वार्षिक प्रतिवेदन
Annual Report

2009-2010

भाकृअनुप
ICAR

भारतीय गन्ना अनुसंधान संस्थान
Indian Institute of Sugarcane Research

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भारतीय गन्ना अनुसंधान संस्थान
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Skip furrow method of irrigation
in sugarcane

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Preface

World sugar balance forecasts point to a widening gap (of about 9.42 mln tonnes) between world sugar consumption (166.58 mln tonnes) and global sugar output (157.16 mln tonnes) for the period, October 2009 to September 2010, the second consecutive year. India is likely to produce more sugar this season, about 20 mln tonnes compared to just 15.5 mln tonnes in 2008-09. Since the estimates for domestic consumption are quite high at 22.5 mln tonnes, India will remain a potential importer this year too in world sugar market, giving signals for the world sugar prices to remain high. Indian farmers could not derive much benefits of short supply situation in global market, as they had already reduced their area under cane and were apprehensive of putting more area under cane. Since the immediate area response to sugar market prices is very less in cane, the only way left is to have an increase in the yield of the cane crop.

Giving more emphasis to yield enhancement under such situation demands that new approaches in sugarcane extension be studied and tried which may help guide cane growers in an efficient and effective manner. The Indian Institute of Sugarcane Research, Lucknow carried out work in this direction and has issued monthly crop advisories to cane growers through innovative approaches under public private partnership. The main research focus during the year was on yield enhancement, i.e., through development of high-sugar and high-yielding varieties, improvement in seed cane quality and quantity, mechanization of sugarcane cultivation, and proper management of ratoon crop. Number of genotypes are being maintained, multiplied and have been advanced to State Varietal Trials in order to develop high-sugar varieties of sugarcane. The Institute also gave emphasis on farmers' participatory action orientated research and demonstrated its improved technologies on planting techniques, quality seed cane, better ratoon management, nuitrient and water management and crop mechanization on farmers' fields. The Institute also organized one National Seminar on mechanization of sugarcane cultivation and *Kisan Mela* as a part of its mechanization drive.

The present Annual Report carrying the above description in detail, consists of 23 theme-based chapters. The report is a mirror of all the Institute activities during the year 2009-10 (April – March). Dr. D.V. Yadav, Head, Crop Production Division & I/c RCM and Dr. A. K. Sharma, Principal Scientist (Agril. Econ.), Sri Mahendra Singh (T -7-8), Sri G.K. Singh (T-6), the Technical Officers, and Sri. D.C. Pant, LDC, RCM, deserve appreciation of their sincere efforts in the compilation, editing and presenting the information nicely, and bringing out this report in time. Thanks are also due to all the Heads of Divisions / Incharges of Sections and scientists for their cooperation in providing the information in the requisite format.

(R.L. Yadav)
Director

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कार्यकारी सारांश

फसल सुधार

गन्ना के जननद्रव्य का रखरखाव

एस. ओफिसिनेरम, एस. बारबरी, एस. साइनेन्स, आईएसएच क्लोन, इक्षु आईएसएच क्लोन, एलजी सलेक्संस, व्यावसायिक शंकरण आदि समेत, 210 जीन प्ररूपों को अनुरक्षित किया गया तथा संस्थान मे शोधरत् परियोजनाओं की माँग के अनुरूप आपूर्तित किया गया।

उष्ण कटिबन्धीय परिक्षेत्र हेतु गन्ना प्रजातियों एवं अभिजनकों का विकास

स्टेशन परीक्षण मे 10 चयनित जीन प्ररूपों एवं एक शीघ्र तथा एक मध्य देर से परिपक्व होने वाले नियंत्रकों का परीक्षण किया गया। इनमे से एलजी 04602 तथा एलजी 04603 सर्वाधिक गन्ना उपज देने वाले पाये गये। इसके पश्चात् एलजी 05447, एलजी 02434 तथा एलजी 04006 की उपज घटते हुए क्रम मे आंकलित की गयी। यद्यपि, प्रथम दोनो जीन प्ररूपों की परिपक्वता बहुत देर से आयी। दो अन्य जीन प्ररूप एलजी 4012 तथा एलजी 4079 शीघ्र परिपक्व होने वाले एवं उच्च शर्करा युक्त थे किन्तु मिल योग्य गन्नो की संख्या कम होने के कारण गन्ना उपज सामान्य पायी गयी। निष्कर्ष के आधार पर एलजी 05447 (मध्य देर), एलजी 02434 (मध्य देर), एलजी 04006 (मध्य देर), एलजी 04602 (देर) तथा एलजी 4012 (शीघ्र) को ए आई सी आर पी (गन्ना) तथा उत्तर प्रदेश राज्य प्रजाति परीक्षण मे बहुस्थानिक परीक्षण हेतु भेजने लायक पाया गया।

क्रन्तक, एआईसीआरपी (गन्ना) परीक्षण हेतु शामिल

एलजी 01030 (कोलख 09201) जो शीघ्र परिपक्व होने वाला क्रन्तक है, एआईसीआरपी (गन्ना) के अन्तर्गत उत्तर-पश्चिमी परिक्षेत्र के लिए परीक्षण हेतु सम्मिलित कर लिया गया है। इसे उत्तर प्रदेश राज्य प्रजाति परीक्षण हेतु भी शामिल किया गया है।

पाँच अभिजनक एलजी 04601, एलजी 04602, एलजी 04603, एलजी 04604 तथा एलजी 04605 को राष्ट्रीय संकरण उद्यान मे सम्मिलित करने हेतु गन्ना प्रजनन संस्थान, कोयम्बतूर मे संगरोधी परीक्षण किया जा रहा है।

उत्तर-पश्चिम परिक्षेत्र हेतु एआईसीआरपी (गन्ना) के बहुस्थानिक मूल्यांकन के अन्तर्गत, जीन प्ररूप कोलख 04238, कोलख 05203 तथा कोलख 7201, परीक्षणो की विभिन्न अवस्थाओ मे हैं। एलजी 2919 को उत्तर प्रदेश राज्य प्रजाति परीक्षण हेतु सम्मिलित किया गया है।

कोलख 09202 (एलजी 05031), शीघ्र परिपक्व तथा कोलख 09204 (एलजी 04043), मध्य-देरी से परिपक्व होने वाले क्रन्तको को बहुस्थानिक परीक्षण हेतु एआईसीआरपी (गन्ना) तथा उत्तर प्रदेश राज्य प्रजाति परीक्षण मे स्वीकृत कर लिया गया है।

उत्तर प्रदेश राज्य जोनल प्रजाति परीक्षण में क्रन्तक शामिल

एलजी 05823, एक मध्य-देरी से परिपक्व होने वाला क्रन्तक जो कि लाल सड़न के तीन रोगाणु प्रभेदो (सी. एफ. 08, सी. एफ. 09 तथा सी. एफ. 11) के लिए प्रतिरोधी है, को उत्तर प्रदेश राज्य जोनल प्रजाति परीक्षण के अन्तर्गत बहुस्थानिक परीक्षण हेतु स्वीकृत किया गया है।

कुल 260 ईएसटी- एसएसआर चिन्हको को चार हजार विशिष्ट भारतीय गन्ना ईएसटीज तथा 1069 लाल सड़न विशिष्ट ईएसटीज से विकसित किया गया।

फसल उत्पादन

पेड़ी प्रबंधन

द्वितीय एवं प्रथम फसल क्रम के अन्तर्गत उगाई गयी क्रमशः प्रथम (8.60%) एवं द्वितीय (11.5%) पेड़ी मे सबसे कम खाली स्थान पाये गये जब इनकी बावक फसलो को तीन आँख वाले 60,000 टुकड़े प्रति हेक्टेयर की दर से बोया गया। जबकि 40,000 प्रति हेक्टेयर तीन आँख वाले टुकड़े बोने पर प्राप्त होने वाली प्रथम एवं द्वितीय पेड़ी गन्ना मे क्रमशः 21.25 तथा 27.80 प्रतिशत खाली स्थान पाए गये। औसतन सधन बुवाई (60,000 टुकड़े/हेक्टेयर) से 40,000 टुकड़े/हेक्टेयर टुकड़े बोने की अपेक्षा 17.53 प्रतिशत अधिक गन्ना उपज प्राप्त हुई। इसी प्रकार बुवाई के 45 दिन बाद तीन आँख वाले टुकड़ो की भराई से एवं गन्ने की कटाई से एक माह पूर्व 80 किग्रा/हेक्टेयर पोटाशियम देने से, बिना रिक्त स्थान भराई (67.92 टन/हेक्टेयर) तथा बिना पोटाशियम

प्रयोग (68.27 टन/हेक्टेयर) के गन्ना उपज की अपेक्षा क्रमशः 13.57 एवं 12.62 प्रतिशत अधिक गन्ना उपज प्राप्त हुई।

तीन आँख के टुकड़े बोने से प्राप्त गन्ना उपज (69.55 टन/हेक्टेयर), दो आँख वाले (61.74 टन/हेक्टेयर) एवं एक आँख वाले (53.2 टन/हेक्टेयर) की अपेक्षा सार्थक अन्तर से अधिक पायी गयी। अधिक बीज दर से यद्यपि गन्ना आँख के जमाव पर प्रभाव नहीं पड़ता, फिर भी बीज गन्ना वृद्धि एवं उपज पर काफी प्रभाव पड़ता है। बीज गन्ना को कार्बेन्डाजिम में 15 मिनट तक डुबोने की अपेक्षा जीए 3 विलयन में 15 मिनट तक डुबोने पर वृद्धि एवं बीज गन्ना उपज पर विपरीत प्रभाव देखा गया।

शीघ्र परिपक्व होने वाली गन्ना प्रजाति (कोशा 96268) की शीतकालीन पेड़ी, जनवरी (प्रथम सप्ताह), 2009 को प्रारम्भ की गयी तथा इसी समय सभी उपचार डाले गये। इनमें एसपीएमसी (20 टन/हेक्टेयर) अथवा एसपीएमसी (10 टन/हेक्टेयर) + 25 किग्रा/हेक्टेयर जिंक सल्फेट वाले उपचारों से गन्ने का अंकुरण अच्छा हुआ तथा सर्वाधिक किल्ले (292,000/हेक्टेयर) प्राप्त हुए जबकि अनौपचारित (नियंत्रक) से 276,000/हेक्टेयर किल्ले प्राप्त हुए। एसपीएमसी (20 टन/हेक्टेयर) डालने से सर्वाधिक पेरने योग्य गन्ने (1,10,000/हेक्टेयर) तथा गन्ना उपज (72.0 टन/हेक्टेयर) अभिलेखित की गई। ये परिणाम गन्ने में एसपीएमसी (10 टन/हेक्टेयर) + 25 किग्रा/हेक्टेयर जिंक सल्फेट से प्राप्त गन्ना उपज के लगभग समतुल्य पाये गये। इससे स्पष्ट हुआ कि एसपीएमसी (20 टन/हेक्टेयर) अथवा इसकी आधी मात्रा के साथ 25 किग्रा/हेक्टेयर जिंक सल्फेट को, पेड़ी प्रारम्भ करते समय डालकर शरदकालीन पेड़ी गन्ना की उपज बढ़ायी जा सकती है। गन्ने की गुणवत्ता (सुक्रोज प्रतिशत) पर किसी भी उपचार का प्रभाव नहीं पाया गया।

कम तापमान परिस्थितियों में ठूँठ की आँख के प्रस्फुटन तथा गन्ना रस की गुणवत्ता में सुधार लाने का प्रयास

ताजे कटे ठूँठ पर विभिन्न मिश्रण जिसमें विटामिन (500 पीपीएम) पोटैशियम नाइट्रेट 0.1 प्रतिशत, फाइव फास एक जैव रासायनिक ड्रग (100 पीपीएम) तथा इथ्रेल (500 पीपीएम), के प्रयोग से शरदकालीन जनित द्वितीय पेड़ी का प्रस्फुटन बढ़ाने में सहायक पाया गया। गन्ना प्रजाति कोसे 92423 के प्रस्फुटन में 96.78, 61.11, 33.05 तथा 8.9 प्रतिशत तथा गन्ना वजन में 54.68, 26.15, 19.26 तथा 16.26 प्रतिशत सुधार आया। आक्सिन (160-190 माइक्रोग्राम प्रति ग्राम आईएए) कलियों के प्रस्फुटन का अवरोधक पाया गया।

कटाई उपरान्त प्रबन्धन

गन्ना कटाई से पूर्व मृदा में जिंक सल्फेट (25 किग्रा/हेक्टेयर) डालने पर, गन्ना भण्डारण के समय सीसीएस में मामूली बढ़त (5 प्रतिशत) आँकी गयी। जबकि मैग्नेस सल्फेट से रस की गुणवत्ता निर्धारिकों में कोई सकारात्मक प्रभाव नहीं पाया गया। बेन्जाएल्कोनियम क्लोराइड (2000 मिग्रा/ली.) तथा सोडियम मेटासिलिकेट (1 प्रतिशत) के संयुक्त प्रयोग से, पानी के छिड़काव तथा सूखी पत्तियों के ढके रहने की तुलना में देर से पेराई सत्र में प्रयोग करने से लगभग एक यूनिट का सीसीएस में सुधार पाया गया। कटाई उपरान्त भण्डारित गन्ना पर रासायनिक उपचार के द्वारा डेक्सट्रान सुक्रेज की क्रियाशीलता में आशातीत कमी लाने में प्रभावी सिद्ध पाया गया।

भौतर-जैव रासायनिक अध्ययन

अंकुरिका-चिप को फफूंदनाशी से उपचार के उपरान्त पालीथीन के थैले में रखकर 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 साधारण तापमान में रखने पर प्रस्फुटन कम (40 प्रतिशत) पाया गया। वृद्धि वर्धक रसायनों जैसे एथीफान, कैल्शियम क्लोराइड, सिलिकेलिक अम्ल तथा उनके मिश्रण से शोधित अंकुरिका-चिप सामान्य तापमान में भण्डारित करने पर इसके अंकुरण में नियंत्रक की तुलना में वृद्धि आंकी गयी। मिश्रण वाले उपचार से सर्वाधिक वृद्धि आंकी गयी। बुवाई पूर्व एथीफान (0.1 ग्रा/ली) तथा कैल्शियम क्लोराइड (1 ग्रा/ली) के मिश्रण से शोधित अंकुरिका-चिप्स के प्रस्फुटन, जड़ की बढ़वार तथा पौध की ओज में वृद्धि पायी गयी। प्रहासन शर्करा की मात्रा तथा एसिड इनवर्टेज की क्रियाशीलता एवं एटीपेज एन्जाइम के बीच अच्छा तालमेल होने से प्रस्फुटन एवं पौध ओज सूचकांक में सार्थक सुधार पाया गया।

गन्ने की दैहिक क्षमता में सुधार

गन्ने की छः प्रजातियों के भण्डारण ऊतकों के विश्लेषण से स्पष्ट हुआ कि उच्च शर्करा वाली प्रजातियों की 2 प्रतिशत सुक्रोज विलयन में शोषण क्षमता अधिक थी। यह अन्तर विशेष रूप से प्रारम्भिक अवशोषण अधिक होने के कारण आया। प्रयोगशाला में गन्ने के भण्डारण ऊतकों द्वारा शर्करा संश्लेशण को प्रजातियों की सुक्रोज की मात्रा से सम्बद्ध किया जा सकता है।

पौधे की बढ़वार के नियमन हेतु गन्ना प्रजाति कोसे 92423 को जिबरेलिक एसिड, एनडोल एसिडिक एसिड तथा

साइटोकाइनिन से उपचारित किया गया। जिबरेलिक एसिड उपचार से वृद्धि दर में 10 गुना वृद्धि आयी तथा गन्ने में अधिक शुष्क पदार्थ पाया गया। जिबरेलिक एसिड उपचारित पौधों में यह वृद्धि एसिड एन्जाइम, एमाइलेज, नाइट्रेट रिडक्टेज, प्रोटिऐज तथा घुलनशील कार्बोहाइड्रेड के पत्ती ऊतकों की बढ़ी क्रियाशीलता के कारण आया।

गन्ना टुकड़ों को जिंक सल्फेट विलयन (जिंक 50 पी. पी. एम.) में 24 घंटे तक डुबोने पर गन्ना टुकड़ों के जमाव में वृद्धि (109 प्रतिशत) आंकी गयी जबकि जल शोषित गन्ना टुकड़ों में 75.9% जमाव आंका गया।

उच्च शर्करा संचयन

दो गन्ना जीन प्ररूपों, कोसा 95255 (शीघ्र) तथा बीओ 91 (मध्य-देरी) के ऊपरी, मध्य एवं निचले भाग को एसपीएस घुलनशील एसिड इनवरटेज, सुक्रोज तथा रस की गुणवत्ता निर्धारिकों के मूल्यांकन हेतु गन्ना पकने के विभिन्न महीनों में मूल्यांकन किया गया। गन्ने के मध्य भाग में सुक्रोज फास्फेट सिन्थेज एन्जाइम की अधिक क्रियाशीलता पाई गई जिसका सुक्रोज की मात्रा से सीधा सम्बन्ध पाया गया। गन्ना परिपक्वता के साथ सुक्रोज की मात्रा लगातार बढती गयी तथा फरवरी माह में अधिकतम सुक्रोज की मात्रा (लगभग 16.74 प्रतिशत) तथा नवम्बर माह में कम (12 प्रतिशत) आंकी गयी। मध्य भाग में अधिकतम सुक्रोज सांद्रण अभिलेखित किया गया। गन्ने में सुक्रोज की मात्रा तथा शर्करा के अनुपात में धनात्मक संबन्ध पाया गया।

गन्ने के 12 जीन प्ररूपों को सुक्रोज की मात्रा तथा रस की गुणवत्ता निर्धारिकों हेतु मूल्यांकन किया गया। गन्ना पकने के साथ-साथ सुक्रोज की मात्रा बढ़ती गयी तथा इसका औसत सांद्रण नवम्बर-दिसम्बर तथा जनवरी-फरवरी में लगभग 14.5, 15.6, 16.4 तथा 17.8 क्रमशः आंका गया। कोलख 94184 जीन प्ररूप में सभी महीनों में सर्वाधिक सुक्रोज की मात्रा पायी गयी।

विभिन्न जीन प्ररूप में प्रहासन शर्करा का सांद्रण नवम्बर-दिसम्बर, जनवरी-फरवरी में क्रमशः 0.52 से 1.28 प्रतिशत, 0.43 से 1.29, 0.27 से 0.95 तथा 0.20 से 0.33 पाया गया।

बारह गन्ना जीन प्ररूपों में सुक्रोज/प्रहासन शर्करा अनुपात का अध्ययन किया गया जोकि गन्ने की परिपक्वत्ता के साथ बढ़ता पाया गया तथा 19.95 (नवम्बर) से 137.8 (फरवरी) में आँका गया। विभिन्न जीन प्ररूपों में से कोज 64 का शर्करा/प्रहासन शर्करा प्रतिशत जनवरी तथा फरवरी में अधिकतम पाया गया।

पूर्व विकसित वेदर इनटरेक्टिव मल्टिपल रिग्रेसन माडल को सम-सामयिक किया गया तथा 2008-09 फसल सीजन के लिए वैध किया गया। उत्तर प्रदेश राज्य की औसत गन्ना उपज का 9.41 प्रतिशत आरएमएसई के साथ आंकलन किया गया।

फसल सुरक्षा

नाशीकीटों का सर्वेक्षण/निगरानी

पश्चिमी उ. प्र. की चीनी मिलों के अन्तर्गत 19 गांवों में लगभग 200 हे. क्षेत्र पर सफेद गिडार द्वारा क्षतिग्रस्त फसल में 10 से 30 प्रतिशत की उपज हानि आँकी गयी। कुछ स्थानों पर फसल पूर्णरूप से नष्ट पायी गयी। अत्यधिक संक्रमित खेतों में 10 से 25 सेमी. मृदा गहराई पर प्रति थान 4-7 गिडार पाये गये। सामान्तया ब्लुई दोमट मृदा में उगाई गई गन्ना फसल में सफेद गिडार का प्रकोप पाया गया। पश्चिमी उत्तर प्रदेश में होलोट्रिकिया कान्सैन्गुइनिया तथा मध्य उत्तर प्रदेश में एपोगोनिया प्रजाति का प्रकोप पाया गया।

खड़ी गन्ना फसल में लाल सड़न रोग विकसित करने के लिए तीन आँख का टुकड़ा एवं प्लग विधि द्वारा टीकाकरण अधिक प्रभावी (61.53 प्रतिशत) पाया गया जबकि स्पोर डिप (24 घंटे के लिए) में 46.34 प्रतिशत पाया गया।

लाल सड़न रोग का जैव प्रबंधन

उच्च शर्करा युक्त गन्ना प्रजाति, कोलख 7701 की लाल सड़न रोग द्वारा संक्रमित अनेक आँखों, टी. हरजिएनम, आर्द्र-शुष्क वायु संचार यंत्र द्वारा 54 डिग्री से. पर 90 प्रतिशत आर्द्रता में 2.30 घंटे तक उपचारित करने तथा इन दोनों के संयुक्त प्रयोग द्वारा उपचार करने पर रोग रहित पायी गयीं।

उपरोक्त उपचारों से क्रमशः 53, 68 तथा 73 प्रतिशत आँखों में कोलेटाट्रिकम फैल्क्केटम नहीं पाया गया। टी. हारजिएनम को गन्ना बीज जनित सी. फैल्क्केटम संक्रमण को निर्मूल करने में प्रभावी पाया गया।

गन्ना प्रजाति कोलख 7701 में लाल सड़न रोग नियंत्रण के लिए टीएमसी, एमएचएटी एवं टीएमसी + एमएचएटी के द्वारा क्रमशः 72, 46 एवं 76 प्रतिशत रोग नियंत्रित किया जा सका। टी. हारजेनियम (टी एच 37) के प्रयोग से द्वितियक संक्रमण को अवरूद्ध किया जा सका।

मृदा में ट्राइकोडरमा हरजिएनम का प्रयोग करने से प्रमुख पोषक तत्वों की उपलब्धता अधिक पायी गयी जिसमें नत्रजन 27, फास्फोरस 65 तथा पोटाश 44 प्रतिशत अधिक पायी गयी। सूक्ष्म तत्वों में ताँबा 6, लोहा 100, मैंगनीज 79 तथा जिंक 55

प्रतिशत बढ़ी पायी गयी। लाल सड़न सुग्राही प्रजाति कोलख 7701 द्वारा नत्रजन, फास्फोरस तथा पोटाश का अवशोषण मध्यम अवरोधी प्रजाति कोशा 96268 की अपेक्षा अधिक पाया गया। ट्राइकोडरमा विरडी शीरे का प्रयोग करने पर पेड़ी फसल मे थान की बढ़वार मे 15, किल्ले 8, गन्ने की लम्बाई 5, पोरी की लम्बाई 2, गाँठो की संख्या 8, गन्ने की मोटाई 4, मिल योग्य गन्नो की संख्या 4, गन्ने का वजन 5 तथा गन्ना उपज मे 23 प्रतिशत वृद्धि आँकी गई।

अन्तःजीवी फफूंदो (ट्राइकोडरमा, एस्परजीलस, कीटोनियम एवं फ्यूजेरियम) के प्रयोगशाला मे आंकलन से पता चला कि ट्राइकोडरमा द्वारा इस रोग को अधिकतम (80.2%) तक अवरूद्ध किया जा सका। सी. फालकेटम की वृद्धि एस्परजीलस द्वारा 64.2 प्रतिशत तथा कीटोनियम द्वारा 62.1 प्रतिशत कम की जा सकी।

गन्ना खेती का यंत्रीकरण

गन्ना कटाई यंत्र का विकास

गन्ना कटाई यंत्र का संस्थान के प्रक्षेत्र पर परीक्षण किया गया। यंत्र की औसत कार्य क्षमता 0.15-0.20 हे0 प्रति घंटा आंकी गयी। यंत्र को गन्ना कटाई के लिए आंशिक यंत्रीकरण के रूप मे प्रयोग किया जा सकता है। यंत्र, कटे हुए गन्ने को एक ओर समेट देता है। गन्ने से सूखी पत्तियो को निकालने तथा अंगोले को काटने की प्रक्रिया को अलग से किया जा सकता है।

डिट्रैशर की अभिकल्पना में संशोधन

शक्ति चालित डिट्रैशर की अभिकल्पना को अन्तिम रूप दिया गया। इस यंत्र द्वारा एक साथ तीन गन्नो की सफाई करने के लिए फीडिंग करने पर 2.4 टन/घंटा परिणाम आया। हाथ द्वारा पत्तियो की सफाई करने की अपेक्षा इस यंत्र के प्रयोग से छिलाई लागत मे 17 प्रतिशत की कमी तथा 84 प्रतिशत श्रम की बचत हुयी।

प्रौद्योगिकी हस्तान्तरण

रोजगाँव, हैदरगढ़ एवं बिसवाँ चीनी मिलो के अन्तर्गत आने वाले गन्ना उत्पादको के खेतो पर उन्नत तकनीकी संबंधी 40 प्रदर्शन कार्यक्रम आयोजित किये गये। परम्परागत विधि की अपेक्षा गोल गड्ढा बुवाई विधि द्वारा गन्ना उपज (114.27%), क्रान्तिक वृद्धि अवस्था मे सिंचाई से 28.46 तथा एकान्तर नाली सिंचाई विधि द्वारा सिंचाई करने से 24.24% अधिक आँकी गयी। गोल गड्ढा बुवाई विधि से सिंचाई के पानी मे 16.19 से 38.45 प्रतिशत की बचत आँकी गयी। इस विधि द्वारा परम्परागत विधि की अपेक्षा सर्वाधिक सिंचाई जल उपयोग क्षमता (169.37%) तथा क्रान्तिक अवस्थाओ मे सिंचाई से 108.72 प्रतिशत, पताव बिछावन से 98.37 प्रतिशत तथा एकान्तर नाली विधि मे 48.25 प्रतिशत आँकी गयी।

गोल गड्ढा बुवाई विधि की सर्वाधिक उत्पादन लागत को इसी विधि से प्राप्त सर्वाधिक गन्ना उपज द्वारा क्षतिपूर्ति कर लिया गया। गोल गड्ढा बुवाई विधि से सर्वाधिक वास्तविक आय (रू 220217/हे.) पताव बिछावन से (14,3,833/हे.), एकान्तर कूँड सिंचाई विधि से (रू 125216/हे.) तथा आईसीजीएस से (रू 100420/हे.) आँकी गयी। प्रदर्शित प्रौद्योगिकियो मे सर्वाधिक लाभ/लागत अनुपात (2.83) पताव बिछावन विधि से तत्पश्चात् गोल गड्ढा बुवाई विधि (2.03), एकान्तर नाली सिंचाई विधि (1.96) तथा आई सी जी एस (1.45) से प्राप्त किया गया।

ट्रैक्टर चालित पेड़ी प्रबंधन यंत्र का अग्रिम पंक्ति प्रदर्शन

बाराबंकी जिला मे ग्राम सरदरा पुरवॉ, पो0 सफेदाबाद मे 10 हे क्षेत्र पर नवम्बर 2009 बावक फसल मे चरणबद्ध ढंग से कटाई एवं कलिकाओ मे अंकुरण के उपरान्त आरएमडी को 20 नवम्बर 2009 से 25 नवम्बर 2009 तक चलाया गया। यंत्र को कड़ी परत तोड़ने, कर्षण क्रियाओ को सम्पादित करने, पुरानी जड़े काटने, उर्वरको एवं रासायनिक खादो को डालने तथा 7-10 सेमी मोटी मृदा परत डालने के लिए प्रयोग किया गया। कृषक प्रक्षेत्र पर इस यंत्र के प्रदर्शन मे उर्वरक मीटरिंग प्रणाली तथा शक्ति पारेषित इकाई के मध्य उपयुक्त तालमेल पाया गया।

बीज उत्पादन

गन्ना बीज उत्पादन दिशा निर्देशो के अनुरूप संस्थान द्वारा इस वर्ष 8300 कुन्तल से अधिक बीज गन्ना उत्पादन किया गया।

Executive summary

Crop Improvement

Maintenance of sugarcane germplasm

A collection of 210 genotypes consisting of *S. officinarum*, *S. barberi*, *S. sinense*, ISH clones, IkshuISH clones, LG selections and commercial hybrids was maintained. The required material was supplied to various on- going projects of the Institute.

Development of sugarcane varieties and breeding stocks for sub-tropics

During station trial, ten promising selections along with early and mid-late maturing checks were under test. The best cane yielders were LG 04602 and LG 04603, followed by LG 05447, LG 02434 and LG 04006. The first two, however, were very late in maturity. Two other genotypes, LG 4012 and LG 4079 were early maturing with high sugar but had low NMC and thus moderate yielders. Based on the results, LG 05447 (ML), LG 02434 (ML), LG 04006 (ML), LG 04602 (L) and LG 04012 (E) were found potential entries for multi-location testing under AICRP(S) and UP state varietal testing.

Inclusion of clones in AICRP (S)

LG 01030 (CoLk 09201) an early maturing clone was included in the AICRP (S) trials for the NW Zone. This was also included in the UP state varietal trials.

Five genetic stocks, LG 04601, LG 04602, LG 04603, LG 04604 and LG 04605 are under quarantine at Sugarcane Breeding Institute, Coimbatore for inclusion in the National Hybridization Garden.

Genotypes, CoLk 04238, CoLk 05203 and CoLk 7201 are at different stages of testing in multilocation evaluation under AICRP (S) for north western zone. In addition, LG 2919 has been included in state varietal trials of UP.

CoLk 09202 (LG 05031) an early maturing clone and CoLk 09204 (LG 04043) a mid-late clones, were accepted for multi-location testing under north-west zone of AICRP(S) and UP state zonal varietal trial.

Inclusion of clone in U.P. state zonal varietal trial

LG 05823, a mid late maturing clone having red rot resistance to three pathotypes (Cf 08, Cf 09 and Cf 11) was proposed and accepted for multi-location testing under UP State Zonal Varietal Trial. Total 260 EST-SSR markers were designed and developed from 4000 unique Indian sugarcane ESTs and 1069 red rot specific ESTs.

Crop Production

Ratoon management

The gaps between two adjoining clumps in the first (8.60) and second ratoon (11.50%) canes raised from second and first crop cycles were found minimum when their plant crops of sugarcane were planted at 60,000, 3-bud setts ha^{-1} as against 21.25 and 27.80% under 40,000 3-bud setts ha^{-1}. On an average, a higher planting density produced 17.53% more ratoon cane yield than that observed at planting density of 40,000 3-bud setts ha^{-1} (69.65 t ha^{-1}). Gap filling with, 3-bud setts ha^{-1} at 45 DAP and K application @ 80 kg ha^{-1} one month before sugarcane harvesting in plant cane exerted positive impact on the yield of subsequent ratoon canes and thus produced 13.57 and 12.62% more ratoon canes yield as against no gap filling (67.92 t ha^{-1}) and no K application (68.27 t ha^{-1}), respectively.

The cane yield obtained under 3-bud setts planting (69.55 t ha^{-1}) was significantly higher to 2-bud (61.74 t ha^{-1}) and 1-bud (53.52 t ha^{-1}) sett planting. An increased seed rate although did not affect germination of cane buds, however, it had a significant effect on the growth and yield of seed cane. Dipping of cane setts in 100 ppm GA_3 solution for 15 minutes showed adverse effect on the growth and yield of seed cane than that of dipping cane setts in carbendazim for 15 minutes.

The winter ratoon of early variety (CoS 96268) of sugarcane was initiated during first week of January 2009 and all the treatments were applied at the time of ratoon initiation. Application of 20 t ha^{-1} SPMC (alone) or

10 t ha^{-1} SPMC along with 25 kg ha^{-1} $ZnSO_4$ significantly improved the bud sprouting and resulted in the highest production of shoots (292000 ha^{-1}) over control (276000 ha^{-1}). Highest number of millable canes (110000 ha^{-1}) and cane yield (72.0 t ha^{-1}) were recorded with the application of 20 t ha^{-1} SPMC (alone). These results were comparable with the treatment of 10 t ha^{-1} SPMC + 25 kg ha^{-1} $ZnSO_4$. This clearly suggests that productivity of winter ratoon can be enhanced through application of either 20 t ha^{-1} SPMC (alone) or 10 t ha^{-1} SPMC + 25 kg ha^{-1} $ZnSO_4$. None of the treatments could affect the quality of cane (pol%).

Improving juice quality and stubble bud sprouting under low temperatures

Post-harvest application (to the freshly harvested stubble) of formulation containing a mixture of vitamins (500 ppm); potassium nitrate (0.1%); Five Phos, a biochemic drug (100 ppm) and Ethrel (500 ppm) enhanced sprouting of winter-initiated second ratoon of sugarcane variety CoSe 92423 by 76.78, 61.11, 33.05 and 8.9%., respectively and improved cane weight by 54.58, 26.15, 19.26 and 16.26%, respectively.

Relatively higher concentration of auxins (160-190 µg/g of IAA) retarded sprouting of buds.

Post-harvest management

Pre-harvest soil application of zinc sulphate (@25 kg/ha) in sugarcane showed a marginal improvement in CCS (3%) during storage, whereas manganous sulphate did not elicit any positive response on quality parameters. A combined application of benzalkonium chloride (2000 mg/l) and sodium metasilicate (1%) on billets during late-milling season resulted in nearly one unit increment in CCS over water treated -trash covered control. In harvested stored cane chemical treatment resulted in an appreciable decline in dextransucrase activity.

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

Bud chips stored in polyethylene bags after fungicide treatment and kept at 10 ±1°C for 10 days, exhibited about 80% germination than those stored at room temperature (about 40%). Plant vigour index was low in bud chip seed stocks stored at room temperature.

Bud chip seed stocks soaked in growth promoting chemicals viz., ethephon (T_1), calcium chloride (T_2), salicylic acid (T_3) and their mixture (T_4) for 24 hr exhibited germination improvement over control; improvement was highest with T_4 treatment under field conditions. Pre-planting soaking in ethephon (0.1g l^{-1}) and calcium chloride (1g l^{-1}) solution helped in enhancing bud sprouting, root growth and plant vigour by altering some of the key biochemical attributes essential for the early growth and better establishment of bud chips under field conditions. Reducing sugars contents and activity of acid invertase and ATPase enzymes of sprouted buds exhibited significant positive correlation with bud sprouting and plant vigour index.

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

Pre-treatment of sugarcane trash, mandatory for saccharification causes the production of inhibitors in the hydrolysates to be further processed for saccharification and fermentation. The production of compounds was significantly minimized when pre-treatment was carried out with microbial agents *Aspergillus terrus*, *Cellulomonas uda* and *Aspergillus awamori* as compared to diluted sulphuric acid. Five inhibitors, identified in the acid pre-treated trash, 5 hydroxy-2 methyl furfural (3mg l^{-1}), furfural (50mg l^{-1}, levullinic acid (0.3 mg l^{-1}), 3,4 dihydroxy benzoic acid (0.3 mg l^{-1}) and vanillic acid (0.7mg l^{-1}) were evaluated for their effects on saccharification of sugarcane trash hydrolysates. The mentioned concentrations were tested at two cellulase enzyme (Cellulase) loads of 30 and 60 FPU at three residence times (24 hrs, 72 hrs and 168 hrs). Significant inhibition occurred in the cellulosic digestibility and reducing sugar contents with both 30 and 60 FPU at all the three residence times evaluated. However, maximum depression in cellulose digestibility and reducing sugar contents occurred at 30 FPU with furfural (21.16% and 30.6%) followed by 5 hydroxy-2 methyl furfural (10.1 and 35.46%), 3,4 dihydroxy benzoic acid (12.43 and 26.83% and vanillic acid (15.46 and 30.0%), respectively as compared to the untreated trash hydrolysates.

Improving physiological efficiency of sugarcane

Storage tissues of six sugarcane varieties were analyzed for the potential to absorb sugar from a 2% sucrose solution. The storage tissue of high sucrose accumulating (HSA) varieties absorbed more sugar than those of low sugar accumulating varieties. The differences in uptake resulted largely from differences in the initial uptake of sucrose which was higher in HSA. Within varieties, passive uptake was more from older than those of younger internodes. The ability of the storage tissue of sugarcane to accumulate sugar *in vitro* may be related to potential sucrose content of the varieties.

In order to modulate the extension growth of plants, sugarcane variety CoSe 92423 was treated with GA, IAA and cytokinin. The extension rate was ten times higher due to GA treatment along with higher partitioning of dry matter in the stalk. This was supported by enhanced activities of acid invertase, amylase, nitrate reductase, protease enzymes and concentration of soluble carbohydrate in leaf tissues of GA treated plants.

Germination was the highest (109% over control) in sugarcane setts soaked for 24 hours in zinc sulphate solution (zinc 50 ppm) while germination of sett soaked in water improved germination by 75.9% over control.

Expression of sucrose metabolizing enzymes for high sucrose accumulation in sugarcane

Upper, middle and lower portions of cane stalk of two sugarcane genotypes, CoS 95255 (an early maturing genotype) and BO 91 (a mid-late maturing genotype) were evaluated for SPS, soluble acid invertase, sucrose and juice quality parameters in different months of cane ripening. Middle portion of cane stalk showed higher activity of sucrose phosphate synthase enzyme and was positively correlated with sucrose content. Sucrose content increased gradually with cane ripening, highest sucrose content was observed in the month of February (about 16.74 per cent) and lower in the November (12 per cent). Middle portion showed the highest sucrose concentration. Sucrose content in cane stalk showed significant positive correlation with sucrose / reducing sugars ratio, SPS activity and negative correlation with reducing sugars contents. Sucrose / reducing sugars ratio (S / R ratio) varied widely in different portions of cane stalk; its average value increased significantly from 10.81 to 75 from November to February month, respectively. Top portion showed the highest S / R ratio in the month of February. The S / R ratio showed a significant positive correlation with sucrose content in cane juice. The activity of SAI showed progressive decline during maturation phase, being quicker in early ripening variety compared to late maturing ones.

Twelve sugarcane genotypes were evaluated for sucrose content and juice quality attributes in different months. Sucrose content increased gradually with cane ripening; its average concentration was about 14.5, 15.6, 16.4 and 17.8% in the months of Nov, Dec, Jan, and Feb, respectively. Sucrose content varied widely among different genotypes; it ranged from 12.93 to 17.10%, 13.77 to 17.3, 14.36 to 18.10 and 16.35 to 19.73% in the months of November, December, January and February, respectively. The highest sucrose content was observed in CoLk 94184 genotype in all the months.

Among different genotypes, the reducing sugars concentration was in the range of 0.52 to 1.28%, 0.43 to 1.29%, 0.27 to 0.95% and 0.20 to 0.33% in Nov, Dec, Jan and Feb, respectively.

Sucrose / reducing sugars ratio (S / R ratio) was studied in 12 sugarcane genotypes which markedly increased with cane ripening; it ranged from 19.95 (November) to 137.8 in the month of February. Among different genotypes, CoJ 64 showed highest S / R ratio in the months of January and February.

Weather interactive multiple regression model(s) developed earlier was updated and validated up to 2008-09 crop season. The model estimated the average cane productivity in the state of Uttar Pradesh with a RMSE of 9.41%.

The partitioning of net radiation over sugarcane for the entire crop cycle in terms of ET / Rn indicated that ET / Rn declined with crop age. The average partitioning of net radiation to ET was 95.9% during formative phase whereas it was only 83.4 % during elongation phase. For the entire crop cycle 85.5% of net radiation was utilized for ET.

An analysis of long-term (1976- 2008) monthly total rainfall data for Uttar Pradesh

collected from UP Council of Agricultural Research, Lucknow reflected a declining trend in rainfall in all calendar months. The average annual total rainfall was 918.9 mm with a CV of 21.6% and was found declining @ 12.2 mm / year. The average total monsoon rainfall was 792.8 mm with a CV of 21.4 % and rate of decline was 7.8 mm / year. The impact of monthly rainfall from April to September, monsoon and total annual rainfall on average sugarcane productivity in UP was also worked out.

Crop Protection

Survey and surveillance of insect-pests

White grub infestation was recorded in approx 200 ha area in 19 villages with 10-30% damage of the sugarcane crop in the sugarcane command area of Triveni Engineering & Industries Ltd., Deoband, Saharanpur and Titawi Sugar Complex, Titawi, Muzaffarnagar. Complete crop failure was also observed in certain locations. In the severely infested fields, 4-7 grubs / clump at a soil depth of 10-25 cm was observed. In general, infestation of white grubs was recorded in the sugarcane crops grown in sandy loam soil. *Holotrichia consanguinea* was predominant in western U.P., while *Apogonia* sp. was dominant in central U.P.

Incidence of red rot was observed in CoS 8436 at Biswan Sugar factory, Sitapur. In irrigated ratoon, incidence of settling mortality and spindle infection was observed.

Development of red rot in standing cane

Three-bud setts and plug method of inoculation fared better in producing red rot in standing cane (61.53%) as against spore dip (46.34%) with 24 h incubation.

Management of red rot of sugarcane through bioagents

Several infected buds of CoLk 7701 (HS variety) were found free from the pathogen due to treatment with *T. harzianum* and MHAT at 54^{0}C for 2½ h at 90% RH, alone and in combinations. *Colletotrichum falcatum* could not be recovered from 53, 68 and 73% bud, respectively with TMC, MHAT and TMC + MHAT treatments. It was apparent that *T. harzianum* was also effective in eradicating sett borne infection of *C. falcatum*.

Protection of canes against red rot in CoLk 7701 was recorded up to 72, 46 and 76% in TMC, MHAT and TMC + MHAT treatments, respectively. *T. harzianum* (Th 37) checked secondary infection due to induced systemic resistance in cane plants and it was higher than that of MHAT.

Availability of some of the important macro-and micro-elements in soil increased due to application of *T. harzianum*. N availability enhanced by 27%, P by 65% and K by 44%. Among the micro-nutrients, Cu increased by 6%, Fe by 100%, Mn by 79% and Zn by 55%. Overall organic carbon content increased by 55%. The uptake of N, P and K was higher in red rot susceptible variety, CoLk 7701 than the moderately resistant CoS 96268. The emergence of ratoon clumps was higher due to application of *Trichoderma* enriched press mud by 15%, tiller population by 8%, cane height by 5%, length of internode by 2%, number of internodes by 8%, girth by 4%, number of millable canes by 4%, single cane weight by 5% and total yield by 23%.

Management of red rot through fungal endophyte in sugarcane

In vitro assay of the endophytes (*Trichoderma, Aspergillus, Chaetomium* and *Fusarium)* showed maximum inhibition (80.2%) with *Trichoderma* sp. Growth of *C. falcatum* was reduced (64.2%) by *Aspergillus* sp and *Chaetomium* sp (62.1%).

Mechanization of sugarcane cultivation

Field testing of sugarcane harvester

The harvester was tested at IISR farm. 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 separately.

Design refinement for detrasher

The design of tractor / power operated detrasher was finalized. The output of the detrasher with feeding of 3 canes at a time, was 2.4 t h^{-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.

Transfer of technology

Water use efficient technologies for improving productivity and sustainability of sugarcane

Total 40 demonstrations on the fields of cane growers in the sugar mill Zones of Rauzagaon, Hydergarh and Biswan were conducted. The maximum increase in cane yield was recorded in ring-pit method of planting (114.27%) over the conventional method followed by trash mulching (37.97%), ICGS-irrigation at critical growth stages, (28.46%) and skip furrow method of irrigation (24.24%). The saving in irrigation water varied from 16.19 to 38.45 per cent. The irrigation water use efficiency was recorded the highest in ring-pit method of planting (169.37%) over the conventional method followed by irrigation at critical growth stages (108.72%), trash mulching (98.67%) and skip furrow method of irrigation (48.25%)

The cost of sugarcane cultivation was the highest in case of ring-pit method of planting, the highest return accrued from this technology well compensated the increased cost. The highest net return (Rs. 220217 ha^{-1}) was recorded in case of ring- pit method of planting followed by trash mulching (Rs. 143833 ha^{-1}), skip furrow method of irrigation (Rs. 125216 ha^{-1}) and ICGS (Rs. 100420 ha^{-1}). Among the demonstrated technologies, the highest B/C ratio was observed in trash mulching technology (2.83) followed by ring-pit method of planting(2.03), skip furrow method of irrigation (1.96) and ICGS (1.45) .

Front line demonstration of IISR tractor operated ratoon management device (RMD)

Plant cane was harvested in phases in the month of November, 2009. Buds had already sprouted. RMD was operated from 20.11.2009 to 25.11.2009 in ten ha field in Village Sarthara Purwa, P.O. Safedabad, Dist. Barabanki. The equipment was operated for breaking hard pan, interculturing, off barring, applying manure and chemical fertilizer, and finally for providing 7-10 cm soil cover over the stubbles. Field capacity was 0.34 ha h^{-1}. Shaving was avoided.

During demonstration of the equipment at farmers' field, it was realized that the manure-metering system and the power transmitting unit could be optimized. A prototype of the RMD was thus got fabricated in the divisional workshop. The equipment was administered with required improvement.

Seed Production

More than 8300 quintals of sugarcane seed was produced as per seed production guidelines.

Introduction

The Indian Institute of Sugarcane Research (IISR), Lucknow was established in 1952 by the erstwhile Indian Central Sugarcane Committee for conducting research on fundamental and applied aspects of sugarcane culture as well as to co-ordinate the research work done on this crop in different states of the country. The Government of India took over the Institute from the Indian Central Sugarcane Committee on 1st January, 1954. It was transferred to the Indian Council of Agricultural Research (ICAR), New Delhi on April 1, 1969. The Institute is located in Lucknow, the capital city of Uttar Pradesh and conveniently situated at about 12 kms from 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 sugarcane agriculture.

Mission

Enhancement of sugarcane production, productivity profitability and sustainability to meet future sugar and energy requirement of India.

Mandate

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

i) To conduct basic and applied research on all aspects of production and protection techniques of sugarcane and other sugar crops particularly sugarbeet for different agro-climatic zones of the country.

ii) To work on the breeding of varieties for subtropical region in close collaboration with Sugarcane Breeding Institute, Coimbatore.

iii) To carry out research for diversification and value addition in sugarcane.

iv) To develop linkages with State Agricultural Universities, Research Centres and other organizations for collaborative research, exchange of information and material, and

v) To provide training, and consultancy to end users at regional, national and international levels.

Issues and strategies

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

Issues

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

Strategies

Increasing the levels of cane yield and sugar recovery

a. Introgression of untapped genes in the parental gene pool
b. Enhancing selection efficiency through marker aided selection (MAS)
c. Improving sink strength and source efficiency
d. Enhancing productivity of ratoon cane

Reducing the cost of cane cultivation

a. Nutrient efficiency through rhizospheric engineering and INM technology
b. Water use efficiency through micro-irrigation
c. Land use efficiency through companion cropping
d. Reducing cost of pesticide use in an eco-friendly manner through bio-intensive IPM and IDM.
e. Mechanizing sugarcane farming

Arresting decline in factor productivity

a. Soil biological and nutritional dynamism
b. Carbon sequestering through cropping system

The strategies and corresponding programmes in detail are as follows :

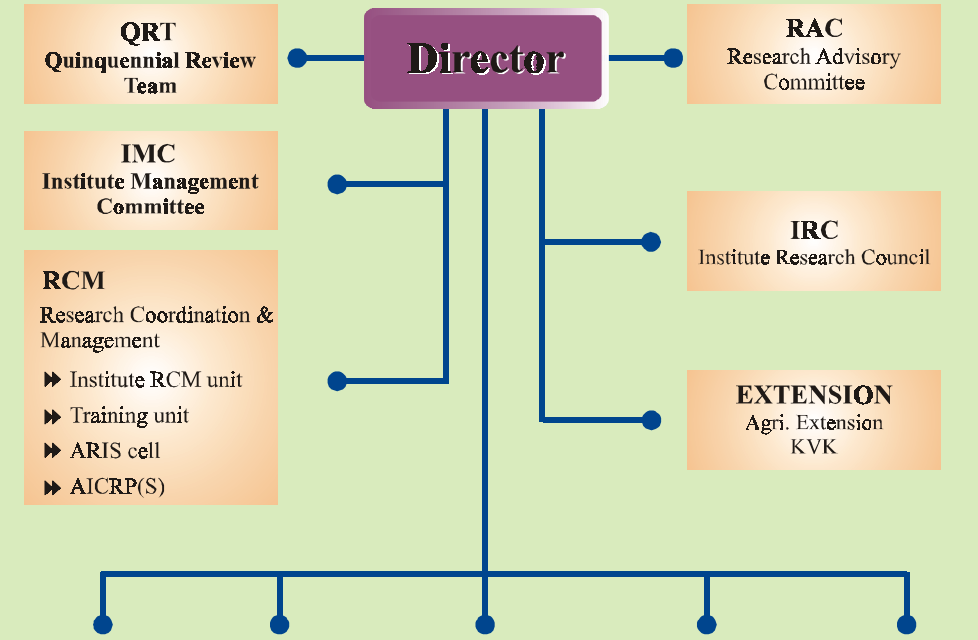
Issues	Strategies	Programmes
A. Increasing levels of cane yield	1) Developing high yielding, disease resistant and pest tolerant, good ratooning varieties	• Pre-breeding programmes
		• Molecular breeding programmes
		• Varietal development programme
		• Mapping the virulence and population diversity of pathogens and insect-pests.
		• Identification of sources of resistance against major diseases and pests
		• Identification of disease / pest resistant cane genotypes
		• Evaluation of physio-biochemical attributes associated with higher productivity
	2) Designing and developing planting methods, planting geometry and integrated nutrient supply system for maximizing yield of plant and ratoon crops.	• Optimising plant population density in sugarcane plant-ratoon system • Developing integrated nutrient management technology for sugarcane plant ratoon system
		• Nutrient use efficiency at cellular and organ level.
		• Design and development of 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 & reducing use of costly inputs like pesticides	• Reducing use of seed cane and cost of planting operations
		• Improving nutrient, water and herbicide use efficiencies
		• Development of cost effective protection technology
		• Optimizing tillering and higher nutrient use efficiency
		• Improving water use efficiency
	3) Enhancing productivity of ratoon cane	• Developing agro-techniques to improve ratoon productivity
		• Plant protection measures for ratoon
		• Improving sprouting of stubble buds
		• Equipment for increasing ratoon productivity
E. Making cultivation of sugar beet in India a success	1) Sugarbeet improvement and seed production	• Development of high yielding and tropicalized varieties of sugar beet • 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 related to sugarcane cultivation. Different Divisions along with Extension & Training Unit and KVK will take part in training programme organized by the Institute on sugarcane production, protection and management to farmers, cane development personnel, extension workers and to those interested in sugarcane cultivation.

Organizational structure

The current organizational structure of the Institute is shown 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 querries received from other Institutes on aspects related to sugarcane research. It is entrusted with the responsibility of printing Annual Report, IISR Newsletter, *Ikshu Samachar* and other publications. The unit also coordinates the preparation of six-monthly progress reports of scientists and its communication to ICAR.

Library and reprography

The IISR Library is well established and has a rich collection of books and Indian and Foreign Journals. During the year 2009-2010, Library budget was Rs. 13.32 lakhs, of which Rs 67, 794 was spent on subscription of 22 Indian Journals, Rs. 11.50 lakhs on 11 Foreign Journals, Rs 10,672 spent on 10 Newspapers, and Rs. 7,665 on 10 Hindi / English magazines. Rs 98,287 were spent on acquisition of 45 Books. In addition to this, resource generation of Rs 40,950 was done by selling 155 Books written by Institute scientists.

The total numbers of titles of serial publications like Annual Reviews / Advances, and Indian and Foreign Journals reached to 386 comprising of 20,200 sets / volumes. During the year, 574 issues of Indian / Foreign journals, Newspapers & Hindi / English magazines and 21 CDs were received. There are 33 Foreign Journals, including 14 of CeRA; 34 Indian Journals out of which 08 are in Hindi; 10 Newspapers; and 10 Hindi / English magazines providing current affairs, in the subscription list. Some of the journals in the Library date back as early as 1913.

Since CeRA, as a centralized service, is in operations from 2007, all the journals / serial publications like Annual Reviews Inc., Elsevier, Indian Journal. Com, Informatics, Nature.com, and Springer, can be accessed directly through internet by the Institute scientific staff. Through CeRA, the Institute is also providing scientific literature to the scientific community of the country.

The literature relating to sugarcane; New Research on sugarcane during 2006, 2007; 2008 and 2009, i.e., research paper published during these years; Holding list, i.e., list of serial publications are available in the IISR Library, Technical programmes of the Institute for 2000-2008, are being regularly updated. Citation index of research papers of the Director by name was prepared. These can be seen by the Institute staff, as shared documents.

The Institute Library acquired a new coloured photo copier during the current financial year.

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^{o}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.

Krishi Vigyan Kendra

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

Dispensary

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

Electronic communication

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

Financial statement (2009-10)

A. Main Institute

(Rs. in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Estt. Charges	1872.52	1872.52	0.00	0.00
T.A.	5.18	5.17	5.46	5.46
HRD	0.00	0.00	0.00	0.00
Other Charges	69.05	69.05	272.09	272.09
Works	43.77	41.06	72.45	72.43
Others items	0.00	0.00	0.00	0.00
OTA	0.00	0.00	0.00	0.00
Total	**1990.52**	**1987.80**	**350.00**	**349.98**

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

(Rs. in lacs)

Particulars	Estt. Charges	T.A.	Other Charges (RC)	NRC	Total
Revised Estimate	322.56	15.01	55.99	86.44	480.00
Expenditure	322.56	15.01	55.99	86.44	480.00

C. Externally Funded Projects

S. No.	Projects	Funding agency	Duration	Amount (Rs. in lacs)
1	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	35.00
3	Development of SSR markers for red rot resistance from EST database of sugarcane	DBT, New Delhi	2009-12	38.22
4	Energy water balance and growth monitoring in sugarcane using satellite data	SAC	2005-10	-

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	51.34
2	Miscellaneous	39.37
	Total	**90.71**

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	4	8	4
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	0	3	0
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	2	5	5
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**	**37**	**85**	**56**

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
Sub Total	0	0	1	1	1	0	1	1

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	23	16	14	14	1	1	0	0	59
Workshop Staff including Engineering Workshop	22	2	8	1	0	0	0	0	33
Photography Staff	0	1	1	1	0	0	0	0	3
Laboratory Technicians	2	1	0	0	0	0	0	0	3
Library / Information / Documentation Staff	0	1	3	1	0	0	0	0	5
Medical and Paramedical Staff	0	0	0	0	0	1	0	0	1
Press and Editorial Staff	0	0	1	0	0	0	0	0	1
Sub Total	47	21	27	17	0	2	0	0	114
Field / Farm Technicians (Motipur)	2	0	0	0	0	0	0	0	2
Total	49	21	27	17	0	2	0	0	116

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
Supporting skilled staff	73	67
Sub Total	**132**	**119**
Upper Division Clerk (Motipur)	1	1
Supporting skilled staff	1	1
Total	**133**	**121**

Crop management for high cane productivity under different environments

2.1 Sugarcane based production system

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 fertiliser schedules in different cropping seasons. Initially soil was low in organic carbon (0.42%), and available nitrogen (220 kg ha^{-1}); medium in phosphorus (34.5 kg P_2O_5 ha^{-1}) and potassium (225 kg K_2O ha^{-1}) contents.

Spring season crop

In spring planting, genotype CoPant 02217 produced the maximum number of millable canes (105600 ha^{-1}) being at *par* with genotype CoLk 9709 (104400 ha^{-1}). The longest cane (214.3 cm) was of CoLk 5202 (Table 2.1). Genotype, CoLk 5202 produced thicker (2.29 cm mean cane diameter) and heavier canes (1035.5 g individual cane weight) as compared to other genotypes. Thus significantly higher cane (83.54 t ha^{-1}) and sugar (10.51 t ha^{-1}) were produced by CoLk 9709. Growth attributes and yield of cane and sugar increased up to application of 150, 60, 60 kg ha^{-1} NPK, the recommended dose. It produced significantly higher cane (78.29 t ha^{-1}) and sugar (9.43 t ha^{-1}) over that of 75% of the recommended doses of NPK (70.44 t ha^{-1} cane and 8.93 t ha^{-1} sugar yields).

Summer season crop

Significantly higher population of millable canes (95490 ha^{-1}) was observed in sugarcane genotype, CoPant 02217. Individual cane length (187.1 cm) was significantly higher in genotype, CoLk 9709 compared to other genotypes. The individual cane diameter (2.46 cm) and the single cane weight (915.6 g) were maximum in CoLk 5202. Genotype, CoLk 9709 produced significantly the maximum cane (66.05 t ha^{-1}) and sugar (8.63 t ha^{-1}). Significant increase in number, length, diameter and weight of millable canes and yield of cane (58.39 t ha^{-1}) and sugar (7.23 t ha^{-1}) was observed up to application of 150, 60, 60 kg NPK ha^{-1}, the recommended dose. Juice quality was not affected due to various fertiliser treatments.

Developing organic farming module for sugarcane crop (AS 57)

A field experiment was started during spring 2006 with an objective to study the effect of organic farming module on the sustainability of crop productivity and soil health. Five treatments as T_1, Recommended NPK + micronutrients through inorganics + control of pests / diseases through chemical mode, T_2, Recommended N through organics (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 and T_5, 75% recommended NPK through inorganics + 25% through organic manures + biofertilizers + biopesticides (*Pseudomonas* + *Trichoderma* / neemcake) were laid out in RBD with four replications. Sugarcane (Cv. CoS 94257) was planted in first week of March 2008 (3rd crop cycle).

Plant - ratoon system (3rd cycle)

The highest number of millable canes (Table 2.2) in plant (108.0 thousand ha^{-1}) and ratoon (108.9 thousand ha^{-1}) were recorded in

Table 2.1: Effect of genotypes and different fertility levels on growth, yield and quality of sugarcane

Treatment	Millable cane				°Brix	Pol % juice	Purity (%)	Cane yield (t/ha)	Sugar yield (t/ha)
	Number (000 ha^{-1})	Length (cm)	Diameter (cm)	Weight (g)					
Spring crop*									
Genotypes									
CoLk 9709	104.4	208.9	2.26	853.3	19.97	18.02	88.05	83.54	10.51
CoPant 02217	105.6	184.9	1.98	886.7	20.03	17.91	89.37	65.54	8.16
CoLk 5202	88.01	214.3	2.29	1035.5	18.92	16.81	88.74	78.75	9.18
CD (P=0.05)	9.02	12.41	0.18	65.28	NS	NS	NS	5.70	0.45
Fertility levels (NPK kg ha^{-1})									
112.5, 45, 45	98.1	192.3	2.12	857.8	20.01	18.12	89.44	70.44	8.93
150, 60, 60	100.2	212.3	2.18	937.8	19.58	17.38	88.66	78.29	9.43
187.5, 75, 75	100.0	203.6	2.22	980	19.34	17.24	89.06	79.10	9.47
CD (P=0.05)	9.02	12.41	0.18	65.28	NS	NS	NS	5.70	0.45
Summer crop**									
Genotypes									
CoLk 9709	93.69	187.1	2.17	842.2	20.74	18.72	90.22	66.05	8.63
CoPant 02217	95.49	183.4	2.06	702.2	20.43	18.58	90.65	63.13	8.22
CoLk 5202	54.28	190.3	2.46	915.6	18.51	15.97	87.30	47.08	5.14
CD (P=0.05)	7.74	10.64	0.26	72.7	0.78	1.05	2.92	4.60	0.35
Fertility levels (NPK, kg ha^{-1})									
112.5, 45, 45	75.17	180.7	2.15	788.9	20.08	17.98	90.28	55.78	6.98
150, 60, 60	83.63	188.7	2.23	817.8	19.96	17.82	89.11	58.39	7.23
187.5, 75, 75	85.93	191.6	2.30	853.3	19.63	17.46	88.78	62.11	7.52
CD (P=0.05)	7.74	10.64	0.26	72.70	0.78	1.05	2.92	4.60	0.35

*Planting date: 08-02-2009 Harvesting date: 10—3-2010; **Planting date: 10-04-2009 Harvesting date: 12-3-2010

T_3 closely followed by T_2 (107.6 and 108.5 thousand ha^{-1}). The highest cane yield of plant crop (79.0 t ha^{-1}) and ratoon cane (76.6 t ha^{-1}) was recorded in T_5 closely followed by T_4 (77.5 t ha^{-1} in plant and 76.2 t ha^{-1} in ratoon). 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 crop. The organic carbon content was highest and equal in T_2 and T_3 (0.55%) after harvest of plant crop but at the harvest of ratoon crop, it was highest in T_3 (0.66%) followed by T_2 (0.65%) against initial value of 0.37% (Table 2.2). Soil fertility status in terms of available N, P and K contents was maintained in all the organic nutrition modules after harvest of sugarcane plant-ratoon crop.

Table 2.2: 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	99.5	100.5	74.0	71.0	0.48	0.48
T_2	107.6	108.4	72.7	73.8	0.55	0.65
T_3	108.0	108.9	73.4	74.0	0.55	0.66
T_4	102.0	102.5	77.5	76.2	0.52	0.64
T_5	101.3	101.7	79.0	76.6	0.50	0.54
C.D. (0.05)	6.46	5.71	2.76	3.34	-	-
Initial value	-	-	-	-	0.37	-

Effect of covered pit planting and covered trench planting 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. Sugarcane was planted during February, 2009. Significantly higher germination (49.3%) was recorded under CPP over control which was closely followed by trench planting. Number of millable canes was highest under covered trench planting system (154.3 thousand ha^{-1}). However, significantly highest cane yield (98.7 t ha^{-1}) was recorded from covered pit planting. The magnitude of increase in yield in CPP was 11.5% over RPP normal. Planting after deep disc (DDP) recorded cane yield (81.2 t ha^{-1}) being 18.2% higher than conventional method of planting.

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 on soil physico-chemical conditions and sugarcane yield. The treatments consisted of 5 sub-soiling treatments and two preparatory tillage. The experimental design was strip plot design with three replications.

Sugarcane variety CoSe 92423 was taken for the experiment. Sub-soiling upto 45-50 cm depth was done with tractor-mounted sub-soiler. Higher infiltration rate (4.69 mm hr^{-1}) and lower bulk density (1.33 M m^{-3}) were recorded under cross sub-soiling at 1.0 m distance. Germination was not affected by tillage treatments while cross sub-soiling at 1.0 m distance recorded significantly highest shoot population (231.3 thousand ha^{-1} at 180 DAP), number of millable cane (176.7 thousand ha^{-1}), cane (86.9 t ha^{-1}) and sugar yield (9.60 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)

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 2.3). This trend reflected to the growth and yield of cane. Accordingly the cane yield of 3-bud setts planting (69.55 t ha^{-1}) was significantly higher to 2-bud (61.74 t ha^{-1}) and 1-bud (53.52 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 GA_3 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.

sprouting, root growth and plant vigour by altering some of the key biochemical attributes essential for the early growth and better establishment of bud chips under field conditions. Reducing sugars contents and

Table 2.3: Effect of sett size, seed rate and sett treatment on growth and seed cane yield of sugarcane

Treatments	Germination (DAP)			No. of tillers (DAP)			NMC (000/ha)	Cane yield (t/ha)	CCS (%)
	30	45	60	120	150	180			
(A) Sett size									
1-bud	11.62	20.23	27.62	146	168	129	97	53.52	11.33
2-bud	20.44	30.68	34.60	160	181	141	113	61.74	11.40
3-bud	29.30	33.72	39.32	181	202	156	121	69.55	11.38
CD (P=0.05)	7.44	2.86	5.81	11.38	10.62	9.44	7.09	4.82	NS
(B) Seed rate									
75%	20.52	29.33	33.92	157	176	152	103	63.33	11.40
100%	20.39	27.09	33.77	168	191	163	118	68.88	11.34
CD (P=0.05)	NS	NS	NS	8.42	12.25	9.41	12.20	3.75	NS
(C) Sett treatment									
Bavistin	23.08	32.62	37.42	170	190	164	119	68.41	11.36
Bav.+GA_3	17.83	24.00	30.27	155	177	151	102	63.80	11.38
CD (P=0.05)	4.18	6.88	5.91	11.85	11.82	10.90	12.66	4.06	NS

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

Bud chips stored in polyethylene bags after fungicide treatment and kept at low temperature conditions (10 ±1°C) exhibited about 80% bud germination after 10 days of storage than one stored at room temperature (about 40%). Similarly, plant vigour index was low in room temperature stored bud chip seed stocks.

Bud chip seed stocks soaked in different growth promoting chemicals viz., ethephon T_1, calcium chloride T_2, salicylic acid T_3 and their mixture T_4 (Plate 2.1) for 24 hr exhibited germination improvement over control; improvement was highest with T_4 treatment under field conditions (Plate 2.2).

Pre-planting soaking in growth promoting chemicals, *viz*., ethephon (0.1g l^{-1}) and calcium chloride (1g l^{-1}) helped in enhancing bud

Plate 2.1 : Bud chip seed stock

Plate 2.2 : Bud chip raised sugarcane crop

activity of acid invertase and ATPase enzymes of sprouted buds exhibited significant positive correlation with bud sprouting and plant vigour index

2.2 Ratoon management in sugarcane

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

The ratoon of early variety of sugarcane (CoS 96268) was initiated during first week of January 2009 and all the treatments (Table 2.4) were applied at the time of ratoon initiation. Application of SPMC (alone) at 20 t ha^{-1} or 10 t ha^{-1} SPMC along with 25 kg $ZnSO_4$ ha^{-1} significantly improved the bud sprouting and resulted in highest production of shoots (292000 ha^{-1}) over control (276000 ha^{-1}). Highest number of millable canes (110000 ha^{-1}) and cane yield (72.0 t ha^{-1}) were recorded with the application of SPMC at 20 t ha^{-1} (alone). These results were comparable with the treatment of 10 t ha^{-1} SPMC + 25 kg $ZnSO_4$ ha^{-1}. This clearly suggested that productivity of winter ratoon can be enhanced through application of either 20 t SPMC ha^{-1} (alone) or 10 t SPMC ha^{-1} + 25 kg $ZnSO_4$ ha^{-1}. None of the treatments could affect the quality of cane (pol %).

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

Improving sprouting of stubble buds

Post-harvest application (to the freshly harvested stubble) of formulation containing mixture of vitamins (500 ppm); potassium nitrate (0.1%); Five Phos, a biochemic drug (100 ppm) and Ethrel (500 ppm) enhanced sprouting of winter-initiated second ratoon in sugarcane

Table 2.4: Effect of treatments on number of shoots, NMC, cane yield and pol % juice of winter started ratoon (2009-10)

Treatment	Number of shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
T_1-Recommended practice (control)	276.0	97.6	60.3	16.9
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.)	278.0	100.0	61.0	17.0
T_3-Application of sulphitation pressmud cake (fresh) @ 20 t ha^{-1} at ratooning	292.0	110.0	72.0	17.0
T_4-Application of 60 kg K_2O ha^{-1} before 30 days of ratooning	280.0	98.6	61.3	16.6
T_5-Intercropping of legume, Senji *(Melilotus alba)*, in ratoon for green manuring	282.0	99.0	62.6	17.1
T_6-Soil application of $ZnSO_4$ @ 25 kg ha^{-1} before 30 days of ratoon initiation	281.0	98.3	62.0	17.1
T_7-Soil application of 60 kg K_2O+ 25 kg $ZnSO_4$ ha^{-1} 30 days before ratooning with irrigation	279.0	99.6	62.3	16.7
T_8-Soil application of 25 kg $ZnSO_4$+ SPMC (fresh) @ 10 t ha^{-1} at ratoon initiation	290.0	108.6	70.0	16.9
C.D. at 5%	8.05	4.60	3.67	NS

SPMC – Sulphitation Pressmud Cake; NMC - Number of millable cane; NS - Not significant

variety CoSe 92423. Improvement (% increase) in maximum number of tillers produced (Tmax) in the all the treatments was 76.78, 61.11, 33.05 and 8.9%, respectively; in number of millable canes (NMC), it was 35.93, 11.56, 10.62% and nil, respectively; and in cane weight, it was 54.58, 26.15, 19.26 and 16.26%, respectively.

Sprouting of winter-initiated ratoon

Sprouting in winter-initiated ratoons, in variety CoSe 92423, during 2009-10 was relatively lesser (1553 shoots / 100 m^2) as compared to the last year, *i.e.*, in 2008-09 (3587 shoots / 100 m^2). It appeared to be due to prevalence of relatively lower maximum and minimum temperatures during 2009-10 as compared to 2008-09. This was also reflected in terms of degree days from December to February (*i.e.*, 49th to 9th Met. Week). The cumulative degree days were 553 during 2009-10 as compared to 682.15 during 2008-09.

Threshold value of auxins for sprouting of sugarcane buds

Attempts were made to alter the concentration of auxin levels in buds by detopping, placing cotton swab soaked in auxin (IAA) in the spindle of the leaves, soaking cut setts in auxin (IAA) solution and drilling hole with cork borer and placing auxin solution in absorbent cotton plug in the hole. Influence of these treatments was studied on germination to work out the threshold value of auxins for germination.

In buds from detopped canes, auxin contents were relatively lower than the control. Other treatments like placing cotton swab soaked in auxin (IAA) in the spindle of the leaves, soaking cut setts in auxin (IAA) solution and drilling hole with cork borer and placing auxin solution in absorbent cotton plug in the hole were given to alter IAA levels. Most of the treatments, except for soaking in IAA (500 mg / l) for 24 hrs did not significantly influence germination. Soaking single bud setts in IAA(500 mg / l) retarded germination and the buds which did not sprout contained relatively higher concentration of auxins (160-190 µ / g of IAA). This concentration appears to be the closest to the threshold value required to retard germination in sugarcane (variety CoSe 92423).

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

Field experiment was started in spring 2003 with the objectives to evaluate the efficacy of different biomanures on yield and quality of sugarcane under plant and subsequent ratoons and to study the changes in physical, chemical and biological properties of soil on long term basis. The highest cane yield of 6th ratoon (60.0 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 2.5). This was followed by SPMC (57.5 t ha^{-1}) and FYM + *Gluconacetobacter* (55.0 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 due to the different treatments.

Soil organic carbon content ranged between 0.64 to 0.69% under different treatment of biomanuring, over its initial value of 0.32%.

Soil microbial activities enhanced due to different biomanurial treatments. The highest value of soil microbial biomass carbon (SMB-C) of 272.70 mg CO_2-C / kg soil was recorded under plots receiving SPMC + *Gluconacetobacter* against initial value of 47.60 mg CO_2-C / kg soil.

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

The gaps in the first ratoon crop (second crop cycle) of sugarcane (CoSe 92423) decreased progressively from 28.40 to 8.60% when raised with increasing planting density from 30,000 to 60,000 three-bud setts / ha (Table 2.6). 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. Gap filling in plant cane with 3-bud setts at 45 DAP produced 82.52 t / ha ratoon cane being 14.06% more than that obtained without gap filling (70.92 t / ha). Application of 80 kg K / ha through irrigation water in plant cane before one month of harvesting produced significantly higher ratoon cane yield to the tune of 13.11%

Table 2.5: NMC, cane yield, soil organic carbon and microbial biomass carbon (SMBC) of 6th ratoon under different biomanurial treatments

Treatments	NMC ('000ha^{-1})	Cane length (cm)	Cane yield (t ha^{-1})	Organic C (%)	SMBC (mg CO_2-C kg^{-1} Soil)
T_0 - Control	53.4	102.0	18.5	0.37	161.45
T_1-Trash 10 t ha^{-1} +*Trichodarma*	61.5	126.3	35.1	0.64	168.00
T_2-Vermicompost @ 10 t ha^{-1}	80.0	138.5	54.0	0.64	247.30
T_3– FYM @ 10 t ha^{-1}	81.1	136.0	54.9	0.65	248.10
T_4- Biogas slurry @ 10 t ha^{-1}	80.5	135.6	54.4	0.65	236.40
T_5– SPMC @ 10 t ha^{-1}	85.3	145.5	57.5	0.69	269.1
T_6- T_1+ *Acetobacter*	60.4	126.3	37.4	0.64	270.50
T_7- T_2+ *Acetobacter*	80.1	138.6	54.2	0.65	251.90
T_8- T_3+ *Acetobacter*	81.1	136.1	55.0	0.65	254.40
T_9- T_4+ *Acetobacter*	80.5	135.6	54.5	0.65	251.50
T_{10}- T_5+ *Acetobacter*	85.6	146.0	60.0	0.69	272.70
T_{11} – *Dhaincha*+*Acetobacte*r	78.7	136.0	51.5	0.65	162.00
T_{12} – NPK (120:60:60 kg ha^{-1})	75.0	138.4	51.0	0.49	140.00
C.D. (0.05) / Initial	5.56	6.33	4.36	0.32	47.60

Table 2.6 : Effect of seed rate, gap-filling and K application followed in planted sugarcane on the growth and yield of first ratoon of second crop cycle

Treatments given in planted sugarcane	Effect on first sugarcane ratoon of second crop cycle					
	No. of clumps (000 ha^{-1})	Gaps (%)	No. of shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (%)
(A) Seed rate (3-bud setts ha^{-1})						
30,000	21.88	28.40	239	108	64.13	11.35
40,000	24.27	2.125	262	116	72.44	11.29
50,000	28.30	16.60	281	124	81.80	11.40
60,000	32.42	8.60	305	131	88.50	11.38
CD (P = 0.05)	3.09	4.60	18.47	6.55	6.42	NS
(B) Gap filling						
No gap filling	24.57	17.00	264	114	70.92	11.36
Gap filling with 3-bud setts at 45 DAP	28.87	20.40	280	126	82.52	11.35
CD (P = 0.05)	3.53	2.80	14.52	9.92	7.55	NS
(C) K application						
No K	24.26	17.30	266	115	71.34	11.30
80 kg K ha^{-1} through irrigation water before one month of plant cane harvesting	29.18	20.10	278	125	82.10	11.41
CD (P = 0.05)	4.62	2.40	10.56	8.56	8.29	NS

over no K application in plant cane (71.34 t ha^{-1}). The CCS% cane did not yield any significant difference due to different treatments in the study.

Similarly, the gaps in the second ratoon crop (1st crop cycle) of sugarcane (CoSe 92423) also decreased progressively from 39.70% to 11.50% when raised with increasing planting density from 30,000 to 60,000 three-bud setts ha^{-1} (Table 2.7). 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 cane with 3-bud setts at 45 DAP produced 74.64 t ha^{-1} ratoon cane being 13.04 % more than that obtained without gap filling (64.91 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 yield to the tune of 12.07% over no K application in plant cane (62.20 t ha^{-1}). CCS% cane did not yield any significant difference due to different treatments in the study.

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

The rhizospheric environments of simultaneously initiated plant, ratoon I and ratoon II crops were assessed for changes in soil physical, chemical and biological properties which were recorded at monthly intervals during the crop cycle. Ratooning had adverse effects on the rhizospheric environment, the root properties and physiological attributes. There was a significant increase in the soil compaction of the ratoon II crop as evidenced by the bulk density.

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

Treatments given in planted sugarcane	Effect on second sugarcane ratoon of first crop cycle					
	No. of clumps (000 ha^{-1})	Gaps (%)	No. of shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (%)
(A) Seed rate (3-bud setts/ha)						
30,000	18.52	39.70	211	101	58.38	11.35
40,000	22.77	27.80	242	109	66.85	11.40
50,000	25.28	20.40	272	118	73.45	11.37
60,000	27.81	11.50	291	127	80.41	11.42
CD (P = 0.05)	2.30	6.40	18.40	6.40	2.86	NS
(B) Gap filling						
No gap filling	21.85	22.40	245	108	64.91	11.38
Gap filling with 3-bud setts at 45 DAP	25.35	27.30	263	120	74.64	11.39
CD (P = 0.05)	3.80	4.50	15.25	10.32	8.55	NS
(C) K application						
No K	21.95	22.50	247	109	65.20	11.37
80 kg K ha^{-1} through irrigation water before one month of plant cane harvesting	25.25	27.20	261	119	74.15	11.40
CD (P = 0.05)	3.65	4.38	12.33	8.80	7.67	NS

The bulk density increased from 1.38 Mgm^{-3} in plant crop to 1.47 Mgm^{-3} in ratoon II crop. This led to significant decline in soil water content (15%), infilteration rates (18%), hydraulic conductivity (48%) and soil aggregate index (35 %) of ratoon II soil. There was an increasing trend in the soil organic content (SOC) in successive ratoon crop as compared with the plant crop but no significant change in the soil NPK contents were observed. The soil respiration and the soil microbial biomass contents were enhanced in ratoon crops compared to the plant crop. There was a significant increase in total sugars, sucrose and reducing sugars in ratoon II crop as compared to the plant crop. Ratooning also induced decline in pH, elevation in total phenols and organic acids. The CEC of roots in the ratoon II crop depressed by 28% compared with the plant crop and membrane permeability was increased in ratoon II by 38%. The NR activity *in vivo* decreased by 62% in ratoon II than plant crop. The number of clumps reduced by 16%, number of tillers by 45% where as leaf area per plant decreased by 61% in ratoon II compared with the plant crop. The numbers of root hairs per cm length decreased by 50% in ratoon II compared with plant crop. The NPK uptakes were lesser by 49, 59 and 56%, respectively in ratoon II as compared to the plant crop, causing a significant decline (49%) in dry weight per plant.

2.3 Crop management for improving physiological efficiency and sucrose content

Improving physiological efficiency of ratoon cane (Exp. Trial)

Since tiller numbers contribute significantly in yield potential of ratoon cane but mortality of tillers (50-60%) and reduced cane weight reduce the overall productivity of ratoon. To improve it, spray of Indole-3-acetic acid, kinetin (6-furfuryl amino purine) and gibberellic acid (GA_3) treatments (100 m mol m^{-3}) were made 30 days after ratoon initiation on foliage (5 ml/plant). The response of the hormones were studied on growth, development, assimilate concentration, tiller number and cane weight in variety CoSe 92423. The treatment of kinetin was effective in reducing the tiller mortality by 10% and increased cane weight by 30%. It also reduced the production of late tillers significantly. The kinetin application improved the concentration of proteins, pigments (chl a and chl b), decreased the lipid per oxidation and improved the soluble carbohydrate in leaf lamina which helped in the survival of tillers.

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

Study of sucrose accumulating tissues to improve sucrose contents

Storage tissue of six sugarcane varieties was assayed for the potential to absorb sugar from 2% sucrose solution. The storage tissue of high sucrose accumulating (HSA) varieties absorbs more sugar from the external solution than that of low accumulating varieties. The differences in uptake resulted largely from differences in the initial uptake of sucrose which was higher in HSA. Within varieties, passive uptake was more from older than younger internodes. The ability of the storage tissue of sugarcane to accumulate sugar *in vitro* may be related to potential sucrose content of the varieties.

Differential labeling of tillers

Differential label of tillers (made up of mild steel wire) were placed in autumn plant crop of variety CoSe 92423 at 45 and 60 days after planting to study tiller dynamics and its impact of sugarcane yield.

Physiological perturbation in source-sink relationship

In order to perturb the extension rate of plants, the treatment of GA, IAA and cytokinin was made in sugarcane variety CoSe 92423. The extension rate was ten times higher due to GA treatment along with higher partitioning of dry matter in to the stalk. This was supported by enhanced activities of acid invertase, amylase, nitrate reductase, protease enzymes and concentration of soluble carbohydrate in leaf tissues of GA treated plants.

Improvement of germination to enhance early growth of sugarcane

Germination was the highest (109%) in sugarcane setts soaked for 24 hours in zinc sulphate solution (zinc 50 ppm) while

germination of sett soaked in water improved germination by 75.9% over the control.

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

Changes in sucrose phosphate synthetase (SPS), acid invertase, sucrose, sucrose and invert sugar ratio and juice quality parameters during ripening

SPS activity : Sucrose phospahate synthetase (SPS) activity in the middle portion of cane stalk was higher compared to top and bottom portions of stalk and was positively correlated with sucrose content.

Acid invertase activity : Soluble acid invertase enzyme was determined in upper, middle and lower portions of cane stalk at different stages of ripening period. It showed higher activity in upper portion except in the month of January in both the varieties. It showed a negative correlation with sucrose content.

Quality parameters during ripening process : Sucrose content increased gradually with ripening, highest sucrose content was observed in the month of February (about 16.74 percent) and lower in the November (12 per cent). Middle portion showed the highest sucrose concentration. Sucrose content in cane stalk showed a significant positive correlation with sucrose / reducing sugars ratio, SPS activity and negative correlation with reducing sugars contents. Reducing sugars gradually decreased with cane ripening, lowest level were recorded in the month of February. Reducing sugars ranged between 1.22% to 0.227% from the month of November to February, respectively. The purity of juice gradually increased during ripening phase; it was about 76% in the month of November and 88% in February. Middle portion showed highest juice purity.

Sucrose / reducing sugars ratio varied widely in different portions of cane stalk; it was very low (7.59) in top portion and highest in basal portion (12.07) in the month of November. Its average value increased significantly from 10.81 to 75 from November to February. Top portion showed highest S / R ratio in the month of February. S / R ratio showed significant positive correlation with sucrose content in cane juice.

Sucrose and juice quality parameters in sugarcane genotypes of varying maturity Twelve sugarcane genotypes were evaluated for sucrose content and juice quality attributes in different months.

Sucrose content increased gradually with cane ripening; its average concentration was about 14.5, 15.6, 16.4 and 17.8% in the months of Nov, Dec, Jan, and Feb, respectively. Sucrose content varied widely among different genotypes; it ranged from 12.93 to 17.10% , 13.77 to 17.3, 14.36 to 18.10 and 16.35 to 19.73% in the months of November, December, January and February, respectively. Highest sucrose content was observed in CoLk 94184 genotype in all the months.

Reducing sugars decreased gradually with cane ripening; its concentration was about 0.81, 0.75, 0.27 and 0.16% in the months of Nov, Dec, Jan and Feb, respectively. Among different genotypes, its concentration was in the range of 0.52 to 1.28%, 0.43 to 1.29%, 0.27 to 0.95% and 0.20 to 0.33% in Nov, Dec, Jan and Feb, respectively.

Sucrose / reducing sugars ratio (S / R ratio) markedly increased with cane ripening; it ranged from 19.95 (November) to 137.8 in the month of February. Among different genotypes, CoJ 64 showed highest S / R ratio in the month of January and February.

Resource management in sugarcane based cropping system

3.1 Nutrient management in sugarcane based cropping system

Optimising 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 and three nitrogen doses were laid out in factorial RBD with three replications.

The results obtained from second ratoon crop of sugarcane revealed that maximum cane yield (66.57 t ha^{-1}) was recorded in M_6 which was significantly higher than M_1 (59.39t ha^{-1}). The yield attributing characters e.g. millable cane, cane length, cane diameter and cane weight also showed the similar results (Table 3.1). Among the different N levels, maximum cane yield (66.07 t ha^{-1}) was observed in N_3 treatment (225 kg N ha^{-1}), which was at par (63.61 t ha^{-1}) 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 (0.62%) was observed with the application of 50% N through inorganic and 50% N through organic source (M_6) as compared to M_1 (0.55%) treatment. It indicated the improvement in soil fertility level due to application of organic source of N at higher rates as compared to inorganic source.

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

Treatment	Millable cane (000 ha^{-1})	Cane yield (t ha^{-1})	Cane length (cm)	Cane diameter (cm)	Cane wt (g)	Sugar yield (t ha^{-1})
A: Inorganic and organic combinations:						
M_1 100% N through inorganics	91.31	59.39	153.33	2.08	723.59	6.82
M_2 90% N through inorganics + 10% through organics	92.41	59.95	155.33	2.11	740.66	6.94
M_3 80% N through inorganics + 20% through organics	94.56	61.19	158.67	2.15	762.47	7.13
M_4 70% N through inorganics + 30% through organics	96.99	62.59	161.67	2.20	777.17	7.41
M_5 60% N through inorganics + 40% through organics	99.41	64.35	166.33	2.27	789.4	7.66
M_6 50% N through inorganics + 50% through organics	102.49	66.57	172.33	2.33	809.07	8.01
CD (P=0.05)	6.10	4.86	10.87	0.11	26.40	0.96
Nitrogen (kg ha^{-1})						
N_1 75	85.03	57.34	147.80	1.99	695.04	6.65
N_2 150	100.05	63.61	164.00	2.27	788.65	7.61
N_3 225	104.41	66.07	172.00	2.31	817.48	7.74
CD (P=0.05)	4.52	3.42	7.60	0.07	18.90	0.66

Assessing physical parameters and fertility status of soil of fields of IISR Farm, Lucknow (C 18.3)

Representative soil samples were collected from different depths (0-15 cm, 15-30 cm and 30-45 cm) from all fields of the farm. Samples were analysed for physical parameters and soil fertility status for available nutrients. The results on status of properties are summarized as under.

Physico-chemical properties : The soils of farm are loam to sandy loam in texture, moderate in surface and sub-surface compaction and moderate to slow for infiltration. The soils are non-saline, non-calcareous and normal in reaction. Organic carbon content ranged from 0.40 to 0.65 percent indicating status rating as low for soil of B and C Block and medium for soils of other blocks.

Macronutrients: The contents of macronutrients in surface soil indicated that the available N varied from 273 to 281 kg ha^{-1} showing medium status for soil of F-Block and low status for soil of other blocks. Available P_2O_5 content ranged from 16.2 to 35.6 kg ha^{-1}. The status was low in soils of B and C-Block and medium in soils of other blocks. Available K_2O ranged from 232 to 254 kg ha^{-1} indicating medium status in soil of all blocks. The nutrients were more in surface layer and showed decreasing trend with depth.

Micronutrients : The contents of micronutrients (mg kg^{-1}) showed variation within and among the soil of different blocks. The content in surface soil (mg kg^{-1}) showed variation from 0.51 to 0.89 for Zn, 1.66 to 1.98 for Cu, 4.36 to 9.20 for Mn and 7.82 to 13.03 for Fe. According to critical limits, the farm soil had sufficient content of all micronutrients. The soil of B-Block was deficient in Zn content only. The surface soil in general contained more amount of nutrients.

Studies on Soil-Crop-Weather data set for simulation of MOSICAS sugarcane growth model with reference nitrogen nutrition (Expl. Trial)

Field experiment was conducted for generating Soil-Crop-Weather related parameters with reference to nitrogen nutrition to run the MOSICAS sugarcane growth model. The treatment consisted of five nitrogen levels viz. 0. 75, 150, 225, 300 Kg N ha^{-1} allocated in Randomized Block Design with six replications. The experiment was initiated during the month of February, 2009 (Spring season). Sugarcane variety CoSe 92423 was planted on 14-02-2009. Recommended doses of P and K (60 kg ha^{-1}) were applied as basal and nitrogen was applied as per the treatment. Apparently highest number of tillers (221.3 thousand ha^{-1}) at 120 DAP, NMC (159.4 thousand ha^{-1}), and cane yield (99.3 t ha^{-1}) was recorded under the treatment of 300 kg N ha^{-1}. However, CCS yield was highest with 225 kg N ha^{-1} (Table 3.2).

Table 3.2 : Effect of varying N levels on growth and yield of sugarcane

Treatment	Germination at 30 DAP (%)	No. of tillers at 120 DAP ('000 ha^{-1})	NMC (000 ha^{-1})	Yield (t ha^{-1})	CCS (t ha^{-1})
N levels					
0	34.60	112.27	90.27	40.21	4.85
75	33.70	158.24	112.34	59.21	6.93
150	35.24	179.34	139.37	74.27	8.34
225	34.21	218.24	147.34	88.29	9.86
300	35.21	221.26	159.37	99.27	9.75
CD at 5%	NS	12.26	12.46	8.46	1.63

3.2 Water management in sugarcane based cropping system

Developing efficient water application techniques in sugarcane (A 1.2.27)

Field experiment is under progress to study the WUE of different planting methods and to find out the most water use efficient

planting method of sugarcane. The experiment consisted of 10 treatments *viz*. T_1-Paired row planting (120-30 cm) and irrigation in furrows parallel to both the cane rows (15 cm apart from sugarcane row), T_2-Paired row planting (120-30 cm) and irrigation in furrows parallel to single row (15 cm apart from sugarcane row) of paired rows, T_3-Furrow planting at 75 cm row spacing and irrigation in furrows of the cane rows, T_4-Furrow planting at 75 cm row spacing and irrigation in furrows opened in the middle of two cane rows, T_5-Furrow planting at 75 cm row spacing and irrigation in skip furrows opened in the middle of two cane rows (skip furrow irrigation method), T_6-Furrow planting at 75 cm row spacing and irrigation in alternate skip furrows opened in the middle of two cane rows (alternate skip furrow irrigation method), T_7-Irrigation in deep trench- sugarcane planted at 120-30 cm, T_8-Irrigation in furrows - sugarcane planted under FIRB system, T_9-Flood irrigation(conventional)–Furrow planting (75 cm), T_{10}-Flood irrigation (conventional)–Paired row planting(120-30 cm). The experiment was laid out in Randomised Block Design with three replications. The planting of the experiment was done on 14-02-10. The experiment is progressing well and initial soil and crop growth data were recorded.

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

The experiment comprising 9 treatment combinations (three planting methods viz., conventional planting (at 75 cm row spacing), paired row planting (at 30:120 cm row spacing) and FIRB method (75 cm row spacing), and three irrigation schedules viz., irrigation at IW / CPE ratio of 0.50, 0.75 and 1.00), was layout in RBD (factorial) with three replications. The soils of the experimental field was sandy loam in texture with slow infiltration rate (1.2 cm hr^{-1}) and bulk density of 1.43 g / cc and can hold 17.2 and 6.49 per cent moisture at field capacity and permanent wilting point, respectively. The soil was low in organic carbon (0.39 %) and available nitrogen (207.8 kg ha^{-1}), medium in phosphorus (25.4 kg P_2O_5 ha^{-1}) and potassium (227.6 kg K_2O ha^{-1}). In all, 4, 6 and 8 irrigations of 8 cm each were given in pre-monsoon period in the treatments of irrigation at IW / CPE ratio of 0.50, 0.75 and 1.00, respectively and one irrigation was applied in the post-monsoon period in all the treatments. A total of 996.8 cm of rainfall was received during the crop season.

The experimental results (Table 3.3) reveal that the germination was significantly higher in sugarcane planted under FIRB method (47.9%) compared to conventional (38.4%) and paired row planting (36.7%) methods. Consequently the tiller count recorded in the month of May was also significantly higher under FIRB method (97.9 thousand ha^{-1}) over other two methods (average value=83 thousand ha^{-1}). However, in the month of June and July, tillering was higher in conventional and paired row planting methods over FIRB planting method but could not result into higher NMC. The cane yield was almost equal in all the planting techniques as a result the irrigation water use efficiency was also almost same. Yield attributing characters viz., NMC, length, girth and weight of cane and cane quality parameters were not affected by planting techniques.

Application of irrigation at IW / CPE ratio of 0.75 significantly enhanced tillering in sugarcane over irrigation at IW / CPE ratio of 0.50 (Table 3.3). The yield attributing characters i.e. cane length, cane girth, cane weight and number of millable canes were significantly higher in the treatment of irrigation at IW / CPE ratio of 0.75 over irrigation at IW / CPE ratio of 0.50, hence resulted in higher cane yield. Cane yield in the treatment of irrigation at IW / CPE ratio of 0.75 was 70.44 t ha^{-1} and was significantly higher over irrigation at IW / CPE ratio of 0.50 (62.63 t ha^{-1}). The application of irrigation at IW / CPE ratio of 1.00 could not enhance the tillering, yield attributing characters and cane yield over irrigation at IW / CPE ratio of 0.75. The cane quality parameter i.e. brix, sucrose % and purity % were not affected by irrigation levels. The irrigation water use efficiency was higher (1.57 t ha^{-1} cm) at low irrigation level i.e. irrigation at IW / CPE ratio of 0.50 and it was reduced to 1.26 and 1.01 t ha^{-1} cm in the treatment of irrigation at IW / CPE ratio of 0.75 and 1.00, respectively.

Table 3.3 : Response of sugarcane to irrigation levels under different planting methods

Treatments	Germination (%)	Tiller count (000 ha^{-1})				Sugarcane yield attributes				Cane yield (t ha^{-1})	Irrigation water use efficiency (t ha cm^{-1})	Juice quality parameters		
		May	June	July	Aug.	Length (cm)	Girth (cm)	Weight (g)	NMC (000 ha^{-1})			Brix	Sucrose (%)	Purity (%)
Planting methods														
CP	38.4	82.8	177.7	193.1	163.1	204.7	2.31	842	88.85	69.44	1.29	18.9	16.7	88.1
PR	36.7	83.1	180.1	184.8	150.3	199.8	2.29	837	84.93	67.84	1.26	18.8	16.6	88.1
FIRB	47.9	97.9	148.1	152.4	132.4	201.9	2.32	852	84.20	68.29	1.28	19.1	17.0	88.8
SEM ±	1.5	3.1	5.1	4.8	4.2	3.1	0.04	7.1	2.80	1.65		0.2	0.2	0.5
CD (P=0.05)	4.6	9.4	15.4	14.3	12.6	NS	NS	NS	NS	NS		NS	NS	NS
Irrigation schedule (IW/CPE ratio)														
0.50	41.6	85.8	161.7	163.4	138.4	194.7	2.30	819	78.73	62.63	1.57	18.9	16.8	88.4
0.75	40.4	86.4	165.6	180.1	153.1	205.7	2.30	852	88.39	70.44	1.26	19.2	17.0	88.6
1.00	41.0	91.7	178.5	186.9	154.1	206.1	2.32	860	90.86	72.49	1.01	18.7	16.5	88.1
SEM ±	1.5	3.1	5.1	4.8	4.2	3.1	0.04	7.1	2.80	1.65	-	0.2	0.2	0.5
CD (P=0.05)	NS	9.4	15.4	14.3	12.6	9.7	NS	21.3	8.4	4.95	-	NS	NS	NS

Note : CP = Conventional planting, PR = Paired row planting, FIRB = FIRB method

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 was recorded with 8 cm depth of irrigation water applied at 1.00 IW / CPE ratio. Irrigation water use efficiency (IWUE) was the highest with 6 cm depth of irrigation water applied at 0.5 IW / CPE ratio. For spring initiated ratoon crop, highest yield was recorded with 8 cm depth of irrigation water applied at 1.00 IW / CPE ratio. However, irrigation water use efficiency (IWUE) was the highest 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 1/06)

FIRB system (FIRBS) of planting increased production of economic bio-mass, irrigation water use efficiency and benefit cost ratio. Highest total gross returns of Rs. 320870 per hectare were obtained when sugarcane was planted in furrows spaced at 90 cm row to row and in between sugarcane rows, two rows of potato were planted at a spacing of 45 cm on

Fig. 8 : Tractor drawn sugarcane-cum-potato planter

raised bed. However, the highest benefit cost ratio of 2.46 was obtained when sugarcane was planted in furrows spaced at 75 cm row to row and in between sugarcane rows, one row of potato was planted on raised bed. Irrigation water use efficiency for potato-sugarcane cropping system was higher when sugarcane was planted in furrows spaced at 75 cm row to row and in between sugarcane rows, one row of potato was planted on raised bed. One tractor drawn sugarcane-cum-potato planter was also developed. The effective field capacity of the planter is 6 h / ha and saving in terms of money is Rs.11, 300 / ha.

3.3 Weed management in sugarcane based cropping system

Management of binding weeds in sugarcane (AS 62)

The treatment details are presented in Table 3.4.

The experimental field was infested with weeds like *Cyperus rotundus, Panicum repens, Cynodon dactylon, Convolvulus arevensis* (bind weed), *Partulaca oleracea, Dactyloctenium aegyptium, Brachaiaria ramosa and Chorchorus* sp. (Table 3.5).

Table 3.4: Treatment details

T_1	Weedy check
T_2	Hoeing at 30, 60 and 90 DAP
T_3	Atrazine 2 kg a.i. ha^{-1} (PE) - 2, 4-D 1 kg a.i. ha^{-1} at 60 DAP
T_4	Atrazine 2 kg a.i. ha^{-1} after 1st irrigation and hoeing 2, 4-D 1 kg a.i. ha^{-1} at 75 DAP
T_5	Metribuzine 1.25 kg a.i. ha^{-1} (PE) - 2, 4-D 1.0 kg a.i. ha^{-1} at 75 DAP
T_6	Metribuzine 2 kg a.i. ha^{-1} (PE) – Almix 20 g ha^{-1} at 75 DAP
T_7	Metribuzine 1.25 kg a.i. ha^{-1} (PE) – Almix 20 g ha^{-1} at 75 DAP
T_8	Atrazine 2 kg a.i. ha^{-1} (PE) – Ethoxysulfuron 50 g a.i. ha^{-1} at 75 DAP
T_9	Atrazine 2 kg a.i. ha^{-1} (PE) – Dicamba 350 g a.i. ha^{-1} at 75 DAP
T_{10}	Metribuzine 1.25 kg a.i. ha^{-1} (PE) – Dicamba 350 g a.i. ha^{-1} at 75 DAP

Table 3.5 : Weed density (species composition and number/m^2) before spraying and 120 days after spraying

Treat-ment	Weed number $(m^2)^{-1}$ before PE spraying								Weed number $(m^2)^{-1}$ at 120 DAP							
	Cr	Pr	Cd	Con	Co	Po	Da	Total	Cr	Pr	Cd	Con	Co	Br	Da	Total
T_1	133	43	27	6	21	11	21	262	173	27	24	8	20	21	24	273
T_2	59	0	21	5	0	0	0	85	75	8	0	6	0	3	3	95
T_3	134	21	16	0	0	0	5	176	90	4	8	0	0	13	4	119
T_4	133	27	0	0	0	0	5	165	70	8	1	0	0	16	0	95
T_5	135	21	5	5	5	0	0	171	43	1	0	5	0	16	3	68
T_6	117	11	27	5	0	0	11	171	91	0	8	0	0	13	0	112
T_7	140	5	11	11	5	0	0	172	85	5	0	0	0	12	0	102
T_8	101	11	43	0	0	0	0	155	37	0	63	0	1	12	0	113
T_9	125	16	21	0	0	0	0	162	101	0	7	0	0	11	0	119
T_{10}	124	21	11	12	5	0	0	173	81	13	12	0	0	14	1	120

All the weedicidal treatments were equally effective in controlling weeds and enhancing cane growth and yield (Table 3.6). Weedicides treated plots produced significantly higher number of cane shoots, millable canes, sugar and cane yield as compard to weedy check plots. However, controlling weeds by manual hoeings (3 hoeings at 30, 60 and 90 DAP) proved superior to chemical weeding with respect to weed control efficiency, cane shoot and millable cane population, cane and sugar yield.

Cane germination and juice quality did not differ significantly due to different treatments.

Presence of *Convolvulus arvensis* prior to treatment and absence of this weed after spraying of Almix / Dicamba (Table 3.5) indicated the effectiveness of these herbicides against this bind weed.

Table 3.6 : Cane germination, shoot population, number of millable canes, Pol % juice, cane and CCS yield under different treatments

Treat-ment	Germination (%)	Shoot population ('000 ha^{-1}) in June	NMC ('000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice	CCS (t ha^{-1})	Weed dry weight at 120 DAP (g/m^2)	WCE
T_1	35.3	134	64.2	38.9	16.77	4.57	307	-
T_2	35.5	212	97.8	69.9	16.85	8.13	27	91.2
T_3	35.4	177	90.7	58.5	16.85	6.76	128	58.3
T_4	34.5	184	87.1	55.9	17.40	6.72	108	64.8
T_5	35.2	183	87.6	60.8	17.29	7.31	111	63.8
T_6	34.5	188	82.8	59.2	17.03	7.13	119	61.2
T_7	36.5	181	94.1	62.5	17.59	7.63	122	60.3
T_8	35.0	185	84.4	61.7	17.03	7.26	128	58.3
T_9	35.9	180	85.2	64.2	17.53	7.83	127	58.6
T_{10}	35.5	178	93.3	58.0	17.02	6.78	125	59.3
CD (0.05)	NS	23	13.3	11.8	NS	1.28	20.5	6.9
Cv	10.9	10.8	9.3	11.5	2.5	10.7	-	-

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

4.1 Studies on *Saccharum* germplasm

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

Maintenance of sugarcane germplasm

A collection of 210 genotypes consisting of *S. officinarum*, *S. barberi*, *S. sinense*, ISH clones, IkshuISH clones, LG selections, commercial hybrids, etc was maintained and the required materials were supplied to various on- going projects of the Institute.

Evaluation of genotypes for quality attributes

For utilization as parents in the development of new sugarcane varieties with high cane and sugar yield and resistance/ tolerance to biotic and abiotic stresses, 25 IkshuISH clones were evaluated for quality parameters. Among the IkshuISH clones, IkshuISH 17 recorded the highest content of sucrose (16.2%) and CCS (11.20%) followed by IkshuISH 2 and IkshuISH 9.

Similarly, 19 ISH clones were evaluated for quality parameters. Among the ISH clones, ISH 164 had shown the highest content of sucrose (18.01%) and CCS (12.51%), followed by ISH 18 and ISH 134.

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

Station Trial

This trial evaluates the best genotypes with commercial merit resulting from different breeding projects of the Division as a prelude to varietal proposals for multi-location testing in the NW Zone under AICRP on Sugarcane. During the year under report, ten promising selections were under test along with early and mid-late maturing checks. The best cane yielders were LG 04602 and LG 04603, followed by LG 05447, LG 02434 and LG 04006. The first two, however, were very late in maturity. Two other genotypes, LG 4012 and LG 4079 were early maturing with high sugar but had low NMC and thus moderate yielders. Based on the results, LG 05447 (ML), LG 02434 (ML), LG 04006 (ML), LG 04602 (L) and LG 04012 (E) are potential entries for multi-location testing under AICRP(S) and UP State Varietal Testing.

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

This institute project has yielded till date 47 high sugar breeding stocks and many sugarcane varieties, which are at different stages of AICRP testing, including the recently released CoLk 94184. LG 95053, a high sugar breeding stock, has been registered with NBPGR. During the year under report, the salient achievements are as follows:

Crossing 2009 : 37 matings, including biparental crosses, general collections and selfs, were made at the National Hybridization Garden, SBI, Coimbatore during the 2009 crossing season.

Fluff raising and seedling transplanting : Over 2000 seedlings were established in the field from the matings attempted in 2008. These predominantly involved the breeding stock developed in this project.

Selection in C_1 generation : Based on early brix and other morphological traits, 307 genotypes were selected and planted in an un-replicated PVT with appropriate checks for further evaluation.

Progeny test of high sugar LG parents : LG 01118, LG 01016 and LG 99112 gave progeny with high mean brix %. LG 01118 was the leading parent with 58% selection for brix % in C_0 and over 70% selection rate from C_1 to C_2 and has the attributes of a desirable breeding stock.

Cross	No. of C_0 seedlings evaluated	Population mean	No. selected in C_0	Mean of selections	Selected from C_1 to C_2	Percent selection over C_0
LG 01118 GC	**224**	**18.51**	**130**	**19.57**	**92**	**41.07**
LG 99112 GC	242	17.63	76	19.26	48	19.83
LG 01016 GC	40	17.36	15	19.56	10	25.00

Selection in PVT : Sixteen clones with commercial attributes were promoted to AVT from PVT. Simultaneously, this material has been given for red rot testing.

Selection in AVT: Only two advance selections, LG 04099 and LG 05480 were included in the station trial, while some good performers with resistance to red rot showed susceptibility to wilt. The clones ear-marked as breeding stock are LG 05436, LG 05438, LG 05464, LG 05470 and LG 05480. It was noticed that wilt took a heavy toll of elite clones so much so that some of the red rot resistant clones could not be promoted. The sucrose content was also affected in wilt prone material.

Inclusion of a clone in AICRP (s)

LG 01030 (CoLk 09201), an early maturing clone was included in the AICRP (s) trials for the NW Zone. This was also included in the UP State Varietal Trials.

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

Hybridization

Six biparental crosses viz., Co 1158 x BO 91, Co 1158 x CoLk 8002, ISH-280 x ISH-23, BO 68 x ISH-287, CoLk 8102 x BO 91 and CoS 767 x CoS 96275 were attempted at SBI, Coimbatore and eight intergeneric hybrids viz., Awela-68 x IK 76-91, 28 NG-39 x IK 76-83, IK 76-56 x IK 76-158, IK 76-91 x Awela-68, IK 76-83 x 28 NG-39, IK 76-158 x IK 76-56, BO 91 x CoLk 94184 and CoLk 94184 x IK 76-81 at Distant hybridization facility, Agali.

Seedling evaluation

2600 seedlings derived from 6 crosses and 8 GCs were transplanted during 2010. One hundred seventy nine C1 clones derived from fourteen biparental crosses involving 4 intergeneric hybrids with *Erianthus* sp as male parent, 10 GCs and 4 selfs were evaluated for initial vigour, cane forming ability and HR Brix.

The genotypes free from natural infestation of top borer and other diseases and pests and above 21percent brix during January, 2010 were advanced to C_2 stage (Table 4.1).

Of 140 C_2 genotypes evaluated for top borer tolerance, general vigour and brix, 48 advanced to C_3 stage. Maximum selection of C_3 stage were from BO 91 x CoS 95255 (8) followed by CoLk 8102 x (Co 7201 x IND 84-466) (6). However none of progenies of two biparental crosses and 4 GCs could be advanced to C_3 stage.

Table 4.1: Range of traits under study for selected clones and population

S.N.	Attributes	Range of population	Range of selected clones
1.	N.M.C. (000 ha^{-1})	98 - 121	98 - 117
2.	Single cane wt (kg)	0.9 - 1.4	0.9 - 1.1
3.	HR Brix % in Nov'09	16.4 - 21.6	21.8 - 21.6
4.	HR Brix % in Jan'10	18.4 - 25.6	21.8 - 25.6
5.	Top borer infestation (%)		
	I brood	0.4 - 1.8	0.4 - 1.0
	II brood	1.2 - 10.9	1.2 - 4.9
	III brood	1.2 - 2.4	1.2 - 2.0
	IV brood	4.6 - 11.6	4.6- 6.6
	V brood	6.4 - 18.4	6.2 - 7.1

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 I and II brood, while 3.1 to 4.2 percent in IV to V brood 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. One clone viz., LG 05601possessing superiority in traits of economic importance was advanced to station trial (Table. 4.2). The 48 genotypes in C_2 and 28 in C_3 were evaluated for juice quality, cane yield and top borer tolerance, 16 were advanced to C_3 and 10 to C_4.

Five genetic stocks (Table 4.3) are under quarantine at Sugarcane Breeding Institute, Coimbatore for inclusion in "National Hybridization Garden"

Two genotypes viz., LG 04602 and LG 04603 were included in station trial of 2009-10. In addition, CoLk 04238, CoLk 05203 and CoLk 7201 are at different stages of testing in multilocation evaluation under AICRP (S) for north western zone. In addition, LG 2919 has been included in state varietal trials of UP.

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

Genotype proposed for multi-location testing

CoLk 09203 (LG 03702), an early maturing clone was accepted for multi-location testing under North-West Zone of AICRP (S) and UP State Zonal Varietal Trial during this period.

Hybridization and seedling raising

A total of 12 biparental crosses viz; CoS 8436 x CoSe 92423, CoS 96268 x Co 62198, CoS 8436 x SP 80-185, Co 89003 x CoSe 92423, Co 98014 x Co 94008, CoSe 92423 x CoS 8436, Co 1148 x Co 775, CoJ 83 x Co Pant 97222, CoPant 84212 x Co 62198, Co 96268 x BO 91, CP 52-1 x Co 86002 and CoJ 99192 x CoS 8436 were attempted at National Hybridization Garden, SBI, Coimbatore, during the crossing season 2009. The fluff received for all the crosses along with 15 GCs, was sown in the glass house to

Table 4.2: Features of advanced stage clone

Genotype	CCS (t ha^{-1})	Yield (t ha^{-1})	Pol% in Nov. '09	Top borer infestation (%)		Total carbohy-drate (mg/g fwt)	Reducing sugar (mg/g fwt)	Protein content (mg/g fwt)
				III rd brood	IV th brood			
LG 05601	9.79	83.39	16.56	4.00	10.00	32.40	8.50	15.30
CoJ 64	6.58	62.22	17.63	15.5	10.34	8.3	2.50	3.40
CoS 767	6.45	55.66	14.71	9.09	10.34	20.20	6.46	11.94
CD 5%	1.80	4.69	1.04	8.38	6.78	2.48	1.49	2.72
CV %	9.74	9.81	4.79	12.87	11.98	8.67	5.82	5.72

Table 4.3: Features of genetic stocks under quarantine at NHG

S. N.	Genetic stocks	Cane yield (t ha^{-1})	CCS %	CCS (t ha^{-1}) in Feb. '10	Top borer cumulative infestation (%)
1	LG 04601	84.2	10.91	9.18	4.38
2	LG 04602	88.6	10.94	9.69	7.32
3	LG 04603	74.3	10.70	7.95	6.92
4	LG 04604	92 / 3	10.4	9.59	9.42
5	LG 04605	72.8	9.11	7.99	3.67

raise the seedlings for evaluation. The fluff of the crosses as well as GCs sown in the glass house recorded good germination.

Seedlings evaluation

About 5060 seedlings raised from previous year crosses were transplanted in field condition. Observations were recorded on survival percentage and general growth vigour at early stage. However, the final selection will be carried out on basis of HR Brix and general growth performance of the individual clone.

Clonal evaluation

Based on the HR Brix and general growth performance, seventy nine clones (C_1 clones) were selected from the C_0 population (Table 4.4). These clones were planted along with two standards i.e. CoJ 64 and CoS 767 in field condition to evaluate further for quality, disease resistance and yield related traits especially for moisture deficit condition. Based on the sucrose % and general growth performance, 42 clones were promoted to the second clonal generation (C_2) for further evaluation (Table 4. 5). Of 42 clones promoted to C_2 generation, about 30 clones recorded more than 17 percent sucrose content in the month of December. Among the selected clones, LG 07720 had shown highest sucrose (18.54%), followed by LG 07785 and LG 07703.

Table 4.4: List of selected clones (C_1) and their parentage

LG Number	Parentage
LG 08701 to LG 08706	CoSe 98231 x Co 86249
LG 08707 to LG 08719	Co 88025 x CoT 8201
LG 08720 to LG 08726	Co 98010 x Co 94008
LG 08727 to LG 08736	Co 86032 x SP 80-3250
LG 08737 to LG 08747	Co 7201 x Co 62198
LG 08748 to LG 08753	Co 98010 x CoPant 97222
LG 08754 to LG 08760	CoJ 72 x CoSe 92423
LG 08761 to LG 08762	Co 8371 x Co 85002
LG 08763	LG 0118 x SP 80-150
LG 08764	CoS 8436 x Co 775
LG 08765 to LG 08771	CoJ 77 GC
LG 08772 to LG 08777	CoS 8432 GC
LG 08778	ISH 100 GC
LG 08779	CoJ 72 GC

Table 4.5: Sucrose percentage in C_1 clones promoted to next generation

S.N.	Genotype	Sucrose % (in December)	S.N.	Genotype	Sucrose % (in December)
1.	**LG 07701**	17.01	25.	**LG 07752**	17.10
2.	**LG 07703**	18.28	26.	**LG 07757**	18.10
3.	**LG 07704**	17.90	27.	**LG 07765**	15.10
4.	**LG 07705**	16.85	28.	**LG 07766**	17.11
5.	**LG 07706**	15.77	29.	**LG 07768**	16.89
6.	**LG 07707**	14.31	30.	**LG 07771**	18.06
7.	**LG 07708**	17.08	31.	**LG 07773**	17.25
8.	**LG 07710**	13.82	32.	**LG 07775**	16.11
9.	**LG 07711**	17.03	33.	**LG 07776**	18.17
10.	**LG 07713**	17.20	34.	**LG 07777**	18.08
11.	**LG 07715**	17.96	35.	**LG 07782**	17.70
12.	**LG 07720**	18.54	36.	**LG 07783**	18.15
13	**LG 07721**	17.80	37.	**LG 07785**	18.46
14.	**LG 07722**	17.25	38.	**LG 07786**	16.26
15.	**LG 07724**	16.07	39.	**LG 07787**	16.90
16.	**LG 07725**	17.96	40.	**LG 07788**	17.34
17.	**LG 07726**	17.40	41.	**LG 07791**	17.70
18.	**LG 07727**	17.10	42.	**LG 07794**	17.55
19.	**LG 07734**	17.08	43.	**CoS 767**	17.06
20.	**LG 07743**	16.15	44.	**CoJ 64**	18.01
21.	**LG 07747**	16.70			
22.	**LG 07748**	16.98		**Mean**	**17.11**
23.	**LG 07750**	18.16		**SE**	**0.16**
24.	**LG 07751**	15.38		**Range**	**13.82-18.54**

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

Inclusion of clone in AICRP (S)

CoLk 09202 (LG 05031), an early maturing clone and CoLk 09204 (LG 04043), a mid-late clone, were accepted for multi-location testing under North-West Zone of AICRP(S) and UP State Zonal Varietal Trial. Four clones namely LG 99270, LG 06004, LG 06011 and LG 06021 were advanced to Station Trial.

Hybridization

Eleven bi-parental crosses (Co 1148 x CoSe 92423, Co 1148 x Co 86011, CoJ 99192 x CoSe 9242309, 87A 298 x CoSe 92423, CoH 76 x Co86011, 87A 298 x CoS 8436, ISH 69 x CoS 88216, CoLk 8002 x Co 62198, BO 130 x BO 91, CP 52-1 x CoS 510 and CP 52-1 x Co 86002) Nine each of Zonal Crosses (Co 98008 x Co775, Co 88025 x Co775, CoJ 99192 x CoS 8436, Co 98010 x Co1148, CoS 8436 x Co 89003, MS 6847 x Co 1148, Co 7314 x Co 1148, CoSe 92423 x CoS 8436 and CoS 8436 x CoPant 97222) and Poly-Crosses (CoS 8436, CoJ 99192, CoJ 83, CoS 8436, CoSe 92423, ISH 100, Co 7201, CoSe 95422 and 81V48 were attempted at National Hybridization Garden, SBI Coimbatore during the crossing season November, 2009.

Evaluation of seedlings

More than 10 thousand seedlings of ten biparental crosses along with nine zonal crosses namely, 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 three poly-crosses of Co 7201, CoS 8436 and CoSe 95422 were transplanted in field condition for evaluation and these seedling were ratooned and selection will be done during October 2010.

Evaluation and selection from ratoon of seedlings (C_0)

On the basis of HR brix % and growth performance, about five hundred thirty nine clones (C_1 clones) were selected from the C_0 population (Seedling generation) of thirty four crosses. These clones were planted in the field for further evaluation and selection.

Evaluation and selection in first clonal generation

A total of 99 clones were selected and planted in augmented design along with two standards, CoJ 64 and CoS 767. On the basis of HR brix % and sucrose % (November), sixteen clones showing early sugar accumulation were selected and advanced to second clonal generation. Four clones namely LG 07065, LG 07086, LG 07095 and LG 07097 were also selected on the basis of sugar content in January as mid late clones.

Performance of advanced clonal generation

A trial comprising of 35 clones was planted along with two standards CoJ 64 and CoS 767 in augmented design during autumn 2008. Based on growth performance and HR Brix%, 10 clones were subjected to juice analysis and observation on yield contributing traits, juice analysis data and yield contributing traits. Clones namely, LG 06021, LG 06011, LG 06017, LG 04012, LG 05020, LG 06004 and LG 05003 were found promising on the basis of pol % as well as CCS % (Table 4.6).

Table 4.6: Performance of advanced clones for quality and yield attributes

Clones	SCW (kg)	Pol% (Nov)	Pol% (Jan)	CCS % Nov	CCS % (Jan)
LG 06030	1.10	15.03	15.86	9.92	10.98
LG 06021	0.74	12.88	18.10	8.24	12.53
LG 06017	1.12	13.65	17.26	8.84	11.86
LG 04049	0.76	13.93	16.10	9.03	11.16
LG 06011	0.70	13.52	16.86	8.71	11.69
LG 04012	0.62	14.05	17.49	9.13	12.12
LG 05020	0.64	14.88	18.43	9.74	12.82
LG 06004	0.96	15.10	18.01	9.92	12.39
LG 05029	1.00	14.69	16.22	9.60	11.23
LG 05003	0.96	15.24	18.63	9.85	12.89
CoJ 64	0.64	17.67	18.43	11.20	12.34
CoS 767	0.72	16.50	17.95	10.90	12.38
Mean	0.84	14.88	17.60	9.64	12.11
S.E.m	0.04	0.36	0.24	0.24	0.16

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

Inclusion of clone in U.P. State Zonal Varietal Trial

LG 05823, a mid late maturing clone having red rot resistance to three pathotypes (Cf 08, Cf 09 and Cf 11) was proposed and accepted for multi-location testing under UP State Zonal Varietal Trial.

Hybridization programme

Sixteen bi-parental CoS 96268 x CoLk 8102, Co 62198 x BO 91, CoC 671 x ISH 147, Co 7201 x ISH 150, Co 7201 x SES 594, Co 85002 x SES 594, BO 91 x Co 62198, ISH 280 x ISH 23, Co1148 x ISH 150, CoS 767 x BO 91, Co 1158 x BO 91, CoLk 8102 x BO 91, Co 85002 x ISH 147, CoJ 99192 x CoS 8436, Co 62198 x ISH 150, BO 68 x ISH 287 and three selfs (ISH 150 self, Co1148 self, BO 91 self) crosses were attempted at National Hybridization Garden, SBI Coimbatore during the crossing season November, 2009. These crosses involved some resistant interspecific hybrids (ISH 147, ISH 150, ISH 280) and commercial varieties (BO 91, CoLk 8102, CoJ 99192) and *Saccharum spontaneum* clone SES 594(resistant) to enhance the genetic diversity for red rot resistance in the base population.

Evaluation and selection of progenies from seedling generation

More than three thousand seedlings from thirteen crosses namely, CoLk 8102 x Co 62198, CoLk 8102 x Co 86002, BO 91 x Co 62198, CoLk 8002 x Co 62198, ISH 1 x CoSe 96426, CoLk 94184 x BO 91, CoS 8436 x BO 91, CoJ 83 x BO 91, Co 1148 x BO 91, Co 1158 x BO 91, Co1148 x ISH 150 and BO 91GC were transplanted in field condition for evaluation and selection process. These progenies were further advanced for ratooning and evaluation.

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

A total of 517 progenies (numbers in parenthesis) from fourteen families namely, ISH 1 x CoSe 96436 (112), CoLk 8002 x Co 62198 (34), CoC 671 x ISH 147(72), BO 91GC (123),CoLk 8102 x Co 86002 (8), Co 7201 x ISH 176 (5), CoS 96268 x CoLk 8002 (4), CoPant 90223 x Co 62198 (3), CoSe 95422GC (87), CoPant 97222 GC (35), Co 89003 GC (21),CoLk 8002 GC (8), CoLk 1158 GC(3) and CoLk 94184 GC (2) were advanced to first clonal generation for screening against red rot pathogen.

Evaluation red rot resistant clones in C_3 generation

On the basis of reaction to red rot in C_3 clones against two red rot pathotypes, Cf 08 and Cf 09, juice quality and growth performance, eleven clones were selected and advance for further evaluation in replicated trial for commercial attributes. Five clones LG 06812, LG 06839, LG 06846(2-2-3), LG 06856 and LG 06890 were found to be promising for high sugar along with moderately resistant to resistant reaction to red rot pathotypes (Table 4.7) .

Table 4.7: Performance of promising C_3 clones and reaction to pathotypes of *Colletotrichum falcatum* (Cf 08 and Cf 09) using plug method of inoculation during August 2009

Clones	Parentage	Sucrose % at 10 months	Reaction to Pathotypes	
			Cf 08	Cf 09
LG 06810	CoS 96268 GC	14.8	MR	MS
LG 06812	BO 92 GC	14.8	MR	MR
LG 06823	HR 83-144 GC	14.0	MR	MS
LG 06839	CoSnk 03-44 GC	16.6	MR	MR
LG 06856	CoLk 7901 GC	18.2	R	R
LG 06861	HR 83-65 GC	13.3	MR	MR
LG 06879	HR 83-65 GC	14.8	R	R
LG 06890	HR 83-65 GC	17.5	MS	MR
LG 06846	CoLk 7901 GC	18.7	MR	MR

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

Advance varietal trial (Early) I Plant: A trial comprising of five early maturing entries viz., Co 05009, CoH 05262, CoH 05265, CoLk 05201 and CoPk 05191 with two checks viz., CoJ 64 and Co Pant 84211 were evaluated for their performance as plant crop. Genotype CoPk 05191 was significantly found to be the best for cane (108.3 t ha^{-1}) and sugar yield (12.67 t ha^{-1}), followed by CoLk 05201 over best check CoPant 84211 (51.67, 6.05 t ha^{-1}). Genotypes Co 05009, CoH 05262 and CoH 05265 were found to be severely affected by wilt.

Initial varietal trial (Early): Five early maturing entries viz., Co 06032, CoH 06261, CoH 06262, CoH 06263and CoPant 06221 along with two checks viz., CoJ 64 and CoPant 84211 were evaluated for yield and juice quality. CoH 06261was superior in sugar yield (66.9 t ha^{-1}) over the best check CoPant 84211 (53.2 t ha^{-1}), followed by CoH 06263 (62.5 t / ha). None of the genotypes showed significant superiority over the best check, CoJ 64 for Pol % and CCS % at 8 and 10 months stages. Genotypes Co 06032 and CoH 06262 were found to be severely affected by wilt.

Multiplication: Nine genotypes viz, Co 07024, CoLk 07201, CoH 07261, CoPb 07211, Co 07023, Co 07026, CoPant 07221, Co 07025 and CoH 07262 were multiplied for raising Initial Varietal Trial for 2010 -11. Genotype CoH 07262 was severely affected by wilt.

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

Initial Varietal Trial (mid-late)

Fifteen genotypes *viz.*, Co 06033, Co 06034, Co 06035, Co 06037, CoH 06264, CoH 06265, CoH 06266, CoPant 06223, CoPant 06224, CoPant 06225, CoPb 06214, CoPb 06219, CoS 06241, CoS 06246 and CoS 06247 along with three standards, Co 1148, CoS 767 and CoS 8436 were evaluated for yield and quality parameters. The genotype CoH 06265 recorded highest cane yield (91.4 t ha^{-1}), followed by CoS 06246 (90.6 t ha^{-1}). These genotypes were significantly superior over all the three standards for cane yield. The genotypes CoPant 06224 showed significant higher CCS yield (10.43 t ha^{1}) over the best standard, followed by CoH 06265 (10.33 t ha^{1}). Co 06034, Co 06035, CoH 06266, CoPb 06214 and CoS 06246 had also shown higher cane and CCS yield than the best standard. Among the genotypes, Co 06034 recorded highest sucrose percentage (17.5%), followed by CoH 06266 (17.3) and CoPant 06224 (17.3%). Among the standard varieties, CoS 767 recorded highest CCS yield (8.71 t ha^{-1}), followed CoS 8436 and Co 1148.

Advance Varietal Trial (Mid late) I Plant

A trial comprising of eight genotypes *viz.*, Co 05011, CoH 05266, CoH 05269, CoPant 05222, CoPant 05224, CoPb 05211, CoPk 05192 and UP 05233 along with three standard varieties, Co 1148, CoS 767 and CoS 8436 were evaluated for yield and quality parameters. The genotype Co 05011 recorded highest cane yield (85.8 t ha^{-1}) as well as CCS yield (9.96 t ha^{-1}) which was significant superior to the respective best checks. CoPant 05222 exhibited highest sucrose % at 12 months (18.4%), followed by CoPb 05211 (18.1%) and CoH 05266 (17.5%). Among the standard varieties, CoS 767 was the best for cane yield (68.8 t ha^{-1}) and CoS 8436 was best for CCS yield (8.14 t ha^{-1}).

Advance Varietal Trial (Mid-late) 1I plant

A trial comprising of six test genotypes *viz.*, Co 0327, Co 0424, CoLk 99271, CoLk 04238, CoPant 04222 and CoS 03222 along with three standard varieties *viz.*, Co 1148, CoS 767 and CoS 8436 was conducted. Various observations on yield and quality parameters were recorded. Genotype CoLk 99271 exhibited highest cane yield (86.2 t ha^{-1}) and CCS yield (9.67 t ha^{-1}) followed by CoPant 04222 and CoLk 04238. The genotype Co 0424 showed highest sucrose percentage (17.9%) followed by CoS 03222 and Co 0327. Among the standards, CoS 767 was the best checks for cane yield (67.8 t ha^{-1}) and CoS 8436 was best for CCS yield (7.92 t ha^{-1}).

Advance Varietal Trial (Mid-late) Ratoon

Six genotypes i.e. Co 0327, Co 0424, CoLk 99271, CoLk 04238, CoPant 04222 and CoS 03222 along with three standard varieties *viz.*, Co 1148, CoS 767 and CoS 8436 were evaluated for their ratooning ability. The genotype CoLk 99271 had shown best ratooning ability with

significant higher cane yield (68.8 t ha^{-1}) and CCS yield (7.61 t ha^{-1}) over the best standard. CoLk 04238 was also a good ratooner with higher cane yield (63.2 t ha^{-1}) and sugar yield (6.25 t ha^{-1}). Among the standard varieties, CoS 767 was the best for cane yield (62.2 t ha^{-1}).

Seed multiplication

The seed of seventeen genotypes *viz.*, Co 07027, Co 07028, CoH 07263, CoH 07264, CoH 07265, CoLk 07202, CoLk 07203, CoPant 07223, CoPant 07224, CoPb 07212, CoPb 07213, CoPb 07214, CoS 07231, CoS 07232, CoS 07233, CoS 07234 and CoSe 01424 along with a new standard variety CoPant 97222 was multiplied for the next year's Initial Varietal Trial.

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

Multiplication

The Inter zonal initial varietal trial (IZIVT) entries as detailed below have been multiplied and maintained at IISR, Lucknow as per the technical programme:

Early (35) : Co 0114, Co 0211, Co 0301, Co 0302, Co 0303, Co 0305, Co 0306, Co 0308, Co 0309, Co 0310, Co 0312, Co 0313, Co 0314, Co 0315, Co 0316, MS 202, MS 0219, CoM 0250, CoM 0251, CoM 0261, PI 96-0843, CoA 03081, CoV 03101, CoOr 03151, CoOr 03152, CoC 03061, CoC 03062, CoJ 03192, CoS 03292, CoSe 03234, BO 138, CoP 03181, CoBln 03171, CoBln 03172 and CoBln 03173.

Mid-late (25) : Co 0112, Co 0311, Co 0317, Co 0318, Co 0320, Co 0322, Co 0323, Co 0325, Co 0326, Co 0328, CoVC 99134, MS 0209, MS 0217, MS 0221, CoM 0265, CoM 0272, CoVSI 03301, CoA 03082, CoV 03102, CoC 03063, CoLk 9910, BO 141, CoBln 03174, CoBln 03175 and CoBln 03176.

In addition, the IZIVT early trial comprising of eighteen entries and two standards were planted during March, 2010 as per the technical programme.

Fluff Supply Programme (B 2)

This project aims to develop sugarcane varieties for the sub-tropical region using the fluff received from the Principal Investigator (Breeding) under the auspices of the AICRP on Sugarcane. The material in hand is up till the crosses of 2005, after which the fluff is being raised under the institute project B 2.13.

During the year under report, one Advance Varietal Trial in the plant crop and two ratoon crop trials (AVT and PVT) were conducted. Based on the observations on cane productivity and quality, the salient results are as follows:

Identification of clones for the Station Trial

Seven selections were included in the Station Trial 2010-11 from Advance Varietal Trials in plant and ratoon crops, namely, LG 04438, LG 05302, LG 05319, LG 05398, LG 05403, LG 05405 and LG 05416, based on cane yield, quality and red rot reaction. The performance of selections in the advance varietal trial is given in (Table 4.8).

Selections for Advance Varietal Trial

Sixteen promising genotypes were promoted to AVT from the ratoon of PVT and planted for further testing for commercial merit. These have also been given for testing for red rot.

Station Trial 2009-10

LG 02434 performed well in the Station Trial 2009-10 and has commercial attributes as a sugarcane variety. It may be proposed for testing in AICRP(S) for the NW Zone.

Table 4.8: Performance of advance selections in plant crop

S.N.	Genotype	No. of millable canes/ 15 m^2	Single cane weight (kg)	Pol % juice in Nov.	Pol % juice in Jan.	Cane yield (t ha^{-1})
1	LG 05324	146.3	0.700	14.32	17.72	68.29
2	LG 05398	165.3	0.690	15.17	15.74	76.05
3	LG 05350	165.3	0.820	14.22	15.80	83.77
4	LG 05414	155.3	0.700	13.89	16.38	72.49
5	LG 04365	74.3	0.680	15.63	16.83	25.11
6	LG 3310	162.3	0.887	12.04	13.77	95.96
7	LG 05397	80.7	0.650	15.27	15.97	29.40
8	LG 05403	124.0	0.830	16.54	18.05	68.61
9	LG 05355	144.3	0.677	13.31	14.97	65.11
10	LG 05405	144.7	0.557	14.77	16.16	53.69
11	LG 05410	151.7	0.753	14.90	16.76	59.76
12	LG 05309	156.7	0.757	14.37	16.48	79.03
13	LG 02330	75.7	0.667	16.87	18.05	33.63
14	LG 05305	121.3	0.833	17.67	18.75	67.41
15	LG 05419	146.0	0.473	17.22	16.92	46.07
16	LG 05306	202.0	0.600	13.11	15.77	80.80
17	LG 05367	133.3	0.830	16.34	16.44	73.78
18	LG 05302	153.0	0.743	16.80	19.04	75.82
19	CoJ 64	121.7	0.653	17.01	17.74	53.45
20	CoS 767	171.3	0.623	15.41	16.92	67.41
	Mean	139.8	0.71	15.13	16.71	66.38
	CD 5%	48.6	0.22	3.1	1.87	20.57
	CV %	18.6	1.182	3.61	2.08	11.44

4.3. Cytogenetic and biotechnological techniques for sugarcane improvement

Genetic improvement of sugarcane through tissue culture (B 3.7)

This project aims to evaluate the usefulness of *in vitro* generated somaclonal variation in sugarcane. Salient results of work done are as follows:

Identification and utilization of somaclones in breeding

During 2009-10, field evaluation of several somaclones in different generations was carried out in one plant crop and two ratoon crops unreplicated experiments with source varieties as checks. Fifty-four somaclones from CoJ 64, Co 87263, Co 7717, CoLk 8001, CoLk 8102, BO 91 and CoS 767 were selected, based on quality (HR brix and / or pol % juice), cane morphology, number of millable canes and the cane weight. A few somaclones of Co 7717, a wilt susceptible variety, showed relative tolerance to wilt under natural conditions, and have been advanced for further observation (Table 4.9). A somaclone of CoJ 64 (SC 64-101), showing resistance to red rot and sent to NHG has been used in crossing and the seedlings grown for progeny evaluation.

Table 4.9: Details of somaclones advanced (2009-10)

Variety	No. of somaclones advanced	Generation	Salient features
CoLk 8102	11 5	R_4 R_3	Better cane weight / higher sucrose content, Earlier maturity
CoJ 64	7 4 1	R_4 R_3	Higher NMC, Better cane weight, Comparable sugar content Red rot resistant
CoLk 8001	8	R_4	Better productivity
Co 7717	3	R_3	Better tolerance to wilt
BO 91	4 3	R_4 R_3	Better cane weight and sucrose content Earlier maturity
CoS 767	5	R_4	Two are red rot resistant, Better cane weight / sucrose
Co 87263	1	R_4	Higher NMC & cane weight

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

The project was initiated in Nov. 2003 with the objective of development of molecular markers for sugar genes in sugarcane, which ultimately, can be used in Marker Assisted Selection.

Parental studies: Based on available information, 30 clones with varying sugar content (Hand Refractometer Brix range 10-22%) were planted in the field for selecting suitable genotypes. Hand refractometer brix was recorded during November first week. Juice analyses were carried out during November and January. Seedling populations in other projects were also screened to identify clones, with high HR brix values (19 and above) and low values (less than 15). Based on the observations, parental lines with contrasting sugar content at peak period (sucrose % 17-18 and above as high sugar parents and sucrose % 13 and below as low sugar parent) were used for further studies in the laboratory. Two low sugar parental clones with mean pol % values of 11-13 % were identified from the population developed in this project. The breeding behaviour of these genotypes will be tested.

Laboratory studies: DNA isolation was carried out using standard procedures from the contrasting clones for PCR based marker studies in the laboratory. Since biochemical studies using total proteins did not give desirable results with respect to differential banding patterns, further studies were mostly confined to DNA markers. Random primers, microsatellites, EST-based primers related to sugar genes, unigene sequences etc. were used for identifying polymorphic markers among the clones under study. Approximately 40 primers exhibited polymorphism among the sugarcane clones with varying sugar content. These putative markers will be used for further validation studies using segregating population developed for this purpose.

Development of segregating population: For validation of the primers identified, segregating population has to be developed using the contrasting parents studied. Even though a total of 9 biparental crosses and 5 selfings were attempted, sufficient number of seedlings could not be obtained from all the matings. Crosses involving the clones CoLk 94184, LG 94114, CoLk 7901, HR-83-65, ISH 176 and a self of CoS 96268 (developed in some other project) were maintained and studied. The population of CoS 96268 self and CoLk 7901 x HR-83-65 showed wide variation with respect to sugar content. The mean pol % values ranged from 9.16-18.2 and 10.2 -19.8 respectively. These studies continued till November 2009. The results are being followed up with validation of putative markers and mapping of the loci involved in sugar content, for which, a project has already been initiated.

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

The project was initiated in December 2009 with the aim of mapping of genomic regions involved in sugar accumulation in sugarcane. Juice analyses were carried out in January (and also in February for some low sugar clones) for phenotyping segregating population. The results indicated that the population from CoS 96268 self and CoLk 7901 x HR-83-65 carry a wide range of variations for mean pol %. Based on the data, suitable population was advanced further without any selection and planted during spring planting 2010.

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

A total of 1000 seedlings of three crosses, viz. Co 1148 x BO 91, Co 1158 x BO 91 and CoJ 64 x BO 91 were transplanted in the fields for development of mapping population. Parental polymorphism was carried out between resistant and susceptible parents using 50 SSR markers available in the public domain. Twenty-five percent markers were found polymorphic in different sets of parents used in the crossing for development of mapping population.

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

Sugarcane stalk borer (*Chilo auricilius* Dudgeon) is a serious sugarcane pest in subtropical cane belt of India whose endophytic lifestyle hampers effective chemical and biological controls. Therefore, development of alternative control methods is extremely important. In the present study, sugarcane cultivar CoLk 8102, a subtropical variety susceptible to stalk borer was transformed with the *Cry1Ab* gene, which confers resistance to the sugarcane stalk borer. Embryogenic calli produced from 6-month-old healthy leaf whorl were transformed with *Agrobacterium* strain, EHA105 that harboured a binary vector pCAMBIA3301 carrying *Cry1Ab*, phosphinothricin acetyltransferase (bar) and an intron containing ß-glucuronidase (GUS - intron) genes in the T-DNA region. Co-cultivation on Murashige and Skoog (MS)-based medium for a period of 3 days produced the highest number of GUS positive calli. The transformed calli were put on selective medium to remove chimeras. Genetic transformants were regenerated from transformed calli (Plate 4.1 a, b, c, d). Transformation was confirmed by a histochemical ß-glucuronidase (GUS) assay (Plate 4.2 a, b) and PCR amplification of the bar gene (Plate 4.3). PCR amplification results showed successful integration of Cry1Ab gene in plant genome. Hardened transformed plants have been transferred in the earthen pots (Plate 4.4) containing mixture of sand, vermicompost and soil (1:1:1) for their further evaluation and to measure the endotoxin protein expression.

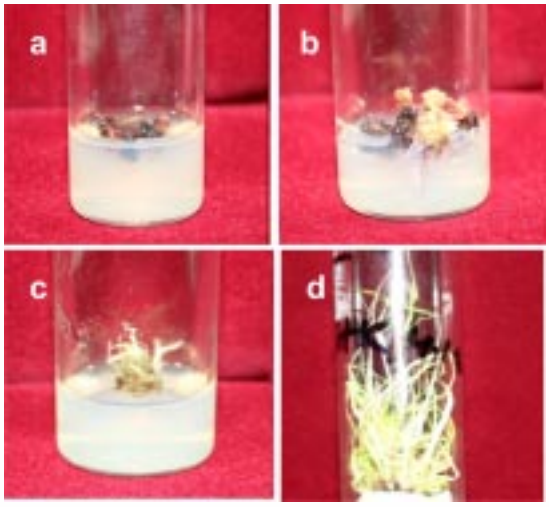


Plate 4.1. Different stages of development of transformants. (a) Untreated callus on selection medium (MS + 50mg l^{-1} Kanamycine); (b) Treated callus on selection medium; (c) Regeneration of plantlets; (d) Transformants

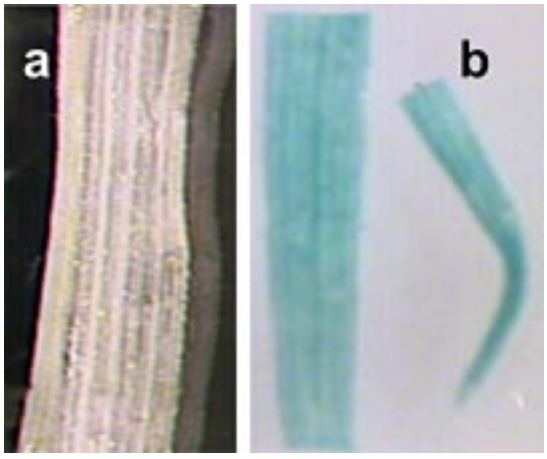


Plate 4.2. Expression of GUS reported gene in the leaf of transformed plant after staining with X-Gluc. (a) Leaf of control plant (b) Leaf of transformed plant giving blue coloration

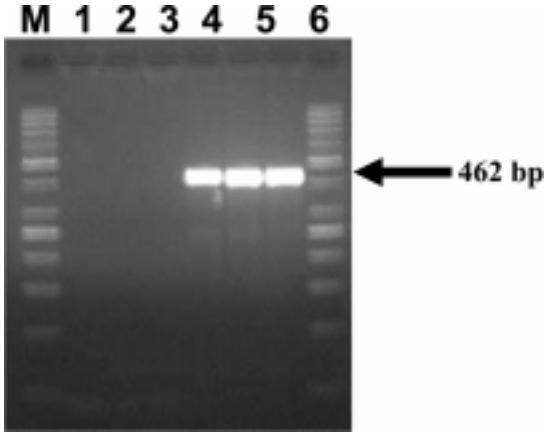


Plate 4.3. PCR amplification of the bar gene fragment in transformed sugarcane plants. Lanes: M= Marker (50 bp ladder); 1-3 DNA sample of non-transformed control plant; 4-6 DNA samples from transformants. Arrow indicate bar gene amplification product (462 bp)

Plate 4.4. Transformed plants in the earthen pots

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

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 sugarcane variety CoSe 01235. Three-budded setts of this variety were obtained through conventionally grown crop (T_1) and crop raised using micropropagated plantlets (T_2). These setts were planted in seven replications following recommended package of practices. The data revealed that source of planting material and its interaction showed significant effect on millable canes, cane height, number of nodes / cane, cane girth, cane weight (Table 4.10). However, no significant variation was observed on quality parameters in the different treatments. Significant impact of source of planting material was also observed on cane yield. A total of 13.8 % increase was observed in cane yield in the crop raised using setts obtained through micropropagated plantlets over conventional method.

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

The project was initiated in January 2010 with an aim to identify red rot specific disease resistance gene analogues. Even though red rot is one of the most important diseases of sugarcane in India especially in the subtropical belt, very little information is available regarding genes governing resistance against this disease. For the identification of resistance gene analogues in sugarcane, a search was carried out on sequences available in Genbank (NCBI,

Table 4.10: Effect of seed cane raised from micropropagated plantlets on growth, yield and quality of sugarcane variety CoSe 01235

Treatments	NMCs (000/ha)	Cane height (m)	No. of nodes/ cane	Cane girth (cm)	Single cane weight (g)	Cane yield (t/ha)	CCS%
T_1	122.53	1.76	19.00	1.96	0.54	65.9	11.82
T_2	159.03	2.01	24.29	1.85	0.51	80.8	11.77
CD (0.05)	**25.2**	**0.09**	**1.72**	**0.08**	**0.01**	**12.8**	**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).

National Center for Biotechnology Information, www.ncbi.nih.gov/) using sequences of known *R*-genes selected from the literature. Conserved regions were identified from the sequence alignment and were used for degenerate primer design. These degenerate primers designed based on known resistant genes (R-genes) would be used in combinations to elucidate RGAs in sugarcane.

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

This project has been initiated with objectives of designing and development of SSR markers using EST database of sugarcane and, their utilization for identification of linked markers for red rot resistance in sugarcane. A total of 260 EST-SSR markers were designed and developed from 4000 unique Indian sugarcane EST and 1069 red rot specific ESTs. Validation and polymorphism survey is being carried out (Fig.1). A new class of functional markers, Conserved Intron Scanning Primer (CISP) from sugarcane was also developed using ESTs of sugarcane and respective homologues in whole genome sequence of rice, sorghum and barley to find out the suitability of CISP markers in sugarcane genotyping. Nineteen developed CISP markers were used for genomic analysis of 38 genotypes of sugarcane consisting of varieties, interspecific hybrids, species and related genera. Eighteen of the 19 markers (94.7%) generated amplicons of different length. A species-specific sequence was identified, which can easily differentiate *Saccharum* species and its hybrids from *Erianthus*. A mapping population developed from the self of CoS 96268 has been planted in the field for genotyping and phenotyping.

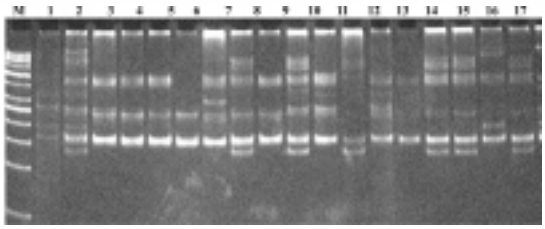


Fig. 1. DNA profiling pattern of different sugarcane genotypes as generated by EST-SSR 13
M:50 bp DNA ladder; 1-CoS 96268, 2-CoLk 94184, 3-CoLk 97147, 4-CoLk 05202, 5-CoJ 64 Somaclone, 6-ISH 288, 7-ISH 07, 8-ISH 133, 9-ISH 164, 10-ISH 38, 11-CoJ 64, 12-CoC 671, 13-CoS 8432, 14-CoLk 7701, 15-Co 997, 16-Co7717, 17-CoS 2399, 18-Khakai

DUS Testing Project (2009-10)

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

A total of six sugarcane varieties namely BO 145, BO 147, BO 139, CoP 9302, BO 141and CoPant 99214 were collected from RAU, Pusa and GBPUA&T, Pantnagar. These varieties are being maintained in the field. A total of 96 varieties were characterized as per the existing DUS Guidelines. The other varieties which have been collected during the period under report will be characterized during 2010-11. All the varieties have been planted in the field under maintenance of reference collection.

Epidemiology and integrated disease management

5.1 Epidemiology of diseases of sugarcane

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

A survey was conducted to assess the white grub problem in the sugarcane command area of Triveni Engineering & Industries Ltd., Deoband, Saharanpur and Titawi Sugar Complex, Titawi, Muzaffarnagar. White grub infestation was recorded in approx 200 ha area in 19 villages with 10-30% damage of the sugarcane crop. Complete crop failure was also observed in certain locations. In the severely infested fields, 4-7 grubs / clump at a soil depth of 10-25 cm was observed. In general, infestation of white grubs was recorded in the sugarcane crops grown in sandy loam soil. *Holotrichia consanguinea* was predominant in western U.P., while *Apogonia* sp. was dominant in central U.P.

Sugarcane fields (plant and ratoon) at Biswan Sugar factory, Sitapur were surveyed for the incidence of pests and diseases. Incidence of red rot was observed in CoS 8436. In irrigated ratoon, incidence of settling mortality and spindle infection was observed.

Survey was also conducted in the factory command area of Hargaon and Rozagaon Sugar Factories. Red rot was observed in several locations in the standing crop. The most affected variety was CoLk 8102 followed by CoS 8436. In the red rot affected fields, disease incidence ranged from 2-10%. In addition, incidences of leaf scald and GSD were also recorded in CoLk 8102. Sugarcane area around RAU, Pusa was surveyed for the incidence of red rot. The disease was observed in BO 128 and CoBln 5501.

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

To find out the level of sett borne infection needed for the expression of red rot in standing cane, cane setts (75 two-and 50 three-bud) were inoculated with conidial suspension of *Colletotrichum falcatum* (10^6 conidia / ml). Inoculation of setts affected the germination and two-bud setts were more sensitive in comparison to three-bud setts. Similarly, plug method of inoculation caused almost total germination failure in two-bud setts (registered only 0.66% germination as against 45.33% in control). The three buds setts were superior to two-bud setts in producing red rot in standing crop(49 canes). In two-bud setts, only a few produced the disease in standing cane (only six). So far as the result goes, three-bud setts and plug method of inoculation fared better in producing red rot in standing cane (61.53%) as against spore dip (46.34%) with 24 h incubation.

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

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

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

Twenty non-sporulating variant cultures of Cf 01 (isolated from Co 1148) were established during this period. These cultures were only producing dark mycelia on OMA plates. During August-September, these mycelial cultures were inoculated on the host genotype (Co 1148) using plug method. The results of inoculations differed widely from the assumption. Almost 90 per cent of the mycelial cultures did show some degree of pathogenicity. However, the intensity varied; none produced disease reaction to the level as produced with the spore inoculation. Ten per

cent of the cultures failed to elicit disease reaction and remained restricted to inoculated internode. In the second approach, Cf 01 was inoculated on the sugarcane differentials and reisolations were made. The reisolates will be tested on the differentials to check any change in the virulence behaviour.

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

This year, three new isolates *i.e.* two from CoLk 8102 (IR-11 and IR -12) and one from CoS 8436 (IR-13) were evaluated on the designated differentials viz., Baragua (*S. officinarum*), Khakai (*S. sinense*) and SES-594 (*S. spontaneum*), Co 1148, Co 7717, CoJ 64, Co 419, Co 997, CoC 671, Co 975, Co 62399, BO 91, CoS 767 and on CoS 8436 using plug method of inoculation. After 60 days of inoculation, observation was taken by splitting the cane.

The isolate IR-11 and IR -12 showed a close proximity between them on eight differentials and IR-13 on ten differentials. IR-11 showed resistant reaction on CoS 767 and intermediate reaction on Co 975, Co 62399, Co 7717, while isolate IR-12 showed intermediate and susceptible reaction on these differentials. Isolate IR-13 also showed almost identical reaction on set of differentials similar to IR-11 and IR-12. On comparison with the reaction of existing pathotypes of North West Zone, it was found that all the three test isolates have close proximity with the existing pathotype Cf 08. Hence, it was concluded from this study that there is no emergence of any new virulent pathotype in this zone.

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

5.3 Evaluation of germplasm/ genotypes for major disease of sugarcane

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

This year, seventy four genotypes were evaluated against red rot and smut along with three susceptible checks i.e. CoJ 64 (for Cf 08) and CoS 767 (for Cf 09) and CoLk 9617 for smut.

Red rot

All the genotypes were tested against two pathotypes of *Colletotrichum falcatum* (Cf 08 and Cf 09) by plug method.

It was observed that eighteen genotypes *viz.*, 1-10-15, 1-2-3, 2-50-7, 3-13-6, 3-2-13, 3-32-13, 3-39-7, 4-32-2, LG 04059, LG 05408, LG 05433, LG 05435, LG 05444, LG 05463, LG 05480, LG 05484, LG 05490 and LG 2362 were moderately susceptible (MS) to highly susceptible (HS) to both the test pathotypes. In addition, five genotypes *viz.*, 1-36-3, 2-4-2, 3-10-11, LG 05436 and LG 5445 were susceptible to highly susceptible to pathotype Cf 08. The rest of the genotypes showed red rot reaction in the range of resistant (R) to moderately resistant (MR).

Smut

Thirteen genotypes i.e. 1-16-13, 1-3-12, 1-5-4, 1-9-3, 2-13-4, 2-51-9, 3-11-14, 3-15-3, 3-31-6, A 22, LG 04006, LG 2362 and LG 5425 were found susceptible and rest 61 genotypes were found resistant to smut.

Wilt

Natural incidence of wilt disease was also observed in thirteen genotypes viz. 1-10-15, 1-14-14, 1-39-1, 1-5-9, 1-8-8, 2-13-4, 2-19-3, 2-54-3, 3-13-6, 3-23-20, 3-26-2, 7-33-3 and LG 05463.

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

Thirty six genotypes i.e., five AVT (Early) *viz.*, Co 06032, Co Pant 06221, CoH 06261, CoH 06262, CoH 06263; three AVT (Early)-I Plant *viz.*, CoH 05262, CoLk 05201, CoPk 05191;fifteen IVT (Mid late) *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, CoH 06266; eight AVT (Mid late)-I Plant *viz.*, Co 05011, CoH 05266, CoH 05269, CoPb 05211, UP 05233, CoPant 05222, CoPant 05224, CoPk 05192 and five AVT (Mid late)-II Plant *viz.*, Co 0327, Co 0327, Co 0424, CoLk 99271 and CoPant 04222 were screened against red rot and smut along with respective susceptible checks i.e. two checks *viz.*, CoJ 64 (for Cf 08) and CoS 767 (for Cf 09) for red rot and CoLk 9617 for smut.

Red rot

Three genotypes *viz.*, Co 06033, CoH 06261 and CoPant 06221 were moderately suceptible (MS) to susceptible (S) against both the test pathotypes (Cf 08 and Cf 09), while twelve genotypes viz., Co 0327, Co 0424, Co 05233, Co 06032, CoH 05262, CoH 06263, CoH 06264, CoH 06265, CoPant 06223, CoPb 06214, CoPb 06219 and Co 06264 were moderately susceptible to susceptible against Cf 08 and two genotypes, CoPant 06224, CoS 06241 were moderately susceptible to susceptible against Cf 09. The remaining genotypes exhibited red rot reaction in the range of resistant (R) to moderately resistant (MR).

Smut

Nine genotypes *viz.*, Co 05233, Co 06033, Co 06035, CoH 05266, CoH 06262, CoH 06266, CoPant 05224, CoPant 06224, CoS 06247 were found susceptible to smut.

Wilt

Natural incidence of wilt was observed in four genotypes *viz.*, Co 06033, CoH 06266, CoPb 06214 and CoPb 06219.

5.4 Sugarcane disease management

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

Several infected buds of CoLk 7701 (HS variety) were found free from the pathogen due to treatment with *T. harzianum* and MHAT at 54^{0}C for 2½ h at 90% RH, alone and in combinations. *Colletotrichum falcatum* could not be recovered from 53, 68 and 73% bud, respectively with TMC, MHAT and TMC + MHAT treatments. It was apparent that *T. harzianum* was also effective in eradicating sett borne infection of *C. falcatum*.

Protection of canes against red rot in CoLk 7701 was recorded up to 72, 46 and 76% in TMC, MHAT and TMC + MHAT treatments, respectively. *T. harzianum* (Th 37) checked secondary infection due to induced systemic resistance in cane plants and it was higher than that of MHAT.

Availability of some of the important macro-and micro-elements in soil increased due to application of *T. harzianum*. N availability enhanced by 27%, P by 65% and K by 44%. Among the micro-nutrients, Cu increased by 6%, Fe by 100% Mn by 79% and Zn by 55%. Overall organic carbon content increased by 55%. The uptake of N, P and K was higher in red rot susceptible variety, CoLk 7701 than the moderately resistant CoS 96268. The emergence of ratoon clumps was higher due to application of *Trichoderma* enriched press mud by 15%, tiller population by 8%, cane height by 5%, length of internode by 2%, number of internode by 8%, girth by 4%, number of millable cane by 4%, single cane weight by 5% and total yield by 23%.

T. harzianum strains Th-37 and Th-38 were characterized based on phylogenic analysis of nucleotide sequences. Total genomic DNA was extracted from mycelial mats by CTAB procedure. Universal primers pair ITS-4 and ITS-5 were used to amplify Internal Transcribed Spacer (ITS) regions of the r DNA cluster (ITS1-5.8S- ITS2) and PCR products were directly sequenced. Sequences available in the NCBI database were blast searched. The 5.8S region was found conserved and much of the sequence variability was due to transition / transverse mutations in the ITS1 and ITS2 regions. The analysis showed that both the strains belonged to the *T. harzianum* clad. Both Th 37 and Th 38 are distinct yet have close genetic similarity coefficients (up to 0.77) and matched with several established strains / isolates of *T. harzianum* reported worldwide. The SNPs located in the ITS1 and ITS2 regions were further helpful in the differentiation of *T. harzianum* isolates.

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

Degenerate primers were designed from conserved domains within chitinases from several different plant species. Conserved amino acid sequences of plant chitinases were used to design these primers from PCR amplifications. Chitinase protein sequences from different species were retrieved from the NCBI database. Amino acid sequence alignment was performed and the conserved regions were used for degenerate primer design. These primers will be used for reverse transcriptase reaction of total RNA isolated from healthy and red rot infected plant tissue. Nine sugarcane varieties *i.e.* three red rot resistant (BO 91, CoS 96268 and CoLk

94184) and six susceptible (Co 1148, CoJ 64, CoS 767, CoS 8436, CoLk 7701 and CoLk 8102) were planted for this purpose.

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

The population of endophytic fungi from twenty five sugarcane genotypes was studied for the antagonistic activity against *Colletotrichum falcatum*. Frequency of colonization in different plant parts as well as in different varieties differed widely. Overall colonizations in different tissues were 75.5% in leaves, 52.6% in internodes and 47.3% in buds of sugarcane. Least fungal colonization was observed in nodal portion of the cane. The preponderant endophytic fungi isolated belonged to the genera of *Trichoderma, Aspergillus, Chaetomium* and *Fusarium*. *In vitro* assay of the endophytes showed maximum inhibition (80.2%) with *Trichoderma* sp. Growth of *C. falcatum* was reduced (64.2%) by *Aspergillus* sp. and *Chaetomium* sp. (62.1%).

Bio-ecology and integrated management of insect-pests

6.1 Bio-ecology of insects-pests of sugarcane

Biological control activities at Pravaranagar (EM01)

Seasonal fluctuation in the incidence of early shoot borer (*Chilo infuscatellus*) and pink borer (*Sesamia inference*) was recorded from April 2009 to March 2010. Maximum incidence (13.40%) of shoot borer was recorded in the first fortnight of May and it coincided with the maximum activity of its larval parasite *Sturmiopsis* sp. During August-September parasitisation of *Cotesia flavipes*, another larval parasite was also observed.

Similarly population build up of scale insect (*Melanaspis glomerata* Green) and the predatory and parasitic activity containing this pest were also recorded. In ratoon crop, the infestation was noticed (8.12%) from July and maximum incidence (79.25%) was recorded in March 2010, however, maximum parasitisation (19.56%) was observed during October. Presence of predatory beetle was noticed during September 2009.

The activity of *Pyrilla* was noticed from April 2009 and it reached its peak during August (about 40 adults and 80 nymphs / 100 clumps). Fresh cocoons of *Epiricania* were noticed in June.

During this period, about 329 farmers were supplied with trichocards and about 500 ha sugarcane area was covered.

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

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

A field experiment using top borer susceptible variety CoLk 8102 was carried out in RBD. The experimental plots were separated from each other by bunds having a distance of 90 cm. All agronomic practices were followed to raise a good crop. Observations on incidence of top borer (II to III brood) were recorded. Parasitoids (*Trichogramma* sp., *Telenomus* sp., *Stenobracon* sp., *Isotima javensis*, *Rhaconotus* sp.) were released as per the schedule and application of carbofuran @1 kg.a.i / ha against III brood of top borer was carried out. Cane yield was recorded at harvest.

The mean incidence of top borer (III brood) was recorded as 2.43 % in conserve release of all parasitoids followed by conserve release of larval parasitoids, *Stenobracon* sp. and *Rhaconotus* sp. In chemical treatment, incidence was 4.3 %, where as in control plot, the incidence was 6.56 %.

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

Experiment on bio-management of termite was laid out at IISR farm (cv. CoPant 84212) under spring planting. The experiment comprised of 10 treatments *viz*. *Metarhizium anisopliae* sett dipping, *Beauveria bassiana* sett dipping, *Trichoderma harzianum* in furrows, sett dipping in NSKE, *Trichoderma harzianum* + neemazin powder in furrows, Neemazin powder+urea (coated) in furrows, chlorpyriphos 20 EC @ 1.0 kg a.i. / ha (standard check), Imidacloprid 17.8 SL over setts, *Verticillium lecanii* sett dipping and untreated check. Cultural operations were given from time to time. Data on germination, total number of millable canes and yield were recorded. One month after planting, observation on the termite damage was recorded by digging the setts. Sett damage varied from 3.18-15% and bud damage from 5.12-20.26%. Shoot damage ranged from 2.58 -12.16 %. Maximum yield was obtained from chlorpyriphos treatment (82.16 t / ha) and it was immediately followed by imidacloprid (81.70 t / ha), whereas it was 68.84 t / ha in untreated check.

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

A survey was conducted to assess the white grub problem in sugarcane as reported in section 5.1. The white grub infestation was recorded in approx 200 ha area, of which 17 ha was severely infested by the grubs. In general, 10-30% damage of the sugarcane crop was recorded, however, in the severely infested fields, complete crop failure was observed. The affected villages were Jakhwala, Mathura, Bhala, Niamu, Charthawal, Akabargarh, Sikanderpur, Badgaon, Khudda, Shimbhalki, Mogalapur, Mahabalipur, Kulheri, Niamu, Akbargarh, Sikanderpur, Pipalshah, Anaich, Naglarai.

More than 2500 beetles of white grubs of *Apogonia* sp., *Adoretus* sp., *Orthophagus calta*, *Orthophagus* sp., *Schizonycha ruficollis* and many unidentified species were collected through light trap (July to October) installed at the IISR farm. The relative abundance (RA) study revealed that *Apogonia* sp. was predominant during July and September with RA of 42.19% and 23.61% respectively, while *Orthophagus* sp. was dominant in August with RA of 32.52% and *Adoretus* sp. during October with RA of 46.26%.

In order to manage the beetle stage of the pest, light trap was modified. The modified trap is currently under testing in sugarcane agro-ecosystem. Similarly, for the management of the grub stage of the pest, entomopathogenic bacteria associated with diseased white grub from sugarcane agro-ecosystem was isolated. Further purification and multiplication of the bacteria is in progress.

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

The mean survival (1.95 days), developmental period (5.0 days), fecundity (15.56 eggs / female), adult emergence (50.53%) and female emergence (25.56%) was observed in the laboratory on host, *Corcyra cephalonica* for 5 generations at 38± 2 ^{0}C of *Trichogramma japonicum* (reared from F_1 to F_{10} generations at 36 ± 2 ^{0}C). However, at 40± 2 ^{0}C, the mean survival (1.1 days), developmental period (4.2 days), fecundity (11.61 eggs / female), adult emergence (28.96%) and female emergence (12.30%) were reduced drastically.

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

Eggs were obtained by keeping field collected moths in the laboratory. Newly hatched larvae (10 nos.)were released in three ways *viz*., 1. On detached inner most unfurled tender leaf, 2. On the exposed growing point of the cane and 3. On the young crown leaf. The crown was covered with wide mouth glass with muslin cloth as mouth covering. These were kept at 27 ± 2^{0}C and 70 ± 5% RH in BOD. Larvae did not accept detached inner most tender leaf and exposed growing point. In crown with young leaves only one larva penetrated 2 leaf sheath coverings over the growing point. One moulting was observed but larvae could not reach the growing point and perished.

Diets were prepared and dispensed in glass tubes and autoclaved before offering to larvae. Ten neonate larvae were released in single tube and covered with black paper in the manner that a slit of light should appear at bottom of the tube. Glass tubes with larvae were kept at 27 ± 2 ^{0}C in BOD. Observations on larval survival were recorded daily. It was observed that the neonate larvae did not feed on most of the diets provided and died within 24 hours of release. In one diet combination, neonate larvae survived for 3 days with an increase in their size but no moulting was observed. Larvae did not bore the diet and eventually perished.

Monitoring of insect-pest and bioagents in sugarcane agro-eco system (E30)

Three-bud setts of CoLk 8102 were planted in March, 2009. Recommended agronomic practices were followed to raise a good crop. Periodic observations on incidence of pests and parasitoids of designated pests were recorded.

The incidence of top borer II, III and IV brood was 6.58, 10.02 and 9.35 %, respectively. The incidence of internode borer, stalk borer and pink borer was 22.93, 4.61 and 2.64 %, respectively. Root borer incidence was 0.3 % in

May and 67.85% in October. Termite incidence ranged from 2.65% to 23.85% from May to December.

Incidence of mealy bug ranged 2.34 - 3.4% (in 6 m row) in May to August and it increased to 17.43% in the month of November. Number of black bug/clump was low (2.34 - 4.68). Puparia of white fly were observed in September (3.1/ clump). No. of egg masses of pyrilla were 2.5 and 4.58/clump in September and December, respectively. Cocoons of *Epiricania melanoleuca* were noticed in the month of September. Number of millable canes (NMC) were 86,600/ha and cane yield was 59.91 t ha^{-1}.

Total parasitisation of top borer (IV brood) larvae due to *Rhaconotus scirpophagae* was 34.61%, while it was 2.8% in V brood. *Elasmus* sp. was also noticed in V brood.

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

Seven varieties of early group *viz*. CoLk 05201, CoH 05262, CoH 05265, CoPk 05191, Co 05009, CoJ 64, CoPant 84211 and seventeen varieties of mid late group *viz*. Co 05011, CoPb 05211, CoPant 05222, CoPant 05224, Up 05233, CoH 05266, CoH 05269, CoPk 05192, Co 0327, Co 0424, CoLk 99271, CoLk 04238, CoPant 04222, CoS 03222, CoS 767, CoS 8436 and Co 1148 were evaluated against major borer pests. Maximum infestation of top borer, stalk borer and internode borer was recorded as 2.82, 4.91 and 2.30%, respectively.

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

Beauveria bassiana and *Metarhizium anisopliae* multiplied on autoclaved potato dextrose medium. Autoclaving was done at 15 PSI for 50 minutes. Streptomycin was mixed in lukewarm medium before plaiting and incubated overnight. After inoculation ptridishes were kept at 27 ± 2 ^{0}C and 70% RH in BOD. Growth of *Metarhizium anisopliae* was faster than *Beauveria bassiana*. Spores of *Metarhizium anisopliae* and *Beauveria bassiana* were harvested 14 and 15 days after inoculation, respectively. Pure cultures of both fungi were maintained on PDA throughout the year.

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

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

Pheromone traps of top borer, early shoot borer and stalk borer were installed (three each) in two sugarcane fields (0.5 ha) with variety CoS 94257. Pheromone traps of stalk borer and early shoot borer were separately placed in the same field, whereas pheromone traps of top borer were installed in another field. Numbers of moths trapped were recorded regularly during the emergence. The pheromone lures were put well in advance of moth emergence. Lures of top borer were effective in attracting the moths. The percent incidence of top borer in plots with traps, was 5.54, 8.27, 3.57 and 2.0% against without traps as 8.17, 9.62, 5.10 and 3.52% 1st, 2nd 3rd and 4th brood, respectively.

In case of stalk borer, very low numbers of moths were attracted to the lures. Early shoot borer moths were not found in any of the pheromone traps throughout the year.

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)

The harvester was tested at IISR farm at different speeds (350, 500 and 650 rpm) of cutting blades. The speed of cutting blades was varied by varying the teeths of the double sprockets used for transmitting the PTO power to the cutting blades. The cutting was clean without any splitting and rupture of cane stubbles at 500 rpm of cutting blade. The average effective field capacity of the equipment was 0.15-0.20 ha/h 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 separately.

Plate 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)

The design of tractor/power operated detrasher was finalized. Detrasher 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 different varieties of harvested canes, with their tops first, to the detrashing rollers through the feeding chute. 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

Plate 7.2. Sugarcane detrasher

Plate 7.3. Sugarcane detrasher in operation

94.5% depending upon the variety. The output of the detrasher varied with the number of canes passed at a time. For feeding of 3 canes at a time, the output of the detrasher was 2.4 t/h. There was a saving of about 17% in cost of operation and 84% in labour requirement using the detrasher as compared to manual method.

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

Traditionally sugarcane is planted at of 75-90 cm row spacing causing major constraint in the mechanization of subsequent cultural operations. With a view to facilitate mechanization without sacrificing optimum plant population, paired row planting at 30:120 cm spacing has been advocated. In order to mechanize this labour intensive operation, a tractor operated paired row sugarcane cutter planter was designed and developed. With the help of this equipment, all the operations involved in cane planting were accomplished in a single pass of the equipment. The novel feature of the newly developed planter is its sett cutting mechanism. The ground surface has been used as reference for cutting the whole cane into setts, thereby avoiding the shortcomings of feeding rollers, seed chute etc. This mechanism facilitates free fall of the cut setts without gaps. The equipment was tested in the field. The length of the setts varied from 35 to 37 cm. The equipment plants one pair of rows at a spacing of 30 cm in the single pass. Tractor rear wheel marking is utilized to maintain inter pair spacing of 120 cm. The effective field capacity of the equipment was 0.20-0.25 ha/h with a field efficiency of 65-70%.

Another prototype of wide spaced paired row cutter planter is under development with attachment for making furrows at both ends of the paired rows. The modifications in power transmission has also been done in the second prototype for making it sturdy and dust proof.

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

Following four types of blades of various profiles and angles being used presently in different sugarcane planters got fabricated (Fig. 7.1). IISR first model and khalsa type

Plate 7.4. Front view of wide spaced paired row sugarcane cutter planter

1) IISR ridger type of two disc planter
2) IISR Multipurpose planter
3) VSI planter developed under NATP

The test set up (Fig. 7.2) has been designed for measurement of cutting energy of different types of cutting blades. The fabrication of the test set up is under progress.

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

Residue mulcher –cum- bio applicator was designed on the principle of shearing a compressed and formatted layer of residue into small pieces and mingling the cut pieces in soil. It uses convex side of the curved blade mounted on a rotating shaft at the rate of 300 rpm. Circumferential speed of the outer edge of the shearing blade was 8-10.5 ms^{-1}. A preparatory roller has been provided ahead of the set of blades only to compress and prepare the layer of residue in a proper format for smooth shearing and for intermingling the cut pieces with resilient soil by force through downward movement (Plate 7.5). As per recommendation, it is required to spray definite chemicals or bio-agents for quickening the process of decomposition. The unit has been equipped with a set of nozzles for each row. These are attached to the liquid container. The bio-agents or the chemicals are mixed with water for application in the field.

Prototype feasibility trial of tractor operated sugarcane harvester (FIM/ IISR/PFT/2009/1)

The feasibility trial of IISR tractor operated front mounted sugarcane harvester was conducted at IISR farm. The row to row spacing was 75 cm. The variety was CoS 95270. The crop was partially lodged. The performance of the equipment was satisfactory in cutting and windowing of harvested cane for the rows which were not lodged. However, in lodged canes, cane were lifted before harvesting the row. The average effective field capacity of the equipment was 0.15-0.20 ha/h with field efficiency of 50-60%.

Front view

Rear view

Plate 7.5. Residue mulcher-cum-bio applicator

Prototype feasibility trial of power operated sugarcane detrasher (FIM/IISR/PFT/2009/2)

The feasibility trial of IISR power operated detrasher was conducted at IISR farm. The harvested canes of variety CoS 95270 were fed from their green tops side through the feeding chute to the detrashing rollers. The average trash left on the cane after passing through the detrasher was 5.5%. Average trash removal efficiency was 80.0%.

Prototype feasibility trial of LASER guided land leveller (FIM/IISR/PFT/2009/3)

Technical specifications for tractor operated LASER guided land leveller have been finalized.

Development of suitable post-harvest technology

8.1 Post-harvest losses in sugarcane

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

1. Effect of soil application of zinc on post-harvest quality of sugarcane

Sugarcane variety CoSe 92423 subjected to pre-harvest soil application of zinc and manganous sulphate (@25 kg / ha) in the third week of December i.e. 11 weeks before the harvest was evaluated for its impact on the post-harvest quality. Sucrose and purity in zinc treated cane recorded 1.9 and 0.7 percent increase after 7 days of staling compared to trash covered control. Application of manganous sulphate treated cane did not show any improvement in juice quality during staling.

2. Post-harvest application of chemicals on billet quality during late crushing season

Efficacy of an aqueous chemical formulation consisting of benzalkonium chloride (2000 mg / l) and sodium metasilicate (1%) was evaluated to minimize post-harvest deterioration of cane billets during late-milling season. It was noticed that the loss in commercial cane sugar (CCS) in untreated, water sprayed + trash covered and chemically treated cane after 7 days of storage was 8.63, 5.54 and 4.40 units, respectively. This indicated that chemical formulation was quite effective during late season and its application on the billets resulted in one unit increment in CCS over control. Other quality parameters viz., reducing sugars and titrable acidity /100 brix also recorded appreciable differences in treated and control billets.

3. Dextransucrase activity during post-harvest period

In manually harvested full green cane, transferase activity in untreated, water treated + trash covered and chemically treated cane showed an increase of 91.06, 79.78 and 56.40 units, respectively 240 hours after storage during late-season. This indicated the efficacy of chemical treatment in minimizing post-harvest sucrose losses.

8.2 Sugarcane processing for manufacturing of jaggery and developing storage techniques

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

The rollers of crusher were modified and fitted. The thickness of collar of king roller was increased to 25 mm with 35 mm depth. Accordingly, size of other two rollers was reduced for accommodating modified king roller. All old bushes were replaced by new ones. Testing of crusher showed juice extraction of 56 per cent (cane basis) on crushing capacity of 412 kg / h.

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

Modified filter was fabricated and tested with sugarcane juice . The filtration efficiency was found 80% at 300 l h^{-1} filtration capacity.

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

The peeler was tested. During the testing, single cane feeding was maintained manually. The capacity of the unit was 100 kg / h with 85% peeling efficiency.

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

Different components viz. one set of three horizontal rollers(king,feed and extraction), one set of three gears for power transmission, sugarcane entry and bagasse exit port and framing plate in rectangular shape were

fabricated . Rollers with gears were mounted in counter rotating fashion in rectangular frame plate and in all assembled maintaining proper alignment.

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

The testing of rotary system in vertical plane was done at rotor speed of 11-15 rpm in the open pan filled with about 150 lit of cane juice . About 100 ml juice filled in the each bucket of horizontal rotor totaling to about 600 ml was lifted and poured back into the juice mass of the pan for uniform mixing and it worked satisfactorily

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

Performance of smaller pans with different fin sizes and spacings was evaluated experimentally using water boiling test. Data revealed that the efficiency increased with increase in area of heat receiving surface of pan. Pan with 311 per cent increase in area of heat receiving surface gave maximum improvement in heat utilization efficiency (67 per cent). It was also found that smaller and more number of fins could be better choice over larger and lesser fins for a given increase in area of heat receiving surface. More fins could be accommodated with lesser weight in case of thinner fins.

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

Value added jaggery bars measuring 75 x 25 x 12.5 mm and 50 x 25 x 12.5 mm and each weighing about 30 g and 20 g, respectively were prepared. Such shape is suitable for individual packaging and ease in handling. A chain of individual packs can be made easily. Such kind of jaggery is supposed to give better profitability.

Storability of value-added jaggery was assessed for a period of six months at room temperature. This stored well and at par with plain jaggery. However, the strength of jaggery improved due to reinforcement of *aonla* fibres. Negligible loss of vitamin C was observed during the storage period.

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

The drier was tested for drying of fresh jaggery . The moisture content of jaggery on dry weight basis was reduced from 13.5% to 7.8% after 9 hours of drying. Two tempering of half an hour duration were provided at three hours of drying interval. First tempering of half an hour duration was provided three hours after drying and second, after another three hours of further drying (cumulative drying period of six hours). During the entire drying period, the rate of drying falls under falling drying rate periods. Rate of drying (reduction in moisture content on dry weight basis, % per unit time) decreased with an increase in the drying time. It was found that the overall performance of the drier was satisfactory. Samples from the dried jaggery were collected and stored for six months. During the analysis of stored jaggery samples, the qualitative parameters like sucrose, reducing sugar and colour reading were found at *par* with the natural dried jaggery.

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

A 100 kg jaggery cube solar dryer was fabricated. It consisted of wooden drying chamber with double staked trays and provision of intake of ambient air, radiation trapping glass, chimney and metallic frame.

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

Mechanical strength of the selected packaging materials was determined for packaging under modified atmosphere of jaggery samples. Institutions dealing with packaging (CIPHET and PAU, Ludhiana) were contacted for determining other properties like water and vapour transmission rate of the selected packaging materials.

8.3 Diversification of sugarcane based by - products

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

Significant reduction in production of inhibitors was noticed in sugarcane trash hydrolysates with *Aspergillus terrus*, *Cellulomonas uda* and *Aspergillus awamori* pre-treatment as compared to acid pre-treatment.

Significant reduction in cellulose digestibility (%) and reducing sugar contents (10- 35%) on saccharification of acid pre-treated sugarcane trash was observed with 5 hydroxy-2 methyl furfural, furfural, levullinic acid, 3,4 dihydroxy benzoic acid and vanillic acid.

9 Sugar beet improvement, its seed production and crop management

Developing sugar beet varieties for Indian agro-climates (B 2.15)

The work of this project is carried out at two locations i.e., Lucknow and Mukteswar. Lucknow is for root crop evaluation and raising of the steckling crop for germplasm maintenance and breeding work; while Mukteswar activity involves sugar beet flowering, breeding and seed production.

This year, the germplasm received from USA was evaluated for flowering behavior and pollen fertility at Mukteswar. Male sterility was observed in SR-96 and as expected in FC-722 CMS. Some experimental composites and crosses were made at Mukteswar. The composites viz., LKC-2006 and LKC-2007; high brix and heat tolerant material IISR Comp-1 HBHT and three hybrids viz., SR-97 X LS-6, Hilima X LS-6 and LK-0503 X LS-6 were evaluated along with LS-6 and Shubhra for their root crop performance at Lucknow. The LKC-2007, IISR Comp-1 HBHT and Hilima X LS-6 possessed superiority in sugar yield (Table 9.1).

The indigenous variety, LS-6 was taken for bulk seed programme and 110 kg of seed was produced, of which more than half was sold. In addition, 18 kg seed of thirty-six germplasm / breeding lines / composites and hybrids was produced at Mukteswar.

Evaluation of sugarbeet hybrids (CR-1/08)

This is a two-year contract research project to test the root crop performance of five sugarbeet hybrids developed by KWS and provided by M/s J. K. Agri. Genetics, Hyderabad.

During the first year of the trial, these hybrids viz., Arriba, Calixta, Capitana, Esperanza and Sandrina were evaluated along with two checks LS-6 & Shubhra and another indigenous variety, IISR Comp-1. The experiment had two objectives:

1. To find out the optimal sowing time
2. To find out the better performing hybrids

Table 9.1: Performance of composites and crosses in relation to standards

Genotype	Plant pop. (000 ha^{-1})	Root length (cm)	Crown size (cm)	Root weight (kg)	Top yield (t ha^{-1})	Root yield (t ha^{-1})	Brix%	Sugar content (%)	Sugar yield (t ha^{-1})
LKC - 2007	88.5	28.3	7.2	0.73	5.01	64.81	19.87	13.79	8.937
LKC - 2006	88.8	35.7	9.1	0.44	4.38	39.04	20.67	14.55	5.680
IISR Comp-1 HBHT	87.2	45.1	8.8	0.74	6.16	64.15	20.47	14.21	9.116
SR - 97 X LS – 6	89.9	24.5	8.0	0.58	4.38	51.78	20.13	13.97	7.234
Hilima X LS – 6	92.7	26.4	9.9	0.78	4.69	71.90	20.60	14.30	10.282
LK - 0503 X LS – 6	88.6	33.1	9.3	0.54	3.78	48.19	20.73	14.59	7.031
LS – 6	85.4	31.5	9.9	0.86	4.67	73.31	19.93	13.83	10.139
Shubhra	90.7	29.6	7.7	0.67	3.75	60.56	22.27	15.68	9.496
CD 5%	0.8	1.13	0.29	0.04	0.67	3.43	1.01	0.52	0.59
CV %	1.0	10.53	12.08	6.73	12.61	6.57	5.60	4.09	7.89

Optimal sowing time

Replicated trials in RBD at three dates of sowing viz, first fortnight of October (D_1), second fortnight of October (D_2) and first fortnight of November (D_3) were conducted.

The second fortnight of October (Table 9.2) was found to be the best for root weight (0.833 kg), root yield (74.2 t / ha) and sugar yield (11.24 t / ha). However, D_1 was the best for sucrose content in roots (15.56%), although D_2 was close (15.17%).

Promising Hybrids

Sandrina and Calixta showed promise as compared with checks for sugar yield. No hybrid was superior to Shubhra in root quality (sucrose content). For root yield, all the hybrids were comparable with the checks, while Sandrina and Calixta were significantly better (over 70 t / ha).

Besides, data were generated on the root weight and quality at different times of harvesting, i.e., 135, 150, 165, 180, 195 and 210 days after sowing. The results shall be concluded next year.

Table 9.2 : Performance of sugar beet hybrids at 180 days as affected by sowing time

Variety	Root weight (kg)			Sucrose content (%)			Root yield (t ha^{-1})			Gross sugar (t ha^{-1})		
	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3	D_1	D_2	D_3
Arriba	0.63	0.91	0.62	15.33	14.49	14.66	59.3	79.2	61.7	9.10	11.48	9.04
Calixta	0.71	0.89	0.69	16.29	15.00	13.89	65.4	77.3	68.0	10.66	11.60	9.44
Capitana	0.76	0.65	0.71	15.38	15.10	13.89	69.9	61.6	66.1	10.76	9.30	9.18
Esperanza	0.62	0.79	0.59	14.42	14.29	13.20	57.8	78.3	57.8	8.33	11.18	7.64
Sandrina	0.73	0.76	0.64	14.95	15.30	13.43	71.5	81.6	67.1	10.69	12.48	9.01
Shubhra	0.54	0.78	0.69	17.11	16.84	13.02	57.3	72.8	65.3	9.81	12.26	8.50
LS- 6	0.67	0.92	0.61	15.72	15.25	12.98	60.7	72.4	56.4	9.54	11.04	7.32
IISR Comp- 1	0.66	0.91	0.62	15.24	15.05	14.71	64.3	70.4	60.2	9.79	10.60	8.85
Mean	0.66	0.83	0.65	15.56	15.17	13.72	63.29	74.20	62.82	9.83	11.24	8.62
CD 5%	0.03	0.04	0.03	1.95	2.27	1.59	2.36	2.26	2.61	1.03	2.11	0.89
CV %	2.60	2.43	2.18	6.96	9.17	6.24	1.90	1.37	2.09	5.90	10.30	5.58

D1 : 15th of October D2 : 31st of October D3 : 15th of November

10 Technology adoption, constraints analysis, socio-economics, statistical models/procedures, database and computer applications

10.1 Technology adoption and analysis of constraints

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 to 115 trainees from sugar mills and agricultural department of different state governments who attended different training programmes at IISR, Lucknow. The responses of trainees on pre - and post-attitudes were ascertained with the help of developed attitude scale. Based on such responses, pre- and post-attitude scores were calculated as 135.3 and 167.2, respectively, with an increase of 23.56 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 developments 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) (MWR-1/08)

Total 40 demonstrations (Table 10.1) on the fields of cane growers in the sugar mill zones of Rauzagaon, Hydergarh and Biswan were conducted during 2009-10 crop season. The results of demonstrations revealed that there was a significant increase in crop yield, irrigation water saving and irrigation water use efficiency (Table 10.1). The maximum increase in cane yield was recorded in ring-pit method of planting (114.27%) over the conventional method followed by trash mulching (37.97%), irrigation at critical growth stages (28.46%) and skip furrow method of irrigation (24.24%). The saving in irrigation water varied from 16.19 to 38.45 per cent. The irrigation water use efficiency was recorded the highest in ring-pit method of planting (169.37%) over the conventional method followed by irrigation at critical growth stages (108.72%), trash mulching (98.67%) and skip furrow method of irrigation (48.25%).

The cost of sugarcane cultivation was the highest in case of ring-pit method of planting, the highest return accrued from this technology well compensated the increased cost (Table 10.2). The highest net return (Rs. 220217 ha^{-1}) was recorded in case of ring- pit method of planting followed by trash mulching (Rs. 143833 ha^{-1}), skip furrow method of irrigation (Rs. 125216 ha^{-1}) and ICGS (Rs. 100420 ha^{-1}). Among the demonstrated technologies, the highest B/C ratio was observed in trash mulching technology (2.83) followed by ring-pit method of planting (2.03), skip furrow method of irrigation (1.96) and ICGS (1.45) .

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

Tech-nology	No. of demon-strations	Average yield (t ha^{-1})		Increase in cane yield (%)	Irrigation water applied (ha-cm)		Saving in irrigation water (%)	IWUE (kg cane/ ha-cm)		% Increase in IWUE
		Demon-stration	Conven-tional		Demon-stration	Conven-tional		Demon-stration	Conven-tional	
Skip furrow method of irrigation	10	85.43	68.76	24.24	59.00	70.40	16.19	1447.97	976.70	48.25
Ring-pit method of planting	13	147.33	68.76	114.27	56.00	70.40	20.45	2630.90	976.70	169.37
Trash mulching	10	88.30	64.00	37.97	50.00	72.00	30.56	1766.00	888.89	98.67
ICGS	7	88.33	68.76	28.46	43.33	70.40	38.45	2038.54	108.72	108.72

ICGS- Irrigation at critical growth stages, IWUE – Irrigation water use efficiency

Table 10.2: Comparative economics of demonstrated technology over farmer's practice in planted and ratoon crops of sugarcane

S. No.	Particulars	Farmers' practice		Demonstrated technology			
		Plant cane	Ratoon	Trash mulching in ratoon	Ring pit	ICGS	Skip furrow
					In planted sugarcane		
1.	Cost of production (Rs ha^{-1})	66764	41273	50787	108426	69091	63916
2.	Yield (t ha^{-1})	68.76	64	88.30	147.33	88.33	85.43
3.	Gross return (Rs ha^{-1})	152871	141125	194620	328643	196511	189132
4.	Net return (Rs ha^{-1})	86107	99852	143833	220217	100420	125216
5.	B:C ratio	1.29	2.42	2.83	2.03	1.45	1.96

ICGS- Irrigation at critical growth stages, B:C ratio= Net return: Cost of production

10.2 Socio-economics and policy analysis

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

Time series data on cost of cultivation of sugarcane crop for six states in India viz., Andhra Pradesh, Haryana, Karnataka, Maharashtra, Tamil Nadu and Uttar Pradesh, were collected from Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi to analyse the trend and growth in cost of cultivation during 1996-97 to 2003-04.

The annual linear and compound growth rates for the period 1996-97 to 2003-04 were estimated to measure the growth in cost of cultivation of sugarcane in different states of India (Fig. 10.1). The highest growth rate (Table 10.3) was registered for Maharshtra (11.17 %) followed by Karnataka (9.51%), Haryana (8.70%) and Uttar Pradesh (4.49%). However there was no significant change in cost of cultivation in Tamil Nadu and Andhra Pradesh. As far as in cost term, there was Rs. 5261 / ha / year increase in Maharashtra followed by Karnataka (Rs. 3778 / ha / year) , Haryana (Rs. 3657 / ha / year) and Uttar Pradesh

(Rs. 1248 / ha / year). In case of value of sugarcane, there was 8.38 % growth in Haryana followed by 5.84 % in Karnataka and 4.74% in Maharashtra per year. The profit margin of sugarcane cultivation was highest in Karnataka (Rs. 24100 ha^{-1}) followed by Tamil Nadu (Rs. 19769 ha^{-1}), whereas in UP and Haryana, it was found nearly Rs. 10000 ha^{-1} (Table 10.4). The average cost of cultivation was highest in Tamil Nadu (Rs. 60128 ha^{-1}) followed by Andhra Pradesh (Rs. 48334 ha^{-1}), Maharshtra (Rs. 48265 ha^{-1}). The lowest cost of cultivation was in Uttar Pradesh Rs. 27770 / ha during this period. Similarly in case of value of sugarcane, it was estimated highest in Tamil Nadu (Rs. 79896 ha^{-1}) and lowest in Uttar Pradesh (Rs. 37586 ha^{-1}). The maximum increase in cost of cultivation in sugarcane was observed in Maharashtra (109%) followed by Karnataka (75%) and Haryana (63%). There was no significant change in cost of production of sugarcane during this period i.e., 1996-97 to 2003-4 for Tamil Nadu and Andhra Pradesh. In Maharashtra, cost of cultivation increased during this period because of increase in cost of per unit seed (kg) by 81.74%, fertilizer (kg Nutrient) by 79.04%, manure (qtl.) by 76.33%., human labour (Man hr.) by 73.62% and animal labour (pair hr.) by 70.92%. Similary in case of Karnataka, increase in cost of per unit seed (kg) by 15%, fertilizer (kg nutrient) by 27%, manure (qtl.) by 21%., human Labour (man hr.) by 37% and animal labour (pair hr.) by 95%. In Tamil Nadu, only animal labour and manure were affected for change in rate per unit cost (Rs.). Change in operational cost was highest in Maharashtra by 175% followed by Tamil Nadu by 125% during this period.

The maximum increase in cost of irrigation was observed for Karnataka (440%) followed by UP (120%) and Maharashtra by 119%. As far as input used (Rs ha^{-1}) is concernd, there was maximum increase in fertilizer, manure and seed over this period. Where in Tamil Nadu, Andhra Pradesh and UP, there was no significant increase in use of input per hectare. The economics of sugarcane cultivation in three selected states (Uttar Pradesh, Haryana and Karnataka) varied substantially, depending upon its agro-climatic conditions, nature of crop (plant or ratoon), variety grown, input use, etc. Being a water-intensive crop, availability of adequate water was a crucial factor, which affected the cost of cultivation. Sugarcane is also a labor intensive crop. Labor accounts for 50% or even more of the total variable input cost in sugarcane cultivation.

Rice-wheat is the most common cropping system in UP which occupied nearly 15.16 M ha area during 2003-04 and having yield, 2.18 t ha^{-1} of rice and 2.79 t ha^{-1} of wheat. The increase in cost of cultivation of wheat in UP was 38% and in Haryana was 44% over the period, year 1996-97 to 2003-04. The increase in cost of cultivation of rice was 63% in Haryana (63%) and 28% in UP. The increase is less for sugarcane which is calculated as UP (28%) and Haryana (30%). Thus, the analysis of the data over the years reveals that the cost of cultivation of sugarcane has not increased as more as the competitive crops like rice and wheat which is also one of the factor for increasing area under sugarcane in sub-tropical India.

Table 10.3: Economics of sugarcane cultivation in different states of India

State	Compound growth rate of cost of cultivation (%)	Linear growth rate of cost of cultivation (Rs/year)	Linear growth rate in profit margin (Rs/year)	Compound growth rate of values of sugarcane (%)	Linear growth rate of values of sugarcane (%)
Uttar Pradesh	4.49	1248	-235	2.67	1013
Haryana	8.7	3657	587	8.38	4245
Maharashtra	11.17	5261	-2942	4.74	2320
Karnataka	9.51	3778	-191	5.84	3587
Tamil Nadu	0.001	-4	-4	-4.86	-4199
Andhra Pradesh	-0.41	-212	212	-0.35	-189

Table 10.4: Average of profit margin of sugarcane cultivation in India (1996-97 to 2003-04)

State	Cost of cultivation (Rs/ha)	Value of sugarcane (Rs/ha)	Profit margin (Rs/ha)
Uttar Pradesh	27770	37586	9816
Haryana	41297	51187	9890
Maharashtra	48265	47783	Not profitable
Karnataka	43178	67277	24100
Tamil Nadu	60128	79896	19769
Andhra Pradesh	48334	53709	5375

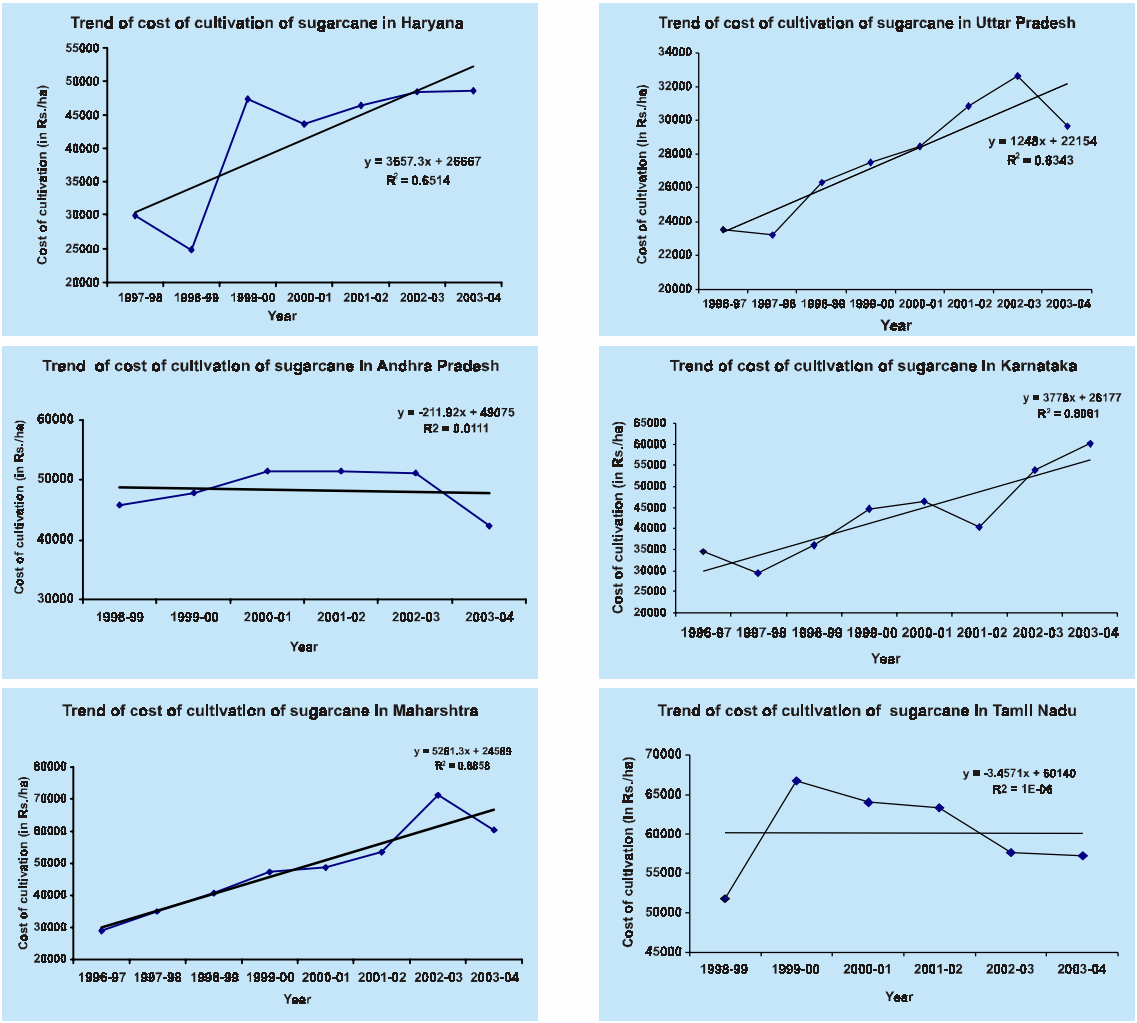


Fig. 10.1. Trends in cost of cultivation of different states

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

The sugar industry of India, being the largest agro based processing industries in rural India, has been the focal point for socio-economic development in the rural areas by mobilising rural resources, generating employment and higher incomes, transport and communication facilities. Many sugar factories have established schools, colleges, medical centres etc for the benefit of the rural populations in the area which have long-term productivity consequences. The industry has created ample

employment opportunities in rural areas. Sugarcane sector provides employment to millions of people in the country as self-employment to the farmers, wage employment to agricultural labourers in sugarcane cultivation and in other cane based small-scale enterprises. It also provides employment as skilled and non-skilled workers in sugar mills, gur and khandsari units, and in other ancillary activities. The contribution of sugar sector in employment generation in India was estimated under the project during the year under reference.

Employment to farmers

There are 5.997 million (say 60 lacs) sugarcane-growing holdings in India as per Agricultural Census 2000-01, which accounts for 5.07 percent of the total farmers (operational holdings) in India. Majority (91.87%) of cane farmers existed in 10 main cane producing states, viz A.P., Karnataka, T.N., Maharashtra, Gujarat, Punjab, Haryana, U.P., Uttrakhand and Bihar. Of the approximately 59.97 lakhs cane-growers in India, about 29.77 lakhs (49.66%) cane growers are marginal farmers having less than 1 ha area, and 15.17 lakhs (25.30%) have total holding size of 1-2 ha. About 9.94 lakhs (16.61%) have holdings of 2.0 to 4.0 hactares each, and about 5.07 lakhs cane growers (8.46%) own more than 4 hectares, including sugar barons who own hundreds of acres. Thus, 75 per cent of the cane cultivators (45 lakhs) are small and marginal farmers. The proportion of small & marginal cane growers is higher in sub-tropical region (76.93%) compared to tropical region (71.78%). Cane growers of more than 4 ha in size were just 8.46% or (5.07 lacs) of the total cane growers in India, out of which, 1.0% or about 60 thousand holdings grow cane in more than 10 ha in size. The proportion of marginal and small cane farms is also quite high (81.42%) in UP, while it is very low (8.64%) in Punjab, and moderately low in Haryana (45.93%). The proportion of large cane farms is highest in Punjab (15.10%) followed by Haryana (5.17%). The share of medium and large holdings in Gujarat is quite higher compared to other states.

The sugarcane cultivators as percentage of total cultivators in India are just 4.7%. The sugarcane cultivation has given sustenance to about 42 million population in rural areas (5.65% of the total rural population in India. It was estimated that the sugarcane cultivation provides employment to about 24 million cane growers and their family members (10.2% of the total agricultural workers) in India (Table 10.5). Sugarcane is the most profitable crop in areas where it is cultivated. It provides cash income to farmers to carry out their business and other obligations. At present market rates, it provides gross returns (@ Rs. 200 per quintal or even more for 70 tons per ha crop yield on an average) worth Rs. 1.40 lacs, and cash income (net profit) at Rs. 40-60 thousands per ha. To an average marginal farmer, sugarcane provides about Rs. 50000 gross returns from his average cane farm size of 0.36 ha, where as a large farmer with his average cane farm size of 3.56 ha gets around Rs. 5.00 lacs per year as gross income. Based on these estimates, the cane farmers get around Rs. 26000 crores as their gross income on an average.

Employment to labour in sugarcane cultivation

Sugarcane cultivation operations are carried out manually, except field preparation like ploughing, harrowing, forming ridges and furrows. Being a long duration crop, sugarcane needs 230 to 300 mandays of labour per ha distributed over a period of 8 months from October to May. However, as per data from the Cost of Cultivation Scheme, GOI, the actual labour use per ha varied from 141 days ha^{-1} in Haryana to 301 days ha^{-1} in TN. Based on this information, it has been estimated that 883 mln mandays are used annually for sugarcane cultivation, out of which 350 mln mandays (39.6%) are contributed by family labour, 485 mln mandays (54.9%) by casual hired labour. Sugarcane growers also keep labour on their farms on permanent basis, and the extent of such permanent attached labour was estimated to about 48 mln mandays (5.40%).

Employment in Sugar Mills

Sugar industry is the second largest industry, which provides employment to a large number of technical and non-technical personnel. They are connected directly and indirectly with the processing of sugarcane into sugar. The manufacture of sugar requires the

application of different technologies. It involves several biochemical processes like fermentation, boiling and sugar chemistry. Professionals who have the technical knowledge on sugar technology, industrial fermentation and alcohol technology, sugar instrumentation technology, environmental science, pulp and paper technology, and sugar boiling are employed in sugar mills. In addition, management of the mill operations is highly paid job in the industry. Mechanical or electrical engineers are also employed in Sugar Industry. Sugar technologists are also employed in sugar factories, alcoholic or non- alcoholic production plants or sugar research labs. Agriculture graduates / post graduates are employed in cane area development in almost every sugar mill. The sugar industry provides employment to these graduates for the development of cane areas.

Sugar industry is a complicated industry and consists of not only engineering and technology processes, but also requires number of administrative personnel. It employs unskilled, semi skilled, skilled and highly skilled technicians and supervisory staff. The numbers of persons employed per factory varied from 609 in MP to 1168 in TN. On an average, about 800 persons are employed per sugar mill. Further the sugar industry is a seasonal industry and a good number of persons are employed on the seasonal basis and others remain on non-seasonal or permanent basis. An approximate indication of the percentage composition of seasonal and non-seasonal employees in the sugar industry indicates that 55% workers are seasonal and 45% are non-seasonal on an average. With modernisation and continuous upgradation in the capacity of sugar mills upto 13000 TCD in as well as improvement in the technical efficiency of the operations of the sugar mills, number of persons employed per sugar factory will be higher and may average about 1000 persons per sugar factory, however, such sugarmills are quite less in India.

The sugar industry has given direct employment to about 5 lakh rural people. Sugar industry is one of the largest pay masters, the aggregate salaries, wages and other benefits accrued to the employees in the sugar industry, on an average, amounted to Rs. 6.7 to 8.5 crores per sugar mill per year and about Rs. 3300-4200 crores per year in aggregate.

Employment in gur & khandsari units

Over 1 lakh people are employed in the khandseri units. In UP, there were 1061 licensed khandsari units out of which only 300 are in operation providing employment to about 1.20 lakhs rural population in UP state where Khandsari units are more concentrated. There is limited information on the number of gur and khandsari making units in India, as the sector lies in the unorganized sector. Quenquinnium Surveys provide information on the number of animal as well as power operated crushers in India. There are 8.32 lakh animal- and 3.39 lakh power-operated cane crushers in India. It was estimated that the gur making units in the country are about 5.05 lakhs (1.66 lakhs animal-operated and 3.39 lakhs power-operated) which provides employment to about 21.86 lakh people in gur making units in rural India.

Employment in sugarcane transport

The persons engaged in cane transport are around 4398 per day per sugar mill. This amounts to employment of about 8.7 lakh persons in sub-tropical region where the cane is carried to purchase centres first and then to the mills, and around 14.8 lakhs at the country level.

Employment in backward and forward linked industries.

The sugar industry provides a host of others gain employment in industries, which use its by- products as their raw material, particularly the ethanol, cogen and the distillery units. Employment opportunites have been generated in the construction of roads in the cane command areas. In addition, there is indirect employment in the form of tyre puncture repair units, *pan masala gumaties* at mill gate as well as its purchase centres. For example, in central UP, at least 2 persons per centres i.e. 60-70 persons per day per sugar mill has got self employment.

Table 10.5: Estimates of contribution of sugar sector to employment generation in India

Particulars	Unit	Value
Sugarcane Growers / cultivators	Millions	6.00
Sugarcane growers / cultivators in sub-tropical region	Millions	3.69
Sugarcane growers / cultivators in tropical region	Millions	2.30
Small & marginal category sugarcane growers	Millions	2.977
Total dependent population of cultivators	Millions	41.98
Total workers in sugarcane	Millions	23.99
Total cultivators in India 2001	Millions	127.6
Total agri. workers in India in 2001	Millions	235.1
Total rural population in India, 2001	Millions	741.7
Total agri. labourers in India in 2001	Millions	107.5
Total workers in India	Millions	402.5
Sugarcane cultivators as % of total cultivators	%	4.70
Sugarcane workers as % of total agri workers	%	10.20
Employment to labour in sugarcane cultivation		
Total labour	mmd	883.61
Family labour	mmd	350.39
Casual labour	mmd	485.47
Attached labour	mmd	47.74
Direct employment in sugar mills		
Persons employed per sugar mill	Nos.	798
Seasonal labour share	%	55.1
Total employment (persons) in sugar mills	lakhs	4.02
Average annual wage bill per sugar mill	Rs. Crores	6.74
Total average wage bill of all sugar mills	Rs. Crores	3387
Employment in Gur & Khandsari sector		
No. of gur making units	lakhs	5.05
Persons engaged in gur making	lakhs	21.85
Cane farm size		
Average size of cane farm	ha	0.77
Average size of marginal cane farm	ha	0.36
Average size of large cane farm	ha	3.56

Abbr: mmd- million mandays

Developing efficient sugarcane marketing strategies in India (AES 4.12)

Cane supply arrangements are extremely important both for the growers and the sugar factory. Sugarcane is perishable and the sucrose contents get reduced if it is not milled within a short period after harvesting. The factory wants a planned inflow of cane from large number of farmers [10,000 to 15,000 farmers] in about 150 to180 days. Hence, there arises a need to carry out planning to complete the operations efficiently for the maximum benefit of the farmers and the factory as per existing institutional (Acts and Orders) norms. Under existing norms, cane price is set by the Central Govt. (SMP) as well as by the State Govts. (SAPs). The State Governments also reserve the area for various sugar mills. However, the practices regarding cane supply vary considerably in the States. Any improvement in the existing arrangements would require a thorough study of 3 types of marketing arrangements existing in India, the regulatory framework and the intermediate purchasing societies / groups that have become more constraining rather than facilitating. Hence, there remains a need for alternative efficient marketing arrangements.

Broadly 3 types of sugarcane supply arrangements exist in India. Maharashtra and Gujarat have a similar system. The sub-tropical States i.e., UP, Bihar, Punjab and Haryana have a different system. The tropical States, Tamil Nadu, Andhra Pradesh and Karnataka follow another system. Each system has its positive points and its drawbacks. Neither system is complete in itself. There have occurred gradual distortions in the cane marketing systems over time, and the both systems (in Maharashtra as well as in UP) have become detrimental for the growers / mills. A very careful planning / fine-tuning / improvement of cane supply arrangements is necessary to complete the operations efficiently for the maximum benefit of the farmers and the factory. The existing marketing arrangements are being studied under this project.

10.3 Development of statistical models/procedures

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

Weather during 2008-09 crop season

The weather during the crop season 2009-2010 was characterized by lower average maximum temperature in May, September, October, November 09 and January 2010 by 1.1, 0.1, 0.8, 1.3 and 4.2°C, respectively compared to long term (LT) average (1980-2008). It remained relatively higher during April, June, July, August, December 09, February and March, 2010 by 0.8, 2.0, 1.5, 0.6, 0.3, 0.1 and 2.9°C, respectively compared to LT (1980-2009) average.

The minimum temperature exceeded LT average during April, May, July, September, November, December, 09, January February and March 2010 by 0.7, 0.1,1.0,0.2, 1.3, 0.2, 0.7, 1.6 and 2.0°C, respectively. It remained lower during October 09 by 1.2°C. It was normal during June and August 09.

Morning relative humidity remained lower than LT average during April, June, July, August, October 09 and March 2010 by 10, 10, 3,2,4 and 3%, respectively. It exceeded LT normal during May 09, January and February 2010 by 4, 2 and 3% respectively. It remained normal during September, November and December09.

Afternoon relative humidity was above LT normal during May, September, November 09, January and February 2010 by 7, 1, 4, 17 and 2% respectively. It remained below LT normal during April, June, July, August, October and December 09 by 6, 15, 8, 2 and 7% respectively. It remained normal during March 2010.

The duration of bright sunshine remained lower than LT average during all through the crop season from April 09 to March 2010 ranging from 0.4 to 3.7 h day^{-1} except in the month of July where it exceeded LT normal by 0.6 h day^{-1}. The maximum reduction in duration of bright sunshine was observed in November 09 (3.7 h day^{-1}) and minimum was in March 2010 (0.4 h day^{-1}).

During the crop cycle 2009-2010, the total rainfall received was 1000.4 mm as against LT normal of 912.6 mm. During monsoon season, the total rainfall received was 833.0 mm as against LT normal of 797.4 mm. Thus monsoon rainfall was in excess by 35.6 mm.

Weather-based yield prediction model for sugarcane in UP

A weather interactive model for predicting sugarcane yield for the state of Uttar Pradesh developed during 2007-08 was up dated till 2008-09. The monthly average of weather parameters *such as* maximum (Tmax) and minimum (Tmin) temperature, morning (RH7) and afternoon (RH14) relative humidity, rainfall (Rain) and range of temperature (Trange) were used from April to September. Three models were developed. Model 1 includes weather parameters Tmin, RH7, RH14, Rain and Trange. Model 2 is based on Tmax, Tmin, RH7, RH14, Rain and Trange. Model 3 included Tmax, Tmin, RH7, RH14, and Rain. These multiple regression models were developed using generated variables for each weather parameter based on respective correlation coefficients of individual weather parameters with yield during April to September. The models were updated for each year for predicting the yield in the following year. The coefficients of multiple determination of these models were found to be significant at 1 %.

Model description

$$Y = a_0 + \sum_{i=1}^{p} a_i z_i + e$$

$$= a_0 + a_1 z_1 + a_2 z_2 + \text{————} a_p z_p + e$$

where

$$z_i = \sum_{w=1}^{f} r_{iw} * x_{iw}$$

Y is yield, x_{iw} is value of i^{th} weather parameter in w^{th} month and r_{iw} is value of correlation coefficient between yield and i^{th} weather parameter in w^{th} month, p is number of weather variables for prediction and e is error term

Model validation

The models were validated from 2000-01 to 2008-09 sugarcane crop seasons. Model 2 was found best with RMSE of 9.41% (Table 10.6).

Table 10.6: Validation of models

Crop cycle	Yield (t ha^{-1})			
	Observed	Model 1	Model 2	Model 3
2000-01	54.7	54.7	53.5	51.2
2001-02	58.0	59.2	56.9	54.8
2002-03	56.3	59.2	52.3	53.1
2003-04	55.5	60.4	44.2	44.5
2004-05	60.7	68.7	58.2	52.8
2005-06	58.2	66.9	60.2	54.3
2006-07	59.6	68.0	62.8	57.4
2007-08	57.2	65.3	62.9	59.2
2008-09	52.3	59.8	59.9	56.8
Average	56.9	62.5	56.8	53.8
RMSE		6.4	5.4	5.4
%RMSE		11.21	9.41	9.47

SAC-IISR programme on energy and water balance and crop growth monitoring using satellite data

During the period of report, radiation and water balance studies were conducted in an autumn sugarcane crop (CoS 94257). The crop was planted on 27.10.2008 with row spacing of 0.80 m. in 0.4 ha. The crop received nitrogen @ 150 kg ha^{-1} (in three splits) through urea, phosphorous (P_2O_5) @ 60 kg ha^{-1} through DAP and potassium (K_2O) @ 40 kg ha^{-1} through MOP. Both P and K were applied as basal at the time of planting. The crop received 5 pre-monsoon irrigations each of 7.5 cm depth each. The crop was harvested in November 2009.

Canopy development

The canopy development in terms of LAI. as a function of crop age is given in Fig.10.2.

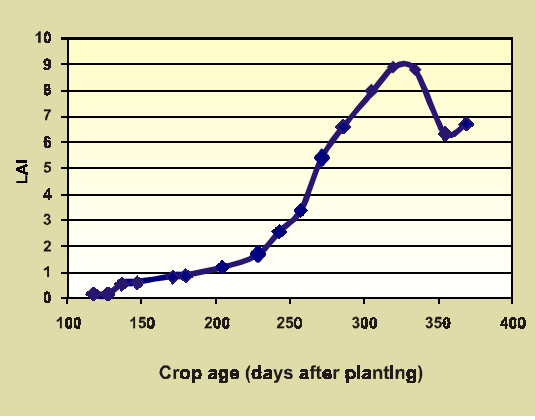


Fig. 10.2. Leaf area index profile in sugarcane

The LAI shows a sharp increase from 228 days of planting (mid-June) to 334 days (end-September) and started decreasing afterward.

Leaf area- height ratio profile

The leaf area (cm^2) to crop height (cm) showed a declining trend with crop age. A highly significant correlation (r = - 0.9337) between leaf area to height ratio with crop age was observed. A very sharp decline in ratio was observed from 257 days after planting (early July) when crop enters into elongation phase. This indicates that the rate of elongation exceeds the rate of foliage development (in terms of leaf area) during elongation phase as compared shoot formation stage.

Equivalent leaf water thickness

The equivalent leaf water thickness was studied in sugarcane varieties, CoS 99259 and CoS 96274 during their active shoot formation and elongation phases (Table 10.7).

Table 10.7: Shoot population, plant height, green leaf number and equivalent leaf water thickness

Date	Shoots (m^{-2})	Height (cm)	Green leaves (Nos.)	Equivalent leaf water thickness
CoS 99259				
06.05.09	2.6	20.2	10.2	0.025371
20.05.09	4.04	31.4	17.75	0.016954
06.06.09	4.98	33.7	21.80	0.01800
20.06.09	5.30	42.2	23.67	0.017324
06.07.09	5.61	50.9	26.79	0.014461
21.08.09	10.90	102.98	82.2	0.015388
07.09.09	10.90	121.04	86.0	0.015579
CoS 96274				
06.05.09	2.6	18.8	11.2	0.025341
20.05.09	3.93	29.5	16.95	0.015663
06.06.09	5.14	32.6	20.58	0.16663
20.06.09	5.75	39.8	23.61	0.014367
06.07.09	6.05	48.6	26.33	0.011472
21.08.09	9.38	122.15	79.3	0.014429
07.09.09	9.68	150.69	81.7	0.014046

It is observed that equivalent leaf water thickness was relatively higher in shoot formation phase as compared to elongation phase in both the varieties. It was also seen that variety CoS 97264 maintained a higher equivalent leaf water thickness as compared to CoS 99259 in both the crop phases.

Crop data at harvest

The autumn planted sugarcane variety, CoS 94257 was harvested on 17th November, 2009. At harvest, it had 11844±2780 millable cane s ha^{-1} having 2.11±0.28 m average cane height, 2.55±0.29 cm average cane girth, 21.71±6.06 average number of internode / stalk, 29.01±1.05 t ha^{-1} green top weight, 3.95±0.95 t ha^{-1} dry leaf weight, 62.59±2.79t ha^{-1} cane stalk weight and 95.47±3.92 t ha^{-1} total biomass.

Radiation balance over sugarcane

The radiation balance over sugarcane crop was worked out from observation of total incoming radiation and net radiation over crop (cv. CoS 94257) using net radiometer and pyrranometer during entire crop cycle on the satellite pass dates provided by SAC. The variability of total incoming radiation, net radiation and albedo is shown in Fig 10.3.

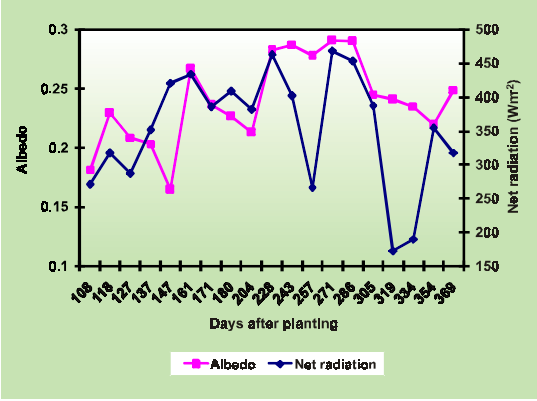


Fig. 10.3. Net radiation and albedo profile in sugarcane

It was observed that the average albedo during formative (tillering) phase (mid–May) was 0.2145 (± 0.0321) whereas during elongation phase, it was 0.2619(± 0.0265). It is apparent the albedo during the elongation phase was relatively higher than formative phase with lesser variability, which may be attributed to better canopy development in terms of ground coverage in elongation phase as indicated in Fig. 10.2.

Water balance studies

The evapotranspiration in the entire crop cycle was studied for autumn planted crop of sugarcane variety CoS 94257 (Table 10.8).

Partitioning of net radiation to ET

For the entire crop cycle, 85.5% of net radiation was utilized for ET. It is observed ET / Rn declined with crop age indicating relatively lower fraction of net radiation being partitioned to ET. The average partitioning of net radiation to ET was 95.9 % during formative phase whereas it was only 83.4 % during elongation phase. The following linear relationship was observed between crop age (X) and ET / Rn (Y)

$$Y = -0.0014X + 1.1995 \quad (R^2 = 0.5101)$$

Table 10.8: Evapotranspiration in sugarcane (CoS 94257)

Date of observation	Crop age (DAP)	Rn (Wm^{-2})	ET (Wm^{-2})	ET (mm day-1)
22.03.09	147	301.2	292.0	10.1
15.04.09	171	299.6	297.6	10.3
24.04.09	180	408.6	398.2	13.8
18.05.09	204	382.1	343.7	11.9
19.06.09	236	462.9	438.2	15.1
26.06.09	243	401.7	395.3	13.7
10.07.09	257	376.0	280.9	9.7
24.07.08	271	468.3	313.8	10.8
08.08.09	286	453.4	330.5	11.4
10.09.09	319	172.3	155.4	5.4
25.09.09	334	189.8	124.9	4.3
14.10.09	353	354.0	272.2	9.4
28.10.09	365	317.9	278.8	9.6

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

The programme became operative at the institute from April 2009. The long-term (1976-2008) monthly total rainfall data for Uttar Pradesh were collected from UP Council of Agricultural Research, Lucknow. The data were analyzed for variability trends.

Long –term variability trends of rainfall in Uttar Pradesh

Analysis of the long-term (1976-2008) monthly total rainfall indicated that the rainfall pattern reflected declining trend in all months of the year as well as annual and monsoon rainfall (Table 10.9). During the monsoon period, the highest rate of decline of 3.23 mm / year was noticed for the month of July followed in order by September (2.19 mm / year) and August (1.81 mm / year). The monsoon and annual rainfall reflected a decline of 7.77 and 12.15 mm / year, respectively. During the monsoon period, the highest CV (41.8%) was noticed for the month of September followed in order by August (33.1%) and July (31.6%). The CV for annual and monsoon rainfall was 21.6 and 21.4%, respectively.

Table 10.9: Average annual, monsoon and monthly total rainfall, %CV and rate of decline of rainfall in UP

Month	Total rainfall (mm) (Average)	CV (%)	Rate of decline (mm/year)
January	16.1	93.4	-0.67**
February	19.2	89.4	-0.34
March	12.7	114.7	-0.56*
April	10.8	140.4	-0.66
May	25.7	104.1	-1.21**
June	106.2	51.9	-0.55
July	269.3	32.6	-3.23*
August	249.0	33.1	-1.81
September	168.2	41.8	-2.19
October	28.1	114.6	-0.37
November	4.2	159.0	-0.20
December	9.4	131.1	-0.37
Annual	918.9	21.6	-12.15***
Monsoon	792.8	21.4	-7.77***

* - Significant at 5%, **- Significant at 2% and ***- Significant at 1%

Rainfall and yield relationship

The correlation of yield with rainfall received during March to May is highly significant. This period coincides with shoot formation (tillering) phase of the crop. The further analysis indicated that if the total rainfall during this period exceeds 50 mm, it might depress the yield at harvest.

Effect of July rainfall on sugarcane productivity in UP

The impact of July rainfall was assessed on average sugarcane productivity in the state of Uttar Pradesh as rainfall in July triggers the elongation phase of the crop. The correlation between %deviation in rainfall from long-term normal rainfall of July and sugarcane productivity was =-0.4082 (significant at 5%). The following linear regression between cane yield (Y) and %deviation of rainfall (X) in July from long-term normal was obtained.

$$Y = -0.0681X + 54.234 \ (R^2 = 0.1666 \ df = 30)$$

Effect of annual rainfall on cane yield in UP

The correlation (r = -0.3984) between annual rainfall and cane yield (Table 10.10) was significant (at 5%). The following linear regression between cane yield (Y) and annual rainfall (X) was obtained.

$$Y = -0.0135X + 65.686 \ (R^2 = 0.1587 \ df = 31)$$

The average cane productivity was 56.6 (± 5.9) t ha^{-1} when annual rainfall received was up to 900 mm. The average cane yield was 50.9(± 7.4) t ha^{-1} when rainfall was between 900-1000mm. With rainfall exceeding 1000 mm, the average productivity was 49.4(± 4.9) t ha^{-1}.

Table 10.10: Correlation between monthly rainfall and cane yield

Months	Correlation (r)	Month	Correlation (r)
April	-0.3197	September	-0.2185
May	**-0.3486***	March-May	**-0.4774****
June	-0.2293	Monsoon	-0.2947
July	**-0.3475***	Annual	**-0.3984***
August	0.0226		

***- Significant at 5% ***- Significant at 1%**

10.4 Development of database and information systems

Data warehouse on sugarcane production system (AES 4.8)

Field experiments in sugarcane research generate vast amount of data related to field operations, input and experimental results. In traditional system, these data are stored by research workers either in hard copy or individually in office tools. A major problem in existing system is reutilization of data with historical perspective and integration of data generated in various experiments. Further, such management of projects undertaken by research workers do not provide efficient information dissemination, thus, hampers the need of decision support in research planning and management.

Software has been developed to manage the data generated in sugarcane field experiments at the institute. It has been developed on web platform with following features:

- Management of research projects and experiments in sugarcane research
- Information management of field trials conducted under an experiment
- Scheduling of field operations conducted and input used in trials
- Inventory of farm field, operation categories and input type
- Recording of results obtained from experimental trials
- General reports on research projects, experiments, field trials, field operations / input schedule, farm record and experimental results of experiments conducted at the institute farm
- Analytical report on historical data of field experiments and integrated reports on field input and results of various experiments
- Security of data with restriction based on user-id and password.

Web-oriented nature of the software provides online accessibility of the same at institute computer network. It has been developed using Active Server Pages (ASP) and Hyper Text Markup Language (HTML) with database support of MS-Access. Figure below shows the screen shot of software showing menu items under 'General Report's module.

Software consists of eight modules on following aspects:

Project details

Module support recording and updation of research projects of the institute, experiments conducted under project and treatment schedule of research projects.

Experiments

It enables defining of field layout for trial conducted at the farm field. Further details of field trials such as crop undertaken, season, location, etc are managed through this module.

Field operations

It provides interface and control modules for recording schedule of field operations and input provided at all stages of field experiment.

Farm record

Module records and manages the information of institute experimental fields, field operation categories and input type.

Results

Experimental results of field trials conducted may be managed with this module.

General reports

This module has various programmes to generate general reports of research projects, experiments, field trials, field operations / input schedule, farm record and experimental results of experiments conducted at the institute farm

Analytical reports

Statistically analysed data are generated in this module for experimental results obtained from field trials. It also provide a search engine to search and generate integrated results from historical data of field trials of various experiments.

User profiles

It gives mechanism to log on into the system using valid user Id and password. User data may be added and updated through this

Fig. 10.4. Screen shot of software showing 'Report' menu items

module. Further, various rights of data and report may be managed using 'User Profiles' module.

Software supports three types of users viz. Administrator, Project leader and General user. Project Leader has all rights to record, update and view experimental details of their project. General user may only see data for which rights are provided to him. Administrator has full rights to all data and modules in the system.

Another most important feature of the software is re-usability in other crop. Software may be implemented in other crop research institutes by changing basic information about the crop / institute in database. Work is in progress to add modules to record and report annual target and achievements of the project to aid in reporting mechanism. Further, work will be started to develop sugarcane field management system on the same line for sugarcane farmers of the country.

Decision support tools in sugarcane cultivation (AES 4.10)

Domain knowledge acquired and analysed has been represented in the form of domain ontology and domain models. Domain ontology presents the vocabularies of the sugarcane crop disorder diagnosis and consists of concepts, properties of concepts, legal values of properties, antecedent statements and multimedia elements. Two types of ontologies has been constructed for disorder diagnosis in sugarcane crop viz. Ontology for Crop Status and Ontology for Disorder Diagnosis. A sample of domain ontology for disorder diagnosis is shown in (Table 10.11). Further, a number of domain models has been designed for decision from the ontologies. Few samples of domain models used by experts in diagnosis of disorder has been shown in Table 10.12. Knowledge base stores all the above knowledge in the form of Data Tables and Rule Tables.

Table 10.11: Sample of domain ontology for disorder diagnosis

Concept	**Region**	**Crop**		**Disorder**
Properties	**State**	**Type**	**Stage**	**Name**
Values	UP Bihar Maha-rashtra Madhya Pradesh	Plant Ratoon	Germi-nation Tillering Elongation Maturity	Stalk Borer Red Rot N deficiency Top Borer

Further, two categories of software module has been identified while developing decision support tools viz. Knowledge Updation modules and Decision Support modules. Knowledge updation deals with the loading of knowledge in the knowledge base and updation of the same, while Decision Support modules are end user software to get decision support from the system. Knowledge Updation modules has been developed at this stage using computer scripting languages viz., Active Server Pages (ASP) and Hyper Text Markup Language (HTML), while MS-Access support the repository of knowledge in the form of knowledge base. Domain ontology in sugarcane

Table 10.12: Sample of domain models used by experts in diagnosis of disorder

(Region: State = Uttar Pradesh & Crop: Type='Plant' & Crop: Stage = Maturity)

SUSPECT

(Nitrogen Deficiency & Shoot Borer & Root Borer & Red Rot)

(Disorder: Name= 'Red Rot')

ESTABLISH

(Disorder: Disorder Category = 'Disease')

(Disorder : Name = Red Rot & Crop: Stage = Maturity)

ESTABLISH

(Symptom : Category = Cane symptom & Symptom : Category = Leaf symptom)

(Disorder : Suspected = Red Rot & Crop: Stage = Maturity & Symptom : Category = Cane Symptom)

ESTABLISH

(Symptom : Textual = 'Red tissues seen on cutting the cane longitudinally' & Symptom : Textual = 'Red lesions on surface of cane')

(Symptom : Category = Cane symptom & Symptom : Textual = 'Red tissues seen on cutting the cane longitudinally')

CONFIRM

(Disorder : Name = Red Rot)

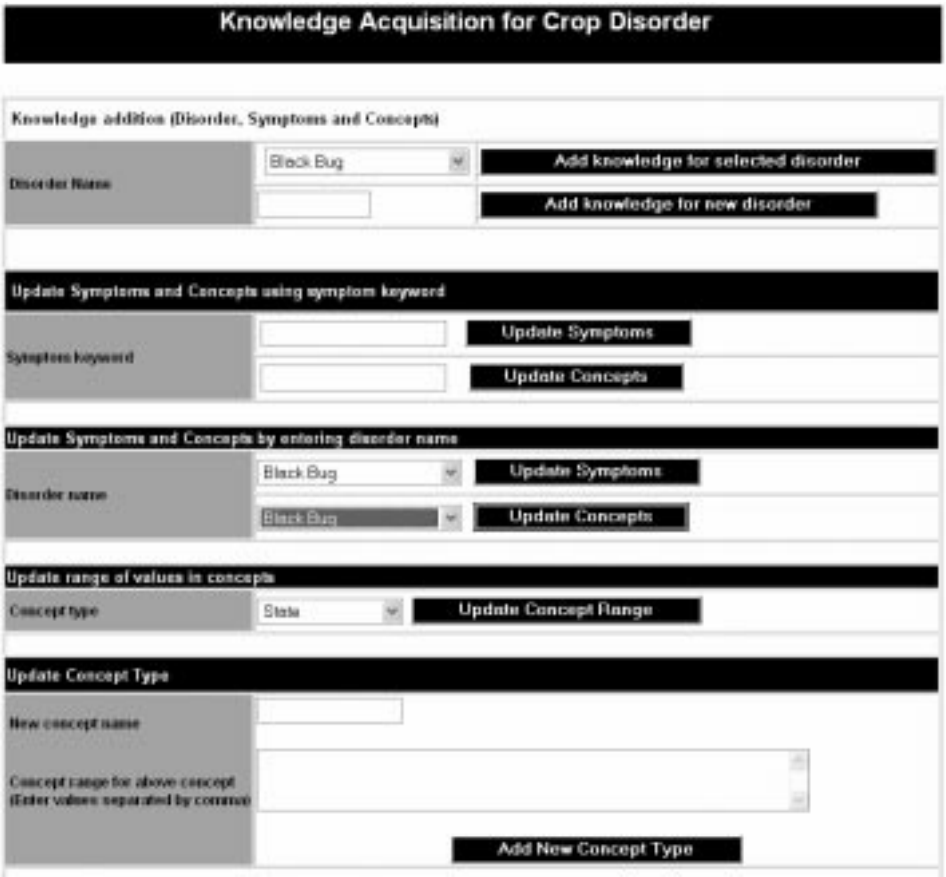


Fig 10.5. User interface for knowledge updation

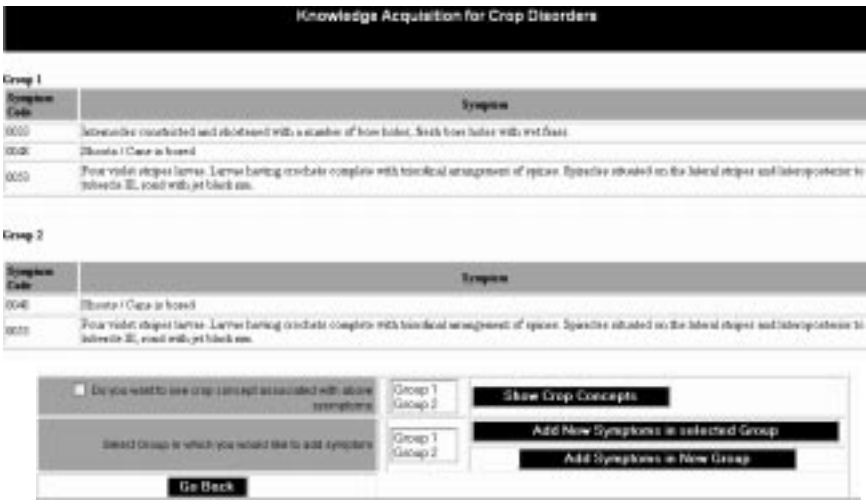


Fig. 10.6. Screen view for adding symptoms in knowledge base

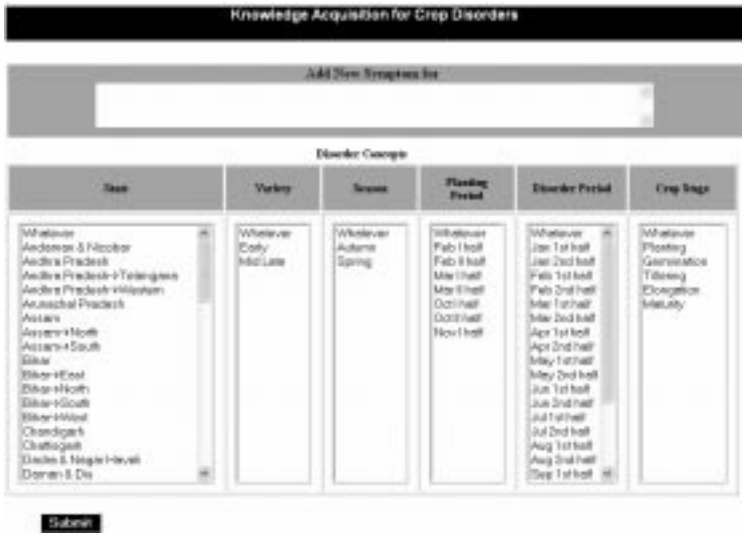


Fig. 10.7. Symptoms addition and concept relation

Fig. 10.8. Updation of concepts in knowledge base

crop disorder diagnosis consists of domain concepts, properties of concepts, legal values of properties, antecedent statements and multimedia elements. User interface and Functional module has been developed in Model-View-Controller (MVC) architecture for updation of knowledge existing in the form of ontology and domain models. Figure 10.5 to 10.8 show screen shots of knowledge updation module.

Knowledge updation module has been designed and developed in web environment to make it accessible on network using any standard web browser. Since domain experts for knowledge updation may have different physical locations, web-oriented nature of knowledge updation will enable updation of knowledge online using internet services. Knowledge acquired for disorder diagnosis in sugarcane crop has been loaded and updated in the system using these knowledge updation modules.

Transfer of technology

11.1 Technologies developed

Post -harvest application of formulation containing vitamins (500 mg / l), potassium nitrate (0.1%), Five Phos (100 mg / l) and Ethrel (500 mg / l) could be used to improve sprouting in winter initiated ratoons.

A combined application of benzalkonium chloride (2000 mg / l) and sodium metasilicate (1%) over billets during late-milling season was effective in minimizing sucrose losses.

11.2 Technology under testing

1. Initial studies have shown that bud chip technology could be one of the most viable and economical alternatives in reducing the cost of sugarcane production provided its survival and early vigour is improved under field condition. The technology developed to improve low temperature bud sprouting is being tested to improve germination of sugarcane under conventional planting. It was found that pre-harvest treatment of $ZnSO_4$ (25 kg ha^{-1}) improved germination by 14% over control.
2. Front line demonstration (FLD) of IISR tractor operated ratoon management device.

A survey was conducted in the Barabanki District to identify farmers for conducting front line demonstrations of the Ratoon Management Device (RMD). It was observed that farmers could not harvest their previous sugarcane plant crop in a stretch and so the stubble buds were allowed to sprout in phases. The emphasis was thus laid to execute all the cultural operations but for the shaving. RMD was operated from November 20-25, 2009 in ten ha field in Village Sarthara Purwa, P.O. Safedabad, Dist. Barabanki and plant cane was harvested in phases during the month. Buds had already sprouted. The equipment was operated for breaking hard pan, interculturing, off barring, applying manure and chemical fertilizers, and finally for providing 7-10 cm soil cover over the stubbles. Field capacity was 0.34 ha h^{-1}.

During demonstration of the equipment at farmers' fields, it was realized that the manure-metering system and the power transmitting unit could be optimized. A prototype of the RMD was also got fabricated. The equipment was administered with required improvement.

11.3 Seed production and distribution

More than 8300 quintals of sugarcane seed (seed cane) was produced as per seed production guidelines (Table. 11.1). The seed was distributed to farmers through sugar mills.

Table 11.1: Sugarcane seed production at IISR, Lucknow

Variety	Maturity group	Quantity (in quintals)
CoLk 94184	Early	800
CoS 96268	Early	1600
CoSe 92423	Mid-late	800
CoS 96275	Mid-late	800
CoS 99259	Mid-late	800
CoPant 97222	Mid-late	500
CoS 94257	Mid-late	2800
CoS 96269	Mid-late	200
Total	-	8300

11.4 Knowledge dissemination

a) Extension brochures published

Following four extension brochures (English) were prepared and published on water saving sugarcane technologies.

1. Ring-pit method of sugarcane planting for saving irrigation water.
2. Irrigation scheduling at critical growth of sugarcane to save water.
3. Skip-furrow method of irrigation for saving water in sugarcane.
4. Trash mulching for saving irrigation water in sugarcane ratoon.

b) New initiatives introduced

The Institute entered into a Memorandum of Understanding (MoU) with Reuters India Pvt. Ltd. on July 21, 2009 to provide information in respect of sugarcane cultivation in U.P. on package of practices, querries solution, sugarcane related IMD forecasts along with news and advisory on diseases and insect-pests, meetings / farmers' fair information etc. to the Reuters India Pvt. Ltd. for onward transmission to farmers.

c) Exhibitions

An exhibition of sugarcane production technology was organized at NBFGR on the occasion of 27th Foundation Day Celebration of NBFGR, Lucknow on December 12, 2009. The major objective of exhibition was to showcase the remunerative sugarcane production technologies through meaningful display of exhibits and sugarcane machines. About 500 farmers and development personnel visited the exhibition site and got benefited by interacting with the scientists.

An exhibition of sugarcane technologies was organized at CISH, Residential Campus, Raebareli Road, Lucknow on February 24-25, 2010. The main objective of the exhibition was 'showcasting of agricultural technologies through exhibition'. About 500 farmers from different places of the state visited the Institute stalls and got acquitted with the latest development in sugarcane cultivation technologies.

d) *Kisan Mela*

An Exhibition and *Kisan Mela* was organized on the occasion of National Seminar on Mechanization of Sugarcane Cultivation held at IISR, Lucknow on March 19-20, 2010. Elaborate display of sugarcane technologies with the help of posters, live materials, specimen etc. were done for the benefit of 500 farmers who visited the mela.

Technology exhibition stalls of different research organizations, manufacturers, KVKs and line departments were also set up in *Kisan Mela*. The visiting farmers saw various exhibition stalls and interacted to learn the knowhow on technologies being demonstrated.

Cane Commissioner, UP, visiting Farmers' Fair

e) Field visits/days

The Institute organized a number of field visits / days to demonstrate the technologies to the farmers in Sitapur district under FPARP.

The institute organised a field day to demonstrate the use and advantage of sugar cane cutter planter to farmers who visited the Institute during Farmers' Fair on March 19, 2010.

Field visits through KVK Lucknow : Under KVK, Lucknow, the Institute organized 17 visits to farmers' fields in selected villages, Gosaiganj, Sarojani Nagar, Malihabad, Kakori and Mohanlalganj blocks of the district to disseminate technical information on horticulture, animal husbandry, agronomy, soil science and home science.

25 groups of farmers (806) from different states under ATMA, Horticulture Mission etc., visited at KVK, Indian Institute of Sugarcane Research, Lucknow. During the visit, they were exposed to the different technologies of sugarcane crop, jaggery and *khandsari* processing unit, Krishi Vigyan Kendra, vermicompost unit and developed implements related to sugarcane cultivation.

Farmers' Day and *Kisan Gosthies* : The farmer's day was celebrated on December 23 at Ahamadpur khera village and a *Kisan Gosthi* on producing healthy potato seed through "**Seed Plot Technique**" was organised in which 25 farmers participated.

Two kisan *gosthies* were also organized on i) sugarcane cultivation and ii) potato seed production. Important aspects like i) variety, ii) IPM iii) INM iv) production technology and v) mechanization in sugarcane cultivation were covered. About 200 farmers participated in *gosthies*.

f) Dissemination through mass media

i) Press releases / newspaper coverage

1. नमक की अधिकता से नष्ट हो रही उर्वरा शक्ति। दैनिक जागरण, लखनऊ, 19 अगस्त, 2009।
2. सालाना 35 लाख का घाटा झेल रहे किसान। अमर उजाला, लखनऊ, 19 अगस्त, 2009।
3. गन्ना उत्पादन बढ़ाने के लिए मंत्रणा। दैनिक जागरण, लखनऊ, 20 मार्च, 2010।
4. अधिक लाभ के लिए यंत्रों का उपयोग करें किसान। राष्ट्रीय सहारा, लखनऊ, 20 मार्च, 2010।
5. गन्ना किसानों को दी जाए नवीनतम तकनीक की जानकारी। अमर उजाला, लखनऊ, 20 मार्च, 2010।
6. किसानों ने सीखी गन्ने की खेती। दैनिक जागरण, लखनऊ, 21 मार्च, 2010।
7. Sugar prices: More involvement of pvt entrepreneurs advocated. Pioneer, Lucknow, 20 March, 2010.

ii) T.V./Radio talks

The Institute Scientists delivered 4 T.V. talks on different aspects under *Krishi Darshan* Programme. The Institute Scientists / Technical officers also delivered Radio talks on cane cultivation as follows :

Name	Topic	Date
Dr. R.L. Yadav	गन्ना पेड़ी से अधिक उत्पादन	Jan. 18, 10
	गन्ने की बसन्तकालीन खेती	Jan. 22, 09
	गन्ने की फसल में आवश्यक कृषि कार्य	May 18, 09
	शरदकालीन गन्ने की प्रजातियाँ एवं खेती	Sep. 14, 09
	गन्ने की शरदकालीन खेती	Oct. 15, 09

TV and Radio talks through KVK, Lucknow

Name	Topic	Date
T.V. talk		
Dr. R.K. Singh P.C.	आलू की खेती में रोग एवं कीट प्रबंधन	Oct. 09, 09
	आलू में रोग एवं कीट नियंत्रण	Dec. 18, 09
Dr. Rakesh Kumar Singh	ग्रीष्म ऋतु में पशुओं का रख-रखाव	May 13, 09
	पशुओं में गला घोंटू रोग	Jun. 02, 09
	पशुओं में टीकाकरण	Jul. 17, 09
	पशुओं में अन्तः परजीवी	Sep. 04, 09
Dr. Om Prakash	रबी फसलों में पोशक तत्वों का प्रबंधन	Jan. 12, 09
	फसलों हेतु सूक्ष्म पोशक तत्वों की भूमिका	Apr. 29, 09
Radio talk		
Dr. R.K.Singh, P.C.	बैगन की खेती	Jun. 10, 09
	आलू की उन्नत प्रजातियाँ व खेती	Oct. 08, 09
Dr. Om Prakash	मृदा परीक्षण कब और कैसे	Jun. 04, 09
	मृदा उर्वरकता को बनाये रखने के उपाय	Feb. 22, 09

g) 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 recognized and are invited in various scientific and planning forums. In addition, the scientists also train students from different colleges in some frontier areas and thus assist them in building their academic capability.

12.1 International Training Programme

The Institute developed following 4 International Training Programmes on sugarcane related aspects.

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.

International training programme for the capacity building of Afro-Asian Rural Development Organization (AARDO) Member Countries on "Manufacturing and storage of Jaggery" from Nov. 16 to Dec. 15, 2009 was organized by the Institute. The training programme was sponsored by the AARDO. Under this training, two persons viz., Mr. Raed Abd al Qader Mohamad Ali, Extension Officer, National Centre for Agricultural Research and Extension, Irbid, Jordan and Mr.Leonard Oloo Ofula, District Environmental & Land Development Officer, District Agriculture Office, Ministry of Agriculture, Maragoli, Western Province, Kenya were trained. They were provided with theoretical as well practical knowledge and skill on jaggery production, packaging and storage including latest information on sugarcane cultivation practices for optimization of profitability from sugarcane cultivation.

Trainee from Kenya and Jordan, AARDO Countries

12.2 Training to researchers

a) Summer School on Quality Seed Cane in Sugarcane

An ICAR-sponsored Summer School on Quality seed cane in sugarcane was organized in the Division of Plant Physiology & Biochemistry of the Institute from June 10-30, 2009. Dr. A.K. Shrivastava was Course Director of the program. It was inaugurated by Dr. Basant Ram, Vice Chancellor, NDUA&T, Kumarganj, Faizabad. The valedictory session was presided over by Dr. R. L.Yadav, Director, IISR. He stressed upon the importance of quality seed cane in improving cane and sugar productivity. The Summer School was attended by 11 participants, 1 from Andhra Pradesh, 2 from Tamil Nadu, 1 from Haryana and 7 from Uttar Pradesh. Of these, 6 were from SAU's , 2 from KVKs and 3 from ICAR system.

b) FET of ARS Probationers Scientists

A multi-disciplinary team of six Agriculture Research Service (ARS) Probationer Scientists was deputed by the National Academy of Agricultural Research Management (NAARM), Hyderabad for Field Experience Training (FET) from August 4-24, 2009 at the Institute. The Ismailnagar village in Gosainanj block of Lucknow district was selected for FET. The Probationer Scientists analyzed the agro-ecological situations and constraints in farming through PRA techniques under the guidance of local FET Coordinator, Dr. D.V. Yadav and his team. Gradual decrease in soil productivity due to salinization as a result of water seepage from Indira Canal and low farm income due to lack of know-how about agricultural technology among the farmers in the village emerged as major constraints in farming. They also undertook a 7-days industrial attachment training for orientation about functioning of the agro-industries and the line departments engaged in agricultural as well as rural development in the state.

12.3 Training of sugarcane development personnels

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.

One-month training was organized on "Sugarcane Management and Development" during July 1-31, 2009 for cane development cane managers / officers from U.P., Bihar, Madhya Pradesh and Uttarakhand participated. In the interactive session with the trainees, Dr. R.L. Yadav, Director, IISR stressed upon the importance of this training in accelerating large-scale adoption of modern technologies of sugarcane cultivation in sugar mill zones. He emphasized that trained cane officers will serve as "torch-bearers" in their respective mill zones to spread the technologies with expected dividends of high sugarcane and sugar productivity. Total 22 trainees from different states of India participated and got acquainted with the latest technical know-how in sugarcane cultivation in the Training Programme.

Other training programmes

Five days Training on गन्ना उत्पादन तकनीक एवं गन्ने में एकीकृत नाशीजीव प्रबन्धन sponsored by State Agriculture Management Institute, Rehmankhera, Lucknow (U.P.) from 5-9 October, 2009 was organized. In this training, 29 officials of state line departments / agencies viz., Agriculture, Sugarcane Development, Plant Protection, ATMA, etc. from different parts of Uttar Pradesh and 3 farmers were trained. They were provided with latest knowledge in sugarcane production, protection and farm machineries for maximizing the sugarcane productivity.

National level trainings on "Mechanization in Sugarcane" from February 10-12, 2010, National level training on 'Integrated Nutrient Management Including Bio-Fertilizers in Sugarcane' from February 15-17, 2010, and "Training on Intercropping with Sugarcane" from February 24-26, 2010, as sponsored by Directorate of Sugarcane Development, Aliganj were organised in which 12 to 14 trainees, participated.

A model training course "Sugarcane and its Ratoon Management" was held at the

Institute from 4-11 March, 2010. In this training, 17 trainees from different states of India participated. It was sponsored by Directorate of Extension, Ministry of Agriculture, GOI, New Delhi.

12.4 Trainings at KVK, Lucknow

Eighty two trainings, including 35 off campus trainings, were organized for practicing farmers' (72), rural youth (5) and in-service personnel (5) for upgrading their knowledge and skill on various thematic areas viz. weed management, resource conservation technologies, cropping system, seed production (crop production), off season vegetables, nursery raising, training and pruning, rejuvenation of old orchards (Horticulture), soil fertility management, soil and water conservation, production and use of organic inputs, management of problematic soil, soil sampling and testing (soil health and fertility), minimization of nutrient losses in processing, income generating activities for empowerment of rural women, kitchen gardening, value addition, women and child care (Home science), dairy management, piggery management, poultry management, disease management, goat farming, production of quality animal products (Livestock production management) etc. A total of 2198 trainees were trained during 2009-10.

12.5 Training to students

During the year, 15 UG / PG students from different institutes and universities were trained in the Institute.

Awards and recognition

13.1 Awards

Dr. S. N. Sushil received the "WIPO- Gold Medal" as team leader for the best invention of the year-2008 for developing "Eco-friendly novel technology for managing white grubs in north-west Himalayas" from World Intellectual Property Organization, Geneva (An agency of UNO).

13.2 Fellowships

Dr. Amaresh Chandra, Head, Division of Plant Physiology received Fellowship of National Academy of Agricultural Sciences (FNAAS) in Year 2010.

13.3 Recognitions

Dr. Amaresh Chandra, Member, National Academy of Sciences (MNASc), India in Year 2009.

Dr. S. Solomon has been reappointed as a Secretary of the International Association of Professionals in Sugar and Integrated Technologies (IAPSIT) for a period of 2010-2013

Dr. S. Solomon has been nominated as President & Coordinator of the 4th IAPSIT International Sugar Conference (IS-2011) to be held at New Delhi in November, 2011.

13.4 Editors of Journals/councilors of societies

Dr. Sangeeta Srivastava served as editorial board member of the journal "Plant Cell Biotechnology and Molecular Biology".

Dr. R.K. Singh nominated as one of the Editor of Journal of Physiology and Molecular Biology of Plants".

Dr. A. K Sah, Sr. Scientist (Agril. Extension) has been elected Executive Councilor of Indian Society of Extension Education (ISEE), New Delhi for the period 2009-12.

13.5 Nominations

Dr. S.K. Duttamajumder was nominated to act as a member in the *Review Committee on Genetic Manipulation* (RCGM), under the Department of Biotechnology, Govt. of India.

Dr. S.K. Duttamajumder was nominated by the DG, ICAR to act as a member of the Management Committee of IISR, Lucknow for a period of three years w.e.f. 24.11.2009.

Dr. S. K. Duttamajumder was also nominated to act as a Central Committee member for monitoring Bt brinjal trials.

Dr. A.D. Pathak served as DBT nominee in IBS Committee f UPCSR, Shahjahanpur.

13.6 Refree for Journals/Reviewers

Dr. Sangeeta Srivastava acted as referee for International Journal of Plant Physiology and Biochemistry.

Dr. M. Swapna served as referee for the journal "Journal of Tropical Agriculture".

13.7 Other Recognitions

Dr. A.K. Shrivastava as Member Secretary of the QRT of the IISR, Lucknow and AICRP(Sugarcane).

Dr. A.K. Shrivastava as Course-Director, Summer School on Quality Seed Cane in Sugarcane, organized at the IISR, Lucknow *w.e.f.* June 10-30, 2009.

Dr. S. Solomon as Member of the Institute Management Committee of Sugarcane Breeding Institute, Coimbatore.

13.8 Fellow/Members of the Societies

Dr. Radha Jain became Fellow, Indian Society of Agricultural Biochemistry.

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 levels 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 Sugar Cane 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.

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*.

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.

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.

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

An ICAR Net work Programme on Climate Change on Assessment of Impact of Climate Change on Productivity and Quality of Sugarcane in Sub-tropical India and opportunities of agronomic adaptation has been in operation since April 2009 where many ICAR institutions are also participating.

14.3 Collaboration with Central Line Departments

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

Directorate of Sugarcane Development : The Directorate sponsored 3 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 is strengthening its linkages with SAUs / other general Universities through AICRP cooperative centres.

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

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)

programmes. The Institute has 4 contract research projects out of which one is on evaluation of sugarbeet hybrids, and 3 are on evaluation of insecticides and weedicides. In order to commercialize the equipments / machinery developed at IISR, Lucknow, meets / field days were also organized with the manufacturers of farm machinery and equipments. In the area of technology dissemination / extension, the institute has signed a MOU with a private news agency Reutors.

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.
- Under one externally funded programme on Farmers' participatory action research on water use efficient technologies for improving productivity and sustainability of sugarcane (FPARP), the institute carried out field demonstrations on 4 different water efficient and high yielding sugarcane production technologies. Forty demonstrations were conducted during 2009-10 crop season on farmers's fields in sugar mill areas of Biswan, Rauzagaon and Haidergarh under this project.

14.7 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 activities as follows :

KVK (IISR), Lucknow Activities in brief

The activities of KVK include on farm testing of developed technologies to see their suitability under different farming situations, front line demonstration of frontier technologies, training to farmers for upgrading their knowledge and skills and training of extension personnel to orient them in development of latest technology. The main activities of the KVK are summarized as below.

(i) Research Programme

A. On Farm Testing: Eight on-farm trials were conducted pertaining to various disciplines as per identified major thrust areas, which are summarized below:

Performance of inter crops in autumn planted sugarcane

Performance of inter crops in autumn planted sugarcane was studied in farmers' fields at five locations. Treatments were Farmers' practice for planting of sugarcane after harvest of rabi crop, sugarcane + potato, sugarcane + coriander and sugarcane + mustard. Yield of intercrops like potato (289.0 q ha^{-1}), coriander (10.5q ha^{-1}) and mustard (15.2 q ha^{-1}) was recorded. Sugarcane in all the treatments will be harvested in autumn season, 2010.

Performance of weedicide to increase mentha yield and reduce the cost of weed control

Performance of weedicide in mentha was studied in farmers' field at five locations. Application of preemergence herbicide i.e. pendimethaline @ 1.0 kg a.i. ha^{-1} reduced weed more effectively and recorded highest yield (51.2 kg ha^{-1}) over farmer practice (44.1kg ha^{-1}).

Evaluation of processing varieties of potato at farmers' field

Three varieties of potato namely Kufri Chipsona 1, Kufri Chipsona 2 and Kufri Chipsona 3 were evaluated in farmers' field at five locations. Local check was farmers' practice (either unknown planting material or Kufri Bahar). Kufri Chipsona - 1 gave the highest potato tuber yield (315.9 q ha^{-1}), followed by Kufri Chipsona 3 (310.6 q ha^{-1}) and minimum in Kufri Chipsona 2 (270.9 q ha^{-1}) with 24%,

23% and 22% dry matter, respectively, however, farmer's practice gave 265.5q ha^{-1} with 18.5% dry matter.

Effect of paclobutrazol to control irregular bearing in mango Cv. Dashahari

Treatments Farmer's practice (No treatment), soil application of paclobutrazol (3.2ml m^{-1} canopy diameter), and paclobutrazol (1.6 ml m^{-1} canopy diameter) were assessed in 4 identified mango plants (in each treatment) in which fruiting took place in previous year. Profuse flowering took place in both treated treatments.

Evaluation of mentha cultivars at farmers' field

Varieties of mentha namely, Kushal, Saksham, Koshi and Himalya were evaluated in farmers' field at five locations. Local check was farmers' practice (either unknown planting material or Koshi). Koshi recorded the highest menthol yield (60.2kg ha^{-1}) with Rs. 27130 as net income followed by Saksham (55.9kg ha^{-1}) with Rs. 24335, Kushal (54.1 kg ha^{-1}) with Rs. 23165 as net income, Himalya (52.1 kg ha^{-1}) with Rs. 21865 and lowest in Farmer's practice (44.1 kg ha^{-1}) with Rs. 17665. The yield of menthol was below the varietal potential due to severe drought conditions during the crop period.

Assessment of newly released high yielding variety of wheat

Three varieties of wheat namely, PBW 343 (Farmer practice), C B W- 38 and Shatabdi (K 0307) were evaluated in farmers' field at five locations. Shatabdi recorded highest grain yield (42.6q ha^{-1}) with Rs. 34125 as net income followed by CBW 38 (41.8q ha^{-1}) with Rs. 33245. Lowest yield was recorded with Farmer's practice (40.7 q ha^{-1}) with income of Rs. 32555.

Assessment of newly released high yielding variety of wheat in late sowing conditions

Varieties of wheat namely Malviya 234 (Farmer's practice), Narendra 1076 and Unnat Halana were evaluated in farmers' field at five locations. Narendra 1076 recorded the highest grain yield (32.6q ha^{-1}) with Rs. 19,525 as net income followed by Unnat Halana (30.2 q ha^{-1}) with Rs. 16885 and lowest in Farmer's practice (28.9 q ha^{-1}) with Rs. 15975.

Control of mortality in buffalo calves

Treatments comprised regular deworming at 4 months interval (Fenbendanzole @ 5 mg / kg body weight), mineral mixture supplemented multi-vitamins @ 50 g day^{-1} to mother in the last trimester of pregnancy and Piprazin hydrate used in buffalo calves in place of Fenbendanzole and Albendanzole. Mineral mixture with Fenbendanzole @ 5 mg / kg body weight) 3 times in a year controlled the mortality of buffalo calves upto 80% and also increased milk production in buffalo.

B. Conducting frontline demonstrations on various crops and technologies

Treatment of potato tuber with boric acid for reducing black scurf

Potato seed tuber treatment with 3% boric acid to reduce incidence of black scurf was carried out at 5 farmers' fields (150 q potato tuber treated) for planting in 5.0 ha area. Reduction of black scurf from 71.25% to 55.5% as compared to untreated tuber treatment (farmers' practice) was observed.

Production of healthy and disease free planting material of potato

An increase of 11.5% yield of potato seed crop over traditional potato crop was achieved with the use of "Seed Plot Technique" at farmers' field. Incidence of various diseases like viruses, PALCV, late blight, soil and tuber borne diseases was negligible in demonstration fields, while in farmers' practice (traditional crop), it was about 15.46%.

Performance of vegetable pea variety Kashi Nandini

Performance of variety of vegetable pea i.e. Kashi Nandini was demonstrated at 20 farmers' fields in 3.0 ha area, following recommended practices. Yield of demonstration plot was 57.8q ha^{-1} green veg. pea which was 10.7% increase over farmers practice.

Performance of sugarbeet variety LS-06 for fodder

Performance of sugarbeet variety, LS-06 was demonstrated in 17 farmers' fields for animal fodder during summer season at Lucknow. Seed of sugarbeet was distributed to 16 farmers for sowing in 500 -700 sqm area, each. About 2-3 kg root of sugarbeet / animal / day was provided up to 15 days continuously. The yield

of milk increased from 0.4 l kg / day / animal to 1.0 l kg / day / animal.

Performance of hybrid sweet sorghum for fodder

Variety of sweet sorghum i.e. CSH 22 was demonstrated at 35 farmers fields for fodder during rainy season in Lucknow. The yield of milk by increased about 15.8%.

Performance of berseem

Performance of variety of berseem i.e. JHB 146 and BB3 was demonstrated in 69 farmers' by fields at different locations in 3.0 ha area each, following recommended practices. Yield of demonstration plot was 505q ha^{-1} which was 27.15% higher over farmers' practice (401.9q / ha).

Performance of sesamum

Performance of variety of sesamum i.e. Shekhar + balanced fertilization (12:60:40 kg ha^{-1}) was demonstrated at 12 farmers' field. Yield of sesamum increased by 62% over local check (unknown variety)

Performance of toria

Performance of variety of toria i.e. PT 507 + balanced fertilization (12:60:40 kg ha^{-1}) was demonstrated in 22 farmers fields at different locations. The yield of toria increased by 31% over farmers' practice.

Performance of mustard

Performance of variety of, mustard i.e. Urvashi + balanced fertilization (12:60:40 kg ha^{-1}) was demonstrarted in 34 farmers fields at different locations. The yield of mustard increased by 40% over farmers' practice.

Performance of field pea

Performance of variety of field pea i.e. KMPR 522 was demonstrated at 14 farmers' fields with following recommended practices. The yield of field pea increased by 36.2% over farmers' practice.

Performance of arhar

Performance of variety of pigeon pea i.e. Chamtkar was demonstrated at 9 farmers' fields by following recommended practices. The yield of field pea increased by 53.37% over farmers' practice.

Wheat sown by zero-tilled seed cum fertilizer drill machine

Wheat var. PBW 343 (Shatabdi) was sown with zero-tilled seed cum fertilizer drill machine in 3.0 ha area. The yield of demonstration was 8.1% higher as compared to farmer practice (35.5q ha^{-1}).

Performance of wheat var. 0K307 and CBW 038

Wheat var. 0K307 (Shatabdi) and CBW 038 were sown in 3.0 and 2.0 ha area, respectively. The yield of demonstration was 8.5% and 5.6% higher as compared to farmer practice (40.7q ha^{-1})

Performance of nutritional kitchen gardening

Three sizes of nutritional kitchen gardening i.e. small family size: 100m^2, medium family size: 150m^2 and Large family size: 200m^2 were demonstrated at nine locations, following recommended practices. About 50% vegetable requirement of the families was fulfilled with kitchen garden along with the utilization of the backyard space.

Preparation of mango squash

For minimizing the post-harvest losses, mango squash was prepared by the farmers for their own use as well as for commercial purpose, which can be exploited as income generating activity for rural women, during mango gluts. Keeping this fact in view, preparation of mango squash was demonstrated to four groups i.e. Sarwasti, Ganga, Yamuna and Gomti.

14.8 Collaboration with local Institutions

Institute shares its resources of Guest Houses, lab facilities etc. for the use of other ICAR institutes such as CISH, Lucknow & NBFGR & CSSRI Regional Centre, Lucknow. Directors of the other ICAR institutes are also invited to the institute on important occasions.

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Technical programme (2009-10)

Crop management for high cane productivity under different environment

Sugarcane based production system

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

AS-57 Developing organic farming module for sugarcane crop (K.P. Singh and Archna Suman; Duration 2/06 – 2/12)

Expl Trial Effect of covered pit planting and covered trench planting on productivity and quality of sugarcane (A.K. Singh, P.N. Singh and Akhilesh Kr.Singh; Duration 2008-11)

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, A.K. Shrivastava and S. Solomon, Duration; 04/2008-03/2011)

Ratoon management in sugarcane

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

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

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

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

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

Crop management for improving physiological efficiency and sucrose content

Exp. Trial Trial Improving physiological efficiency of ratoon cane (R. K. Rai, A. K. Shrivastava and Pushpa Singh; Duration 3/08–3/11)

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

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

Resource management in sugarcane based cropping system

Nutrient management in sugarcane based cropping system

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 3/07-3/10)

C 18.3 Assessing physical parameters and fertility status of soil of fields of IISR Farm, Lucknow (Todi Singh and Rajendra Gupta; Duration 4/09-4/10)

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

Water management in sugarcane based cropping system

A 1.2.27 Developing efficient water application techniques in sugarcane (A. K. Singh, D. V. Yadav, S. N. Singh and P. N. Singh; Duration 2010-14)

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

AE 6.7 Optimization of irrigation water requirement of plant and ratoon crop of sugarcane in sub-tropical India (Rajendra Gupta; Duration 10/06-2/10)

UPCAR1/06 Enhancing field water use efficiency for sugarcane cropping system through FIRBS (Rajendra Gupta; Duration 9/06-9/09)

Weed management in sugarcane based cropping system

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

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

Studies on *Saccharum* germplas

B.1.7 Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions (Sanjeev Kumar, P.K. Singh, J. Singh; Duration 01/1995-LT)

Development of sugarcane varieties and breeding stocks for sub-tropics

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

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

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

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

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

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

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

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

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

Cytogenetic and biotechnological techniques for sugarcane improvement

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

B3.13 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 3.19 Mapping of loci linked to sugar content in sugarcane (M. Swapna, Sangeeta Srivastava and D. K. Pandey Duration 12 / 09 – 3 / 15)

B3.14 Molecular diversity analysis for biotic stresses of *Saccharum* germplasm (R.K.Singh, D.K. Pandey, M. Swapna and Sunita Lal; Duration 10 / 04 – LT)

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

B3.16 Optimizing standards for sugarcane seed production through micro propagation (R.K. Singh, Vijai Singh, J. Singh and A.K. Singh–A; Duration 10 / 06– 09 / 10)

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

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 and integrated disease management

Epidemiology of diseases of sugarcane

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

M 2.15 Development of red rot in standing cane through sett-borne infection. (S.C. Misra and S.K. Duttamajumder; Duration 2009-2012)

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

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

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

Evaluation of germplasm/genotypes for major disease of sugarcane

M 17 Evaluation / screening of sugarcane germplasm / genotypes against red rot and smut. (HoD and Ramji Lal ; Duration 2002-Long term).

PP 17 Evaluation of varieties / genotypes for resistance to red rot, smut and wilt. (HoD and Ramji Lal; Duration 2002-Long term).

Sugarcane disease management

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

M 15.4 Management of red rot through modulating host resistance. (Ramji Lal, V. Singh, Sangeeta Srivastava, S.K. Shukla, Radha Jain and Sanjeev Kumar; Duration 2009-2013).

M 15.5 Management of red rot through fungal endophyte in sugarcane. (Sunita Lal and R.K. Singh; Duration 2009-2013).

Bio-ecology and integrated management of insect-pests

EM 0.1 Biological control activities at Pravaranagar (M.S.). (R.B. Jadhav).

E 4.2 (ii) Colonization of parasitoids for management of top borer *Scirphophaga excerptalis* Walker. (Arun Baitha and G.M. Tripathi; Duration 2009-11).

E 4.2 (iii) Bio-management of termites in sugarcane. (G.M. Tripathi, S. N. Sushil and M.R. Singh; Duration 2009-12).

E 4.2(iv) Bio-intensive management of white grubs in sugarcane. (S.N. Sushil, G.M. Tripathi and Deeksha Joshi; Duration 2009-13).

E4.2.1(iv) Development of high temperature tolerant strain of *Trichogramma chilonis* and *Trichogramma japonicum*. (Arun Baitha; Duration 2005-1010).

E 11.1 Development of techniques for laboratory mass multiplication of top borer and its parasitoids. (M. R. Singh; Duration 2006-12).

E 30 Monitoring of insect-pests and bio-agents in sugarcane agro-ecosystem. (M.R. Singh and A. Baitha; Duration 2006-long term).

E 4.1 Evaluation of varieties / genotypes for their reaction against major insect-pests. (G.M.Tripathi; Duration 2003-Long term).

E 27 Mass multiplication of potential bio-agents of sugarcane insect-pests. (A. Baitha; Duration) (2003-Long term).

E 32 Population dynamics of sugarcane borers (early shoot borer, top borer, interned borer and stalk borer) through pheromone trap. (G.M. Tripathi; Duration 2008-11)

Development of appropriate farm machinery for mechanization of sugarcane cultivation

Design and development of equipment

AE 1.9 E Development of sugarcane harvester (A.K. Singh, M.P. Sharma and Jaswant Singh; Duration 8/06– 4/10)

AE 1.18A Design refinement of a power operated equipment for detrashing of harvested sugarcane (A.K. Singh and M.P. Sharma; Duration 7/05– 6/10)

AE 1.22D: Development of a wide spaced paired row sugarcane cutter planter (M.P. Sharma, A.K. Singh, A.C. Srivastava and Jaswant Singh; Duration 12/08– 11/11)

AE 4.5 Evaluation and refinement of sett cutting mechanism of sugarcane planter (R.K. Pangasa and P. R. Singh; Duration 3/08-4/12)

AE 8.1 Design and development of residue mulchur-cum-bio application (P.R. Singh, Archna Suman and A.C. Srivastava; Duration 9/07-8/10)

FIM / IISR / PFT / 2009 / 1: Prototype feasibility trial of IISR tractor operated sugarcane Harvester (A.K. Singh, M.P. Sharma and Jaswant Singh)

FIM / IISR / PFT / 2009 / 2: Prototype feasibility trial of IISR power operated sugarcane Detrasher (A.K. Singh, M.P. Sharma and Jaswant Singh)

FIM / IISR / PFT / 2009 / 3: Prototype feasibility trial of LASER guided land leveler (R.Gupta,P.R. Singh and R.K. Pangasa)

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; 3 / 04 – 4 / 2010)

Sugarcane processing for manufacturing of jaggery and developing storage techniques

LKO / PHT / 07 / 05: Refinement of 3-roller horizontal power driven crusher developed at IISR. (S.I. Anwar and Jaswant Singh; Duration 1 / 07-12 / 09)

LKO / PHTS / 05 / 3 Development of mechanical filtration unit for sugarcane juice(R.D. Singh and Dilip Kumar; Duration 3 / 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 / PHTS / 07 / 2: Design and development of a small capacity cane crushing unit for house hold purpose (Jaswant Singh and Dilip Kumar)

LKO / PHTS / 07 / 3: Development of a device for churning of sugarcane juice in an open pan furnace (Jaswant Singh and A. K. Singh; Duration 12 / 06-11 / 09)

LKO / PHT / 07 / 04: Optimization of fins provided to the pan bottom for improved efficiency of jaggery making furnace. (S.I. Anwar; Duration 1 / 07-12 / 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 / PHT / 07 / 06: Testing and evaluation of IISR jaggery drier(A. K. Singh, Jaswant Singh and R. D. Singh; Duration 4 / 07-12 / 09)

LKO / PHT / 07 / 07: Development of a solar drier for jaggery drying (Jaswant Singh, R.D. Singh and Dilip Kumar; Duration 4 / 07-3 / 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 04 / 08-03 / 11).

Sugar beet improvement, its seed production and crop management

B2.15 Developing sugarbeet varieties for Indian agro climates. (A.D. Pathak Raman Kapur, S. K. Duttamajumder and R. K. Tiwari; Duration 09 / 08–Long term-to be reviewed after 5 years)

CR-1 / 08 Evaluation of sugarbeet 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)

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

Technology adoption and analysis of constraints

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 – 3/10)

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 analysing contribution of sugarcane in Indian Economy. (A.K. Sharma, R.L. Yadav, D.V. Yadav and Hema Pandey; Duration 1/08-3/11)

AES 4.12 Developing efficient sugarcane marketing strategies in India

A.K. Sharma, R.L. Yadav, D.V. Yadav and M.R. Verma : Duration 1/10 to 3/12.

Development of statistical model/ procedure

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)

SAC-IISR1/05 Energy -Water Balance and Growth Monitoring in Sugarcane Using Satellite Data (Arun K. Srivastava, and S. N. Singh; Duration: 10/05-3/10)

ICAR Net work Climate Change on Assessment of Impact of Climate Change on Productivity and Quality of Sugarcane in Sub-tropical India and opportunities of agronomic adaptation (Arun K. Srivastava, Ashok K. Shrivastava and S.N. Singh; Duration: 2007-12)

AES 4.8 Data warehouse on sugarcane production system (S.S.Hasan, P.K. Bajpai and Rajesh Kumar; Duration 1/06-3/11)

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

Transfer of Technology

FIM/IISR/FLD/09/01 Front line demonstration (FLD) of IISR tractor operated ratoon management device (RMD) (A.C Srivastava and P.R. Singh)

Consultancy, contract research and patents

Consultancy

Crop advisory services for the state of UP on sugarcane crop (R. L. Yadav, D. V. Yadav, S. N. Singh, Vijai Singh, Maharam Singh, A. K. Singh and Mahendra Singh, 07/09-07/10)

An MoU was signed between this Institute and Reuters India Pvt. Ltd. on 21.07.2009 on advisory services for the state of UP on sugarcane crop. The Reuter India Pvt. Ltd. deposited Rs. 1.00 Lakh in advance to the Institute as consultancy charges. Since then, the Institute has been regularly sending the advisory services to the reuters.

Contract research projects

During the year, the following 4 contract research projects were undertaken.

Code	Title	Period	Concerned Scientists	Amount (Rs. in Lacs)	Firm/company
CR1/07	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	6.0	Syngenta India Pvt. Ltd. Karnal
CR-1/08	Evaluation of sugarbeet hybrids	10/08-09/10	A.D. Pathak, R.L. Yadav, D.V. Yadav, Raman Kapur, S.Solomon, S.K. Duttamajumder and R. K. Tiwari	5.00	J K Agri Genetics Ltd. Hyderabad
CR-1/10	Evaluation of Sulfentrazone 4%F for control of weeds in sugarcane.	03/10-02/12	R. S. Chauhan, D. V. Yadav, and R. L. Yadav	5.00	FMC India Private Limited
CR-2/10	Evaluation of regent 0.3G against early shoot borer and termites along with the yield and sugar recovery parameters in sugarcane.	03/10-02/12	S. N. Shushil, G. M. Tripathi, S. K. Duttamajumder, D. V. Yadav, and R. L. Yadav	5.00	Bayer Crop Science

Externally funded research projects

During the year, the Institute operated the following externally funded research projects.

SAC-11SR 05/1	Energy water balance and growth monitoring in sugarcane using satellite data (Arun Kumar Srivastava and S. N. Singh; Duration 10/05-03/10)
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., UPCAR, Lucknow
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) Total cost Rs. 50 lakhs, The Ministry of Water Resources, Govt of India.
DBT-1/09	Development of SSR markers for red rot resistance from EST database of sugarcane. (R.K. Singh, Sangeeta Srivastava, S.K. Dattamajumder, M.Swapna and Raman Kapur; Duration 15.01.09 to 14.01.12). Total cost Rs. 38.22 lakhs.
OP 1/09	Outreach programme in net work mode Diagnosis and management of leaf spot diseases of field and horticultural crops during 11th plan (2007-12). CCPI: Smt. Sunita Lal. Total outlay for IISR, Lucknow, Rs. 33.10 lakhs.

18 Monitoring and evaluation

Research Advisory Committee (RAC) Meeting

In accordance with the ICAR letter F. No. 4(10)/07-IA.III dated Feb. 4, 2008, the XV meeting of the RAC of IISR was held on May 2, 2009. The Chairman, Dr. H. K. Jain and the members, Drs. B. L. Jalali, D. G. Hapse, D. N. Yadav, N. Balasundaram, T. C. Thakur, R. L. Yadav, Shri Anil Chowdhary and D. V. Yadav, Member-Secretary participated in the meeting.

Based on the critical review of the presentations, agenda papers and discussions, the RAC made the following recommendations:

Division of Crop Improvement

i) The details of the crossing programme being carried out by the Division may be compiled and presented in the next meeting in order to identify suitable parents and specific heterotic crosses. The success of these crossings should be presented in the next meeting.

ii) The narrow genetic base of the parents used in the crossing programme continues to hinder the successful development of varieties, especially with reference to red rot resistance and sugar content. Thus, large nurseries from crosses involving diverse parents may be produced and evaluated for the purpose.

iii) Moderate the pre-breeding programme by following an approach different from a conventional approach, particularly for the new crosses. Limited inbreeding may be attempted to evolve relatively true breeding parents in the pre-breeding programmes.

iv) Sugarbeet programme should be strengthened with separate staff. Develop a group of scientists to work entirely on sugar beet. If the institute is not having requisite number of scientists, demand for such scientific strength be made to ICAR to provide manpower either on transfer or on deputation basis, or redeploying the existing staff.

Division of Crop Production

i) The booklet/brochure on ratoon management entitled "Make more money from your Ratoon Crop" be prepared and sent to all cane departments so that it may be helpful to them to disseminate the advances in ratoon management technology in a better way in respective states.

ii) If literature is to be sent to sugar mills, it would be better if it is sent through ISMA, New Delhi and NCFSF, New Delhi.

iii) Scientists be encouraged to work on conservation agronomy. In case, the Institute has more number of extension educationists, some of these scientists may be diverted towards this research area.

iv) The extension education research work in the institute may involve the study on the institutional mechanisms with a focus on

new approaches for dissemination of sugarcane production technology.

v) More farmers' participatory research on promising technologies, particularly on raised bed seed planting and ratoon management device be taken up. Also develop a system to communicate the results of participatory research in a better way.

vi) Sub-soiling is desired but it is not to be repeated every year. Start an experiment to examine the soil profile and the benefits of sub-soiling in sugarcane fields where sugarcane is being grown at least for the last 15 years.

vii) A lot of literature on Conservation Agriculture was distributed to the participants of international conference, "4th World Congress on Conservation Agriculture: Innovations for Improving Efficiency, Equity and Environment" organized on 4-7 Feb, 2009 at New Delhi. Ensure that the scientists read this book. Encourage a group of scientists to make 2 or 3 presentations on its different aspects, and discuss threadbare to explore new directions in conservation agriculture. This is important as the next revolution is expected to take place more by new agronomy (conservation agriculture) than by genetic and other advances.

viii) Intensify work on irrigation water management. Transfer some extension scientists, if surplus, to work on irrigation water management

Division of Crop Protection

i) The research work on plant protection is not prioritized. The programme in Crop Protection should start prioritizing, identifying key diseases and pests where most of the efforts should be directed to.

ii) *In-situ* conservation of bio-diversity should be done at the institute level but not in each research project.

Division of Plant Physiology and Bio-Chemistry

i) The on-going research work in the division (such as on chemical use, sugar recovery) is of practical importance. It should be brought to some logical conclusion.

ii) Physiological efficiency of ratoon and plant cane be worked out and be expressed in measurable terms.

iii) Research work on allele mining may be initiated.

Division of Agril. Engineering

i) IISR has done commendable work in developing farm machinery for sugarcane cultivation. Recently, the manufacturing rights of 7 technologies have also been given to private manufacturers. The IISR / ICAR should now organize a major initiative with the cane commissioners and sugar mills so that of these 7 technologies, at least one, the most efficient and successful machine, the sugarcane cutter planter is widely adopted in the next five years. Efforts be made so that at least 10% of the sugarcane farmers may plant their sugarcane with the help of the sugarcane cutter planter.

ii) The economics of technologies to be taken up for large scale transfer be worked out at farmer's fields and reported.

Agrometerology

i) Correlation between weather data and sugarcane yield needs to be studied for yield forecasting.

Economics, Statistics and Computer Applications

i) The database on research projects and their yearly progress is to be prepared so that it could be used as a management tool.

General/Policy /liaison issues

i) ICAR has got a project worth Rs. 53 Crores on identifying new genes and allelles. It would be better if IISR is a part of this project.

ii) IISR should not work in isolation. There is an urgent need to work in collaborations with national and international research organizations. Foreign collaborations

should be built up, however, prior to going in its favour, first identify the areas of research where the institute would like to draw some benefits. RAC, therefore, recommends that closer collaborations with other countries be made in areas which are of necessity and importance to IISR and the country.

iii) A study should be made for the feasibility of production of ethanol in India when the country is not in a position to produce enough sugar and has the shortage of sugar production as in year 2008-09. What will be some of the new approaches for producing ethanol by extending or intensifying the production of sugarcane in the country, should be examined in the course of the study.

iv) There is a need for at least one meeting of sugarcane researchers, and state cane departments officials every year at IISR, Lucknow in order to better address the obstacles in extension in sugarcane cultivation well in advance, and in the dissemination of advances in sugarcane production technology.

The XVI meeting of RAC was held again on March 26, 2010. Following members of the Research Advisory Committee participated in the meeting. The Chairman, Dr. H. K. Jain and the members, Drs. D. G. Hapse, D. N. Yadav, N. Balasundaram, T. C. Thakur, R. L. Yadav, and D. V. Yadav, Member-Secretary participated in the meeting.

Besides, the Heads of Divisions / Incharges of Sections of the institute also participated in the meeting**.** The major recommendations of the RAC as approved by ICAR were as follows.

1. The committee noted that while good work has been done by the Institute, its downstream research which includes interactions with sugarcane farmers, sugarcane millers, staff of the cane commissioners and other government departments concerned with sugarcane production are limited. The Institute should strengthen this kind of extension oriented research, so that there is a wider adoption of its technologies by the farmers.

2. Based on the technologies which have already been developed, the institute should organize a number of missions for the transfer of its technologies. The first of these missions should relate to the management of the Ratoon sugarcane crop, so that its productivity is significantly increased on a national average basis. The manuscript which the institute has already compiled on the management of the sugarcane Ratoon crop should be published in the form of a book. In addition, a 15 page summary in the form of an extension advisory should be prepared for the benefit of the farmers and the staff of the government departments including the cane commissioners. This small booklet in a simple form should communicate recommendations for increasing the production of the Ratoon crop as discussed in the course of the RAC meeting.

3. Another mission should be organized to help solve the problem of planting of sugarcane with very high seed rates. This is a primitive practice which should now be replaced with science based technologies. Both micro-propagation and bud chipping show the way forward. It is no good saying that these methods are not perfect. They should be further improved and they must ultimately be taken to the farmers.

4. Sugarcane breeding through the present methods starting in the 1920s has made tremendous progress with the hybridization techniques developed in the 1920s. Time has come now when further improvement should be made in the breeding methodology through pre-breeding, so that the crosses can be made with a greater degree of reproducibility.

5. The work on QTLs should be intensified specially for abiotic stress in the context of climate change.

6. The work on sugar beet improvement should be further strengthened so that in the years to come it begins to supplement sugarcane as a major source of sugar in the country. It should be recognized that sugarcane is more sensitive to climate change compared to sugar beet.

7. Keeping in view the increasing incidence of drought and temperature variations,

agronomic research should be intensified based on new tillage, planting and irrigation techniques. The sugarcane crop in India desperately needs a new kind of agronomic management.

8. Intercropping in sugarcane will increasingly become a more important source of profitability for the farmers. The work of intercropping with a diverse range of short duration of crops like pulses, oilseeds and cereals should be intensified. The economics of the different production systems should be worked out.

9. As far as disease management is concerned, emphasis should be on tolerance rather than immunity as long as the damage done by the crop is not economically significant, high sugar content varieties should be released.

10. IPM research in sugarcane for control of disease and pests should be intensified and effort should be made to see that the control agents are widely available to the farmers through service centers.

11. The Division of Plant Physiology and Biochemistry should develop technologies which will help to minimize post-harvest losses, increase sugar content and improve the balance between sink and source. The basic researches in this field should be through the externally aided projects.

12. In the field of agriculture engineering, the Institute has now reached a stage when it should make it a mission to take some of its improved machines to the farmers in cooperation with the sugar mills, the engineering industry, the service centers, the big farmers who rent their machines to small farmers [custom hiring]. This should be done not only in Uttar Pradesh, but in other sugar growing states, where these machines are more readily acceptable.

13. The social scientists in the institute should work out the economics of all the technologies developed by the scientists in other divisions. Also they should prepare a paper on the future of sugarcane and sugar industry in India suggesting ways and means of overcoming the cyclic effects.

The action taken report on the recommendations made in the meeting held on May 2, 2009 were reported to the RAC in the meeting on March 26, 2010. The RAC expressed satisfaction on the action taken report.

Institute Research Council (IRC) Meeting

The Institute Research Council (IRC) meeting of Indian Institute of Sugarcane Research (IISR), Lucknow was held under the Chairmanship of Dr. R.L. Yadav, Director of the Institute during 11-14 August 2009 to review and discuss the on-going research projects on sugarcane in the institute. In this meeting, 58 scientists and 4 technical officers of the institute participated and discussed the research findings of 56 research projects going-on in the institute (Table 18.1).

Table 18.1: Number of research projects during 2008-09 for discussion in IRC meeting

Division	Inst. Proj.		Ext. Aided		Ntwrk /AP Cess	Contra ct.	Total		AICRP Proj.	Expl. Stds	Grand Total	
	OG	R	OG	R			OG	R			OG	R
Crop Improvement	14	-	-	1	1	1	**16**	**1**	2	-	18	1
Crop Production	9	1	1	-	-	-	**10**	**1**	7	5	22	1
Plant Phy. & Biochem	5	-	-	-	-	-	**5**	-	-	4	9	-
Crop Protection	9	6	-	-	-	2	**11**	**6**	12	-	23	6
Agril. Engineering	7	-	1	-	-	-	**8**	-	10	-	18	-
Eco/stat/com	4	-	-	-	-	-	**4**	-	-	1	5	-
Ag. Meteorolgy	1	-	1	-	-	-	**2**	-	-	-	2	-
Total	49	7	3	1	1	3	**56**	**8**	31	10	97	8

Note: OG=on-going, R= Recently initiated.

At the outset, Dr.R.L Yadav, Chairman, IRC appraised the house about the emerging challenges of Indian Agriculture, and its implications for the research priorities. He apprised the house that after the green revolution in wheat and rice during the late 1960s, if there is any other crop that has registered a phenomenal growth during the last 6-7 years, it is cotton. Cotton production in India has doubled during the last 7 to 8 years. This is primarily the result of introducing Bt (*Bacillus thuringiensis*) technology in cotton, the new technology which was formally released in 2002. Not only there is a gain in terms of yield, but also there was a substantial reduction in the use of pesticides. As a result, within seven years, more than 80% of the cotton area has come under Bt. cotton. The Chairman also apprised the house that there is a wide variation in agricultural growth across different states in India at least during the last seven to eight years. At one end, there are states like Gujarat that are showing strong growth of 8%-10% per annum in agriculture, while at the other end are states like Uttar Pradesh, West Bengal, etc., that are growing barely at 1%-2.5% per annum. The Chairman highlighted that the issue from such growth pattern is that whether the laggard states can learn some lesson from the fast moving states and pull up the overall performance of Indian agriculture. He also highlighted the emphasis of the Gujarat State Government on water management and water augmentation, investment in infrastructure, irrigation works and other public goods. He also highlighted the expanding reach of technology from the private sector, and apprised about the emerging crop technologies that may change the future course of agriculture. He mentioned about *mycorrhizal* technology that TERI has developed for quite some time. The field trials of this factory produced fungal material show that by coating it on crop seeds it can enhance crop nutrition and yield by 5% to 25%, but more importantly reduce fertilizer consumption by 25% to 50%. Even the low cost material is being multiplied. If this technology takes off, it can lead to huge saving in fertilizer subsidy, which can be invested in developing irrigation in drier areas or in developing road network in rural areas.

Keeping in view these developments, the Chairman emphasized the need for drawing lessons for sugarcane crop and for carrying out sugarcane research on priority areas that may have the potential to make a discernible increase in yield or sugar recovery in sugarcane. He emphasized for repeating the success story of cotton in case of sugarcane crop also. He stressed upon for having Bt. Genes for sugarcane top borer and felt the need for developing a strong Biotechnology cell in the institute that may help facilitate the work in right direction with renewed vigour. The Chairman also emphasized the need for imparting priority to water management, m*ycorrhiza* technologies and on optimising plant population in sugarcane cultivation by increasing the physiological efficiency.

The Chairman, IRC also apprised the scientists that the crop is viewed as an exhaustive crop. The Chairman exhorted the members that there is a need to carry out proper valuation of sugarcane crop in terms of its contribution towards maintenance / restoration of soil fertility.

The Chairman also emphasized the need for improving visibility in research by having at least 2 good international research projects in the Institute.

Review of research projects

As desired by the Chairman, the Divisional level progress during the year 2008-09 was presented by respective HODs. Each scientist having Institute Research project as PI presented his research output, deliverables and workload related to research and miscellaneous activities. After the review of the divisional progress and 56 individual research project outcomes, the IRC made division / section specific comments as follows:

Other observations

The Chairman, IRC emphasized the need for the creation of biotechnology cell in the Institute. *Modus operandi* for its establishment was also discussed in the meeting. Dr. R.K. Singh, Pr. Scientist, Biotechnology was asked to make a presentation on the likely form of the proposed Biotechnology Cell. After presentation by Dr. R.K.Singh and the discussion that emerged following the presentation, the IRC felt the need for having more elaborate exercise on the proposal and making revised presentation

Division/section	IRC Observations
Crop Improvement	1. The area allocated for seed cane production (1.5 ha) is quite less. This aspect may be considered seriously in the Division. 2. A proposal for including vars. CoLk 9709 and CoLk 9705 in ISMA / AICRP trials for testing be submitted at the earliest. 3. Projects on maintenance of germplasm be discussed in the Division of Crop Improvement. If any scientist from other Divisions is interested in studying additional characters such as red rot resistance and other physiological parameters, he / she is welcome to take up such studies. 4. Development of a variety is the first priority for the Institute. Hence, research programmes be tailored to achieve this goal. 5. Some price tag on sugar beet seed being distributed be fixed. 6. Projects in the Division be reviewed for the numbers of entries that are going from such projects for AICRP or other trials.
Crop Production	The Division must give priority to research work on irrigation & water management and in the optimization of plant population
Crop Protection	1. A note on the role of IISR Divisional Biocontrol Center, Pravaranagar be developed and submitted to IISR, Lucknow. 2. All work pertaining to survey of insect-pests & diseases may be taken up under one research project, EM 01. 3. There are hot spots of red rot in central UP and whether the population of *Trichoderma* is less in these areas need to be verified. HOD, Crop Protection should establish a mechanism to study the build up of *Trichoderma*. 4. A folder / publication on the control of red rot through the use of *Trichoderma* be developed. 5. *Trichoderma* mass multiplication be done at IISR, and supplied to sugar mills alongwith relevant literature. While supplying seed cane to sugar mills, there is a need to supply *Trichoderma* along with the seedcane and a leaflet on how to use it. 6. For all AICRP (S) Projects to be taken up in the Division, HOD may decide who is going to be the PI/ Co-PI of the project / activity. 7. HOD, Crop Protection must work out the type of interactions required with Crop Improvement Division in the screening of varieties against insects and diseases. 8. HOD, Crop Protection must visit Pravaranagar center at least once in a year. 9. There must be more emphasis on research on red rot in the Division compared to other diseases.
Plant Physiology and Bio-Chemistry	1. Two mega projects were approved for the Division. These are: (i) Optimization of plant population for improving sugarcane yield; and (ii) Enhancement of sucrose content in sugarcane. All research work in the Division is to be directed towards addressing these issues. Activities be prepared to meet out short, medium and long term objectives.

Agril. Engineering	1. Action must be ensured to sort out patent issues related to the development of sugarcane harvester with the private entrepreneurs involved in the development earlier, if any. The matter may be taken up on urgent basis. 2. While approving in principle an inter-divisional programme for accelerating adoption of mechanization of sugarcane planting, the IRC desired that the Agricultural Engineering Division should take the lead in this programme, and accordingly the revised programme be submitted at an early date. 3. The research work on post-harvest technology pertaining to gur should be directed towards drying, moisture reduction, quality packaging and storage of gur. 4. The projects/activities undertaken under AICRPs were not presented for discussion in IRC meeting. The technical programme of all the activities being undertaken under AICRPs located outside the institute should be submitted to RCM well in advance. Moreover, AICRP approved technical programme being undertaken in the institute should be communicated by the concerned Project Coordinator well in time to the Institute. 5. A letter from Dr. R.L. Patil, Director, CIPHET, Ludhiana in respect of collaboration on commodity based post- harvest technology was read in IRC meeting. Based on discussions, it was emphasized by IRC that there is a need to focus on "what are post- harvest problems in sugarcane and what is the engineering aspect in it?" The Chairman also emphasized that collaboration with ICAR institutes/ AICRP need to be made a 2-way process in which the concern of the Institute is also addressed. He thus emphasized the need to chalk out a programme for collaboration with other institutions well in advance, and in keeping with the mandate of the institute.
Agrometerology	1. One lecture on climate change and on conservation agriculture is to be given to trainees. Quarterly progress report in this respect may be sent to RCM for onward submission to ICAR. 2. Climatological database of all the major sugarcane growing states be developed.
Ag. Economics and Statistics	Research priority for Agricultural Statistics is to take projects on yield forecasting /predictions. Conclude all on-going statistical research projects to prioritize work on yield forecasting/ prediction models. Specify the growth parameters. Finalize the growth parameters by discussing these parameters in a separate group, if considered necessary.
Regional Centre, Motipur	1. Area under var. CoLk 94184 in Bihar may be assessed through survey. 2. Assessment of mechanisation drive be carried out. Dr. P.R. Singh from the Division of Agricultural Engineering will visit to Motipur Centre in January, 2010 to see the status of machinery supplied to the center and make arrangements to better utilize the unused machinery. Mr. Devender Kumar, I/c, Motipur Centre will send a request letter for this at least one month before the planting season. 3. For undertaking research work, I/c centre may submit RPFs.
Divisional Regional centre, Paravaranagar	HOD, Crop Protection must visit Pravaranagar at least once in a year. The activities/findings at Pravaranagar be reported in EM-01. A note on the status of work carried out be submitted to the institute.

within one month of the IRC meeting.

The IRC also devoted considerable time on the discussion on the impact of climate change on sugar cultivation. The contents of a letter from Additional Secretary, DARE, Sri N.K. Das on the subject entitled "Massive Campaign on Capacity Building in the area of Climate Change and Agriculture" were read in IRC meeting itself to sensitize the members. It was decided that the training unit of the Institute and the KVK, Lucknow would take appropriate action and include lectures on climate change and conservation agriculture in their training programmers to sensitize the participants, extension personnel and farmers. Sh. Arun Kumar Srivastava, I/C, Agro meteorology is assigned the work of preparing an action plan for 2009-10 for the training module already prepared by ICAR on quarterly basis and communicating it to ICAR at the earliest. He would also submit the quarterly progress report, in this respect, to ICAR, New Delhi.

Appraisal and approval of New Research Project proposals

Before carrying out the appraisal of new research projects, the Chairman emphasized that new project proposals which will have an element of technology development would only be given priority. Eighteen new/revised research project proposals were submitted for consideration for approval of IRC. Of this, 8 research projects were approved in IRC meeting itself. Two projects were identified for further discussion in a team of scientists constituting the biotechnology group. Two mega projects were approved for the Division of Plant Physiology and Biochemistry, and the four project proposals submitted for discussion were considered for revision. These proposals will be taken up under the two main projects approved for the division.

Review visits to field Experiments and Research Laboratories

The review visits of field Experiments and Research Laboratories of the institute were carried out by reviewing bodies such as RAC members and by other dignitaries from ICAR, New Delhi. In addition, 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 units were visited during the year.

Visit of DSCL officials

An institute level monitoring team-visited FPARP demonstration sites in Sitapur district frequently. 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.

An FPARP demonstration on farmers' fields in Biswan sugar mill Sitapur district (UP)

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.

There is less viewership of the institute website and the Chairman, IRC of the Institute also expressed concern over less viewership of the Institute website. He exhorted the scientists to open the website at least once in a day. The members also felt the need for institutionalising the supply of material for website and the upgradation of website daily or at regular intervals. The IRC agreed that there is a need to add meaning to view the website and important events / activities be put on the Institute website. The status of online information development was also reviewed and it was emphasized that I/c, ARIS Cell would review its status very frequently and apprise I/c, RCM at regular intervals. The IRC also made a few observations for better research information management.

- All the papers submitted for publication are to be routed through RCM. If these papers are not sent through RCM, verification of such work / paper would not be done, as required for career promotion etc.
- The institute need to have information on the spread / coverage of institute technology. There is a need for assessment of area under CoLk 94184 in Bihar & UP, assessment of Mechanisation (sugarcane cutter planter, RMD etc.) in UP / other states. Surveys / studies be carried out to assess the magnitude of such coverage.
- Press releases be carried out on major recommendations for every IRC meeting. The information about IRC / RAC meeting be put in the website also.

Institute Technology Management Committee (ITMC) Meeting

In accordance with the ICAR Guidelines for Intellectual Property Management and Technology Transfer / Commercialization, the Institute Technology Management Committee (ITMC) with the following members was reconstituted on November 17, 2009 to decide all issues of IP Management and technology transfer / commercialization.

1. Dr. R.L. Yadav, Director- Chairman
2. Dr. Jaswant Singh, HOD (Ag. Eng.)- Member
3. Dr. Raman Kapur, HOD, Crop-Improvement - Member
4. Dr. Amaresh Chandra, HOD (PPB)- Member
5. Dr. S.K. Duttamajumder, HOD, Crop Protection- Member
6. Dr. A.K. Sharma, Sr. Scientist (Ag. Econ.)- Member
7. HOD (Crop Production) Dr. D.V. Yadav, & I/c, RCM - 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 is less, and this aspect may be considered seriously.

Institute Management Committee (IMC) Meeting

The Institute management committee with the following composition met on November 27, 2009 for its 30th meeting. The regular agenda of the meeting pertained to annual budget and other administrative activities. The proposal for write off of the remaining Institute vehicles (03 Nos.) was also presented before IMC. The research achievements during the year were also presented in the meeting. As per guidelines of the Council, this meeting was research oriented. Shri Arun Kumar Srivastava, Principal Scientist & I/c Agrometeorology presented the presentation entitled "Climate change & its impact on sugarcane production".

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**	Dr. Girish Pandey, Associate Director NDUA&T Faizabad	Member
Non-official members	Sri. Krishna Pal Singh Rathi	Member
	Sri. Anil Chowdhary	Member
ICAR representative	-	Member
Financial Advisor / Account officer nominated by President	Sri G.C. Pant, FAO, IVRI, Izatnagar	Member
Others	Dr. D.V. Yadav, HOD, Crop Production	Special Invitee
	Dr. S.K. Duttamajumder Head, Crop Protection	Special Invitee @
	Dr. Jaswant Singh, Head, Agri. Engg.	Special Invitee
	Dr. R.K. Singh, PC, KVK, Lucknow	Special Invitee
	Dr. O.K. Sinha, PC, AICRP (S)	Special Invitee@
	Dr. Amaresh Chandra Head, Pl. Physiology & Biochemistry	Special Invitee
	Sri Arun K Srivastava, P.S.	Special Invitee
	Sri Sartaj Ali	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, @ later on nominated by DG, ICAR as members

Institute Joint Staff Council (IJSC) Meeting

The IJSC with the following composition met on 05.09.2009 and discussed matters pertaining to staff weefare.

Dr. R.L. Yadav, Director, Chairman	
Members Eelected	**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)

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 2009-10 were constituted/ reconstituted on April 21, 2009. The meetings of these committees were held as per need of the task.

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

Purchase Advisory Committee
1. Dr. D.V. Yadav – Chairman
2. Dr. A.K. Singh (Engg)
3. Dr. D.K. Pandey
4. AF&AO
5. SAO – Member Secretary

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

Human Resource Development
1. Dr. O.K. Sinha – Chairman
2. I/c RCM
3. Dr. R.K. Rai
4. Dr. Arun Baitha
5. AFAO
6. SAO

IISR Publication & Library Committee
1. Dr. D.V. Yadav – Chairman
2. Dr. S.K. Duttamazumder
3. Dr. Ashwani K. Sharma
4. SAO
5. FAO
6. Incharge, Library – Member Secretary

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

Security & Vigilance Committee
1. Dr. R.S. Chauhan – Chairman
2. Dr. R.D. Singh (Engg.)
3. Sh. S. Bhatnagar (I/c Security)
4. AFAO
5. SAO – Member Secretary

Transfer of Technology
1. Dr. R.P. Verma – Chairman
2. Dr. S.N. Singh
3. All HODs.
4. I/c KVK
5. I/c RCM – Member Secretary

Staff Welfare Committee
1. Dr. A.K. Singh (Agro.) – Chairman
2. Dr. M. R. Singh
3. Dr. S.K. Sethi
4. Sh. M.H. Ansari
5. Secretary, IJSC
6. SAO – Member Secretary

Grievances Cell
1. Dr. Amresh Chandra – Chairman
2. Dr. Pushpa Singh
3. Dr. Todi Singh
4. AFAO
5. SAO – Member Secretary

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

Contract Research/Consultancy
1. Dr. D. V. Yadav – Chairman
2. Dr. A.K. Singh (Engg.)
3. Dr. A.D. Pathak
4. Dr. Ashwani Kumar – Member Secretary
5. AFAO

Event Coordination Committee
Dr. Ashok Shrivastava – Chairman
Dr. S.C. Mishra
Dr. S.N. Sushil
Dr. Sanjeev Kumar
SAO – Member Secretary

Sports Committee
Dr. P.R. Singh – Chairman
Dr. S.I. Anwar
Dr. Radha Jain
SAO
Secretary, IJSC
Secretary, Recreation Club – Member Secretary

Residence Allotment Committee
Dr. Raman Kapur – Chairman
Dr. Ramji Lal
Dr. K.P. Singh
I/c Maintenance
SAO – Member Secretary

Human resource development

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

a) Mass Group participation of scientists/participation at Lucknow

Name of Scientists	Topic/Subject	Place	Date
All scientists of the Institute	India's Glorious past-The Present Struggle & Where is the country going-lectures by Prof. P.P.Jauhar	IISR, Lucknow	Nov. 25, 2009
Dr. A. Chandra, Dr. A.K. Shrivastava Dr. S. Solomon, Dr. R. Jain, Dr. R.K. Rai, Dr. R. Banerji and Dr. Pushpa Singh	Improving Physiological Efficiency of Sugarcane	IISR, Lucknow	May 18, 2009 and Aug. 21, 2009
All the scientists of the Crop Protection Division, Drs. A Chandra, O.K. Sinha, Raman Kapur, Rajesh Kumar	Group Meeting on Advances in Plant Disease Management on the occasion of 70th Birthday Celebration of Prof. A.N. Mukhopadhaya	IISR, Lucknow	Mar. 12, 2010
All scientists of the Ag. Engineering Division and other scientists	National Seminar on 'Mechanization of sugarcane cultivation'	IISR, Lucknow	Mar. 19-20, 2010
Drs. D.V. Yadav, R.K. Singh, Om Prakash, Er. R. Gupta, Shri Mahendra Singh, and Shri G.K. Singh	Conference on "Food and Evoromental Security through Resource Convervation in Central India: Challenges and Opportunities (FESCO-2009)"	CSWCRTI, Research Centre, Agra	Sep. 16-18, 2009
Drs. R.L. Yadav, D.V. Yadav, O.K. Sinha, S. K. Duttamajumder, Ramji Lal, Sunita Lal, M. R. Singh, J. Singh, Rajesh Kumar, R.S. Chauhan, Om Prakash	Group Meeting of All India Coordinated Research Project on Sugarcane	Rajendra Agriculture University, Pusa, Samastipur (Bihar)	Nov. 6-8, 2009

B) Individual participation of the scientists

Name of Scientist (s)	Topic/Subject	Place	Date
Crop Production			
Dr. R.L.Yadav	National Symposium (in *Hindi*) "*Satrangi Kranti Hetu* integrated management of natural resources"	IARI, New Delhi	Apr. 4, 2009
	Annual day celebrations of NAAS	New Delhi	Jun. 4-5, 2009
	Indo-American workshop on IPR	New Delhi	Oct. 2-7, 2009
	Discussions on Mega Project on natural fibre and by product utilization	ICAR, New Delhi	Oct. 29-30, 2009
	Meeting of the Group of the Expert for the Development of sugar, Sector	Krishi Bhavan, New Delhi	Apr. 23-24, 2009
	Brainstorming session at on nutrients ratio NAAS	NAAS, New Delhi	May 28-29, 2009
	Screening Committee meeting to consider cane development proposals for SDF loan	New Delhi	May 9-12, 2009
	ICAR Foundation Celebrations Day of ICAR	ICAR, New Delhi	Jul. 16-18, 2009
	Director's Conference	ICAR, New Delhi	Jul. 17, 2009
	Executive Council meeting of Sugar Technologists' Association of India	New Delhi	Oct. 2-7, 2009
Dr. D.V. Yadav	Special training programme for vigilance officers of ICAR institutes	NAARM, Hyderabad	Oct. 29-31, 2009
	International Symposium on "Potassium role and benefits in nutrient management for food production, quality and reduced environment damages"	OUAT, Bhubaneshwar	Nov. 5-7, 2009
	5th Asian Regional Conference on "Improvement in efficiency of irrigation projects through technology up-gradation and better operation and maintenance" organized by Central Water Commission, Ministry of Water Resources, GoI and Indian National Committee on Irrigation and Drainage	New Delhi	Dec. 9-11, 2009
	Platinum Jubilee Symposium on "Soil science in meeting the challenges of food security and environmental quality" and also presented a paper in National Seminar on "Development in soil science-2009" organized by Indian Society of Soil Science	New Delhi	Dec. 22-25, 2009
Dr. A.K. Sah	National Seminar on 'Enhancing efficiency of extension for sustainable agriculture and livestock production' organized by ISEE, New Delhi.	IVRI, Izatnagar, U.P.	29-30 December, 2010

Crop Improvement

Name of Scientist (s)	Topic/Subject	Place	Date
Dr. M. Swapna	DBT sponsored training on Molecular Marker Applications in Crop Improvement	Centre of Excellence in Genomics at ICRISAT, Patancheru	May 18-29, 2009
Dr. Sanjeev Kumar	Summer School in Quality Seed Cane in Sugarcane	IISR, Lucknow	June 10-30, 2009

Crop Protection

A. Baitha	XVIII Biocontrol Workers Group Meeting on Biological Control of Crop Pests & Weeds	AAU, Jorhat (Assam)	May 29-30, 2009
S. N. Sushil	Conference on Leveraging Innovation for Knowledge Economy the held at the Indian Institute of Sciences,	Bangalore	Nov.19-20, 2009

Plant Physiology and Bio-chemistry

Dr. Pushpa Singh	Ethical, Legal and Gender issues in Science	ASCI, Hyderabad	Jan. 18-22, 2010

Agril Engineering

Dr. Jaswant Singh	40th Institute Management Committee meeting of CIAE, Bhopal	CIAE, Bhopal	Dec. 29, 2009
	44th Annual Convention and Symposium of ISAE	IARI, New Delhi	Jan. 28-30, 2010
Dr. S.I. Anwar	International Conference on Food Security and Environmental Sustainability	IIT, Kharagpur	Dec. 17-19, 2009
	44th Annual Convention and Symposium of ISAE	IARI, New Delhi	Jan. 28-30, 2010
Dr. R.D. Singh	International Conference on Food Security and Environmental Sustainability	IIT, Kharagpur	Dec. 17-19, 2009
	44th Annual Convention and Symposium of ISAE	IARI, New Delhi	Jan. 28-30, 2010

Economics and Statistics

Dr. A.K. Sharma	Training Programme on "Economic Models for Human Welfare Analysis: Applications to Crop-based Biofuels" under NCAP-IFPRI Collaborative Project on "Biofuels and the Poor"	NCAP, New Delhi	July 27-30, 2009
	Fundamentals of IPR	UPCAR, Lucknow	Mar. 5-6, 2010
	Workshop on Agricultural Productivity Challenges in Eastern India	BIRD, Lucknow	Feb. 24-26, 2010
	Meeting under the Chairmanship of the Chief Secretary, Govt. of U.P. on Sugarcane Price Fixation in U.P.	Yojana Bhavan, Lucknow	Oct 8, 2009
Dr P. K. Bajpai	National Workshop for the sensitization of ARIS Incharge	NBPGR, New Delhi	Mar. 19, 2010
	Workshop on "Designs of Experiments"	IASRI, New Delhi	Apr. 29, 2009

Agrometeorology

Arun K. Srivastava	ICAR sponsored Summer School on Quality seed Cane in Sugarcane (As resource person)	IISR, Lucknow	June 10-30, 2009
	Annual Workshop of Network Project on Climate change	CDRIDA, Hyderabad	July 3-4, 2009
	Workshop on 'Info-Crop - Application for climate change research	IARI, New Delhi	Nov. 30 Dec. 2, 2009

AICRP on Sugarcane

Scientist/(S)	Name of the Conference/ Seminar/Workshop/ Symposia	Date	Place
2. Dr. Om.Prakash	Participated as a team member to screen Zonal Verietal Trial of AICRP(S) in Peninsular Zone-I ,comprising the states of Kerala, Karnataka, Andhra Pradesh and Maharashtra.	Sep. 2-13, 2009	Peninsular zone-I
3. Dr. Rajesh Kumar	Participated as a team member to screen Zonal Verietal Trial of AICRP(S) in Peninsular Zone-I ,comprising the states of Kerala, Karnataka, Andhra Pradesh and Maharashtra.	Sep. 2-13, 2009	Peninsular zone-I

KVK, Lucknow

Dr. R K Singh	Mid term review Workshop of KVKs	CSAUA&T, Kanpur	May 28-30, 2008
	Annual Zonal workshop of KVKs Zone 4	CSAUA&T, Kanpur	Oct. 24-26, 2009
	National Conference on KVKs	TNUA&T, Coimbatore, (TN)	Nov. 6-9, 2009
Dr. V K Singh	Mid term review Workshop of KVKs	CSAUA&T, Kanpur	May 28-30, 2008
	Annual Zonal workshop of KVKs Zone 4	CSAUA&T, Kanpur	Oct. 24-26, 2009
Dr. Om Prakash	Winter School on Improving Sodic Soil Quality; input use efficiency and crop productivity through Integrated Nutrient Management	CSSRI, Karnal (HR)	Nov 21-Dec 11, 2009
	Training Programme pertaining to KVK/SAUs/ICAR Institutes with NABARDs Initiative for Rural Prosperity	Bankers Institute of Rural Development (BIRD), Lucknow	Mar. 16-19, 2010
Dr. Rakesh Kr. Singh	Training Programme pertaining to KVK/SAUs/ICAR Institutes with NABARDs Initiative for Rural Prosperity	Bankers Institute of Rural Development (BIRD), Lucknow	Mar. 16-19, 2010

Participation of other staff members

Technical Staff

Mahendra Singh, T 7-8	Fundamentals on IPR	UPCAR, Lucknow	Mar. 5-6, 2010
	Knowledge Management Training Programme	ISTM, New Delhi	Mar. 3-4, 2010
S.K. Awasthi, T 7-8	Knowledge Management Training Programme	ISTM, New Delhi	Mar. 3-4, 2010
Anita Sawnani	Summer School on quality cane in sugarcane	IISR, Lucknow	Jun. 10-30, 2009
D.C. Rajak	Summer School on quality cane in sugarcane	IISR, Lucknow	Jun. 10-30, 2009

Administrative Staff

K.P. Yadav, AAO	Handling of CAT cases	ISTM, New Delhi	Aug. 26-28, 2010
Prasant Kamal Srivastava, UDC	Handling of CAT cases	ISTM, New Delhi	Jul. 29-31, 2010

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Workshops, seminars, symposia organized

National Seminar and *Kisan Mela*

National seminar on Mechanization of Sugarcane Cultivation and *Kisan Mela* was organized on March 19-20, 2010 at IISR. It was inaugurated by Mr Sudhir M Bobde, Cane Commissioner, Govt of U.P., Lucknow and presided over by Dr R.L.Yadava, Director, I.I.S.R. Lucknow. One hundred fifty delegates participated in the seminar. Participants were from different quarters i.e. Scientists, Research Engineers, Cane Department Officials, Sugar Mills Officials, Manufacturers of Tractor and Farm Implements and Progressive Farmers from different states such as U.P., Bihar, M.P., Andhra Pradesh, Haryana, Punjab, Maharashtra and Tamil Nadu. The live demonstration of IISR designed sugarcane equipment was also organized for the delegates and farmers. Private entrepreneurs exhibited their farm equipments and other products in the *Kisan Mela.* About 500 farmers attended the *Kisan Mela.*

During deliberations in the seminar following recommendations / action plan emerged for spread of mechanization in sugarcane cultivation.

i) Plan to be prepared by the sugar mills for mechanical planting in their respective area in the initial stage and subsequently more operations could be included.

ii) Identifying the machine and source of supply in consultation with IISR, Lucknow, if required.

iii) Manufacturer selected should ensure the quality control for which he shall send prototype to IISR for performance testing, if desired. This quality will have to be maintained by him in future supply.

iv) Manufacturers will provide working design of the supplied equipment and will ensure after-sale service during the use period.

v) IISR may provide trainings to the manufacturers and the users at their cost for the proper operation and maintenance of the equipment.

vi) Any suitable device pertaining to the sub-soiling through RMD / Sub-soiler should be used to improve soil health and ratoon productivity. For this also, the sugar factories should plan in advance.

vii) Initially, DSCL and Balrampur group of industries have agreed to initiate this plan in their areas of operations.

viii) Group meeting may be arranged in future to take stock of the progress made in this regard.

Interactive meeting organized

A Brain Storming discussion was held on May 18, 2009 in Plant Physiology and Biochemistry Division under the Chairmanship of Dr. R.L. Yadav, Director, IISR, Lucknow on "Physiological efficiency and its improvement in Sugarcane". All scientists of the Division participated in discussion along with Scientists from CIMAP, CISH. Dr. R.L. Yadav emphasized the importance of this discussion to enhance the overall sugarcane productivity. Dr. R.S. Sangwan (CIMAP) emphasized the role of enzymes and precise regulation and better understanding of source and sink in relation to sugar as a signal molecule. Dr. A.H.A. Faruqui, (CIMAP) was of the view that it's the harmones which if manipulated will help in increase of dry matter and sugarcane productivity. Dr. N.K. Srivastava (CIMAP) was of the view that nutrient has its own role to increase the sugar content. Dr. Menhi Lal, (Emeritus Scientist) emphasized the role of environment and genotype to maximize sugarcane production.

Dr. V.K. Singh (CISH) suggested for better understanding of tillering mechanization in sugarcane for enhanced production of sugarcane.

An interactive meeting on "Improving Physiological efficiency in sugarcane" was held in the Division on August 21, 2009 under the Chairmanship of Dr. R.L. Yadav, Director, IISR, Lucknow. Dr. Sudama Singh, Ex-Director, U.P. Council of Sugarcane Research, Shahjahanpur and a renowned Plant Physiologist was the Chief Guest & Expert for this meeting. Based on the discussion, two projects viz., PB 23 and PB 24 were approved by IRC to enhance physiological efficiency of sugarcane.

Group meeting of AICRP on sugarcane

The Group Meeting of AICRP on Sugarcane was held at the Rajendra Agricultural University (RAU), Pusa, Samastipur, and Inaugurated by Dr. M.L. Chaudhary, Vice-Chancellor, RAU, Pusa. Dr. Chaudhary, in his inaugural speech urged the professionals to opt community and mission mode approach of technology transfer for adoption proven sugarcane technologies by quality seed material to the farmers. He laid emphasis on making available certified that problem of water-logging and drought should be addressed appropriately. Dr. K.C. Jain, Asstt. Director General (CC), ICAR, New Delhi chaired the inaugural session and Dr. B.C. Choudhary, Director of Reasearch, RAU, Pusa welcomed the delegates. Dr. O.K. Sinha, Project Coordinator (Sugarcane) presented the salient achievements of AICRP for the year 2008-09. Dr. R.L. Yadav, Director, IISR, Lucknow, in his introductory remarks, stated that sugarcane production in the country is in critical stage. Major reasons for decline in cane production are the low price of sugarcane and delay in payment to growers by sugar mills. He suggested that about 50% of the anticipated cost of cane may be given to growers at planting time and the rest after supply to mills. He urged for announcement of cane price well before planting. Dr. N. Vijayan Nair, Director, Sugarcane Breeding Institute, Coimbatore stated that the then Indian Agricultural Research Institute, Pusa introduced excellent sugarcane varieties and new cultivation practices. He pointed out that current decline in sugarcane production is not due to lack of technology, but due to shifting of sugarcane area to other remunerative crops. He emphasized to address the problems arising due to climate change.

Dr. K.C. Jain remarked that over the years, cyclic process of low and high cane and sugar production has been observed. The problems in sugarcane cultivation are natural as well as man-made. For addressing the natural problems like drought, water-logging and insect-pests & diseases, improved technologies should be developed. Man-made problems like delay in payment, labour shortage, and non-availability of inputs can be resolved by practice of appropriate management.

The concurrent Technical Sessions on Crop Improvement, Crop Production, Pathology and Entomology were held.

In Crop Improvement discipline, the session was chaired by Dr. K.C. Jain, ADG (CC). Dr. N. Vijayan Nair presented the summary of research achievements. Under fluff supply programme, 32.42 kg of fluff was supplied to AICRP centres for raising seedlings. A total of 30 early and 32 midlate elite clones were identified. Fifty two new entries were accepted for zonal varietal trial.

A meeting of Varietal Identification Committee was held under the Chairmanship of Dr. K.C. Jain, ADG (CC). Out of 16 proposals, the following 9 varieties were identified for release in the country : Co 0314 (Shyamala) – early, Co 0218 (Shreyas) – midlate and CoM 0265 (Phule 265) for Peninsular Zone; CoOr 03151 (Sabita) – early and CoA 03081 – early for East Coast Zone; Co 0239 (Karan-6) – early and Co 0124 (Karan-5) for North West Zone; and CoSe 01421 (Imarti) – early and BO 146 – midlate for North Central Zone.

In Crop Production discipline, the session was chaired by Dr. R.L. Yadav. The progress report was presented by Dr. S.K. Saini, P.I. Two technologies were recommended viz., Control of flowering in sugarcane by foliar spray of ethrel @250-300 ppm (2.5 – 3.0 ml / 10 lit of water) at 4 month-stage of the crop. For weed management in ratoon crop, pre-emergence application of either atrazine @ 2.0 kg a.i. / ha or metribuzin @ 1.0 kg a.i. ha^{-1} (800-1000 litre water ha^{-1}) followed by 2,4-D Na salt @ 1.0 kg ha^{-1} (600-800

lit water haha^{-1}) or hoeing at 45 days after ratooning can be successfully practised. Trash mulching in alternate rows or hoeing in unmulched furrow at 1 & 6 weeks after ratoon initiation is also a good option.

In Pathology discipline, the session was chaired by Dr. R.C. Rai, Professor & Head, Deptt. of Plant Pathology, RAU, Pusa. The progress report was presented by the P.I. Varieties resistant to red rot, smut and wilt were identified. Technology was recommended for chemical control of rust which is as follows : Propineb @ 0.25% and Mancozeb @ 0.2% were found to be effective. Either of the fungicide should be sprayed on the foliage just after the appearance of rust pustules, thrice at 15 days interval.

In Entomology discipline, the session was chaired by Dr. R.P. Yadav, University Professor, Deptt. of Entomology, RAU, Pusa. The progress report was presented by the P.I. A technology for the management of white woolly aphid was recommended which is as follows: The bioagents, *Dipha aphidivora, Micromus igorotus* and *Chrysoperla carnea* may be redistributed in sugarcane fields where population of bioagents is deficient or low. However, need-based chemical application of imidacloprid 200 SL @ 100 g a.i. ha^{-1} or chlorpyriphos 20 EC @ 1.0 kg a.i. ha^{-1} or oxydemeton methyl 25 EC @ 1.0 kg a.i. ha^{-1} or thiomethoxam 25 WG @ 50 g a.i. ha^{-1} may be made.

The Joint Technical Session on Review of Frontline Demonstrations and Breeder Seed Production Programme under Macro Management Scheme of DAC, Min. of Agriculture, Govt. of India was held under the chairmanship of Dr. V.S. Verma, Dean (Agriculture), RAU, Pusa. A total of 121 FLDs were conducted and 3771 tonnes and 5.83 lakh setts were produced under Breeder Seed Production in the country. Plenary session was chaired by Dr. K.C. Jain, ADG(CC). The development of high sucrose varieties with tolerance to drought and water-logging was emphasized in the Plenary Session.

Group Meeting on 'Advances in Plant Disease Management' held

The Group Meeting was held at this Institute on 12th March, 2010 under the Chairmanship of Dr. B.L. Jalali, Ex-Director of Research, Haryana Agricultural University, Hisar. Dr. A.N. Mukopadhyay, Ex-Vice-Chancellor, Assam Agri. University, Jorhat was the Chief Guest. Dr. R.L. Yadav, Director, IISR welcomed the participants. Dr. O.K. Sinha, Project Coordinator (Sugarcane), IISR introduced the significance of the Group Meeting and hoped the disease management practices being adopted in other crops would help in managing sugarcane diseases, especially red rot.

Dr. A.N. Mukhopadhyay, presented a holistic view of biocontrol of plant diseases through *Trichoderma* spp. He elaborated the mechanism with which pathogens are suppressed by *Trichoderma.* Success has been achieved in controlling diseases of tobacco, chickpea, sugarbeet, ground nut and other crops. Dr. B.L. Jalali, Chairman lauded the achievements in bio-control and stressed on the need to do more efforts in this area of disease management. A total of 10 presentations were made on disease management in different crops.

Zonal Breeders' Meet of Peninsular and East Cost Zone

The Zonal Breeders' Meet was held at the Sugarcane Breeding Institute, Coimbatore on 24 November, 2009 to finalize the technical programme of Crop Improvement discipline. The meeting was chaired by Dr. N. Vijayan Nair, Director, Sugarcane Breeding Institute, Coimbatore. Breeders from the AICRP centers in Peninsular and East Coast Zones participated in the meeting. The Chairman reviewed the crossing work being performed at NHG. The zonal entries of IVT-early and mid-late (2009-10) were short-listed based on their growth performance and diseases reaction and promoted to Advanced Varietals Trial.

Brain Storming on Post-Harvest Technology

A brain storming on Post-Harvest Technology of Sugarcane including gur and khandsari was held under the Chairmanship of Dr. R.L. Yadav, Director, IISR, Lucknow on 24 October, 2009. The meeting was Co-chaired by Dr. S.K. Nanda, Project Coordinator, AICRP (PHT), CIPHET, Ludhiana and Professor B.P.N. Singh, Ex-Dean, College of Technology, GBPUA&T, Pantnagar was the Guest of

Honour. About 50 participants from Maharashtra, Tamil Nadu, Uttaranchal, Punjab and Uttar Pradesh states participated in the meeting. The group expressed confidence in sustenance and survival of jaggery and khandsari industry in the country, at the same time acknowledged the infrastructure and expertise developed by IISR in this area to disseminate the knowledge among end users. The emphasis was laid upon to improve productivity, was opined that immediate attention be given on the jaggery with special reference to reduce losses during rainy season. The meeting ended with vote of thanks by Dr. Jaswant Singh, HOD, Agril. Engg., IISR, Lucknow organized at IISR on 24th October, 2009. Participants from Punjab, Haryana, Uttar Pradesh, Utrakhand, Tamil Nadu and Andhra Pradesh attended the brain storming dissussion.

Events organized

ICAR Inter-Institutional (North Zone) Sports Meet

ICAR Inter-Institutional North Zone Sports Meet was organized at IISR, Lucknow from 6-9 July, 2009. The sports meet was inaugurated by Mr. Ashwin Kumar Srivastav, Divisional Manager (Operation-NR), at Northern Railway Stadium, Charbagh, Lucknow. The Inaugural tune played by *Prisoners' Band of Adarsh Karagar, Lucknow* made the opening spectacular and memorable. Dr. R.L. Yadav, Director, IISR, welcomed the participants and wished a

memorable and happy stay in the city of Nawabs. On this occasion, a *Souvenir* on sports meet highlighting the tournament schedule and tourist places in Lucknow was also released. Er. M.P. Sharma, Principal Scientist (Agri. Engg.), IISR, Lucknow was the Chairman of the Games Organizing Committee.

In this sports meet, 763 sports persons from 23 ICAR Institutes located at Lucknow, Kanpur, Barelli, Varanasi, Mathura, Meerut (Uttar Pradesh), Almora, Nainital, Dehradun (Uttarakhand), Karnal, Hisar (Haryana), Ludhiana (Punjab), Shimla, Solan (Himachal Pradesh) and Srinagar (Jammu & Kashmir) participated. In the meet, 20 categories of *Track & Field events* (comprising of running, jumping and over throws), 10 categories of *Indoor Games* (badminton, table tennis, carom and chess) and 4 categories of Out Games (football, kabaddi, volleyball smashing & shooting) were played. NDRI, Karnal bagged the Champion Trophy of this sports meet. The closing ceremony was held on 9 July, 2009 and Dr. R.L. Yadav, Director, IISR, Lucknow distributed the shield and medals to winning teams and players.

Annual Sports Competition

In order to encourage overall development of the employees of the institute, the institute provided all the facilities for inculcating the sportsmanship spirit in 17 competitions organized in the institute. In the area of volleyball, football, race, cycle race, disc throw, ball throw, arrow throw, high jump, long jump, badminton, carom, chesh, TT and kabaddi. Dr. R.L. Yadav, Director of the Institute honoured all the winners of the sports on the eve of the Republic Day.

Exams conducted

The Institute conducted following examination during the year.

- ICAR's 14th All Indian Entrance Examination for UG Admission by ICAR

for Admission to 15 seats in Under Graduate Programme for Admission to Agriculture and allied subjects on May 23, 2009 at Lucknow.

- ICAR's 14th All Indian Entrance Examination for Post Graduate Admission on May 24, 2009.
- ARS / NET Examination, 2009 by ASRB on April 26, 2009.

Farmer's awareness programme on climate change

Farmers' awareness programme on climate change was organized at the institute campus on 9th January 2010 in which 40 sugarcane farmers from eastern Uttar Pradesh participated. The farmers were given brief background information on climate change in an interactive mode. The farmers were given a questionnaire to know their awareness about climate change and its gross effects on their agricultural activities. Their response was encouraging so far as their awareness was concerned. It was apparent that the farmers have fair knowledge on climate change aspects and its possible impact on changing agriculture scenario in general and sugarcane in particular.

Hindi Pakhwara Celebrated

To promote Hindi in daily office work *"Hindi Pakhwara"* was celebrated during 14-30 September, 2009. During the fortnight long celebration, various competitions viz., Hindi translation, Hindi typing, and maximum work done in Hindi were organized. A *Hasya Kavi Sammelan* was organized on 24 September, 2009. Renowned Hindi Kavi, Sri. Wahid Ali Wahid, Sri Anil Baujharh and Sri Deval Ashish made the audience delighted and cheerful with their humorous recitation. The *Pakhwara* was concluded on 30 September, 2009 under the Chairmanship of the Director, IISR, Lucknow and he gave away the prizes to winners of different competitions.

Independence Day

Independence Day was celebrated with the presence of all scientists, officers and staff members on August 15, 2009. A Flag hoisting ceremony followed by an address by Dr. R.L. Yadav, Director of the institute and a unity walk were the hallmarks of the day. Dr. R.L. Yadav, emphasized to take inspiration to carry out duties with devotion from the great sons and the leaders of India on this eve. Sweets were also distributed to mark the occasion by the Staff Recreation Club, IISR, Lucknow.

Republic Day

Republic Day was celebrated on January 26, 2010. All the scientists, officers and staff members participated in an event organized in front of the main Institute building. Dr. R.L. Yadav, Director of the Institute addressed the participants to mark the occasion.

Shahid Day (Martyr Day)

Martyr Day was observed on January 30, 2010 by observing a 2-minute silence by all the officers and staff members in front of the main building. The contributions of martyrs were also remembered on this day.

Welcome/farewell functions

The scientific strength that joined in the institute was welcomed in the IRC meeting. The staff members who superannuated during the years were bid farewell by organizing farewell functions by Staff Welfare Committee on behalf of the staff of the Institute.

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Distinguished visitors

Dr. Ajay Kumar, Chief Vigilance Officer, ICAR, New Delhi on April 9, 2009.

Dr. H.K. Jain, Ex-Director / ARI, New Delhi on May 2, 2009, and March 26, 2010.

Dr. N. Balasundaram, Ex-Director, SBI Coimbatore on March 26, 2010.

Dr. B.L. Jalali, Ex-Director of Research, CCSHAU, Hisar visited on May 2, 2009.

Dr. D.G. Hapse, Ex-Director, VSI, Pune visited on May 2, 2009 and March 26, 2010.

Dr. D.N. Yadav, Farmer Professor, AAU, Anand visited on May 2, 2009 and March 26, 2010.

Dr. T.C. Thakur, Professor of Eminence, GBPUAT, Pantnagar visited on May 2, 2009 and March 26, 2010.

Drs. R.S. Sangwan, AHA Farooqi and N.K. Srivastava, CIMAP, Lucknow on May 18, 2009.

Dr. Sudama Singh, Ex-Director, UPCSR, Shahjahanpur on May 18, 2009.

Dr. Basant Ram, Vice-Chancellor, NDUA & T, Kumarganj, Faizabad on June 10, 2009.

Dr. S.K. Nanda, PC, AICRP (PHT), and Prof. B.P.N. Singh, Ex-Dean, College of Technology, GBPUAT, Pantnagar visited on Oct. 24, 2009.

Shri. Sudhir Bhargava, Member Governing Body, ICAR, New Delhi visited IISR on November 24, 2009 and interacted with the Director and the coordinator, KVK on transfer of technology

Prof. P.P. Jauhar, University of North Dakota at Fargo, USA, the Area Director and Research geneticist with USDA, ARS, and the Fellow of the American Association of Advancement of Science on November 25, 2009.

About 40 trainee farmers from Western U.P. with IFFCO, Lucknow on Jan. 29, 2010.

About 40 students from College of Agriculture, Tikamgarh, JNKVV, Jabalpur (M.P.), Jan. 5, 2010.

Senior officers from DSCL Sugar, Rupapur on Jan. 22, 2010.

About 40 Commercial Bank Officers from BIRD, Lucknow on Feb. 25, 2010.

Sri. Sudhir M Bobde, IAS, Cane Commissioner, UP visited on March 19, 2010

Infrastructure development

The infra-structure created / civil works carried out during the year 200-10, consisted of the following work items:

S. No.	Item	Amount (Rs. in lacs)	Agency to whom work allotted
1	Providing & fixing of false ceiling in Director's committee room	1.34	CPWD
2	Boundary wall around KVK at G. Block, IISR, Lucknow	30.00	CPWD
3	Redevelopment of Tube well No. 10	3.51	U.P. Jal Nigam
4	Fabrication & fixing of steel ladder in the Ist floor of Adm. Builing at IISR, Lucknow	0.47	CPWD
5	Providing street lighting on the farm of IISR, regional centre, Motipur	7.25	CPWD
6	Installation of high water dischanging capacity tube well at IISR regional centre, Motipur	6.50	Water Resources, Tube well wing, Patna
7	Boundary wall of IISR regional centre, Motipur	20.00	CPWD
8	Recarpeting of colony road at Ikshupuri colony	7.76	CPWD
9	White-washing & painting of IISR community centre	2.46	Other Agency
10	Replacement of existing AMF penel 200 KVA KEC make KVA, AUR necessary cabling etc.	2.37	Other Agency
11	Re-plastering (ii) repainting (iii) minor brick work(iv) civil work of 2ft height of boundary wall of Ikshupuri colony from colony gate to butchery ground, and (v) construction / minor repair of broken part of farm building gate and portion of boundary wall	4.68	Other Agency
12	Replacement of MS Doors in mist chamber No. 02 and transparent filer glass roofing in Polyhouse no.02 at IISR, Lucknow	5.63	Other Agency
13	Power cable laying and connection between feeder piller (near Bank) and Feeder Pillar (near bio control) for electricity supply to guest House , bio control, KVK building, drinking water, tube well No. 11 at IISR, Lucknow	0.95	Other Agency
14	Re- plastering (ii) repainting (iii) minor brick work and (iv) Civil work at 2 ft height on the entire stretch of boundary wall at Ikshupuri colony 450 mt. on Jail Road and construction / minor repairs at broken part of boundary wall	4.69	Other Agency
15	Repair & painting *gur* godown at IISR, Lucknow	0.47	Other Agency
16	Replacement of MS doors in Mist chamber No. 01 and transparent fibre glass roofing in Polyhouse No. 01 at IISR, Lucknow	5.63	Other Agency
17	Replacement of existing AMF panel 200 KVA, KEC Make 200 KVA, AUR necessary calling etc.	3.34	Other Agency
18	Replacement at AMF panel and AVR (automatic voltage regulator at 110 KVA DG set installed near dispensary.	1.60	Other Agency
19	Repair at farm road street light (phase-1) at IISR, Lucknow	4.99	Other Agency
20	Repairing & painting at Jaggery complex at IISR, Lucknow	1.46	Other Agency

Personnel (as on March 31, 2010)

Director	:	Dr. R.L. Yadav
Administration		
Senior Administrative Officer	:	Sri Rajeev Lal
I/c, Asstt. Finance & Accounts Officer	:	Sri Manna Lal
Drawing & Disbursing Officer	:	Sri Shatruhan Kumar
Asstt. Administrative Officer	:	Sri R.K. Khanna
	:	Sri Shatruhan Kumar
	:	Sri K.P. Yadav
	:	Sri Sartaj Ali
I/c, Security Officer	:	Sri Sanjay Bhatnagar
Research Coordination and Management		
Principal Scientist & Incharge	:	Dr. D.V. Yadav
Senior Scientist (Ag. Econ.)	:	Dr. Ashwani K. Sharma
Technical Officer	:	Sri Mahendra Singh
	:	Sri G.K. Singh
Crop Production		
Principal Scientist & Head	:	Dr. D.V. Yadav
Principal Scientist (Soil Chem. / Fer. / Microbiology)	:	Dr. P.N. Singh
Principal Scientist (Agronomy)	:	Dr. R.S. Verma
	:	Dr. R.S. Chauhan
	:	Dr. S.K. Shukla
Principal Scientist (Agril. Extension)	:	Dr. Ram Pal Verma
	:	Dr. (Mrs.) Hema Pandey
Senior Scientist (Agronomy)	:	Dr. K.P. Singh
	:	Dr. S.N. Singh
	:	Dr. A.K. Singh
	:	Dr. Ishwar Singh
Senior Scientist (Soil Chem. / Fer. / Microbiology)	:	Dr. Todi Singh
Senior Scientist (Soil Water Con. Engg.)	:	Er. Rajendra Gupta
Senior Scientist (Agril. Extension)	:	Dr. A.K. Sah
Scientist SS	:	Sri Kamta Prasad
Technical Officer	:	Sri Ram Singh
	:	Sri S.N. Srivastava
	:	Dr. R.K. Singh
Plant Physiology & Biochemistry		
Principal Scientist & Head	:	Dr. Amaresh Chandra
Principal Scientist (Biochemistry PS)	:	Dr. Ashok K. Shrivastava
	:	Dr. S. Solomon
Senior Scientist (Plant Physiology)	:	Dr. R.K. Rai

	:	Dr. (Smt.) Radha Jain
Senior Scientist (Biochemistry PS)	:	Sri Raman Banerjee
Senior Scientist (Organic Chemistry)	:	Dr. Pushpa Singh
Technical Officer	:	Dr. (Smt.) Namita Arya
	:	Smt. Anita Sawnani
	:	Sri Ram Darash
	:	Sri S.P. Shukla

Crop Improvement

Principal Scientist & Head	:	Dr. Raman Kapur
Principal Scientist (Plant Breeding)	:	Dr. Jyotsendra Singh
	:	Dr. A.D. Pathak
Senior Scientist (Plant Breeding)	:	Dr. D.K. Pandey
	:	Dr. P.K. Singh
	:	Dr. Sanjeev Kumar
Principal Scientist (Gen. & Cytogenetics)	:	Dr. (Smt.) Sangeeta Srivastava
Principal Scientist (Bio-technology)	:	Dr. R.K. Singh
Scientist SS (Genetics)	:	Dr. M. Swapna
Technical Officer	:	Smt. Hem Lata Madhok
	:	Sri Ram Hit
	:	Sri V.K. Saxena
	:	Sri Ram Kumar
	:	Smt. Pramila Lal
	:	Sri Ram Sewak

Crop Protection

Principal Scientist & Head	:	Dr. S.K. Duttamajumder
Principal Scientist (Plant Pathology)	:	Dr. Vijai Singh
	:	Dr. Ram Ji Lal
	:	Smt. Sunita Lal
Senior Scientist (Agril. Entomology)	:	Dr. G.M. Tripathi
	:	Dr. S.N. Susheel
	:	Dr. Maharam Singh
	:	Dr. Arun Baitha
Scientist S.G (Plant Pathology)	:	Sri S.C. Misra
Technical Officer	:	Sri R.B. Jadhav
	:	Dr. S.K. Awasthi
	:	Dr. D.C. Rajak
	:	Sri Sanjay Bhatnagar
	:	Sh. B.B. Joshi
	:	Sri Amar Nath
	:	Sri Niranjan Lal
	:	Sri M.P. Sharma
	:	Sri I.P. Maurya

Agril. Engineering

Principal Scientist & Head	:	Dr. Jaswant Singh

Principal Scientist (Farm Mach. & Power)	:	Dr. A.C. Srivastava
	:	Dr. P.R. Singh
Principal Scientist (Elec. & Instr.)	:	Sri R.K. Pangasa
Senior Scientist (Farm Mach. & Power)	:	Dr. A.K. Singh
	:	Dr. S.I. Anwar
	:	Dr. R.D. Singh
Scientist (Ag. Str. / Proc. Engg.)	:	Er. Dilip Kumar
Technical Officer	:	Sri Jasbeer Singh
	:	Sri M.H. Ansari
	:	Sri S.K. Kushwaha
	:	Sri S.K. Misra
	:	Sri Vinayak Sawant
	:	Sri V.N. Mehrotra
	:	Sri S.K. Savita
	:	Sri R.N. Kureel
	:	Sri Mathura Prasad
	:	Sri Someshwar Misra
	:	Sri K.N. Singh
	:	Sri Rajendra Singh
Economics/Statistics/ARIS Cell		
Principal Scientist & I/c	:	Dr. P.K. Bajpai
Scientist SS (Computer Science)	:	Sri S.S. Hasan
Technical Officer	:	Dr. Mani Ram Verma
Agrometeorology		
Principal Scientist & I/c	:	Sri Arun Kumar Srivastava
Technical Officer	:	Sri Surendra Singh
Radio Tracer Laboratory		
Principal Scientist & Incharge	:	Dr. S.K. Shukla
Training Unit		
Principal Scientist and I/c	:	Dr. D.V. Yadav
Principal Scientist (Agril. Extension)	:	Dr. R.P. Verma
Technical Officer	:	Sri A.K. Singh
AICRP on Sugarcane		
Project Coordinator	:	Dr. O.K. Sinha
Principal Scientist (Agril. Entomology)	:	Dr. Om Prakash
Principal Scientist (Agril. Statistics)	:	Dr. Rajesh Kumar
Technical Officer (Agril. Statistics)	:	Dr. J.K.S. Gautam
	:	Sri Adil Zubair
Farm		
Scientist Incharge	:	Dr. D.V. Yadav
Farm Manager	:	Sri S.K. Pal
Technical Officer	:	Sri Nar Singh
	:	Sri Raghvendra Kumar
	:	Sri Jiyawan Ram

	:	Sri Satya Narayan
	:	Sri B.B. Singh
Krishi Vigyan Kendra		
Programme Coordinator & Incharge	:	Dr. R.K. Singh
Technical Officer	:	Dr. V.K. Singh
	:	Dr. Om Prakash
	:	Smt. Mithilesh Tiwari
Hindi Unit		
Principal Scientist & I/c	:	Dr. D.V. Yadav
Arts & Photography		
Scientist Incharge	:	Dr. D.V. Yadav
Technical Officer	:	Sri Vipin Dhawan
	:	Sri Y.M. Singh
	:	Sri Avadhesh Kumar
Dispensary		
Incharge	:	Sri Rajeev Lal
Senior Medical Officer	:	Dr. S.K. Sethi
Library		
Scientist Incharge	:	Dr. Ashok K. Shrivastava
Technical Officer	:	Sri G.K. Gupta
	:	Sri G.D. Dhariyal
	:	Sri Ghanshyam Ram
Incharge, Seed Production Unit	:	Dr. J. Singh
Incharge, Central Laboratory	:	Dr. Pushpa Singh
Technical Officer	:	Smt. Asha Gaur
	:	Smt. Meena Nigam
Incharge, Vehicles	:	Sri K.P. Yadav
Consultancy Cell		
Scientist Incharge	:	Dr. D.V. Yadav
Guest House		
Manager	:	Dr. S.K. Awasthi
Estate		
Officer-In-Charge	:	Dr. Jaswant Singh
Technical Officer	:	Shri M.H. Ansari
IISR Regional Centre, Motipur (Bihar)		
Senior Scientist (Plant Breeding) & Incharge	:	Dr. Devender Kumar
Senior Scientist (Agronomy)	:	Dr. V.P. Jaiswal (on leave)

STAFF NEWS

New Joining

Scientists

Dr. Amaresh Chandra joined IISR as Head, PP&B Division on 1 April, 2009.

Dr. S.K. Duttamajumder, Principal Scientist joined as HOD, Crop Protection w.e.f. 10.08.2009.

Dr. (Mrs.) Deeksha Joshi, Scientist, SS (Plant Pathology) joined IISR on November 3, 2009 on transfer basis from UPKAS, Almora.

Dr. R.K. Singh, Senior Scientist jointed as Principal Scientist (Plant Biotechnology) on 10.08.2009.

Administrative Staff

Shri Sant Ram, T-2 joined IISR on 1 April, 2009 on transfer from IARI Regional Station, Indore.

Transfers

Dr. P.K. Singh, Sr. Scientist was relieved on 12 May, 2009 to join PPV & FR authority, New Delhi as Registrar.

Dr. Archna Suman, Principal Scientist was relieved on 31 July, 2009 to join IARI, New Delhi as Principal Scientist.

Dr. V.K. Singh, SMS Agronomy, KVK was relieved on Dec. 12, 2009 to join KVK, Moderma, Jharkhand (under CRRI, Cuttack) as Programme coordinator

Superannuation

Scientists

Er. M.P. Sharma, Principal Scientist retired on 30.09.2009.

Dr. A. P. Singh, Principal Scientist retired on 30.09.2009.

Others

Shri P.C. Misra, UDC retired on 30.06.2009.

Shri L.K. Lama, T-5 retired on 30.06.2009.

Shri Maikoo Lal, SS Gd.II retired on 30.07.2009.

Shri Manna Lal, A.A.O. retired on 31.08.2009

Shri Mathur Prasad, T-2 retired on 30.09.2009.

Career advancement

In this period, following persons got promotion in their respective service career.

Name	Post	Date
Shri Ramesh Prasad Verma	UDC	08.04.2009
Shri Avadhesh Kumar Yadav	T-5	01.04.2007
Kumari Maya Agrawal	Assistant	08.04.2009
Shri Pankaj Kumar Arora	UDC	01.07.2009
Shrimati Raj Shankar	Assistant	01.09.2009
Shri Nag Chand	Assistant	01.09.2009
Shri Sartaj Ali	AAO	01.09.2009
Shri Shyam Lal	UDC	08.09.2009
Shri S.C. Jaiswal	UDC	08.09.2009

Necrology

Shri Ravi Kant Saxena, SSG.III expired on 13.09.2009.

Dr. R.K. Tewari, Principal Scientist expired on 12.11.2009.

Meteorological data

(Year 2009-10)

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Rainy days (No.)	Wind velocity (km hr^{-1})	Duration of sunshine (hr day^{-1})
	Max	Min	07 Hr	14 Hr				
Apr. 09	38.3	20.9	45	16	0.2	0	6.5	5.2
May 09	38.0	24.7	63	38	17.2	2	3.9	3.8
Jun. 09	39.7	26.2	62	33	58.2	3	3.8	2.1
Jul. 09	35.1	26.8	84	64	184.0	11	3.2	4.2
Aug. 09	33.6	25.6	88	71	326.2	12	3.2	1.8
Sep. 09	32.6	24.2	90	69	264.6	8	2.1	2.7
Oct. 09	31.5	17.5	86	48	112.8	4	1.8	4.2
Nov. 09	27.5	13.0	91	43	3.2	0	2.0	2.0
Dec. 09	24.3	8.1	92	39	3.6	0	2.0	2.0
Jan. 10	17.4	7.9	94	66	10.6	1	2.5	1.3
Feb. 10	25.5	11.7	90	42	19.8	4	3.5	4.5
Mar. 10	34.2	16.8	71	30	0	0	4.5	5.9
Average	31.5	18.6	80	47	-	-	3.2	3.3
Total	-	-	-	-	1000.4	45	-	-

Glossary

Abbreviation	Full Form
AAO	Assistant Administrative Officer
AICRP (BC)	All India Coordinated Research Project on Biological Control
AICRP (S)	All India Coordinated Research Project on Sugarcane
ARIS	Agricultural Research Information System
ARS	Agricultural Research Service
ASP	Active Server Page
ATMA	Agriculture Technology Management
AARDO	Agro-Asian Rural Development Organisation Agency
ASTI	The Association of Sugarcane Technologists of India
ATR	Action Taken Report
AVT	Advance Varietal Trial
AWS	Automatic Weather Station
CCS	Commercial Cane Sugar
CEY	Cane Equivalent Yield
CFU	Colony Forming Units
CMA	Corn Meal Agar
CMS	Cytoplasmic Male Stariltiy
Co	Sugarcane Var. Hybridisation & Testing at Coimbatore
CoH	Sugarcane Var. Hybrisation at Coimbatore & Testing at Hisar
CoJ	Sugarcane Var. Hybridisation at Coimbatore & Testing at Jallandhar
CoLk	Sugarcane Var. Hybridisation at Coimbatore, Testing at Lucknow
CoPk	Sugarcane Var. Hybridisation at Coimbatore & Testing at Pratap Kota
Co Pant	Sugarcane Var. Hybridisation at Coimbatore & Testing at Pantnagar
CoS	Sugarcane Var. Hybridisation at Coimbatore & Testing at Shahjahanpur
CoSe	Sugarcane Var. Hybridisation at Coimbatore & Testing at Seohari
CCT	Controlled Condition Testing
CPP	Covered Pit Planting
CTP	Covered Trench Planting
CSP	Cadre Strength in Position
CTAB	Catyltrimethyl Ammonium Bromide
CV	Coefficient of Variation
Cv	Cultivar
CVRC	Central Variety Release Committee
DAH	Days after Harvest
DAP	Days after Planting
DAS	Days after Sowing
DARI	Days after ratoon initiation
DBT	Department of Biotechnology
DDP	Furrow planting after deep disc
DUS	Distinctiveness, Uniformity and Stability
ESTs	Expressed Sequence Tags
Expl.	Exploratory
FET	Field Experience Training
FIMS	Farm Information Management System

FIRB	Furrow Irrigated Raised Bed
FISH	Fluorescent *in situ* hybridization
FMD	Foot Mouth Disease (Cattle)
FP	Farmers' Practice
FPU	Filter Paper Unit
FSF	Flame Spreader Fins
FYM	Farm Yard Manure
GC	General Cross
GISH	Genomic *in situ* hybridization
HOD	Head of Division
HR Brix	Hand Refractrometer Brix
HRD	Human Resource Development
HS	Highly Susceptible
HTML	Hyper Text Markup Language
IAA	Indole Acetic Acid
IAAO	Indole Acetic Acid Oxidase
IAPSIT	International Association of Professionals in Sugar and Integrated Technologies
ICS	Integrated Communication Strategy
IDM	International Department of Meteorology
IDM	Integrated Disease Management
IE(I)	Institute of Engineers (India)
IISR	Indian Institute of Sugarcane Research
IMC	Institute Management Committee
INM	Integrated Nutrient Management
INSEY	In Season Estimate of Yield
IPM	Integrated Pest Management
IRC	Institute Research Council
ISAE	Indian Society of Agricultural Engineering
ISEE	Indian Society of Extension Education
ISEP	Indian Society of Extension Professionals
ISSR	Inter Simple Sequence Repeat
IVLP	Institute Village Linkage Programme
IVT	Initital Varietal Trial
IZVT	Inter Zonal Varietal Trial
KADS	Knowledge Analyis & Design Support
KVK	Krishi Vigyan Kendra
LAI	Leaf Area Index
LAN	Local Area Network
LCC	Leaf Colour Chart
LER	Land Equivalent Ratio
LG	Linkage Group
MHAT	Moist Hot Air Treatment
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPN	Most Probable Number
MR	Moderately Resistant
MS	Moderately Susceptible
MTA	Material Transfer Agreement

MVC	Model-View Controller
NAARM	National Academy of Agriculture Research Management, Hyderabad
NDVI	Normalized Difference Vegetation Index
NDUA&T	Narendra Dev University of Agriculture & Technologies, Faizabad
NAIP	National Agricultural Innovative Programme
NAR	Net Assimilation Rate
NFOA	Nitrogen Fertilization Optimization Algorithm
NHG	National Hybridization Garden
NMC	Number of Millable Canes
NPK	Nitrogen, phosphorus and Potassium
NRA	Nitrate Reductase Activity
NRC	Non-Recurring Contingency
NSI	National Sugar Institute
NUE	Nitrogen Use Efficiency
NR	Nitrate Reductase
NS	Non signficant
NWZ	North West Zone
NCZ	North Central Zone
OMA	Oat Meal Agar
Palewa	Pre-planting or pre-sowing irrigation (local term)
PCR	Polymerase Chain Reaction
PDA	Potato Dextrose Agar
PF	Parallel Fins
PHT	Post-Harvest Technology
Pi	Phoshorus inorganic
PI	Principal Investigator
PLER	Partial Land Equivalent Ratio
PMC	Press Mud Cake
PTO	Power Take Off
QUAT	Quaternary
QTL	Qualitative Trait Loci
PSB	Phosphate Solubilising Bacteria
PVT	Primary Varietal Trial
PT	Preparatory Tillage
R	Resistant
RAC	Research Advisory Committee
RAPD	Randon Amplified Polymorphic DNA
RBD	Randomised Block Design
RC	Recurring Contingency
RCBD	Randomized Complete Block Design
RCM	Research Coordination and Management
RDF	Recommended Dose of Fertilizers
RE	Revised Estimate (Budget)
RF	Radial Fins
RGR	Relative Growth Rate
RH	Relative Humidity
RMD	Ratoon Management Device
RPP	Ring pit planting

RWC	Rice-Wheat Consortium
S	Susceptible
SAI	Soluble Acid Invertase
SMBC	Soil Microbial Biomass Carbon
SOD	Super Oxide Dismutase
SCMV	Sugar Cane Mosaic Virus
SPAD	Soil Plant Analysis Development (Chlorophyll Meter)
SPM	Sulphitation Press Mud
SPMC	Sulphitation Press Mud Cake
SQL	Structural Query Language
SSF	Simultaneous Saccharification and Fermentation
SSP	Single Super Phosphate
SSR	Simple Sequence Repeat
STAI	Sugar Technologists' Association of India
STP	Spaced Transplanting
SWA	Sugarcane Woolly Aphid
SCS	Sanctioned Cadre Strength
TA	Traveling Allowance
TMC	Trichoderma mixed culture
TO	Tractor Operated
TOT	Transfer of Technology
TP	Trench Planting
TPC	Total Phenolic Content
UPCAR	Uttar Pradesh Council of Agricultural Research, Lucknow
UPCSR	Uttar Pradesh Council of Sugarcane Research, Shahjahanpur
UPGMA	Unweighted pair-group method of Arithmatic mean
VSI	Vasantdada Sugar Institute, Pune
VC	Vermi Compost
VPN	Vitrual Private Network
VPKAS	Vivekananda *Parvatiya Krishi Anusandhan Shala*, Almora
WSI	Wilt Severity Index
WHRS	Waste Heat Release System
WCE	Weed Control Efficiency
RAPD	Randomly Amplified Polymorphic DNA
YEM	Yeast extract Mannitol
UDSC	University of Delhi, South Campus

भाकृअनुप
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भारतीय गन्ना अनुसंधान संस्थान

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