 – LT)

Development of sugarcane varieties and breeding stocks for sub-tropics

B 2.3 — Development of sugarcane breeding stocks for high sugar. (Raman Kapur and S.K. Duttamajumdar; Duration 11/93 – 03/14)

B 2.6 — Genetic evaluation of sugarcane genetypes and crosses for their suitability under late-planted conditions; (A.D. Pathak; Duration 10/98-10/08)

B 2.9 — Development of top borer tolerant genetic stocks of sugarcane; (A.D.Pathak, R.K.Rai, R.K.Tewari and Rajesh Kumar; Duration 03/00 – 02/10-Long term)

B 2.10 — Development of sugarcane varieties for moisture deficit environment. (Sanjeev Kumar, J. Singh and P.K. Singh; Duration 03/02–02/12)

B 2.13 — Development of sugarcane varieties for sub-tropics (J. Singh, D.K. Pandey, P.K.Singh and Sanjeev Kumar ; Duration 10/2003–LT)

B 2.14 — Development of breeding stocks of sugarcane for durable resistance to red rot. (D.K. Pandey, P.K. Singh, Sunita Lal and J. Singh; Duration 10/04–10/10)

B 1.1 — Evaluation of early maturing sugarcane clones of North West Zone (J. Singh and D.K. Pandey; Duration 2/09–LT)

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

B 1.3 — Inter zonal varietal trials under AICRP(S) (A. D. Pathak; Duration 9/08–LT)

B 1-M — Evaluation of early and mid-late maturing entries of sugarcane in AICRP(S) North Central Zone at IISR, Regional Centre Motipur (Devendra Kumar; Duration: LT)

B 2.15 — Developing sugarbeet varieties for Indian agro climates. (A.D. Pathak Raman Kapur, S. K. Duttamajumder and R. K. Tiwari; Duration 09/08–Long term-to be reviewed after 5 years)

Cytogenetic and biotechnological approaches for sugarcane improvement

B 3.7 — Genetic improvement of sugarcane through tissue culture. (Raman Kapur and R.K. Singh; Duration 08/92 – LT)

B 3.8 — Cytomorphological and molecular characterization of some sugarcane genotypes; (Sangeeta Srivastava; Duration 09/93 – 10/08)

B 3.13 — Identification of biochemical and molecular markers for sugar genes in sugarcane. (M. Swapna, Sangeeta Srivastava and D.K. Pandey; Duration 11/03 – 11/09)

B 3.14 — Molecular diversity analysis for biotic stresses of Saccharum germplasm (R.K.Singh, D.K.Pandey, M. Swapna and Sunita Lal; Duration 10/04 – LT)

B 3.15	Genetic transformation in Sugarcane for resistance against borers (R.K.Singh, Raman Kapur, Sangeeta Srivastava and M.R.Singh; Duration 10/06 – 09/11)
B3.16	Optimizing standards for sugarcane seed production through micro propagation (R.K. Singh, Vijai Singh, J. Singh, Archna Suman and A.K. Singh; Duration 10/06–09/10)
DBT-1/09	Development of SSR markers for red rot resistance from EST databae of Sugarcane. (R. K. Singh, Sangeeta Srivastava, S. K. Dattamajumder, M. Swapna and Raman Kapur; Duration 15.01.09 to 14.01.12)
DUS Testing	Equipping and strengthening of designated DUS test centers under central sector scheme for implementation of PVP legislation

Epidemiology of diseases of sugarcane

E M-01	Survey and surveillance of insect-pests and diseases of sugarcane in sub tropical area (Vijai Singh, Ramji Lal, S.K. Duttamajumdar, R. K. Tewari and G. M. Tripathi; Duration 4/06-3/09)
M 2.13	Mechanism of variability in Colletotrichum falcatum causing red rot in sugarcane (A.P. Singh, Vijai Singh, Ramji Lal and Sunita Lal; Duration 10/06-9/09)

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

M 3.5	Determiniation of casual organism(s) of wilt disease of sugarcane (S.K. Duttamajumder and S.C. Misra; Duration 1/03-3/09)
PP 14	Identification of pathotypes in red rot pathogen (Ramji Lal)
PP 14a	Maintenance of isolated of red rot pathogen (Sunita Lal)
PP 29	Molecular characterization of isolates/ pathotypes of Colletotrichum falcatum (Sunita Lal)
Expl. Trial	Investigation on spread of red rot of sugarcane. (S.K. Duttamajumder and S.C. Misra)

Integrated disease management in sugarcane

M 15.3	Management of red rot disease of sugarcane through Bio-agents (Vijai Singh, S.N. Srivastava and Ramji Lal; Duration 2004-2009)
M 17	Evaluation/screening of sugarcane germplasm/genotypes against red rot and smut (Vijai Singh, Ramji Lal and Sunita Lal; Duration 1992-LT)
PP 17	Evaluation of varieties/genotypes against red rot, smut and wilt (Vijai Singh and Ramji Lal)
C 15.7	Cellular and molecular interaction of the bacterial isolates with pathogens causing major diseases of sugarcane. (Archna Sumnan, Sunita Lal and Pushpa Singh; Duration 10/03–03/09)

Bio-ecology and integrated management of insect-pests

Bio-ecology of insect –pests of sugarcane

E 4.2 (i)	Bio-intensive management of top borer of sugarcane. (M.R. Singh, R.K. Tewari, and Arun Baitha; Duration 3/07-3/09)
E 30	Monitoring of insect-pests and bio-agents in sugarcane agro-eco system (Arun Baitha and M.R.Singh)
E 4.2.1(iv)	Development of high temperature tolerant strain of Trichogramma chilonis and Trichogramma japonicum (Arun Baitha and D.C.Srivastava; Duration 10/05-9/10)

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

E 4.1	Evaluation of varieties/genotypes for their reaction against major insect-pests (R.K.Tewari and G.M.Tripathi)
E 11.1	Development of techniques for laboratory mass multiplication of top borer and its parasitoids (M.R.Singh; Duration 2/06-3/09)
E 27	Mass multiplication of potential bio-agents of sugarcane pests (M.R. Singh and Arun Baitha)

E 28	Survey and surveillance of sugarcane insect pests (G. M. Tripathi and R. K. Tewari)
E 32	Population dynamics of sugarcane borers (early shoot borer, top borer, internode borer and stalk borer) through pheromone trap (G. M. Tripathi and R. K. Tewari)
E 4.2	Biological control of sugarcane moth borers, pyrilla and scale through exotic and indigenous parasitoids and predators (R. B. Jadhav)

Development of appropriate farm machinery for mechanization of sugarcane cultivation

AE 1.9 E	Development of sugarcane harvester (A.K. Singh, M.P. Sharma and Jaswant Singh; Duration 8/06– 4/10)
AE 1.18 A	Design refinement of a power operated equipment for detrashing of harvested sugarcane (A.K. Singh and M.P. Sharma; Duration 7/05– 6/09)
AE 1.19 A	Development of a tractor operated mounted type two row ratoon management device (RMD) (A.C. Srivastava; Duration 4/05-3/09) Final report submitted
AE 1.33	Development of an engine operated walking type multipurpose equipment for sugarcane cultivation (M.P. Sharma and A.K. Singh; Duration 4/05-3/09)
AE 4.5	Evaluation and refinement of sett cutting mechanism of sugarcane planter (R.K. Pangasa and P. R. Singh; Duration 3/08-4/12)
AE 8.1	Design and development of residue mulchur-cum-bio application (P.R. Singh, Archna Suman and A.C. Srivastava; Duration 9/07-8/10)

Development of suitable post-harvest technology

Post-harvest losses in sugarcane

PB-19	Management of post harvest deterioration of sucrose in sugarcane. (S.Solomon, Raman Banerji and Pushpa Singh; Duration 4/04-3/10)

Manufacturing and storage of jaggery

LKO/PHTS/05/3	Development of mechanical filtration unit for sugarcane juice (R.D. Singh and Dilip Kumar; Duration 3/05-12/09)
LKO/PHTS/05/4	Value addition of jaggery through natural source of vitamin C (S.I. Anwar, and R.D. Singh; Duration 1/05-12/09)
LKO/JKS/07/01	Development of sugarcane peeler (Dilip Kumar, Jaswant Singh and P.R. Singh; Duration 5/07-4/10)
LKO/PHT/07/02	Design and development of a small capacity cane crushing unit for house hold purpose (Jaswant Singh and Dilip Kumar; Duration 12/06-3/09)
LKO/PHT/07/03	Development of a device for churning of sugarcane juice in an open pan furnace (Jaswant Singh and A.K. Singh; Duration 12/06-11/09)
LKO/PHT/07/04	Optimisation of fins provided to the pan bottom for improved efficiency of jaggery making furnace (S.I. Anwar; Duration 1/07-12/09)
LKO/PHT/07/05	Refinement of 3-roller horizontal power driven crusher developed at IISR (S.I. Anwar and Jaswant Singh; Duration 1/07-12/09)
LKO/PHT/07/06	Testing and evaluation of IISR jaggery drier (A.K. Singh, Jaswant Singh and R.D. Singh; Duration 4/07-9/09)
LKO/PHT/07/07	Development of a solar drier for jaggery drying (Jaswant Singh, R.D. Singh and Dilip Kumar; Duration 4/08-3/09)
LKO/PHT/08/01	Evaluation of packaging materials for modified atmosphere packaging of jaggery (R.D. Singh, Jaswant Singh and S. I. Anwar; Duration 1/09-12/12)

Diversification of sugarcane based by-products

PB-21 Identification of inhibitors in sugarcane biomass hydrolyzates and their effect on ethanol yields. (Pushpa Singh, Archna Suman and A. K. Shrivastava; Duration 2008-11)

Sugar beet improvement, its seed production and crop management

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

CR-1/08 Evaluation of sugar beet hybrids. (A.D.Pathak, R. L. Yadav, D. V. Yadav, Raman Kapur, S. Solomon, Dr. S. K. Duttamajumder and R. K. Tiwari; Duration 10/08-09/10)-No report received.

CR-1/07 Evaluation of insecticides and fungicides against insect pests and diseases of sub tropical sugar beet crop (R. K. Tewari, Sunita Lal and R.L.Yadav; Duration 08/08-07/09)

Technology adoption, constraints analysis, socio-economics, statistical modeling, database and 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; Duration 11/05 – 10/08)

ET 1.11 Development of a scale to measure the attitude of extension personnel towards sugarcane production technology (R.P.Verma, A.K.Sah and Kamta Prasad; Duration 10/06 – 9/09)

MWR-1/08 Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane. (D.V. Yadav, R.P. Verma, A.K. Sah, Kamta Prasad, Rajendra Gupta and K.P. Singh; Duration 1/08-3/11)

Socio-economics and policy analysis

AES 4.7 Analysis of sugarcane area, production and yield in different sugarcane growing states and the country (Rajesh Kumar, P.K. Bajpai and S.S.Hasan; Duration 4/05-3/10)

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; Duration 08/08 –08/10)

Development of statistical models/ procedures

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

AM 4 Development of Atlas for Sugarcane Cultivation in India (Arun K. Srivastava, R.L. Yadav, A.K. Sharma, and D.V. Yadav; Duration 9/06-8/08)

SAC-IISR Programme (1/05) Energy -Water Balance and Growth Monitoring in Sugarcane Using Satellite Data (Arun K. Srivastava, and S. N. Singh; Duration: 10/05-3/10)

Development of database and information systems

AES 4.8 Data warehouse on sugarcane production system (S.S.Hasan, P.K. Bajpai and Rajesh Kumar; Duration 1/06-12/08)

AES 4.10 Development of decision support tools in sugarcane cultivation (S.S. Hasan, Rajesh Kumar, S.K. Shukla, A.K. Sah and Arun Baitha Duration 1/08-12/10).

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Consultancy, contract research and patents

Consultancy

Advisory service was provided to the concerned sugar mills on aassessment of damage of sugarcane crop due to water stagnation and heavy rainfall in factory zones of Haidergarh, Rozagaon, Akbarpur and Balrampur Chini Mills Ltd., Balrampur, U.P. during October 23-25, 2008.

Contract research projects

During the year, the following contract research projects were undertaken.

Code	Title	Period	Concerned Scientists	Amount (Rs. (Rs.in Lacs)	Firm/company
CR-1/08	Evaluation of sugar beet hybrids	10/08-09/10	A.D. Pathak, R.L. Yadav, D.V. Yadav, Raman Kapur, S.Solomon, S.K. Duttamajumder and R. K. Tiwari	5.00	J. K. Agri. Genetics Ltd. Hyderabad
CR-1/07	Evaluation of insecticides and fungicides against insect-pests and diseases of subtropical sugarbeet	08/08-07/09	R.K.Tewari, Sunita Lal and R. L.Yadav	6.00	Syngenta India Pvt. Ltd. Karnal
CR-3/06	Evaluation of E 2 Y 45 0.4% GR against termite and top borer in sugarcane	2006-09	M. R. Singh and R. L. Yadav	5.00	M/S E.I. DuPont India Pvt. Ltd. Gurgaon

Externally funded research projects

During the year 2008-09, IISR received, 2 externally funded research projects, making a total of 4 such research projects in the Institute.

MWR-1/08	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, Duration January, 2008 to March, 2011) From: The Ministry of Water Resources, Govt of India with budgetary allocation of Rs.50 lakhs.
DBT-1/09	Development of SSR markers for red rot resistance from EST databae of sugarcane. (R.K. Singh, Sangeeta Srivastava, S.K. Dattamajumder, Raman Kapur and M. Swapna; Duration 15.01.09 to 14.01.12). Total Cost Rs. 38.22 lakhs
UPCAR-1/06	Enhancing field water use efficiency in sugarcane cropping system through FIRBS. (Rajendra Gupta; 09-10-2006 to 08-10-2009) Total Cost Rs. 8.41 lakhs
SAC-11SR 05/1	Energy water balance and growth monitoring in sugarcane using satellite data (Arun Kumar Srivastava and S. N. Singh; 10/05-03/10) Total Cost upto 2008-09, Rs. 10.80 lakhs

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Monitoring and evaluation

Research Advisory Committee (RAC)

In accordance with the ICAR letter F. No. 4(10)/ 07-IA.III dated Feb. 4, 2008, the Research Advisory Committee of the Indian Institute of Sugarcane Research, Lucknow consisting of the following members met at Lucknow on July 8 and 9, 2008.

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 major recooendations of RAC as approved by ICAR vide letter no. F.No. 4(6) 06-IA-III dated 01.12.2008 are as follows:

1. 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.

RAC meeting in progress

2. The germ-plasm collection of sugar beet should be strengethened. 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.
3. More intensive research on nutrient management is required. Balanced and integrated use of nutrients be emphasized to sustain soil health.
4. 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".
5. Bring out a publication on biological control of insect-pest and diseases in sugarcane.
6. Termites in sandy soil and white grubs are the problem. The eco-friendly control measures be developed.
7. 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 convervation agronomy should be more fully recognized for the developed of improved packages of practices.
8. Sugar beet need to be included in the research mandate, goals and objectives of the institute. Research programme on sugar beet need to be strongly strenghtend. The Institute should have a section on sugar beet. A proposal could be in 11th Five Year Plan on under NAIP.

ICAR observation: One of the recommendations relate to inclusion of sugarbeet in the mandate of IISR. It is submitted that the mandate of IISR, Lucknow **is**

basic and applied research on all aspects of production and protection techniques of sugarcane and sugar crops, therefore, IISR, Lucknow may conduct needed research on sugarbeet also within the budget approved for IISR, Lucknow by the EFC during XIth Plan. However, for policy issues specific proposals may be submitted by IISR.

Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) comprising of 63 scientists of the Indian Institute of Sugarcane Research (IISR), Lucknow met on August 21-23, 2008 under the Chairmanship of Dr. R.L. Yadav, Director of the Institute to review and discuss 101 on-going research projects on sugarcane in the institute. In this meeting, the progress of these research projects was reviewed, mid-term correction was made wherever necessary, 13 new project proposals were discussed threadbare for their suitability, of which 9 proposals were finally approved.

- Dr. R.L. Yadav, the Chairman, IRC emphasized for knowledge management and Innovations at the outset of the meeting, and also explained the difference between the features of working team and a group. He emphasized the need for a working team in the institute in order to achieve the desired results within a time frame. He also explained the task and social behavioral functions as well as the basic ethical principles for scientists. A written matter on ethics for scientists was also distributed.

The Chairman, IRC emphasized that the ultimate objective of the meeting is to fine tune the raw research results into deliverables to maintain a steady flow of research out come to the stakeholders and end users. In this regard, a need to systematize the research work to highlight the institute's role was emphasized. The Chairman also stressed for more focused and output/ outcome controlled review and overall monitoring of the research work. He devoted considerable time in help refining deliverables into recommendations and the recommendations so generated. It was also emphasized that it would be made customary that the important research outputs generated during the year at respective divisions be developed into recommendations /technologies etc. and pass on, by the respective HODs every year, to the IRC for review and vetting so that any further action in their refinement, verification etc., if any, could be decided in IRC meeting. It would also help the institute in both internal and external reporting of the research results of the institute in time. The recommendations/ technologies should invariably be supplied with a write-up or a step-by-step procedure for the demonstration of the technology.

The low level of transfer of improved sugarcane production technology to the farmers is a matter of concern. The IRC felt that the institute activities need to be reflected in ICAR news /ICAR Reporter. It also recommended that all the planting of the cane in the institute farm should be carried out with the planter(s) developed at the institute. Ratoon Management Device (RMD) developed at the institute be also used in all the ratoon experiments/fields.

Division/ Section	IRC observations
Crop Improvement Division	1. The seed of sugarcane variety CoLK 94184 to be multiplied/increased at IISR as well as at Institute Regional Centre, Motipur (Bihar). 2. Systematize the research work being undertaken on red rot resistance so that it could be better highlighted.
Crop Production Division	1. Sustainability of organic sugarcane cultivation be studied in greater detail. 2. Focus research work on water use efficiency in sugarcane (quantity of water is required to produce one ton of sugarcane under flat system and under improved raised bed system be werlead out). 3. The visibility of extension wing be enhanced.
Crop Protection Division	1. The plant protection specialists in an inter-disciplinary research project with the plant breeders should focus their research to workout the reasons for resistance of a disease or to identify characters responsible for resistance or susceptibility of a disease, rather than identifying genotypes. 2. A publication on parasites/ predators of insect-pests of sugarcane be brought out. 3. There is a need to develop biological control of termites. 4. Climate change or weather variables be captured for insect-pests/disease management studies.

Plant Physiology and Bio-Chemistry Division	1.	The physiological efficiency of sugarcane should be kept in focus in the divisional research work.
Agricultural Engineering Division	1.	Patent issues related to the development of sugarcane **harvester** be taken up on urgent basis, if any. The matter may be taken up on urgent basis.
	2.	An inter-divisional programme for accelerating adoption of mechanization of sugarcane planting, with the lead role by Agricultural Engineers be taken up.
	3.	There is a need to better streamline reporting of AICRP activities being undertaken.
Agrometeorology	1.	Climatological database of all the major sugarcane growing states be developed.
	2.	There is a need to carry out research work on climate change and its implications for sugarcane cultivation in India.

Review of Research progress at divisional level

The division/section level review of the research was carried out in IRC meeting itself. The IRC suggested following improvements during 2008-09 review of the divisional performance.

Review by the Heads of Divisions/ Incharges of Sections

The Heads of Divisions namely Crop Improvement, Crop Production, Crop Protection, Plant Physiology & Bio-Chemistry and Agril. Engineering and Incharges, Agrometeorology and Krishi Vigyan Kendra carried out a review of all the activities prior to IRC and RAC meetings and presented the focus i.e. long-term goal and then in its continuity, the yearly focus and the research work progress/salient research achievements pertaining to their division/section in these meetings.

Review visits to field Experiments and Research Laboratories

The review visits of field Experiments and Research Laboratories of the institute were carried out

Discussion with farmers and mill personnel in FPARP Village

RAC members being explained about machines for sugarcane cultivation

by reviewing bodies such as RAC members and by other dignitaries from ICAR, New Delhi. The RAC members visited, in July 2008, the Engineering Workshop having implements for mechanization of sugarcane farming, jaggery production unit, Biotechnology Laboratory, Ethanol production technology from sugarcane biomass and bio-control of red-rot. They visited the technology demonstration block and organic farming in G-block of the Institute farm.

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. The IISR Web Site is regularly updated for IISR research projects, technologies, achievements, tender notifications, Seminar/ Symposia, staff list and cadre strength, RTI reports, 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.

The individual research project files are maintained in RCM unit of the institute and an overview of all the research projects was prepared and presented to the IRC. The institute as on March 31, 2009 was having a total scientific strength of 69 scientists and they were working on 109 different types of research projects. Of these, 56 were institute projects, 29 AICRP projects, 4 Externally aided projects, 4 Network projects and 6 Contract research projects, and 10 exploratory studies as shown below.

Number of research projects presented to IRC for discussion

Division/section	Inst. Proj.	AICRP Proj	Ext. Aided	Ntwrk/ AP Cess	Contra ct.	Expl. Stds.	Total
Crop Improvement	13	2		1			16
Crop Production	12	8	1		3	4	28
Plant Phy. & Biochem	5			2		3	10
Crop Protection	10	8		1	3	2	24
Agril. Engineering	9	11	1				21
Eco/stat/computer	5					1	6
Ag. Meteorolgy	2		2				4
Total	56	29	4	4	6	10	109

Visit of CWC monitoring team

A monitoring team from Central Water Commission, Lucknow comprising of Dr. Naresh Kumar, Director and Shri Rakesh Verma, Asstt. Director, M&A Directorate visited FPARP demonstration sites in Sitapur district on 16 October 2008. On 18 December 2008, they also visited the demonstration sites in Barabanaki district. They interacted with the participating farmers to have a. feedback. The team members were highly satisfied with the progress in the Farmer's participatory project.

Dr. R.L. Yadav, Director, IISR and Dr. D.V. Yadav, Project Leader, FPARP discussing the performance of ring-pit planting on farmers' field

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, Pr. Scientist (Microbiology)- Member
4. Dr. A.K. Shrivastava, I/c, 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, HOD (Crop Production)- Member-Secretary

Monitoring of seed production activities

Review meeting under the Chairmanship of the Director was held to monitor seed cane production activities in the institute farm. It was decided that the Cane Commissioner, Uttar Pradesh be informed about the availability of seed cane on the Institute farm for its further dissemination to farmers through sugar factories. The regular review of seed production activities at the Institute Regional Centre at Motipur (Bihar) was also emphasized. It was emphasized that the area allocated for seed cane production (1.5 ha) is quite less, and this aspect may be considered seriously.

Institute Management Committee (IMC)

The Institute Management Committee with the following composition met on December 02, 2008 for

its 29th meeting. The regular agenda of the meeting pertained to annual budget and other administrative activities. The research achievements during the year were also presented in the meeting.

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 2008-09 were constituted/ reconstituted on April 21, 2009. The meetings of these committees were held as per need of the task.

Representation	Name	Designation
Director of the Institute	Dr. R.L. Yadav	*ex-officio* Chairman
Representative of U.P. Govt.*	Sh. S.P. Singh, (Additional Cane Commissioner, U.P.)	Member
Representative of other State Govt.#	Vacant	Member
SAU representative**	Sri. Ved Prakash, NDUA&T Faizabad, (Asstt. Prof.)	Member
Non-official members	Sri. Krishna Pal Singh Rathi	Member
	Sri. Anil Chowdhary	Member
Scientists of ICAR Institutes nominated by DG, ICAR	Dr. Ashok Kumar Shrivastava, IISR, Lucknow	Member
	Dr. B. Sundra, SBI, Coimbatore	Member
	Dr. Raman Kapur, IISR, Lucknow	Member
	Dr. Shiv Kumar, IIPR, Kanpur	Member
ICAR representative	-	Member
Financial Advisor/ Account officer nominated by President	-	Member
Others	Dr. D.V. Yadav, I/c, RCM	Special Invitee
	Dr. Vijai Singh, I/c Head, Crop Protection	Special Invitee
	Dr. Jaswant Singh, Head, Agri. Engg.	Special Invitee
	Dr. R.K. Singh, PC, KVK, Lucknow	Special Invitee
Administrative Officer of the Institute	Sh. Rajeev Lal	*ex-officio* Member-Secretary

*Cane Commissioner, U.P., # Cane Commissioner, Uttrakhand, **Director of Research, NDUA&T, Kumarganj, Faizabad

Institute Joint Staff Council (IJSC)

The IJSC with the following composition met on 13.05.2008 and discussed matters pertaining to staff welfare.

Dr. R.L. Yadav, Director, Chairman	
Members elected	**Members nominated**
Sh. Someshwar Mishra, T-5	Sr. A.O.
Sh. Anand Mohan 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. Rajender Kumar, SS Grade-I (Member-Secretary)	Sh. Hans Raj, SS Grade-III
	Sh. G.K. Singh, T-6 (Member-Secretary)

Policy, Planning & Expenditure

1. Dr. A.K. Shrivastava – Chairman
2. Dr. Sangeeta Srivastava
3. Dr. R.K. Singh, KVK
4. Incharge, RCM
5. AFAO
6. SAO-Member-Secretary

Purchase Advisory Committee

1. Dr. D.V. Yadav-Chairman
2. Dr. A.K. Singh (Engg.)

3. Dr. D.K. Pandey
4. AFAO
5. SAO-Member-Secretary

Farm Advisory Committee

1. Dr. D.V. Yadav – Chairman
2. Er. Rajendra Gupta
3. Dr. R.S. Chauhan
4. Sri. S.C. Mishra
5. Dr. J. Singh
6. SAO
7. AFAO
8. Farm Manager-Member-Secretary

Human Resource Development

1. Dr. O.K. Sinha – Chairman
2. Dr. R.K. Rai
3. Dr. Arun Baitha
4. AFAO
5. I/c, RCM
6. SAO-Member-Secretary

IISR Publication & Library Committee

1. Dr. D.V. Yadav – Chairman
2. Dr. Ashwani K. Sharma
3. Dr. S.K. Duttamazumder
4. SAO
5. AFAO
6. Incharge, Library-Member-Secretary

Works Committee

1. Dr. Jaswant Singh-Chairman
2. Dr. R.S. Chauhan
3. SAO
4. AFAO
5. Dr. R.K. Singh (Crop Imp.)
6. Sri. M.H. Ansari - Member-Secretary

Security & Vigilance Committee

1. Dr. R.S. Chauhan– Chairman
2. Dr. R.D. Singh (Engg.)
3. Farm Manager
4. S. Bhatnagar
5. AFAO
6. SAO - Member-Secretary

Transfer of Technology

1. Dr. R.P. Verma – Chairman
2. Dr. Shiv Naik Singh
3. I/c, KVK
4. All HODs
5. I/c, RCM - Member-Secretary

Staff Welfare Committee

1. Dr. A.K. Singh (Agron.) – Chairman
2. Dr. M.R. Singh
3. Sri. M.H. Ansari
4. Dr. S.K. Sethi
5. Secretary, IJSC
6. SAO - Member - Secretary

Grievances Cell

1. Dr. A. Chandra – Chairman
2. Dr. Todi Singh
3. Dr. Pushpa Singh
4. AFAO
5. SAO - Member - Secretary

Women Cell

1. Mrs. Sunita Lal – Chairman
2. Dr. M. Swapna
3. Smt. Pramila Lal
4. Smt. Usha Sharma
5. SAO - Member - Secretary

Contract Research/Consultancy Committee

1. Dr. D.V. Yadav – Chairman
2. Dr. A.D. Pathak
3. Dr. A.K. Singh (Engg.)
4. AFAO
5. Dr. Ashwani K. Sharma -Member-Secretary

Event Coordination Committee

1. Dr. Ashok Kumar Shrivastava – Chairman
2. Dr. S.N. Susheel
3. Sri. S.C. Mishra

भाकृअनुप
ICAR

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