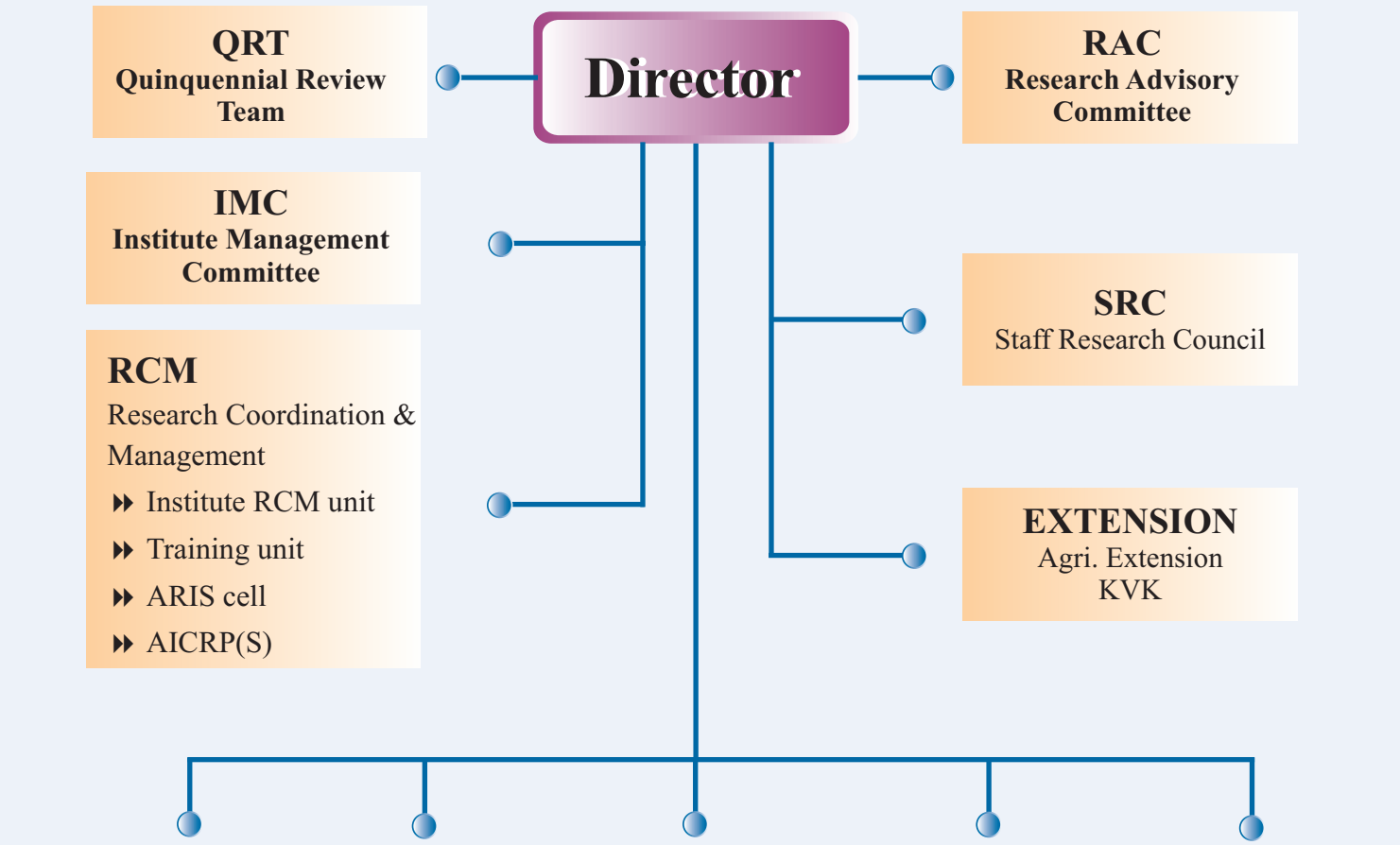
वार्षिक प्रतिवेदन
Annual Report

2006-2007

भाकृअनुप
ICAR

भारतीय गन्ना अनुसंधान संस्थान
Indian Institute of Sugarcane Research

Indian Institute of Sugarcane Research Lucknow



Organizational set-up

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Preface

India's sugar production has risen sharply to more than 25 mln tonnes in 2006-07 from 21 mln tonnes the previous year and 13.8 mln tones in 2004-05. The sharp rise in sugar production is the result of favourable weather conditions and new processing capacities following higher returns to cane growers. India annually consumes about 19 mln tonnes of sugar and the higher output could put more pressure on prices which have fallen by Rs 500 to Rs. 1300 per 100 kg over the last six months. Higher output coupled with a drop in global prices have made sugar exports from India unprofitable. These are the cyclic fluctuations and are expected to smoothen out with suitable measures like liberalization of the sugar sector as well as creation of buffer stocks by the Govt. in the pipeline. India has to produce over 450 mln. tonnes of sugarcane to meet the requirement of 29 mln. tonnes of white sugar in addition to jaggery and *khandsari* by 2020 A.D. and the scope of horizontal expansion is limited, it could only be increased if vertical increase in yield and sugar recovery both is carried out through sustained research and development efforts.

The Indian Institute of Sugarcane Research, Lucknow carried out research work in the area of crop diversification, judicious water management, integrated nutrient management, integrated disease and pest management, bio-technology and mechanization of sugarcane crop. During the year, the research work was made more focused and the major emphasis was given on planting techniques and quality cane seed, and in enhancing the yield of the ratoon crop, development of high-sugar, red rot resistant, high-yielding varieties, and the mechanization of cane cultivation. The seed standards were worked out. The improved planting methods and crop geometry and the STP method for fast multiplication of seed cane are being demonstrated to the farmers and sugar mill personnel for their wide adoption. Mechanization to reduce the cost of sugarcane cultivation was given priority and a multipurpose ratoon management device (RMD) was developed at the Institute to mechanize the cumbersome and labour intensive operations of almost culturally ignored ratoon crop. During the period under reference, the scientists were encouraged to undertake contract research projects. Institute-sugarmill and institute-manufacturer interfaces (in the form of public-private partnership), training programmes to sugar mill extension functionaries and farmers, on-farm trials and demonstrations were carried out to expedite the transfer of technology. The farmers' view point was also taken in fine tuning of the research programmes. The HRD activities, monitoring & evaluation and the research information management were strengthened.

The present Annual Report, consisting of 23 theme-based chapters, is a mirror of all the Institute activities during the year 2006-07 (April – March). I wish to express my appreciation for the efforts put in by Dr. D.V. Yadav, Principal Scientist & I/c, RCM, Dr. Ashwani K. Sharma, Sr. Scientist (Agril. Econ.) and Sri Mahendra Singh, Technical Officer, in the compilation and editing of the report. Thanks are also due to all the Heads of Divisions/Incharges of Sections and scientists for their cooperation in providing the information timely and in the requisite format. The help received from Sri Dharmendra Chandra Pant and Sri Pankaj Arora in typing this manuscript is gratefully acknowledged.

(R.L. Yadav)
Director

Contents

सारांश

फसल सुधार

दो लाल सड़न प्रतिरोधी अनुवांशिकी स्टॉक इक्षु आईएसएच-1 (पीआईओ 91-190 x एसआईपी 93 - 190) तथा इक्षु आईएसएच - 23 (पीआईओ 91-829xएसआईपी 315), (राष्ट्रीय पहचान आईसी 548345 तथा आईसी 548346) तथा एक उच्च चीनी युक्त प्रजनन स्टॉक एलजी 95053, राष्ट्रीय पौध अनुवांशिकी संसाधन ब्यूरो, नई दिल्ली में पंजीकरण के लिए जमा किये गये।

भारतीय चीनी मिल संघ द्वारा चीनी मिलों में वृहद स्तर पर परीक्षण हेतु कोलक 94184 तथा कोलक 9709 को चुना गया। अखिल भारतीय समन्वित गन्ना अनुसंधान परियोजना के अन्तर्गत, उत्तर-पश्चिम तथा उत्तरी मध्य क्षेत्रों के लिए 12 प्रजातियों का परीक्षण किया जा रहा है। इनमें से कोलक 9705, मध्य पछेती किस्म तथा अगेती किस्मों में से कोलक 9709 तथा कोलक 94184 ने अच्छा प्रदर्शन किया है।

गन्ना किस्म कोजे 64 से एक लाल सड़न रोग के प्रति प्रतिरोधिता युक्त सोमाक्लोनल वेरिएन्ट, बीओ 91 से एक उच्च चीनीयुक्त अन्य सोमाक्लोनल वेरिएन्ट तथा 10 उच्च चीनीयुक्त अन्य प्रजनन स्टॉक, राष्ट्रीय संकरण बाग (एनएचजी), कोयम्बतूर को भेजे गये। लोकप्रिय/नई तैयार की गई प्रजातियों का लगभग 8 हजार क्विंटल बीज गन्ना पैदा किया गया। प्रौद्योगिकी विभाग के वित्त पोषण द्वारा चलाई जा रही एक सह-भागी परियोजना के अन्तर्गत लाल सड़न रोग के विरुद्ध सी-डीएनए लाइब्रेरी से 1069 ईएसटी तैयार कर जीन बैंक में भेजे गये। बयालीस गन्ना प्रजातियों का 'आरएपीडी' तथा 'एसएसआर' चिन्हों (मार्कर) के साथ यौगिक विविधता विश्लेषण किया गया।

चार गन्ना प्रजातियों के जीनोम डी एन ए का 30 रेंडम प्राइमर के साथ जब 'आरएपीडी' प्रोफाइल तैयार किया गया तो 30 पीपीएम क्रोमियम से उपचारित कोलक 94184 गन्ने में एक अतिरिक्त बैंड पाया गया जो क्रोमियम की विषाक्तता के विरुद्ध सहनशीलता के लिए उत्तरदायी हो सकता है।

गन्ना जीन प्रारूपों का सस्य मूल्यांकन

उन्नत जीन प्रारूपों के सस्य मूल्यांकन से विदित हुआ है कि ग्रीष्मकाल की बुआई के लिए अन्य जीन प्रारूपों की तुलना में, कोशा 96275, काफी श्रेष्ठ आँकी गई तथा इसकी उपज 75.6 टन प्रति हे. प्राप्त की गई।

10 टन गोबर की खाद के साथ 150 किलोग्राम नत्रजन प्रति हे. के उपयोग में गन्ने की अगेती किस्मों में से कोलक 94184, नत्रजन उपयोग हेतु सबसे सक्षम आँकी गई। इस दर पर इसकी नत्रजन उपयोग क्षमता 262 किलोग्राम गन्ना उपज प्रति किलो प्रयुक्त नत्रजन पाई गई जबकि गोबर की खाद के बिना क्षमता मात्र 224 किलोग्राम गन्ना उपज प्रति किलो प्रयुक्त नत्रजन आँकी गई। कोशा 95270 तथा बीओ 128 भी 252.7 तथा 200.7 किलोग्राम गन्ना उपज प्रति किलो नत्रजन क्षमता के साथ सक्षम जीन प्रारूप पाये गये। मध्य एवं पछेती किस्मों में से को एच 110 तथा कोलक 9616 क्रमशः 322 एवं 252 किलोग्राम गन्ना उपज प्रति किलोग्राम नत्रजन क्षमता के साथ सक्षम जीन प्रारूप पाये गये।

पेड़ी प्रबन्धन

पेड़ी फसल में रिक्त स्थानों को कम करने के उद्देश्य से पौध संख्या प्रबन्धन पर आधारित अध्ययन के अनुसार, पारंपरिक विधि द्वारा 90 सेमी. के अन्तराल पर बोए गन्ने की तुलना में, दोहरी पांक्ति विधि (30:120 सेमी.) से गन्ने की बुआई करने से स्थान रिक्तता घट कर 9.5 प्रतिशत रह गई और अधिकतम पेरने योग्य गन्नों की संख्या (120.5 हजार गन्ने प्रति हे.) तथा गन्ना उपज (92.9 टन प्रति हे.) प्राप्त हुए।

बावक गन्ना फसल में 25 प्रतिशत अधिक बीज गन्ने के उपयोग करने से या पौध फसल में प्रथम सिंचाई के समय रिक्त स्थानों की पूर्ति करने से पेड़ी गन्ना फसल की उत्पादकता बढ़ाने में कारगर सिद्ध हुए।

बावक गन्ना फसल में 75 किग्रा. पोटाश प्रति हे. की दर से प्रयोग करने से पेड़ी गन्ना की उपज तथा व्यावसायिक गन्ना चीनी में 10 प्रतिशत के लगभग बढ़ोत्तरी पाई गई। बावक फसल में ट्राइकोडरमा विरडी द्वारा उपचारित गन्ना बीज के प्रयोग से, इसकी पेड़ी गन्ना फसल में गन्नों के वजन, गन्ना उपज तथा व्यावसायिक गन्ना चीनी की मात्रा में वृद्धि पाई गई। बावक गन्ना फसल में 10 टन प्रति हे. गोबर की खाद के साथ ट्राइकोडरमा के प्रयोग से प्रथम पेड़ी की उपज 88.2 टन प्रति हे. प्राप्त हुई जो 7.5 टन पताव/ट्रैस प्रति हेक्टेयर की दर से ट्राइकोडरमा के साथ प्रयोग करने से उपलब्ध पेड़ी गन्ना उपज (82.9 टन प्रति हे.) से अधिक थी। अतः स्पष्ट है कि गले सड़े पदार्थ जैविक कारकों (बायो-एजेन्टस) की कार्यक्षमता बढ़ाने में मुख्य भूमिका अदा करते हैं।

अतिशीत ताप पर एसिड इनवर्टेज की कमी, अवकारक

शर्करा की मात्रा में कमी, इन्डोल एसिटिक एसिड एवं फिनोल की मात्रा में बढ़ोत्तरी तथा नाइट्रेट रिडक्टेज एवं एस.ओ.डी. की गतिशीलता में वृद्धि के कारण शर्करा (सुक्रोज) की गतिशीलता अवरूद्ध हो जाती है और परिणामस्वरूप किल्लों का प्रस्फुटन नहीं हो पाता है। अंकुरिका का आकार एवं उसमें नमी अथवा जड़ों की संख्या एवं उनकी लंबाई में वृद्धि उसके अधिक तापमान (25 डिग्री सेंटीग्रेड) पर प्रस्फुटन से सम्बन्धित है। प्रस्फुटित अंकुरों में अवकारक शर्करा की मात्रा, एसिड इनवर्टेज की विशिष्ट गतिशीलता तथा एटीपेज की मात्रा में वृद्धि पायी गयी जबकि प्रोटीन, आई.ए.ए. एवं पी.आई. की मात्रा में कमी पाई गई ।

गन्ना आधारित फसल चक्र में नत्रजन प्रबंधन

गेहूँ+गन्ना की फर्ब विधि द्वारा बुआई करने पर सभी खाद क्रमों (सड्यूल) के प्रयोग से दोनों फसलों की उत्पादकता में वृद्धि पाई गई। फर्ब विधि के अन्तर्गत पोषक तत्व क्षमता 64.46 सी ई वाई किलोग्राम प्रति किलोग्राम पोषक तत्व आँकी गई जोकि समतल विधि (45.47) की अपेक्षा काफी अधिक पाई गई। 270 किलोग्राम नत्रजन, 120 किलोग्राम फास्फोरस तथा 120 किलोग्राम पोटाश की स्वीकृत मात्रा के साथ नवम्बर माह में गेहूँ की बुआई तथा 80 सेमी. दूरी पर बनाये गये कुंडों में फरवरी माह में गन्ने की बुआई करने से सबसे अधिक पोषक तत्व क्षमता (74.1 सी ई वाई किलोग्राम प्रति किलोग्राम पोषक तत्व) आँकी गई।

बावक गन्ना-प्रथम पेड़ी-द्वितीय पेड़ी-गेहूँ-धान फसल चक्र में प्रथम पेड़ी फसल पर नत्रजन प्रयोग का असर (80.5 टन/हे.) स्पष्ट रूप से प्राप्त हुआ। जबकि अन्य मुख्य पोषक तत्वों (जैसे फास्फोरस, पोटाश तथा सल्फर) तथा सूक्ष्म पोषक तत्वों (जैसे जिंक, ताँबा, मैंगनीज तथा लोहा) के समन्वय का उपज की वृद्धि में योगदान नहीं पाया गया।

बावक गन्ना-पेड़ी गन्ना फसल चक्र में गन्ना की किस्म कोसे 92423 में गन्ना की सूखी पत्तियाँ अकेली अथवा जैविक खाद के साथ प्रयोग करने पर, केवल रासायनिक श्वादों के माध्यम से ही 100 प्रतिशत नत्रजन, फास्फोरस तथा पोटाश की पूर्ति करने से प्राप्त गन्ना उपज की तुलना में पेड़ी गन्ना उपज में वृद्धि नहीं पाई गई।

जिंक तथा फास्फोरस पोषक तत्वों के स्रोत एवं स्तरों की अनुरूपता पर शोध करने से विदित हुआ है कि गन्ने की फसल के लिए पोषक तत्व पोषण के लिए 60 किलोग्राम फास्फोरस प्रति हे. विशेषकर सिंगल सुपर फास्फेट के माध्यम से तथा 20 किलोग्राम जिंक सल्फेट प्रति हे. सही युगम सिद्ध हुए हैं।

मृदा में गन्ने की सूखी पत्तियों की शीघ्र घुलनशीलता के लिए *एसपरजीलस टीरियस* सबसे सक्षम कारक पाया गया। क्योंकि इसके कारण कार्बन : नत्रजन अनुपात में 61 प्रतिशत की कमी तथा सेलुलेज उत्पादन में 12 गुणा बढ़ोत्तरी हुई। *एसपरजीलस टीरियस* के उपरांत *सेलुलोमोनास यूडा, ट्राईकोडरमा रीसी* तथा *जाइगोमोनास मोबिलिस* घटते क्रम में अन्य सक्षम कारक पाये गये।

गन्ना फसल के लिए कार्बनिक पोषक तत्व मोड्यूल

प्रत्येक वर्ष, 10 टन प्रति हे. की दर से सल्फीटेशन प्रेसमड के साथ एसिटोबेक्टर डालने से तृतीय पेड़ी में पेरने योग्य गन्नों की अधिकतम संख्या (102.7 हजार प्रति हे.) तथा 70 टन प्रति हे. गन्ना उपज प्राप्त हुई। इस उपचार के परिणामस्वरूप मृदा सूक्ष्म जीवाणु जैविक कार्बन (2553 मिलीग्राम कार्बनिक कार्बन प्रति किलोग्राम मृदा) सबसे अधिक आँका गया। दूसरे स्थान पर दस टन गोबर की खाद के साथ *एसिटोबेक्टर* उपचार में मृदा कार्बनिक कार्बन 2542 मिलीग्राम कार्बनिक कार्बन प्रति किलोग्राम मृदा आँका गया। अतः स्पष्ट है कि *एसिटोबेक्टर* के उपचार उपरांत कार्बनिक खादें फसल के पोषक तत्व की ज़रूरत को पूरा करती हैं तथा साथ ही बहु पेड़ी गन्ना फसल में मृदा स्वास्थ्य को भी बनाये रखती है।

कार्बनिक खेती मोड्यूल के रूप में 10 टन प्रति हे. सल्फीटेशन प्रेसमड तथा 10 टन प्रति हे. गोबर की खाद के एक साथ प्रयोग करने से शरद्कालीन तथा ग्रीष्मकालीन बोए गन्ने से प्राप्त पेड़ी की उपज क्रमशः 85.2 टन प्रति हे. और 74.3 टन प्रति हे. प्राप्त हुई। शरद्कालीन तथा ग्रीष्मकालीन बोए गन्ने से प्राप्त पेड़ी फसल में क्रमशः 17-34 प्रतिशत तथा 7 से 21 प्रतिशत मृदा कार्बनिक कार्बन में वृद्धि आँकी गई। मृदा सूक्ष्म जीवाणु नत्रजन एवं मृदा सूक्ष्म जीवाणु कार्बन में भी काफी वृद्धि आँकी गई। बीस टन गोबर की खाद + *ट्राइकोडरमा विरडी* + मसूर/मूंग के कार्बनिक खेती मोड्यूल में सबसे अधिक मृदा सूक्ष्म जीवाणु गतिशीलता आँकी गई। अतः गन्ना की शरद्कालीन एवं ग्रीष्मकालीन दोनों फसलों के लिए 10 टन प्रति हे. सल्फीटेशन प्रेसमड + 10 टन प्रति हे. गोबर की खाद एक आदर्श कार्बनिक खेती मोड्यूल पाया गया। शरद्कालीन फसल में 10 टन प्रति हे. सल्फीटेशन प्रेसमड + *एजोटोबेक्टर* तथा ग्रीष्मकालीन फसल के लिए 20 टन प्रति हे. गोबर की खाद + *ट्राइकोडरमा विरडी* + मूंग क्रमशः अन्य सक्षम मोड्यूल पाये गये। ये मोड्यूल न केवल गन्ने की उत्पादकता को बनाए रखने में सक्षम पाये गये बल्कि राइजोसफेरिक सूक्ष्म जीवाणु पुँज को बढ़ाने, मृदा स्वास्थ्य को बनाए रखने तथा धान-शरद्कालीन गन्ना-पेड़ी-गेहूँ तथा धान-बरसीन-ग्रीष्मकालीन गन्ना-पेड़ी-गेहूँ

के अन्तर्गत बावक-पेड़ी सिस्टम को आर्थिक दृष्टि से सक्षम बनाने में भी योग्य पाये गये।

सूखे की स्थिति से निपटने के लिए तकनीक

बीज गन्ना के टुकड़ों को चूने के संतृप्त पानी में भिगोने, बुआई के पूर्व कुंडों में दस टन प्रति हे0 की दर से गोबर की खाद डालने, बुआई के 60 दिनों के उपरान्त पताव बिछाव, बुआई के 90, 105 तथा 120 दिनों के उपरान्त यूरिया और पोटेशियम क्लोराइड के 2.5 प्रतिशत घोल का छिड़काव के साथ-साथ बुआई के 170 दिनों के उपरान्त 60 किलोग्राम पोटाश प्रति हे. की दर से अतिरिक्त खाद देने पर सर्वाधिक (85.3 टन प्रति हे.) गन्ना एवं (9.58 टन प्रति हे.) चीनी प्राप्त हुए। अतिरिक्त पोटाश के प्रयोग से रस की गुणवत्ता में भी आशातीत वृद्धि पाई गई। अतः बुआई की गोल गड्डा विधि तथा गन्ना बीज के उपचारीकरण के साथ-साथ पोटाश खाद की पर्याप्त मात्रा के प्रयोग से गन्ना पौधों में उन गुणों की वृद्धि हुई जो उन्हें सूखे की स्थिति से निपटने में सहायक सिद्ध हुए।

समन्वित खरपतवार प्रबंधन

साइप्रेस रोटेन्डस तथा *साइनोडोन डेक्टाइलोन* तथा अन्य चौड़ी पत्ती वाले खरपतवारों के कारण पेड़ी गन्ना फसल की उपज में 30.6 प्रतिशत की कमी पाई गई। जमाव पूर्व एटराजीन दो किलोग्राम (ए आई) प्रति हे. तथा जमाव उपरान्त एक किलोग्राम (ए आई) 2, 4 -डी प्रति हे. या पेड़ी शुरू करने के 45 दिन बाद निराई-गुड़ाई करने से 90.9 टन प्रति हे. पेड़ी गन्ना उपज प्राप्त की गई। गन्ने की एक एकान्तर पंक्ति में पताव बिछाव (ट्रैस) के साथ शेष पंक्ति में दो निराई-गुड़ाई (प्रथम और छठे सप्ताह में) करने से 92.3 टन प्रति हे. गन्ना उपज आँकी गई जो कि पारंपरिक विधि के अनुसार तीन निराई-गुड़ाई (पेड़ी शुरू करने के प्रथम, चतुर्थ तथा सातवें सप्ताह) से प्राप्त उपज के बराबर पाई गई। अतः इस प्रकार समन्वित खरपतवार प्रबंधन कारगर एवं मजदूरी की बचत करने में सक्षम पाया गया।

एकीकृत रोग प्रबन्धन

उत्तर प्रदेश के तराई क्षेत्र में कोशा 8436 में 5 से 10 प्रतिशत लाल सड़न रोग पाया गया जबकि जल प्लावित क्षेत्रों में पेड़ी गन्ना फसल में इसका प्रकोप 70 प्रतिशत तक आँका गया।

सूखा रोग प्रभावित गन्ना पौधों की जड़ों से कई प्रकार के फफूंदी समूह पाये गये जिनमें लगभग 50 प्रतिशत तक फ्यूजेरियम समूह पाया तथा घटते क्रम में अन्य फफूंदी समूह, राइजोकटोनिया, नाइग्रोस्पोरा, पीथियम तथा ट्राइकोडरमा (8 से 12 प्रतिशत) पाये गये। इसके अतिरिक्त अल्टरनेरिया, राइजोपस, म्यूकर, एसपरजीलस, पैनसीलियम तथा पेइसीलोमाइसीस भी पाये गये।

उत्तर पश्चिमी क्षेत्र में गन्ने के लाल सड़न रोग के जनक सी एफ 08 से मिलते-जुलते, संस्थान द्वारा चार अन्य प्रभेद, कोशा 8432 से आई आर 5, कोलक 8102 से आई आर 6, कोशा 98231 से आई आर 7 तथा कोशा 8436 से आई आर 8 एकत्र किए गए।

बीज गन्ना को *सोलेनम नाइग्रम* के पर्ण निचोड़, उसके उपरांत *ट्राइकोडरमा विरडी* के जीवाणु घोल तथा कल्चर फिल्टरेट से उपचारित करके तथा *ट्राइकोडरमा विरडी* के मृदा में मिलाने से गन्ने के कंडुआ रोग के प्रकोप में काफी कमी आँकी गई।

उत्तर प्रदेश एवं बिहार में गन्ना की राइजोसफेरिक मृदा से *ट्राइकोडरमा* के 10, *एसपरजीलस* के 4, और *कीटोमियम* के 2 नये प्रभेद उपलब्ध किए गए। इन प्रभेदों की विरोधी गतिविधि को *सी. फेलकेटम* तथा *ट्राइकोडरमा* के विरुद्ध परीक्षण किया गया तथा यह पाया गया कि एसपरजीलेस और *कीटोमियम* की अपेक्षा *ट्राइकोडरमा* के प्रभेद ज़्यादा प्रभावी हैं।

ट्राइकोडरमा बीजाणु घोल (पी डी ए पर 7 दिनों की वृद्धि, 1:106 की दर से तरलीकरण) से बीज गन्ना उपचारित करने, बुआई के समय 20 किलोग्राम प्रति हे. गोबर की खाद में टी एम सी पाउडर के रूप में मिलाने से तथा 2.50 प्रतिशत *ट्राइकोडरमा* के मैटाबोलाइटस को किल्ले प्रस्फुटन अवस्था में उपयोग करने से लाल सड़न रोग की रोकथाम तथा गन्ना फसल की बढ़वार को बढ़ाने में कारगर सिद्ध हुए हैं।

टी. हरजीनियम के दो प्रभेदों (टी 37 एवं टी 38) ने सी. फलकेटम के विरुद्ध सर्वांगी प्रेरित प्रतिरोधिता प्रदान की जिससे इसका टीका लगाने पर भी लाल सड़न रोग से 45 से 55 प्रतिशत बचाव किया। *टी. हरजीनियम* ने जमाव (10 से 20 प्रतिशत), किल्लों की संख्या, पेरने योग्य गन्नों की संख्या तथा गन्ना उपज में 10-15 टन प्रति हे. की वृद्धि का योगदान किया।

दो जीन प्रारूप, 1-16-7 एवं 1-32-2, सी एफ 08 के प्रति सामान्य प्रतिरोधी जबकि सी एफ 09 के लिए सामान्य संवेदनशील पाए गए। प्रारूप I-18-6 तथा II -3-2, सी एफ 08 के प्रति संवेदनशील से अतिसंवेदनशील तथा सी एफ 09 के विरुद्ध सामान्य प्रतिरोधी पाए गए।

कंडवा रोग के प्रति चार जीन प्रारूप जैसे 1-14-7, 2-15-10, IV-4-4 तथा कोलक 2919 सामान्य संवेदनशील पाए गए।

फ्यूजेरियम सेकेरी के 146 प्रभेद एकत्र किये गये जो या तो फुज्जीदार धूसर सफेद या फुज्जीदार नीला सफेद थे। लहसुन/कार्नेशन के पत्तों का प्रयोग करते हुए, स्थूल बीजाणु पैदा करने की एक तकनीक विकसित की गई। इसके मेक्रोकोनेडिया 26-40 x 3-3.5 माइक्रोमीटर पाए गए। इन चयनित प्रारूपों का 'आरएपीडी' तथा 'एसएसआर' मार्कर (चिन्हों) द्वारा यौगिक गुण-वर्गीकरण किया गया। इसका पी सी आर वृहद पदार्थ 264 से 3629 बी पी तक पाया गया।

पीड़क कीट प्रबन्धन

उत्तर प्रदेश के विभिन्न भागों में दीमक का प्रकोप 5 से 10 प्रतिशत जबकि चोटी बेधक कीट एवं तना बेधक कीट का प्रकोप नगण्य पाया गया। इसके विपरीत मीली मत्कुण (बग) का प्रकोप 60 से 80 प्रतिशत तक पाया गया जब कि ऊनी माहु का प्रकोप निम्न से मध्य स्तर का आँका गया। बिहार में चोटी बेधक कीट तथा सफेद लट का तीव्र प्रकोप पाया गया।

गन्ना खेतों में चोटी बेधक कीट के अण्डों पर *टेलीनोमस* तथा *ट्राइकोडरमा क्लोनिस* का परजीवीकरण पाया गया। चोटी बेधक कीट (तृतीय पीढ़ी) की सुंडियों पर सबसे अधिक परजीवीकरण 68.75 प्रतिशत आँका गया जिसमें *रेकोनोटस* द्वारा 27.28 प्रतिशत तथा *आइसोटिमा* द्वारा 72.72 प्रतिशत परजीवीकरण पाया गया।

प्रयोगशाला में तापमान सहनशील प्रभेद उत्पन्न करने के लिए *टी. किलोनिस इशी* को 28 डिग्री सेंटीग्रेड से 2 डिग्री अधिक तापमान पर उसकी 10 पीढ़ियों को पाला गया/बनाये रखा गया। प्रयोगशाला में 26 डिग्री सेंटीग्रेड पर टी. किलोनिस की प्रारम्भिक पीढ़ियों में प्रजनन क्षमता कम पायी गई जो पीढ़ी दर पीढ़ी बढ़ते हुए बाद की पीढ़ियों में काफी बढ़ी हुई पाई गई। तापमान 26 से 28 डिग्री बढ़ जाने के कारण कीट की उम्र तथा उसकी प्रजनन क्षमता में कमी आँकी गयी।

पेड़ी गन्ना की तीन अवस्थाओं में कीट समूहों के अध्ययन से विदित हुआ है कि पताव बिछाव अवस्था में सबसे ज़्यादा कीटों का प्रकोप पाया जाता है। पत्तियों के जलाने से तना बेधक कीट, पोरी बेधक कीट तथा जड़ बेधक कीट के प्रकोप में कमी पायी गयी। अधिकतम बचाव अवस्था में लागत : लाभ अनुपात 1:5.6 आँका गया।

चोटी बेधक कीट के समरूप दिखने वाले सफेद पतंगों के लिए एक कृत्रिम आहार तैयार किया गया। *टेलीनोमस बेनीफीशियनस* को पालने में इस पतंगे के अण्डों का प्रयोग किया गया।

कोटेशिया के परजीवीकरण तथा प्रयोगशाला में उसकी वृद्धि के लिए तना बेधक कीट की सूंडियों को खेतों में से एकत्र किया गया। खेतों से एकत्र की गई इन सूंडियों में से 70 प्रतिशत मादा कीट तथा प्रयोगशाला में पाली गयी सूंडियों में से 40 प्रतिशत मादा कीट उपलब्ध हुए।

लगभग 26 दिनों तक लगातार पतंगों की उत्पत्ति आँकी गई। विभिन्न पीढ़ियों (I, II, III, IV एवं V) में नर पतंगों की संख्या क्रमशः 60, 27, 15, 16 तथा 9 पतंगें प्रति दिन प्रति ट्रेप आँके गए।

गन्ना के ऊनी माहु कीट के प्रकोप को कम करने तथा परजीवियों के संवर्द्धन और उनकी बढ़ोत्तरी के लिए *डिफा एफीडीबोरा* की एक हजार सूंडियाँ या *माइक्रोमस इगोरोटस* की दो हजार सूंडियाँ प्रति हे. प्रभावी सिद्ध हुई हैं। गन्ने में चीनी परता में 9.21 प्रतिशत (कोशा 8436) से 18.44 प्रतिशत (कोशा 767) कमी आँकी गई जबकि गन्नों के वजन में 10.54 प्रतिशत (कोशा 8436) से 19.75 प्रतिशत (कोशा 767) की कमी आँकी गयी।

यंत्रीकरण/मशीनीकरण

पेड़ी प्रोमोटर का डिजाइन तैयार किया गया और उसमें प्रत्येक पंक्ति के लिए एक फलोंटिग टाईप पहिए (ग्राउंड व्हील) को लगाया गया ताकि देशी/रासायनिक खाद इकाई के मीटर सिस्टम को चलाया जा सके। इस यंत्र के अन्य इकाईयों जैसे मेन फ्रेम, लोटिंग टाईप पहिए, रिपर, देशी/रासायनिक खाद को दानेदार अवस्था में डालने के लिए डिब्बे (कनटेनर) की अभिकल्पना तैयार की गई तथा उन्हें मेनफ्रेम के साथ जोड़ा गया।

फर्ब सिस्टम के लिए ट्रैक्टर चालित शुगरकेन प्लान्टर कम सीडर का प्रथम प्रोटोटाइप तैयार कर तीन क्षेत्रों में इसका परीक्षण किया गया। इस यंत्र का गेहूँ, मूँग एवं उड़द के बीजों को ऊँची क्यारियों में बुआई करने के साथ-साथ गन्ना बीज की कुंडों में बुआई के लिए परीक्षण किया गया।

पत्तियों को अलग करने की एक बिजली चलित मशीन जिसमें एक फीडिंग इकाई, पत्तियों को अलग करने की इकाई तथा साफ गन्ने को बाहर निकालने की इकाई सम्मिलित है, विकसित की गई। इस मशीन का 1.46 किलोवाट (2.00 अश्व शक्ति) के मीटर पर परीक्षण किया गया। इस यंत्र को ट्रैक्टर से चलाने की भी सुविधा प्रदान की गई है। इस यंत्र की पत्तियों को साफ करने की क्षमता 100 प्रतिशत आँकी गई है। सूखी तथा हरी पत्तियाँ जो गन्ने के साथ शेष पायी गई, वे गन्ना

किस्म पर निर्भर करता है तथा मात्र 0 से 0.5 प्रतिशत तक ही आँकी गई।

आई आई एस आर पेड़ी प्रबन्धन यन्त्र, द्विपंक्ति बहुउद्देशीय कटर प्लांटर, ट्रैक्टर चालित द्विपंक्ति स्टबल सेवर, ट्रैक्टर चालित रिज टाइप कटर प्लांटर तथा ट्रैक्टर चालित द्विपंक्ति पिट डिगर के एक-एक प्रोटोटाइप तैयार किए गए।

कटाई उपरान्त की तकनीक

किस्म कोशे 92423 पर मार्च महीने में कटाई पूर्व जिंक सल्फेट (1000 मिलीग्राम जस्ता प्रति लीटर) का पत्तियों पर छिड़काव करने से कटाई उपरान्त चीनी का कम नुकसान होता है। जिंक उपचारित गन्ने को सूखी पत्तियों से 8 दिन तक ढके रखने के उपरान्त भी बिना जिंक उपचारित तथा पत्तियों से ढके रखने की अपेक्षा ज़्यादा शर्करा (सुक्रोज) तथा रस की शुद्धता पायी गई। काटे गए गन्ने पर 2.5 से 4 ग्राम बैन्जालकोनियम क्लोराइड प्रति लीटर और 0.2 से 0.5 ग्राम सोडियम लोरेल सल्फेट प्रति लीटर के प्रतिपादन का छिड़काव करने के बाद सूखी पत्तियों से ढकने पर शर्करा (सुक्रोज) के नुकसान को काफी कम किया जा सकता है। इस उपचार के परिणामस्वरूप, कटाई के 10 दिनों उपरान्त भी रखे बासी गन्ने में व्यावसायिक गन्ना चीनी में 2 इकाई की वृद्धि पाई गई।

तकनीकी हस्तान्तरण

गन्ने की नयी अनुमोदित एवं स्वीकृत प्रजातियों का लगभग 4100 कुन्तल बीज गन्ना, भारतीय गन्ना अनुसंधान संस्थान, लखनऊ प्रक्षेत्र में पैदा कर उत्तर प्रदेश की चीनी मिलों के माध्यम से किसानों में वितरित किया गया। इसके अतिरिक्त संस्थान के क्षेत्रीय शोध केन्द्र, मोतीपुर, बिहार प्रक्षेत्र से प्रजाति को 89029 (गण्डक) का लगभग 584 कुन्तल बीज गन्ना, बिहार की चीनी मिलों के माध्यम से किसानों में वितरित किया गया। प्रवरानगर क्षेत्र (महाराष्ट्र) में गन्ने के वूली एफिड कीट के नियंत्रण के लिए किसानों के खेतों में *डिफा एफिडीवोरा* परजीवी के 12000 कोकून तथा 25000 सूंडियाँ छोड़े गए। इसके अतिरिक्त गन्ना किसानों के 446 हे. क्षेत्र में तना बेधक कीट के विरुद्ध *ट्राईकोग्रामा किलोनीस* परजीवी के 50 हजार प्रौढ़ कीट प्रति हे. की दर से छोड़े गए।

"भारतीय गन्ना अनुसंधान संस्थान; एक नज़र में", गन्ना बुआई की उन्नत विधियाँ तथा पेड़ी प्रबन्धन पर तीन डाक्यूमेन्टरी फिल्में बनाई गई।

गन्ने की उत्पादन लागत

देश के छः प्रमुख गन्ना उत्पादक राज्यों महाराष्ट्र, तमिलनाडु, कर्नाटक, आन्ध्र प्रदेश, गुजरात तथा उत्तर प्रदेश में गन्ना उत्पादन लागत के विश्लेषण से स्पष्ट हुआ है कि वर्ष 2001-2005 में प्रति हे. औसत गन्ना उत्पादन लागत उत्तर प्रदेश में सबसे कम (29417 रुपये) तथा तमिलनाडु में सबसे अधिक (54450 रुपये) पाई गई। उत्पादन लागत के दो मुख्य कारकों, मजदूरी लागत एवं सिंचाई लागत में आशातीत वृद्धि आँकी गई जबकि गन्ने की उत्पादकता में उसके अनुरूप काफी कम वृद्धि दर आँकी गई। वर्ष 1970-71 से वर्ष 2005-2006 तक के 35 वर्षों के अन्तराल में विभिन्न राज्यों में गन्ने की उत्पादकता में मात्र 15-20 टन प्रति हे. की ही वृद्धि पाई गई। उत्तर प्रदेश तथा महाराष्ट्र में गन्ने की खेती करने में लाभ लागत अनुपात एक से कम होने के साथ-साथ कम होता पाया गया है। अतः कुल रिटर्न में से लाभ का अंश, वर्ष दर वर्ष कम होता गया है। अतः किसानों की मजदूरी की लागत को कम करने तथा गन्ना उपज में वृद्धि करने से गन्ना खेती से किसानों को लाभांश की दर में बढ़ोत्तरी की सम्भावनायें हैं।

डेटाबेस

संस्थान में हर दिन के मौसम सम्बन्धी आँकड़े एकत्र करके उनको वैज्ञानिकों की आवश्यकता के अनुरूप प्रदान किया जाता है। इसके अलावा अन्य केन्द्रीय संस्थानों, केन्द्रीय मौसम विभाग तथा राजकीय संस्थानों जैसे उपकार तथा कृषि विश्वविद्यालयों को भी आँकड़े प्रदान किए जाते हैं। गन्ना फसल के अन्तर्गत क्षेत्रफल, पैदावार, उत्पादकता, चीनी मिलों की संख्या, सिंचित क्षेत्रफल तथा भूमि उपयोग के जनपदवार आँकड़ों को योजना आयोग द्वारा निर्धारित जोन वार तैयार किया गया। गन्ना क्षेत्रफल, उत्पादन, उत्पादकता, एवं चीनी मिलों की संख्या को दर्शाने के लिए जी आई एस नक्शे भी तैयार किए गए हैं।

विविध

संस्थान द्वारा इस वर्ष जमा किए गए चार पेटेन्ट पर कार्यवाही की जा रही है। अन्तर्राष्ट्रीय स्तर पर जापान तथा आस्ट्रेलिया के साथ मिलकर शोध परियोजनाएं बनाने पर कार्यवाही की गई है। भारतीय शोध पत्रिकाओं, जरनल तथा विदेशी शोध पत्रिकाओं (जरनल) में 6 शोध पत्र प्रकाशित हुए हैं। इस वर्ष लगभग प्रत्येक वैज्ञानिक ने संस्थान में या अन्यत्र सेमिनार/कार्यशाला में भाग लिया है। संस्थान के विभिन्न शोध कार्यों की शोध सलाहकार समिति, वैज्ञानिक शोध परिषद् तथा अन्य स्तरों पर समीक्षा की गई है।

Executive Summary

Crop Improvement

Two red-rot resistant sugarcane genetic stocks viz. IkshuISH-1 (PIO 91-190 x SIP 93-190) and IkshuISH-23 (PIO 91-829 x SIP 315) [national identity IC 548345 and IC 548346] and one high sugar breeding stock LG 95053 were submitted for registration with NBPGR.

CoLk 94184 and CoLk 9709 were selected by Indian Sugar Mill Association (ISMA) for large-scale factory trials. Twelve varieties are under testing with AICRP(S) in the NW and NC Zones. Out of these, CoLk 9705 (mid-late), CoLk 9709 (early) and CoLk 94184 (early) have shown promise.

One somaclonal variant of CoJ 64 showing resistance to red-rot, and another from BO 91 with higher sugar productivity were sent to National Hybridization Garden (NHG), Coimbatore (along with 10 high sugar breeding stocks. More than 8000 quintals of seed of popular/ newly released sugarcane varieties was produced, 1069 ESTs from a subtracted c-DNA library against red-rot were developed and submitted to GenBank under a collaborative DBT project with University of Delhi (South Campus). Forty-two sugarcane varieties were subjected to molecular diversity analysis with RAPD and SSR markers.

RAPD profile of genomic DNA from four varieties with about 30 random primers showed presence of an extra band in sugarcane variety CoLk 94184 treated with 30 ppm Chromium. This could be related to its tolerance to chromium toxicity.

Agronomic evaluation of sugarcane genotypes

Agronomic evaluation of promising genotypes revealed that genotype, CoS 96275 established its superiority for summer planting (75.6 t ha^{-1}) over other genotypes.

Efficient input-use sugarcane genotypes

Investigation on genotypic variations in sugarcane for nitrogen use efficiency (NUE) revealed that among early group, CoLk 94184 was observed to be the most efficient for nitrogen use at 150 kg N ha^{-1} both with 10 t FYM (262 kg cane kg^{-1} applied N) and without FYM (224 kg cane kg^{-1} applied N). Genotypes, CoS 95270 and BO 128 were also identified as efficient ones with NUE of 252.7 and 200.7 kg cane kg^{-1} applied N, respectively. Among mid-late group, CoH 110 and CoLk 9616 with corresponding NUE of 322 and 252 kg cane kg^{-1} applied N were reckoned as efficient genotypes for nitrogen use at 10 t ha^{-1} FYM + 150 kg N ha^{-1}.

In another study, the NUE of CoLk 97147 continued to be higher at nitrogen levels from 75 to 225 kg ha^{-1} than CoLk 94184 indicating that the former genotype exhibited greater amplitude to nitrogen use than latter one.

Ratoon management

Studies on plant population management for minimizing gaps in ratoon revealed that sugarcane planted in paired row system (30:120 cm) significantly reduced the gaps (9.5%), produced the highest NMC (120.5 thousand ha^{-1}) and cane yield (92.9 t ha^{-1}) over conventional planting at 90 cm spacing. Increasing 25% seed rate or gap filling at 1st irrigation in plant crop proved applicable practice for enhancing ratoon productivity.

Application of 75 kg ha^{-1} K_2O to plant crop increased yield of ratoon cane and CCS by over 10% each over no K application (60.2 and 6.89 t ha^{-1}). Similarly inoculation of seed cane with *Trichoderma viride* improved weight of individual cane, and the yield of cane as well as CCS in ratoon crop.

Application of 10 t FYM + *Trichoderma viride* produced significantly the highest cane yield (88.2 t ha^{-1}) in 1st ratoon over 7.5 t ha^{-1} trash + *Trichoderma viride* (82.9 t ha^{-1}) suggesting key role of rotten substrate in functional activities of bio-agents.

At chilling temperature, there occurs an immobilisation of sucrose due to suppression of acid invertase, reduced content of reducing

sugars, accumulation of IAA, phenols and increased activities of Nitrate Reductase and SOD and it resulted in non-sprouting of the buds as such. Increase in bud size, bud moisture, root numbers and their length was associated with sprouting at higher temperature (25 °C). In sprouted buds, the reducing sugars and the specific activities of acid invertase and ATPase increased gradually while soluble protein , IAA and Pi contents decreased.

Nutrient management in sugarcane based cropping systems

FIRB systems of wheat + sugarcane planting significantly augmented the productivity of component crops (higher CEY) at all fertilizer schedules. The nutrient use efficiency (increase in CEY kg ha^{-1} kg^{-1} applied nutrients) was greater under FIRB (64.46) than under flat method (45.47). The highest NUE of 74.1 kg CEY per kg applied nutrient was observed for wheat (Nov) + sugarcane (Feb) in 80 cm spaced furrows under FIRB at recommended doses of NPK i.e. 270:120:120 kg ha^{-1} for crops in the system.

Under plant cane-1st ratoon-2nd ratoon-wheat-paddy rotation, the response to only N (80.5 t ha^{-1}) was conspicuous in 1st ratoon crop. Integration of other macro–(P, K, S) and micro–nutrients (Zn, Cu, Mn, Fe) could not add to the benefit.

In sugarcane plant-ratoon system (Cv. CoSe 92423) incorporation of trash and/or trash + biofertilizer could not increase ratoon yield significantly over 100% NPK through fertilizers.

Studies on compatibility of Zn with P sources and levels revealed that application of 60 kg ha^{-1} P_2O_5 preferably through SSP and 20 kg ha^{-1} $ZnSO_4$ appeared compatible combination for sugarcane crop nutrition.

The most effective agent causing the maximum solubilization of trash was found to be *Aspergillus terreus*. It caused 61% drop in C: N ratio and 12 fold increase in production of cellulase production. *Aspergillus terreus* was followed by *Cellulomonas uda*, *Trichoderma reesi* and *Zygomonas mobilis*

Organic nutrition modules for sugarcane

Application of 10 t ha^{-1} sulphitation pressmud cake + *Acetobactor* every year registered the highest NMC (102.7 thousand ha^{-1}) and cane yield (70 t ha^{-1}) in 3rd ratoon. This treatment also recorded the highest Soil Microbial Biomass Carbon (2553 mg CO_2-C kg^{-1} Soil) and was closely follwed by 10 t ha^{-1} FYM + Acetobacter (2542 mg CO_2-C kg^{-1} Soil) indicating that these organic manures mediated through *Acetobacter* to meet the nutritional requirement of crop and also maintain soil health under multi-ratooning of sugarcane.

Organic farming module consisting of SPM, 10 t ha^{-1} + FYM, 10 t ha^{-1} produced the highest ratoon cane of 85.2 t ha^{-1} initiated from autumn planted crop and 74.3 t ha^{-1} initiated from spring planted crop. There was increase in soil organic carbon in plots after harvest of ratoon initiated from autumn (17-34%) and spring (7-21%) planted crops under different organic farming modules. Soil microbial activity estimated as soil microbial biomass C and N were more in all the organic module treatments compared to control being the highest in 20 t ha^{-1} FYM + *Trichoderma viride* + lentil/mungbean module. Therefore, SPM, 10 t ha^{-1} + FYM, 10 t ha^{-1} proved an ideal organic farming module for both autumn and spring planted sugarcane. The SPM, 10 t ha^{-1} + *Azotobacter* in autumn planted crop and 20 t FYM + *Trichoderma viride* + mungbean intercropping in spring planted crop were identified the next better combinations. These organic farming modules were reckoned as efficient not only for maintaining and enhancing cane productivity but also enriching rhizospheric microbial pool, maintaining soil health, and making plant-ratoon system economically viable in two distinct diversified cropping systems viz., Rice-Autumn Sugarcane-Ratoon-Wheat; Rice-Berseem-Spring Sugarcane-Ratoon-Wheat.

Agro-techniques for management of summer drought

Significantly the highest yield of cane (85.3 t ha^{-1}) as well as sugar (9.58 t ha^{-1}) was recorded by additional 60 kg ha^{-1} K_2O at 170 days after planting over and above soaking setts in

saturated lime water + foliar spray of urea and KCl @ 2.5 % at 90, 105 and 120 DAP + trash mulch after 60 DAP + application of FYM @ 10 t ha^{-1} in the furrows before planting. Additional 60 kg $ha^{-1}K_2O$ significantly improved the juice quality. Therefore, Ring-Pit planting of sugarcane and sett treatment followed by adequate K nutrition imparted endurance characteristics to sugarcane plants under drought spells during grand growth period of the crop.

Integrated weed management

Weeds infestation (*Cyperus rotundus, Cynodon dactylon* and others broad leaved weeds) in ratoon crop caused 30.6% reduction in cane yield. Atrazine 2 kg a.i. ha^{-1} (pre-emergence) + 1 kg a.i. 2, 4-D (post-emergence) or hoeing 45 days after ratoon initiation (90.9 t ha^{-1}) and trash mulching in alternate rows + 2 hoeings in remaining alternate rows (1^{st} and 6^{th} week) produced cane yield (92.3 t ha^{-1}) *at par* with conventional practice of 3 hoeings (1^{st}, 4^{th} and 7^{th} weeks) after ratoon initiation (94 t ha^{-1}). Thus, these integrated approach proved effective and labour saving ones.

Integrated disease management

Red-rot was noticed in CoS 8436 (5-10%) in *Terai* region, while in some low lying/water logged fields, the incidence was as high as 70% in the ratoon.

Isolation from roots of wilt affected sugarcane plants yielded a number of fungi belonging to the genera, like *Fusarium, Rhizoctonia, Nigrospora, Pythium, Trichoderma, Alternaria, Rhizopus, Mucor, Aspergillus, Penicillium,* and *Paecillomyces. Fusarium* remained the most prevalent genera representing almost half of the isolated fungi followed by *Rhizoctonia*, *Nigrospora*, *Pythium* and *Trichoderma* (8-12% depending on the season).

Four isolates *viz.*, IR-5 (from CoS 8432), IR 6 (from CoLk 8102), IR 7 (from CoS 98231) and IR-8 (from CoS 8436) were similar to pathotype Cf 08 (CoJ 64) prevalent in North-West Zone.

Smut incidence was reduced in plots planted after the sett treatment with leaf extract of *S. nigrum* followed by sett treatment with *T. viride* spore suspension, culture filtrate and soil application of *T. viride* .

Ten fresh isolates of *Trichoderma*, 4 isolates of *Aspergillus* sp. and 2 isolates of *Chaetomium* sp. were obtained from sugarcane rhizosphere soil collected from U.P. and Bihar. Antagonistic activity of these isolates was tested against *C. falcatum*. *Trichoderma* strains were more effective than that of *Aspergillus* and *Chaetomium*.

Sett treatment with *Trichoderma* spore suspension (7 days growth on PDA, dilution $1:10^6$), TMC in powder form in FYM @ 20 kg ha^{-1} at the time of planting, metabolites of *Trichoderma* (2.50%) applied at tiller stage performed better in checking red rot and promoting growth of sugarcane.

Two strains of *T. harzianum* (T 37 and T 38) also induced systemic resistance and provided protection (45-55%) in challenge inoculation with *C. falcatum*. *T. harzianum* also enhanced germination (10-12%), tillers, NMC and yield (10-15 t ha^{-1}) over the check.

Two genotypes *viz.*, 1-16-7 and 1-32-2 were moderately resistant to pathotype Cf 08, while moderately susceptible to Cf 09. Genotypes, 1-18-6 and II-3-2 were susceptible to highly susceptible to Cf 08 and were moderately resistant to Cf 09.

Four genotypes *viz.*, 1-14-7, 2-15-10, IV-4-4, and CoLk 2919 were moderately susceptible to smut.

Fusarium sacchari isolates (146) were collected which were either too fluffy ashy white or fluffy bluish white. A technique of macrospore production using carnation/garlic leaf was developed. Macroconidia measured 26 (30-35)-40 µm x 3-3.5 µm. Molecular characterization of selected isolates was carried out through RAPD and ISSR markers. The PCR amplification product ranged from 264-3629 bp.

Bio-ecology and insect – pests management

The incidence of termites (5-10%), top borer (traces), stalk borer (traces), mealy bugs (60-80%), woolly aphid (low to medium) was recorded in different parts of Uttar Pradesh. Top borer and

white grubs were observed as the most serious pests in Bihar.

Parasitisation of egg masses of top borer with *Telenomus* sp. and *Trichogramma chilonis* was noticed in the field. Total parasitization of top borer (III brood) larvae was 68.75%, which comprised of 27.28% *Rhaconotus* sp. and 72.72% *Isotima* sp.

T. chilonis Ishii as maintained at 2^0C higher temperature (28 ± 2^0C) for ten generations in the laboratory for development of temperature tolerant strain. In laboratory rearing (26^0C), the low fecundity rate of *T. chilonis* in early generations gradually improved in advanced generations. With the increase in temperature from 26 to 28^0C, the longevity and fecundity was reduced.

The pest complex of sugarcane studied under three conditions of ratooning revealed that mulched condition had significantly greater infestation and parasitization. The burning of trash reduced the incidence of stalk, internode and root borers. Maximum protection given to crop yielded the cost benefit ratio of 1:5.6

An artificial diet was developed for white moth, closely resembling to top borer. Eggs of this moth were used for rearing of *Telenomus beneficiens.*

Field collected stalk borer larvae were preferred for parasitisation of *Cotesia* for laboratory multiplication as field-collected larvae of stalk borer gave 70% female emergence while laboratory-reared larvae gave 40% females.

The emergence of moths continued for an average of 26 days. The catches of male moths in different broods were 60, 27, 15, 16 and 9 moths $trap^{-1}$ day^{-1} in I, II, III, IV, V broods, respectively.

Conservation and augmentation through field releases of effective predators *viz., Dipha aphidivora* @ 1000 larvae or *Micromus igorotus* @ 2000 larvae ha^{-1} was effective in controlling sugarcane woolly aphid throughout the country. The loss in sugar recovery ranged from 9.21 (CoS 8436) to 18.44% (CoS 767) and in weight from 10.54 (CoS 8436) to 19.75% (CoS 767).

Mechanisation of sugarcane cultivation

Ratoon Promoter was designed and provided with one floating type ground wheel for each row to drive metering system of the manure/fertilizer disbursing unit. Sub units like mainframe, floating type ground wheels, rippers, containers for manure and fertilizer in granular form have been fabricated and fastened with the main frame.

The first prototype of FIRB: T.O. Sugarcane Planter-cum-seeder was developed and field tested at three different locations. Planter was tested for drilling of wheat, *urd* and *moong* seeds on the raised beds along with planting of cane in furrows

A power operated improved detrasher consisting of feeding unit, trash removing unit, and clean cane ejection unit was developed. The equipment was tested with the help of a 1.46 kW (2.0 HP) electric motor as a source of power. Provision was made to operate the equipment with tractor PTO. Performance of the equipment was satisfactory. The detopping efficiency (removal of green top) was as high as 100 per cent. The trash (green + dry) left in the cleaned cane varied from 0.0 to 5.0% depending upon the variety.

One prototype each of IISR ratoon management device, IISR Two row multipurpose cutter planter, IISR T.D. Stubble Shaver (2 row), IISR T.D. ridger type cutter planter, IISR T.D. two bottom pit digger was developed.

Post-harvest technology

A pre-harvest foliar spray of $ZnSO_4$ (Zn^{++} @ 1000 mg l^{-1}) on variety CoSe 92423, in the month of March, showed reduction in post-harvest sucrose loss. Sucrose % and purity of juice was higher after 8 days of staling in Zn treated cane covered with trash as compared to untreated trash covered control. Spraying of a formulation containing (2.5-4.0 g Benzalkonium chloride l^{-1} + 0.2-05 g Sodium lauryl sulphate l^{-1}) on harvested cane followed by covering with trash appreciably reduced sucrose losses after harvest. This treatment improved CCS by 2 units after a staling of 10 days.

Transfer of Technology

About 4100 quintals of seed cane of popular/ newly released sugarcane varieties, produced at IISR, Lucknow was distributed to sugar mills in U.P. Approximatly, 584 quintals seed cane of variety Co 89029 (*Gandak*) were distributed among the farmers and sugar factories of Bihar through IISR, Regional Station, Motipur, Bihar.

A total of 12,000 cocoons and 25,000 larvae of pyralid predator *Dipha aphidivora* were released in farmer's field against sugarcane woolly aphid around Pravaranagar area for its colonization. The release of *Trichogramma chilonis* @ 50,000 adults ha^{-1} was done in 446 ha sugarcane area of 326 farmers against shoot borer.

Documentary Films on *Bharatiya Ganna Anusandhan Sansthan : Ek Nazar Mein, Ganna Buwai ki Unnat Vidhiyan* and *Pedi Prabandhan* were prepared.

Cost of cultivation of sugarcane

The analysis of the cost of cultivation of the major agronomic scenario, and returns from sugarcane cultivation in 6 important cane growing states (Maharashtra, Tamil Nadu, Karnataka, A.P., Gujarat and UP) of India revealed that the average per ha operational cost of cultivation of sugarcane was the lowest in UP (Rs. 29417) and the highest in Tamilnadu (Rs. 54450) in 2001-05 period. Two important components of cost of cultivation viz., labour cost and irrigation cost grew at a much higher rate while the growth rate in yield was very low. The yield of sugarcane during the period grew by 15 – 20 tonnes per ha in different states. The benefit: cost ratio in sugarcane cultivation, still less than one, has decreased in UP and Maharashtra highlighting that the percentage share of benefits in gross returns has decreased over the years. Thus, there is a need to reduce the cost of labour as well as to enhance the yield of sugarcane to raise the margins of benefits to the farmers.

Database

The daily weather is compiled, collated and supplied as per needs of the scientists of the institute, ICAR institutes, central organizations such as IMD, Govt. of India, SAU's and state agencies such as UPCAR, Lucknow.

The district wise data on sugarcane acreage, production, productivity, number of sugar mills, irrigation scenario, land use pattern etc. were collected and grouped agro-climatic zones (as per Planning Commission classification). The GIS maps were generated for sugarcane area, cane production, cane productivity, and distribution of sugar mills in various zones.

Miscellaneous

Four patents are in the process of finalization. The institute has initiated talks for collaborative research projects with Japan and Australia. About 35 research papers were published in national journals and six in foreign journals. Almost every scientist participated in seminars/workshops organized either at the institute or outside the institute. The institute has effectively monitored its various research programmes through RAC, SRC and other reviews at different levels.

1 Introduction

The Indian Institute of Sugarcane Research (IISR), Lucknow was established in 1952 by the erstwhile Indian Central Sugarcane Committee for conducting research on fundamental and applied aspects of sugarcane culture as well as to co-ordinate the research work done on this crop in different states of the country. The Government of India took over the Institute from the Indian Central Sugarcane Committee on 1st January, 1954. It was transferred to the Indian Council of Agricultural Research (ICAR), New Delhi on April 1, 1969, along with other central agricultural research institutes. The Institute is located in Lucknow, the capital city of Uttar Pradesh and conveniently situated at about 12 kms from Lucknow's Amousi Airport and about 5 kms each from Lucknow Railway station and Charbagh Bus station. The climate of the area is sub-tropical semi-arid type. Monthly average maximum temperature during April to June ranges from 36^0 C to 40^0 C and minimum temperature during November to February ranges from 7^0C to 11.5^0 C. The annual average rainfall is around 880 mm.

Mandate

On the recommendation of the Research Advisory Committee of the Institute, the following new mandate was approved by the ICAR in 2001:

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 to provide training, consultancy and other users at regional, national and international levels.

Research Concerns

Keeping in view the mandate and mission of the different Divisions, and discussion among the members of SRC, the following major "Research Concerns" were identified:

- Low and plateauing of sugarcane yield in subtropical India
- High cost of cultivation of sugarcane
- Low sugar recovery and sugar production

To address the above mentioned research concerns, the following researchable issues were identified for the Institute:

- High sugar high yielding variety
- Input use efficiency
- Water use efficiency

To work out the speedy solutions of the above mentioned researchable issues, these were prioritised and accordingly the research programmes/thrust areas were identified as below:

Priorities	Programmes/Thrust areas
To develop red rot resistant sugarcane varieties for higher sugar productivity	1. Developing high sugar breeding stock 2. Utilization of Spontaneum and Erianthus gene pool enhancing rationing potential under cold temperature conditions 3. Breeding for red rot resistance
To improve productivity of ratoon cane in north sub-tropical India	1. Optimizing plant population density through new crop geometry 2. Balance use of fertilizers (balancing of greater dose of N with K fertilization) 3. Bio-manuring of sugarcane

Control of red rot disease of sugarcane through potential bio-agents	1. Isolation/identification, testing and multiplication of potential bio-agents for control of insect-pests and diseases
To minimize post-harvest losses for improving sugar recovery	1. Post-harvest management for reducing losses of sugar recovery in harvested cane 2. Enhancing cold tolerance in sugarcane especially stubble sprouting and improving sugar recovery
To develop a sugarcane harvester	1. Optimization and multifarious use of planter 2. Identification, design and development of cane harvester 3. Irrigation water management

Long term strategies

The long term strategies of the Institute identified to address the issues are as under:

Issues	Strategies
Developing early maturing, red rot resistant high sugar varieties of sugarcane	• Pre-breeding strategies • Varietal development • Molecular breeding strategies
Nutrient use efficiency in sugarcane plant-ratoon production system	• Developing integrated nutrient management-INM technology for sugarcane • Improving the productivity of sugarcane ratoon • Optimizing plant population density in sugarcane ratoon system
Bio-control of red rot and wilt	• Identification of bioagents against red rot and wilt • Collection of isolates of pathogens/bioagents • Bio-efficacy of bioagents against red rot and wilt pathogens in vitro and in vivo • Characterization of bioagents • Mode of action of bioagents • Standardization of delivery system • Mass production of bioagents
Characterization of biodiversity in red rot and wilt pathogens	• Collection of isolates of the pathogens from different locations in the country • Purification and maintenance of all isolates • Morphological, cultural and molecular characterization of all isolates • Phylogenetic relationship
Etiology of wilt syndrome, role of association of nematodes and disease management	• Isolation of fungi from different plant parts of wilt affected canes • Establishment of Koch's postulates and identification of causal organisms • Characterization of isolates of wilt pathogen • Role of nematodes in causation of wilt • Management of wilt through various approaches
Module for integrated management of major diseases	• Management of major diseases through bioagents, botanicals, etc. • Induction of systemic resistance through biotic and abiotic factors • Diseases management through varietal resistance • Evaluation of IDM module

Identification of alternative host for the parasitoids *Isotima javensis* and *Telonomus beneficiens*	• Collection of immature stages of lepidopterons and the parasitoids • Evaluation of immature stages of lepidopterons for their parasitic suitability • Determination of biological parameters of alternative host and the parasitoids • Mass multiplication of alternative host
Development of laboratory rearing technique for mass multiplication of top borer	• Standardization of suitable media • To determine efficacy of developed medium • Mass multiplication of parasitoids
Biodiversity in *Trichogramma chilonits* and *T. japonicum,* their molecular characterization and identification fo potential strain(s)	• Periodic collection of egg masses of moth borers of sugarcane from different locations • Rearing of parasitoids • Molecular characterization of different collections of *Trichogramma* spp. • Determination of biological parameters for identification of potential strain (s)
Evaluation of synthetic sex pheromones and standardization of application technique for management of top borer	• Testing efficacy of synthetic sex pheromones • Standaridization of application technique
Development of bio-intensive IPM for insect-pests and rodents	• Evaluation of crops possessing allelopathic effect against sub-terranean insect-pests • Evaluation of newer chemicals and bio-pesticides against major insect-pests and rodents and estimation of pesticide residue • Assessing compatibility of pesticides with bio-agents • Integration of development components and evaluation of IPM module
Physiological efficiency of sugarcane	• Dry matter production partitioning to assess cane yield and sucrose production
Sucrose accumulation, earliness in ripening and maintenance in juice quality	• Physiological evaluation of early ripening, progression, amelioration and maintaining better juice quality for a longer duration
Tolerance to low temperature stress	• Factors impacting juice quality at low temperature; sprouting of winter harvested crop; physio-biochemical markers for cold tolerance
Minimization of post-harvest sucrose losses under field conditions	• Assessment of nature and magnitude of post-harvest losses in sugarcane from early through late crushing
Management of post-harvest sucrose losses	• Use of anti-inversion and biocidal compounds (pre-and post-harvest treatment) and bio-agents(s) • Development of an integrated post-harvest management approach to minimize loss in sucrose and juice percentage in cane
Development of whole cane harvester	• Development of wind rower cane harvester • Development of bulk cane detrasher • Development of loading system from the field/out centre
Mechanization of sugarcane planting	• Development of small engine operated waling type Sugarcane Planter – Keeping in view the needs of small and marginal holdings
Improving water use efficiency	• Sprinkler irrigation • Drip irrigation

Organizational structure

The current organizational structure of the Institute, shown in the flow chart on the next page is as under:

Divisions

Crop Production

Crop Improvement

Plant Physiology and Biochemistry

Crop Protection

Agricultural Engineering

Service units/sections

Research Coordination & Management

Radio Tracer Laboratory

Agro-meteorology Laboratory

Agricultural Economics and Statistics

ARIS Cell

Central Laboratory

General facilities

Juice Analysis Laboratory

Library and Reprography

Arts and Photography

Dispensary

Security (Watch and Ward)

Farm

Estate and instrument maintenance

Electrical and tubewell installation

Civil repair and maintenance

Refrigeration and airconditioning

Instrumentation

Operation and maintenance of vehicles

Regional Centre

IISR Regional Centre : Motipur, Bihar

Divisional Biocontrol Centre : Pravaranagar (MS)

Research support services and activities

Research coordination & management unit

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

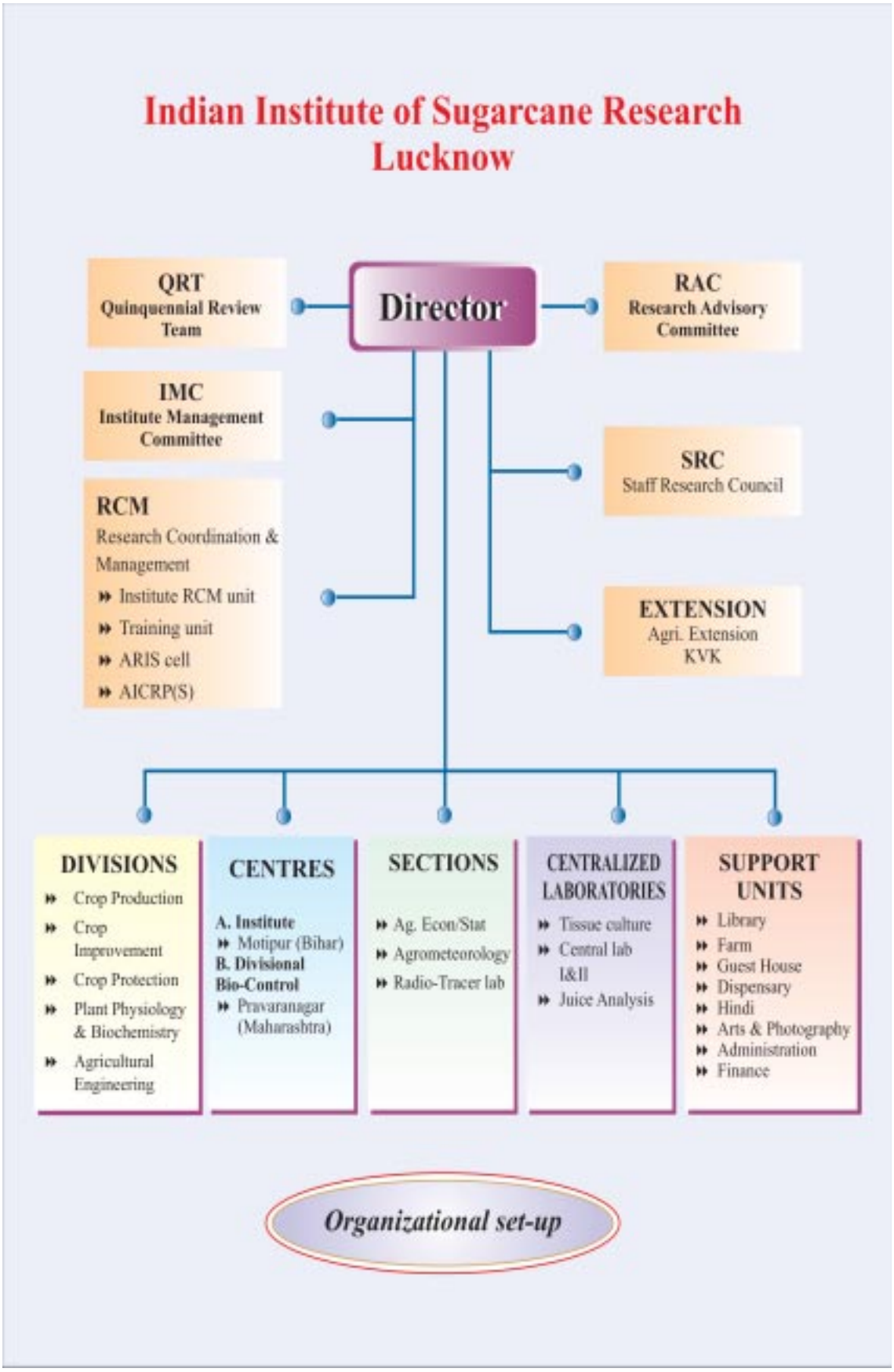
Library and reprography

The IISR Library is well established and has a rich collection of books, journals, annual reports, reference materials, CD ROMs, etc. The library offers reference and reprographic services to its readers/clientele. During this year, the Library budget was Rs. 10.70 lakh, out of which Rs. 1.05 lakh was spent on purchase/ acquisition of 122 books and Rs. 9.65 lakh was spent on subscription of Indian and International Journals. Total number of books in the Library has reached to 9,698 and the total titles of Indian and foreign journals 390, comprising 17,450 sets/volumes. During the year, 1,500 issues of Indian and International Journals, and 135 Annual reports were received. There are 20 Indian, 45 International Journals, 10 Newspapers and 7 Hindi/English magazines on the current subscription list. Some of the journals date as back as early as 1913. About 2000 readers were provided reference service during the year.

For modernization/digitization, 18 CD ROMs and one photocopier was purchased and steps to provide on-line data access to the readers are being taken.

Radio tracer laboratory

The Radio Tracer Laboratory of the Institute houses sophisticated instruments like Liquid



Organizational set-up

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. A total of 6736 juice samples were analyzed from October to March, 2007. Approximately 1400 samples were analysed for chemical and biochemical parameters such as Total Carbohydrates, Reducing Sugars, Protein (Glomalin), Dehydrogenase, Acid Phosphatase, Alkaline Phosphatase, Amylase, Invertase, Cellulase, Phosphorus in the year 2006-07. Press-mud samples obtained from a sugar factory were also analyzed for macro- and micro-nutrients.

Central laboratory

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

Soil Science laboratory

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

Bio-technology laboratory

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

ARIS cell

ARIS Cell is well equipped with latest computing and printing facilities. Campus-wide Local Area Network (LAN) has been developed using Fiber Optic and UTP cabling on Ernet based network. The auditorium, KVK, guest house and farm section have been connected to the main IISR network through optical fibre cabling. LINUX operating system is being used as field and print server to provide printing, campus-wide messaging and data sharing services. The cell is well connected to Internet via dial-up connectivity. Internet and E-mail services are being shared on existing network through Proxy Server. The IISR also received 256 kbps C-Band VSAT link for Internet connectivity on ERNET backbone under ICAR Net project. The cell has been further strengthened with two Xeon based Windows server to meet the LAN requirement and e-mail facility in its own address and Internet connectivity to the existing 65 nodes using UTP and optical fibre cable network. The IISR has obtained its own domain

under ERNET, India. During the year, ARIS Cell compiled information for Institute Information Bank (Institute Profile and Crop Profile), updated the Web Site of Indian Institute of Sugarcane Research, Lucknow (www.iisr.nic.in) and the Intranet Site of Indian Institute of Sugarcane Research, Lucknow (iisr.ernet.local). The Website of IISR, Lucknow has been redesigned and updated as per the guidelines of "Advisory Committee for Development of Web pages of ICAR Institutes".

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. During the year, 8 pairs of bullocks were added to the farm assets.

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 instruction, a Women's Cell is functioning since July 22, 1997. Smt. Sunita Lal, Pr. Scientist is the chairperson of the cell. Smt. Radha Jain, Sr. Scientist; Smt. S.L. Barjo, Assistant; Smt Anita Sawnani T-5, Technical Officer and Shri Rajeev Lal, Sr. Administrative Officer are the members of the Women cell.

Krishi Vigyan Kendra

Krishi Vigyan Kendra under the administrative control of IISR, Lucknow w.e.f. October 25, 1999 is disseminating technological activities as per its mandate.

Dispensary

It provides health care services to the Institute's staff and their dependents. It is equipped with x-ray instrument.

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 (2006-07)

Budget allocation (RE) and expenditure of the main Institute and AICRP on Sugarcane during 2006-2007 are furnished below:

A. Institute

(Rs. in lacs)

Particulars	Non-Plan		Plan	
	Revised Estimate	Expenditure	Revised Estimate	Expenditure
Estt. Charges	807.00	807.00	-	-
T.A.	6.00	6.00	6.00	6.00
HRD	-	-	-	0.12
Other charges	118.85	118.85	119.40	119.40
Works	58.07	58.07	25.60	25.60
Other items	-	-	-	-
OTA	0.15	0.15	-	-
Total	**990.07**	**990.07**	**151.00**	**151.12**

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

(Rs. in Lacs)

Particulars	Estt. Charges	T.A.	Other Charges (RC)	NRC	Grant in aid to centres	Total
Revised Estimate	186.36	9.65	35.60	2.00	-	233.61
Expenditure	200.63	7.35	32.94	1.85	-	242.77

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

C. Externally Funded Projects

S. No.	Projects	Funding agency	Duration	Amount (Rs.in lacs)
1	**DBT 1/03 :** Development of PCR based diagnostic kits for red rot and smut diseases of sugarcane	DBT, Govt. of India, New Delhi	03-06	10.0
2	**DBT 2/03 :** Development of ESTs in identification and transfer in sugarcane	DBT, Govt. of India, New Delhi	03-06	107.91
3	**UPCAR 1/03 :** Evaluation and standardization of organic farming techniques for sugarcane production system	UPCAR, Lucknow	03-07	13.18
4	**UPCAR 1/06 :** Enhancing field water use efficiency in sugarcane cropping system through FIRBs	UPCAR, Lucknow	06-09	1.60
		Total (over the years)		**132.69**

During 2006-07, the revenue receipt of the Institute was Rs. 35.37 lac.

Sl. No.	Realisation of Revenue Receipt	Amount (Rs. In lac)
1.	Farm Produce/Misc.	35.37
2.	Consultancy	-
3.	Royalty and Publication	-
	Total	**35.37**

Staff Position

IISR, Lucknow

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Agricultural Chemistry	0	0	1	0	2	0	3	0
Agricultural Entomology	1	1	2	0	5	5	8	6
Agronomy	2	1	2	3	8	8	12	12
Bio-Chemistry (Plant Science)	0	0	1	0	2	2	3	2
Bio-Technology (Plant Science)	1	0	1	10	2	0	4	0
Microbiology (Agriculture)	0	0	1	0	2	1	3	1
Nematology (Agriculture)	0	0	1	0	1	1	2	1
Plant Breeding	1	1	2	2	6	4	9	7
Plant Pathology	1	0	2	2	5	6	8	8
Plant Physiology (Ag/Hort. Corps)	1	1	1	0	2	3	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	2	0	0	1	3	2
Electronics & Instrumentation	0	0	0	1	0	0	0	1
Farm Machinery & Power	1	1	1	2	3	3	5	6
Soil & Water Conservation Engineering	0	0	1	0	1	1	2	1
Organic Chemistry	0	0	0	0	0	1	0	1
Agricultural Economics	0	0	1	1	1	0	2	1
Agricultural Extension	1	0	1	0	3	3	5	3
Agricultural Statistics	0	0	1	0	1	2	2	2
Computer Application in Agriculture	0	0	0	0	1	1	1	1
Genetics & Cytogenetics	0	0	1	1	2	3	3	4
Sub Total	**11**	**7**	**24**	**13**	**50**	**47**	**85**	**67**

All India Coordinated Research Project on Sugarcane

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Any crop science subject (Project Coordinator)	1	1	0	0	0	0	1	1
Agronomy	0	0	1	1	0	0	1	1
Plant Breeding	0	0	1	1	0	0	1	1
Agricultural Entomology	0	0	1	1	0	0	1	1
Sub Total	**1**	**1**	**3**	**3**	**0**	**0**	**4**	**4**

IISR Regional Station, Motipur

Discipline	Principal Scientist		Senior Scientist		Scientist		Total	
	SCS	CSP	SCS	CSP	SCS	CSP	SCS	CSP
Plant Breeding	0	0	1	1	0	0	1	1
Agronomy	0	0	0	1	1	0	1	1
Sub Total	0	0	1	2	1	0	2	2

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

Technicals

Functional Group	T-1	T-2	T-3	T-4	T-5	T-6	T(7-8)	T-9	Total
SCS									
Field/Farm Technicians	16	18	22	11	1	1	0	0	69
Workshop Staff induding Engineering Workshop	31	4	5	5	0	0	0	0	45
Photography Staff	0	1	1	2	0	0	0	0	4
Laboratory Technicians	2	1	0	0	0	0	0	0	3
Library/Information/Documentation Staff	0	1	2	1	0	0	0	0	4
Medical and Paramedical Staff	0	0	0	0	0	1	0	0	1
Press and Editorial Staff	0	0	1	0	0	0	0	0	1
Sub Total	49	25	31	19	1	2	0	0	127
Field/Farm Technicians (Motipur)	1	0	1	0	0	0	0	0	2
Total	50	25	32	19	1	2	0	0	129
CSP									
Field/Farm Technicians	15	18	20	10	1	1	0	0	65
Workshop Staff induding Engineering Workshop	29	4	5	5	0	0	0	0	43
Photography Staff	0	1	1	2	0	0	0	0	4
Laboratory Technicians	2	1	0	0	0	0	0	0	3
Library/Information/Documentation Staff	0	1	2	1	0	0	0	0	4
Medical and Paramedical Staff	0	0	0	0	0	1	0	0	1
Press and Editorial Staff	0	0	1	0	0	0	0	0	1
Sub Total	46	25	29	18	1	2	0	0	121
Field/Farm Technicians (Motipur)	1	0	1	0	0	0	0	0	2
Total	47	25	30	18	1	2	0	0	123

Administrative Staff

Designation	SCS	CSP
Asst. Director (Official Languages)	1	0
Senior Administartive Officer	1	1
Asst.Administartive Officer	4	4
Asst. Finance & Accounts Officer	1	1
Personal Assistant Grade II	2	2
Assistant	14	14
Upper Division Clerk	15	15
Lower Division Clerk	13	10
Private Secretary	1	0
Steno Grade III	7	6
Security Officer	1	1
Subordinate Staff Grade I	22	16
Subordinate Staff Grade II	31	31
Subordinate Staff Grade III	18	18
Subordinate Staff Grade IV	9	9
Sub Total	**140**	**128**
Upper Division Clerk (Motipur)	1	1
Subordinate Staff Grade 1 (Motipur)	1	1
Total	**142**	**130**

2 Crop management for high cane productivity under different environments

2.1 Sugarcane based production system

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

A field experiment with 6 intercropping systems and 3 sole stands in RBD with 3 replications was conducted to explore the possibility of intercropping linseed with autumn planted sugarcane (CoSe 92423). Sugarcane intercropped with linseed cv. *Parvati* (1:3 row ratio) produced number of millable canes (NMC) at 108.7 thousand t ha^{-1} and cane yield (80.9 t ha^{-1}) at *par* with sole sugarcane. This was closely followed by sugarcane + linseed cv. *Garima* (1:3) intercropping system (Table 2.1). Significantly the highest cane equivalent yield (95.7 t ha^{-1}) was obtained under sugarcane + linseed cv. *Parvati* (1:3) intercropping system. This system also recorded the highest Land Equivalent Ratio (LER) at 1.82. The quality parameters of sugarcane were not affected by different intercropping systems and commercial cane sugar (CCS) yield followed the trend of cane production. Thus, autumn planted sugarcane (Cv. CoSe 92423) may be intercropped with linseed (Cv. *Parvati*) in 1:3 row ratio for enhancing land productivity, harnessing crop associability and increasing economic profitability of sugarcane based production system.

Agronomic evaluation of promising genotypes of sugarcane (AS 42)

An experiment was conducted with three sugarcane genotypes (CoJ 99192, CoS 96275 and CoS 94257) under three NPK levels (112.5,45,45; 150,60,60 and 187.5,75,75 kg ha^{-1}) with a view to identify suitable genotypes under various fertiliser schedules in different cropping seasons (spring and summer planting) of subtropical India. Initial soil chemical analysis revealed that soil was low in soil organic carbon (0.45%), low in available nitrogen (195 kg ha^{-1}) and medium in phosphorus (32.5 kg ha^{-1} P_2O_5) and potassium (240 kg ha^{-1} K_2O). In spring planted crop, Genotype, CoS 96275 produced the highest

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

Cropping Systems	Nos. of tillers (000 ha^{-1})			NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Linseed yield (kg ha^{-1})	Cane equivalent yield (t ha^{-1})	PLER		LER
	March	May	July					Sugar cane	Linseed	
S + L P (1:3)	77.8	208.9	173.4	108.7	80.9	972	95.7	0.93	0.89	1.82
S + L G (1:3)	70.7	171.5	134.3	103.1	76.3	774	88.1	0.88	0.88	1.76
S + L P (1:4)	66.3	135.1	117.0	95.2	69.3	823	81.8	0.80	0.76	1.56
S + L G (1:4)	75.2	137.4	111.9	99.7	71.3	816	83.6	0.82	0.93	1.75
S + L P (B)	78.9	135.2	106.0	94.3	71.6	677	81.9	0.83	0.62	1.45
S + L G (B)	77.8	108.5	98.6	86.7	64.6	580	73.4	0.74	0.66	1.40
S (Sole)	217.8	305.5	216.5	125.4	86.7	-	86.7	1.00	-	1.00
LP (Sole)	-	-	-	-	-	1087	16.52*	-	1.00	1.00
LG (Sole)	-	-	-	-	-	875	13.30*	-	1.00	1.00
CD (P = 0.05)	29.79	46.22	27.59	17.83	8.63	270.2	7.82	-	-	-

Abbr. S = Sugarcane, LP = Linseed cv. *Parvati*, LG = Linseed cv. *Garima*, LER=Land Equivalent Ratio, PLER = Partial Land Equivalent Ratio

Note: The price of sugarcane was Rs. 1250 per tonne and that of linseed was Rs. 1900 per quintal

The recommended fertilizer dose for sugarcane was 150:60:60 kg ha^{-1} NPK and 60:40:40:30 kg ha^{-1} NPKS for linseed.

*Not included in statistical analysis

number of millable cane (128300 ha^{-1}), though there was no significant difference in individual cane length among the genotypes. Genotype, CoJ 99192 produced thicker canes compared to CoS 96275 and CoS 94257 (Table 2.2). Mean individual cane weight of CoS 94257 was significantly higher at 860.1 g. Significantly higher cane yield (90.50 t ha^{-1}) was harvested from CoJ 99192, which was 8.8% higher over CoS 96275 and 18.14 % to that from CoS 94257. The maximum CCS production (13.21 t ha^{-1}) was obtained with genotype, CoJ 99192. The number of millable canes, cane length, diameter, weight, cane yield and CCS were at *par* between 150, 60, 60 and 187.5,75,75 kg NPK ha^{-1}. It, thus highlights that the recommended level of NPK (150, 60 and 60 kg ha^{-1}) resulted in higher cane (86.3 t ha^{-1}) and CCS (12.03 t ha^{-1}) yields over 75% of the recommended NPK dose.

In summer planted crop, the higher number of millable canes (122200 ha^{-1}) were counted in sugarcane genotype, CoS 96275. The cane length (215.6 cm) was significantly higher in CoS 96275 as compared to CoJ 99192 and CoS 94257. Genotype, CoS 94257 had higher thickness (1.99 cm diameter) and shorter cane length (182.3 cm) than other genotypes. Individual cane weight was the highest for CoJ 99192 (710.6 g). Genotype, CoS 96275 produced significantly the highest cane (75.6 t ha^{-1}) and CCS (10.96 t ha^{-1}) yields. Number of millable canes (108600 ha^{-1}) at 150:60:60 kg ha^{1} NPK were significantly higher than 75% of recommended level of NPK (112.5:45:45 kg ha^{1} NPK). Significant increase in cane length, diameter and weight was also observed up to the recommended level of NPK. Various treatments could not bring tangible variation in juice quality. However, significant increase in cane (72.8 t ha^{1}) and CCS (10.06 t ha^{-1}) yields was obtained at recommended NPK level.

Drought management in sugarcane (AS 56)

The experiment consisted of 4 planting methods (planting at 60 cm row spacing, 90 cm row spacing; trench planting at 120 cm apart and pit planting) and 4 drought management practices, viz. (i) control (recommended practices), (ii) soaking cane setts in saturated lime water + foliar spray of urea and KCl @ 2.5 % at 90, 105 and 120 days after planting (DAP) + trash mulch after 60 DAP + addition of FYM @ 10 t ha^{-1}in the furrows before planting, (iii) 2nd treatment + additional 60 kg ha^{-1} K_2O at last irrigation, and (iv) 2nd treatment + additional 60 kg ha^{-1} K_2O at 170 DAP) in thrice replicated strip-plot design. Sugarcane (CoSe 92423) was planted in the last week of February, 2006 with pre-planting irrigation (*Palewa*). The crop received 150 kg N + 60 kg P_2O_5 + 60 kg K_2O ha^{-1} in addition to treatmental K. Three irrigations were applied before the onset of monsoon. No irrigation was given during rainy months and post-rainy period.

Table 2.2: Effect of genotypes and different fertility levels on growth, yield and quality of sugarcane

Treatments	Spring Crop*			Summer Crop**		
	Millable canes (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (t ha^{-1})	Millable canes (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (t ha^{-1})
Genotypes						
V_1- CoJ 99192	126.2	90.50	13.21	108.8	69.5	10.04
V_2- _ CoS 96275	128.3	83.20	11.65	122.2	75.6	10.96
V_3- CoS 94257	111.6	76.6	10.07	72.11	64.2	7.85
CD (P<0.05)	7.50	6.80	0.73	8.50	3.90	0.52
Fertility levels (NPK kg ha^{-1})						
D_1- 112.5, 45, 45	110.7	75.20	10.49	91.11	66.3	9.15
D_2- 150, 60, 60	125.9	86.3	12.03	108.6	72.8	10.06
D_3- 187.5, 75, 75	129.6	88.8	12.30	103.4	70.2	9.70
CD (P=0.05)	7.50	6.80	0.73	8.50	3.90	0.52

Note : *For spring crop, the planting date is 11.02.2006 & the harvesting date: 13.02.2007. ** For summer crop the planting date is 11.04.2006 and the harvesting date is 07.03.2007.

Significantly the highest germination (50.4%) was recorded under pit planting method. The yield attributes viz.; cane length (255.8 cm), girth (2.89 cm) and individual cane weight (1.27 kg) were significantly higher under pit method of planting resulting in significantly higher cane (87.2 t ha^{1}) as well as sugar (9.72 t ha^{1}) yield (Table 2.3). The germination in trench method was 49.1%. Planting of sugarcane at 60 cm spacing produced significantly the highest number of tillers as well as NMCs at 140.4 thousand ha^{1}.

The percentage of germination with sett soaking in saturated lime water was at 46.8%. The number of tillers at various crop growth stages and number of millable canes increased significantly under the treatment involving lime water soaking of setts + urea and KCl spray + FYM. This treatment also produced significantly higher individual cane weight.

The addition of 60 kg ha^{-1} K_2O at 170 DAP over and above the second treatment significantly increased cane (85.3 t ha^{-1}) as well as sugar (9.58 t ha^{-1}) yields. It also improved the juice quality.

Developing organic farming module for sugarcane crop (AS 57)

Field experiment was started during spring season (March) 2006 to study the effect of organic farming modules on sustainability of crop productivity and soil health. Five treatments were laid out in RBD with four replications. The highest cane yield of plant crop (89.8 t ha^{-1}) was recorded with 75% recommended NPK through inorganics + 25% through organic manures + biofertilizers + biopesticides closely followed by 75% of recommended N through organics + biofertilizers + 25% of recommended NPK through inorganics + biopesticides (87.7 t ha^{-1}). Juice quality remained unaffected by these treatments.

Evaluation and standardization of organic farming techniques for sugarcane production system (UPCAR 1/03)

The project was undertaken with a view to standardize the protocol of organic cultivation of sugarcane and developing efficient crop nutrition module for sugarcane planted in autumn and spring in different cropping systems. Biomanurial crop nutrition module consisting of sulphitation pressmud (SPM) 10 t + FYM 10 t ha^{-1} in ratoon of autumn planted sugarcane produced the highest leaf area index (LAI) (4.0) and dry matter accumulation (33.5 t ha^{-1}) during the grand growth phase of the crop. The crop continued to register higher relative growth rate (RGR) as well as net assimilation rate (NAR) under this treatment. The

Table 2.3: Effect of treatments on growth and yield attributes of sugarcane

Treatments	NMC (000 ha^{-1})	Cane length (cm)	Cane girth (cm)	Weight per cane (kg)	CCS %	CCS (t ha^{-1})	Cane yield (t ha^{-1})
Planting Methods							
60 cm row spacing	140.4	230.2	2.29	0.81	10.30	7.87	75.5
90 cm row spacing	115.4	235.1	2.34	0.93	10.54	7.50	71.0
Trench planting	126.5	239.1	2.45	1.13	10.61	8.30	78.1
Pit planting	134.6	255.8	2.89	1.27	11.12	9.72	87.2
CD (P = 0.05)	23.42	12.50	0.39	0.43	0.85	0.86	4.29
Drought Management Practices							
Control	120.0	229.0	2.35	0.91	10.08	7.23	71.6
Lime soaking + FYM + KCl & Urea spray	123.1	235.9	2.24	0.99	10.48	7.91	75.3
Additional 60 kg ha^{-1} K_2O at last irrigation	131.7	244.1	2.49	1.09	10.89	8.67	79.5
Additional 60 kg ha^{-1} K_2O at 170 DAP	142.2	251.0	2.69	1.17	11.22	9.58	85.3
CD (P = 0.05)	12.70	10.83	0.26	0.22	0.57	0.45	3.15

Abrr. DAP: Days After Planting

combination of 10 t SPM + 10 t FYM ha^{-1} gave the highest number (113.8 thousand ha^{-1}) of 230.9 cm long and 2.7 cm thick millable canes. This nutrition module produced the highest yield of cane (85.2 t ha^{-1}) and commercial cane sugar (CCS) at 10.3 t ha^{1}. Application of SPM, 10 t ha^{-1} + *Acetobacter* (75.6 t ha^{-1}) and FYM, 20 t ha^{-1} + *Trichoderma viride* + Lentil intercropping with yield of sugarcane at 73.8 t ha^{-1} were next in the order. Biomanurial treatments viz.; SPM, 10 t ha-^{1} + FYM, 10 t ha^{-1} with cane yield of 74.3 t ha^{-1} also maintained their superiority over others in ratoon of spring planted sugarcane. The next best treatment (68.6 t ha^{-1}) was SPM, 10 t ha^{-1} + mungbean (1:2) intercropping in plant crop. Besides, these modules were equally effective in building up soil organic carbon and improving rhizospheric microbial activities. Therefore, SPM, 10 t ha^{-1}+ FYM, 10 t ha^{-1}proved ideal organic farming module for both autumn and spring planted sugarcane. The SPM, 10 t ha^{-1} + *Azotobacter* in autumn planted crop and 20 t ha^{-1} FYM + *Trichoderma viride* + mungbean intercropping in spring planted crop were identified the next best combinations. These organic farming modules were reckoned as efficient not only for enhancing and maintaining cane productivity but also enriching rhizospheric microbial pool, maintaining soil health, and making plant-ratoon system economically viable in two distinct diversified cropping systems viz., Rice-Autumn sugarcane-ratoon-wheat and Rice-Berseem-spring sugarcane-ratoon-wheat.

2.2 Ratoon management in sugarcane

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

The first ratoon crop (2nd cycle) of sugarcane planted under paired row system (30:120 cm) proved superior to conventional planting system (90 cm) by significantly lowering the gaps (9.5%) and producing higher number of millable canes (1.205 lakhs ha^{-1}) and canes yield (92.9 t ha^{-1}) (Table 2.4).

Treatments of higher seed rates (25 and 50%) and gap filling (plant cane) at first irrigation under normal seed rate lowered the intensity of gaps in ratoon (9.0 %) as compared to normal seed rate without gap filling (17.5 %). An increase in seed rate (25 %) in plant crop not only reduced the gaps but also produced significantly higher number of millable canes (1.213 lac ha^{-1}) and cane yield (91.3 t ha^{-1}) over normal seed rate (84.3 t ha^{-1}). However, gap filling at first irrigation under normal seed rate proved equally effective and produced cane yield (90.3 t ha^{-1}) *at par* with higher seed rate (25 %). It suggests that sugarcane planted under paired row system (30:120 cm) with higher seed rate (25 %) or sugarcane planted with normal seed rate and gap filling at 1st irrigation proved equally good in increasing ratoon yield. This practice also curtailed the gap filling operation in ratoon crop.

Table 2.4: Effect of row spacing and seed rate on ratoon crop of sugarcane

Treatments (In plant cane)	Ratoon 2006-2007					
	Clumps (000 ha^{-1})	Gaps (%)	Maximum shoots (000 ha^{-1})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
A. Row spacing						
90 cm. (single)	28.0	15.1	342.4	114.1	87.4	16.3
30:120 cm (paired)	29.8	9.5	361.6	120.5	92.9	16.1
C.D. at 5%	NS	2.30	8.50	6.16	3.06	NS
B. Seed rate (setts ha^{-1})						
Normal (40000 ha^{-1})	27.2	17.5	323.91	107.0	84.3	16.1
25% higher (50000 ha^{1})	30.0	8.8	364.0	121.3	91.3	16.1
50 % higher (60000 ha^{1})	30.2	8.3	365.3	121.7	92.0	16.2
Normal + gap filling at 1st irrigation in plant crop	29.8	9.6	355.3	118.3	90.3	16.3
C.D. at 5 %	2.01	4.02	12.43	9.62	3.92	NS

Abbr: NMC = Number of millable canes, NS = Not significant

Improving juice quality and stubble bud sprouting in sugarcane during low temperature (PB 18)

An experiment was conducted to investigate the biochemical changes occurring in the buds and the root band zones of the single bud sugarcane sett at low temperatures and comparing with bud sprouting at 25°C. At the low temperature (0, 5 and 10°C), the reducing sugars, acid invertase, IAA oxidase and ATPase activities were decreased whereas the total phenols, protein, IAA and activities of nitrate reductase (NR) *in vivo* and super oxide dismutase (SOD) were increased as compared to at 25°C. There was no change in sucrose content at the chilling temperatures whereas at 25°C, there was a drastic decline in sucrose content. This indicates that the sprouting of the buds at low temperatures could not be achieved because of immobilization of sucrose due to suppression of the acid invertase, reduced content of reducing sugars, accumulation of IAA, phenols and increased activities of NR and SOD. The increased NR activity at lower temperature increased the nitrite content in the buds, which caused toxicity due to its nonutilization, leading to suppression in the buds sprouting. The increased SOD activity provided evidence that buds are under low temperature stress conditions and the produced superoxide oxygen was converted into H_2O_2, which after accumulation creates toxicity in the cells and suppresses the bud sprouting.

The morpho-biochemical changes associated with the sprouting of sugarcane buds were also investigated. Results revealed increase in bud size, bud moisture and root number and length with sprouting, while unsprouted buds showed comparatively lower values of all these parameters. In sprouted bud, the reducing sugars and specific activity of acid invertase and ATPase increased gradually with the process of sprouting while soluble protein, IAA and Pi contents decreased. After 5 days of sprouting, reducing sugars decreased while non-reducing sugars (sucrose) and IAA increased which indicate completion of bud sprouting and growth of young settling initiated the *de novo* synthesis of IAA and carbohydrates.

2.3 Integrated weed management in sugarcane based cropping system

Weed management in sugarcane ratoon (AS 55)

The weed infestation reduced the ratoon (Cv.CoSe 92423) cane yield by 30.6% under weedy condition (control). Among the weed control treatments, three hoeings (1st, 4th and 7th week after ratoon initiation) reduced the weed infestation to the minimum with the lowest weed dry matter production (20 g m^{-2}). This treatment (Table 2.5) recorded the highest number of millable canes (119.9 thousand ha^{-1}) and cane yield (94.0 t ha^{-1}) which were comparable with the herbicidal treatments (atrazine/metribuzin/glycel) followed by either 2, 4-D application or one hoeing (post-emergence). Similarly, trash mulching either in alternate rows or in all the rows of cane effectively controlled the weeds and produced cane yield *at par* with three hoeings. This clearly indicates that an integrated weed management practice (herbicide + hoeing / mulching + hoeing) may replace the traditional method of weed control (3 hoeings). None of the control measures could affect the pol % juice.

Evaluation of Velpar K_4 60 WP herbicide for control of sugarcane weeds as post-emergence application (CR-6/06)

Post-emergence application of weedicide (Velpar, Hexazinone and Diuron) at 75 days of sugarcane planting (after second interculture) proved effective in an experimental field predominantly infested with *Cyperus rotundus, Trianthema monogyna, Digera arvensis, Panicum sp., Echinocloa colonum, Dactyloctenium aegyptium.*The treatments produced cane yield *at par* with standard check (three hoeings done at 40, 60 and 80 days after planting). Application of weedicide alone without interculture did not prove much effective in controlling weeds and increasing cane yield and remained significantly inferior to treatments where weedicides were applied after two intercultural operations. Cane juice quality did not differ significantly due to different weed control treatments (Table 2.6).

Table 2.5: Effect of weed control treatments on weed number, weed dry weight, NMC and yield of ratoon

Treatment	Weeds (Number m^{-2})	Weed dry weight (g m^{-2})	NMC (000 ha^{-1})	Cane yield (t ha^{-1})
T_1 – Weedy check (control)	148.0	75.6	104.5	65.7
T_2 – Three hoeings (1st, 4th, & 7th week after ratoon initiation)	40.0	20.0	119.9	94.0
T_3 – Atrazine 2.0 kg ha^{-1} (PE) + 2, 4-D 1.0 kg ha^{-1} at 45 DARI	47.3	24.6	115.8	90.0
T_4 – Atrazine 2.0 kg ha^{-1} (PE) + one hoeing at 45 DARI	43.6	22.3	116.6	90.9
T_5 – Metribuzin 1.0 kg ha^{-1} (PE) + 2, 4-D 1.0 kg ha^{-1} at 45 DARI	50.0	26.0	114.7	89.6
T_6 – Metribuzin 1.0 kg ha^{-1} (PE) + one hoeing at 45 DARI	45.0	23.6	117.0	89.3
T_7 – Glycel 0.4 kg ha^{-1} after 3 weeks of ratoon initiation	53.3	28.3	114.2	88.2
T_8 – Glycel 0.4 kg ha^{-1} (at 3 weeks) + one hoeing at 60 DARI	45.6	25.0	117.4	89.0
T_9 – Trash mulching in alternate rows + hoeings at 1st and 6th week	43.3	23.3	109.2	92.3
T_{10} – Trash mulching between all the rows	55.0	27.3	108.2	89.2
C.D. at 5 %	10.84	10.62	6.20	5.00

Abbr: NMC = Number of millable canes, PE = Pre-emergence, DARI = Days after ratoon initiation, NS = Not significant

Table 2.6: Effect of weed control treatments on weed dry weight, weed control efficiency (WCE), millable canes, cane yield and juice quality

Treatments	Weed dry wt (q ha^{-1})	WCE (%)	Millable canes (000 ha^{-1})	Cane yield (t ha^{-1})
Post-em application at 45 DAP				
T_1 – Velpar 1.0 kg a.i. ha^{-1}	5.42	63.4	86	55.6
T_2 – Velpar 1.2 kg a.i. ha^{-1}	5.11	65.5	89	56.4
T_3 – Velpar 1.4 kg a.i. ha^{-1}	4.92	66.8	88	56.2
T_4 – Hexazinone 0.3 kg a.i. ha^{-1}	7.02	52.6	78	48.2
T_5 – Diuron 1.6 kg a.i. ha^{-1}	6.08	59.9	80	50.8
Post-em application at 75 DAP (after second interculture)				
T_6 – Velpar 1.0 kg a.i. ha^{-1}	0.68	95.4	102	66.2
1_7 – Velpar 1.2 kg a.i. ha^{-1}	0.62	95.8	104	67.1
T_8 – Velpar 1.4 kg a.i. ha^{-1}	0.68	95.4	106	67.8
T_9 – Hexazinone 0.3 kg a.i. ha^{-1}	0.78	94.7	101	64.8
T_{10} – Diuron 1.6 kg a.i. ha^{-1}	0.93	93.7	102	65.3
T_{11} – Standard check (three hoeings)	1.02	93.1	105	68.6
T_{12} – Untreated	14.80	-	65	40.8
C.D. (P=0.05)	0.48	-	8.5	4.8

3

Resource management in sugarcane based cropping system

3.1 Nutrient management in sugarcane based cropping system

Sustaining sugarcane production and soil health through integration of nutrient sources in sugarcane based cropping system (AS 51)

The experiment with ratoon crop (Cv CoSe 92423) in third cycle of plant-ratoon system indicated that the cane yield was significantly highest in 100% (Table 3.1) NPK and decreased with reducing NPK application. The integration of trash incorporation and biofertilizer could not exhibit marked beneficial effect on cane yield. Incorporation of green manuring crop (*dhaincha*) in inter-row spaces indicated adverse effect on cane yield. No marked effect on soil fertility status of soil was noticed.

Table 3.1: Cane yield (t ha^{-1}) under different treatments

Treatments	Yield	Treatments	Yield
100 % NPK	92.9	100 % NPK + Trash + B.F.	92.1
100 % NPK + Trash	92.6	50 % NPK + G.M. + B.F.	76.0
100 % NPK + Trash	92.2	50 % NPK + G.M. + B.F.	77.3
75 % NPK + G.M.	87.9	75 % NPK + 25 % N (V.C.) + B.F.	89.4
100 % NPK + Trash + B.F.	93.6	100 % NPK + Trash + B.F.	93.5
C.D. at 5 %			4.5

Compatibility of Zinc application with sources and levels of phosphorus in sugarcane (AS 52)

This experiment initiated during spring season 2005 was continued for second year to find out the effect of the sources and levels of phosphorus in relation to zinc nutrition on growth, yield and juice quality of sugarcane. The treatments comprised of two sources of phosphorus, single superphosphate (SSP) and diammonium phosphate (DAP) and three levels (40, 60 & 80 kg ha^{-}) of phosphorus in main-plots and three levels of zinc sulphate (20, 30 and 40 kg ha^{-1}) in sub-plots in split plot design with three replications. Crop received uniform dose of 150 kg N ha^{-1} and 60 kg K_2O ha^{-1}. One third N and full doses of P, K and Zn were applied in furrows at the time of planting. Remaining dose of N was applied in two equal splits.

Both the sources of phosphorus were found equally effective in terms of yield attributes, yield and juice quality parameters (Table 3.2). The SSP produced more NMC, longer and heavier cane than DAP. The increase in dose of phosphorus from 40 to 60 kg ha^{-1} caused significant improvement in cane length, cane diameter, individual cane weight, cane and sugar yield. The doses, 60 & 80 kg ha^{-1} being *at par* between themselves. Though the application of 40 kg ha^{-1} $ZnSO_4$ improved yield attributes like juice quality, cane and sugar yield, there was no significant difference amongst 20, 30 and 40 kg ha^{-1} $ZnSO_4$. Therefore, it could be concluded that application of 60 kg ha^{-1} P_2O_5 preferably through SSP and 20 kg ha^{-1} Zinc sulphate appeared adequate for sugarcane nutrition.

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

The experiment on first ratoon of second cycle of cropping system (Plant cane-first ratoon-second ratoon-wheat-paddy) with the treatments, control, N, P, K, PK, NP, NK, NS, NPK, NPK+S, NPK+Zn, NPK+Cu, NPK+Mn, NPK+Fe, NPK+S+Zn and NPK+micronutrients (Zn+Cu+Mn+Fe) replicated four times in RBD indicated that the cane yield increased significantly (73.1%) by application of 150 kg N ha^{-1} over no fertilizer, control (Table 3.3). The magnitude of increase in yield by the integration of P, K and S with N remained low and non-significant over N application. The integration of other nutrients with NPK also did not result in significant yield increase over NPK. The juice quality remained unaffected by the treatments.

Table 3.2: Effect of sources and levels of phosphorus and zinc doses on growth, cane yield and sugar yield in sugarcane

Treat-ments	Germina-tion (% at 45 DAP)	NMC (000 ha^{-1})	Cane length (cm)	Cane dia. (cm)	Cane weight (g)	Cane yield (t ha^{-1})	Brix (%)	Pol (%)	CCS (%)	Sugar yield (t ha^{-1})
Sources of phosphorus										
SSP	41.54	114.460	225.2	2.37	980	93.889	19.69	17.72	12.529	11.763
DAP	40.24	112.995	211.4	2.42	965	91.405	19.51	17.76	12.620	11.535
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Levels of phosphorus (kg ha^{-1} P_2O_5)										
40	38.26	111.228	212.3	2.32	933	88.612	19.67	17.76	12.574	11.142
60	41.96	113.797	224.2	2.42	987	93.311	19.58	17.79	12.638	11.793
80	42.45	116.158	218.4	2.44	998	96.019	19.55	17.66	12.511	12.013
CD at 5%	NS	NS	10.9	0.09	51	4.492	NS	NS	NS	0.473
Levels of zinc sulphate (kg ha^{-1})										
20	40.14	110.927	219.5	2.35	951	90.463	19.51	17.63	12.487	11.296
30	41.32	114.353	222.3	2.43	974	92.963	19.53	17.70	12.557	11.673
40	41.21	115.904	213.1	2.41	992	94.514	19.76	17.88	12.679	11.983
CD at 5%	NS	NS	NS	0.06	NS	NS	NS	NS	NS	NS

Note: Date of planting: February 16, 2006; Date of harvesting: February 19, 2007; Variety: CoSe 92423

Table 3.3: Cane yield (t ha^{-1}) of first ratoon under different treatments

Treatments	Cane yield (t ha^{-1})	Treatments	Cane yield (t ha^{-1})
Control (No fertilizer)	46.5	NPK	82.5
N	80.5	NPK + S	83.5
P	47.0	NPK + Zn	83.3
K	46.7	NPK + Cu	82.5
PK	47.2	NPK + Mn	82.5
NP	80.8	NPK + Fe	82.7
NK	80.3	NPK + S + Zn	84.0
NS	81.3	NPK + Micro-nutrients (Zn, Cu, Mn, Fe)	84.3
C.D. at 5%	2.7	-	2.7

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

A field experiment was conducted on plant crop of sugarcane during spring season of 2006-07 in order to compare the performance of different NPKS complex fertilizers viz., 12-16-16-06, 14-20-10-06 and 15-17-11-07 supplied by the Shriram Fertilizers and Chemicals, New Delhi.

The results indicated that neither cane yield nor quality parameters varied significantly due to different fertilizer treatments (Table 3.4). Thus, these NPKS fertilizers are equally effective source of nutrients and can be considered for application in sugarcane cultivation.

Table 3.4: Yield and juice quality of sugarcane affected by different NPKS fertilizers

Treatments		Cane yield (t ha^{-1})	Juice quality (%)		
P K (kg ha^{-1})	Source of nutrients		Brix	Pol	Purity
60 - 60	Urea – DAP – MOP	81.6	19.6	17.2	87.7
60 - 60	Urea – SSP – MOP	81.5	19.6	17.1	87.2
60 - 60	NPKS fertilizer (12:16:16:06)	79.5	19.5	17.0	87.2
60 - 30	NPKS fertilizer (14:20:10:06)	79.7	19.6	17.1	87.2
60 - 39	NPKS fertilizer (15:17: 11: 07)	78.4	19.5	17.1	87.7
80 - 80	NPKS fertilizer (12: 16: 16: 06)	80.6	19.7	17.2	87.2
80 - 40	NPKS fertilizer (14: 20: 10: 06)	79.8	19.6	17.1	87.2
80 - 52	NPKS fertilizer (15: 17: 11: 07)	80.0	19.5	17.0	87.2
C.D. at 5%		NS	NS	NS	NS

Note: N dose was 150 kg ha^{-1} in all treatments. The remaining amount of N was adjusted by urea application. The treatments were replicated thrice in a RBD

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

An experiment was conducted with Wellgro organic manure and NPK combination to identify the best combination of organics and inorganics for increasing cane yield as well as sustainining soil health. Application of recommended doses of P and K (basal) mixed with 300 kg ha^{-1} Wellgro manure and top dressing of recommended nitrogen (150 kg ha^{-1} as T_3) improved number of millable cane (98000 ha^{-1}), cane length (227 cm) and individual cane weight (1030 g) significantly. At this level, the number of millable canes increased by 19.5 and 26.8% over 50% RD basal P and K with 200 kg Wellgro manure $ha^{-1}$and N dose and 50% N mixed in 200 kg Wellgro ha^{-1} (T_{11}) and T_{12} (no fertilizer application), respectively. In the same treatment, mean cane weight also increased by 17.0 and 45% over T_{11} and T_{12}, respectively (Table 3.5). Juice quality (brix, pol and purity) did not register tangible difference among various treatments. The highest cane (88.8 t ha^{-1}) and CCS (10.99 t ha^{-1}) yield were observed at T_3. The increase in cane and CCS yield with T_3 was 31.2 and 30.4%, respectively over recommended NPK application (T_1). However, this increase was 56 and 54.8%, over control treatment (T_{12}). The highest agronomic efficiency (212.6 kg cane kg^{-1} N applied) was worked out with T_3, whereas with recommended NPK fertilization (T_1), it was only 72 kg cane kg^{-1} N applied. Soil organic carbon and Soil Microbial Biomass Carbon (SMBC) increased with application of Wellgro manure with inorganic fertilization as compared to recommended NPK/ no fertilization. Thus, it was observed that sugarcane responded well to organic manure in addition to recommended NPK through inorganic fertilizers.

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

Two separate field experiments were conducted on eight early and eight midlate maturing sugarcane genotypes under flat planting system during spring in split plot design with 3 replications.

Table 3.5: Effect of various treatments on growth, yield and CCS of sugarcane

Treatments*	NMC (000 ha^{-1})	Cane yield (t ha^{-1})	CCS (t ha^{-1})
T_1, Control: Basal application of P and K and top dressing of N as normal practice	89	67.7	8.43
T_2, RD (recommended dose) basal P & K mixed with 200 kg Wellgro soil ha^{-1} and top dressing N as recommended	90	75.1	9.19
T_3, RD basal P & K mixed with 300 kg Wellgro soil ha^{-1} and top dressing N as recommended	98	88.8	10.99
T_4, RD basal P & K mixed with 400 kg Wellgro soil ha^{-1} and top dressing N as recommended	89.7	82.5	10.62
T_5, RD basal P & K mixed with 500 kg Wellgro soil ha^{-1} and top dressing N as recommended	90.3	77.9	10.12
T_6, RD basal P & K and 200 kg ha^{-1} Wellgro soil mixed with N dose	79.3	69.5	8.81
T_7, RD basal P & K and 300 kg ha^{-1} Wellgro soil mixed with N dose	87.7	77.6	9.66
T_8, RD basal P & K and 400 kg ha^{-1} Wellgro soil mixed with N dose	92.3	84.0	10.69
T_9, RD basal P & K and 500 kg ha^{-1} Wellgro soil mixed with N dose	86	76.80	9.63
T_{10}, RD basal P & K mixed with 200 kg ha^{-1} Wellgro soil and N dose mixed with 200 kg Wellgro soil ha^{-1}	95	80.0	9.76
T_{11}, 50% RD basal P & K mixed in 200 kg Wellgro soil ha^{-1} and N dose and 50% N mixed in 200 kg Wellgro soil ha^{-1}	82	69.6	8.86
T_{12}, No fertiliser application	77.3	56.9	7.10
C.D. (P =0.05)	6.30	7.30	0.60

Note: *Treatments = 12, Design = RBD, Plot size is 7.5 m X 4.5 m; Sugarcane variety = CoS 94257, Planting date is 24.03. 2006; Row to row spacing is 75 cm; Recommended NPK dose (kg ha^{-1}) for Plant cane is 150: 60: 60; N application period for Plant cane is 1/3rd basal, 1/3rd in May and 1/3rd in June, 2006; P & K are full at basal. Organics (Wellgro soil) is as per treatments.

Among early sugarcane genotypes, genotype, CoLk 94184 produced the highest number of millable canes (130.9 thousand ha^{-1}), cane yield (66.9 t ha^{-1}), CCS content (18.01%) and CCS yield (8.71 t ha^{-1}) and was closely followed by BO 128 and CoS 95270 (Table 3.6). Application of 150 kg N ha^{-1} + 10 t FYM ha^{-1} gave the highest NMC (108.8 thousand ha^{-1}) and cane yield (65.6 t ha^{-1}). The CoLk 94184 was observed to be the most efficient genotype for nitrogen use both with FYM (262.0 kg cane kg^{-1} N) and without FYM (224.0 kg cane kg^{-1} N). The genotypes, CoS 95270 and BO 128 were also identified efficient ones with NUE of 252.7 and 200.7 kg cane kg N^{-1}, respectively.

Amongst mid-late sugarcane genotypes, CoH 110 recorded significantly the highest number of millable canes (127.0 thousand ha^{-1}) and cane yield (63.4 t ha^{-1}) and the highest CCS (7.78 t ha^{-1}). Genotypes CoLk 9616 was found to be *at par* with CoH 110 in terms fo NMC and cane yield but inferior in terms of CCS. The nitrogen use efficiency of these two genotypes was higher than that of others genotypes. Genotype, CoH 110 was identified as the most efficient with NUE of 322 kg cane kg^{-1} N at 150 kg N + 10 t FYM ha^{-1}. The nitrogen use efficiency of CoLk 9616 was worked out to be 252 kg cane kg^{-1} N at 150 kg N + 10 t FYM ha^{-1}. Similar to

Table 3.6: Productivity and nitrogen use efficiency of early and mid-late sugarcane genotypes

Treatment /Sugarcane Genotypes	Germination (%)	No. of tillers in May (000 ha^{-1})	NMC (000 ha^{-1})	Yield (t ha^{-1})	CCS (%)	CCS (t ha^{-1})	Nitrogen Use Efficiency (kg cane kg^{-1} N)	
							150 kg N ha^{-1}	10 t FYM + 150 kg N ha^{-1}
Early genotypes								
CoS 95270	33.9	120.5	84.7	60.4	12.50	7.57	187.3	252.7
CoS 96258	36.9	148.7	87.9	46.3	12.80	5.98	132.7	193.3
CoH 92201	20.9	69.8	54.1	36.6	12.84	4.70	107.3	166.7
BO 130	21.3	81.9	70.7	46.8	12.45	5.84	153.3	148.0
CoS 96268	39.9	143.3	91.9	50.4	13.19	6.66	106.0	178.7
CoPt 98224	33.4	136.8	102.6	48.3	11.63	5.66	158.0	184.0
BO 128	35.2	120.4	107.4	61.3	12.17	7.50	166.7	200.7
CoLk 94184	43.2	160.8	130.9	66.9	13.01	8.71	224.0	262.0
CD (P=0.05)	4.61	12.36	13.63	8.36	0.85	2.28	-	-
Nitrogen levels								
0-Control	32.3	94.7	74.8	35.9	12.41	4.45	-	-
150 kg N ha^{-1}	32.5	134.2	99.0	59.1	12.64	7.47	-	-
10 t ha^{-1} FYM	33.0	104.9	82.5	48.1	12.46	5.97	-	-
150 kg N + 10 t FYM ha^{-1}	34.5	157.2	108.8	65.6	12.80	8.41	-	-
CD (P=0.05)	NS	7.42	8.76	5.86	NS	1.95	-	-
Mid-late genotypes								
CoJ 20193	3.3	107.2	97.0	49.3	12.78	6.31	147.3	126.0
CoS 99259	31.7	97.6	91.9	44.5	12.15	5.40	102.7	134.7
CoS 96275	34.7	111.0	106.7	59.5	12.48	7.48	192.0	227.3
CoPt 99214	31.3	115.8	101.2	54.5	11.40	6.20	180.7	206.0
CoH 110	38.1	141.7	127.0	63.4	12.22	7.78	276.0	322.0
CoH 119	31.1	107.6	102.5	55.5	11.71	6.47	160.7	160.7
CoLk 9616	43.7	136.9	119.2	63.1	10.26	6.46	215.3	252.0
CoJ 99192	28.4	111.9	100.2	56.9	10.96	6.24	177.3	195.3
CD (P=0.05)	4.79	9.48	10.12	8.13	1.63	1.35	-	-
Nitrogen levels								
0-Control	34.3	96.8	85.1	37.2	11.70	4.35	-	-
150 kg N ha^{-1}	34.4	123.1	110.4	64.5	11.69	7.51	-	-
10 t ha^{-1} FYM	33.4	104.4	97.6	53.9	11.76	6.34	-	-
150kg N + 10 t FYM ha^{-1}	34.0	140.6	129.7	67.7	11.82	7.98	-	-
CD (P=0.05)	NS	5.75	6.69	5.84	NS	2.85	-	-

early group, mid-late genotypes produced the highest NMC (129.7 thousand ha^{-1}) and yield (67.7 t ha^{-1}) at 150 kg N + 10 t ha^{-1} FYM.

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

Under two sets of field experiments consisting of 16 genotypes (8 early: CoS 95270, CoS 96258, CoH 92201, BO 130, CoS 96268, CoPt 98224, BO 128, CoLk 94184 and 8 mid-late : CoJ 20193, CoS 99259, CoS 96275, CoPt 99214, CoH 110, CoH 119, CoLk 9616, CoJ 99192) planted in ring-pit system with 4 N levels (0, 150 kg N ha^{-1}, 10 t FYM ha^{-1} and 150 kg N + 10 t FYM ha^{-1}) and replicated in split-plot design. Ratoon was initiated in January for early genotypes and in February for mid-late genotypes. The treatments as applied to plant crop were also imposed in ratoon crop.

Among early genotypes, the highest NUE was worked out for BO 130 (242.9 kg cane kg^{-1} N) followed by CoLk 94184 (224.8 kg cane kg^{-1} N). Among mid-late group, genotype CoPt 99214 recorded the highest NUE (246.1 kg cane kg^{-1} N) followed by CoS 96275 (209 kg cane kg^{-1} N) at 150 kg N ha^{-1} + 10 t FYM ha^{-1}.

Agronomy of new sugarcane genotypes (Expl. Trial)

The treatments consisted of 2 sugarcane genotypes (CoLk 94184 and CoLk 97147) planted at 3 row spacings (60, 75 and 90 cm) and fertilized with 4 nitrogen doses (0, 75, 150 and 225 kg ha^{-1}). The main plot treatments included the combinations of genotypes spacings while sub plots, the nitrogen levels in split-plot design replicated thrice. The recommended doses of phosphorus (60 kg ha^{-1} P_2O_5) and potassium (60 kg ha^{-1} K_2O) and 1/3rd of treatmental N were applied at the time of sugarcane planting in autumn. The remaining amount of N was scheduled as per the treatments.

Sugarcane genotype CoLk 94184 recoded significantly higher germination (42.3%), number of tillers in July (221.7 thousand ha^{-1}), number of millable cane (112.7 thousand ha^{-1}) and cane yield (70.5 t ha^{-1}) as compared to CoLk 97147 (Table 3.7). This genotype also produced higher commercial cane sugar (9.45 t ha^{-1}). There was no significant variation in cane yields due to different spacings. Application of 150 and 225 kg N ha^{-1}differed significantly between themselves and improved NMC and yield over 0 and 75 kg N ha^{-1}. Genotype CoLk 94184 produced the highest cane yield (93.84 t ha^{-1}) at 90 cm spacing and 225 kg N/ha, while CoLk

Table 3.7: Effect of treatments on growth yield and quality of sugarcane genotypes

Treatments	Germination (%)	No. of tillers in July (000 ha^{-1})	NMC (000 ha^{-1})	Yield (t ha^{-1})	CCS (%)	CCS (t ha^{-1})	NUE (kg cane kg^{-1} N)	
							CoLk 94184	CoLk 97147
Genotypes								
CoLk 94184	42.3	221.7	112.7	70.5	13.41	9.45	-	-
CoLk 97147	33.0	182.8	95.5	59.2	12.56	7.42	-	-
CD (P=0.05)	3.5	7.83	5.20	6.56	0.68	0.58		
Spacing (cm)								
60	37.1	235.8	110.7	67.3	12.88	8.68	-	-
75	39.4	198.5	102.9	63.8	13.18	8.40	-	-
90	36.4	172.5	98.7	63.6	12.89	8.22	-	-
CD (P=0.05)	NS	9.59	6.35	NS	NS	NS	-	-
N levels (kg N ha^{-1})								
0	36.9	112.8	86.7	45.7	13.13	6.02	-	-
75	35.9	200.8	93.8	58.1	12.94	7.51	128.1	199.3
150	39.0	237.4	112.2	72.8	12.87	9.40	165.7	196.1
225	38.6	258.1	123.7	83.0	13.00	10.81	151.4	180.7
CD (P=0.05)	NS	11.61	8.58	3.67	NS	0.56	-	-

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

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

Third ratoon in a field experiment initiated (in spring, 2003) with the objective to evaluate the efficacy of different biomanures on yield and quality of sugarcane under plant and subsequent ratoons and to study the changes in physicochemical and microbial properties of soil on long term basis recorded the highest cane yield (70.0 t ha^{-1}) with SPMC + *Acetobacter* (Table 3.6). This was followed by SPMC (67.4 t ha^{-1}), recommended dose of NPK fertilizers (66.0 t ha^{-1}) and vermicompost + *Acetobacter* (65.8 t ha^{-1}). The growth and yield attributing characters viz. dry matter production, number of tillers, plant height, number of millable canes, cane length, cane thickness and cane weight also exhibited similar trend. Juice quality viz., brix and sucrose % did not differ significantly by the different treatments, however, the highest brix of ^{0}17.9 was recorded with SPMC *and SPMC* +*Acetobacter.* The highest *sucrose* of 15.1% was recorded in biogas slurry closely followed by biogas slurry + *Acetobacter* and sugarcane trash with *Trichoderma* + *Acetobacter* treatment (15.0%).

Soil organic carbon ranged between 0.50 to 0.66% under different treatments of bio manuring, over its initial value of 0.32 % (Table 3.8). Soil microbial activity enhanced due to different biomanurial treatments.. The highest value of soil microbial biomass carbon (SMBC) of 2553.0 mg CO_2-C kg^{-1} soil was recorded under plots receiving SPMC + *Acetobacter.and* closely followed by FYM+ *Acetobacter* (2542.0 mg CO_2 kg^{-1} soil) against initial value of 76 mg CO_2-C kg^{-1} soil.

Table 3.8: NMC, cane yield, juice quality, soil organic carbon and microbial biomass carbon (SMBC) of 3rd ratoon under different biomanurial treatments

Treatments	NMC	Cane length (cm)	Cane yield (t ha^{-1})	Juice quality		OC (%)	SMBC
				^{0}Brix	Sucrose (%)		
T_0 - Control	74.7	140.8	37.6	17.3	14.6	0.35	1053.1
T_1 -Trash @10 t ha^{-1} +*Trichodarma*	88.6	160.5	53.7	17.4	14.7	0.60	1075.4
T_2 -Vermicompost @ 10 t ha^{-1}	95.6	166.6	64.6	17.0	14.1	0.56	1759.8
T_3 – FYM @ 10 t ha^{-1}	94.1	164.5	63.3	17.6	14.1	0.59	1759.8
T_4 - Biogas slurry @ 10 t ha^{-1}	94.4	164.5	63.5	17.7	15.1	0.53	1759.8
T_5 – SPMC @ 10 t ha^{-1}	99.5	173.8	67.4	17.9	15.0	0.66	1862.1
T_6 – T_1+ *Acetobacter*	90.7	165.0	55.6	17.6	15.0	0.61	1075.4
T_7 – T_2+ *Acetobacter*	96.8	173.8	65.8	17.2	14.5	0.56	1759.8
T_8 – T_3+ *Acetobacter*	95.2	174.4	64.4	17.3	14.8	0.60	2542.0
T_9 – T_4+ *Acetobacter*	95.6	174.2	64.9	17.6	15.0	0.56	1768.8
T_{10} - T_5+ *Acetobacter*	102.7	180.8	70.0	17.9	14.9	0.63	2553.0
T_{11} – *Dhaincha* green manure +*Acetobacter*	93.1	164.8	61.7	17.7	14.9	0.50	1053.1
T_{12} – NPK (120:60:60 kg ha^{-1})	99.9	175.0	66.0	17.2	14.1	0.45	1662.1
Initial						0.32	76.0
C.D. (0.05)	3.88	14.56	6.25	-	-		

Note: NMC is in '000 ha^{-1}; SMBC is in mg CO_2-C kg^{-1} soil

Nutrient use efficiency in different wheat (*Triticum aestivum*) + sugarcane (*Saccharum* sp. hybrid) croppings under Furrow Irrigated Raised Bed System (FIRBS) (A 2.34)

A field experiment was conducted during the crop season of 2005-2007 to work out nutrient use efficiency in wheat + sugarcane cropping systems i.e. wheat (three rows on each raised bed) + sugarcane (80 cm spacing) under FIRB, wheat (two rows on each raised bed) + sugarcane (60 cm spacing) under FIRB, three rows of wheat between two rows of 80 cm spaced sugarcane under flat method and was compared with wheat – sugarcane sequential system under 75 %, 100 % and 125 % of recommended dose of fertilizer NPK.

Wheat crop

Grain yield of wheat in FIRB and flat method of wheat + sugarcane planting were *at par* (average 46.3 q ha^{-1}). However, wheat under FIRB system (47.9 q ha^{-1}) registered slightly higher grain over yield flat method (46.3 q ha^{-1}). The yield of attributes i.e. number of earhead per metre row, grains per earhead and test weight of wheat were significantly higher under FIRB compared to that under flat method of wheat sowing.

The grain yield of wheat increased up to 100 % of recommended NPK. However, the response of wheat to fertilizer was different under different systems of planting. Wheat responded upto 75 % of recommended NPK under FIRB system and the yield obtained was at *par* with the yield at 100 % of recommended NPK under flat method, indicating 25 % saving in fertilizer use. The NUE recorded under FIRB system was higher over flat method. The highest value of NUE (6.28 kg per kg nutrient applied) was recorded at 75 % of recommended NPK under FIRB system higher than wheat under flat method with the corresponding value of 5.67.

Sugarcane crop

Sugarcane planted either in the month of November or February with wheat under FIRB system registered significantly higher cane yield over wheat + sugarcane under flat method due to higher number of millable canes. The highest cane yield (83.14 t ha^{-1}) was recorded under conditions of wheat (Nov.) two rows on each raised bed + sugarcane (Feb.) in 60 cm spaced furrows.

In wheat + sugarcane system, cane yield increased significantly to the tune of 27.0, 39.97 and 49.75 per cent with 75, 100 and 125 % of recommended dose of NPK over control, respectively. The increase in cane yield was due to increase in NMC, cane length and cane weight. Nutrient use efficiency in sugarcane was higher under FIRB system than under flat method. The highest NUE (105.8 kg per kg of nutrient applied) was recorded under wheat (Nov.) + sugarcane (Feb.) in 80 cm spaced furrows with recommended dose of nutrient (150 kg N + 60 kg P_2O_5 + 60 kg K_2O). Whereas, the lowest value of NUE was observed in flat method.

FIRB system of wheat + sugarcane planting significantly augmented the cane equivalent yield (CEY) over flat method at all the levels of fertilizer application. The highest CCS of 12.9 t ha^{-1} was recorded in wheat (Nov) + sugarcane (Feb) in 60 cm spaced furrow under FIRB system at 125 % of recommended dose of NPK. However, the lowest value of CEY was observed in wheat (Nov) + sugarcane (Nov) under flat method. The nutrient use efficiency of the system (increase in CEY kg ha^{-1} per kg nutrient applied) was also worked out to be greater under FIRB system compared to that under flat under method. The highest NUE (74.11 kg per kg nutrient applied) was observed in wheat (Nov) + sugarcane (Feb) in 80 cm spaced furrow under FIRB system at recommended NPK.

Improving productivity and quality of ratoon cane through integration of organics, bio-agents and inorganic fertilizers with special reference to potassium nutrition (A 3.21)

Carry over effect of treatments applied in plant cane was assessed on sugarccane ratoon. Effect of different doses of nitrogen and potassium with and without *Trichoderma viride* (Table 3.9) was observed on sugarcane genotype (CoLk 9617). Application of different levels of

Table 3.9: Carryover effect of N, K and inoculation of *Trichoderma viride* on growth, cane and CCS yield

Treatments	Millable canes (000 ha^{-1})	Cane length (cm)	Cane diameter (cm)	Cane weight (g)	Cane yield (t ha^{-1})	CCS (t ha^{-1})
N (kg ha^{-1})						
150	103.4	181.1	2.10	752.2	63.9	7.38
300	99.3	178.3	2.11	722.1	63.6	7.31
CD (P<0.05)	NS	NS	NS	NS	NS	NS
K_2O (kg ha^{-1})						
0	92.8	181.1	2.08	736.7	60.2	6.89
75	106.2	178.1	2.09	738.3	66.7	7.68
150	105.0	179.9	2.13	736.6	64.41	7.47
CD (P<0.05)	7.60	NS	NS	NS	5.20	0.52
Seed cane treatment						
With *Trichoderma*	102.3	185.6	2.15	768.8	67.9	7.86
Without *Trichoderma*	98.4	173.9	2.05	705.5	59.6	6.83
CD (P<0.05)	NS	8.30	NS	43.50	4.30	0.40

nitrogen in plant cane could not influence growth and yield of ratoon cane. Potassium applied @ 75 kg K_2O ha^{-1} in plant cane, however, increased number of millable canes in ratoon crop (106200 ha^{-1}) significantly. Thus, the application of 75 kg K_2O ha^{-1} increased ratoon yield and CCS by 10.8 and 10.3%, respectively over no K application (60.2 and 6.89 t ha^{-1}, respectively). Seed cane inoculation with *Trichoderma viride* significantly improved individual cane weight (768.8 g), ratoon (67.9 t ha^{-1}) and CCS (7.86 t ha^{-1}) yields.

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

This experiment was initiated during spring season (February, 2005) with an objective to find out the effective combination of biomanure with N fertilizer for enhancing nitrogen use efficiency and sustaining cane productivity under multi-ratooning system. Six organic manurial treatments, viz. i) FYM, ii) Trash, iii) FYM+ *Trichoderma viride*, iv) Trash + *Trichoderma viride*, v) FYM+Gluconacetobacter, and *vi)* Trash + Gluconacetobacter and three N doses, viz. 0, 100 and 200 kg ha^{-1}, in RBD with three replications by planting sugarcane (Cv. CoSe 92423) as uniform crop in February, 2005 were imposed in ratoon initiated during February, 2006.

The highest yield of 88.17 t ha^{-1} (Table 3.10) in 1st ratoon was recorded with 10 t FYM ha^{-1} + *Trichoderma viride* which was significantly higher than that obtained with 7.5 t trash ha^{-1} +*Trichoderma viride* (82.88 t ha^{-1}). FYM 10t ha^{-1} alone or with *Trichoderma* / Gluconacetobacter gave significantly higher cane yield as compared to trash 7.5 t ha^{-1} alone or with *Trichoderma* / Gluconacetobacter. However, differences in cane yield under FYM alone, FYM+ *Trichoderma* and FYM+Gluconacetobacter were not significant. Likewise, the differences in cane yield due to trash 7.5 t ha^{-1}alone or with *Trichoderma* / Gluconacetobacter were also not significant.

The highest cane yield of 89.17 t ha^{-1}was recorded with 200 kg N ha^{-1} which was significantly higher than 100 kg N ha^{-1} (86.36 t ha^{-1}) and control (77.32 t ha^{-1}). The interaction between organics and nitrogen levels on cane yield was not significant. Maximum number of shoot population and millable cane exhibited the similar trend as that of ratoon yield. Juice quality (Pol% juice) remained unaffected due to various treatments.

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

The performance of sugarcane was studied under 4 cropping systems which included wheat + sugarcane under FIRB system, wheat +

Table 3.10: Influence of organics and inorganic fertilizer nitrogen on first ratoon crop

Treatments	Shoot population (000 ha^{-1})	Millable canes (000 ha^{-1})	Cane yield (t ha^{-1})	Pol % juice
A - Organics				
F_1 - FYM @ 10 t ha^{-1}	305.22	113.75	85.09	16.55
F_2 - Trash @ 7.5 t ha^{-1}	289.91	109.84	81.28	16.59
F_3 – F_1 + Trichoderma viride	310.38	117.23	88 17	16.45
F_4 – F_1 +Gluconacetobacter	308.91	115.95	86.77	16.54
F_5 – F_2 + Trichoderma viride	291.06	112.59	82.68	16.35
F_6 – F_2 + Gluconacetobacter	289.92	111.26	81 70	16.85
C.D. at 5%	5.49	3.89	3.17	NS
(B) Nitrogen doses (kg ha^{-1})				
N_0 – 0	274.02	103.67	77.32	16.63
N_1 – 100	307.58	116.92	86.36	16.56
N_2 - 200	316.09	119.89	89.17	16.48
C.D. at 5%	3.89	2.86	2.40	NS

sugarcane under Flat method, wheat – sugarcane sequential system and the sole sugarcane. The grain yield of wheat was almost equal in all the cropping systems whereas, sugarcane yield attributes and yield varied over the systems (Table 3.11). Tiller count in the month of April was the highest in sole sugarcane (256.9 thousand ha^{-1}) followed by wheat + sugarcane under FIRB system (111.9 thousand ha^{-1}). Whereas it was the lowest (49.75 thousand ha^{-1}). The tiller count in wheat + sugarcane in flat method. The highest cane yield was obtained in sole sugarcane (82.6 t ha^{-1}) followed by wheat + sugarcane under FIRB system (77.2 t ha^{-1}) compared to the yield of 52.2 t ha^{-1} under wheat + sugarcane in Flat method. The higher cane yield in sole sugarcane and sugarcane under FIRB system was due to more number of heavier millable canes compared to that under wheat – sugarcane sequential system and wheat + sugarcane in Flat method. Wheat + sugarcane under FIRB system produced the highest CEY of 112.6 t ha^{-1} (Table 3.11). However, the CEY obtained in wheat + sugarcane in Flat method and wheat – sugarcane sequential system was almost equal to sole sugarcane. These observations indicate that these are non-remunerative systems because of extra cost involved in wheat production. Thus, wheat + sugarcane under FIRB is the only remunerative system over sole sugarcane.

Table 3.11: Performance of sugarcane in wheat + sugarcane cropping under FIRB system

Cropping systems	Grain yield of wheat (q ha^{-1})	Sugarcane					Benefit** (Rs. ha^{-1})
		Tillers*	NMC (000 ha^{-1})	Cane weight (kg)	Cane yield (t ha^{-1})	CEY (t ha^{-1})	
Wheat + sugarcane under FIRB system	50.6	111.88	80.31	0.997	77.19	112.60	25044
Wheat + sugarcane under flat method	49.2	51.75	62.80	0.892	52.18	86.68	-1468
Wheat - sugarcane	49.8	56.45	72.50	0.842	56.25	91.26	70
Sole sugarcane	-	256.88	82.19	1.045	82.56	83.56	-

*Tillers (000 ha^{-1}) in the month of April; **Benefit over sole sugarcane

3.2 Heavy metal toxicity management in sugarcane-based cropping system

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

Four sugarcane varieties (BO 91, CoLk 94184, CoS 96268 and CoS 767) were evaluated for their response to Chromium toxicity under soil-pot culture conditions. The results indicated that the variety CoLk 94184 showed good germination and lower tiller mortality. Its overall growth was also higher as compared to the other varieties studied. The reactive hydrogen peroxide production was high in all the varieties as shown by high SOD activities compared to controls. In contrast, activities of glutathione reductase ascorbate peroxidase and glutamyl cysteine synthase were found higher in the variety CoLk 94184 which shows the operation of ascorbate-glutathione cycle in well coordination with the catabolic system. This could provide tolerance to chromium toxicity in this variety. The RAPD profile of genomic DNA from four varieties with about 30 random primers showed presence of an extra band in sugarcane variety CoLk 94184 treated with 30 ppm Chromium. This could be related to its tolerance to chromium toxicity (Fig. 3.1).

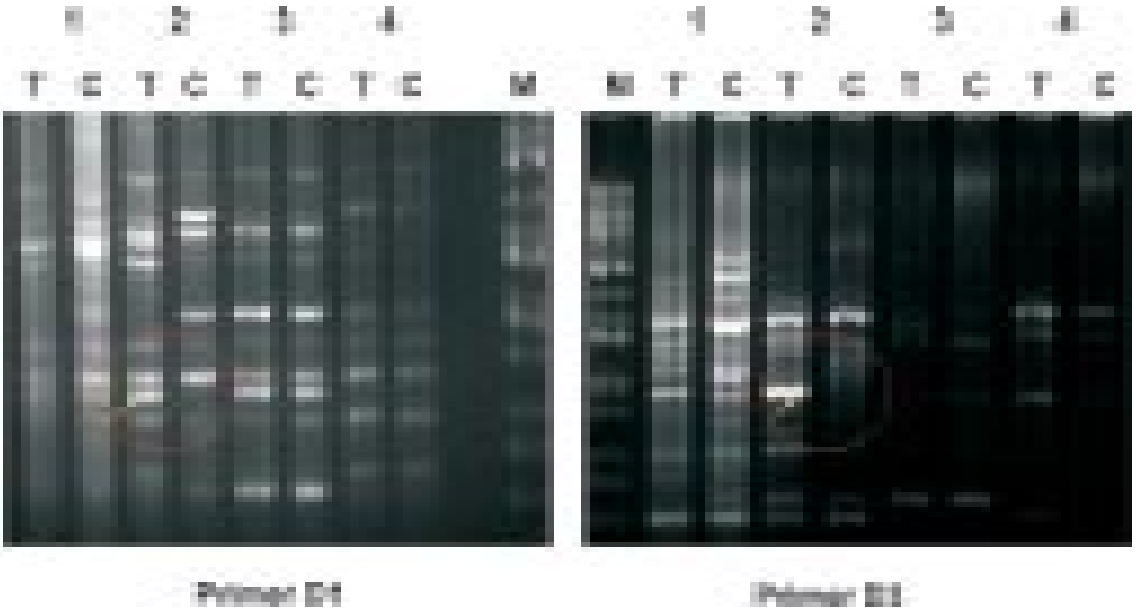


Fig. 3.1. The RAPD profile of genomic DNA from four varieties using primers D1 and D2 (1: BO 91; 2:CoLk 94184; 3:CoS 96268; 4: CoS 767 and T: 30 ppm Cr Treatment; C: Control)

4

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

4.1 Studies on Saccharum germplasm

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

Two inter-specific hybrid genetic stocks viz. Ikshu ISH-1 (PIO 91-190 x SIP 93-190) and Ikshu ISH-23 (PIO 91-829 x SIP 315), which are moderately resistant (MR) to three prevalent races of red rot pathogen, were accepted for registration with national identity IC 548345 and IC 548346 at NBPGR during December, 2006.

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

Juice quality and fibre data on 48 commercial hybrid genotypes grown under normal conditions were recorded for identifying high sugar and low fibre parents. Genotype LG 94126 recorded 20.68 Brix, 17.54 % Pol in juice (in Oct) and CCS 11.89%, LG 95263 recorded best purity in juice 86.88% and low fibre 9.676 % while Co 93009 recorded high fibre 18.436 %.

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

Evaluation of elite clones under Station Trial 2006-07

A trial comprising of 12 elite sugarcane clones developed in the Institute *viz.* CoLk 9709, CoLk 99271, CoLk 04237, CoLk 9705, IV-6-7,

Table 4.1: Mean performance of elite clones in Station Trial during 2006-07

S. No.	Genotypes	Germination %	NMC (000 t ha^{-1})	SCW (Kg)	Cane yield (t ha^{-1})	CCS (t ha^{-1})	Pol % Nov	Pol % Feb	Fibre %
1	CoLk 9709	28.00	92.90	0.80	77.10	10.40	16.30	19.60	12.40
2	CoLk 99271	34.70	128.80	0.70	90.00	11.70	16.10	19.00	12.20
3	CoLk 04237	27.00	97.70	0.60	55.10	6.80	16.50	18.00	10.00
4	CoLk 9705	26.70	102.10	0.70	66.40	10.50	15.00	18.70	11.50
5	IV-6-7	21.80	103.60	0.60	66.10	7.90	15.60	17.50	12.40
6	CoLk 04238	40.40	121.70	0.70	90.10	10.70	16.40	17.20	12.60
7	LG 2909	12.20	92.90	1.00	91.20	10.00	12.70	16.20	12.00
8	CoLk 5201	26.40	118.80	0.60	74.30	9.30	16.70	18.40	15.20
9	CoLk 97147	21.30	74.60	0.70	53.30	7.20	17.00	19.60	12.00
10	CoLk 94184	28.50	107.50	0.70	71.50	9.30	17.20	18.90	15.10
11	CoLk 9710	21.80	134.50	0.60	73.70	9.40	15.00	18.50	12.00
12	CoLk 05202	39.80	99.40	1.00	100.00	13.20	16.80	19.30	14.00
13	CoS 96268	23.00	91.20	0.70	62.10	7.40	16.30	17.50	12.10
14	CoJ 64	34.10	94.40	0.60	60.70	7.90	17.20	19.20	10.70
15	CoS 767	32.50	87.50	0.80	69.90	8.90	16.60	18.70	13.10
	GM	**27.90**	**103.20**	**0.70**	**73.40**	**9.40**	**16.08**	**18.40**	**12.49**
	Range	**12.2 – 40.4**	**74.6 – 34.5**	**0.6 – 1.0**	**53.3 – 100.0**	**6.8 – 13.20**	**12.7 – 17.2**	**16.2 – 19.6**	**10.0 – 15.2**
	SEM	**3.26**	**8.40**	**0.03**	**5.74**	**0.97**	**0.71**	**0.28**	**0.67**
	CV %	**20.24**	**14.1****	**7.4****	**13.54****	**17.84**	**7.70**	**2.63**	**9.34**
	CD (0.05)	**9.48**	**24.33**	**0.08**	**16.61**	**2.81****	**2.07***	**0.8****	**1.95****

CoLk 04238, LG 2909, CoLk 5201, CoLk 97147, CoLk 94184, CoLk 9710 and CoLk 05202 with three checks, CoJ 64, CoS 96268 and CoS 767 (Table 4.1) was conducted in RCBD with three replications. Analysis of variance indicated that all the clones had significant variations among themselves for all the characters except CCS% (12 month) and purity% (8 & 12 month). The data (Table 4.1) indicated that CoLk 9710 produced the highest NMC followed by CoLk 99271 over the checks. The CoLk 05202 showed maximum cane and sugar yield followed by LG 2909 in respect of cane yield and CoLk 99271 in respect of sugar yield. In the evaluated clones, the fibre content ranged from 10.0 to 15.2%.

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

LG 95053, a high sugar selection with tested progeny performance has been applied for registration with NBPGR as a sugarcane breeding stock.

For the development of improved parental clones for subtropical agro-climate with high sugar accumulation potential, 42 high sugar LG selections have been sent to the Sugarcane Breeding Institute for enriching the breeding population in the National Hybridization Garden. Of these, ten were added this year to SBI, Coimbatore. Every year, these LG clones are observed for their flowering behaviour and are utilised in crossing to study progeny performance. Seedlings from twenty-seven such matings affected in 2005 were transplanted in September, 2006. The C_0 population of 2004 crossing season resulted in 101 selections. A greater selection rate was observed where LG 97050, LG 95123 and LG 94184 were used as parents. Family means with respect to sugar indicate the efficacy of this approach. Four selections with varietal attributes were identified this year. Natural incidence of diseases was quite low in the seedlings and in different clonal generations this year.

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

The Co seedlings were evaluated for juice brix, plant stand and general initial vigour in 5 biparental crosses and 2 General Crosses. Genotypes of C1 and C2 stage were evaluated for yield, HR brix morphological attributes, natural incidence of diseases and pests and adaptation to late-planted conditions. Five clones were evaluated for faster initial growth, juice quality. Four clones advanced to C2 stage. Fifteen C2 stage clones evaluated for yield and quality. Six clones exhibiting superiority advanced to C3 stage. In C3 stage, 6 clones were evaluated for yield, quality and adaptation to late planting condition. Three clones possessed superiority.

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

Fifteen biparental crosses, eleven general collections and two selfs were attempted at SBI,Coimbatore and SBI, Regional Centre; Agali. Three thousand seedlings derived from 14 biparental/GCs were evaluated for initial vigour, top borer tolerance. One hundred eighty seven seedlings advanced for further evaluation. The ratoon crop of Co seedlings was evaluated for plant stand, Top-borer incidence, natural incidence of other important diseases and pests, and hand refractometer brix. One hundred six selections were advanced to C1 stage. The range of top borer varied from 0 to 23 percent. The range in biparental crosses involving Erianthus species genotype as one of the parent varied from 0 to 4.84 percent. In C1, 108 clones were evaluated for juice quality, yield and top borer incidence. The 40 genotypes were advanced to C2, stage. In C2,12 genotypes were evaluated and 2 were promoted to C3 stage based on yield, juice quality and top borer tolerance. In C3 stage, 6 genotypes were evaluated for yield, juice quality, top borer tolerance and red rot resistance. Two genotypes viz., LG 2909 as mid late group and LG 2910 as early found superior and will be proposed for multilocation evaluation under AICRP (S).

The mid rib and leaf lamina silica content had impact on top borer tolerance in genotypes. Silica content is negatively correlated with top borer tolerance (Table 4.2).

The correlation of top borer tolerance in

Table 4.2: Correlation studies between top borer infestation and silica content

Attributes	Brood 1	Brood 2	Brood 3	Brood 4	Brood 5	Cumulative	Midrib Silica (mg g^{-1} dw)
Brood 1	1						
Brood 2	0.837	1					
Brood 3	0.749	0.868	1				
Brood 4	0.0492	0.104	0.373	1			
Brood 5	0.254	0.163	0.417	0.638	1		
Cumulative	0.786	0.8426	**0.929**	0.532	0.623	1	
Midrib Silica	-0.519	-0.483	-0.692	-0.646	-0.792	-0.815	1
Silica content in leaf lamina	-0.518	-0.511	-0.723	-0.617	-0.775	-0.823	0.963

different broods and silica content reveals that both the traits are negatively correlated (Table 4.2). However, the highest correlation value was noticed for third brood and cumulative infestation with silica content. The third brood contributed more to cumulative infestation.

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

Hybridization and raising of seedlings

A total of 21 bi-parental crosses were attempted at National Hybridization Garden, SBI, Coimbatore during November, 2006. Fluff received for all the crosses was sown in the glass house. In addition, fluff of 20 general crosses (GCs) were also sown in the nursery beds. Most of the bi-parental crosses as well as GCs showed good germination under controlled condition.

Evaluation of clonal generations

Fourteen clones were evaluated in augmented design along with three standards i.e. CoJ 64, CoS 767 and CoS 8436. Out of which, three clones, LG 03701, LG 03702 and LG 03706 showed superiority for sucrose per cent as well as cane yield and its components over the standard varieties. These three clones were promoted for further evaluation and also given for red rot testing.

Evaluation of elite clones

Another set of nine elite clones (Table 4.3) were evaluated under normal as well as moisture deficit condition along with three standards i.e. BO 91, CoJ 64 and CoS 767. There was significant difference among the genotypes for cane and sugar yield and most of its component traits. The genotype LG 03001 recorded the highest cane and sugar yield under both the conditions followed by LG 03002 and LG 03005. Maximum reduction in cane yield and sugar yield under moisture deficit condition was noted for LG 03009 followed by CoJ 64. However, the least affected genotypes due to moisture stress were LG 03007 and BO 91, which showed the lowest percent reduction in sugar and cane yield.

Table 4.3: Performance of elite sugarcane clones under normal and moisture deficit conditions

Genotype	Cane yield (t ha^{-1})		CCS (t ha^{-1})	
	N	D	N	D
LG 03001	98.34	76.54	12.21	9.12
LG 03002	95.50	73.32	11.04	8.64
LG 03003	80.86	62.60	9.48	6.90
LG 03004	70.98	52.61	8.31	6.04
LG 03005	95.05	72.46	10.05	7.39
LG 03006	59.66	47.79	6.26	5.07
LG 03007	49.19	42.49	5.69	4.73
LG 03008	66.24	55.12	7.28	5.49
LG 03009	65.18	45.96	8.07	5.16
CoS 767	69.37	56.12	9.49	7.21
BO 91	68.84	59.30	8.72	7.46
CoJ 64	43.43	31.81	5.67	3.90
General mean	71.89	56.34	8.52	6.43
CV (%)	11.88	16.05	16.57	15.19
CD (0.05)	14.46	15.31	2.39	1.65
SE(mean)	4.93	5.22	0.82	0.56

Note : N - normal and D- moisture deficit conditions

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

Hybridization and raising of seedlings

The crosses viz. LG 99122 x NCo 310, CoLk 8102 x HR 83-65, Co 1158 x Co 62198, CoLk 94184 x CoLk 8102, UP 9530 x Co 86002, CoLk 94184 x ISH 176, CoLk 8102 x CoJn 862072, LG 95053 x Co 775, CP 52-1 x CoH 70, ISH 100 x CoS 88216, CoJ 64 x Co 94008 and 81 V 48 x Co 1148 were attempted at NHG, SBI Coimbatore during November, 2006.

In addition, fluff of 11 zonal crosses (8 bi-parental and 3 poly crosses) and 20 GCs was also requested for evaluation. The fluff received of these crosses was tested for germination in BOD at 30^0C and crosses with good germination were sown in glass house to raise seedling population.

Evaluation of sugarcane crosses

A total of 1548 seedlings from 17 crosses (12 BiPs, 3 GCs and 2 self's) were transplanted in field under puddled conditions in July, 2006. Low incidence of weeds during early period led to higher survival of seedlings and resulted in better growth. Observations were recorded on HR Brix%, cane forming tillers and visual score of each stool. A total of 257 clones from 11 crosses were selected and planted in the field for multiplication and evaluation along with standards (CoS 8436, CoJ 64, CoS 8436 and CoPant 84211.

Evaluation of Co (Ratoon) clones

Sugarcane seedlings transplanted during July, 2005 were harvested in spring season of 2006 to initiate ratoon crop. Selection was done considering HR Brix %, cane diameter, green top and NMC per stool and other morphological features. A total of 28 clones were selected and planted during autumn season of 2006 for further evaluation along with checks.

Evaluation of C-1 clones

A total of 87 clones selected from the ratoon of seedlings from 2004 crossing series on the basis of HR Brix %, cane diameter, green top and NMC per stool and other morphological features planted in the field along with three standards (CoS 767, CoJ 64 and CoS 8436) in augmented design for further evaluation. Observations were recorded for germination %, yield and its attributes, HR Brix% (October and December) and juice analysis of selected clones. A total of 19 clones were selected considering morphology of the clones and juice characteristics for further evaluation along with standards.

Evaluation of C-2 clones

A total of 24 selected clones were planted with three standards (CoS 767, CoJ 64 and CoS 8436) in RCBD for further evaluation. Observations were recorded for germination %, yield and its attributes, HR Brix% (October and December) and juice analysis of selected clones. Analysis of variance indicated significant difference among these clones for germination%, yield and its attributes, HR Brix% (October and December) and juice parameters. A total of 10 clones were selected and advanced for further evaluation.

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

Evaluation of clones for resistance to red rot

In order to select the resistant parents for breeding programme, 23 clones comprising inter-specific hybrids (ISH), *S. spontaneum* species and commercial hybrid varieties were inoculated by plug method using two patho-types of *Colletotrichum falcatum* (Cf 08 and Cf 09). *S. spontaneum* clone SES 594 exhibited resistant reaction to all major patho-types (Table 4.4). ISH 150 clone showed resistant reaction to both patho-types while other ISH exhibited MR reaction to Cf 08 and Cf 09 except ISH 288 (MS, MR), ISH 148 (MS, MS) and ISH 14 (S, MS), respectively.

Hybridization programme

Twenty bi-parental, two self's and fifteen general crosses were attempted at National Hybridisation Garden, Sugarcane Breeding Institute, Coimbatore and the fluff received was sown in glass house to raise and evaluate seedling population during 2007-08.

Table 4.4: Reaction of parents to pathotypes of *Colletotrichum falcatum* (Cf 08 and Cf 09) inoculated during August, 2006

S. No.	Parents/ clones	Reaction to red rot pathotype	
		Cf 08	Cf 09
1	CoS 767	MS	S
2	CoS 8436	HS	HS
3	CoJ 64	S	S
4	CoS 96268	S	S
5	CoLk 5202	MR	MR
6	CoLk 97147	MR	MR
7	CoLk 94184	MR	MR
8	H2 (LG 03001)	MS	MS
9	I6 (LG 03105)	MR	MR
10	A7 (LG 03002)	MR	MR
11	ISH 12	MR	MR
12	ISH 5	MR	MR
13	ISH 148	MS	MS
14	ISH 126	MR	MR
15	ISH 14	S	MS
16	ISH 150	R	R
17	ISH 147	MR	MR
18	ISH 288	MS	MR
19	Co 1148	S	S
20	SES 594	R	R
21	BO 91	R	R
22	R3-7 (LG 04010)	R	MR
23	H6	MR	MR

Evaluation and selection of progenies from seedling generation

Two hundred eighty five progenies from 12 crosses viz. HR 83-65 x Co 86002, HR 83-65 x CoC 8001, CoS 96268 x C0 86002, BO 91 x CoC 8001, CoS 96268 Self, ISH 1 GC, HR 83-144 GC, CoNk 03-44 GC, Co 86032 GC, BO 92 GC, CoLk 7901 GC and HR 83-65 GC were selected to raise first clonal generation based on brix (%), total number of tillers per clump, number of shoots per clump, NMC, cane diameter and visual performance of the progenies. The progenies of bi parental cross BO 91 x CoC 8001 showed the maximum mean for HR Brix (21.18%) with coefficient of variation (CV) (5.34%) followed by CoLk 7901 GC (21.12%) with CV (5.33%).

Among the 12 families, CoS 96268 Self having 368 seedlings with general mean of HR brix (16.2%) and CV (8.0%), gave selections worth 48 progenies with high mean HR brix (18%) and low CV (1.27%). Selected progenies of this family also exhibited good growth and NMC.

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

Clones from the ratoon of seedling population (245 clones) and first clonal generation (102 clones) were tested by the plug method using two pathotypes of *C. falcatum* by inoculating more than 7000 canes (August, 2006). Forty three clones (out of which 13 clones showed moderately resistant 17 clones moderately susceptible and 13 clones MR/MS reaction to Cf 08 and Cf 09) were further advanced to second clonal generation for red rot testing and evaluation of the yield and the quality traits. The testing for red rot indicated that four Clones, LG 05802, LG 05806, LG 05808 and LG 05809 from CoLk 8002 GC, LG 05817 from CoLk 8102 x ISH 176 and two clones, LG 05826 and LG 05827 from CoLk 8102 x CoSe 92423 showed moderately resistant reaction to both patho-types in first clonal generation and MS/MR reaction in ratoon of seedlings with a range of 16.5% to 21.5% HR brix.

Zonal Varietal Trials (North West Zone) of AICRP on Sugarcane (B.1)

Advance varietal trial (Early) II Plant and Ratoon: A trial comprising of three early maturing entries viz., CoLk 9412, CoSe 0421 and CoS 97248 with two checks viz., CoJ 64 and Co Pant 84211 were evaluated for their performance as plant and ratoon crops. None of genotypes were significantly superior to CoPant 84211, the best check for cane and sugar yield (7.43 t ha^{-1}). However CoLk 9412 was found to be promising in yield (57.63 t ha^{-1}) and juice quality over check, CoJ 64 (48.43 t ha^{-1} and 6.43 t ha^{-1}) in plant crop. Genotypes were not found superior to checks for yield and quality in ratoon crop.

Advance varietal trial (Early) I Plant : Eleven entries viz., CoLk 9709, CoS 02258, CoS 03252, Co Pant 02217, Co 0116, Co 0118, Co 0237, Co 0238 and Co H 118 including two checks viz., CoJ 64 and Co Pant 84211were evaluated for yield and juice quality. Four genotypes, Co 316, CoS 03252, Co 0237 and Co H 118 exhibited very poor germination and growth. The CoLk 9709 was significantly superior in cane and sugar yield to both the checks, while Co Pant 02217

and Co 0238 were superior in cane and sugar yield to CoJ 64 only.

Initial varietal trial (Early): A trial comprising of fourteen early maturing entries viz., CoLk 9902, CoLk 97147, CoH 125, CoH 126, CoH 127,CoJ 03191, CoJ 03192,Co 316, CoS 03251,CoS 03272, CoS 03279, CoS 03292, Co Pant 03219, Co Pant 03220 along with two checks viz., CoJ 64 and Co Pant 84211were evaluated for yield and juice quality in plant crop. Clone namely, Co Pant 03220(14.3 t ha^{-1}) was superior in sugar yield to best check, Co Pant 84211 followed by CoS 03279(12.2 t ha^{-1}), CoLk 9902(11.6 t ha^{-1}) and CoH 125 (9.0 t ha^{-1}). None of the genotypes showed significant superiority over the best check, CoJ 64 in Pol % and CCS % at 10 months stage.

Initial Varietal Trial (Mid-late)

Eight genotypes viz., CoH 128, CoH 129, CoH 130, CoJ 03193, CoLk 9910, Co 0331, CoS 03261 and CoPant 03221 along with three standards, Co 1148, CoS 8436 and CoS 767 were evaluated for cane and sugar yield and their component traits. The CoS 03261 exhibited the highest sugar yield i.e. 10.81 t ha^{-1} followed by CoH 129 (9.62 t ha^{-1}) and CoH 128 (9.10 t ha^{-1}), while the sugar yield of best standard, CoS 8436 was 7.64 t ha^{-1}. Similarly, CoS 03261 showed the highest cane yield (85.90 t ha^{-1}) followed by CoH 129 (82.27 t ha^{-1}) and CoH 128 (73.89 t ha^{-1}), while the best check, CoS 8436 gave 59.75 t ha^{-1} of cane yield. None of the genotypes exhibited significantly higher pol % and CCS % over the standard varieties.

Advanced Varietal Trial- I (Mid-late)

Fifteen genotypes viz., Co 0121, Co 0122, Co 123, Co 0124, Co 0240, Co 0241, CoS 01256, CoS 01268, CoS 98259, CoLk 9705, CoLk 9710, CoH 115, CoH 117, CoPk 59 and CoPk 112 along with three standards Co 1148, CoS 8436 and CoS 767 were evaluated for cane and sugar yield. The genotype, CoLk 9705 showed the highest sugar yield i.e. 10.57 t ha^{-1} followed by Co 0124 (9.26 t ha^{-1}) and CoLk 9710 (8.64 t ha^{-1}). Similarly, CoLk 9705 recorded maximum cane yield i.e. 85.69 t ha^{-1} followed by Co 0124 (71.45 t ha^{-1}) and CoLk 9710 (68.57 t ha^{-1}). However, the highest pol % and CCS % were recorded in CoPk 59 (18.85 and 13.19) followed by CoH 117 (18.56 and12.98) and Co 0122 (18.45 and 12.89), while the best check, CoS 8436 exhibited 18.23% and 12.88% of pol and CCS, respectively at 12 months of crop age.

Seed multiplication

The seed of six genotypes viz., CoLk 99271, CoLk 04238, CoS 03222, CoPant 04222, Co 0327 and Co 0424 were multiplied for next year's Initial varietal Trial.

Fluff Supply Programme (B 2)

Under the programme of AICRP on Sugarcane for the development of sugarcane varieties for subtropical region from Sugarcane Breeding Institute, Coimbatore, the selections 1-14-7 and 1-31-2 did well in the plant crop as early and mid-maturing clones, respectively; while in the ratoon crop, 1-19-7, 2-1-9 and 1-30-5 performed well and, therefore, were promoted. Selection was carried out in C_0 and C_1 generations based on the cane characters and early brix. One hundred and twenty-four seedlings were advanced to C_1 in the autumn season. Sixty-two promising clones were planted in the spring season for evaluation of agronomic attributes in two separate trials. The AVT and PVT trials have been retained to evaluate the selected clones for ratoon performance. The fluff received under this programme was sown (under another Institute Project, B 2.13). Two early maturing clones, LG 9902 and LG 9917 were sent to SBI, Coimbatore for use in the NHG. These two clones are also under evaluation in the multi location trials for the North West zone under AICRP on Sugarcane.

Zonal Varietal Trial (North Central & Eastern Zone), Indian Institute of Sugarcane Research Regional Centre, Motipur (Bihar)

Initial Varietal Trial (Early): Four entries viz, CoSe 03234, CoSe 03421, BO 138 and CoP 03181 including three checks viz., CoSe 95422, CoS 687 and BO 120 were evaluated for yield and juice quality. None of the genotypes showed significant difference in cane as well as sugar yield over the best check, CoSe 95422.

Initial Varietal Trial (Mid late): Four entries viz, CoSe 02231, CoSe 03422, BO 141 and CoP 03182 including three checks viz., BO 91, BO 128 and CoSe 92423 were evaluated for yield and juice quality. None of the genotypes showed significant difference in cane as well as sugar yield over the best check, CoSe 92423.

Advanced Varietal Trial(Early) I Plant: A trial comprising of twelve early maturing entries viz., Co 0229, Co 0230, Co 0231, Co 0232, CoSe 01421, CoSe 02235, UP 0090, UP 01104, BO 145, CoP 02181, CoLk 9411 and CoLk 9412 with three checks viz., CoSe 95422, CoS 687 and BO 120 were evaluated for yield and quality parameters in the plant crop. Genotype BO 145 was found to be the best in cane yield (90.7 t ha^{-1}) followed by CoLk 9412 (87.0 t ha^{-1}). While, CoLk 9412 produced the maximum sugar yield (10.3 t ha^{-1}) followed by BO 145 (9.5 t ha^{-1}). None of the genotypes showed significant difference in sucrose%.

Advanced Varietal Trial (Early) II Plant crop and ratoon: Four entries viz., CoSe 00421, BO 139, BO 140 and CoLk 94184 alongwith 3 standards viz., BO 120, CoS 687 and CoSe 95422 were evaluated for yield and quality in II plant as well as ratoon crop. CoLk 94184 was best in sugar yield and cane yield, followed by BO 140 in plant crop, while CoLk 94184 was superior in sugar yield and cane yield in ratoon crop. CoLk 94184 possessed the highest sucrose% in juice in varieties under evaluation in plant and ratoon crop.

Advanced varietal Trial (Mid late)

Twelve entries viz., UP 0098, CoSe 01424, UP 0097, Co 0236, Co 0235, Co 0233, CoSe 01434, UP 01105, UP 01108, BO 146, BO 147 and CoP 02162 alongwith three standards viz., BO 91, BO 128 and CoSe 92423 were evaluated for yield and quality. The Co 0233, Co 0236, BO 147 and BO 146 showed superiority in sugar yield and cane yield, while Co 0233 was the best in juice quality at 360 days.

4.3 Cytogenetic and biochnological approaches for sugarcane improvement

Genetic improvement of sugarcane through tissue culture (B 3.7)

This project has been underway to assess the merit of 'somaclonal variation' as a breeding tool to enhance desirable variation among the adapted sugarcane varieties to serve the purpose of defect elimination or value addition. It has been established that variation for all agronomic traits can be generated through tissue culture involving a callus phase, and the probability of obtaining variants with overall superiority depends on the number of regenerants produced. During the year 2006-07, selection in the R_0 population of somaclones for refractometer brix, plant morphology and vigour resulted in 94 of these from seven varieties to be advanced in autumn. Similarly, a population of nearly 300 somaclones in plant-to-row progeny in R_1 generation was evaluated for reaction to artificial inoculation with the red rot pathogen. Variation for resistance to red rot was observed and about 70 desirableones were planted in spring, while the red rot testing would be repeated in the ratoon crop. The evaluation of ten variants each in the plant and ratoon crop in separate replicated trials showed SC 8102-2K3-22 and SC 8102-2K4-11 in the plant crop and SC 8102-2K3-2, SC 8102-2K3-15 and SC 8103-2K3-24 in the ratoon crop having superiority for sugar content as compared with CoLk 8102, while retaining the resistance to red rot. Two somaclones, SC 64-101 (LG 641), somaclone of CoJ 64 for resistance to red rot (against cf 08 and cf 09) and SC 91-85 (LG 911) somaclone of BO 91 with higher sugar yield were sent to National Hybridization Garden, Sugarcane Breeding Institute, Coimbatore for use as parents in commercial breeding. The molecular characterization of a selected set of 10 somaclonal variants with only six SSR markers showed that even with this small number, two somaclones, SC 64-101 and SC 8102-2K4-1 differed from their source varieties by 15 and 18%, respectively.

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

This project aims to understand the molecular genetic diversity within the commercial cultivars, genoytypes and species level germplasm of sugarcane. Forty-two cultivated sugarcane genotypes were used for molecular characterization during 2006-07. The PCR amplification was done using random decamers and ISSR markers (Fig. 4.1). Fifty-two

RAPD primers were able to produce 77.55% polymorphism. Ten simple sequence repeats of di, tri and tetra oligonucleotide motifs were used as primers for ISSR analysis. The frequency and clustering of specific simple sequence repeats was variable and motif-specific. The genetic similarity coefficients among these genotypes ranged from 0.63 to 0.97 for the studied primers. The average genetic similarity was 75%. UPGMA based cluster analysis (Fig. 4.2) placed these sugarcane genotypes into two distinct clusters. The arrangement of genotypes in different clusters was in agreement with their pedigree records to some extent. Though the genetic base of these genotypes appeared quite narrow as reflected by the similarity coefficients, genetically distinct cultivars were identified that could be used as potentially important sources of germplasm for further sugarcane improvement.

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

The project aims to identify biochemical and molecular markers for sugar genes in sugarcane. Based on observations of juice analysis during October, 2006, December, 2006 and also in February, 2007 for selected clones, clones with 19.0 and above pol% and those in the range of 14-15 pol% in December are being used for laboratory studies. A total of 20 RAPD

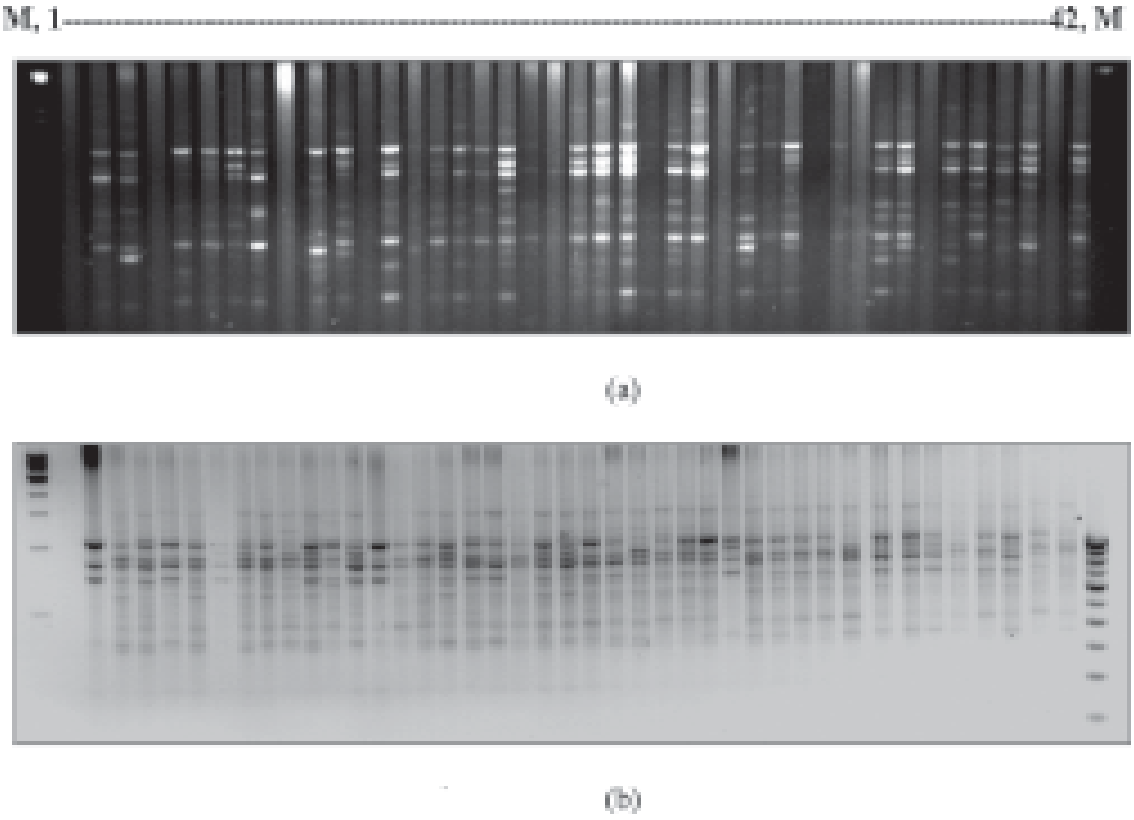


Fig. 4.1. DNA amplification profile of forty-two sugarcane genotypes generated by a). random decamer primer OPA-08 b).primer ISSR-14

M – marker, Lane 1-42. CoPt 84211, CoPt 84212, CoPt 90222, CoPt 90223, CoPt 92222, CoPt 93227, CoPt 96218, CoPt 97222, BO 91, BO 109, BO 110, BO 128, BO 129, POJ 2823, CoLk 8001, CoLk 8102, CoLk 8901, CoLk 9411, CoLk 9414, CoLk 9601, CoLk 9606, CoLk 9616, CoLk9618, CoLk 9701, CoH 92, CoH 98, CoH 108, CoH 110, CoJ 64, CoJ 81191, CoJ 96192, CoSe 92423, CoSe 95422, CoS 767, CoS 91269, Co 1148, Co 1158, Co 98016, Co 98017, Co 98018, CoC 671, UP 5

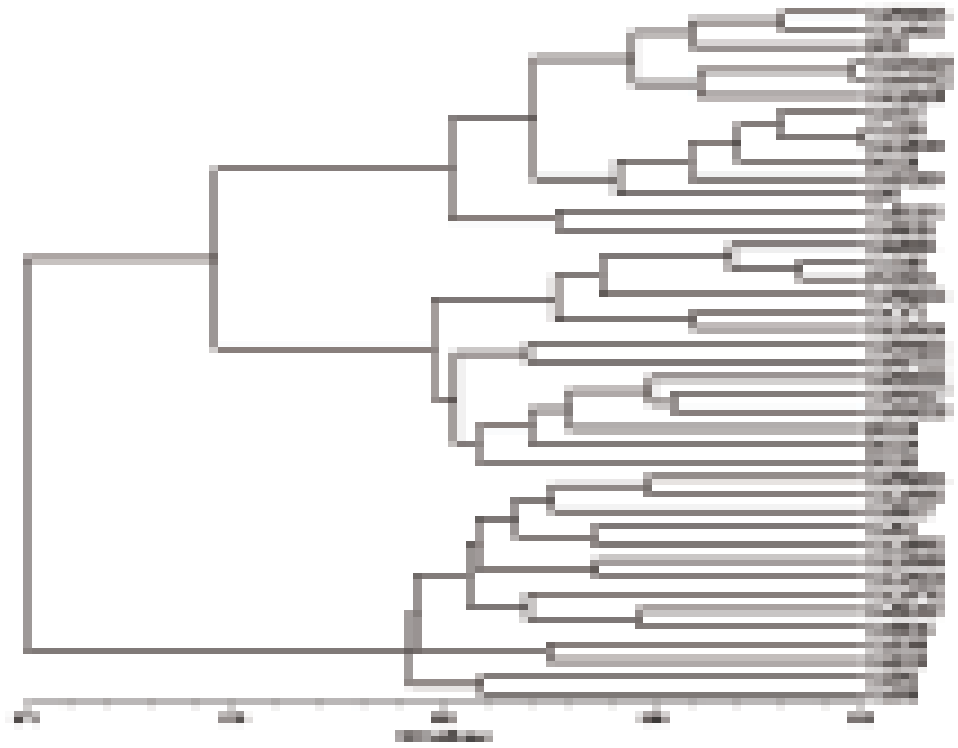


Fig. 4.2. UPGMA cluster analysis based dendrogram showing genetic relationship among sugarcane genotypes.

and 40 SSR markers have already been screened, of which, four primer sequences showed differential banding patterns. Efforts are continuing to identify large number of polymorphic primers linked to sugar trait. Poly Acrylamide Gel Electrophoresis is also being standardized to explore the chances of identifying more markers. Nine matings were carried out at National Hybridization Garden, SBI, Coimbatore for generating segregating population and fluff obtained was sown in the glasshouse. Six of these crosses gave satisfactory germination. These crosses involved CoLk 7901, LG 94114, Co 62198, ISH 280, ISH 176 and HR 83-65 as the parents.

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

Efforts were made to identify molecular markers linked with red rot resistant gene (s) in sugarcane, using association mapping and mapping population approaches. For association mapping, sixty diverse genotypes/ cultivars of varying red rot reaction were selected from 300 genotypes of sugarcane and were phenotyped as 6 resistant (R), 24 moderately resistant (MR), 4 susceptible (S) and 16 highly susceptible (HS). The DNA was isolated from 32 genotypes and micro satellite technique was standardized for genetic diversity analysis.

Two highly susceptible cultivars (*Saccharum* species hybrid) viz. CoS 7717 and Co 88025 and one clone of *Saccharum spontaneoum* (SES 594) resistant against most of the prevalent races of red rot in north India were used for the crosses at NHG at Coimbatore and fluff was sown in the glasshouse. The cross, Co 7717 x SES 594 showed excellent germination and it was selected to be used as mapping population for tagging and mapping for red rot resistant gene(s) in sugarcane. Parental polymorphism studies were carried out between two genotypes, Co 7717 and SES 594 using 20 SSR markers. Out of 20 SSR markers, 6 (30%) SSR markers showed polymorphism between these two parents. Identification of polymorphic SSR markers using more number of SSR primers is in progress.

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

The efforts are in progress to develop suitable protocol for genetic transformation in sugarcane as well as transgenics against borers. Four Bt gene constructs (Cry 1 Ab, Cry 1Aa, Cry 1F, Cry1IA5) and pBI 121 containing â glucuronidase (GUS) reporter gene were procured from Bt lab, NRCPB, IARI, New Delhi and were maintained in yeast extract monitol (YEM) medium and preserved in equal volume of 40% glycerol at 70^0 C for their further utilization. For development of transient genetic transformation, the embryonic calli of CoJ 64 were immersed in *Agrobacterium* (harboring pBI 121 plasmid) suspension for 10 min. The infected explants were blot dried and inoculated on basal MS medium for co-cultivation and placed for 3 days in dark at 25± 2^0 C. After co-cultivation, the agro infected calli were assayed histochemically for GUS expression after staining with X-Gluc for over night at 37^0 C. The non-transformed control callus did not show blue colour where as the putative transformed calli exhibited blue colouration (Fig. 4.3). To evaluate the efficacy of Bt genes, protein bioassay was carried out using the protein of Cry 1 Ac. Three doses 50, 100 and 200 ppm of Cry 1 Ac protein was mixed in artificial diet and allowed to feed the larvae of sugarcane stalk borer. The maximum lethality (75%) was observed at 200ppm dose while it was 50 % at 100 ppm. Great loss has been observed in pupae weight, which was 97.1%, 95.1% and 89.0% at 200, 100 and 50 ppm, respectively. The adults developed from treated pupae were unable to mate. The impact of Bt protein on stalk borer of sugarcane at different stages has been given in the Table 4.5. The production of protein from Bt gene was also standardized.

Fig. 4.3. *Agrobacterium* (harboring pBI 121 plasmid) mediated transient genetic transformation in sugarcane callus of cultivar CoJ 64

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

In order to produce value added, disease free and genetically pure micropropagated plantlets (as per norms of seed standard described by DBT and AICRP on sugarcane), the plantlets of cultivars, CoS 96268, CoS 8432 and CoS 97261 were produced using disease free explants from nursery seed plot grown after MHAT. These were tested for the freedom from sugarcane mosaic virus (SCMV) infection through bio indexing on international differentials of sorghum varieties, Atlas and Rio at 3rd and 6th subcultures. The tested plantlets were found free from SCMV infection. Genetic fidelity of plantlets was tested at 3rd subculture and hardened plantlets after 6th subculture along with parent cultivar, CoS 96268 using 5

Table 4.5: Effect of Bt protein of Cry 1Ac gene on 1st and 2nd instars larvae of stalk borer in sugarcane

Dose (ppm)	Mortality* (%)				Pupation in days		Loss (%) in weight of pupae
	20 days after feeding		40 days after feeding				
	1st instar	2nd instar	1st instar	2nd instar	1st instar	2nd instar	
Control	20	40	10	20	45	45	-
50	75	100	20	30	-	45	89.0
100	85	100	30	50	-	41	95.1
200	100	100	40	75	-	41	97.1

* Data based on 20 larvae per treatment

SSR markers. The DNA fingerprint developed from SSR primer (NKS 2) was given in Fig. 4.4. These markers showed monomorphic pattern, which proves that developed micropropagated plantlets were genetically pure and true to the type of the parent cultivar, CoS 96268. To produce value added micro propagated plantlets, the microbial consortium inoculation procedures are being standardized during rooting and in hardened plantlets. The work on plant geometry of the micro propagated plantlets is in progress.

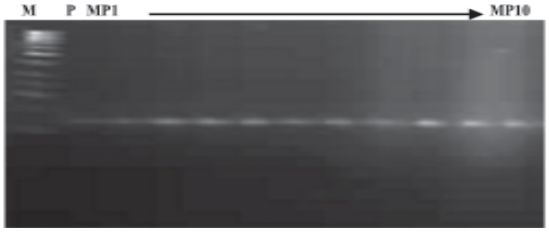


Fig. 4.4. Testing of genetic purity using SSR marker NK S2, M = Standard Marker, P = Control Plant CoS 96268, MP 1-MP 10 = Micro propagated plants

Development of ESTs, gene identification and transformation in sugarcane (DBT 2/03)

Under a DBT funded collaborative project on functional genomics of sugarcane, an EST resource has been generated in the form of general cDNA libraries for different tissues of sugarcane variety, CoS 767. Apart from this, subtractive libraries from stressed and non-stressed plants of designated varieties were constructed against drought, water logging and red rot. In case of drought and red rot, the candidate variety was Co 1148, while for water logging it was the tolerant variety, CoS 8118. A preliminary transformation protocol for sugarcane transformation using *Agrobacterium* was developed showing the expression of the reporter gene. A subtracted library from the stalk tissue of challenged and non-challenged Co 1148 with cf 01 isolate of red rot pathogen was prepared, and sequenced at UDSC. The sequence data from this library resulted in 1069 sequences being submitted rendering the total number of ESTs generated and submitted to the Gen Bank to 26453 under this project.

In order to produce a non-redundant dataset, the entire sugarcane EST collection comprising of 2,55,716 sequences available publicly at GenBank was combined with the EST data generated under this project and clustered using the CAP3 software. This resulted in 61,966 non-redundant molecules. Further analysis revealed that 416 contigs and 3586 singlets were unique to this work. The entire dataset consisting of 61,966 molecules was used for the identification of simple sequence repeats (SSR markers). This resulted in 12,529 SSRs at a frequency of one SSR per 4.2 kb sequence. The maximum occurrence was of tri- (31%) and tetramers (37%). These SSRs could be studied for polymorphism and used in the genetic analysis of diverse sugarcane clones. The annotation of these EST contigs resulted in detecting functionality of these sequences by blasting these against the known gene sequences for homology and also against the rice and *Arabidopsis* proteome. Several ESTs revealed similarity with stress and disease related genes. A search carried out to identify the EST contigs that have a complete reading frame revealed several such contigs.

Expression studies were carried out with some genes from the general and the red rot subtracted libraries. A few disease-related genes did not show expression in the tolerant variety, while some other genes were found to be up-regulated or down-regulated. Various stress related genes were induced to significant levels under dehydration stress. Detailed studies of these gene functions would help understanding the physiological behaviour of sugarcane plant under various stress or pathogen attack. Such genes would thus be the candidate genes for sugarcane transformation.

5 Epidemiology and integrated disease management

5.1 Epidemiology of diseases of sugarcane

Survey of plant parasitic nematodes in sugarcane intensive areas and identification of problem areas (M 6.8)

Nematode survey conducted at IISR farm, Lucknow indicated the preponderance of *Hoplolaimus*, *Helicotylenchus*, *Pratylenchus*, *Hemicriconemoides* and *Paratylenchus* species in low (1-200/250 cc soil) to moderate (201-500/ 250 cc soil) numbers. *Helicotylenchus* spp. and *Tylenchorhynchus* spp. were, however, recorded in high (501–1000/ 250 cc soil) population in some fields. *Hemicriconemoides* sp., *Paratylenchus* sp., *Trichodorus* and *Longidorus* species were found in low to moderate numbers.

Helicotylenchus indicus, H. crenacauda, H. erythrinae, Hoplolaimus indicus, Tylenchorhynchus goldeni, T. divittatus, Quinisulcius capitatus, Paratylenchus projectus, Trichodorus mirzai, Pralytenchus coffeae, and *P. pratensis* were the most common species identified from different fields.

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

Sugarcane crop (plant and ratoon) were surveyed for the occurrence of diseases in commercial cane cultivars *viz.*, CoS 8436, CoS 767, CoSe 92423, CoS 96268, CoS 88230, CoJ 85, etc., grown in the factory command areas of Bajaj Hindustan Ltd., Gola Gokarannath, and Saksaria Sugar Mill, Biswan during July-August 2006.

The incidence of red rot was noticed in cane variety, CoS 8436 (5-10%) in the fields surveyed. The red rot incidence was in the range of 20-30% in the ratoon fields of villages viz., Basalipur, Jhaupur, Batpurwa colony, Paharpur. The incidence of red rot (<5%) was also noticed in two varieties *viz.*, CoS 88230 and CoJ 85 in the factory command area of M/S Bajaj Hindustan Ltd., Gola Gokarannath.

The incidence of red rot was as high as 70% in ratoon crop of CoS 8436 in some low lying/ waterlogged field and was about 20-25% in upland fields in the mill command area in Saksaria Sugar Mill, Biswan.

The incidence of Grassy shoot disease (GSD) was also noticed in CoSe 92423 (>5%) in the village Maukheda and in CoS 92261 (10-20%) in Jatpura village under M/S Bajaj Hindustan Ltd., Gola Gokarannath. The incidence of minor disease like Pokkah boeng was also observed in CoS 8436 and CoSe 92423 in Chattipur Raja and Chattipur Attarah villages of Lakhimpur District of U.P.

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

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

Different inoculation methods (stalk, sett and soil inoculation) were tried to reproduce wilt with 10 representative stalk isolates (out of 97) of *Fusarium sacchari*. None of the inoculation methods tested was successful in producing typical wilt symptoms (cavity formation and gradual yellowing) in the cane.

Isolation from roots of wilt affected sugarcane plants yielded a number of fungi belonging to the genera, like *Fusarium, Rhizoctonia, Nigrospora, Pythium, Trichoderma, Alternaria, Rhizopus, Mucor, Aspergillus, Penicillium,* and *Paecillomyces*. *Fusarium* remained the most prevalent genera representing almost half of the isolated fungi followed by *Rhizoctonia*, *Nigrospora*, *Pythium* and *Trichoderma* (8-12% depending on the season).

Experiment with planting of cane at fortnight intervals from June to September along with the normal spring (February and March)

and autumn plantings (October) revealed that the autumn initiated crop (16 months crop) was more prone to wilt with 85-100% clump mortality than the spring initiated crop (12 months crop) with 60-70% clump mortality.

Double strength of fungicides like Bavistin and Ridomil (4g/l) were applied around the clump twice at fortnight interval. These fungicides delayed the appearance of wilt syndrome and Bavistin was found superior to Ridomil. Later on, treated clumps succumbed to wilt. The application of antibiotics (Streptomycin and Penicillin) on the other hand predisposed cane plants to wilt infection, as treated clumps showed wilt symptoms earlier as well as & the incidence at harvest was also higher than that in the control. The increase in wilt severity may be due to the checking of antagonistic soil bacteria involved in containing organisms causing wilt.

Observations on root borer and termite damage in relation to wilt in different cane genotypes revealed that root borer has little or no bearings on the incidence of wilt. Root borer incidence was 20% (clump basis), whereas wilt incidence was 80% in the susceptible genotype, Co 7717. Cases were available where root borer damage was there without any sign of wilt.

Identification of pathotypes in red rot pathogen (PP 14)

Four isolates *viz.,* IR-5 (from CoS 8432), IR 6(from CoLk 8102), IR 7 (from CoS 98231) and IR-8 (from CoS 8436) were tested on 13 differentials by plug method and their reactions were compared with the pathotypes existing in North-West Zone of India. It was observed that all the four isolates showed almost identical disease reaction and were similar to pathotype Cf 08 (CoJ 64).

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

Under this programme, 18 pathotypes/ isolates of red rot were maintained in the laboratory and their virulence was checked by field inoculation. The isolates are as follows :

Seven pathotypes *viz.*, Cf 01 (Co 1148), Cf 02 (Co 7717), Cf 03 (CoJ 64), Cf 07 (CoJ 64), Cf 08 (CoJ 64), Cf 09 (CoS 767), Cf 11(CoJ 64) of North-West Zone; three pathotypes *viz.*, Cf 04 (Co 419), Cf 06 (CoC 671), Cf 10 (85A261) of East -Coast Zone. Eight local isolates *viz.,* IR-1 (CoJ 64), IR-2 (CoJ 64), IR-3 (CoJ 83), IR-4 (Co 7717), IR-5 (CoS 8432), IR-6 (CoLk 8102), IR 7 (CoS 98231) and IR 8 (CoS 8436) were collected by IISR, Lucknow.

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

Three pathotypes of North-West Zone were taken for molecular characterization. Monoconidial cultures were established for each pathotypes. Fresh mycelial mat (0.5 g) from one-week-old culture grown on OMA was used for DNA extraction by CTAB (Cetyl-tri-methyl ammonium bromide) method. This modified method was reproducible and quality of DNA obtained was assessed by spectrophotometer (A_{260}/A_{280}).

5.3 Integrated disease management in sugarcane

Management of sugarcane smut through plant products and bio-agents (M 8.7)

Two plant species *viz., Solanum nigrum* and *Calendula officinalis* and a bio-agent *Trichoderma viride* (isolate T6) were evaluated against smut.

Three-bud setts (CoLk 9617) were dipped in teliospore suspension (appox. 10^6 spores ml^{-1}) for 30 min and incubated overnight before planting. Treated setts were subsequently dipped for 3 hours in *T. viride* spore suspension (10^6 spores ml^{-1}) / culture filtrate (5%) and for 6 hours in leaf extracts (10%) of *S. nigrum* / *C. officinalis* before planting. Filed application of *T. viride* @ 20 kg TMC ha^{-1} in furrows at the time of planting was also carried out. Whole/ chopped plants of *S. nigrum* and *C. officinalis* were also applied in furrows @ 3 q ha^{-1}. After the harvest of plant crop, chopped leaves of *S. nigrum* and *C. officinalis* @ 3 q ha^{-1} and *T. viride* (20 kg TMC ha^{-1}) were also applied around stubbles in ratoon crop.

Smut incidence was reduced in plots planted after the sett treatment with the leaf extract of *S. nigrum* followed by in sett treatment with *T. viride* spore suspension, culture filtrate and soil application with *T. viride* . There was also increase in number of millable canes and yield (t ha^{-1}) in these plots over diseased check.

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

Ten fresh isolates of *Trichoderma*, 4 isolates of *Aspergillus* sp. and 2 isolates of *Chaetomium* sp. were obtained from sugarcane rhizosphere soil collected from U.P. and Bihar. Antagonistic activity of these isolates was tested against *C. falcatum*. *Trichoderma* strains were more effective than that of *Aspergillus* and *Chaetomium*.

Five potent isolates of *T. harzianum* and *T. viride* (T 6, T 24, T 27, T 37 and T 38) were mass multiplied on FYM and press mud. The growth of *Trichoderma* on press mud was better than the FYM.

Different formulations of *Trichoderma* were tested under field conditions. Sett treatment with *Trichoderma* spore suspension (7 days growth on PDA, dilution $1:10^6$). TMC in powder form in FYM @ 20 kg ha^{-1} applied as soil treatment was found better than 10 or 40 kg ha^{-1} dozes. The metabolites of *Trichoderma* (2.50%) applied at tiller stage performed better than 1.25 and 5.00% concentrations. The powder form of *Trichoderma* applied at the time of planting coupled with metabolites at tiller stage gave better result.

Two strains of *T. harzianum* (T 37 and T 38) were found superior to other strains. These strains also induced systemic resistance in cane stalks. A protection of 45-55% was recorded in challenge inoculation with red rot.

Besides the disease protection, *T. harzianum* treatment also enhanced germination (10-12%), tillers, NMC and yield (10-15 t ha^{-1}) over the check. Leaf area was increased considerably and root and shoot weights were also increased. *T. viride* was better in promoting the growth of sugarcane but was inferior to *T. harzianum* in inducing systemic resistance in sugarcane.

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

Forty-five genotypes were screened against red rot and smut diseases. In addition, somaclones of CoS 767 (40), CoJ 64 (89) CoLk 8001 (01) were also tested for their reaction against red rot.

(a) Red rot

All the genotypes and somaclones were tested against two pathotypes (Cf 08 and Cf 09) of red rot by plug method of inoculation.

Genotype CoLk 2925 was resistant to both the pathotypes. Twenty genotypes *viz.*, 4-32-4, IV-4-4, CoLk 05203, CoLk 2917, CoLk 2922, CoLk 2924, 64-101, 91-85, CoLk 8102-2k3-5, CoLk 8102-2k3-6, CoLk 8102-2k3-15, CoLk 8102-2k3-20, CoLk 8102-2k3-22, CoLk 8102-2k3-24, CoLk 8102-2k4-1, CoLk 8102-2k4-4, CoLk 8102-2k4-6, CoLk 8102-2k4-11, CoLk 8102-2k4-15 and CoLk 8102 were moderately resistant to both the pathotypes of *C. falcatum*.

Two genotypes *viz.*, 1-16-7 and 1-32-2 were moderately resistant to pathotype Cf 08, while moderately susceptible to Cf 09. Genotypes 1-18-6 and II-3-2 were susceptible to highly susceptible to Cf 08 and were moderately resistant to Cf 09. The remaining genotypes were moderately to highly susceptible to both the test pathotypes.

A somaclone of CoS 767 (2K5-767-3-15) showed resistance to pathotype Cf 09, while all the somaclones of CoJ 64 were moderately susceptible to highly susceptible to pathotype Cf 08.

(b) Smut

Four genotypes *viz.*, 1-14-7, 2-15-10, IV-4-4, and CoLk 2919 were moderately susceptible to smut. The remaining forty-one genotypes showed resistance/tolerance to smut.

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

Thirty-six genotypes were tested against red rot, smut and wilt.

(a) Red rot

All the genotypes were tested against red rot (Cf 08 and Cf 09 pathotypes) by both plug and nodal methods of inoculation.

Plug method

One genotype, CoH 130 was moderately resistant (MR). Genotypes viz., Co 00120, Co 00240, Co 00331, CoH 118, CoH 128, CoLk 9705, CoLk 9709, CoPant 02218, CoPk 59, CoPk 112, CoS 00221, CoS 01256, CoS 01268, CoS 02264, CoS 03219, CoS 03261 CoS 03279, CoS 03292 and CoS 98259 were moderately susceptible (MS) to susceptible (S) and CoH 126, CoJ 03192

were highly susceptible to both the test pathotypes. The remaining genotypes showed varying degree of susceptibility.

Nodal Method

Four genotypes, CoJ 2191, CoH 129, CoH 130 and CoJ 03193 were resistant (R), CoLk 9705, CoLk 9709, CoPk 59, CoPk 112, CoS 01268, Co 00240, Co 00241, CoS 03279 and CoS 03261 were moderately resistant (MR), and CoS 03252, CoS 00221,CoS 98259, CoPant 02218, CoS 8436, Co 1148, CoH 125, CoH 126, CoH 127, CoJ 03192,CoPant 03220 and CoJ 64 were moderately susceptible (MS) to susceptible (S) to both the test pathotypes by nodal method .

(b) Smut

Genotypes viz., Co 00120, CoH 118, CoLk 9705, CoPk 59, CoPk 112, CoS 01268, CoS 00221, CoS 00264, CoS 98259, CoS 01256, Co 00240, Co 00241, CoJ 3191, CoS 8436, Co 0316, CoH 125, CoH 126, CoH 127, CoJ 03192, CoS 03279, CoPt 03219, CoPant 03220, CoPant 84211, CoS 03251, Co 00331, CoS 03261, CoH 128, CoH 129, CoH 130 and CoJ 03193 were resistant, CoS 03252 and CoPant 02217 were moderately susceptible (MS) and CoS 00237, CoLk 9709 were susceptible (S) and CoLk 9617 was highly susceptible (HS).

(c) Wilt

Three genotypes *viz.*, CoS 00221, CoS 01268, CoS 98259 and CoLk 9716 (Check) were susceptible. The wilt severity index (WSI) ranged from 3.0 to 4.0 on 0-4 scale. The remaining genotypes were found tolerant/resistant.

Network project on wilt of crops with special reference to cultural, morphological, molecular characterization and pathogenic variability of isolates in India (Network Project)

A total of 146 *Fusarium sacchari* isolates were collected from different states (Gujarat, Haryana, Punjab, Uttar Pradesh and Bihar) and 101 isolates were characterized on the basis of growth, sporulation and pigment production. Isolates (80%) were grouped in fluffy ashy white or fluffy bluish white. A technique of macrospore production using carnation/garlic leaf was developed. Macroconidia measured 26 (30-35)-40 ìm x 3-3.5 ìm. Usually the macro conidia were irregularly straight, 3 septate with less distinct foot cell.

Molecular characterization of selected isolates was carried out through RAPD and ISSR markers. Twenty-four primers from Operon kits and 14 simple sequence primers were used. A total of 1551 RAPD bands were produced across all the isolates (6-22 bands/isolate). The PCR amplification product ranged from 264-3629 bp. Similarly, with ISSR, 1460 bands were developed. Based on their molecular weight, the ISSR bands were grouped into 196 ISSR markers.

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

To check the development of red-rot disease in sugarcane, 11 potent bacterial, fungal and actinomycete bioagents were tested under field conditions with 12 treatments (11 bioagents + Control) in three replications, randomized in two blocks one each of red rot sensitive (CoJ 64) and moderately resistant (CoS 96275) plant varieties. After 60 days of pathogen inoculation, data recorded on disease development indicated that invariably bioagents inoculations reduced the disease intensity as measured in inter-nodal portions of the cane by plug inoculation method. Isolates of *Serratia marscens*, *Pseudomonas fluorescens, Acetobacter diazotrophicus*, *Trichoderma* and *Penicillium* spp. were found to be effective in managing the disease development. The disease intensity recorded was moderately resistant (2.1-4.0) for *Trichoderma* spp. and moderately susceptible (4.1-6.0) for *Serratia, Acetobacter, Pseudomonas* and *Penicillium* as compared to highly susceptible in untreated control (8.1-9.0). Two enzymes per-oxidases (PO) and chitinases related with plant defense mechanism were analyzed in control and bioagents treated plant roots and stem. The activity of PO was 2.4 times higher in bioagents treated plants as compared to untreated plants, whereas increase in chitinases was only 1.6 times.

Apart from disease management, bioagents promoted plant growth as observed by more cane weight (14%), height (9%), total millable canes (8%) and yield (6.5%). The plant growth promoting effect is mainly due to beneficial properties associated with these bioagents such as N-fixation, production of Indole Acetic Acid (IAA), siderophores and organic acids.

Bio-ecology and integrated management of insect–pests

6.1 Bio-ecology of insect-pests of sugarcane

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

Survey was undertaken in sub-tropical region including Meerut, (Western UP) Gola (Central U.P.) and Motipur (Bihar) areas for the occurrence of insect-pests. Woolly aphid was found in low to medium intensity in western Uttar Pradesh. Termites (5-10% incidence), top borer (traces), stalk borer (traces), mealy bugs (*Saccharicoccus sacchari*) in nodal region were found causing 60-80% damage to stalks in *Terai* region. In Bihar, top borer and white grubs were observed as most serious pests.

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

The periodic observations on the incidence of insect-pests on CoSe 92423 revealed the occurrence of top borer (2.62%) and pink borer (2.25%) during May. However, the incidence of pyrilla, top borer, stalk borer and internode borer was low during June. Incidences of top borer III- brood (7.55%), IV- brood (5.68%), V- brood (7.05%), stalk borer (4.63%), internode borer (3.56%) and termite (7.12%) were recorded. Parasitisation of egg masses of top borer with *Telenomus* sp. and *Trichogramma chilonis* was noticed. Total parasitization of top borer (III brood) larvae was 68.75%, which comprised of 27.28% *Rhaconotus* sp. and 72.72% *Isotima* sp.

Development of temperature tolerant strains of *Trichogramma chilonis* and *Trichogramma japonicum* (E 4.2.1 (iv))

Wild strain of *T. chilonis* Ishii was collected from internode borer egg masses in September and maintained on the eggs of *Corcyra cephalonica* for 15 generations at 26 ± 2^{0}C and 70 ± 5% RH. These were further maintained at 2^{0}C higher temperature (28 ± 2^{0}C) for ten generations in the laboratory for development of temperature tolerant strain. The low fecundity rate of *T. chilonis* in early generations gradually improved in advanced generations. With the increase in temperature from 26 to 28^{0}C, the longevity and fecundity was reduced.

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

The monitoring of insect-pests in different conditions of ratooning, *viz.,* trash mulching, trash burning, and no trash revealed that the clumps (35.54%) and shoots (23.67%) were significantly damaged in trash mulching followed by no trash (19.52%) and 3.18%, respectively. The incidence of top borer up to IV brood was also the highest in trash mulching. The pest and parasitoid ratio between *Pyrilla* and *Epiricania* was 5.05:1 in trash mulching, while it was 7.08:1 in trash burning. The infestation of mealy bugs was significantly higher under mulch conditions. The parasitisation of egg masses by *Telenomus* sp. and larvae of top borer (I, II, III brood) by *Isotima javensis* and *Rhaconotus* sp. was significantly higher in trash mulching.

Maximum protection given to crop against insect-pests yielded significantly higher cane yield (65.87 t ha^{-1}) over unprotected crop (28.87 t ha^{-1}). The cost benefit ratio was 1:5.6.

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

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

Twenty genotypes were evaluated against top borer, root borer, stalk borer, internode borer and pink borer. Genotypes CoPk 59, Co 00241,

CoPant 02218, CoS 03252, CoPk 112, CoPant 84211, CoLk 9709, CoS 767, CoS 01268, CoH 118 and CoLk 9705 showed low incidence of top borer (1.5 to 4.51%) as compared to Co 00238 and Co 1148 (4.71 to 6.67%). The stalk borer incidence was also low and ranged from 0.19 to 1.32% in Co 00237, CoPant 02217, Co 00238 and CoLk 9705. Incidence of internode borer, root borer, and pink borer was also very low.

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

At IISR bio-control centre, Pravaranagar, maximum incidence and intensity of scale insect, *Melanaspis glomerata* in *adsali* crop was recorded during January whereas maximum parasitisation was observed during October. The maximum Pyrilla was observed during August (35-42 adults and 55 to 74 nymphs/100 clumps). Fresh cocoons of *E. melanoleuca* were noticed from June to November.

A total of 12,000 cocoons and 25,000 larvae of pyralid predator *Dipha aphidivora* were released in farmer's fields against sugarcane woolly aphid around Pravaranagar area for its colonization.

The release of *Trichogramma chilonis* @ 50,000 adults ha^{-1} was done in 446 ha sugarcane area of 326 farmers against shoot borer from April, 2006 to March, 2007.

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

An artificial diet was developed for white moth, closely resembling to that for top borer. Eggs of this moth were used for rearing of *Telenomus beneficiens.*

Mass multiplication of potential bio-agents of sugarcane insect-pests (E 27, AICRPS)

Cotesia flavipes (field collected strain) was multiplied on laboratory reared larvae of stalk borer at 25 ± 2°C and 60-70 % RH. Field-collected larvae of stalk borer gave 70% female emergence while laboratory-reared larvae gave 40% females. Hence, field collected stalk borer larvae were preferred for parasitisation of *Cotesia* for laboratory multiplication.

Two entomopathogenic fungi, *Beauveria bassiana* and *Metarhizium anisopliae* were multiplied on PDA as well as on autoclaved rice (broken) at 27°C. Early spore formation was observed on rice in comparison to PDA.

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

The field evaluation of sex pheromone lure of top borer was carried out in 5 ha sugarcane area using 125 water traps. The catches of male moths in different broods were 60, 27, 15, 16 and 9 moths $trap^{-1}$ day^{-1} in I, II, III, IV, V broods, respectively. The emergence of moths continued for an average of 26 days. However, 75 to 96 per cent catch was recoded only in half of the total duration of emergence period.

Bionomics and management of sugarcane woolly aphid (APC-1/04; N 5.5)

Conservation and augmentation (through field releases of effective predators *viz., Dipha aphidivora* @ 1000 larvae or *Micromus igorotus* @ 2000 larvae ha^{-1} have been proved effective in controlling sugarcane woolly aphid throughout the country.

Fourth instar larvae of *D. aphidivora* consumed maximum number of sugarcane woolly aphid in comparison to other instars larvae during 4 hrs of feeding under both unstarved (11.38 nymph + adults) and starved (11.45 nymphs+ adults) conditions. The oviposition was achieved earliest when *C. lanigera* was used as prey followed by *A. craccivora*, *A. gossypii* and *R. maidis.* Woolly aphid population was reduced by 63.03 per cent after 45 days of *Dipha* release and by 38.52 per cent of *Micromus igorotus* release. *Dipha aphidivora* was superior to *M. igorotus* in controlling the woolly aphid population.

The loss in sugar recovery ranged from 9.21 (CoS 8436) to 18.44 per cent (CoS 767) and the loss in weight from 10.54 (CoS 8436) to 19.75 per cent (CoS 767), respectively.

Maintenance and supply of *Epiricania melanoleuca* for the biological control of *Pyrilla perpusilla* (AICRP, BC-3)

The spatial distribution of parasitoids of Pyrilla in variety CoS 95255 and CoSe 92423 were recoded in August-September, 2006 at IISR, farm, Lucknow. Population counts were made at fortnight intervals on 10 plants (3 leaves per plant; i.e. upper, middle and lower) in each block. Middle and lower leaves harboured more number of cocoons (1-2 leaf $^{-1}$) in variety CoSe 92423 in August. Pyrilla population was low in September due to parasitisation by the ecto-parasitoid, *E. melanoleuca.*

Eggs and cocoons (50,000) of *Epiricania* were collected from the areas of predominance and redistributed to 500 farmers of Pravaranagar, Maharashtra.

Evaluation of bio-efficacy of Bifenthrin 10 EC against sugarcane termites (CR-5/06)

The experiment was conducted in spring planted sugarcane (CoPant 84212, RBD design with 11 treatments). The treatments consisted of Bifenthrin 10 EC (60, 80,100,160,320 g a.i. ha^{-1}); chlropyriphos 20 EC@ 1 kg a.i. ha^{-1}; Endosulfan 35EC @1 kg a.i. ha^{-1}; Bifenthrin10 EC @80 g+ Carbendazim@125 g a.i./ha^{1}, Bifenthrin10 EC @80 g +Monocrotophos 36 SL @500 g a.i. ha^{-1} and Bifenthrin 10 EC @ 80 g + urea 2%. All the insecticides were mixed in sand-soil mixture and applied in furrows at the time of planting after placement of setts. The minimum bud damage (44.44%) was recorded in Bifenthrin10 EC @ 80 g + Monocrotophos 36 SL @ 500 g a.i. ha^{-1} and minimum incidence (29.67%) of termite was observed three months after planting in Bifenthrin 10 EC @ 100 g a.i. ha^{-1} compared to other treatments and control (63.45%).

Evaluation of E 2Y 45 20 SC against termites and top borer of sugarcane (CR-1/05)

A field experiment was carried out during 2006-2007 to evaluate the bio-efficacy of E 2Y45 20 SC against termites and top borer of sugarcane.

Variety, CoLk 8102 was planted in February, 2006. Insecticide was applied as sett soaking for 15 min(@ 50 g, 75 g, 100 g, 150 g and 200 g a. i. ha^{-1} in 1000 liters of water), application of insecticidal solution on cut setts in furrow (@ 50 g, 75 g, 100 g, 150 g and 200 g a. i. ha^{-1} in 1000 liters of water) and drenching of standing crop was done (@ 50 g, 75 g and 150 g a. i./ ha^{-1} 1000 liters of water). Chlorpyriphos @1.0 kg a.i. ha^{-1}, endosulfan 1.0 kg a. i. ha^{-1} against termites (as standard check) at the time of planting in furrows after placement of setts and carbofuran (as standard check) was applied @ 1.0 kg a.i.ha^{-1} against top borer. There were 14 treatments including standard and untreated check.

Termite infestation was significantly reduced in all the treatments of the insecticide E 2Y45 20 SC over standard check. The germination ranged from 37.25 to 43.39% as against standard check endosulfan (37.20%), chlorpyriphos (33.16%), and untreated check (31.39%).

Infestation of top borer (II, III and IV brood) in all the treatments having E 2Y45 20 SC and carbofuran was significantly less than the untreated check.

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

An experiment was laid out to evaluate the bio-efficacy of E 2Y45 0.4 GR against termites and top borer of sugarcane. Variety, CoPant 84212 was planted in April, 2006. The treatments were E 2Y45 0.4 GR @ 50 g, 75 g, 100 g and 150 g a. i. ha^{-1}, chlorpyriphos @ 1.0 kg a. i. ha^{-1}, endosulfan 1.0 kg a. i. ha^{-1} against termites applied at the time of planting, while carbofuran @ 1.0 kg a. i. ha^{-1} against top borer was applied in June.

The observations revealed that the application of candidate insecticide at the time of planting provided significant protection to buds, thereby, resulting in higher per cent germination (30.04%) over checks viz., chlorpyriphos (23.92%), endoslufan (20.92%) and untreated (17.81%). The damage to setts and shoots was also significantly low in insecticidal treatments. The incidence of top borer in III and IV broods was low in insecticidal treatments.

Exploratory Trial : Bio-friendly management of borer pests of sugarcane

Variety, CoPant 84212 was planted in March, 2006 (design RBD, replication three, plot size 27m^2). Eight treatments were based on intermingling of plant derived insecticides and bio-agents. Carbofuran was taken as a standard check. The incidence of top borer (III & IV broods) was significantly low in all the treatments in comparison to untreated check. Topdressing of urea synchronizing with the emergence of top borer moth during June resulted in higher infructuous attack (5.24%) of top borer. Low incidence of both stalk and internode borers was also recorded.

Demonstration of IPM and IDM technology against key pests and diseases at Institute farm

The recommended IPM and IDM technology was demonstrated at IISR farm with variety, CoSe 92423. The IPM plot received chlorpyriphos @ 1 kg a.i ha^{-1} at planting; removal of top borer egg masses (II brood), conservation of natural egg parasitoids (*Trichogramma* and *Telenomus*) emerged from field collected egg masses of top borer; application of carbofuran @ 1 kg a.i. ha^{-1} in June against third brood of top borer; release of *Trichogramma chilonis* @ 50,000 adults ha^{-1} at 10 days interval from July to October and release of larval parasitoid, *Cotesia flavipes* @ 500 gravid female week^{-1} ha^{-1} from July to November against stem borer and removal of dry leaves and late shoots at 30 days interval from September onwards.

In IDM practices, setts were treated in Moist Hot Air Unit at 54°C for 2½ hrs; setts were dipped in Carbendazim @ 0.2% for 1 hr before planting; and 2 kg *Trichoderma* (20 kg ha^{-1}TMC) mixed in soil at the time of planting. The same dose of *Trichoderma* was applied in between the rows at the time of tillering.

The incidence of top borer (III, IV brood) was minimum (9.79%) in IPM in comparison to the standard check (16.75%).The incidence of stalk borer, internode borer and termite was quite low under IPM practices. Comparative performance of IPM/IDM recorded the higher yield (75.06 t ha^{-1}) over check (59.20 t ha^{-1}).

7

Development of appropriate farm machinery for mechanization of sugarcane cultivation

7.1 Design and development of equipment

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

RMD has been found remunerative and efficient equipment for managing ratoon crop especially in areas where large scale and not piece meal harvesting is in practice. However, in subtropical region, the practice of stubble shaving is too strenuous and uneconomical to be done by conventional methods. It calls for developing yet another simplified and economical equipment.

Ratoon Promoter was thus, designed consisting of various sub-units to carry out cultural operations like ripping, off-barring, applying manure/fertilizer in granular and / or liquid form, interculturing and finally the earthing –up. The unit has been provided with one floating type ground wheel for each row to drive metering system of the manure/fertilizer disbursing unit. Sub-units like mainframe, floating type ground wheels, rippers, containers for manure and fertilizer in granular form have been fabricated and fastened with the main frame. Further fabrication work is in progress.

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

The first prototype has been developed and field tested at three different locations. The equipment was able to perform following operations simultaneously:

(i) Opening of two deep furrows (20-25 cm) at spacing of 75 cm.

(ii) Preparation of two raised beds (one full and two halves). Top width of the beds varied from 30-35 cm.

(iii) Cutting of canes into 37 cm long setts and placing them in the furrows.

(iv) Application of fertilizers and insecticides in the furrows.

(v) Drilling of seeds in two rows on the top of the raised beds. Row to row spacing has been kept 19 cm, depth of seed placement comes approximately 5 cm.

Planter was tested for drilling of wheat, *urd* and *moong* seeds on the raised beds along with planting of cane in furrows.

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

Aids were developed and attached to the engine operated walking type equipment for planting of sugarcane. The prototype was functionally tested. The function of furrow making unit was satisfactory. The remaining planting unit did not appear to be a viable proposition due insufficient power of the engine. Therefore, its use could be limited to opening of furrows for planting of cane. Efforts have been made to develop aids for intercultural operations through rotavator/sweep shovels, earthing-up and deep tillage in case of ratoon crop as a tool for off-barring.

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

A power operated improved detrasher was developed. It consisted of feeding unit, trash removing unit, and clean cane ejection unit. The developed equipment was tested with the help of a 1.46 kW (2.0 HP) electric motor as a source of power. Provision has also been made to operate the equipment with tractor PTO. Performance of the equipment was satisfactory. The detopping efficiency (removal of green top) was as high as 100 per cent. The trash (green + dry) left in the cleaned cane varies from 0.0 to 5.0% depending upon the variety.

Development of sugarcane harvester (AE 1.9 E)

Starting from August, 2006, the conceptual design of a front mounted windrower harvester for cutting of cane stalks has been worked out. The harvesting equipment consists of mounting system, base cutting unit and crop gathering unit. The tractive power of the tractor is to be used for operating the harvesting equipment. Hydraulic motors will be used for mounting as well as base cutting and crop gathering units.

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

MHAT unit of six quintal capacity takes around four hours time to treat 6 qtls of cane seed. Seed is treated at 52 degree centigrade and 100 per cent humidity. Seed rate for plantation is 6 t ha^{-1}. Accordingly, if present MHAT is used continuously, it will take 16 hours time and if loading and unloading time is added, it will take more than a day to treat seed.To reduce time for treating seed cane, it was thought to make MHAT unit of bigger capacity with modified trolleys so that after treatment, the seed can be taken directly to the field for planting and the trolleys can be unloaded at the field itself. Hence, it was decided to make a permanent brick and concrete structure with all electrical gazettes like heaters, fans, humidity generator, electronics circuits to monitor temperature, humidity, time and controlling circuit to control different gazettes. Permanent structure should be able to house at least four trolleys fitted with wheels, which can be shifted inside or outside the unit. After loading the trolleys outside the unit, the trolleys can be slided inside the MHAT unit.

Accordingly the brick concrete room has been designed. The walls of the room have been designed with cement concrete hollow bricks so that leakage of temperature from inside MHAT to outside atmosphere can be minimized. Similarly, the roof will be given mudfaska treatment. Room will be provided with double wall-insulated doors and there will be separate observation chamber. The whole unit can be closed with MS rolling shutters. Four numbers of drums have been designed and these will be rolling on railway lines fitted on the floor of the room so that these can be loaded outside the unit and slided inside the unit after loading. For loading seed, different trays have also been designed. Each drum is provided with the collars so that one drum will tightly fit with the other drum. Same way, the second set will be fitted with one another. This has been done to avoid unnecessary heat currents flowing inside the chamber. The unit will be having 16 heaters of 1.5 Kw capacity and 2 numbers of heaters for generating steam. It will be having 2 numbers of fans of 24 inch diameter. Besides this, observation room will be provided with digital readout of temp, humidity, time, power-consumed voltage in each phase. It will also point out that the heaters are on.

7.2 Manufacturing of prototypes and their feasibility trials

Manufacturing of prototypes for conducting field adoptability trials under varying agro-climatic and soil conditions (FIM/IISR/PMW/86)

Prototypes fabricated

Prototype	Number
IISR ratoon management device	1
IISR Two row multipurpose cutter planter	1
IISR T.D. Stubble Shaver (2 row)	1
IISR T.D. ridger type cutter planter	1
IISR T.D. two bottom pit digger	1
Jhabau	20
Total	**25**

Note-*Jhabau* is a manually operated curved sword like equipment of 1-1.5 metres long used for cutting/clearing weeds/bushes

8

Development of suitable post-harvest technology

8.1 Post-harvest losses in sugarcane

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

The post-harvest sucrose loss is one of the major causes for low sugar recovery in sub-tropical belt of India. The after-harvest losses are accentuated by *in situ* inversion and microbial multiplication on the cut ends and bruised sites. Pre- and post-harvest application of certain chemicals or formulations were tried to minimize sucrose losses in harvested sugarcane under field conditions.

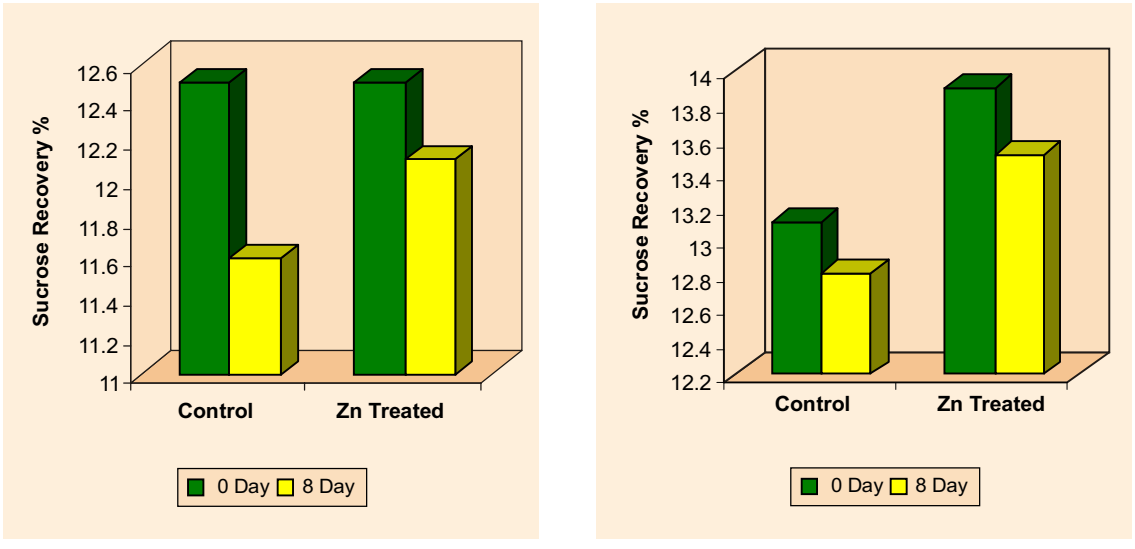
Pre-harvest foliar application of zinc sulphate

A pre-harvest foliar spray of $ZnSO_4$ (Zn^{++} @ 1000 mg l^{-1}) on variety CoSe 92423 (Fig.8.1A) in the month of March showed reduction in post-harvest sucrose loss. The sucrose % and purity of juice were higher 8 days after staling in Zn treated cane covered with trash as compared to untreated trash covered control. The sucrose recovery in zinc treated eight days stale cane was 4.3 per cent higher compared with untreated trash covered control. This increment in sucrose recovery was 5.5 per cent in variety CoS 95255 (Fig. 8.1B) subjected to 14 days of staling.

Application of Zn did not alter foliar acid invertase activity and reducing sugars but showed marginal improvement in the sucrose content in juice.

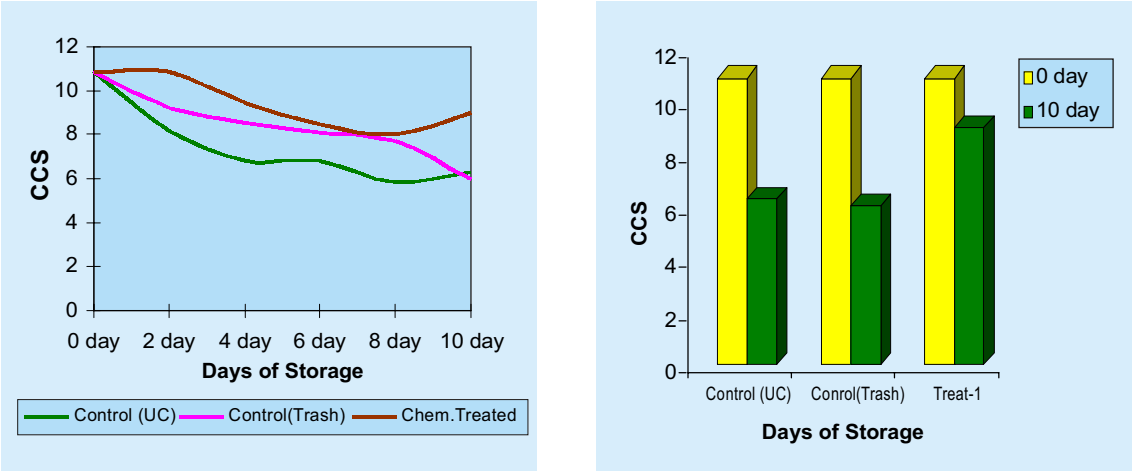
Post-harvest application of chemicals

Application of an aqueous solution containing benzalkonium chloride and sodium lauryl sulphate was tried to minimize sucrose loss in harvested stored cane. A single spray of this formulation containing Benzalkonium chloride, 2.5-4.0 g l^{-1} + Sodium lauryl sulphate, 0.2-0.5 g l^{-1}, on harvested cane covered with trash could appreciably reduce sucrose loss after harvest (Fig.8.2A). The difference in CCS value between chemically treated and untreated cane (control) was 2.0 units after 10 days of staling (Fig. 8.2B).



A B

Fig. 8.1. Effect of pre-harvest foliar application of zinc on sucrose recovery from harvested stored cane of variety CoSe 92423(A) and CoS 95255 (B)



A B

Fig. 8.2. Effect of application of benzalkonim chloride based formulation on loss of sugar in harvested stored cane (A) and reduction in CCS loss after 10 days of staling (B)

8.2 Manufacturing and storage of jaggery

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

The survey was conducted for assessment of post-harvest losses in ten crops/ commodities viz. wheat, paddy, pigeon pea, mustard, bajara, mango, guava, potato, green pea, sugarcane, jaggery, and *khandsari* in 5 districts of Uttar Pradesh namely Chandauli, Deoria, Kanpur Dehat, Etawah, and Unnao. Data are being compiled from selected farmers by enquiry as well as by observation on pre designed questionnaires/schedules.

Investigations on Lucknow furnace for waste heat recovery for useful purposes (AE 7 (H)/LKO/JKS/02/01)

Modification in waste heat recovery system (WHRS) was done. Mild steel flats of 25 x 3 mm were welded length-wise on the surface of the pipe fixed in flue gas channel. This increased surface area for heat collection. The testing of system showed improvement over the previous system.

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

The crusher procured from TNAU was installed and commissioned by maintaining proper alignment for power transmission. Test proforma was developed after reviewing BIS test code of power cane crusher. Preliminary testing of the crusher with limited quantity of sugarcane indicated only sixty per cent juice extraction of available juice in cane against 70%. During testing, the following major manufacturing problems/defects were observed:

1. Teeth of king roller and extraction rollers were not matching.
2. Bagasse choking between third and forth roller jammed rollers in operation and any further run/operation would have caused major break down/breakage.
3. Fed cane got trapped in both sides of the king roller causing jam. It could have caused major break down if not stopped.
4. The gun metal bush, fitted below the fourth roller in the body, would come out while the cane crusher was in operation.
5. The crusher made a lot of noise during operation.

Due to these defects, further testing could not be continued. Now efforts are being made to get the above defects rectified with the help of manufacturer who supplied the unit through TNAU.

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

A plastic filter unit of diameter 80 mm and length 260 mm was assembled. The candle of 70 mm diameter having synthetic material as a filter medium was kept in the filter unit. A pump of 800 litre capacity was used to pump the juice to the filter. It has a backwash facility also. It was found that it was able to remove 15-20 % of the total impurities present in the juice. The active charcoal unit was also fabricated. It consisted of aluminium casing, inlet-outlet valve, active charcoal granules and a small plastic mesh filter. The Prototype of the first unit i.e. plastic mesh filter has been developed. It consisted a slotted plastic cylinder body of 150 mm diameter and 608 mm length, end cap, plastic flange, submersible motor and plastic cloth of 1 mm mesh size. This filter will be used to separate coarse impurities like trash, bagasse particles, fibre, sand and other large insoluble impurities present in the juice.

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

Value addition of jaggery was done using Indian gooseberry (*Aonla*) as a natural source of vitamin C. *Aonla* was added in suitable form and identified quantity at a proper stage of jaggery preparation. Sensory evaluation of the samples revealed that the taste of jaggery was acceptable. Storability of jaggery samples was also observed which was also acceptable except the darkening of samples, which is the common phenomenon even with normal jaggery. Chemical analysis of fresh samples indicated Vitamin C content to the tune of 75.4 mg per 100 g sample. Thus, the concept can effectively be used for enriching jaggery with vitamin C making it more nutritious.

8.3 Diversification of sugarcane based by-products

Development of pre-treatment and hydrolysis process for conversion of sugarcane biomass to ethanol (APC-2/04)

Several pre-treatment processes were tested on sugarcane biomass at combined severity factor ($\log_{10}[R_o]$ –pH), an expression relating pH, temperature and residence time varying from 0.5 – 2.2 minutes. The temperature ranged from 100-225°C and the residence time from 2–15 minutes. The most effective process (using the highest level of xylan solubilization coupled with high levels of xylose recovery as selection criteria) was with dil. H_2SO_4 (1.5%, w/w) at solid residence time of 15 min. and a solid liquid ratio of 7:1. Under these conditions, 8-10% delignification occurred, 82% of xylan got solubilised and 75% of xylose was recovered. The pretreated solids on saccharification with cellulase loading of 60 FPU per g cellulose yielded 48-57% of reducing sugars.

An alternative microbial process for pretreatment of sugarcane trash was tested by screening eight bioagents (Fungi and bacteria). The bioagents helped in solubilisation of sugarcane trash by the production of cellulases (C: N ratio and levels of lignin used as selection criteria). All the bioagents narrowed down the C: N ratio of trash from 108:1 to varying ranges of approximately 42:1 to 60:1. The most effective agent causing the maximum solubilization of trash was found to be *Aspergillus terreus*. It caused 61% drop in C: N ratio and 12 fold increase in production of cellulase. .*Aspergillus terreus* was followed by *Cellulomonas uda*, *Trichoderma reesi* and *Zygomonas mobilis* (52% and 49% drop in C:N ratio and ten fold and nine fold increase in cellulase production, respectively. The microbial pretreated biomass on saccharification with 15 FPU per g cellulose yielded 27-35% reducing sugars. The saccharification process of the microbial pretreated biomass for increasing the production of reducing sugars is underway.

9 Sugarbeet improvements and its seed production

It has already been established through research conducted for nearly three decades that sugarbeet can be grown successfully as a winter crop in north India. The interest to explore its feasibility under tropical conditions, particularly considering the availability of tropicalized sugarbeet varieties, is of recent origin. The IISR has been coordinating a network of sugarbeet research entitled, "Developing Agro-Techniques for Tropicalized Sugarbeet In India", with five centres. During the second year of the Network project, Lucknow and Mukteswar centres under IISR carried out experiments in breeding, plant pathology, agricultural engineering and seed production.

Evaluation of varieties

Two experiments were conducted to evaluate the root crop performance of two separate sets of varieties in winter season at Lucknow. The advance trial was carried out with the entries of Shubhra (HI 0064), Cauvery (Dorotea), Indus (Posada), seed obtained from Syngenta and IISR Comp-1, LS-6, R-06, seed obtained from IISR.

Indus was the top performer with respect to yield (over 70 t ha^{-1}), which was attributable to the highest root weight despite lower plant population. Cauvery was the next to Indus, followed by IISR Comp-1 and LS-6 in agreement with the results obtained last year, Shubhra was the best variety in terms of quality, recording over 17% sugar in roots. It was followed by R-06, IISR Comp-1 and Cauvery (Table 9.1). The negative relationship between root weight and sugar content was observed in Indus (with the highest root weight and low sugar content), while R-06 with lowest root weight had the second highest sugar content.

Sugar yield as measured by the gross sugar followed the trend of root yield with Indus and Cauvery occupying the top two positions with over 11 tonnes of sugar per hectare (Table 9.1). The IISR Comp-1 occupied the third position in the end of May, outperforming Shubhra. However, differences among IISR Comp-1, Shubhra and LS-6 were not significant. Towards April end, these varieties and Cauvery were at *par* with each other with respect to sugar yield.

The number of roots affected by root rot was higher in Syngenta varieties. However, high temperature and high humidity in the end of May and June virtually devastated the roots of all the varieties affecting more than 80% of the plant population. Only IISR Comp-1 and Shubhra still had some healthy roots left.

In the second varietal trial, 20 varieties were taken (4 from IISR and 16 from Syngenta), with IISR Comp-1 and HI-0064 as checks. For root yield, LKC-11 (48.4 t ha^{-1}) over IISR Comp-1 (33.1 t ha^{-1}) and IN-14 (60.7 t ha^{-1}), IN-15 (60.7 t ha^{-1}) and IN-03 (56.5 t ha^{-1}) over Shubhra (43.8 t ha^{-1}) were significantly better. For gross sugar, LKC-11 (7.49 t ha^{-1}) was better than IISR Comp-1. LKC-11 was at *par* with Shubhra. There were many promising Syngenta entries, viz. IN-15 (9.17 t ha^{-1}), IN-14, IN-03, IN-16, IN-11 and IN-01 (8.21 t ha^{-1}), but none were significantly better than Shubhra (7.30 t ha^{-1}).

This trial brought out the superiority of some new Syngenta varietal material. With regards to heat tolerance, LKC-11 and IN-03, IN-04, IN-06, IN-11, IN-12, IN 15 and IN-16 compared favourably with IISR Comp-1 and Shubhra (Table 9.1). Among these, IN-06, IN-15 and IN-16 appear to possess some resistance to root rot as well.

Natural incidence of diseases once again showed that indigenous varieties were relatively less affected by root rots but had more of *Cercospora* leaf spot (Table 9.1). Interestingly, Shubhra was comparable with the indigenous varieties with respect to root rot. In the other

Table 9.1: Mean values for economic character

Variety	Plant popul-ation	Single root weight (g)		Sugar content (%)		Root yield (t ha^{-1})		Gross Sugar (t ha^{-1})		Disease incidence (%)	
	Apr 25	Apr 28	May 26	Apr 28	May 26	May 26	Apr 28	May 26	Apr 28	Root rot	Leaf spot
IISR COMP - 1	197	497.5	690.5	$14.3^{3,4}$	$16.3^{3,4}$	10.00^{3}	48.9^{4}	61.6^{3}	6.95^{5}	25.26	14.93
SHUBHRA	205	462.0	562.5	16.6^{1}	17.4^{1}	8.82^{4}	47.4^{5}	50.9^{5}	7.52^{3}	25.37	11.44
LS - 6	199	511.0	630.0	14.0^{5}	15.2^{6}	8.69^{5}	50.8^{3}	57.4^{4}	7.21^{4}	27.54	14.63
CAUVERY	188	589.5	823.5	$14.3^{3,4}$	$16.3^{3,4}$	11.19^{1}	55.8^{2}	68.7^{2}	7.94^{2}	37.24	10.30
R - 06	203	381.5	541.5	14.9^{2}	16.6^{2}	8.01^{6}	38.6^{6}	48.3^{6}	5.73^{6}	28.30	12.26
INDUS	174	894.5	948.0	13.8^{6}	15.7^{5}	11.16^{2}	77.9^{1}	71.4^{1}	10.71^{1}	33.99	12.09
Mean	194	556.0	699.3	14.7	16.3	9.65	53.2	61.6	7.68	29.62	12.61
CD at 5%	NS	75.73	59.72	0.67	0.65	1.57	11.33	10.24	1.73	7.89	2.95
CV %		9.02	5.65	3.07	2.67	10.78	14.10	11.36	15.00	-	-

Note- Figures in superscript represent rank; Year 2006-07; Plant population is per plot of 20 m^2

varietal trial, nine entries showed relative tolerance to root rots, which ranged from 24.16 to 46.75%. For *Cercospora* leaf spot, the range was 10.46 to 23.32%. For the management of root rots, it was observed that *Trichoderma viride* reduced the *Sclerotium* root rot. Among the insect-pests, it was mainly *Spilosoma obliqua* Wlk., with an incidence of 2-10% and was easily managed through the recommended spray of Endosulfan 35 EC.

With respect to implements developed at IISR for sugarbeet sowing, the sugarbeet FIRB seeder was used for sowing at VSI and at the factory farm at Samarth SSK, the factory where a sugarbeet pilot plant is being established. This can be tried next year for large scale sowing with on the spot adjustments based on the soil tilth. In addition, the hand operated rotary planter was tried at IISR.

Breeding and seed production

The seed of exotic germplasm obtained from Iran (5 varieties) and USA (2 lines) were taken to Mukteswar for maintenance and for evaluation with respect to root performance. Secondly, seed production of indigenous varieties and breeding lines yielded over 38 kg of seed. The bulk of seed was of IISR Comp-1 and LS-6. The rest belonged to 16 elite breeding lines. The seed for trials at different stations was supplied from the Mukteswar. Finally, limited crossing among the new and the indigenous lines was attempted to produce a few experimental hybrids. Besides, selection for heat tolerance and sugar content was carried out at Lucknow and the selected material was transplanted at Mukteswar for use in breeding.

10

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

10.1 Technology adoption and analysis of constraints

Integrated communication strategy (ICS) for accelerating the adoption of sugarcane production technology (ET 1.10)

Under the ICS, the identification and segmentation of clientele targets (viz., sugar mill personnel, development personnel and sugarcane farmers) were done for effective dissemination of information in sugarcane production technology. Messages on different sugarcane production technology were developed and articles were published in newspapers for disseminating the information among clientele groups

A total of 127 items related to various areas of scientific sugarcane cultivation were formulated and a questionnaire was developed. For knowledge test development. Judges' opinions from 30 experts belonging to different sugar mills/organizations were obtained on 3 point continuum i.e. very important, important and not important through mail questionnaire. Judges' responses were quantified by giving scores 3, 2, 1 for very important, important and not important responses, respectively in case of positive statements and scoring was reversed for negative statements. As a result of item analysis, 60 items were selected for final format of knowledge test. Reconnaissance Survey to disseminate the information, consolidate the knowledge and bring desirable change in adoption level of sugarcane production technology through ICS was carried out in the cane command area of the Balrampur Chini Mills, Rauzagaon (Barabanki) and the base line data were collected out of about 28000 ha of cane area, less than 10% is under autumn cane, varieties under early group; among mid late group, major varieties were CoSe 92423, CoS 97264, CoS 97261, CoS 767 and CoS 91269. In a *kisan goshthi* organised at Bahlolpur village in Burhwal Society, the information on sugarcane production technology was disseminated and farmers' problems were ascertained. In a group meeting with cane department staff, the modalities to implement ICS in mill zone for information dissemination were chalked out.

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

In order to assess the attitudinal changes of sugarcane development personnel after imparting training at IISR, Lucknow, 183 statements covering all relevant aspects of sugarcane cultivation were prepared. For construction of scale, 141 statements were retained for final analysis. The statements were subjected to 60 expert opinions in three point continuum, viz., most important, important and not important with the respective weightage of 3, 2 and 1 for positive statements and scoring was reversed for negative statements.

Item analysis was carried out on the basis of difference between the means of high and low groups. The total score obtained on the statements by all the experts were arranged in descending order. The top 25 and bottom 25 per cent responses constituted the criteria groups. The mean for individual item within high and low groups was calculated and mean difference worked out. The grand mean difference between high and low group was calculated. The items having mean difference (X_H-X_L) greater than grand mean difference of high and low groups i.e. ?X_H /n - ?X_L /n were selected. Finally, 66 items were selected for further inclusion in the attitude scale.

10.2 Socio-economics and policy analysis

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

Long term trends based on secondary data for the years 1975-76 to 2005-06 in sugarcane yields, cost of cultivation of the major agronomic scenario, and returns from sugarcane cultivation in 6 important cane growing states (Maharashtra, Tamilnadu, Karnataka, A.P., Gujarat and UP) of India were analysed. Per ha cost of cultivation of sugarcane in early seventies at current prices was the lowest in UP (Rs. 2266) and the highest in Karnataka (Rs. 4006). In the new millennium, UP state is still having lower cost of cultivation (Rs. 29417) compared to other states. The highest cost of cultivation at Rs. 54450 was in Tamilnadu (Table 10.1, Fig. 10.1). The cost of production per tonne of cane varied from Rs. 50 to Rs. 67 across the states. The profit per ha at Rs. 30757 was found to be the highest in

Table 10.1 : Cost of sugarcane cultivation/production in important cane growing states of India (in rupees)

Year (5 yr average)	Total operational cost (Rs. ha^{-1})	Cost of production (Rs. Qtl^{-1}.)	Profit margin (Rs. ha^{-1})	B:C ratio	Yield (t ha^{-1})
UP					
1971-75	2266.54	5.29	1484.64	0.73	42.68
2001-05	29417.23	50.67	17407.74	0.60	58.09
Haryana					
1971-75	3179.49	7.68	265.31	0.11	41.79
2001-05	40152.51	67.32	10422.76	0.26	59.66
Gujarat					
1971-75	3368.61	6.65	1403.88	0.44	50.57
2001-05	36087.54	50.11	29127.49	0.80	72.01
AP					
1971-75	3053.13	4.30	3554.39	1.31	73.72
2001-05	40001.80	53.96	23834.62	0.60	74.47
Karnataka					
1971-75	4007.56	5.26	3457.59	0.96	77.42
2001-05	44540.39	56.60	24792.69	0.56	79.15
Tamilnadu					
1971-75	3810.24	4.21	3495.24	0.96	89.85
2001-05	54440.65	52.34	29690.44	0.55	104.06
Maharashtra					
1971-75	3546.00	4.29	4762.71	1.43	81.02
2001-05	36766.02	53.08	30756.88	0.87	70.23

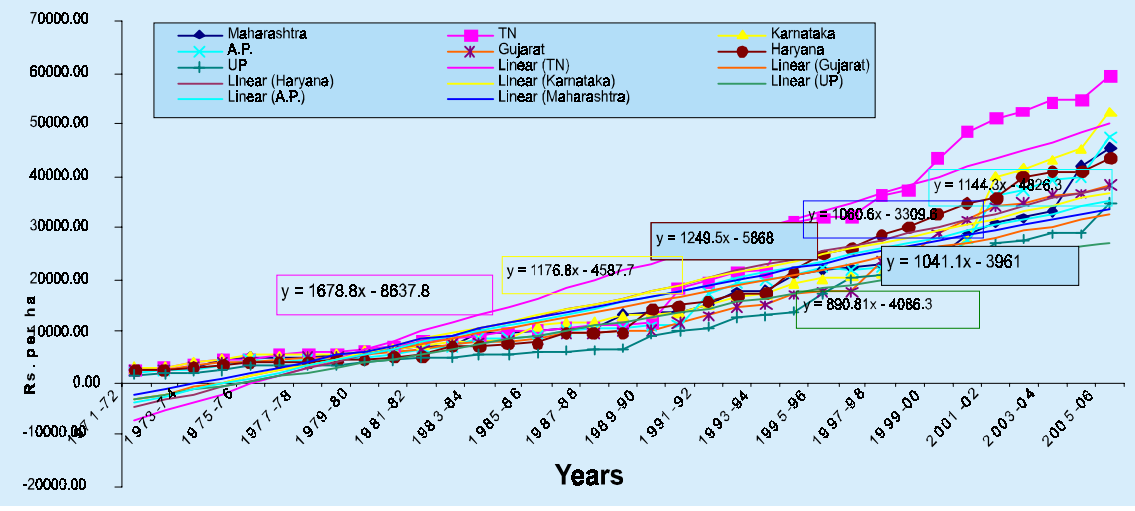
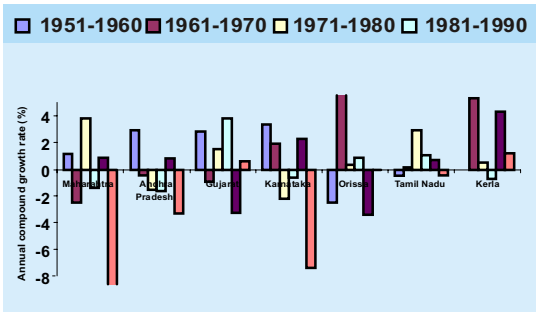


Fig. 10.1. Trends in operational cost of sugarcane cultivation in important cane growing states of India

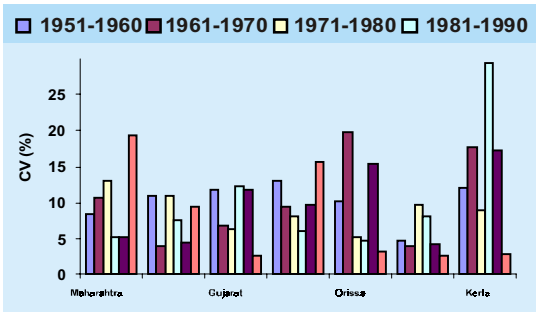
Maharashtra. Two important components of cost of cultivation viz., labour cost and irrigation cost grew at a much higher rate while the growth rate in yields were very low. The yield of sugarcane during the period grew by 15 – 20 tonnes per ha in different states. The benefit: cost ratio in sugarcane cultivation, still lower than one, has decreased in UP and Maharashtra states highlighting that the percentage share of benefits in gross returns has decreased over the years. In all other states, the mixed trends were observed w.r.t. B : C ratio. The findings, thus, highlight the need to reduce the cost of labour requirement and improve the input use efficiency to enhance yield of sugarcane and reduce cost of input use. It, thus, points towards the need for mechanization of sugarcane operations to minimize cost, and enhancement of yield and sugar recovery to maximize returns.

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

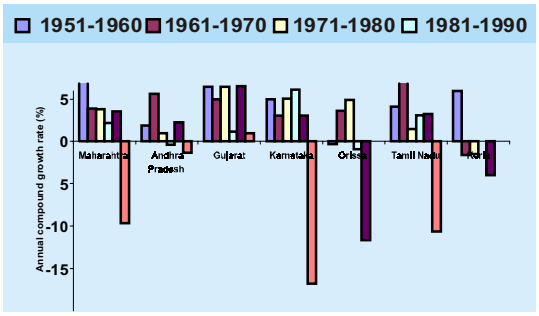
The tropical states of India account for 31.65% sugarcane area and 37.79% production of sugarcane in the country. The decade's annual compound growth for the last 5 decades of the 20th century and the first 5 years of the new millennium (2001-05) were estimated to measure growth in yield, area and production of cane in tropical states of the country. (Fig. 10.2 a, b, c). All the states in tropical region except



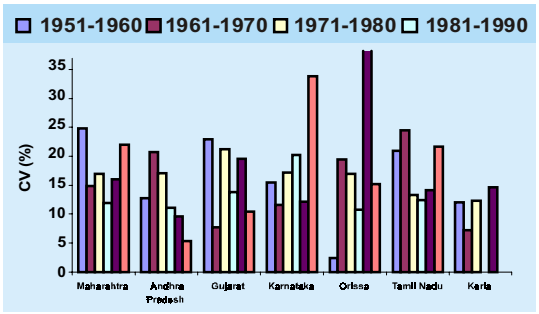
(a) Growth rate (Area)



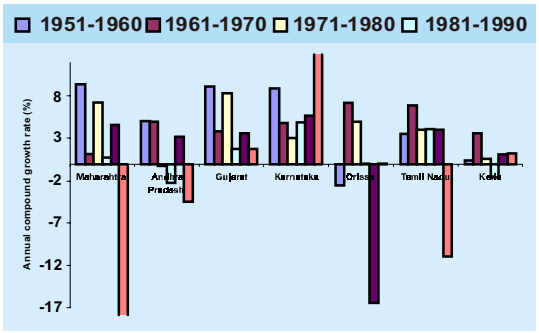
(d) CV (Area)



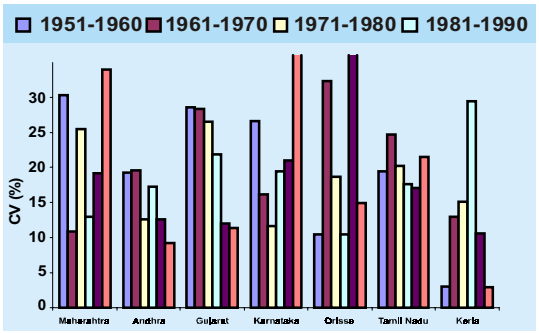
(b) Growth rate (Production)



(e) CV (Production)



(c) Growth rate (Yield)



(f) CV (Yield)

Fig. 10.2. Comparison of growth and coefficient of variations in area, yield and production of cane in different periods in tropical states of India

Gujarat registered negative compound growth rates or nearly zero during 2001-2005 for cane yield and cane area. In case of cane production, Maharastra (-18.65), Tamil Nadu (-10.95%) and Andhra Pradesh (-4.5%), the major producers of cane in tropical region recorded quite high negative growth rates. Karnataka though experienced negative growth both in terms of area and yield, showed positive growth of 15.64% in terms of production. Major tropical states did not observe any decline in the cane area in previous decades as happened in the first 5 years of this millennium.

The coefficient of variation (CV) of cane productivity, area and production (Fig. 10.2 d, e, f) reveals that the unstability in sugarcane yield was high in Maharashtra, Karnataka and Andhra Pradesh in the last 5 years compared to different previous decades. This period was most unstable for cane yield in these states. In case of cane area, the unstability during the last 5 years was high in Karnataka (33.78%), Maharashtra (22.5%) and Tamilnadu (22%) compared to previous 2-3 decades periods. Thus, all the states in tropical region had coefficient of variation (CV) 44.09% during 2001-2005 and Maharastra (24.81%) during 1951-1960.

Similar trends were observed for cane production in tropical states of country. It is, thus, evident that during the last five years, the maximum unstability was observed in Maharastra, and Karnataka for cane area, production and yield. It may be due to the high negative growth rates in cane area resulting in drastic reduction in cane production. The picture so emerged may be due to the drought and the outbreak of woolly aphid as well as due to other natural calamities in major cane producing states of the tropical region of the country.

10.3 Development of statistical models/ procedures

Dynamics of sugar production and factors affecting its prediction (AES 4.6)

Fluctuations in terms of coefficient of variation(C.V.) in the ratio of cane crushed to total cane production (1984-2004) was studied for its consideration as predictor variable for sugar production in major sugarcane growing states i.e., Maharashtra, Karnataka, Andhra Pradesh & Uttar Pradesh. Uttar Pradesh showed the lowest fluctuation in area (8.74%) and production (15.39%) whereas Karnataka showed maximum fluctuation in all the parameters i. e., area (26.54%), production (34.39%), cane crushed (36.71%), sugar production (37.90%) and cane crushed in proportion to total production (22.30%). Andhra Pradesh showed the lowest C.V. in cane crushed & in the proportion of cane crushed to total production of cane. The proportion ranged from 0.35 to 0.51 in U.P., from 0.40 to 0.61 in Karnataka, from 0.57 to 0.77 in A.P. and from 1.00 to 1.44 in Maharashtra. The correlation between production and the proportion crushed was positive & significant (0.67) in U.P. where as in other states, the non-significant association was found between the two variables. The sugar production in U.P. was estimated by estimated proportion / average proportion, production and recovery. Average prediction error was considerably reduced (1.26%) in comparison to average proportion in U.P. (4.29%).

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

Weather during 2006-07 crop season was recorded in terms of various parameters. The weather during the crop season 2006-2007 was characterized by lower average maximum temperature in May, June, July and November, 2006, respectively by 2.7, 1.9, 0.9, and 0.5°C as compared to long term (LT) average (1980-2005). It was also lower during February and March, 2007, respectively by 1.4 and 2.9 °C as compared to LT (1908-2006) average. It remained higher in September, October and December, 2006 and January, 2007, respectively by 1.2, 0.8, 0.6 and 1.5 °C as compared to LT average. The minimum temperature exceeded LT normal from April to December, 2006 ranging from 0.2 to 1.2 °C and February, 2007, by 1.7 °C. Morning relative humidity remained lower than LT average from August to December, 2006 and January, 2007, ranging from 1-5 %. It exceeded LT normal during April, May and June, 2006 and February and March, 2007, respectively by 5, 13, 5, 6 and

5%. Afternoon relative humidity was lower during August, September, October and December, 2006 and January, 2007, respectively by 4, 7, 6, 6 and 18% as compared to LT average. It remained higher during April, May, June and July, 2006 and February and March, 2007 respectively by 3,17,7,2,13 and 4% as compared to LT average. The duration of bright sunshine remained higher than LT average during April, August, September, October, 2006 and March, 2007, respectively by 0.7, 0.9,1.8,1.6 and 1.5 h day^{-1}. It remained lower during May, June, July, November and December, 2006 and January and February, 2007, respectively by 2.6, 1.4, 0.3,1.6, 2.7,1.6 and 1.7 h day^{-1}. The rainfall received during the months of April, May, June, and July, 2006 and February and March, 2007 exceeded LT normal, respectively by 12.4, 43.8, 86.4 and 142.8, 61.9 and 24.5 mm. It remained deficient by 99, 177.6, 17.9, 0.7, 6.3, and 17 mm, respectively during August, September, October, November and December, 2006 and January, 2007. However, the total rainfall received during the crop cycle exceeded long-term normal by 53.3 mm.

Weather based multiple regression model for predicting sugarcane productivity was developed for Gujarat State from database for 9 years (1994-2002) collected from Navsari, Gujarat. The observed and predicted yields are shown in Fig. 10.3 and the model is described below:

$$Y = 86.2801 - 0.06704*Tmax\ (22) + 0.08366*RH14\ (27) - 0.00396*Rainfall\ (29)\ (R^2 = 0.9457)$$

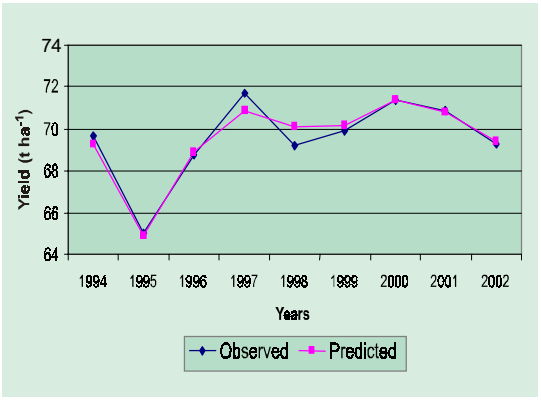


Fig.10.3. Observed and predicted yield of sugarcane in Gujarat

Where Y is the cane productivity (t ha^{-1}), Tmax (22) is the maximum temperature in 22nd met week, RH14(27) is the afternoon relative humidity in 27th met week, and Rain(29) is the rainfall received during 29th met week.

Development of Atlas for sugarcane cultivation in India (AM 4)

The project commenced in August, 2006 with major objectives : i) to collect, compile, collate and document district wise database on sugarcane and sugar production indices and socioeconomic parameters, ii) to develop crop database on agroclimatic zone basis and iii) to develop agroclimatic zone level GIS maps for sugarcane cultivation indices. The district wise data on sugarcane acreage, production, productivity, number of sugar mills, irrigation scenario, land use pattern etc. were collected from published literature. The data were compiled on agroclimatic zone (as per Planning Commission classification) basis. The GIS maps were generated for cane area production, and productivity of sugarcane, distribution of sugar mills in various zones and the average catchment area of each factory in various zones. The GIS maps were also generated for area, production, productivity, number of sugar mills and the average sugar recovery on state level.

SAC-IISR Programme : Energy and water balance and crop growth monitoring using satellite data (1/05)

Sugarcane cv. CoSe 92423 was planted on February 25, 2006 with recommended package and practices at research farm of the institute (Lat. 26° 48', Long. 80° 50' and 111m above mean sea level). Observations such as shoot population, average plant height, leaf area index, and total biomass were recorded for as well as temperature, relative humidity and wind profile within the microclimate after the establishment of the crop (by multi-level automatic weather station). The NDVI data during crop cycle and the crop parameters at harvest (January 12, 2007) were recorded (Table 10.2).

The NDVI-LAI relationship was developed from the data collected during the crop cycle.

Table 10.2: Crop parameters at harvest

Parameters	Mean Value
NMC	136000±3780
Av. cane height (m)	2.23 ± 0.25
Av. cane girth (cm)	2.45 ± 0.33
Internodes per stalk* (Av. No.)	25.8 ± 0.3.3
Green leaf weight* (t ha^{-1})	11.13 ± 1.27
Dry leaf weight* (t ha^{-1})	10.12 ± 0.97
Cane stalk weight (t ha^{-1})	83.23± 3.79

Note : Av. - Average, NMC - Number of millable canes ha^{-1}, * represents weight at harvest

An exponential relationship as given below was observed between NDVI and LAI of sugarcane.

$Y = 0.0813*e^{5.3244X}$ (R^2=0.9014), where Y is LAI and X is NDVI

The observed values of LAI along with model estimates are shown in Fig.10.4.

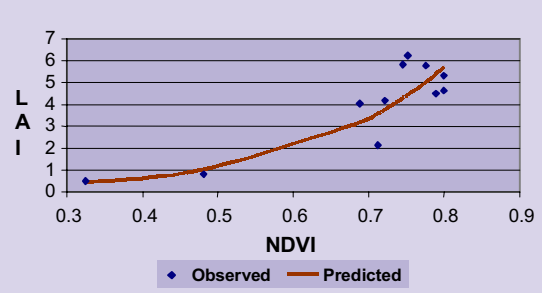


Fig. 10.4. NDVI-LAI relationship in sugarcane

Development of a precision N application technology based on NDVI index using Green Seeker Sensors for intercropping of sugarcane and wheat (CIMMYT/RWC-USAID, 1/05)

In the second cycle of the experimental trial, RWC, the raised bed planter was used. Nitrogen doses were 0, 30,60,90,120,150,180 and 210 kg ha^{-1}(as basal) before sowing of wheat and sugarcane (CoSe 92423) planted in furrows at 1.34 m inter row distance on 7th November, 06. Wheat, sugarcane +wheat and sugarcane alone were also raised with recommended package and practices for comparison purpose the observations of GS NDVI were recorded at satellite pass dates provided by RWC. The SPAD-LCC observations were also recorded for wheat crop (PBW 343) sown on raised beds at different nitrogen doses. The observations on the GS NDVI during wheat crop cycle (Table 10.3) show that the highest NDVI was observed at 88 DAS.

The SPAD- LCC (leaf colour chart) relationship in wheat crop raised on beds at different nitrogen levels was studied. The SPAD reading and LCC was significantly and positively correlated (r= 0.8836). The exponential relationship between SPAD reading and LCC developed for wheat crop is $Y= 0.7871\ e^{0.0032X}$ (R^2=0.8536), where, Y is LCC score, and X is SPAD reading. The relationship is shown in Fig. 10.5.

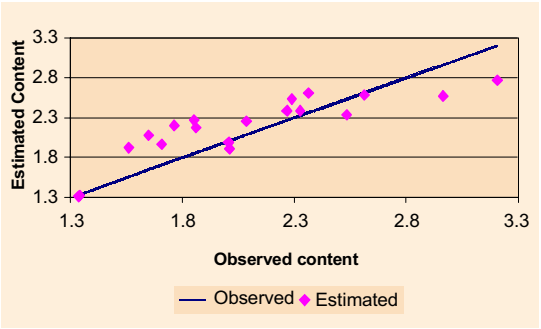


Fig. 10.5. SPAD-LCC relationship in wheat

The SPAD-Chlorophyll relationship was studied at various crop stages in plant crop of sugarcane (CoSe 92423) during 2006. A highly

Table 10.3: Profile of GS NDVI in wheat crop on specified satellite pass dates

N levels (kg ha^{-1})	Dates of observation						
	23.11.06	17.12.06	04.01.07	18.01.07	02.02.07	27.02.06	15.03.07
0	0.106	0.613	0.638	0.776	**0.831**	0.806	0.520
30	0.104	0.645	0.776	0.795	**0.887**	0.845	0.608
60	0.105	0.649	0.784	0.841	**0.876**	0.836	0.610
90	0.108	0.657	0.844	0.868	**0.905**	0.847	0.648
120	0.100	0.601	0.788	0.910	**0.912**	0.857	0.701
150	0.105	0.579	0.820	0.910	**0.915**	0.869	0.819
180	0.134	0.649	0.810	0.896	**0.922**	0.865	0.769
210	0.238	0.576	0.799	0.897	**0.920**	0.862	0.729

significant and positive correlation (r= 0.9673) was observed in SPAD reading and chlorophyll content in sugarcane leaves. A linear regression was developed for estimating chlorophyll content in sugarcane leaves (Fig. 10.6) and the relationship was validated successfully (Fig. 10.7).

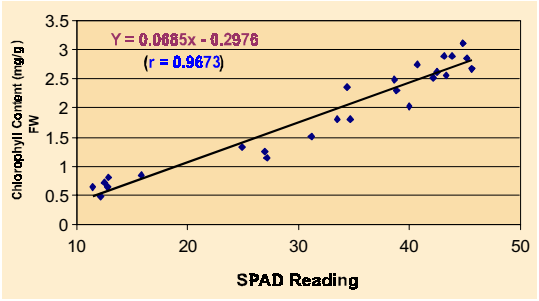
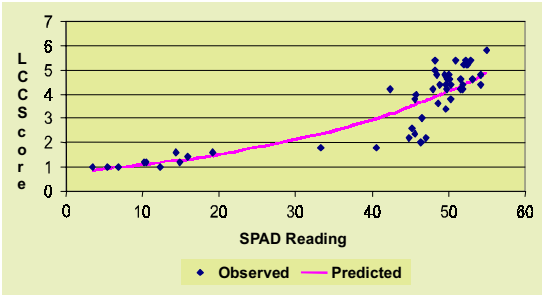


Fig. 10.6. SPAD reading and chlorophyll content in sugarcane



10.7. SPAD validation of chlorophyll content in sugarcane

Development of statistical procedures for analysis of count data in sugarcane protection trials (AES 4.4)

Analysis of spatial pattern of infestation in sugarcane early shoot borer, *Chilo infuscatellus* Snell.

Survey was conducted by IISR Bio Control Center -Nellore, AP in sugarcane command area of KCSF Ltd, Nellore during 2000-2001 to determine the spatial distribution pattern of infestation of sugarcane Early Shoot Borer, ***Chilo infuscatellus*** Snellen**.** Data were used to study the aggregated pattern of infestation of sugarcane early shoot borer and also sequential count plans for infestation of sugarcane early shoot borer, *Chilo infuscatellus* Snell. Unprotected commercial variety '87 A 298' was surveyed and twenty samples of 100 cane each were selected from May to October, 2000. In each month, number of infested canes were counted and arranged in frequency distribution. Mean (x) and variance (S^2) were calculated. Spatial distribution of infestation of early shoot borer, *Chilo Infuscatellus* Snell on sugarcane was studied using different statistical techniques to compute various indices (Table 10.4)

The variance values were more than mean number of infested cane of early shoot borer during all the months of observations indicating contagious manner of infestation of early shoot borer. The distribution parameter (K) values were > 1 in all the months (except May and October) indicating that the early shoot borer distribution was aggregated in nature. The patchiness index values varied from 1.06 to 2.5 (>1) which suggest aggregated nature of the distribution. In most of the months, the value of normal variable (d) is greater than 1.96 and positive, which showed the possibility of contagious nature of distribution. David and Moore's index values being >0 and positive in all the months indicated that the distribution was neither random nor regular. Similarly, Lexi's index and Lloyd's index of mean were indicative of aggregation of early shoot borer. It was observed that infestation of sugarcane early

Table 10.4: Parameters for aggregation index

Months	$\bar{x}$	S^2	K	$x^*/\bar{x}$	David and Moor Index	Standard normal variate(d)	Lexi's index	Lloyd's index of mean(X*)
May	1.35	3.83	0.73	2.36	1.84	4.30	1.68	3.19
June	11.75	20.19	16.36	1.06	0.72	2.00	1.31	12.47
July	11.05	19.15	15.08	1.07	0.73	2.03	1.32	11.78
August	1.00	2.00	1.00	2.00	1.00	2.64	1.41	2.00
September	0.70	1.11	1.20	1.84	0.59	1.68	1.26	1.29
October	0.20	0.26	0.67	2.50	0.30	0.95	1.14	0.50

Note : Standard normal variate $d = \sqrt{2\chi^2} - \sqrt{2v-1}$, Where $\chi^2 = \frac{S^2(n-1)}{\bar{x}}$ and v = n-1, David and Moor Index = $\frac{S^2}{\bar{x}} - 1$, Lexi's indes = $\sqrt{\frac{S^2}{\bar{x}}}$, Lloyd's index of mean,Where $K = \frac{\bar{x}^2}{S^2 - \bar{x}}$

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

A plastic filter unit of diameter 80 mm and length 260 mm was assembled. The candle of 70 mm diameter having synthetic material as a filter medium was kept in the filter unit. A pump of 800 litre capacity was used to pump the juice to the filter. It has a backwash facility also. It was found that it was able to remove 15-20 % of the total impurities present in the juice. The active charcoal unit was also fabricated. It consisted of aluminium casing, inlet-outlet valve, active charcoal granules and a small plastic mesh filter. The Prototype of the first unit i.e. plastic mesh filter has been developed. It consisted a slotted plastic cylinder body of 150 mm diameter and 608 mm length, end cap, plastic flange, submersible motor and plastic cloth of 1 mm mesh size. This filter will be used to separate coarse impurities like trash, bagasse particles, fibre, sand and other large insoluble impurities present in the juice.

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

Value addition of jaggery was done using Indian gooseberry (*Aonla*) as a natural source of vitamin C. *Aonla* was added in suitable form and identified quantity at a proper stage of jaggery preparation. Sensory evaluation of the samples revealed that the taste of jaggery was acceptable. Storability of jaggery samples was also observed which was also acceptable except the darkening of samples, which is the common phenomenon even with normal jaggery. Chemical analysis of fresh samples indicated Vitamin C content to the tune of 75.4 mg per 100 g sample. Thus, the concept can effectively be used for enriching jaggery with vitamin C making it more nutritious.

8.3 Diversification of sugarcane based by-products

Development of pre-treatment and hydrolysis process for conversion of sugarcane biomass to ethanol (APC-2/04)

Several pre-treatment processes were tested on sugarcane biomass at combined severity factor ($\log_{10}[R_o]$ –pH), an expression relating pH, temperature and residence time varying from 0.5 – 2.2 minutes. The temperature ranged from 100-225°C and the residence time from 2–15 minutes. The most effective process (using the highest level of xylan solubilization coupled with high levels of xylose recovery as selection criteria) was with dil. H_2SO_4 (1.5%, w/w) at solid residence time of 15 min. and a solid liquid ratio of 7:1. Under these conditions, 8-10% delignification occurred, 82% of xylan got solubilised and 75% of xylose was recovered. The pretreated solids on saccharification with cellulase loading of 60 FPU per g cellulose yielded 48-57% of reducing sugars.

An alternative microbial process for pretreatment of sugarcane trash was tested by screening eight bioagents (Fungi and bacteria). The bioagents helped in solubilisation of sugarcane trash by the production of cellulases (C: N ratio and levels of lignin used as selection criteria). All the bioagents narrowed down the C: N ratio of trash from 108:1 to varying ranges of approximately 42:1 to 60:1. The most effective agent causing the maximum solubilization of trash was found to be *Aspergillus terreus*. It caused 61% drop in C: N ratio and 12 fold increase in production of cellulase. .*Aspergillus terreus* was followed by *Cellulomonas uda*, *Trichoderma reesi* and *Zygomonas mobilis* (52% and 49% drop in C:N ratio and ten fold and nine fold increase in cellulase production, respectively. The microbial pretreated biomass on saccharification with 15 FPU per g cellulose yielded 27-35% reducing sugars. The saccharification process of the microbial pretreated biomass for increasing the production of reducing sugars is underway.

9 Sugarbeet improvements and its seed production

It has already been established through research conducted for nearly three decades that sugarbeet can be grown successfully as a winter crop in north India. The interest to explore its feasibility under tropical conditions, particularly considering the availability of tropicalized sugarbeet varieties, is of recent origin. The IISR has been coordinating a network of sugarbeet research entitled, "Developing Agro-Techniques for Tropicalized Sugarbeet In India", with five centres. During the second year of the Network project, Lucknow and Mukteswar centres under IISR carried out experiments in breeding, plant pathology, agricultural engineering and seed production.

Evaluation of varieties

Two experiments were conducted to evaluate the root crop performance of two separate sets of varieties in winter season at Lucknow. The advance trial was carried out with the entries of Shubhra (HI 0064), Cauvery (Dorotea), Indus (Posada), seed obtained from Syngenta and IISR Comp-1, LS-6, R-06, seed obtained from IISR.

Indus was the top performer with respect to yield (over 70 t ha^{-1}), which was attributable to the highest root weight despite lower plant population. Cauvery was the next to Indus, followed by IISR Comp-1 and LS-6 in agreement with the results obtained last year, Shubhra was the best variety in terms of quality, recording over 17% sugar in roots. It was followed by R-06, IISR Comp-1 and Cauvery (Table 9.1). The negative relationship between root weight and sugar content was observed in Indus (with the highest root weight and low sugar content), while R-06 with lowest root weight had the second highest sugar content.

Sugar yield as measured by the gross sugar followed the trend of root yield with Indus and Cauvery occupying the top two positions with over 11 tonnes of sugar per hectare (Table 9.1). The IISR Comp-1 occupied the third position in the end of May, outperforming Shubhra. However, differences among IISR Comp-1, Shubhra and LS-6 were not significant. Towards April end, these varieties and Cauvery were at *par* with each other with respect to sugar yield.

The number of roots affected by root rot was higher in Syngenta varieties. However, high temperature and high humidity in the end of May and June virtually devastated the roots of all the varieties affecting more than 80% of the plant population. Only IISR Comp-1 and Shubhra still had some healthy roots left.

In the second varietal trial, 20 varieties were taken (4 from IISR and 16 from Syngenta), with IISR Comp-1 and HI-0064 as checks. For root yield, LKC-11 (48.4 t ha^{-1}) over IISR Comp-1 (33.1 t ha^{-1}) and IN-14 (60.7 t ha^{-1}), IN-15 (60.7 t ha^{-1}) and IN-03 (56.5 t ha^{-1}) over Shubhra (43.8 t ha^{-1}) were significantly better. For gross sugar, LKC-11 (7.49 t ha^{-1}) was better than IISR Comp-1. LKC-11 was at *par* with Shubhra. There were many promising Syngenta entries, viz. IN-15 (9.17 t ha^{-1}), IN-14, IN-03, IN-16, IN-11 and IN-01 (8.21 t ha^{-1}), but none were significantly better than Shubhra (7.30 t ha^{-1}).

This trial brought out the superiority of some new Syngenta varietal material. With regards to heat tolerance, LKC-11 and IN-03, IN-04, IN-06, IN-11, IN-12, IN 15 and IN-16 compared favourably with IISR Comp-1 and Shubhra (Table 9.1). Among these, IN-06, IN-15 and IN-16 appear to possess some resistance to root rot as well.

Natural incidence of diseases once again showed that indigenous varieties were relatively less affected by root rots but had more of *Cercospora* leaf spot (Table 9.1). Interestingly, Shubhra was comparable with the indigenous varieties with respect to root rot. In the other

Table 9.1: Mean values for economic character

Variety	Plant popul-ation	Single root weight (g)		Sugar content (%)		Root yield (t ha^{-1})		Gross Sugar (t ha^{-1})		Disease incidence (%)	
	Apr 25	Apr 28	May 26	Apr 28	May 26	May 26	Apr 28	May 26	Apr 28	Root rot	Leaf spot
IISR COMP - 1	197	497.5	690.5	$14.3^{3,4}$	$16.3^{3,4}$	10.00^{3}	48.9^{4}	61.6^{3}	6.95^{5}	25.26	14.93
SHUBHRA	205	462.0	562.5	16.6^{1}	17.4^{1}	8.82^{4}	47.4^{5}	50.9^{5}	7.52^{3}	25.37	11.44
LS - 6	199	511.0	630.0	14.0^{5}	15.2^{6}	8.69^{5}	50.8^{3}	57.4^{4}	7.21^{4}	27.54	14.63
CAUVERY	188	589.5	823.5	$14.3^{3,4}$	$16.3^{3,4}$	11.19^{1}	55.8^{2}	68.7^{2}	7.94^{2}	37.24	10.30
R - 06	203	381.5	541.5	14.9^{2}	16.6^{2}	8.01^{6}	38.6^{6}	48.3^{6}	5.73^{6}	28.30	12.26
INDUS	174	894.5	948.0	13.8^{6}	15.7^{5}	11.16^{2}	77.9^{1}	71.4^{1}	10.71^{1}	33.99	12.09
Mean	194	556.0	699.3	14.7	16.3	9.65	53.2	61.6	7.68	29.62	12.61
CD at 5%	NS	75.73	59.72	0.67	0.65	1.57	11.33	10.24	1.73	7.89	2.95
CV %		9.02	5.65	3.07	2.67	10.78	14.10	11.36	15.00	-	-

Note- Figures in superscript represent rank; Year 2006-07; Plant population is per plot of 20 m^2

varietal trial, nine entries showed relative tolerance to root rots, which ranged from 24.16 to 46.75%. For *Cercospora* leaf spot, the range was 10.46 to 23.32%. For the management of root rots, it was observed that *Trichoderma viride* reduced the *Sclerotium* root rot. Among the insect-pests, it was mainly *Spilosoma obliqua* Wlk., with an incidence of 2-10% and was easily managed through the recommended spray of Endosulfan 35 EC.

With respect to implements developed at IISR for sugarbeet sowing, the sugarbeet FIRB seeder was used for sowing at VSI and at the factory farm at Samarth SSK, the factory where a sugarbeet pilot plant is being established. This can be tried next year for large scale sowing with on the spot adjustments based on the soil tilth. In addition, the hand operated rotary planter was tried at IISR.

Breeding and seed production

The seed of exotic germplasm obtained from Iran (5 varieties) and USA (2 lines) were taken to Mukteswar for maintenance and for evaluation with respect to root performance. Secondly, seed production of indigenous varieties and breeding lines yielded over 38 kg of seed. The bulk of seed was of IISR Comp-1 and LS-6. The rest belonged to 16 elite breeding lines. The seed for trials at different stations was supplied from the Mukteswar. Finally, limited crossing among the new and the indigenous lines was attempted to produce a few experimental hybrids. Besides, selection for heat tolerance and sugar content was carried out at Lucknow and the selected material was transplanted at Mukteswar for use in breeding.

10

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

10.1 Technology adoption and analysis of constraints

Integrated communication strategy (ICS) for accelerating the adoption of sugarcane production technology (ET 1.10)

Under the ICS, the identification and segmentation of clientele targets (viz., sugar mill personnel, development personnel and sugarcane farmers) were done for effective dissemination of information in sugarcane production technology. Messages on different sugarcane production technology were developed and articles were published in newspapers for disseminating the information among clientele groups

A total of 127 items related to various areas of scientific sugarcane cultivation were formulated and a questionnaire was developed. For knowledge test development. Judges' opinions from 30 experts belonging to different sugar mills/organizations were obtained on 3 point continuum i.e. very important, important and not important through mail questionnaire. Judges' responses were quantified by giving scores 3, 2, 1 for very important, important and not important responses, respectively in case of positive statements and scoring was reversed for negative statements. As a result of item analysis, 60 items were selected for final format of knowledge test. Reconnaissance Survey to disseminate the information, consolidate the knowledge and bring desirable change in adoption level of sugarcane production technology through ICS was carried out in the cane command area of the Balrampur Chini Mills, Rauzagaon (Barabanki) and the base line data were collected out of about 28000 ha of cane area, less than 10% is under autumn cane, varieties under early group; among mid late group, major varieties were CoSe 92423, CoS 97264, CoS 97261, CoS 767 and CoS 91269. In a *kisan goshthi* organised at Bahlolpur village in Burhwal Society, the information on sugarcane production technology was disseminated and farmers' problems were ascertained. In a group meeting with cane department staff, the modalities to implement ICS in mill zone for information dissemination were chalked out.

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

In order to assess the attitudinal changes of sugarcane development personnel after imparting training at IISR, Lucknow, 183 statements covering all relevant aspects of sugarcane cultivation were prepared. For construction of scale, 141 statements were retained for final analysis. The statements were subjected to 60 expert opinions in three point continuum, viz., most important, important and not important with the respective weightage of 3, 2 and 1 for positive statements and scoring was reversed for negative statements.

Item analysis was carried out on the basis of difference between the means of high and low groups. The total score obtained on the statements by all the experts were arranged in descending order. The top 25 and bottom 25 per cent responses constituted the criteria groups. The mean for individual item within high and low groups was calculated and mean difference worked out. The grand mean difference between high and low group was calculated. The items having mean difference (X_H-X_L) greater than grand mean difference of high and low groups i.e. ?X_H /n - ?X_L /n were selected. Finally, 66 items were selected for further inclusion in the attitude scale.

10.2 Socio-economics and policy analysis

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

Long term trends based on secondary data for the years 1975-76 to 2005-06 in sugarcane yields, cost of cultivation of the major agronomic scenario, and returns from sugarcane cultivation in 6 important cane growing states (Maharashtra, Tamilnadu, Karnataka, A.P., Gujarat and UP) of India were analysed. Per ha cost of cultivation of sugarcane in early seventies at current prices was the lowest in UP (Rs. 2266) and the highest in Karnataka (Rs. 4006). In the new millennium, UP state is still having lower cost of cultivation (Rs. 29417) compared to other states. The highest cost of cultivation at Rs. 54450 was in Tamilnadu (Table 10.1, Fig. 10.1). The cost of production per tonne of cane varied from Rs. 50 to Rs. 67 across the states. The profit per ha at Rs. 30757 was found to be the highest in

Table 10.1 : Cost of sugarcane cultivation/production in important cane growing states of India (in rupees)

Year (5 yr average)	Total operational cost (Rs. ha^{-1})	Cost of production (Rs. Qtl^{-1}.)	Profit margin (Rs. ha^{-1})	B:C ratio	Yield (t ha^{-1})
UP					
1971-75	2266.54	5.29	1484.64	0.73	42.68
2001-05	29417.23	50.67	17407.74	0.60	58.09
Haryana					
1971-75	3179.49	7.68	265.31	0.11	41.79
2001-05	40152.51	67.32	10422.76	0.26	59.66
Gujarat					
1971-75	3368.61	6.65	1403.88	0.44	50.57
2001-05	36087.54	50.11	29127.49	0.80	72.01
AP					
1971-75	3053.13	4.30	3554.39	1.31	73.72
2001-05	40001.80	53.96	23834.62	0.60	74.47
Karnataka					
1971-75	4007.56	5.26	3457.59	0.96	77.42
2001-05	44540.39	56.60	24792.69	0.56	79.15
Tamilnadu					
1971-75	3810.24	4.21	3495.24	0.96	89.85
2001-05	54440.65	52.34	29690.44	0.55	104.06
Maharashtra					
1971-75	3546.00	4.29	4762.71	1.43	81.02
2001-05	36766.02	53.08	30756.88	0.87	70.23

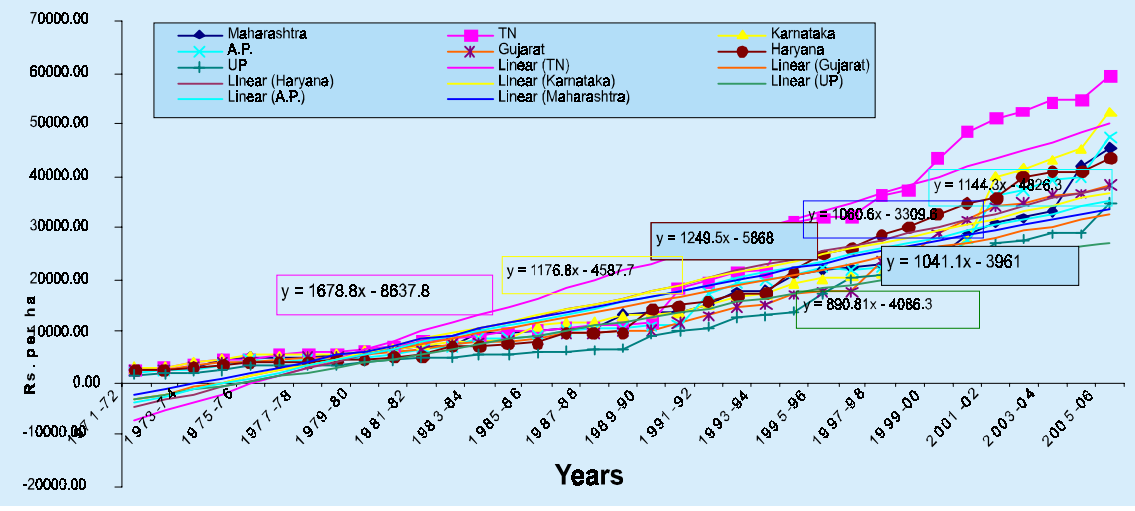
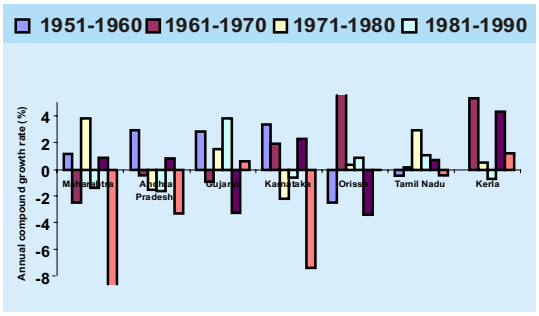


Fig. 10.1. Trends in operational cost of sugarcane cultivation in important cane growing states of India

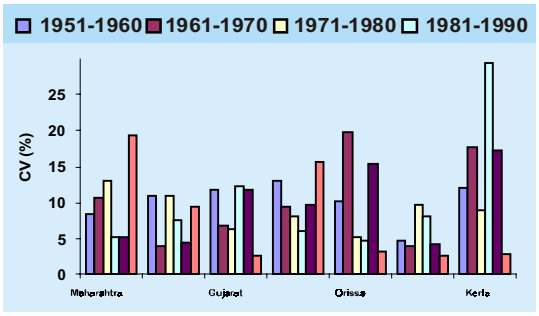
Maharashtra. Two important components of cost of cultivation viz., labour cost and irrigation cost grew at a much higher rate while the growth rate in yields were very low. The yield of sugarcane during the period grew by 15 – 20 tonnes per ha in different states. The benefit: cost ratio in sugarcane cultivation, still lower than one, has decreased in UP and Maharashtra states highlighting that the percentage share of benefits in gross returns has decreased over the years. In all other states, the mixed trends were observed w.r.t. B : C ratio. The findings, thus, highlight the need to reduce the cost of labour requirement and improve the input use efficiency to enhance yield of sugarcane and reduce cost of input use. It, thus, points towards the need for mechanization of sugarcane operations to minimize cost, and enhancement of yield and sugar recovery to maximize returns.

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

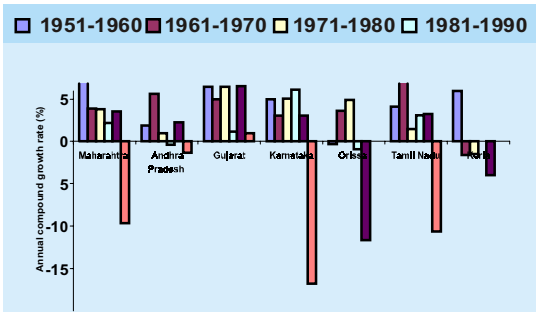
The tropical states of India account for 31.65% sugarcane area and 37.79% production of sugarcane in the country. The decade's annual compound growth for the last 5 decades of the 20th century and the first 5 years of the new millennium (2001-05) were estimated to measure growth in yield, area and production of cane in tropical states of the country. (Fig. 10.2 a, b, c). All the states in tropical region except



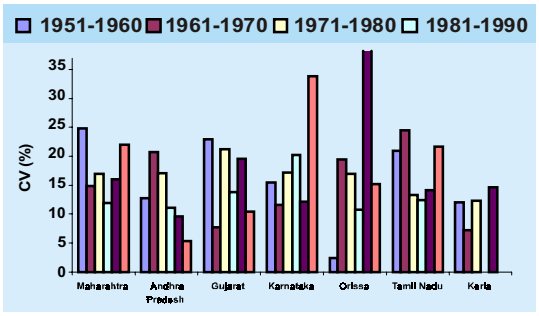
(a) Growth rate (Area)



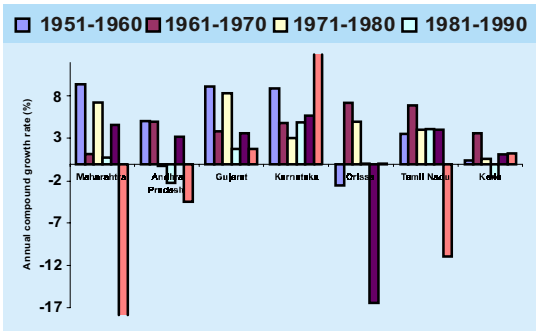
(d) CV (Area)



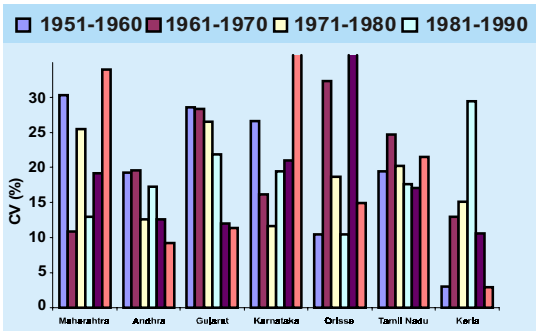
(b) Growth rate (Production)



(e) CV (Production)



(c) Growth rate (Yield)



(f) CV (Yield)

Fig. 10.2. Comparison of growth and coefficient of variations in area, yield and production of cane in different periods in tropical states of India

Gujarat registered negative compound growth rates or nearly zero during 2001-2005 for cane yield and cane area. In case of cane production, Maharastra (-18.65), Tamil Nadu (-10.95%) and Andhra Pradesh (-4.5%), the major producers of cane in tropical region recorded quite high negative growth rates. Karnataka though experienced negative growth both in terms of area and yield, showed positive growth of 15.64% in terms of production. Major tropical states did not observe any decline in the cane area in previous decades as happened in the first 5 years of this millennium.

The coefficient of variation (CV) of cane productivity, area and production (Fig. 10.2 d, e, f) reveals that the unstability in sugarcane yield was high in Maharashtra, Karnataka and Andhra Pradesh in the last 5 years compared to different previous decades. This period was most unstable for cane yield in these states. In case of cane area, the unstability during the last 5 years was high in Karnataka (33.78%), Maharashtra (22.5%) and Tamilnadu (22%) compared to previous 2-3 decades periods. Thus, all the states in tropical region had coefficient of variation (CV) 44.09% during 2001-2005 and Maharastra (24.81%) during 1951-1960.

Similar trends were observed for cane production in tropical states of country. It is, thus, evident that during the last five years, the maximum unstability was observed in Maharastra, and Karnataka for cane area, production and yield. It may be due to the high negative growth rates in cane area resulting in drastic reduction in cane production. The picture so emerged may be due to the drought and the outbreak of woolly aphid as well as due to other natural calamities in major cane producing states of the tropical region of the country.

10.3 Development of statistical models/ procedures

Dynamics of sugar production and factors affecting its prediction (AES 4.6)

Fluctuations in terms of coefficient of variation(C.V.) in the ratio of cane crushed to total cane production (1984-2004) was studied for its consideration as predictor variable for sugar production in major sugarcane growing states i.e., Maharashtra, Karnataka, Andhra Pradesh & Uttar Pradesh. Uttar Pradesh showed the lowest fluctuation in area (8.74%) and production (15.39%) whereas Karnataka showed maximum fluctuation in all the parameters i. e., area (26.54%), production (34.39%), cane crushed (36.71%), sugar production (37.90%) and cane crushed in proportion to total production (22.30%). Andhra Pradesh showed the lowest C.V. in cane crushed & in the proportion of cane crushed to total production of cane. The proportion ranged from 0.35 to 0.51 in U.P., from 0.40 to 0.61 in Karnataka, from 0.57 to 0.77 in A.P. and from 1.00 to 1.44 in Maharashtra. The correlation between production and the proportion crushed was positive & significant (0.67) in U.P. where as in other states, the non-significant association was found between the two variables. The sugar production in U.P. was estimated by estimated proportion / average proportion, production and recovery. Average prediction error was considerably reduced (1.26%) in comparison to average proportion in U.P. (4.29%).

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

Weather during 2006-07 crop season was recorded in terms of various parameters. The weather during the crop season 2006-2007 was characterized by lower average maximum temperature in May, June, July and November, 2006, respectively by 2.7, 1.9, 0.9, and 0.5°C as compared to long term (LT) average (1980-2005). It was also lower during February and March, 2007, respectively by 1.4 and 2.9 °C as compared to LT (1908-2006) average. It remained higher in September, October and December, 2006 and January, 2007, respectively by 1.2, 0.8, 0.6 and 1.5 °C as compared to LT average. The minimum temperature exceeded LT normal from April to December, 2006 ranging from 0.2 to 1.2 °C and February, 2007, by 1.7 °C. Morning relative humidity remained lower than LT average from August to December, 2006 and January, 2007, ranging from 1-5 %. It exceeded LT normal during April, May and June, 2006 and February and March, 2007, respectively by 5, 13, 5, 6 and

5%. Afternoon relative humidity was lower during August, September, October and December, 2006 and January, 2007, respectively by 4, 7, 6, 6 and 18% as compared to LT average. It remained higher during April, May, June and July, 2006 and February and March, 2007 respectively by 3,17,7,2,13 and 4% as compared to LT average. The duration of bright sunshine remained higher than LT average during April, August, September, October, 2006 and March, 2007, respectively by 0.7, 0.9,1.8,1.6 and 1.5 h day^{-1}. It remained lower during May, June, July, November and December, 2006 and January and February, 2007, respectively by 2.6, 1.4, 0.3,1.6, 2.7,1.6 and 1.7 h day^{-1}. The rainfall received during the months of April, May, June, and July, 2006 and February and March, 2007 exceeded LT normal, respectively by 12.4, 43.8, 86.4 and 142.8, 61.9 and 24.5 mm. It remained deficient by 99, 177.6, 17.9, 0.7, 6.3, and 17 mm, respectively during August, September, October, November and December, 2006 and January, 2007. However, the total rainfall received during the crop cycle exceeded long-term normal by 53.3 mm.

Weather based multiple regression model for predicting sugarcane productivity was developed for Gujarat State from database for 9 years (1994-2002) collected from Navsari, Gujarat. The observed and predicted yields are shown in Fig. 10.3 and the model is described below:

$$Y = 86.2801 - 0.06704*Tmax\ (22) + 0.08366*RH14\ (27) - 0.00396*Rainfall\ (29)\ (R^2 = 0.9457)$$

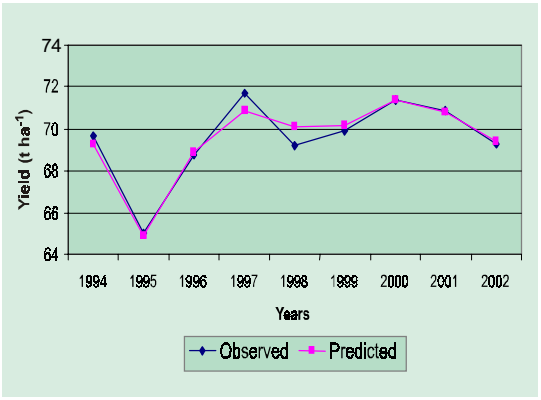


Fig.10.3. Observed and predicted yield of sugarcane in Gujarat

Where Y is the cane productivity (t ha^{-1}), Tmax (22) is the maximum temperature in 22nd met week, RH14(27) is the afternoon relative humidity in 27th met week, and Rain(29) is the rainfall received during 29th met week.

Development of Atlas for sugarcane cultivation in India (AM 4)

The project commenced in August, 2006 with major objectives : i) to collect, compile, collate and document district wise database on sugarcane and sugar production indices and socioeconomic parameters, ii) to develop crop database on agroclimatic zone basis and iii) to develop agroclimatic zone level GIS maps for sugarcane cultivation indices. The district wise data on sugarcane acreage, production, productivity, number of sugar mills, irrigation scenario, land use pattern etc. were collected from published literature. The data were compiled on agroclimatic zone (as per Planning Commission classification) basis. The GIS maps were generated for cane area production, and productivity of sugarcane, distribution of sugar mills in various zones and the average catchment area of each factory in various zones. The GIS maps were also generated for area, production, productivity, number of sugar mills and the average sugar recovery on state level.

SAC-IISR Programme : Energy and water balance and crop growth monitoring using satellite data (1/05)

Sugarcane cv. CoSe 92423 was planted on February 25, 2006 with recommended package and practices at research farm of the institute (Lat. 26° 48', Long. 80° 50' and 111m above mean sea level). Observations such as shoot population, average plant height, leaf area index, and total biomass were recorded for as well as temperature, relative humidity and wind profile within the microclimate after the establishment of the crop (by multi-level automatic weather station). The NDVI data during crop cycle and the crop parameters at harvest (January 12, 2007) were recorded (Table 10.2).

The NDVI-LAI relationship was developed from the data collected during the crop cycle.

Table 10.2: Crop parameters at harvest

Parameters	Mean Value
NMC	136000±3780
Av. cane height (m)	2.23 ± 0.25
Av. cane girth (cm)	2.45 ± 0.33
Internodes per stalk* (Av. No.)	25.8 ± 0.3.3
Green leaf weight* (t ha^{-1})	11.13 ± 1.27
Dry leaf weight* (t ha^{-1})	10.12 ± 0.97
Cane stalk weight (t ha^{-1})	83.23± 3.79

Note : Av. - Average, NMC - Number of millable canes ha^{-1}, * represents weight at harvest

An exponential relationship as given below was observed between NDVI and LAI of sugarcane.

$Y = 0.0813*e^{5.3244X}$ (R^2=0.9014), where Y is LAI and X is NDVI

The observed values of LAI along with model estimates are shown in Fig.10.4.

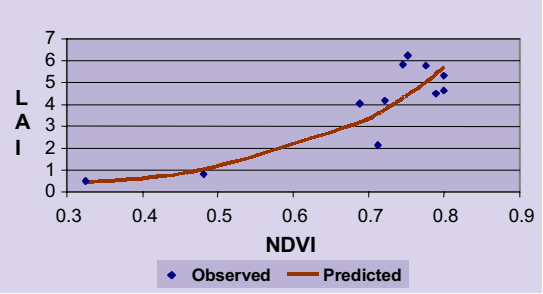


Fig. 10.4. NDVI-LAI relationship in sugarcane

Development of a precision N application technology based on NDVI index using Green Seeker Sensors for intercropping of sugarcane and wheat (CIMMYT/RWC-USAID, 1/05)

In the second cycle of the experimental trial, RWC, the raised bed planter was used. Nitrogen doses were 0, 30,60,90,120,150,180 and 210 kg ha^{-1}(as basal) before sowing of wheat and sugarcane (CoSe 92423) planted in furrows at 1.34 m inter row distance on 7th November, 06. Wheat, sugarcane +wheat and sugarcane alone were also raised with recommended package and practices for comparison purpose the observations of GS NDVI were recorded at satellite pass dates provided by RWC. The SPAD-LCC observations were also recorded for wheat crop (PBW 343) sown on raised beds at different nitrogen doses. The observations on the GS NDVI during wheat crop cycle (Table 10.3) show that the highest NDVI was observed at 88 DAS.

The SPAD- LCC (leaf colour chart) relationship in wheat crop raised on beds at different nitrogen levels was studied. The SPAD reading and LCC was significantly and positively correlated (r= 0.8836). The exponential relationship between SPAD reading and LCC developed for wheat crop is $Y= 0.7871\ e^{0.0032X}$ (R^2=0.8536), where, Y is LCC score, and X is SPAD reading. The relationship is shown in Fig. 10.5.

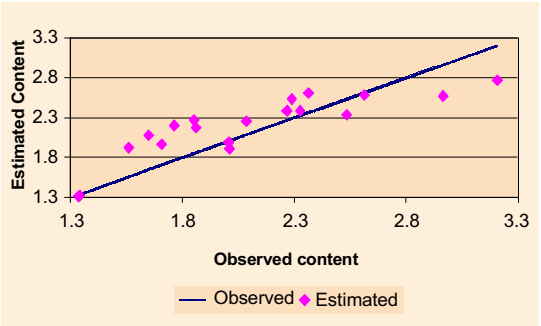


Fig. 10.5. SPAD-LCC relationship in wheat

The SPAD-Chlorophyll relationship was studied at various crop stages in plant crop of sugarcane (CoSe 92423) during 2006. A highly

Table 10.3: Profile of GS NDVI in wheat crop on specified satellite pass dates

N levels (kg ha^{-1})	Dates of observation						
	23.11.06	17.12.06	04.01.07	18.01.07	02.02.07	27.02.06	15.03.07
0	0.106	0.613	0.638	0.776	**0.831**	0.806	0.520
30	0.104	0.645	0.776	0.795	**0.887**	0.845	0.608
60	0.105	0.649	0.784	0.841	**0.876**	0.836	0.610
90	0.108	0.657	0.844	0.868	**0.905**	0.847	0.648
120	0.100	0.601	0.788	0.910	**0.912**	0.857	0.701
150	0.105	0.579	0.820	0.910	**0.915**	0.869	0.819
180	0.134	0.649	0.810	0.896	**0.922**	0.865	0.769
210	0.238	0.576	0.799	0.897	**0.920**	0.862	0.729

significant and positive correlation (r= 0.9673) was observed in SPAD reading and chlorophyll content in sugarcane leaves. A linear regression was developed for estimating chlorophyll content in sugarcane leaves (Fig. 10.6) and the relationship was validated successfully (Fig. 10.7).

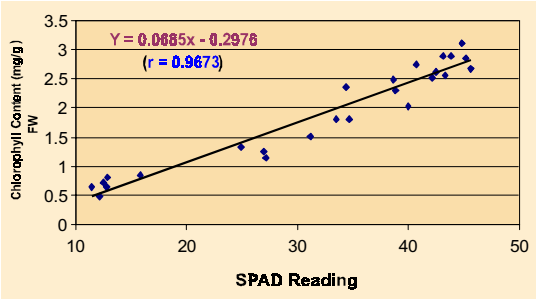
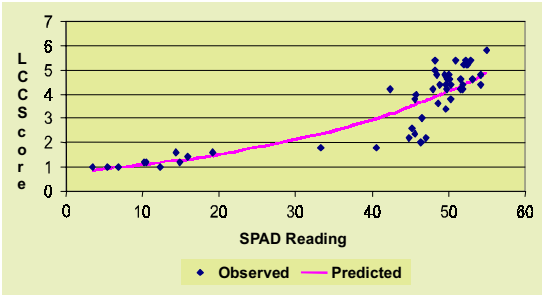


Fig. 10.6. SPAD reading and chlorophyll content in sugarcane



10.7. SPAD validation of chlorophyll content in sugarcane

Development of statistical procedures for analysis of count data in sugarcane protection trials (AES 4.4)

Analysis of spatial pattern of infestation in sugarcane early shoot borer, *Chilo infuscatellus* Snell.

Survey was conducted by IISR Bio Control Center -Nellore, AP in sugarcane command area of KCSF Ltd, Nellore during 2000-2001 to determine the spatial distribution pattern of infestation of sugarcane Early Shoot Borer, ***Chilo infuscatellus*** Snellen**.** Data were used to study the aggregated pattern of infestation of sugarcane early shoot borer and also sequential count plans for infestation of sugarcane early shoot borer, *Chilo infuscatellus* Snell. Unprotected commercial variety '87 A 298' was surveyed and twenty samples of 100 cane each were selected from May to October, 2000. In each month, number of infested canes were counted and arranged in frequency distribution. Mean (x) and variance (S^2) were calculated. Spatial distribution of infestation of early shoot borer, *Chilo Infuscatellus* Snell on sugarcane was studied using different statistical techniques to compute various indices (Table 10.4)

The variance values were more than mean number of infested cane of early shoot borer during all the months of observations indicating contagious manner of infestation of early shoot borer. The distribution parameter (K) values were > 1 in all the months (except May and October) indicating that the early shoot borer distribution was aggregated in nature. The patchiness index values varied from 1.06 to 2.5 (>1) which suggest aggregated nature of the distribution. In most of the months, the value of normal variable (d) is greater than 1.96 and positive, which showed the possibility of contagious nature of distribution. David and Moore's index values being >0 and positive in all the months indicated that the distribution was neither random nor regular. Similarly, Lexi's index and Lloyd's index of mean were indicative of aggregation of early shoot borer. It was observed that infestation of sugarcane early

Table 10.4: Parameters for aggregation index

Months	$\bar{x}$	S^2	K	$x^*/\bar{x}$	David and Moor Index	Standard normal variate(d)	Lexi's index	Lloyd's index of mean(X*)
May	1.35	3.83	0.73	2.36	1.84	4.30	1.68	3.19
June	11.75	20.19	16.36	1.06	0.72	2.00	1.31	12.47
July	11.05	19.15	15.08	1.07	0.73	2.03	1.32	11.78
August	1.00	2.00	1.00	2.00	1.00	2.64	1.41	2.00
September	0.70	1.11	1.20	1.84	0.59	1.68	1.26	1.29
October	0.20	0.26	0.67	2.50	0.30	0.95	1.14	0.50

Note : Standard normal variate $d = \sqrt{2\chi^2} - \sqrt{2v-1}$, Where $\chi^2 = \frac{S^2(n-1)}{\bar{x}}$ and v = n-1, David and Moor Index = $\frac{S^2}{\bar{x}} - 1$, Lexi's indes = $\sqrt{\frac{S^2}{\bar{x}}}$, Lloyd's index of mean,Where $K = \frac{\bar{x}^2}{S^2 - \bar{x}}$

shoot borer, *Chilo infuscatellus* Snell, exhibited aggregated or contagious or clumped nature of distribution in the field. The aggregated pattern of infestation of sugarcane early shoot borer was further confirmed by Taylor's power law and lwao's regression equation. The results indicated that the infestation of sugarcane early shoot borer, *Chilo Infuscatellus* Snell was over dispersed or clumped or aggregated in nature of distribution.

Sequential count plans for total number of sugarcane early shoot borer infested cane (in a sample of 100 canes) were developed. Fewer samples were required with Taylor's power law to achieve the same level of precision and therefore, this method is probably more useful for sequential sampling. The results from this study provide a reliable and efficient sequential sampling plan suitable for use in an integrated pest management.

10.4 Development of database and information systems

Identification, prioritization and implementation of computer applications at IISR(AES 4.5)

Information KIOSK

Information KIOSK software with the information categories such as 'About IISR' and its constituents, technologies of the Institute, research projects, publications of the Institute, video / photo library, news / messages, links / contact was developed. The software is having three layer architecture namely, Client Side Interface Layer, Server Side Application Layer and Database Layer. It will enable the visitors of the institute to have information about the Institute at the touch of the screen elements. Thumb size buttons have been used for information access and control, to provide friendly interface to the user, and other control elements have been avoided keeping in view required features of Information KIOSK terminal.

IISR Information Services

IISR Information Services is a three layer architecture. Server Side Application Layer uses Active Server Pages (ASP) codes to define software logic and interface to database. Client Side Interface Layer uses HTML, Visual Basic Script and Java Script to provide web interface to user. Third layer is Database Layer to provide database connectivity to user. New web pages on "IISR Information Services" such Composition of various committees RAC, QRT, IMC and their proceedings, Resource Generation and Seed Production at the Institute, Web pages and formats for Institute Profile and Crop Profile were also developed.

Intelligent Reporting System

Intelligent Reporting System has been installed and configured successfully at the Institute Server and tested for data loading, security and transfer from Local Area Network. Software will be accessible to users using URL arist1/icarclient/pages/default.aspx from any Web Browser and by entering valid User-ID and password. It is an integrated web-enabled solution aimed to consolidate the regular activities in the originating centers across the country to the ICAR Head Quarters at New Delhi. Intelligent Reporting System (IRS) efforts within an ICAR centers in India will give upto date information with day-to-day activities to the higher level management in ICAR, New Delhi.

IISR Website

Developed and configured Virtual Private Network (VPN) facility for web site updation. New domain iisr.res.in has been registered to access institute website with new address. By using new features IISR Website has been updated regularly. for IISR research projects, technologies, achievements, tender notifications, seminar/ symposia, staff list and cadre strength, RTI reports, crop management, sugarcane / sugar statistics, etc. Moreover, the updation of employee's bio-data and cadre strength is being carried out periodically after a period of one month.

Data warehouse on sugarcane production system (AES 4.8)

Data warehouse

Entity-Relationship model of the database containing five entities viz. sugarcane growing places, sugarcane production statistics, weather data, sugar mills and Agro-Ecological Regions have been developed. Data warehouse architecture consists of four parts namely Data Source, Staging Area, Warehouse and Users. Data sources for the warehouse could be Operational System, Flat Files, etc. There will be three types of data available in the data warehouse viz. raw data, summary data and

meta data. Staging Area simplifies generating summaries and the general warehouse management. On user end, it can be used for Data Analysis, Reporting and Data Mining using some user interface agent to data warehouse. All the places have been codified using state and district code combination. The code consists of two parts, first is two digit state code and second is two digit district code separated by an underscore. Further, sugarcane statistics table has been updated with the area, production, yield data of various sugarcane growing states since 1950 to 2004. Agro-ecological region has been recorded in the database and related to sugarcane growing places for identifying data based an agro-ecological regions.

Information bank

Institute Information Bank has been developed as per the guidelines of the ICAR, consisting of two categories of information viz. Institute Profile and Crop Profile. Institute Profile contains all administrative and research information of the Institute. A few formats for information collection from different functional units of the Institute have been developed. An E-Book system of Information compilation and access has also been devised. This is a Client/Server system in which all the information is stored on Web Server in the form of web pages. A Home/Index page has been designed to provide link for various categories of information. The Information is accessible to user via their Web Browser using URL iisr.ernet.local.

Other facilities

- A new domain address iisr.res.in has been registered with ERNET India to have another address to access institute web site.
- Virtual Private Network (VPN) facility has been developed and configured at the Institute to facilitate updation of institute website.

11

Transfer of technology

Technologies developed

1. Plant population management for enhancing ratoon productivity

The gaps carried forward from plant crop itself are the major cause of decreased cane yield of ratoon under subtropical environment. To overcome this, sugarcane planted under paired row system (30:120 cm) using 20% higher seed rate or normal seed rate with gap filling at 1st irrigation proved to be the best practice in increasing ratoon yield as this curtailed the gap filling operation in ratoon crop.

2. Microbes mediated organic nutrition modules for sustainable sugarcane productivity and soil quality

10 t ha^{-1} SPMC + *Acetobactor* meets the nutritional requirement of crop and also maintains rhizospheric soil quality parameters viz., physico-chemical characteristics and microbial activities under multi-ratooning of sugarcane and resulted in cane field of 70 t ha^{-1} in 3rd ratoon.

3. Identification of efficient nitrogen use sugarcane genotypes

Sugarcane genotypes, CoLk 94184 among early group and CoH 110 among midlate group were identified as nitrogen use efficient ones. The nitrogen use efficiency could further be enhanced by application of 10 t ha^{-1} FYM over 150 kg ha^{-1} fertilizer N.

4. Agro-techniques for drought management in sugarcane

Application of additional 60 kg ha^{-1} K_2O at 170 DAP over and above soaking setts in saturated lime water + foliar spray of urea and KCl @ 2.5 % at 90, 105 and 120 DAP + trash mulch after 60 DAP + FYM @ 10 t ha^{-1} in the furrows before planting produced significantly the highest cane (85.3 t ha^{-1}) as well as sugar (9.58 t ha^{-1}) yield. Additional 60 kg ha^{-1} K_2O also improved the juice quality significantly.

Also the ring-pit planting of sugarcane and sett treatment followed by adequate K nutrition imparted endurance characteristics to sugarcane plants to tolerate intermittent drought spells during grand growth period of the crop.

Transfer of Technology

The Institute technologies were transferred through the training programmes conducted by the Institute, interface between IISR and sugar factories, manufacturers of agricultural implements, frontline demonstrations (FLDs) etc. The following sugarcane production technologies were transferred through FLDs :

Technology	Number of demonstrations
Sugarcane + Wheat	4
Ring-pit method of sugarcane planting	2
FIRB method of sugarcane planting	2
Sugarcane + *Moong*	2
Sugarcane + *Urd*	4
Integrated pest management in sugarcane	2
Sugarcane + Mustard	2

A few new technologies as under are under process of transfer.

- Relay cropping autumn sugarcane in skipped rice rows with potato
- Application of potassium for improving stubble sprouting in sugarcane ratoon
- Bio-intensive organic nutrition module for sugarcane plant ratoon system
- Ratoon management device
- Tractor operated multipurpose equipment

A total of 12,000 cocoons and 25,000 larvae of pyralid predator *Dipha aphidivora* were released in farmer's fields against sugarcane woolly aphid around Pravaranagar (Maharashtra) area for its colonization. The *Trichogramma chilonis* @ 50,000 adults ha^{-1} was released in 446 ha sugarcane area of 326 farmers

against shoot borer from April, 2006 to March, 2007.

Scientists-Farmers Meetings

Problems in sugarcane cultivation and marketing were highlighted in Scientists-Farmers Meetings organised by BCM, Rauzagaon (Barabanki) on Febraury 26, 2007 at Vaishpurwa village of Dariyabad sugarcane cooperative society which was attended by extension educationists of the Institute.

Technical Guidance to visiting farmers

Technical guidance to 500 farmers/ extension workers/students/development personnel was provided during their visits to the experimental farm of the institute. Letters received from the farmers and extension workers of various states were replied giving them details of sugarcane production technologies.

Trainings at KVK, Lucknow

Both on-campus and off-campus trainings to 444 farmers & 84 farm women were organized at KVK, Lucknow. In addition training to 20 extension functionaries was also imparted.

Front Line Demonstrations (FLDs)

FLDs on oilseed crops like sesamum, groundnut, and mustard were carried out in 5 ha area of 20-25 farmers for each oilseed crop. The FLDs on field pea (5 ha of 8 farmers), rice (5 ha area of 20 farmers), Jowar (2ha area of 20 farmers) and wheat (5 ha area of 21 farmers) were also carried out. In addition, demonstrations on animal treatments (Infertility, Mastitis and deworming) were also carried out in the Lucknow district.

Kisan Gosthies

Institute scientists (Extension Education) participated in *kisan gosthies* organised by BCM, Rauzagaon (Barabanki) on February 5, 2007 at Bahlolpur village located in command area of sugar mill under Burhwal sugarcane cooperative society. About 200 sugarcane farmers and cane development officers attended this *gosthi*.

Scientists also participated in '*kisan gosthi*' at Indian Institute of Vegetable Research, Varanasi (UP) on January 27-28, 2007 and a lecture on improved sugarcane cultivation practices was delivered to about 2000 participating farmers.

Documentary Films

Scripts for three Documentary Films on ***Bharatiya Ganna Anusandhan Sansthan : Ek Nazar Mein, Ganna Buwai ki Unnat Vidhiyan*** and ***Pedi Prabandhan*** were prepared, edited and finalized. The shooting for the documentary film was carried out at the Institute, sugar mills and at farmers' fields.

Exhibitions

An exhibition of sugarcane production technology was organised at Sabji Kisan Mela at Sargatia, Kushinagar and was visited by 500 farmers, researchers and extension personnes.

Seed production and supply

About 4100 quintals of seed cane of improved varieties was supplied from Institute main farm in U.P. The varietywise seedcane distributed was CoS 94257 (1630.74 q), CoS 96268 (1315.15 q), CoSe 92423 (660.69 q), CoS 8436 (190.85 q), CoS 99259 (165.52 q), CoS 97264 (119.39 q) and others (24.73 q). Variety Co 89029 (Gandak) was planted as seed crop in area of 2.0 ha at IISR, Regional Station, Motipur, Bihar. Approximately 584 quintals of seedcane were distributed to sugar factories among the farmers of Bihar.

Technology dissemintation through Mass Media

Press release (Hindi)

1 मिठास की खातिर स्टीवीया, ईधन के लिए गन्ना। दैनिक जागरण, लखनऊ, 29 मार्च, 2007 ।

2 चीनी से ढाई सौ गुनी मीठी है स्टीवीया की पत्ती । आज, लखनऊ, 29 मार्च, 2007 ।

3 अब मिठास के लिए स्टीवीया तथा ऊर्जा के लिए गन्ना उगाया जायेगा। स्वतंत्र भारत, लखनऊ, 29 मार्च, 2007।

4 फसल विविधिकरण का अधिक उत्पादन एवं मृदा उर्वरा शक्ति बनाये रखने में योगदान। आज, लखनऊ व कानपुर, 21 फरवरी, 2007।

5 गड्ढा विधि से गन्ने की बुआई : अधिक उपज एवं लाभ। आज, लखनऊ व कानपुर, 14 फरवरी, 2007।

6 गन्ना सब्सिडी प्रक्रिया सरल बनायें। दैनिक जागरण, लखनऊ, 13 फरवरी, 2007।

7 भारतीय गन्ना अनुसंधान केन्द्र में गोष्ठी। राष्ट्रीय सहारा, लखनऊ, 13 फरवरी, 2007।

8 कृषि यंत्रों पर सब्सिडी का सरलीकरण किया जायेगा । हिन्दुस्तान, लखनऊ, 13 फरवरी, 2007।

9 सही तकनीक से बढ़ेगी गन्ने की पैदावार। दैनिक जागरण, लखनऊ, 25 जनवरी, 2007।

10 गन्ने का उत्पादन एवं चीनी परता बढ़ाने पर जोर। हिन्दुस्तान, लखनऊ, 25 जनवरी, 2007।

11 गलत पद्धतियों के इस्तेमाल से बचें गन्ना किसान। दैनिक जागरण, लखनऊ, 24 जनवरी, 2007।

12 गड्ढा विधि गन्ना उत्पादन बढ़ाने में लाभकारी। हिन्दुस्तान, लखनऊ, 24 जनवरी, 2007।

13 देश भर के गन्ना विशेषज्ञ अधिक उपज के लिए करेंगे विचार विमर्श। स्वतंत्र भारत, लखनऊ, 23 जनवरी, 2007।

14 वैज्ञानिक ढंग से गन्ना लगाने की सलाह। दैनिक जागरण, मुजफ्फरपुर/पटना, 5 सितम्बर, 2006 ।

15 सुखाड़ -जलजमाव को लेकर गन्ना के नये प्रभेद की उठी मांग। हिन्दुस्तान, मुजफ्फरपुर/पटना, 5 सितम्बर, 2006।

16 गन्ने में रोग से लड़ने वाले जीव की पहचान। हिन्दुस्तान, लखनऊ, 13 जुलाई, 2006।

17 गन्ने में लाल रोग से पीड़ित हैं कई राज्य। युनाइटेड भारत, इलाहाबाद, 13 जुलाई, 2006।

18 डीएनए कीट से दूर होंगे गन्ने के रोग। हिन्दुस्तान, लखनऊ, 25 मई, 2006।

19 धर्मवीर यादव, 2006. ट्राइकोडर्मा मिटाएगा गन्ने की 'रेड राट' बीमारी । हिन्दुस्तान, लखनऊ, दिनॉक 07 दिसम्बर (गुरूवार), 2006

20 धर्मवीर यादव, 2006. अब मशीन काटेगी गन्ना! हिन्दुस्तान, लखनऊ, दिनॉक 12 दिसम्बर, 2006

Press release (English)

1. Workshop on Agricultural Products. The Hindustan Times, Lucknow, February 13, 2007.
2. Combined efforts needed to improve sugarcane productivity. The Times of India. Lucknow, 25 January, 2007.
3. National Seminar on Sugarcane. The Indian Express, Lucknow, January 23, 2007.
4. Local Beat: Seminar on Sugarcane. The Times of India. Lucknow, January 23, 2007.
5. IISR Developing Red Rot Resistant Variety of Sugarcane. The Times of India, Lucknow, July 13, 2006.

TV Interview/Talk

Name of scientist	Topic	Channel/Programme	Date and time of broadcast
Dr. R. L. Yadav Director	गड्ढा विधि से बुआई कर अधिक उपज एवम् लाभ ।	Anndaata in **e-tv** *	6.30 a.m. on February 15, 2007
Dr. Menhi Lal Head, Crop Production Division	गन्ना में सहफसली खेती।	Anndaata in **e-tv** *	6.30 a.m. on February 22, 2007
Dr. D.V. Yadav Incharge RCM	गन्ना किसानों के लिए संस्थान का योगदान	Krishi Darshan, National Network of Doordarshan DD-1	6.30 a.m. on August 2006

*(UP/Uttaranchal)

12

Education and training

International Training Programmes

The institute developed following 3 International Training Programmes on Sugarcane related aspects which also appeared in "ICAR International Training Programmes-2006" manual.

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

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

One month Training Programme on Sugarcane Production Technology

One month Training Programme was organized from July 1 to 31, 2006 for sugarcane development personnel of sugar mills. A total of 20 trainees from Uttar Pradesh and Bihar participated and got acquainted with the latest technical know-how on sugarcane cultivation. Under this training programme, 78 lectures, both theory and practical, were designed to incorporate requisite technical knowhow on sugarcane cultivation. Specifically, the aspects covered were : healthy seed production, varietal management, tissue culture, INM, integrated pest management, intercropping, ratoon management, mechanization and post-harvest technology. The institute also obtained the feed back from the trainees to gradually improve the contents of its future training programmes.

Short trainings

Eight national level trainings each of three days duration sponsored by the Directorate of Sugarcane Development, Govt. of India were organized. The details of the trainings are as under:

S. No.	Topic	Date	No. of participants
1.	Use of appropriate varieties for increasing sugar recovery	Nov. 6-8, 2006	8
2.	Planting techniques for increasing plant population density in sugarcane	Nov. 13-15, 2006	7
3.	Integrated nutrient management in sugarcane	Nov. 16-18, 2006	8
4.	Integrated weed management in sugarcane	Nov. 20-22, 2006	7
5.	Intercropping in sugarcane	Nov. 23-25, 2006	8
6.	Low cost production technologies in sustaining productivity	Nov. 27-29, 2006	9
7.	Sugarcane cultivation in biotic and abiotic conditions	Dec. 5-7, 2006	16
8.	Post-harvest management in sugarcane	Dec. 11-13, 2006	16

Training to Agriculture Research Service (ARS) Probationers

Field Experience Training to 5 scientists (ARS Probationers) from NAARM, Hyderabad was carried out at the Institute KVK, Lucknow from March 22 to April 11, 2007.

Training to farmers

A Farmers' training sponsored by Department of Sugarcane, Government of Bihar was organized for 33 farmers from Bihar for 6 days from Dec. 11-16, 2006 to acquaint them with the latest sugarcane production technology.

Eighty farmers sponsored by ATMA, Lucknow were trained at KVK, IISR, Lucknow as per details as follows :

Title of training	Period	Partici-pant farmers
Seed production technique of major vegetable and cereal crops	Dec.14-16,2006	30
Management and production technique of *Zaid* grown major crops	Mar.19-21,2007	25
Management and production technique of late planted cane and ratoon crop and green fodder crop	Mar.22-24,2007	25

Training to students

Training as a part of the academic requirement of various undergraduate and post-graduate degree programes was provided to B.Sc, M.Sc, B.Tech and M.Tech students for duration varying from one month to 6 months. Seventy two students from public as well as private Institutions were provided training on biotechnology, tissue culture, microbiology, Biochemistry, and related aspects. In addition the training was also imparted to 3 faculty members from SVBPUA&T, Meerut (U.P.) .

Trainings and resource generation

A total of Rs. 2.8975 lacs was realized from training participants as per details given below:-

i)	One-month training for sugarcane development personnel	1.00 lac
ii)	Eight Nos. of National Level Trainings sponsored by Directorate of Sugarcane Development, GOI, New Delhi	1.20 lac
iii)	Six days training for farmers from Bihar	0.6975 lac
	Total	**2.8975 lac**

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Awards and recognitions

Awards

Dr. S. Solomon, Principal Scientist (Biochemistry): Award of Excellence-2006, IAPSIT during International Symposium, Guilin, P.R. China, Dec. 5-8., 2006.

Recognitions

Dr. R.L. Yadav, Director, IISR, Lucknow was selected as member of 11th five year plan working group on agricultural research and education of the Planning Commission, Govt. of India; as Member of state level coordination committee on research and development of sugarcane, Govt. of Haryana; as Member, Advisory Board, National Sugar Institute, Kalyanpur, Kanpur; as Member Standing Research Advisory Committee, Directorate of Sugar, Govt. of India, New Delhi; as Member, Governing Body, U.P.C.S.R., Shahjahanpur; as Member, Governing Body, *Ganna Kisan Sansthan*, Lucknow, U.P., as Member, Research Advisory Council, UPCAR, Lucknow, and as Agricultural expert, UPSC, New Delhi.

Dr. S. Solomon, Principal Scientist (Biochemistry was appointed as Secretary of the International Symposium on *Technologies to Improve Sugar Productivity in Developing Countries,* Guilin, P.R. China, Dec. 5-8, 2006.

Prizes

Dr Jaswant Singh, Principal Scientist and Head, Agricultural Engineering Division: "Hari Mohan Memorial Prize" for presentation of an article entitled "Entrepreneurship development for rehabilitation of Tsunami affected areas" by Institution of Engineers (India), U.P. State Centre Lucknow, February 11, 2007.

Membership in Professional Bodies

Dr. R.L. Yadav, Director, IISR, Lucknow awarded Individual Membership of Integrated Association of Professional in Sugar and Integrated Technology (IAPSIT), Nanning, P.R. China.

Dr. Menhi Lal, Principal Scientist and HOD (Crop Production). Member in Editorial Board of Indian Society of Agronomy, New Delhi.

Dr A. K. Shrivastava, HOD (Plant Physiology & Bio-Chemistry): Consulting Editor for the Indian Journal of Plant Physiology, New Delhi.

Dr. Sangeeta Srivastava, Senior Scientist: Editorial Board member of the journal "Plant Cell Biotechnology and Molecular Biology".

Dr. Ishwar Singh, Senior Scientist (Plant Physiology): Joint Secretary of the Indian Society for Plant Physiology, New Delhi for three years (2007-2009); Member, Editorial Advisory Board of journal , Physiology & Molecular Biology of Plants.

Dr. R.K. Singh, Senior Scientist : Member of International Board of Consulting Editors of Sugar Tech Journal for the year 2007.

Dr. Rajesh Kumar, Senior Scientist: Member of Executive Council of Indian Society of Agricultural Statistics, New Delhi. Member, International Board of consulting Editors (2007 and 2008) of Sugar Tech.

Dr. S.I. Anwar, Senior Scientist, Reviewer for "Solar Energy", the Journal of International Solar Energy Society" by Elsevier Editorial System.

Kamta Prasad, Scientist (S. S.), Agricultural Extension: Councillor, the Indian Journal of Extension Science and Indian Society of Extension Professionals (ISEP), NDRI, Karnal (Haryana), India.

Chairmen/Co-Chairmen

Dr. Menhi Lal: of seminars/workshops Chairman in the Technical Session on Crop Production in 26th Biennial Workshop of All India Coordinated Research Project on Sugarcane at G.B. Pant University of Agriculture and Technology, Pantnagar October 16-18, 2006. Discussions in Brainstorming Session on Identification of future thrust areas for research and development in sugarcane at GBPUA&T, Pantnagar on October 18, 2006. Co-Chairman in Technical Session-I in the National Seminar on 'Comparative advantages to different methods of sugarcane planting' at IISR, Lucknow on January 23-24, 2007.

Dr. D.V. Yadav: Co-Chairperson during Technical Session II of National seminar on comparative advantages to different methods of sugarcane planting organized at IISR, Lucknow on January 23-24, 2007.

Dr. D.V. Yadav: Organizing Secretary for National Seminar on Comparative advantages to different methods of sugarcane planting organized on January 23-24, 2007 at Lucknow.

Dr Jaswant Singh: Co-Chairman on Technical Session V on "Commercialization of technologies and success stories", and 'Business Session': 26th Annual Workshop of AICRP on PHT OUA&T, Bhubaneshwar Dec. 6-9, 2006.

Dr. S. Solomon, Principal Scientist (Biochemistry): Chairman of Session on "Sugar Recovery and Post-harvest Technologies". International Symposium on *Technologies to Improve Sugar Productivity in Developing Countries* Guilin, P.R. China, Dec. 5-8, 2006.

Dr. Arun Kr. Srivastava: Co-Chairman of Plenary Session of the National Seminar on *Agrometeorological Services for Crop and Location Specific Advisories,* IMD Pune, June 21-22, 2006.

Dr. R.K. Singh: Co-Chairman of the Session in the National seminar on Sugarcane Seed Production and Certification, VSI, Pune, February 22-23, 2007.

Nominations

ICAR Level Nominations

Dr. Raman Kapur was nominated by ICAR, DARE, Ministry of Agriculture, Government of India as delegation member to Morocco and Egypt to study sugarbeet cultivation and processing from June 2-11, 2006.

Institute Level Meetings/Events

Dr. D.V. Yadav, member of Nodal Organizing Committee for National Seminar on Comparative Advantages to different Methods of Sugarcane Planting organized at IISR, Lucknow on January 23-24, 2007.

Dr. D.V. Yadav, Member-Secretary of the Staff Research Council and the Research Advisory Committee to IISR, Lucknow.

Dr. Archna Suman, Senior Scientist, Organizing Secretary of Awareness Building Workshop organized by National Agricultural Innovation Project (ICAR) at IISR, Lucknow on September 11, 2006.

Dr. Menhi Lal, Principal Scientist and Head, Division of Crop Production as Liaison Scientist to liaise for Evaluating the Xth Five Year Plan Achievements of IISR, Lucknow as a part of 'Evaluation of Plan Scheme/Programmes of DARE/ICAR' by the Giri Institute of Development Studies, Lucknow.

Nominations for Departmental Promotion Committees

Dr. D.V. Yadav; ICAR nominee for Departmental Promotion Committee for ARS Scientists (Agri. Chem) of CISH, Lucknow

Dr. D.V. Yadav: Technical Member of Sectional Committee of Food & Agril. Division Council, BIS, Manak Bhawan, New Delhi.

Sh. Arun Kr. Srivastava: ICAR nominee as Expert member in Departmental Promotion Committee for career advancement of scientists at PDCSR, Modipuram on July 27, 2006.

Invited Lectures

Dr. R.L.Yadav: Delivered First G. Narasimha Rao Memorial Lecture, ANGRAU(Hyderabad), Tirupati, July 1, 2006.

Dr. D.V. Yadav: presented an invited lead paper entitled Potassium Nutrition of Sugarcane during International Symposium on Balanced Fertilization for Sustaining Crop Productivity organized by PAU, Ludhiana, PRII , Gurgaon and IPR, Switzerland at Ludhiana on November 22-25, 2006.

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Linkages and collaborations

The Institute has developed a 6-pronged strategy to strengthen its liaison and collaboration activities. As a part of this strategy, collaborations 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 farmers, (vi) Collaborations with local institutes/organizations at Lucknow have been strengthened.

(i) Collaboration with International Research Institutions

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

The Institute is also exploring areas of common interest in sugarcane research with Japan and Australia. A two-member Japanese team from Agriculture & Animal Husbandry Corporation, Japan (ALIC) visited IISR Lucknow and another visit of experts from Australia is on the cards.

(ii) Collaboration with National Research Institutions

Collaboration with ICAR Institutes, specially SBI, Coimbatore is existing on crossing, and germplasm and fluff exchange programme. For the development of improved parental clones for subtropical agro-climate with high sugar accumulation potential, 42 high sugar LG selections so far have been sent to the Sugarcane Breeding Institute for enriching the breeding population in the National Hybridization Garden (NHG), SBI, Coimbatore as part of institute research projects. Ten selections added during the year are as follows:

S. No.	LG Name	Selection No.	Parentage
1	LG 99190	II-53-39	CoS 8436 Self
2	LG 99118	II-17-14	CoLk 8901 x 81 V 48
3	LG 01002	I-06-09	81V48 x LG 94184
4	LG 01009	I-13-09	LG 95053 x LG 94184
5	LG 01014	I-18-05	LG 95053 x LG 94184
6	LG 01030	I-45-01	CoH 106 x CoS 92263
7	LG 01116	II-54-10	CoH 106 x Co 8347
8	LG 01170	IV-32-04	CoPant 88220 Self
9	LG 02005	I-19-01	LG 94184 Self
10	LG 02100	II-22-10	LG 95053 x HR 83-65

Under another research project, a total of 21 bi-parental crosses were attempted at National Hybridization Garden, SBI, Coimbatore. In addition, two self's and fifteen general crosses were also attempted at National Hybridisation Garden. The Fluff weight of bi-parental crosses received in grams is given in brackets along with the crosses as shown in the box below:

Quantity (g) of fluff for the bi-parental crosses received from SBI, Coimbatore

CoLk 8102 x ISH 176 (32.2), Co 1158 x CoLk 8102 (20.2), Q 65 x CoH 15 (5.7), CoS 96268 x CoS 8119 (20.2), CoPt 99213 x CoC 775 (23.4), CoPt 90223 x 69-A-5 (39.6), CP 52-1 x BO 91 (32.2), Co 1148 x CoC 8001 (7.8), Co 89003 x CoSe 92423 (11.4), Co 89003 x MS 68/47 (13.5), Co 86249 x Co 775 (16.2), CoH 110 x CoPt 97222 (23.8), CoPt 84212 x Co 94008 (15.6), CoPt 88220 x Co 775 (11.8), Co 87023 x Co 86249 (13.8), Co 92002 x CoH 104 (18.0), CoC 671 x ISH 147 (25.0), Co 88025 x ISH 229 (24.8), CoJ 80 x CoPt 01215 (20.0), CoS 95255 x BO 99 (11.5), CoLk 97169 x CoS 8436 (35.0).

Two early maturing clones, LG 9902 and LG 9917, under evaluation in the multi-location trials for the North West zone under AICRP on Sugarcane, were sent to SBI, Coimbatore for use in the NHG.

LG 95053, a high sugar selection with tested progeny performance has been applied for registration with NBPGR, New Delhi as a sugarcane breeding stock.

A Material Transfer Agreement (MTA) was signed between IISR and NRC (Plant Biotecnology), IARI, New Delhi in the field of transgenic research. Under the agreement, IISR has received four Bt gene constructs (Cry 1AB, Cry 1Aa, Cry 1F and Cry 1 A5) and one reporter gene (PB 1.121) for research purpose.

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

Collaboration with national state level sugarcane research organization in the country has also been made through inviting the scientists/office bearers of these organizations for participation in the seminar/brain storming sessions organized at the institute.

Collaboration with Central Line Departments

- Directorate of Sugarcane Development: The Directorate sponsored eight short-term trainings and one national seminar 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 a programme of Space Application Centre (ISRO), Govt. of India.
- Deptt. of Biotechnology : The Deptt. of

Homology of the assembled sugarcane ESTs to stress-related genes in NCBI database

Query String	Query length	Title	Length	Stage
Contig3394	647	gii33151 122IgbIAY335486.1 I Oryza saliva (japonica cultivargroup) drought-induced protein Dli mRNA, complete cds	972	171
Contig24lO	639	gi145602862igb1AY554050.l I Oryza saliva (japonica cultivargroup) drought-induced hydrophobic protein (DRR1) mRNA, complete cds	571	261
Contig58l	853	gi168301 671IgbIDQ060243.1I Zea mays stress inducible rotein coi6.1 gene, complete cds	3418	833
Contigll64	725	gii66277463igb1D0022951 .11 Triticum aestivum stress responsive protein mRNA, complete cds	846	684
Contig232g	823	gill 5667622ldbj1AB071 694.11 Saccharum officinarum SoDip22 mRNA for drought inducible 22 kD protein, complete cds	831	235
Contig2498	607	gi149234815igb1AY496271.1i Saccharum hybrid cultivar 22 kDa drought-inducible protein mRNA, complete cds	843	1094
SURO1-150-D09-A-074	438	gil60451 52ldbj1AB0334l6.ll Fusarium oxysporum sti35 gene for stress-responsive gene product, complete cds	3321	255
SURO1-121-H09-A-076	417	gil68301 671lgbIDQ060243.1I Zea mays stress inducible rotein coi6.1 gene, complete cds	3418	385
SURO1-132-B07-A-057	409	gi149234815igb1AY496271 .11 Saccharum hybrid cultivar 22 kDa drought-inducible protein mRNA, comolete cds	843	183
SUMO1-058R-C10-A-070	470	gi157233522igb1AY587109.1I Oryza saliva (japonica cultivargroup) dehydration-stress inducible protein 1 mRNA, complete cds	1315	268
SUSO1-031-G03-A-022	425	gill2O543O6iembIAJ300l45.11HVU300145 Hordeum vulgare mRNA for for stress responsive gene protein 6(srg6 gene), cultivar Morex	1584	202
SURO1-192-B12-A-096	413	gil7O999333IrefIXM_749293.1l Aspergillus fumigatus Af293 stress response RCI peplide (Afu3g12350) mRNA, partial cds	174	121
SURO1-192-C07-A-053	412	gi137548822igb1AY137590.1 I Oryza saliva (indica cultivargroup) multiple stress-associated zinc-finger protein (OSISAP1) gene, complete cds	3139	198
SUSO1-059-C05-A-036	430	giI2l 314336IgbIAF503585.1I Oryza sativa (indica cultivargroup) early drought induced protein (R1G1A) mRNA, complete cds	2468	529
SUSO2-023-H09-A-076	396	gi1492348l51gb1AY496271 .11 Saccharum hybrid cultivar 22 kDa drought-inducible protein mRNA, complete cds	843	224

Source: DBT funded collaborative project of IISR, Lucknow and University of Delhi, South Campus, New Delhi.

Biotechnology, Govt. of India, New Delhi sponsored the following two projects:

i) Development of ESTs, gene identification and transformation in sugarcane

ii) Development of PCR-based diagnostic kits for red rot and smut diseases of sugarcane

Under a DBT funded collaborative project on functional genomics of sugarcane, an EST resource has been generated in the form of general cDNA libraries for different tissues of sugarcane variety CoS 767. A subtracted library from the stalk tissue of challenged and non-challenged Co 1148 with cf 01 isolate of red rot pathogen was prepared, and sequenced at UDSC. The sequence data from this library resulted in 1069 sequences being submitted rendering the total number of ESTs generated and submitted to the Gen Bank to 26453 under the project. In order to produce a non-redundant dataset, the entire sugarcane EST collection comprising of 2,55,716 sequences available publicly at GenBank was combined with the EST data generated under this project and clustered using the CAP3 software. This resulted in 61,966 non-redundant molecules. The entire dataset consisting of 61,966 molecules was used for the identification of simple sequence repeats (SSR) markers.

(iii) Collaboration with State Agencies/ state research organizations

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

In addition, the Institute has cooperating centres of 3 other AICRPs, viz. AICRP (FIM), AICRP (BC) and AICRP (PHT). The Institute is also coordinating a Network Project on Sugarbeet.

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

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

ii) Evaluation and standardization of organic farming technology.

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

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

(iv) Collaboration with Private Organizations

Collaboration with industries has also been made through contract research programmes. Out of eight contract research projects, five research projects have been undertaken with 3 agencies in private sector viz. M/s Pest control India Pvt. Ltd., Bangalore, M/s EI Dupont India Limited, Gurgaon and M/s FMC India Pvt. Ltd.,

AICRP (Sugarcane)	18	2	2	Anakapalle, (ANGRAU, Hyderabad); Buralikson (AAU, Jorhat); Bethuadahari (W.B.) ; Cuddalore, (TNAU, Coimbatore); Coimbatore, (SBI, Coimbatore); Faridkot, (PAU, Ludhiana); Ludhiara, (PAU, Ludhiana); Koihapur, (MPKV, Rahuri); Kota (MPUA&T, Udaipur); Mandya, (UAS, Bangalore); Nayasari, (GAU-Navasari); Nayagarh, (OUA&T, Bhubaneshwar); Padegaon, (MPKV, Rahuri); Pantnagar, (GPPUA&T, Pantnagar); Pusa , (RAU , Samastipur); Pawarkheda (JNKVV, Jabalpur); Shahjahanpur, (UPCSR, Shahjahanpur); Sankeshwar, (UAS, Dharwad); Sriganganagar, (RAU, Bikaner); Thirvella, KAU, Trichur); Uchani, (CCSHAU, Hissar); Lucknow, (IISR, Lucknow)

Bangalore on field evaluation of new insecticides against termites and shoot borer in sugarcane. Collaborations with Shriram Fertilizers & Chemicals for testing their product on sugarcane and with ITC Ltd, Guntur for testing of Wellgro manure have been made. Manufacturers of farm machinery and equipments meet was also organized and the *modus operandi* for carrying out further collaboration in this regard was finalized to commercialize the equipments/machinery developed at IISR, Lucknow.

(v) Collaboration with Sugar Mills

- In an attempt to have linkages with the sugar mills of the country, the Institute conducted a one month training programme exclusively for the cane development officers of the sugar mills. In addition, the office bearers of Indian Sugar Mill Association (ISMA) were invited in National Seminars organized by the Institute. The Institute also sends its newsletters to some sugar mills in the country. The institute also helps the sugar industry through contract research projects and consultancies.
- The extension educationists of the Institute participated in group meetings attended by the cane development staff of the sugar mills of U.P. in *Kisan Goshthies* organized by Balrampur Chini Mills, Rauzagaon (Barabanki) in its cane command area at Bahlolpur village under Burhwal cane cooperative society. The Scientists also attended the Scientists-Farmers meet organized by the sugar mill at Vaishpurma village under Dariyabad cane cooperative society.
- Reconnaissance survey was also carried out in the cane command area of Balrampur Chini Mills, Rauzagaon, Barabanki district of U.P. to gather information pertaining to the Integrated Communication Strategy for accelerating the adoption of sugarcane production technology.
- The farmers were linked through Front Line Demonstrations, on-farm trials, advisory services, *Kisan Gosthi*, Field Day, etc as a regular programme of KVK, IISR, Lucknow. Some of the experimental trials were conducted in various sugar mill cane command areas. Three well known and renowned farmers from U.P. having sound knowledge of sugarcane cultivation were selected as resource persons and invited in scientific meetings when the researchable issues in sugarcane were discussed and fine tuned.

(vi) Collaboration with local Institutions

Institute shares its resources of Guest Houses, lab facilities etc. for the use of other ICAR Institutes such as CISH, Lucknow & NBFGR & CSSRI regional centre, Lucknow. The visits of some dignitaries were jointly coordinated by the 3 ICAR institutes located in Lucknow. Directors of the other ICAR institutes are also invited to the Institute on important occasions.

15

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Crop management for high cane productivity under different environments

Sugarcane based production system

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

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

*AS 53: Studies on pre-planting conservation tillage techniques in sugarcane based cropping systems (S.R. Prasad and Rajendra Gupta)

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

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

Expl.Trial: Agronomy of new sugarcane genotypes (A.K. Singh and Menhi Lal)

Expl. Trial: Evaluation of sugarcane genotypes for high nitrogen use efficiency under ring-pit planting system (A.K. Singh, R.L. Yadav and A.D. Pathak)

Ratoon management in sugarcane

A 3.20: Optimizing plant population of ratoon crop by minimizing gaps (R.S. Chauhan and S.N. Singh)

*Expl. Trial: Improving sprouting and productivity of winter initiated ratoon through biological methods (S.K. Shukla, R.L. Yadav and Archna Suman)

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

Integrated weed management in sugarcane based cropping system

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

Field Testing: Comparative performance of sugarcane in wheat + sugarcane cropping under flat and FIRB system (Ishwar Singh and P.R. Singh)

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

CR-01/06: Effect of Wellgro organic manure with NPK on yield and quality of sugarcane (R.L. Yadav, D.V. Yadav and S.K. Shukla)

CR-02/06: Comparative performance of different grades of NPKS mixed fertilizers on yield and quality of sugarcane (D.V. Yadav and Todi Singh)

*CR-06/06: Evaluation of Velpar K_4 60 WP herbicide for control of sugarcane weeds as post emergence application (R.S. Verma and R.L. Yadav)

Resource management in sugarcane

Nutrient management in sugarcane based cropping system

A 2.31: Effect of bio-manuring on sugarcane productivity and soil properties under continuous

ratoons (K.P. Singh, P.N. Singh and Archna Suman)

A2.34: Nutrient use efficiency in different wheat (Triticum aestivum + sugarcane (*Saccharum sp.* hybrid) cropping systems under Furrow Irrigated Raised Bed System (FIRBS) (Ishwar Singh, P.N. Singh, S.K. Shukla and P.R. Singh)

A 3.21: Improving productivity and quality of ratoon cane through integration of organics, bio-agents and inorganic fertilizers with special reference to potassium nutrition (S.K. Shukla, P.N. Singh, R.L. Yadav, S.N. Singh and Archna Suman)

AS 52: Compatibility of zinc application with sources and levels of phosphorus in sugarcane (Arjun Prasad)

AS 51: Sustaining sugarcane production and soil health through integration of nutrient sources in sugarcane based cropping system (Todi Singh, P.N. Singh and Archna Suman)

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

A1.1.26: Identification of sugarcane genotypes for high nitrogen use efficiency (A.K. Singh, R.L. Yadav, Archna Suman and A.D. Pathak)

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

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

*Expl. Trial: Efficacy of "KOZGRO" biofertilizer in combination with other organic sources of nutrients in sugarcane (K.P. Singh and P.N. Singh)

Water Management

*UPCAR 1/06 (New) Enhancing field water use efficiency in sugarcane cropping system through FIRBS (Rajendra Gupta, P.R. Singh, Ishwar Singh and Archana Suman)

Heavy metal toxicity management in sugarcane based cropping system

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

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

Studies on Saccharum germplasm

B 1.7: Collection, maintenance, evaluation and documentation of sugarcane germplasm under sub-tropical conditions (P.K. Singh, J. Singh, Sanjeev Kumar in place of Rajesh Singh)

Development of sugarcane varieties and breeding stocks for sub-tropics

Evaluation of elite clones under Station Trial 2006-07 (A.N. Singh, D.K. Pandey and J. Singh)

B 2.3: Development of sugarcane breeding stocks for high sugar (Late B.L. Srivastava, Raman Kapur and S.K. Duttamajumdar)

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

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

B 2.10: Development of sugarcane

varieties for moisture deficit environment (J. Singh, P.K. Singh, D.K. Pandey new team, Sanjeev Kumar, J. Singh, P.K. Singh and Ishwar Singh)

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

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

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

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

*NEW: Zonal varietal Trials (North East Zone of AICRP) on sugarcane.

Cytogenetic and biotechnological approaches for sugarcane improvement

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

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

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

B 3.14: Molecular Diversity Analysis for biotic stresses of Saccharum germplasm (Rajesh Singh upto 29.11.2006, R. K. Singh, D. K. Pandey and M. Swapna)

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

B 3.16: Optimizing standards for sugarcane seed production through micro propagation (R.K. Singh, Vijai Singh, J. Singh, Archna Suman, A.K. Singh)

DBT 2/03: Development of ESTs, gene identification and transformation in sugarcane (Raman Kapur, Archana Suman, Sungeeta Srivastava, S.K. Dattamajumdar and J. Singh)

Epidemiology and integrated disease management

Epidemiology of diseases of sugarcane

M 6.8: Survey of plant parasitic nematodes in sugarcane intensive areas and identification of problem areas (Abdul Rashid)

PP 22: Survey of sugarcane diseases naturally occurring in the area on important Varieties. (S.N. Srivastava, Vijay Singh, Ram Ji Lal and A.P. Singh)

EM 01A Survey and surveillance of insect-pests and diseases of sugarcane in sub tropical area (Vijay Singh, S. N. Srivastava, Ram Ji Lal, Sunita Lal, A. P. Singh, S. Pandey, Abdul Rashid, S. K. Duttamajumder and S.C.Misra)

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

M 3.5: Determination of causal organism (s) of wilt disease of sugarcane (S.K. Duttamajumder and S.C. Misra)

PP 14: Identification of pathotypes in red rot pathogen. (Ram Ji Lal and Sunita Lal)

PP 14a: Maintenance of isolates of red rot pathogen. (Sunita Lal and Ram Ji Lal)

*DBT 1/03: Development of PCR based

diagnostic kits for red rot and smut diagnostic kits for red rot and smut diseases of sugarcane (O.K. Sinha, Sangeeta Srivastava, Sunita Lal and Archna Suman)

PP29 Molecular characterization of isolates/pathotypes of *Colletotrichum falcatum* (Sunita Lal, Archna Suman and Ram Ji Lal)

Integrated disease management in sugarcane

M 8.7: Management of sugarcane smut through plant products and bio-agents (Ram Ji Lal, O.K. Sinha and Sunita Lal)

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

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

PP 17: Reaction of genotypes against red rot, smut and wilt. (S.K. Gangwar, RamJi Lal, Sunita Lal, Vijai Singh and A.P. Singh)

*PP 27: Assessment cum demonstration of IDM module against major diseases of the area (S.C. Mishra and S.K. Duttamajumder)

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

*APC NW 1/04 Network project on wilt of crops with special reference to cultural, morphological, molecular characterization and pathogenic variability of isolates in India (S. K. Duttamajumder, S. C. Misra and Sangeeta Srivastava)

Bioecology and Integrated Management of Insect-pests and Rodents

Bioecology of insect-pests and rodents of sugarcane

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

*E 6.03: Succession of insect-pests in multiple ratoons of sugarcane and their management (S.K. Gangwar)

*New : Bio intensive management of top barer of sugarcane (S.K. Gangwar, D.C. Srivastava, R.K. Tewari, M.R. Singh & Arun Baitha)

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

EM 01B Survey and surveillance of insect-pests and diseases of sugarcane in sub tropical area (S. K. Gangwar, D. C. Srivastava, R. K. Tewari, G. M. Tripathi, M. R. Singh and Arun Baitha)

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

E.4.2.1 Development of temperature tolerant strains of *Trichogramma chilonis* and *Trichogramma japonicum* (Arun Baitha and D.C.Srivastava)

Management of insect-pests through bioagents, chemical and IPM technology.

*AICRP: (BC) 1 (i) Development of IPM strategy on sugarcane woolly aphid (SWA) (ii) Colonization of *Encarsia flavoscutellum* in sugarcane woolly aphid affected field. (iii) Monitoring and forecasting of sugarcane woolly aphid (iv) Yield

loss assessment due to infestation of sugarcane woolly aphid (G. M. Tripathi)

*AICRP: (BC) 2 — Field evaluation of *Trichogramma japonicum* and *Tetrastichus howardi* against top borer, *Scirpophaga excerptalis* (Arun Baitha)

*AICRP: (BC) 3 — Maintenance and supply of *Epiricania melanoleuca* for the biological control of *Pyrilla perpusilla* (Arun Baitha)

AICRP : (BC) 4 — Bio-intensive pest management practices for sugarcane scales (Arun Baith and R.B. Jadhav)

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

E 27 : — Mass multiplication of potential bio-agents of sugarcane insect pests *Cotesia flavipes* (M. R. Singh and A. Baitha)

*E 30: — Monitoring of insect pests and bioagents in sugarcane agro-eco-system (D.C. Srivastava, M.R. Singh and Arun Baitha)

*APC 1/04, NS.5: Bionomics and Management of Sugarcane Woolly Aphid *ceratovacuna lanigera zehntner* (G. M. Tripathi M.R.Singh)

*CR 1/05 : — Evaluation of E2Y 45 20 SC against termites and top borer of sugarcane (M. R. Singh, J. Chandra and S.K. Gangwar)

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

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

CR-5/06 — Evaluation of bio-efficacy of Bifenthrin 10EC against sugarcane termites (S. K. Gangwar and Arun Baitha)

CR-3/06 — Evaluation of bio-efficacy of E 2Y 45 0.4 GR against termites and top borer of sugarcane (S. K. Gangwar and M. R. Singh)

Expl. Trial: — Bio-friendly management of borer pests of sugarcane (S. K. Gangwar, D.C. Srivastava, M. R. Singh and Arun Baitha)

Crop management for high sucrose productivity

*PB 17: — Developing an alternative chemi-technology to enhance sucrose content in sugarcane: Studies on sucrose synthesizing/ degrading enzymes (S. Solomon, Ishwar Singh and S.K. Shukla)

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

Development of appropriate farm machinery for mechanization of sugarcane cultivation

Design and development of equipment

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

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

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

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

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

*FIM/IISR/PMW/86: Manufacturing of prototypes for conducting field adoptability trials under varying agro-climatic and soil conditions (Jaswant Singh and P.R. Singh)

*AE 1.9E: Development of sugarcane harvester(A.K. Singh, M.P. Sharma and Jaswant Singh) Design and development of residue multure-cum-bio-applicator

(P.R. Singh, Co-PI: Archna Suman and A.C. Srivastava)

*New: Design and development of residue-cum bio-applicator: (P.R. Singh, Archna Suman and A.C. Srivastava)

*New: Optimization of water requirement of plant and ratoon crop of sugarcane in sub-tropical India (Rajendra Gupta, Ishwar Singh)

Development of suitable post-harvest technology

Post-harvest losses in sugarcane

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

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

*AE 7(G)/LKO/JKS/95/7: Investigations on forced air drying characteristics of jaggery and development of a jaggery drier (A.K. Singh and Jaswant Singh)

*AE7/LKO/JKS/01/1: Development of an improved triple pan furnace for jaggery manufacturing (Jaswant Singh)

AE 7(H) / LKO/JKS/02/01: Investigations on Lucknow furnace for waste heat recovery for useful purposes (S.I. Anwar)

*AE 7(I)/LKO/JKS/02/03: Determination of engineering properties of bagasse (R.D. Singh)

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

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

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

Diversification of sugarcane based by-products

APC 2/04: Development of pre-treatment and hydrolysis process for conversion of sugarcane biomass to ethanol (Pushpa Singh, Archna Suman and A.K. Shrivastava)

Sugarbeet improvement and its seed production

NWP 2/04: Developing Agro-techniques for Tropicalized Sugarbeet in India (Raman Kapur, S.N. Srivastava, R.K. Tewari, R.S. Chauhan and P.R. Singh)

Technology adoption, socio-economics, statistical modelling and computer application

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

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

AES 4.9: Analysis of Long Term Trends in Yield and Economics of Sugarcane Cultivation in Important Cane

growing states of India (Ashwani K Sharma and R.L.Yadav)

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)

AES 4.4 : Development of statistical procedures for analysis of count data in sugarcane protection trials (Rajesh Kumar and P.K. Bajpai)

AES 4.5 : Identification, prioritization and Implementation of computer applications at IISR (S.S. Hasan, P.K. Bajpai and Rajesh Kumar)

AES 4.6: Dynamics of sugar production and factors affecting its prediction (P.K. Bajpai and Rajesh Kumar)

AES 4.8: Data warehouse on sugarcane production system (S.S. Hasan, P.K. Bajpai and Rajesh Kumar)

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)

AM 4 : Development of Atlas for Sugarcane Cultivation in India (Arun K. Srivastava, A.K. Sharma, R.L. Yadav and D.V. Yadav)

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

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

This chapter provides information on the complete technical programme consisting of Institute Research Projects, AICRP Projects, as well as externally funded projects. Some of the projects mentioned here initiated during the year and thus the achievements/progress has not been given. The projects marked with asterisk (*) in this chapter have not been provided with progress report elsewhere in this document.

17

Consultancy, contract research and patents

Consultancy, Contract Research and Patents

Consultancy

Agro-Econo-Techno study was carried out as a revival package for the Mysore Sugar Company Limited, Mandya / Bangalore, Karnataka.

Contract research

Seven Memorandum of Understandings (MOU) were signed to carry out the contract research programmes. The details are given in Table 17.1 below :

Table 17.1. Contract research projects at IISR, Lucknow

S. No.	Title	Funding agency	Scientists	Period (CS)*	Duration	Cost Rs. lakh
1	**CR-1/05 :** Field evaluation of E 2Y 45 20 SC against termites and top borer of sugarcane	E.I. Du Point India Pvt. Ltd., Gurgoan	M.R. Singh J. Chandra S.K. Gangwar	2005 –07, (2 CS)	3/05 – 2/07	3.0
2	**CR-1/06 :** Evaluation of wellgrow – an organic manure of sugarcane	ITC Ltd., Guntur	R.L. Yadav D.V. Yadav S.K. Shukla	2006-08 (2 CS)	4/06 – 3/08	2.0
3	**CR-2/06 :** Agronomic evaluation of different new grades of N P K on sugarcane	Shriram Fertilizers & Chemicals, Lucknow	D.V. Yadav and Todi Singh	2006 –08, (2 CS)	3/06 – 2/08	1.50
4	**CR-3/06 :** Bio-efficacy of E 2 Y 45 0.04% GR against top borer and termite in sugarcane	E.I. Du Point India Pvt. Ltd., Karnal	S.K. Gangwar, M. R. Singh, D. C. Srivastava and R. L. Yadav	2006 –08, (2 CS)	06-07 – 07-08	3.0
5	**CR-4/06 :** Field evaluation of sex pheromon of sugarcane top borer	Pest control India Pvt. Ltd., Bangalore	D.C.Srivastava, M.R. Singh, S.K.Gangwar, R.L.Yadav	2006 –08, (2 CS)	06-07 – 07-08	2.0
6	**CR-5/06 :** Evaluation of bio-efficacy of Bifenthrin in 10 EC against Termites in sugarcane	FMC India Pvt. Ltd., Bangalore	S.K. Gangwar, Arun Baitha and R. L. Yadav	2006 –08, (2 CS)	3/06 – 2/08	3.0
7	**CR-6/06 :** Evaluation of Velpar K4 60 WP herbicide for control of sugarcane weeds as post emergence application	E.I. Du Point India Pvt. Ltd., Gurgaon, Haryana	R.S. Verma and R.L. Yadav	2006 –08, (2 CS)	05- 06 & 06- 07	3.0

Patents

Following five patents, as complete applications, were filed with the patent authority as per details given in Table 17.2.

Table 17.2 : Details of patents field by IISR, Lucknow

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

Patents in process

The following patents are in process

1. Efficiency booster for open pan furnaces (Inventor: Dr. S. I. Anwar)
2. A chemical formulation based process to reduce sucrose losses in harvested sugarcane (Inventors: Dr. S. Solomon, Dr. R. L. Yadav and Dr. A. K. Shrivastava)
3. Prolonging shelf life of liquid jaggery (Inventors: Dr. R. S. Dwivedi, Mr. S. P. Shukla, Dr. D.V. Yadav, Dr. R. Dwivedi and Dr. R.L. Yadav)
4. S.S. Furrower (Inventors : Dr. P.R. Singh and Dr. A.C. Srivastava)

18

Monitoring and evaluation

1. Study Visit of Parliamentary Standing Committee on Agriculture

Under the Chairmanship of Prof. Ram Gopal Yadav, the Parliamentary Standing Committee on Agriculture comprising 9 members of the Lok Sabha and six members of the Rajya Sabha along with officials from Lok Sabha Secretariat and DARE visited the Institute and discussed the role and achievements of IISR in the development of sugarcane in India. The Institute represented the Crop Sciences Division of the ICAR, New Delhi for an independent review of the research output/contribution. It was a matter of great pride for the Institute that a Parliamentary Standing Committee on Agriculture conducted on-the-spot-visit and lauded the research achievements of the Institute. The committee also hoped that such good work will continue in future for the benefit of sugarcane, cane farmers and sugar industries of India.

2. Independent Review of IISR Research by The Giri Institute of Development Studies Lucknow

IISR, Lucknow was selected from the Crop Sciences Division of ICAR, for carrying out a comprehensive and in-depth as well as independent evaluation to assess the overall outcome and impact of development programmes of ICAR research Institutes. An Indian Council of Social Sciences Research (ICSSR) organization, namely Giri Institute of Development Studies, Lucknow under the leadership and guidance of Prof. D.M. Diwakar was assigned this job by the Council. Prof. D.M. Diwakar and his team from this Institute critically reviewed the Xth Plan achievements in terms of research and front line transfer of technology keeping in view the mandate and objectives of the Institute and assessed the state of infrastructure and human resource available for research The independent review appreciated the work done and the research contributions by this Institute during Xth plan period.

3. Review of Research Programmes by Research Advisory Committee (RAC)

The RAC Meeting under the Chairmanship of Dr. S.S. Baghel, Vice-Chancellor, Assam Agricultural University, Jorhat and as per composition given below met on February 8-9, 2007. The Chairman in his opening remarks emphasized the necessity of reducing the cost of production by improving the input-use efficiency through judicious use of organic, in-organic and microbial fertilizers in an integrated manner, improving the water use efficiency, breeding/selecting efficient genotypes, improvement in machinery for efficient crushing and in attending various agricultural operations, reduction in post-harvest losses and the economic use of by-products. He also suggested to devise suitable strategy for reducing the energy requirement and diversified uses like ethanol production. Dr. R.L. Yadav, Director, IISR, Lucknow emphasised on reducing the cost

of sugarcane cultivation through i) Improving ratoon cane productivity, ii) Enhancing input-use efficiency, and iii) Mechanization of sugarcane cultivation as future research thrust areas in his welcome address. Dr. D.V. Yadav, Member-Secretary, RAC and the HODs presented the Action Taken Report (ATR) on the general and Divisional recommendations of the XIIth meeting of the RAC. The RAC members after critically reviewing, expressed satisfaction over the action taken on the various recommendations and confirmed the proceedings of the XIIth RAC meeting.

Composition of IISR, Lucknow RAC Committee

The RAC in its meeting made the following recommendations:

S. No.	Name	Status
1.	Dr. S.S. Baghel, VC, AAU, Jorhat	Chairman
2.	Dr. Rakesh Tuli, Director, NBRI, Lucknow	Member
3.	Dr. A.N. Mukhopadhyay, Ex-VC, AAU, Jorhat	Member
4.	Dr. S.B. Jadhav, Ex- Director, VSI, Pune	Member
5.	Dr. J.P. Choudhary, Ex-Prof. & Head, Deptt. of Entomology, HAU, Hisar	Member
6.	Dr. D.P. Misra, Dean, C.B.S.H., GBPUA&T, Pantnagar	Member
7.	Dr. K.C. Jain, ADG (CC), ICAR, New Delhi	Member
8.	Dr. R.L. Yadav, Director, IISR, Lucknow	Member
9.	Dr. D.V. Yadav, Pr. Scientist & I/c, RCM	Member-Secretary

Crop Improvement

The Institute should lay increased emphasis on the development of high-yielding early maturing varieties, combining resistance to red rot. For this objective, Institute should strengthen facilities for increasing the size of seedling population in its various breeding projects, starting with reducing mortality in fluff raised seedlings.

The breeding activity on sugarbeet should continue at the Institute level. This unique asset of the Institute should be fully utilized.

Work on molecular cytogenetics should be taken up to elucidate chromosomal composition of different species in sugarcane varieties to help sugarcane breeding. This may employ techniques such as Fluorescent *in situ* Hybridization (FISH) and Genomic *in situ* Hybridization (GISH).

The Institute has developed more than 26000 ESTs from different tissues of sugarcane. Over 1000 of these ESTs have been derived after subtraction of libraries using red-rot infected stalk. These should immediately be deployed in developing major programmes on allele mining and gene mapping for economically important traits (red-rot, drought, sugar). Network programmes jointly with other Institutes need to be developed with the support from ICAR, DBT or CSIR to utilize the valuable EST resource. First step should be to design SSR markers, then to develop framework linkage map and finally, to identify trait linked markers.

Work on genetic transformation of sugarcane should be expedited.

Red-rot strain identification needs to be taken up through molecular marker evelopment.

Bacillus thuringiensis and endotoxins should be tested against top borer also, which is most damaging pest in north India.

Crop Production

The increased fertilizer use efficiency should receive high priority. The integrated package of organics, in-organics and microbes should be developed.

The water availability is becoming a serious constraint. Studies should be conducted to increase the water use efficiency by identifying rhizospheric microbes from drought prone areas and their application.

The nutrient management trials should be based on common nutrient doses.

The recommended doses of seed is very high and it is one of the major items of the cost of production. Studies should be undertaken to increase the number of tillers and their

establishment efficiency through the use of growth regulators and micro-nutrients.

The formation of sub-soil hard pan is one of the important factors limiting the productivity of ratoon cane. The ratoon management device (RMD) developed by the Institute has a provision for chieseling. Studies should be initiated to study the effects of RMD on soil physical properties, water and nutrient-use efficiency and productivity in ratoon crop.

Crop Protection

Red-rot being the most important disease, the regular monitoring of racial pattern is required. Studies on the basis of breakdown of resistance should be undertaken.

T. viride is being applied for trash management. Effect of such treatment on disease incidence and also on the population dynamics of Trichoderma in soils be studied.

Further work is needed to determine the specific dose of natural enemies for economic management of sugarcane pests.

Work on wooly aphid needs constant attention due to future threats.

The residue level of commonly used pesticides in sugarcane be studied in sugar.

Plant Physiology & Biochemistry

Studies on saccharification of sugarcane trash and other agro-wastes be initiated by using microbial systems rather than chemical treatments.Since hemicelluloses constitute a considerable part of trash, pentoses are major product of saccharification, fermentation studies on pentoses need to be initiated. Collaborative research with other institutes engaged in such work may be explored.

Agricultural Engineering

In the last RAC, it was recommended to develop the cane harvestor. It was brought to the notice of the RAC that the basic work has been done and the cutting and winding units have been developed. For developing a commercially viable model, experts services dealing in hydraulic/automobile engineering are required, which are not available in the Institute. The Institute should develop linkages with suitable institute(s) or private entrepreneurs. If necessary, the Institute may outsource such expertise through consultancy.

Socio-Economics

Many important technologies have been developed by the Institute during recent years. The ex-post analysis of such technologies be carried out.

KVK

Training courses should be of longer duration to impart necessary skills.

FLDs should be used as a tool for evaluation, refinement and dissemination of the technology.

General

It is again emphasized that problems cutting across disciplines may be attended by constituting multi-disciplinary teams.

Very good biotechnological work has been initiated. However, to derive its benefits, it is necessary that the suitable scientific staff is appointed/posted immediately.

4. Staff Research Council (SRC)

The SRC meeting held on August 2-4 and September 6, 2006 under the Chairmanship of Dr. R.L. Yadav, Director of the Institute. While presiding over the meeting and reviewing the progress of the research programmes/ projects, Dr. R.L. Yadav, Director, IISR and Chairman, exhorted the members to prepare 3 or 4 good quality research projects and submit them for funding under NAIP. He also explained the issues to be addressed while preparing the projects for NAIP. He suggested that a separate committee consisting of members viz; Dr. D.V. Yadav, Dr. O.K. Sinha, Dr. A.K. Shrivastava, Er. M.P. Sharma, Dr. Rajesh Singh, Dr. (Mrs.) Archna Suman, Dr. S. Solomon, Dr. A.K. Sharma and Dr. M.R. Singh, be constituted and sound research project proposals on prioritized aspects such as on ratoon management, development of red-rot resistant & high-sugar variety, enhancement of input-use efficiency, and development of sugarcane harvester be prepared. While reviewing the progress of Crop

Production Division, the Chairman desired that a book on sugarcane cultivation in simple language for better understanding of the farmers be written in Hindi wherein all the information ranging from cultivation & input purchases, their source of availability and marketing of the product be given in a farmer friendly mode. He also emphasized the need for another book on ratoon management of sugarcane on similar lines. The Chairman desired that Dr. Menhi Lal, HOD, Crop Production may take leading responsibility on these aspects. While deciding the duration of long term projects/experiments on variety development, the Chairman emphasized that all long term projects should be made time bound. The long period of the project needs to be better quantified / specified (e.g. first 3 years must be specified for crosses, and next 5 to 6 years be specified for targeted objectives, etc.). The Chairman desired that the breeders have to ensure the multiplication and supply of seeds of the varieties they have been associated with the development thereof. Also, efforts need to be made to make the tissue culture work at IISR nationally and internationally recognized. The Chairman, while reviewing the progress of Crop Protection Division, desired that the new projects on red-rot be developed on the aspects highlighted in the brainstorming session organized at IISR, Lucknow so that the implementation of the recommendations is ensured.The Chairman emphasized the need for the development of sugarcane harvester while reviewing the progress of Agricultural Engineering Division. The Chairman also emphasized that the new research project proposals be well focused and be prepared rigorously. In all, 14 research project proposals were approved in the SRC meeting. The Chairman desired that a practical system for strengthening research in extension education in the Institute be developed and exhorted the scientists to discuss & frame modalities for this. He also desired that the names of 3 true sugarcane growers be suggested so that these farmers could be contacted / invited in meetings to obtain farmer's point of view for better fine-tuning of sugarcane research work in the Institute. The Chairman also explained to the members that the costly equipments proposed in new project proposals are likely to be purchased in XIth Five Year Plan period. He, therefore, advised that these equipments / machinery may be proposed for their inclusion in XIth Five Year Plan EFC memo of the Institute.

The Member Secretary, Dr. D.V. Yadav made a presentation on the role and scope of NAIP in order to make the members aware of the main concerns of NAIP so that they may be able to prepare research projects for financing under NAIP. Concept notes on NAIP were also distributed in the meeting to all the members.

Review of IISR Regional Centre, Motipur

Major emphasis in the meeting was also laid to rejuvenate the IISR Regional Centre, Motipur in Bihar and a separate session in the meeting was organized to review the activities of the Centre. While reviewing the progress of activities of Motipur Centre, the Chairman expressed the need to organize one Institute-Sugar Industry interface at Motipur. The programmes/activities of the Centre be discussed in a separate meeting on August 5, 2006 under the Chairmanship of the Director, IISR. The Chairman also desired that some equipments/machinery developed at the Institute be kept at the Motipur Centre for demonstration to the farmers. Subsequently, it was decided to send sufficient number of important equipments like raised bed planter, ratoon management device and multi purpose equipment at the regional centre Motipur (Bihar) so that the centre may become a window of the Institute extension activities and help in the mechanization of sugarcane cultivation in the eastern region. The Chairman also emphasized that the strengthening of the centre will effectively be perused in the XIth Five Year Plan period.

PME Review

The overall review of the research projects at IISR, Lucknow was carried out in PME cell and presented at the start of SRC meeting by Dr. A.K. Sharma, Sr. Scientist (Ag Eco.) and before the start of RAC meeting by Dr. D.V. Yadav, Pr. Scientist (Soil Science).

Review at Scientists level

In order to encourage effective monitoring of the research projects at PI level, Director, R.L. Yadav instructed all the scientists well in advance of the SRC meeting that the review of the research projects in the meeting be made focused on deliverable outputs of the research projects. The presentations were prepared accordingly by the Scientists and discussed in division level meetings prior to their presentation in SRC. The presentations were made by each Prinicipal Investigator in SRC meeting.

Review by Heads of Divisions

The review by Heads of Divisions has been encouraged to develop an effective second line of research management as well as to ensure better implementation of both top-down and bottom-up approaches. The Heads of Divisions presented the overview of divisional level researchable issues, research requirements, achievements of on-going research projects and the deliverable technologies in different review meetings such as RAC, SRC and/or for discussions with the outside experts/visitors. The concept notes for the NAIP projects were prepared and discussed threadbare in separate meeting. The Divisional level progress during the year 2005-06 and Action Taken Report on the recommendations of SRC-2005 were presented by respective HODs, namely Dr. Raman Kapur, HOD (Crop Improvement), Dr. Menhi Lal, HOD (Crop Production), Dr. A.K. Shrivastava, HOD (Plant Physiology & Biochemistry), Dr. S.K. Gangwar, HOD (Crop Protection) and Dr. Jaswant Singh, HOD (Agril Engineering). The ATRs presented were accepted by the SRC. Besides, HOD, Crop Protection presented the recommendations of Brain storming session on red-rot management held at this Institute on July 12, 2006.

Review visits to Field Experiments and Research Laboratories

The field experiments laid-out in order to fulfill the objectives of various research projects were also reviewed by a committee under the leadership of Dr. Menhi Lal, Head of Crop Production Division and comprising scientists of different disciplines before the SRC meeting. The field experiments and laboratories were also visited by RAC members on February 9, 2007. The RAC members critically reviewed the field experiments and facilities available in the Institute to carry out work on the suggested lines and offered valuable suggestions to improve the field experimentation. The field experiments were also shown to the dignitaries who visited the institutes during the year. Field and Labs visits were also carried out by the Parliamentary Standing Committee on Agriculture during the On-Spot-Study Visit of the Institute on November 11-12, 2006.

5. Institute Management Committee (IMC)

The IMC with the following composition met on January 10, 2007 for its 27th Meeting.

Representation	Name	Designation
Director the Institute	Dr. R.L. Yadav	*ex-officio* Chairman
Representative of U.P. Govt. (Cane Commissioner)	-	Member
Representative of other State Govt.*	-	Member
SAU representative **	-	Member
Non-official members	1. Sri Krishna Singh Rathore 2. Sri Anil Chowdhary	Member Member
Scientists of ICAR Institutes nominated by DG, ICAR	1. Dr. Ashok Kumar Shrivastava, (IISR, Lucknow) 2. Dr. S. Sundra, SBI, Coimbatore 3. Dr. Raman Kapur, IISR, Lucknow 4. Dr. Shive Kumar, IIPR, Kanpur	Member
ICAR representative	-	Member
Financial Advisor / Account officer nominated by President	FAO, IVRI, Izatnagar Bareilly (U.P.)	Member
Administrative Officer of the Institute	Sr. Administrative Officer	*ex-officio* Member-Secretary

*Cane Commissioner, Uttarakhand, ** Director of Research, NDUA&T, Kumarganj, Faizabad

The need for initiating meeting with R&D staff posted at different sugar factories particularly in U.P., Haryana and Bihar was emphasized in the meeting. The other points discussed were the repair & maintenance of administrative building including laboratories, revenue receipts of the institute and matters related to staff welfare.

Review of on-going repair and maintenance work

Mr. V. P. Kothiyal, Director (Works), ICAR, New Delhi visited the Institute on 28 November, 2006 and reviewed the on-going repair and maintenance work. He expressed satisfaction at the progress made.

Other Committees at Institute level

For smooth conduct and functioning of the Institute and to provide advice to the Director, the following committees were constituted.

Policy, Planning & Expenditure

1. Dr. D.V. Yadav – Chairman
2. Dr. A.K. Shrivastava
3. Dr. A.N. Singh
4. I/c, KVK
5. AF&AO
6. SAO

Farm Advisory Committee

1. Dr. Menhi Lal – Chairman
2. Er. M.P. Sharma
3. Dr. R.S. Chauhan
4. Dr. Abdul Rashid
5. AFAO
6. SAO
7. Farm Manager

IISR Publication & Library Committee

1. Dr. D.V. Yadav – Chairman
2. Dr. Ashok Kr. Shrivastava
3. Dr. S.K. Duttamazumder
4. SAO
5. FAO
6. Incharge Library

Security & Vigilance Committee

1. Dr. Sukhraj Prasad – Chairman
2. Capt. RAS Yadav
3. Sh. Arun Kr. Srivastava
4. AFAO
5. SAO

Purchase Advisory Committee

1. Dr D.V. Yadav.– Chairman
2. Er. M.P. Sharma
3. Dr. Archna Suman
4. AF&AO
5. SAO

Human Resource Development

1. Dr. A.C. Srivastava – Chairman
2. Dr. S. Solomon
3. Dr. Arun Baitha
4. AFAO
5. SAO
6. AAO (Adm.I)

Works Committee

1. Dr. Jaswant Singh – Chairman
2. Dr. S.R. Prasad
3. Dr. Abdul Rashid
4. AFAO
5. SAO
6. Sh. M.H. Ansari

Transfer of Technology

1. Dr. Menhi Lal – Chairman
2. All HODs
3. I/c, KVK
4. I/c, RCM

Ad-hoc committees were also constituted as per need to prepare quality documents/ concept notes for better organization of events/ seminars in the Institute.

Institute Joint Staff Committee (IJSC)

IJSC Meetings with the following composition were held on July 15, 2006 and November 30, 2006

Dr. R.L. Yadav, Director, Chairman

Members Nominated	Members Elected
Sr. A.O., Member	Sh. Someshwar Mishra, Member
AF&AO, Member	Sh. Ashrit Kumar Singh, Member
Dr. S.N. Singh, Member	Sh. Triloki Prasad , Member
Smt. Usha Kiran Sharma, Member	Sh. Shiv Kumar Soni , Member
Sh. G.K. Singh, Member-Secretary	Sh. Rajender Kumar, Member Secretary

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Human resource development

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

Dr. R.L. Yadav, Director of the Institute has also initiated a series of lectures by inviting prominent personalities in the Institute to deliver lectures on varied aspects ranging from personality development, spritualism and the need for further improvement in the work culture of the Institute. The important lectures delivered were as follows:

Topic	Date	Speakers
Sugarcane Control Order-1966	Sep. 22, 2006	Dr. Ram Moorti Singh

One exclusive human resource development committee has also been constituted to encourage and streamline HRD activities in the Institute. The committee, under the "IISR Seminar Series" organized the seminars as per details given below.

Topic	Date	Speakers
Professionalism in Agricultural Research and Development	Apr. 27, 2006	Dr.A.K. Sah
Methods of performance assessment of the Institute/divisions	May 29, 2006	Dr. A.K.Sharma

Participation of Scientists / other staff in Conferences / Meetings / Workshops / Symposia / Training programme / School, etc.

Participation of scientists at IISR, Lucknow/IISR Regional Centre, Motipur (Bihar)

Participants	Topic	Date
Drs. R.L. Yadav, O.K. Sinha, S.K. Gangwar, Ashok Shrivastava, Raman Kapur R. Dwivedi, Archana Suman, Vijai Singh, Ram Ji Lal, Sunita Lal A.P. Singh, S.K. Duttamajumder, D.K. Pandey, Mr. S.C. Mishra	Brainstorming Session on 'Management of Red Rot' in Sugarcane	Jul. 12, 2006
Drs. D.V. Yadav, A.N. Singh, Raman Kapur, D.K. Pandey, Sangeeta Srivastava, J. Singh, A.D. Pathak, R.K. Singh, P.K. Singh, Sanjeev Kumar and M. Swapna	DUS Review and Interaction meeting with Dr. S. Nagarajan, Chairperson, PVP and Farmers' Rights Authority	Aug. 22, 2006
Drs. Menhi Lal, D.V.Yadav, S.K. Gangwar, Jaswant Singh, A.D. Pathak, Er. M.P. Sharma, R. Kapur and S.N. Singh	IISR-Sugar factory Interface at IISR Regional Centre, Motipur, Bihar	Sep 04, 2006
Drs Menhi Lal, D.V. Yadav, R.S. Verma, R.S. Chauhan, Archna Suman and S.K. Shukla	Awareness Building Workshop organized by National Agricultural Innovation Project (ICAR)	Sep. 11, 2006

Drs. D.V.Yadav, Raman Kapur and A.D. Pathak	Review meeting of the AP Cess Network Project on Developing Agro-techniques for tropicalized sugarbeet in India	Sep. 28, 2006
Drs. D.V.Yadav and R. Kapur	Meetings of the Committee to decide *modus operandi* of Revolving Fund under the Mega Seed Project	
Drs. Sangeeta Srivastava, J. Singh and P.K. Singh	Multivariate Data Analysis and Chemometrics	Nov. 30, 2006
All Scientists/ technical officers of the Institute and the KVK, Lucknow	National Seminar on Comparative advantages to different methods of sugarcane planting organized by Directorate of Sugarcane Development (Govt. of India) at IISR, Lucknow	Jan. 23-24, 2007
Drs. Raman Kapur, A.N. Singh, D.K. Pandey, A.D. Pathak and Sanjeev Kumar	Zonal Breeders' Meet of AICRP on Sugarcane	Feb. 05, 2007
Drs. R.L.Yadav, D.V.Yadav, Menhi Lal, Ers. Jaswant Singh, M.P. Sharma, R.K. Pangasa, P.R.Singh, S.I.Anwar, R.D.Singh, A.K.Singh, Rajendra Gupta, Dilip Kumar,	IISR-Manufacturers' (Agricultural Implements) Interface	Feb. 12, 2007

Invited/outside participations

Name	Topic/Subject	Place	Date
Dr. R.L.Yadav	Brainstorming Session meeting;	VSI, Pune	May 22, 2006
	XI Five Year Plan working Group Meeting & DSR Meeting	New Delhi	Jun.26-28, 2006
	National Steering Committee meeting of rice-wheat	NBPGR, New Delhi	Jun. 29, 2006
	Meeting of Price policy for the sugarcane crops for the 2007-08	Commission for Agricultural Costs and Prices, New Delhi	Jul. 3, 2006
	Meeting on Mechanization of Sugarcane Cultivation	PDCSR, Modipuram	Jul. 29-30, 2006
	Meeting on Information Bank activity, Mile Stone, Network Projects and Vision 2025 under the Chairmanship of DDG(CS)	KAB-II, New Delhi	Oct. 5-7, 2006
	Director's Conference Meeting	NASC Complex, New Delhi	Nov 3-4, 2006
	International Symposium on Technologies to improve Sugar Productivity in developing Countries	China	Dec. 5-8, 2006
	Task Force Meeting for Evaluation and Finalization of DUS test Guidelines of Sugarcane and related issues to plant variety protection	New Delhi	Jan.12-14, 2007
	Meeting of Sugarcane Research & Development	Haryana Sugar Federation, Chandigarh	Feb. 27, 2007
	Mega Seed Project Review Meeting	New Delhi	Mar. 1-2, 2007
	Annual Foundation Day Lecture on the Challenges of biotechnology to improve plant breeding efficiency by Dr. Jean Marcel Ribaut, Director, GCP, CIMMYT	NASC Complex, New Delhi	Mar. 20-22, 2007

Crop Production

Dr. D.V. Yadav	Management Development Programme on Managing Intellectual Property in Agricultural Research Organizations	NAARM, Hyderabad	Jul. 13-19, 2006
	XVIII Meeting of the ICAR Regional Committee No. IV	Patna	Sep.12, 2006
	State Level Seminar on Correcting Nutrient Balance for Sustainable high yield Agriculture in Uttar Pradesh	PPIC-India Programme, Gurgaon	Sep. 20, 2006
	Kisan Gosthi on winter cane	Hydergarh Sugar Mill, Barabanki	Sep. 24, 2006
	26th Biennial Workshop of AICRP on Sugarcane	GBPUAT, Pantnagar	Oct. 16-18, 2006
	Brainstorming Session on Identification of Future Thrust Areas for Research & Development in Sugarcane	GBPUAT, Pantnagar	Oct. 18, 2006
	International Symposium on Balanced Fertilization for Sustaining Crop Productivity	PAU, Ludhiana	Nov. 22-25, 2006
Dr. Menhi Lal	Review Meeting of UPCAR Project "Evaluation and standardization of organic farming technique for sugarcane production system	UPCAR, Lucknow	Jun. 16, 2006
	Brainstorming Session on Increasing water productivity and farm income by integrating farming systems approach in waterlogged sodic soils under Sarda Sahayak Canal Command	UPCAR, Lucknow	Jun. 26, 2006
	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct. 16-18, 2006
	Golden Jubilee National Symposium on Conservation Agriculture and Environment	BHU, Varanasi	Oct. 26-28 2006
Dr. R.S. Chauhan	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct. 16-18, 2006
	Golden Jubilee National Symposium on Conservation Agriculture and Environment	BHU, Varanasi	Oct. 26-28 2006
Dr. R.P Verma	Kisan Gosthi	IIVR, Varanasi	Jan. 27-28, 2007
	Exhibition of Sugarcane Production Technology	*Kisan Mela* at Sargatia, Kushinagar (U.P.)	Mar. 25, 2007
	Scientists-farmers Meeting at Village Vaishpurwa	BCM Rauzagaon, Barabanki	Feb. 26,2007
	Exhibition	CIMAP, Lucknow	Feb. 28, 2007
Dr. Archna Suman	Brain Storming Session on Role of Agriculturally Important Microorganisms in Sustainable Food and Agriculture Production	NBAIM, Mau	Apr. 17, 2006
	Review Meeting of UPCAR Project "Evaluation and standardization of organic farming technique for sugarcane production system	UPCAR, Lucknow	Jun. 16, 2006
	Meeting on Sugarcane mechanization	PDCSR, Modipuram	Jul. 29, 2006
	Meeting on Environment Metagenomics, Department of Biotechnology (DBT)	NIIT, New Delhi	Oct. 03-04, 2006
	International Conference on "Biofuels"	Winrock International, New Delhi	Feb.01-02, 2007

Dr. Todi Singh	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct. 16-18, 2006
Dr. K.P. Singh	Golden Jubilee National Symposium on Conservation Agriculture and Environment	BHU, Varanasi	Oct. 26-28 2006
	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct. 16-18, 2006
	Review Meeting of UPCAR Project "Evaluation and standardization of organic farming technique for sugarcane production system	UPCAR, Lucknow	Jun. 16, 2006
Dr. S.K. Shukla	Golden Jubilee National Symposium on Conservation Agriculture and Environment	BHU, Varanasi	Oct. 26-28 2006
	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	October 16 to 18, 2006
Dr. A.K. Singh	Golden Jubilee National Symposium on Conservation Agriculture and Environment	BHU, Varanasi	Oct. 26-28 2006
	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct. 16 to 18, 2006
Dr. Ishwar Singh	Golden Jubilee National Symposium on Conservation Agriculture and Environment	BHU, Varanasi	Oct. 26-28 2006
Dr. A. K. Sah	National Seminar on Information and Communication Technology Opportunity and Challenges for Agricultural Extension	Navsari Agricultural University, Navsari, Gujarat	Dec. 27-29, 2006
	Kisan Gosthi in a village, Bahlolpur	BCM, Rauzagaon, Barabanki	Feb. 5, 2007
	Scientists-farmers Meeting at Village Vaishpurwa	RCM Rauzegaon Barabanki	Feb. 26, 2007
	Exhibition	CIMAP, Lucknow	Feb. 28, 2007
Dr Kamta Prasad	Exhibition	CIMAP, Lucknow	Feb. 26, 2007
	Advances in Extension Research	Div. Agril. Extension, IARI, New Delhi	Mar. 6-26, 2007

Crop Improvement

Dr. Raman Kapur	26th Biennial Workshop of 'All India Coordinated Research Project on Sugarcane'	GBPUAT, Pantnagar	Oct 16-18, 2006
Dr. A.D. Pathak	26th Biennial Workshop of 'All India Coordinated Research Project on Sugarcane'	GBPUAT, Pantnagar	Oct 16-18, 2006
Dr. J. Singh	Meeting of Task Force-II for 'Evaluation and Finalization of DUS Test Guidelines of Sugarcane and other issues relating to Plant Variety Protection'	NASC Complex, New Delhi	Jan. 10, 2007
	26th Biennial Workshop of 'All India Coordinated Research Project on Sugarcane'	GBPUAT, Pantnagar	Oct 16-18, 2006
	Special Meeting of the Project "Preparation for Protection of Plant Varieties& DUS Testing through ICAR-SAU System"	NBPGR, New Delhi.	Nov. 10, 2006

Dr. P.K. Singh	1st National Workshop of Mega Seed Project 'Seed Production of Agricultural Crops and Fisheries'	NASC Complex, New Delhi	Jun. 27-28, 2006
	Meeting of Task Force-II for 'Evaluation and Finalization of DUS Test Guidelines of Sugarcane and other issues relating to Plant Variety Protection'	NASC Complex, New Delhi	Jan. 10, 2007
	Annual Review Meeting of Mega Seed Project 'Seed Production of Agricultural Crops and Fisheries'	NASC Complex, New Delhi	Mar. 1-2, 2007
Dr. R.K. Singh	Sugarcane Seed Production and Certification	VSI, Pune	Feb. 22-23, 2007

Plant Physiology & Biochemistry

Dr. Ishwar Singh	Workshop and Field Visit of "Green Seeker Users" under CIMMYT-RWC/ USAID Programme	PDCSR, Modipuram (UP), CSSRI and DWR, Karnal, Haryana	July 10-12, 2006
Dr. Ishwar Singh	CIMMYT-RWC/ USAID sponsored training programme on "Principal Component Analysis and NDVI Sensor Towards the Integrated Evaluation of Crop Management"	NASC, New Delhi	Apr. 4-9, 2006.
Dr. (Ms) P. Singh	International Conference on Biofuels	Winrock International, New Delhi	Feb 01-02, 2007

Agricultural Engineering

Dr. Jaswant Singh	World Environment Day organized by Institute of Engineers (India)	UP State Centre, Lucknow	Jun. 5, 2006
	Attended Engineers Day	IE(I), UP State Centre, Lucknow	Sep.15, 2006
	AGM of Institution of Engineers (India), UP State Centre	Lucknow	Feb. 02, 2007
	26th Annual Workshop of AICRP on PHT at OUA&T	Bhubaneshwar	Dec.6-9, 2006
Er. M.P. Sharma	All India Seminar on Mechanized cultivation of sugarcane and safety-quality management in sugar industry	IE(I), Karnataka centre, Bangalore	Mar.10-11, 2007.
Dr. S.I. Anwar	SOLARIS 2007- The 3rd International Conference on Solar Radiation and Day Lighting	IIT, Delhi.	Feb.7-9, 2007
	41st ISAE Annual Convention & Symposium	Junagadh Agricultural University, Junagadh	Jan. 29-31, 2007
Dr. R.D. Singh	41st ISAE Annual Convention & Symposium	Junagadh Agricultural University, Junagadh	Jan. 29-31, 2007
Dr. A.K. Singh	41st ISAE Annual Convention & Symposium	Junagadh Agricultural University, Junagadh	Jan 29-31, 2007
Er. Rajendra Gupta	Micro-Irrigation system and water conservation technology	WTC, IARI, New Delhi	Jan. 2-9, 2007
Er. Dilip Kumar	26th Annual workshop of AICRP on PHT	OUAOT, Bhubaneshwar	Dec. 6-9, 2006

Crop Protection

Drs. S.K. Gangwar	26th Biennial Workshop of AICRP(S)	GBPAU&T, Pantnagar	Oct.16-18, 2006
Dr. Ram Ji Lal	26th Biennial Workshop of AICRP(S)	GBPAU&T, Pantnagar	Oct.16-18, 2006
Dr. S. K. Duttamajumder	Brainstorming session on 'Role of agriculturally important microorganisms in sustainable food and agriculture production	NBAIM, Mau	Apr.17, 2006
	Mid-term review meeting on Network project on wilt of crops	IIVR, Varanasi	Jul. 23, 2007
	2nd Annual meeting on Network project on wilt of crops	NBPGR, New Delhi	Nov. 24, 2007
Dr. M. R. Singh	26th Biennial Workshop of AICRP(S)	GBPAU&T, Pantnagar	Oct.16-18, 2006
Dr. A. Baitha	Biocontrol Workers Group Meeting on Biological Control of Crop Pests and Weeds (XV)	PDBC, Bangalore	May 23-25, 2006

Agro meteorology

Arun K. Srivastava	Workshop of ICAR's Network on climate change	CMFRI, Cochin	Mar.19-21, 2007
	Workshop on crop simulation modelling	SAC, (ISRO) Ahmedabad	Nov. 27-Dec. 1, 2006
	Training programme on 'Application of Remote Sensing and GIS in Agriculture & Soil Science	Remote Sensing Application Centre, UP, Lucknow	Feb.19-23, 2007
	2nd International Rice Congress	NASC Complex, New Delhi,	Oct. 9-13, 2006
	Workshop on Green Seeker programme evaluation	NASC, Complex, New Delhi	Jul. 22-28, 2006
	Workshop –cum-field visit on "Sensor based nitrogen fertilization" under USAID/USDA project	PDCSR, Modipuram	Jul. 9-13, 2006
	National Seminar on Agrometeoro-logical Services for Crop and Location Specific Advisories	IMD, Govt. of India, Pune	Jun. 21-22, 2006
	Workshop for annual review-cum-planning of SAC-ICAR/SAU collaborative project on " Energy –water balance and crop growth monitoring "	SAC (ISRO), Ahmedabad	Apr. 4, 2006
	Workshop on Principal Component Analysis and sensor based nitrogen fertilization	NASC Complex, New Delhi	Apr. 5-9, 2006

Economics and Statistics

Dr. Ashwani Kumar Sharma	Workshop on WTO and its position on Agriculture & Textiles	UPCAR, Lucknow	May 16-17, 2006
	Meeting on concept note preparation on National Intelligence Network (NAIN) for Agricultural Research	IASRI, New Delhi	May 19-20, 2006
	Sixty Sixth Annual Conference of the Indian Society of Agricultural Economics	ICAR Complex for NER, Umaim, Meghalaya	Nov. 8-10, 2006
	Training Programme on Applications of Remote Sensing and GIS in Agriculture & Soil Sciences	Remote Sensing Applications Centre, Uttar Pradesh	Feb. 19-23, 2007
Dr. P.K. Bajpai	International Conference on Statistics and Informatics in Agricultural Research, Diamond Jubilee Celebration of Indian Society of Agricultural Statistics	NASC, New Delhi	Dec. 27-30, 2006
Dr. Rajesh Kumar	International Conference on Statistics and Informatics in Agricultural Research, Diamond Jubilee Celebration of Indian Society of Agricultural Statistics	NASC, New Delhi	Dec. 27-30, 2006
Sh. S.S. Hassan	Workshop on Personnel Management Information System (PERMISnet) and Intelligent Reporting System (IRS)	NASC, New Delhi	Jul. 21-22, 2006
	Training Programme on "Information Bank Management"	NBPGR, New Delhi	May 1, 2006
	International Conference on Statistics and Informatics in Agricultural Research, Diamond Jubilee Celebration of Indian Society of Agricultural Statistics	NASC, New Delhi	Dec. 27-30, 2006

AICRP (Sugarcane)

Dr. O.K. Sinha	Sugarcane Seed Production and Certification	VSI, Pune	Feb. 22-23, 2007
	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct.16-18, 2006
Dr. B.L. Singh	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct.16-18, 2006
Dr. S.K. Chaudhary	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct.16-18, 2006
Dr. O.P. Dubey	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct.16-18, 2006

KVK, IISR, Lucknow

Dr. S.R. Prasad, I/c KVK	National Conference on KVKs	Indian Society of Seed Technology, New Delhi and ANGARU, Hyderabad	Nov. 26– 27, 2006
	26th Biennial Workshop of AICRP on Sugarcane	GBPUA&T, Pantnagar	Oct.16-18, 2006
Dr. R.K. Singh, Programme Coordinator	Advanced seed production training of vegetable	IIVR, Varanasi	Oct. 25 – 28, 2006
	National Conference on KVKs	Indian Society of Seed Technology, New Delhi and ANGARU, Hyderabad	Nov. 26– 27, 2006

Dr. V.K.Singh (KVK)	FLD workshop cum Training	KVK, Chitrakoot	Apr. 17-19, 2006
	Zonal workshop on KVKs of Uttar Pradesh and Uttaranchal	ANDUA&T, Faizabad	Nov. 2-4, 06
	KVK- SMS Zonal Training Course on "Important issues related to management of livestock and commercial aspects	IVRI, Bareilly	Jan. 22-25, 2007
Mr. R.K.Singh (KVK)	FLD workshop cum Training	KVK, Chitrakoot	Apr. 17-19, 2006
	Training on agricultural ecological situation (AES)	State Management Institute, Rahmankhera, Lucknow	Jul. 1-7, 2006
	Q R T meeting on KVKs of UP and Uttaranchal	IIVR,Varanasi	Oct. 12, 2006
	Zonal workshop on KVKs of Uttar Pradesh and Uttaranchal	ANDUA&T, Faizabad	Nov. 2-4, 06

Higher studies completed by Institute staff

Sr. No.	Name	Degree programme	Institute	Remarks
1	Dr. Sanjeev Kumar, Scientist, SS	Ph.D. (Genetics & Plant Breeding)	CSAUA&T, Kanpur	Degree awarded on Dec. 22, 2006
2	Dr. Dinesh Chandra Rajak, T.O.	Ph.D (Entomology)	CSAUA&T, Kanpur	Degree awarded on Sep. 04, 2006

Participation of Technical/Administrative Staff

Sl. No.	Name	Topic	Place	Date
1	Dr S.K. Sethi (Medical Officer)	Management of Stress related disorders hypertension, diabetes, cardiac heart disease	Indian Society of Health Administration, Bangalore	Nov 9-11, 2006
2	Sri R.K. Khanna and Sri K.P. Yadav (AAOs)	National convention on Reservation for the persons with disabilities (PWDS).	NIPA, New Delhi	Sep 30, 2006
3	Smt Raj Shankar and Sri Kuldip Singh (UDCs)	Specialized training programme on purchase procedures	ISTM, New Delhi	Sep. 20-22, 2006
4	Sri R.K. Yadav and Sri Nag Chand (Assistants)	Specialized training programme on purchase procedure	ISTM, New Delhi	Sep. 6-8, 2006
5	Sri Rajeev Lal, Sr. A.O.	Training on Post Graduate Diploma Programme in Public Policy and Management	MDI, Gurgaon	For 21 months from Sep. 02, 2007

Three IISR Scientists/Officers participated in International Symposium on Technologies to Improve Sugar Productivity in Developing Countries held at Guilin, P.R. China

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Workshop, seminars, symposia organized

Seminars

The Institute organized one National Seminar on "Comparative advantages to different methods of sugarcane planting" on January 23-24, 2007 in which 3 technical sessions were held as per details given below. 20.1. Almost all the states were represented by the participants.

Based on the presentations and discussions, the recommendations made are given below :

- In tropical India, planting of sugarcane in wide row spacings (120-150 cm) has proved better for higher cane yield. It also helps in reducing cost on seed and incidence of borers and pyrilla, facilitating intercropping, mechanizing the operations and increasing profitability.
- The ring-pit system of sugarcane planting has shown promise for increasing cane yield considerably in tropical and sub-tropical regions. It is also suitable for undulating and problematic soils.
- Polybag technique for late planting and STP for faster seed multiplication of newly released sugarcane varieties may be adopted.
- Simultaneous sowing of wheat and planting of sugarcane through FIRB (Furrow Irrigated Raised Beds) is a viable option where sugarcane suffers due to late planting after wheat harvest. The technique increases the productivity and profitability of the system by increasing productivity of the component crops, economizing fertilizers and water.
- Integrated nutrient management (INM) in sugarcane by using combinations of in-organic fertilizers with legumes, organic

Details of technical sessions organized in National Seminar at IISR, Lucknow

Technical Sessions	Chairman	Co-Chairman	Rapporteurs	Papers presented
I	Dr. B. Sundra, HOD, Crop Production, SBI, Comimbatore	Dr. Menhi lal, HOD, Crop Production, IISR	Dr S.K. Shukla, Sr. Scientist (Agron)	5
II	Dr. D.G. Hapse	Dr. D.V. Yadav, Pr. Scientist (Soil Science), IISR, Lucknow	Dr. A.K. Sharma, Sr. Scientist (Ag. Econ)	5
III	Dr. S.B. Singh, Director, UPCSR, Shahjahanpur	Dr. S.K. Saini	Dr R.S. Chauhan, Pr. Scientist (Agron)	5
Plenary Session	Dr. R.L. Yadav, Director, IISR, Lucknow	Dr. O.K. Sinha, PC (ALCRP Sugarcane)	Dr R.S. Verma, Pr. Scientist (Agron)	3

manures, crop residues, factory wastes and bio-fertilizers is the need of the day. Farmers must add whatsoever organics available with them in addition to recommended levels of chemical fertilizers for sustainable sugarcane production and soil health.

- Three-tier seed programme needs to be adopted to obtain a healthy and good quality cane seed material.
- Deep placed, well branched and properly spaced cane stubbles having higher number of viable buds are ideal for good ratooning. The planting techniques like ring-pit, trench and STP have the advantage of having higher number of viable buds, so result in higher ratoon cane yields.
- There is an emergent need for the mechanization of operations in sugarcane crop. Ring-pit digger developed at IISR saves 70% cost of digging pits compared to manual digging. The mechanized pit digging needs to be popularized.
- The trench system of sugarcane planting has also proven its potentiality for increasing cane yield. The system also needs mechanization.
- The planting techniques are not performing uniformly across the different situations. So each planting technique is a situation specific. Planting technique must be popularized considering its merits to the cane grower based on his resources and socio-economic conditions.
- IISR should supply either implements or their prototypes for mechanizing of sugarcane cultivation at cost wherever these are required. The Institute should also organize demonstrations of these implements, if required. However, the cost of transportation of the implements, travel expenses of the expert team along with fees to the Institute is to be financed by the organization which requires demonstration.
- It was realized that there was a very low rate of adoption of new planting techniques. In order to speed it up, IISR should identify scientists for liaisoning with each north Indian state for cane development work in the States.
- IISR should also initiate interface meetings with sugar industry and sugarcane development staff in each north Indian State twice i.e. before autumn and spring planting seasons to apprise the sugarcane production technology. For this purpose, IISR should identify a scientist to liaison with cane development authorities/sugar industry of each State. The ISMA should work out the modalities for financing such interfaces without which it will not be possible to make these interfaces successful. The ISMA should also help identifying sugar factories in each state where these are to be arranged.

Brainstorming Sessions

A Brainstorming session on 'Red rot management' was held at IISR, Lucknow on July 12, 2006 under the chairmanship of Dr. A.N. Mukhopadhyay. The scientists from IISR, Lucknow, SBI, Coimbatore, HAU, Hisar, UPCSR, Shahjahanpur, NBRI, Lucknow etc., took part in the session to deliberate upon the future line of research work in red rot management.

AICRP (S) Workshop/Meetings

The 26th biennial Workshop of AICRP (Sugarcane) was held at GBPUA&T, Pantnagar from October 16-18, 2006. Dr. S. C. Modgal, Ex DG, UPCAR, Lucknow was the Chief Guest and Ani Shetty Murthi, FAO expert was the Guest of Honour. Beside the participants of different centres, the meeting was attended by Dr. K.C. Jain, ADG (CC), ICAR, Dr. P.L.Gautam, VC, GBPAU&T, Dr. N. Vijayan Nair, Director, SBI, Coimbatore, Dr. Satyavir, Professor (Plant Pathology), CCSHAU, Hisar, Dr. S.B. Singh, Director, UPCSR, Shahjahanpur, Lucknow, Shri R. C. Pathak, Cane Commissioner, Uttarakhand and Dr. O. K. Sinha, Project Coordinator (Sugarcane). Total participation in the workshop was 150 participants from ICAR, SAUs, State Govt. Depts. and from Sugar Mills. A strong contingent of 17 scientists from IISR attended the AICRP (S) workshop at GBPUA&T, Pantnagar. In the Workshop, seven sugarcane varieties were identified. Two varieties viz., CoS 96268 (*Mithas*) and Co 98014 (Karan-1) are in early maturing category and rest five viz., CoH 119, CoJ 20193, CoS 96275 (Sweety), Co 99004 (Damodar) and Co 99006 (Neeraj) are

in the midlate maturing group. Varieties Co99004 (Damadar) and Co 99006 (Neeraj) were identified for the peninsular zone.

Meeting of Sugarcane Breeders of AICRP on Sugarcane was held under the Chairmanship of Dr. N. Vijayan Nair, Director, SBI, Coimbatore at IISR, Lucknow on February 5, 2007

Meeting on finalization of seed certification standards of tissue culture raised planting material of sugarcane was held under the Chairmanship of Dr. R.L. Yadav, a meeting for finalization of seed certification standards of tissue culture raised planting material of sugarcane on October 9, 2006 at IISR, Lucknow. Dr. N. Vijayan Nair, Director, SBI, Coimbatore, Dr. S.B. Singh, Director, UPCSR, Shahjahanpur Dr. R.K. Chowdhury, Nodal Officer (Seeds), IARI, New Delhi and Dr. O.K. Sinha, Project Coordinator (Sugarcane) participated in the meeting.

IISR-Sugar mill interface

An interface meeting with sugarcane factory personnel of Bihar was organized at the IISR Regional Centre, Motipur on 4 September, 2006. Eight Senior Officers from the Institute e.g. HODs, Dr. Menhi Lal, Dr. S. K. Gangwar, Dr. Raman Kapur and Dr. Jaswant Singh; I/c, KVK, Dr. S. R. Prasad; Dr. S.N. Singh, Incharge, Motipur Centre, Dr. A.D. Pathak, Er. M. P. Sharma and Incharge, RCM, Dr. D.V. Yadav participated in the discussions. In the meeting, in-depth discussions were held on sugarcane seed production, problems of local cane farmers and mechanization of sugarcane farming. A demonstration of implements for sugarcane cultivation was also organized. About 120 participants took active part in deliberations at interface meeting. It was decided that some equipments/machinery developed at the Institute be kept at the Motipur Centre for demonstration to the farmers.

Other meetings

Technical Group/Review Meeting of AP Cess Network Research Project on Sugarbeet on September 28, 2006.

DUS Review Meeting chaired by Dr. S. Nagrajan, Chairperson, PPV&FR Authority on August 22, 2006 at IISR, Lucknow.

Meetings of the Committee to decide *modus operandi* of Revolving Fund under the Mega Seed Project and for day-to-day monitoring of the implementation work under the Mega Seed Project.

Stake Holder Sensitization Workshop on National Agricultural Innovation Project (NAIP) was held on 11.09.2006 at Lucknow financed by NAIP, New Delhi.

7. IISR- Manufacturers Meet

IISR, Lucknow & manufacturers of agricultural implements in the form of Public-Private Partnership Interface was held in the institute on February 12, 2007. Dr. N.B. Singh (Agriculture Commissioner, Ministry of Agriculture, Government of India, Krishi Bhavan, New Delhi) inaugurated the interface between IISR and the manufacturers of agricultural implements as Chief Guest. He fortified the occasion by discussing terms like tax, excise duty and marketing constraints being faced by the manufacturers of agricultural equipments/implements. Technical details of the commercially viable equipment/ implements was presented. Ridger type cutter planter, Raised bed seeder, RBS-raised bed Seeder-cum-cutter planter, Modified 2-row cutter Planter, 3-row multipurpose cutter planter, and Pit digger were selected. There were 14 experienced and reputed manufacturers from Tamil Nadu, Maharashtra, Uttar Pradesh and Punjab, who took keen interest, and actively participated in the discussions. They were also shown live demonstration of the technology/ equipment ready for commercial exploitation. A panel consisting of IISR engineer-scientist and representative of manufacturers discussed and recommended modalities for transfer of these technologies. It was decided that the identified manufacturers will sign a MoA with this

IISR Manufacturer Meet in session

Institute on the terms and conditions, as per ICAR guidelines. Besides resource generation, this step will fill the gap between the researchers and the implements manufacturers/industry paving way for public-private partnership to achieve the goal of supplying the commercially viable prototypes to the cane growers/sugar mills for mechanizing sugarcane farming in the country.

Events

Independence Day and Republic Day were celebrated by the staff along with their family members. Dr. R.L. Yadav, Director of the Institute distributed prizes to winners of intra-institutional games and felicitated them.

Dr. R.L. Yadav, Director, IISR Lucknow along with winners of Intra-Institutional game events

Hindi Awareness Fortnight (*Hindi Chetna Maas/Pakhwara*)

Under the overall guidance of Director, Dr. R.L. Yadav and with the active roll of Incharge, Official Language, Dr. D.V. Yadav, "Hindi Pakhwara" was observed from 14-30 September, 2006. Several competitive events such as essay writing, notes, debates, Hindi general knowledge, Hindi typing on computers, shorthand, question-answer session, drafting, *Antakshari* and *Hasya-Vyanga* involving the staff members were organized to encourage use of Hindi in day-to-day office working and scientific communications among the scientists and other employees of the institute. The winners of various competitions were distributed first, second, and third prizes worth Rs. 500, Rs. 300 and Rs. 200, respectively. A panel of 9 Judges and one assisting sub committee consisting of 23 members made the event successful. Dr. Ram Murti Singh, Additional Cane Commissioner (Retd.), Lucknow, delivered a lecture on "Ganna Niyantran Aadesh-2006" to mark the occasion and lauded the efforts of IISR in encouraging the use of Hindi in the institute.

Dr. R.L. Yadav, Director, IISR, Lucknow distributing prizes to the events winners

Vigilance week

Vigilance week was observed at the Institute with the aim "To be vigilant and to work for the growth and reputation of our organization".

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Distinguished visitors

Prof. Ram Gopal Yadav, the Chairman of the Parliamentary Standing Committee on Agriculture along with 9 members of the Lok Sabha and 6 members of the Rajya Sabha along with officials from Lok Sabha Secretariat and DARE, Government of India visited the Institute on November 11, 2006 and discussed the role and achievements of IISR in the development of sugarcane in India.

Dr. M.V. Rao, Ex-Vice-Chancellor, Acharya N.G. Ranga Agriculture University (A.P.) visited on August 17, 2006 and interacted with the Heads of Divisions/Scientists on the research programmes of the Institute.

Dr. S. Nagarajan, Chairperson, Protection of Plant Varieties and Farmers Rights Authority, New Delhi visited the Institute on August 22, 2006 and sensitized the scientists on the IPR issue relating to plant varieties.

Mr. Hiraghi, Kawahara, Sr. Councillor and Mr. Ukihero Tanigaki, Councillor, Japan on February 6-7, 2007.

Mr. Nagendra from Shakti Sugar Mills, A.P. visited Institute during Jan., 2007.

Mr. Sudhir Kumar, IAS, Resident Commissioner of Karnataka visited on January, 25, 2007 and emphasized for frontline research.

Prof. D. M. Diwakar from the Giri Institute on Development Studies, Lucknow visited on October 4, 2006 to critically review the outcome of the Institute during Xth Plan period of this Institute,

Mr. V. P. Kothiyal, Director (Works), ICAR, New Delhi visited the Institute on November 28, 2006 to review the on-going repair and maintenance work.

Dr. R.L. Yadav, Director, IISR, Lucknow discussing common areas of interest with Japanese team

Dr. G. Kalloo, DDG, Crop Sciences, ICAR visited on November 16, 2006.

Dr. D.G. Hapse, ex-Director, VSI, Pune visited on Jan. 23, 2007.

Dr. S.B. Singh, Director, U.P. Council of Sugarcane Research, Shahjahanpur visited on January 23-24, 2007.

Shri. S.L. Gupta, Secretary, Indian Sugar Mill Association, New Delhi visited on January 23-24, 2007.

Dr. C.P.S. Yadav, Director General, UPCAR, Lucknow visited on January 23, 2007.

Heads of Sugarcane/Sugar research Institutions in the country viz., National Sugar Institute, Kanpur, Director of Sugarcane Development, Govt. of India, U.P. Council of Sugarcane Research, office bearers of ISMA and Cane Commissioners of Different States visited Institute and contributed in the National Seminar on January 23-24, 2006.

Australian delegation comprising Nils Berding, Dr. Jackson, Dr. Laxman from BSES Limited, Gordonvale, visited IISR, Lucknow on 19.04.2007 and made presentation on Australian Sugar Industry and Biotecnology Research. Framework for Australia-India sugarcane research collaboration was suggested after having interaction with the Institute scientists.

Dr. B. Sundra, PS&Head, SBI Coimbatore visited on Jan. 23-24, 2007

Dr. Mehar Singh, Assistant Cane Commissioner of Punjab, and the representatives of Haryana & Gujarat state federation of sugar mill visited on Jan 23-24, 2007.

Dr. A.N. Mukhopadhyay, Ex V.C., AAU, Assam visited on July 12, 2006.

Dr. Satyavir, Former Dean, College of Agriculture, HAU, Hisar visited on July 12, 2006.

Dr. P. Padmanabhan, Head, Crop Protection Division, SBI, Coimbatore visited on July 12, 2006.

Dr. N.B. Singh (Agriculture Commissioner), Ministry of Agriculture, Govt. of India, Krishi Bhavan, New Delhi visited on February 12, 2007.

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Infrastructure development

During the year, 2 Polyhouses, 2 mist chambers and 2 net houses were constructed. The renovation work of main building, refurnishing of Lab (DUS), cable lying, extension of Biotech Lab, face lifting of Administrative Building, repairs of Crop Protection Division Building, rewiring of Guest House and the renovation of workshop continued during this year also. In addition, 2 tube-wells were installed. The procurement of SPAD was also made from RWC.

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Personnel (As on March 31, 2007)

Director	:	Dr. R.L. Yadav

Administration

Head of Office	:	Dr. D. V. Yadav
I/c, Asstt. Finance & Accounts Officer	:	Sri Shatruhan Kumar
Drawing & Disbursing Officer	:	Sri Manna Lal
Asstt. Administrative Officer	:	Sri Manna Lal
	:	Sri R.K. Khanna
	:	Sri Shatruhan Kumar
	:	Sri K.P. Yadav
Security Officer	:	Capt R.A.S. Yadav

Research Coordination and Management

Principal Scientist & Incharge	:	Dr. D.V. Yadav
Senior Scientist (Ag. Econ.)	:	Dr. Ashwani K. Sharma
Technical Officer	:	Sri Mahendra Singh
	:	Sri G.K. Singh

Crop Production

Principal Scientist & I/c, Head	:	Dr. Menhi Lal
Principal Scientist (Soil Chem./Fer./	:	Dr. D.V. Yadav
Microbiology)	:	Dr. P.N. Singh
Principal Scientist (Agronomy)	:	Dr. S.R. Prasad
	:	Dr. R.S. Verma
	:	Dr. R.S. Chauhan
	:	Dr. Arjun Prasad
Principal Scientist (Agril. Extension)	:	Dr. Ram Pal Verma
Senior Scientist (Agronomy)	:	Dr. K.P. Singh
	:	Dr. S.K. Shukla
	:	Dr. A.K. Singh
	:	Dr. Ishwar Singh
Senior Scientist (Soil Chem./Fer./ Microbiology)	:	Dr. Todi Singh
Senior Scientist (Microbiology PS)	:	Dr. (Smt.) Archna Suman
Scientist SS (Agril. Extension)	:	Dr. A.K. Sah
Scientist SS (Agril. Extension)	:	Dr. Kamta Prasad
Technical Officer	:	Sri Ram Singh
	:	Sri S.N. Srivastava
	:	Dr. R.K. Singh

Plant Physiology & Biochemistry

Principal Scientist & I/c, Head	:	Dr. Ashok K. Shrivastava
Principal Scientist (Biochemistry PS)	:	Dr. S. Solomon
Senior Scientist (Plant Physiology)	:	Dr. R.K. Rai
	:	Dr. Ishwar Singh
	:	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

Crop Improvement

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

Crop Protection

Principal Scientist & I/c, Head	:	Dr. S.K. Gangwar
Principal Scientist (Plant Pathology)	:	Dr. Vijay Singh
	:	Dr. S.N. Srivastava
	:	Dr. A.P. Singh
	:	Dr. Ram Ji Lal
	:	Smt. Sunita Lal
	:	Dr. S. Pandey
Principal Scientist (Agril. Entomology)	:	Dr. D.C. Srivastava
	:	Dr. R.K. Tewari
Principal Scientist (Nematology)	:	Dr. Abdul Rashid
Senior Scientist (Plant Pathology)	:	Dr. S.K. Duttamajumder
Senior Scientist (Agril. Entomology)	:	Dr. G.M. Tripathi
Scientist S.G (Plant Pathology)	:	Sri S.C. Misra
Scientist S.S. (Agril. Entomology)	:	Dr. Maharam Singh
	:	Dr. Arun Baitha
Technical Officer	:	Sri R.B. Jadhav
	:	Dr. S.K. Awasthi
	:	Dr. D.C. Rajak
	:	Sri Sanjay Bhatnagar
	:	Sh. B.B. Joshi
	:	Sri Amar Nath
	:	Sri Niranjan Lal
	:	Sri M.P. Sharma
	:	Sri I.P. Maurya

Agril. Engineering

Principal Scientist & Head	:	Dr. Jaswant Singh
Principal Scientist (Farm Mach. & Power)	:	Er. M.P. Sharma
	:	Dr. A.C. Srivastava
	:	Dr. P.R. Singh
Principal Scientist (Elec. & Instr.)	:	Sri R.K. Pangasa
Senior Scientist (Soil Water Con. Engg.)	:	Er. Rajendra Gupta
Senior Scientist (Farm Mach. & Power)	:	Dr. A.K. Singh
	:	Dr. S.I. Anwar
	:	Dr. R.D. Singh
Senior Scientist (Ag. Str./Proc. Engg.)	:	Sri Dilip Kumar
Technical Officer	:	Sri Jasbeer Singh
	:	Sri S.K. Kushwaha
	:	Sri M.H. Ansari
	:	Sri Vinayak Sawant
	:	Sri V.N. Mehrotra
	:	Sri S.K. Savita
	:	Sri R.N. Kureel
	:	Sri Mathura Prasad
	:	Sri Someshwar Misra
	:	Sri K.N. Singh
	:	Sri Sharif Ahmad
	:	Sri Rajendra Singh
	:	Sri S.K. Misra
	:	Sri Jiyawan Ram
	:	Sri Satya Narain

Economics/Statistics/ARIS Cell

Principal Scientist & I/c	:	Dr. P.K. Bajpai
Senior Scientist (Agril. Statistics)	:	Dr. Rajesh Kumar
Scientist SS (Computer Science)	:	Sri S.S. Hasan
Technical Officer	:	Dr. Mani Ram Verma

Agrometeorology

Principal Scientist & I/c	:	Sri Arun Kumar Srivastava
Technical Officer	:	Sri Surendra Singh

Radio Tracer Laboratory

Principal Scientist & Incharge	:	Dr. Ashok K. Shrivastava
Technical Officer	:	Sri S.P. 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
		Sri L.K. Lama

AICRP on Sugarcane

Project Coordinator	:	Dr. O.K. Sinha
Principal Scientist (Agronomy)	:	Dr. B.L. Singh
Senior Scientist (Agril. Entomology)	:	Dr. Om Prakash
Technical Officer	:	Dr. J.K.S. Gautam
	:	Sri Adil Zubair

Farm

Scientist Incharge	:	Dr. Menhi Lal
Farm Manager	:	Sri S.K. Pal
Technical Officer	:	Sri Nar Singh
	:	Sri Ramayan Singh
	:	Sri Raghvendra Kumar
	:	Sri Jiyawan Ram
	:	Sri Satya Narayan
	:	Sri B.B. Singh

Krishi Vigyan Kendra

Principal Scientist & Incharge	:	Dr. S.R. Prasad
Programme Coordinator	:	Dr. R.K. Singh
Technical Officer	:	Dr. V.K. Singh
	:	Dr. Om Prakash
	:	Smt. Mithilesh Tiwari

Hindi Unit

Principal Scientist & I/c	:	Dr. D.V. Yadav

Arts & Photography

Scientist Incharge	:	Dr. D.V. Yadav
Technical Officer	:	Sri Vipin Dhawan
	:	Sri Y.M. Singh
	:	Sri J. Ganguli

Dispensary

Principal Scientist & I/c	:	Dr. S.R. Prasad
Medical Officer	:	Dr. S.K. Sethi

Library

Scientist Incharge	:	Dr. Ashok K. Shrivastava
Technical Officer	:	Sri G.K. Gupta
	:	Sri G.D. Dhariyal
	:	Sri Ghanshyam Ram
Incharge, Seed Production Unit	:	Dr. J. Singh
Incharge, Central Laboratory	:	Dr. Archna Suman
Technical Officer	:	Smt. Asha Gaur
Incharge, Vehicles	:	Sri K.P. Yadav

Consultancy Cell

Scientist Incharge	:	Er. M.P. Sharma/ Dr. D.V. Yadav
Member	:	Dr. S.R. Prasad

Guest House

Officer-In-Charge	:	Dr. D. V. Yadav
Manager	:	Dr. S.K. Awasthi

Estate

Officer-In-Charge	:	Dr. Jaswant Singh
Technical Officer	:	Shri M.H. Ansari

IISR Regional Centre, Motipur

Principal Scientist & Incharge	:	Dr. S.N. Singh
Senior Scientist (Agronomy)	:	Dr. V.P. Jaiswal

STAFF NEWS

Deputation to foreign countries.

Dr. R.L. Yadav, Director to attend the International Symposium on Technologies to improve Sugar Productivity in developing Countries, at China during December 5-8, 2006.

Dr. S. Solomon, Pr. Scientist to attend the International Symposium on Technologies to improve Sugar Productivity in developing Countries, at China during December, 5-8, 2006.

Dr. Raman Kapur, Pr. Scientist & Head, Crop Improvement Division to visit Morocco, Egypt to Study the Sugarbeet Cultivation and processing during June 2-11, 2006.

Joinings

Dr. R. K. Singh, joined as Programme Coordinator/Training Organizer, K.V.K. on July 22, 2006.

Sri Vivek Purwar, joined as Sr. Administrative Officer on September 11, 2006.

Sri Patan Deen, T-2 (Carpenter), joined on transfer from CIRG, Makhdoom, Mathura on November 15, 2006.

Dr. V.P. Jaiswal, Sr. Scientist (Agronomy) joined on February 15, 2007 after availaing long leave.

Transfer/relieving

Dr. Rajesh Singh, Sr. Scientist was relieved on November 27, 2006 for joining as Professor (Genetics & Plant Breeding) at BHU, Varanasi.

Sri Vivek Purwar, Sr. AO, was relieved on October 30, 2006 for joining as Deputy Registrar, Laxmibai National Institute of Physical Education, Gwalior.

Sri T.S.N. Murthy, AF&AO, was relieved on December 18, 2006 (on deputation) to join at DGQA, Pune as Administrative Officer.

Sri Aparesh Mukherjee, Assistant was retired on February 28, 2007 to take up the Post of AAO at NRC on Weed Science, Jabalpur (M.P.) on deputation.

Superannuation

During this period, the following persons were superannuated from their respective services.

Dr. S.K. Choudhary, Principal Scientist (Plant Breeding) on January 31, 2007.

Sri R. K. Shukla, T-6 on Septembr 30, 2006.

Sri Jagat Narayan Yadav, S.S.Gd. III on October 31, 2006.

Dr. K.K. Bajpai, Principal Scientist on December 31, 2006.

Dr. R.S. Dwivedi, Prinicipal Scientist on July 31, 2006

Dr. R. Dwivedi, Principal Scientist on July 31, 2006.

Promotions

During this period, the following persons got promotion in their respective service career with effect from the date mentioned against their name.

Granted next higher scale under ACP Scheme

Sri L.K. Ojha, S.S. Gd. I	w.e.f. 07.07.2006
Sri Ram Avatar, S.S. Gd.I	w.e.f. 25.07.2006
Sri Shatrughan, S.S. Gd. I	w.e.f. 25.07.2006
Sri Radhey Lal, S.S. Gd.I	w.e.f. 25.07.2006
Sri Radhey Mohan, S.S. Gd.I	w.e.f. 25.07.2006
Sri Lallo, S.S. Gd.I	w.e.f. 04.08.2006
Sri Arjun, LDC	w.e.f. 04.08.2006
Sri Ramesh Prasad Verma, LDC	w.e.f. 04.08.2006

Promoted to S.S. Grade II

Sri L.K. Ojha	w.e.f. 12.12.2006
Sri Ram Avatar	w.e.f. 12.12.2006
Sri Shatrughan	w.e.f. 12.12.2006
Sri Radhey Lal	w.e.f. 12.12.2006

Promoted to S.S. Grade III categories

Sri R.K. Sexena	w.e.f. 12.12.2006
Sri Kapil Deo Pandey	w.e.f. 12.12.2006
Sri Rakesh Kumar Srivastava	w.e.f. 12.12.2006
Smt. Manju Srivastava	w.e.f. 12.12.2006

Promoted to S.S. Grade IV categories

Sri Makrand Singh	w.e.f. 12.12.2006
Sri Dasa Ram	w.e.f. 12.12.2006

Promotion in Technical categories

Sri Heera Lal to T-1	w.e.f. 31.08.2006
Sri Jhinku Ram to T-1	w.e.f. 31.08.2006
Sri Sudhir Kumar to T-1	w.e.f. 31.08.2006
Sri D.N. Sinha to T-4	w.e.f. 03.02.2005
Dr. Ram Khilari Singh to T-5	w.e.f. 12.04.2006

Necrology

Dr. H.P. Pandey, T-6 (Technical Officer), expired on 23 August, 2006

24 Meteorological data (2006-07)

Month	Temperature (°C)		RH (%)		Rainfall (mm)	Rainy days	Wind velocity (km hr^{-1})	Duration of sunshine (h day^{-1})
	Tmax	Tmin	07 Hrs	14 Hrs				
Apr., 06	37.2	20.6	60	25	16.0	2	3.7	7.5
May	36.6	25.3	71	47	60.4	3	3.2	4.1
June	36.0	26.4	76	54	204.3	4	2.9	3.9
July	32.9	26.3	89	73	387.5	14	3.1	3.4
Aug	33.2	26.0	89	69	117.3	8	3.0	5.0
Sept.	33.9	24.5	87	62	27.3	4	2.4	6.5
Oct.	33.0	19.4	88	43	23.2	1	2.2	7.6
Nov.	28.4	12.8	87	40	4.6	1	1.5	4.5
Dec.	24.6	8.8	90	40	6.3	1	2.3	2.1
Jan., 07	23.0	7.0	87	32	0.0	0	2.7	3.0
Feb.	24.1	11.8	93	53	74.6	3	3.1	4.2
Mar.	28.4	14.5	79	34	31.5	4	5.1	8.0
	30.9	18.6	83	48			2.9	5.0
Total					**953**	**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
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
CMA	Corn Meal Agar
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
CSP	Cadre Strength in Position
CTAB	Catyltrimethyl ammonium bromide
CV	Coefficient of Variation
Cv	Cultivar
DAH	Days after Harvest
DAP	Days after planting
DAS	Days after Sowing
DBT	Department of Biotechnology
DUS	Distinctiveness, Uniformity and Stability
ESTs	Expressed Sequence Tags
Expl.	Exploratory
FIMS	Farm Information Management System
FIRB	Furrow Irrigated Raised Bed
FMD	Foot Mouth Disease (Cattle)
FP	Farmers' Practice
FSF	Flame Spreader Fins
FYM	Farm Yard Manure
GC	General Cross
HOD	Head of Division
HR Brix	Hand Refractrometer Brix
HRD	Human Resource Development
HS	Highly Susceptible
IAA	Indole Acetic Acid
IAPSIT	International Association of Professionals in Sugar and Integrated Technologies

ICS	Integrated Communication Strategy
IDM	International Department of Meteorology
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
ISAE	Indian Society of Agricultural Engineering
ISEE	Indian Society of Extension Education
ISEP	Indian Society of Extension Professionals
IVLP	Institute Village Linkage Programme
IVT	Initital Varietal Trial
IZVT	Inter Zonal Varietal Trial
KVK	Krishi Vigyan Kendra
LAI	Leaf Area Index
LAN	Local Area Network
LCC	Leaf Colour Chart
LER	Land Equivalent Ratio
MHAT	Moist Hot Air Treatment
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MR	Moderately Resistant
MS	Moderately Susceptible
MTA	Material Transfer Agreement
NDVI	Normalized Difference Vegetation Index
NAIP	National Agricultural Innovative Programme
NAR	Net Assimilation Rate
NFOA	Nitrogen Fertilization Optimization Algorithm
NHG	National Hybridization Garden
NMC	Number of Millable Canes
NPK	Nitrogen, phosphorus and Potassium
NRC	Non-Recurring Contingency
NSI	National Sugar Institute
NUE	Nitrogen Use Efficiency
NR	Nitrate Reductase
NWZ	North West Zone
NCZ	North Central Zone
OMA	Oat Meal Agar
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
PSB	Phosphate Solubilising Bacteria
PT	Preparatory Tillage
R	Resistant
RAC	Research Advisory Committee
RBD	Randomised Block Design

RC	Recurring Contingency
RCBD	Randomized Complete Block Design
RCM	Research Coordination and Management
RDF	Recommended Dose of Fertilizers
RE	Revised Estimate (Budget)
RF	Radial Fins
RGR	Relative Growth Rate
RMD	Ratoon Management Device
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
SRC	Staff Research Council
SSF	Simultaneous Saccharification and Fermentation
SSP	Single Super Phosphate
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
UPCAR	Uttar Pradesh Council of Agricultural Research, Lucknow
UPCSR	Uttar Pradesh Council of Sugarcane Research, Shahjahanpur
UPGMA	Unweighted pair-group method of Arithmatic averages
VSI	Vasantdada Sugar Institute, Pune
VC	Vermi Compost
VPN	Vitrual Private Network
WSI	Wilt Severity Index
WHRS	Waste Heat Release System
WCE	Weed Control Efficiency
RAPD	Randomly Amplified Polymorphic DNA
YEM	Yeast extract Mannitol
UDSC	University of Delhi, South Campus

भाकृअनुप
ICAR

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