वार्षिक प्रतिवेदन
Annual Report
2015-16

भाकृअनुप-केन्द्रीय कृषि अभियांत्रिकी संस्थान

ICAR-Central Institute of Agricultural Engineering

Nabi Bagh, Berasia Road, Bhopal – 462 038

नबीबाग, बैरसिया रोड, भोपाल-462038

ANNUAL REPORT
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ICAR-CIAE Annual Report
No. CIAE/2016/35

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Published by
Director, CIAE, Bhopal

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Word Processing
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Printed at
Neo Printers
17-B, Industrial Area, Govindpura, Bhopal
Phone: +91-755- 6900660

June 2016
Correct citation: Anonymous, Annual Report 2015-16, ICAR-Central Institute of Agricultural Engineering, Bhopal

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Preface

It is a matter of pride that the ICAR-Central Institute of Agricultural Engineering, Bhopal has completed 40 years of service to the farming community of India. While reflecting on the success and learning of the forty years, the institute carried forward its journey to develop and promote improved machines and technologies available to the farming community. The year 2015-16 witnessed providing more focus on delivery of complete mechanization packages, be it cropping system specific–soybean-wheat cropping system or millet/banana/sugarcane cropping; geography specific – Central or Southern or NEH region of India; power source specific – draught animal/power operated machines. In some cases, these packages include post-harvest technologies as well. During development of these packages, attempts have been made to either adopt existing technologies or invent a new technology in order to bridge the gap. Operating in sync with the burgeoning technological scenario, the institute has started incorporation of sensors and computer algorithms in technologies for precision application of inputs. Conservation of resources to economise the farming operations and also to reduce detrimental load on the environment was also on the anvil of research priorities. We realise that promotion of mechanization would make the agriculture more energy demanding and therefore, have directed some of our efforts towards producing energy from agriculture. Other major research challenges for which the institute has put some efforts are; mechanization of horticultural production and post-production unit operations, energy management in agriculture, protected cultivation tools and strategies, combating malnutrition, etc. As a whole, the institute is pursuing technological development through 52 research projects, some of which are in collaboration with stake holding institutions, both public and private.

Over the years, the institute has developed many successful technologies, some of which are yet to find appropriate users in the fullest extent. Training and skill enrichment of different type of stakeholders viz., farmers, manufacturers, upcoming entrepreneurs, extension functionaries, teachers, students, etc. of either gender is continuing since long time. Display and demonstrations of technologies at appropriate platforms is also persisting. To augment the technology dissemination, production and supply of successful prototypes has now become a successful model. Higher education in the field of agricultural engineering as an outreach centre of ICAR-IARI, New Delhi has been added to the institute's activities recently. Presently, eight doctoral students are pursuing studies at the institute.

It is heartening to report that the institute has conducted national/international training programmes for around 2500 beneficiaries, organised five national level seminars/workshops, helped in establishment of 350 agri-machinery custom hiring centres in Madhya Pradesh and 80 in Tamil Nadu, supplied prototypes of 44 equipment and demonstrated its technology to huge number of people. Social responsibility of the institute was served through participation in Mera Gaon Mera Gaurav programme.

The Industrial Extension Project of the institute, that was operational at Coimbatore to disseminate appropriate engineering technologies in southern India, has now been upgraded as a Regional Centre on 27 August 2015. The Institute conducted workshops and meets at different places in India to diagnose the regional and/or commodity based mechanization needs. This exercise has not only helped to understand prevailing problems in grape, onion & garlic, citrus, pulses cultivation, but also helped in development of a network with different stakeholders. One of the major impediments in transfer of engineering technologies to users has been non-availability of quality machines. ICAR-CIAE has initiated four-pronged approach to tackle with this situation. To make available complete production designs of the equipment, training of manufacturers in quality fabrication, testing and certification of machine/equipment and establishment of prototype production centres in different parts of India are the components of this approach. Four All India Coordinated Research Projects(AICRP) and two Consortia Research Platforms (CRPs), being coordinated at the institute, have abetted immensely in the cause of agricultural mechanization.

It is with great pleasure that we acknowledge the support, inspiration and guidance of our mentors; Shri Radha Mohan Singhji, President ICAR and Hon'ble Minister of Agriculture and Farmers' Welfare, Govt. of India; Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR; Dr. S. Ayyappan, Ex-Secretary, DARE and Director General, ICAR; Dr. K. Alagusundaram, Deputy Director General (Engg.), ICAR; Dr. Kanchan K. Singh, Assistant Director General (FE), ICAR and Dr. S.N. Jha, Assistant Director General (PE), ICAR. We are thankful to all staff of ICAR headquarters, in general, and Engineering Subject Matter Division, in particular, for all the physical, financial and intellectual support provided during the year. Due to timely help of these officials, scientific strength of the institute has improved. Institutions like Deptt. of Agriculture, Co-operation & Farmers Welfare, Govt. of India; Directorate of Agricultural Engineering, Govt. of Madhya Pradesh; State Agricultural Universities, and sister institutes from ICAR deserve our special appreciation for their treasured inputs in various activities. Achievements included in this report are all due to the unrelenting efforts put in by the scientific, technical, administrative and supporting staff of the institute. Hope this report of ICAR-CIAE help bring metamorphosis of Indian agriculture through appropriate mechanization.

(Krishna Kumar Singh)
Director

Contents

विशिष्ट सारांश

नए प्रोटोटाइप/उपकरणों का विकास

- दो विभिन्न स्तरों पर उर्वरक के प्रयोग करने हेतु एक ट्रैक्टर चालित पांच कतारी बीज सह उर्वरक ड्रिल का विकास किया गया। इस मशीन द्वारा उर्वरक का प्रयोग (प्रथम स्तर बीज की गहराई के स्तर पर तथा द्वितीय स्तर बीज के नीचे 50 मि.मी. पर किया गया)। मशीन की कार्य क्षमता 3.5 कि. मी. प्रति घण्टे की अग्रगामी गति पर 0.53 हेक्टेयर प्रति घण्टा तथा प्रचालन लागत 600/– रूपए प्रति घण्टा है।
- छोटे बीज जैसे मोटे अनाज, जूट तथा गाजर की बुआई के लिए बीज बुआई यंत्र (प्लांटर्स) के छः विभिन्न डिज़ाइन विकसित किए गए। इनमें दो प्रकार की मापक प्रणालियों का प्रयोग किया गया। ये हैं हस्तचालित एक कतारी, बैलचालित तीन कतारी (दोनों प्रकार के मापक प्रणाली के साथ) तथा ट्रैक्टर चालित छः कतारी मशीन (विभिन्न मापक प्रणालियों के साथ दो प्रोटोटाइप्स) एवं पावर टिलर के लिए एक मशीन। इस मशीन के प्रयोग से छिड़ककर बोने की तुलना में 90 प्रतिशत बीज बचाए जा सकते हैं। इसी प्रकार पारम्परिक विधि की तुलना में 70 प्रतिशत बीजों की बचत की जा सकती है। कतारबद्ध बुआई के फलस्वरूप बेहतर निराई, गुड़ाई एवं उच्च उत्पादकता प्राप्त की जा सकती है।
- बेसल डोज़ (मूलभूत मात्रा) में दानेदार उर्वरक के प्रयोग के लिए जी.पी.एस. आधारित परिवर्तनीय दर उर्वरक एप्लीकेटर का विकास किया गया। विकसित किए गए यंत्र में सूक्ष्म नियंत्रक तथा एक्युएटर को नौ कतारी बीज सह उर्वरक ड्रिल के साथ समायोजित किया गया, यह यंत्र मानचित्र के आधार पर परिवर्तनीय दर पर प्रणाली उर्वरक को क्षेत्र में प्रयोग कर सकता है। नौ निर्गत द्वारों के इस यंत्र के बीच परिवर्तनीयता का गुणांक (CV) या परिवर्तनीयता 11.7–15.0 प्रतिशत था।
- धान तथा गेहूँ की फसल में यूरिया के छिड़काव हेतु स्पेक्ट्रल रिफ्लेक्टेन्स आधारित संवेदक (ग्रीन सीकर) के साथ परिवर्तनीय दर वाली यूरिया छिड़काव प्रणाली तथा यंत्र का विकास किया गया। छिड़काव यंत्र 2 कि.मी. प्रति घण्टे की अग्रगामी गति पर 25 मि.मी. के चौड़े फ्लूटेड रोलर्स के साथ 8.5 से 30 कि.ग्रा. प्रति हेक्टेयर नाइट्रोजन तथा 18.5 से 65 कि.ग्रा. यूरिया प्रति हेक्टेयर की मीटरिंग करने में सक्षम है।
- सब्जी के बीजों जैसे मिर्च, बैंगन व टमाटर को 104 प्रकोष्ठ (Portray) (13x8 आयताकार में) बुआई के लिए एक हस्तचालित नर्सरी सीडर का विकास किया गया। पारम्परिक हस्तचालित विधि द्वारा बीज बोने की तुलना में इस विधि से लागत एवं श्रम में 67 से 68 प्रतिशत तक बचत पाई गई।
- गन्ने के एकल बड सेट काटने की मशीन का विकास किया गया जिसमें उच्च कार्बन स्टील तथा 2800 चक्र प्रति मिनट, घूर्णन गति वाले दो जोड़ी वृत्ताकार ब्लेड्स लगाए गए हैं। मशीन में एक साथ दो प्रचालकों की आवश्यकता होती है एवं इसकी क्षमता 3000 एकल बड्स प्रति घण्टा देखी गई।
- ट्रैक्टर के आगे लगाकर चलाए जानेवाले हाइड्रॉलिक चालित एकल कतारी ज्वारकटाई यंत्र का विकास किया गया। इसकी 3 कि.मी. प्रति घण्टे अग्रगामी गति पर फसल की बाली काटने व उसे एकत्रित करने की दक्षता क्रमशः 96 प्रतिशत तथा 90 प्रतिशत पाई गई। मशीन की कार्यक्षमता एवं प्रचालन की लागत क्रमशः 0.12 से 0.15 हेक्टेयर प्रति घण्टा तथा 3000/– रूपए प्रति हेक्टेयर पाई गई।
- गन्ने के रेशे मापने के लिए हस्तचालित उपकरण का विकास किया गया। इस प्रणाली में माइक्रोप्रोसेसर एवं उपयुक्त सॉफ्टवेयर के साथ बल संवेदी प्रतिरोधक (force sensitive resistor) का उपयोग किया गया है।
- केले के मध्य भाग का प्रसंस्करण करके न्यूनतम प्रसंस्करित टुकड़ों वाला उत्पाद तथा केले के तने से रस निकालने हेतु सम्पूर्ण यान्त्रिकीकरण पैकेज का विकास किया गया। इस पैकेज में (1) केले के मध्य भाग से टुकड़े निकालने के लिए 45–50 कि.ग्रा. प्रति घण्टे क्षमता वाला एक स्वचालित उपकरण, (2) छोटे टुकड़े (dices) प्राप्त करने के लिए 35 कि.ग्रा. प्रति घण्टा क्षमता वाला एक डाइसर (टुकड़े बनाने की मशीन), (3) एक 60 कि.ग्रा. प्रति घण्टे की क्षमता वाली रेशे निकालने की इकाई, (4) एक 50 कि.ग्रा. प्रति घण्टे की क्षमता वाला स्पिन (गोल घूमने वाला) शुष्कक (ड्रायर), (5) रस निकालने के लिए एक 40 कि.ग्रा. प्रति घण्टे की क्षमता वाला ज्यूसर/ग्राइन्डर तथा (6) एक 40 कि.ग्रा. प्रति घण्टे की क्षमता वाला ज्यूस स्क्वीज़र यंत्र है।

- केले के तने की बाहरी छाल से रस्सी बनाने की प्रक्रिया को यान्त्रि त करने के लिए उपकरणों का पैकेज। इसमें (1) केले के तने को आवश्यकतानुसार विभिन्न चौड़ाई (2, 3, तथा 4 मि.मी.) में विभक्त करने के लिए उपकरण तथा (2) विभक्त की गई पट्टिकाओं को मोड़ने व लपेटकर रस्सी बनाने का उपकरण जिससे हस्तचालित विधि की अपेक्षा 20 प्रतिशत उच्च परिणाम प्राप्त किए जा सकते हैं।
- अरहर एवं अन्य अनाजों को सुखाने के लिए 200 कि.ग्रा. क्षमता तथा 1.20 लाख रूपए की लागत वाले संकर (सौर ऊर्जा एवं जैव पदार्थ ऊर्जा) गर्म हवा वाला शुष्कक को विकसित किया गया जो संकर ऊर्जा (सौर ऊर्जा एवं जैव पदार्थ ऊर्जा) द्वारा संचालित है। सौर टनल क्षेत्र में तथा प्लेनम प्रकोष्ठ में तापमान क्रमशः 70+10°से. तथा 50+10°से. तक प्राप्त किया जा सकता है। गीली अरहर में नमी की मात्रा 20 सौर घण्टो (08 घण्टे प्रतिदिन) में 35.5 प्रतिशत से घटकर 8 प्रतिशत तक हो गई जबकि सामान्य खुली धूप में सुखाने में 32 घण्टों का समय लगा।
- पूर्व उपचारित ज्वार के दानों से पोहा तैयार करने के लिए मिलेट फ्लेकिंग मशीन का विकास किया गया जिसकी फ्लेकिंग की दक्षता लगभग 92 प्रतिशत देखी गई। मशीन से प्राप्त फ्लेक्स की न्यूनतम मोटाई 0.5 मि.मी. थी।
- "गारसिनिया कम्बोजिया" से गाढ़ा रस प्राप्त करने के लिए उपकरण का पैकेज (1) एक 40 कि.ग्रा. प्रति घण्टे की क्षमता वाला ज्यूसर/ग्राइन्डर, (2) एक 30 लीटर प्रति घण्टे क्षमता वाला ज्यूस स्क्वीज़र तथा (3) प्राप्त रस को गाढ़ा करने की इकाई जिसकी क्षमता 30 लीटर प्रति समूह है। लगभग 100 कि.ग्रा. "गारसिनिया कम्बोजिया" फलों से ज्यूसर /ग्राइन्डर का उपयोग करते हुए 30 लीटर रस निकाला जा सकता है जिसे अधिक गाढ़ा बनाकर 5–6 लीटर किया जा सकता है। उत्पादन की लागत 300 रूपए प्रति लीटर तथा उत्पाद का विक्रय मूल्य लगभग 700 से 750 रूपए प्रति लीटर है।
- फसल अवशिष्ट से बायोचार (जैविक कोयला) तैयार करने के लिए एक रिएक्टर प्रणाली विकसित की गई। रिएक्टर प्रणाली का ईंधन ब्रिकेट्स थे। प्रक्रिया में उत्पन्न गैस को पुनः प्रणाली में उपयोग कर लिया जाता है। रिएक्टर में ब्रिकेट्स तथा गैस का उपयोग करते हुए तापमान 450 से 500 डिग्री से. बनाए रखा जाता है। अरहर के डन्ठलों से इस तापमान पर 26.8 प्रतिशत कोयला प्राप्त हुआ।

मूल्यांकन/परिशोधन

- कोदो तथा लिटिल मिलेट के लिए यांत्रिकीकरण पैकेज का विकास एवं मूल्यांकन किया गया। इसमें खेत तैयार करने, रोपाई, खरपतवार उखाड़ने, कटाई तथा गहाई के लिए विभिन्न शक्ति स्त्रोतों के विकल्प जैसे हस्तचालित, बैलचालित एवं ट्रैक्टर चालित/स्वचालित मशीनरी सम्मिलित है।
- व्यावसायिक तौर पर उपलब्ध 11 प्राथमिक, द्वितीय एवं संरक्षणपूर्ण खेती संबंधी उपकरणों के कार्यनिष्पादन का मापन बी.आई.एस. द्वारा अनुशंसित गति पर 60 अश्वशक्ति एवं 35 अश्वशक्ति के ट्रैक्टर द्वारा किया गया। इस दौरान गियर एवं थ्रोटल की विभिन्न अवस्थाओं व संयोजनों को परखा गया। विभिन्न कार्यनिष्पादन मापदण्डों के आधार पर देखा गया कि 2 बॉटम मोल्ड बोर्ड हल, 3 बॉटम मोल्ड बोर्ड हल, 1.8 मीटर रोटावेटर, 2.1 मीटर रोटावेटर, स्थिर शॉवल कल्टीवेटर, सबसॉइलर, स्वीप कल्टीवेटर को 60 अश्वशक्ति के ट्रैक्टर के साथ प्रचालित करना किफायती होगा। जबकि 1.5 मीटर रोटावेटर, एक कतारी सबसॉइलर, स्प्रिन्ग शॉवल कल्टीवेटर, छोटा स्थिर शॉवल कल्टीवेटर एवं जीरो टिल ड्रिल को 35 अश्वशक्ति के ट्रैक्टर से काली मिट्टी में प्रचालित करना किफायती होगा।
- भारवाही पशुओं का प्रयोग करते हुए सोयाबीन–चना तथा सोयाबीन–गेहूं फसल चक्र की संरक्षणपूर्ण खेती में विभिन्न जुताई विधियों का मूल्यांकन किया गया। संरक्षित खेती में पशु शक्ति का प्रयोग करने पर, 6 से 13 प्रतिशत कुल ऊर्जा व्यय में प्रचालन लागत (बीज, उवर्रक तथा रसायनों) में 22 से 60 प्रतिशत बचत की जा सकती है।
- बागवानी फसलों के भण्डारण हेतु सौर फोटोवोल्टाइक (SPV) से प्रचालित (2.5 TR) की प्रशीतन प्रणाली का मूल्यांकन ताजे कच्चे व पके आमों, टमाटर, शिमला मिर्च तथा गेंदे के फूलों का भण्डारण करके किया गया। पके हुए/कच्चे दशहरी आमों, टमाटर (cv. NS 503) शिमला मिर्च तथा गेंदे के फूलों की भंडारण अवधि तीन से पांच दिनों की तुलना में बढ़कर 14 से 21 दिन हो गई।

- नाइट्रोजन के वातावरण में चने के डन्ठलों से जैविक कोयला बनाने संबंधी "एन्यूलर कोर बायोचार रिएक्टर" का मूल्यांकन किया गया। नाइट्रोजन वाले वातावरण में बनाया गया जैविक कोयला (Biochar) अधिक स्थिर था।
- सोयाबीन एवं लैन्टाना के फसल अवशिष्ट से बनाए गए कोयले की ऊष्मीय एवं रासायनिक सक्रियता का अध्ययन किया गया। pH में लम्बे समय तक परिवर्तनीयता तथा कोयला प्राप्त करने में रासायनिक सक्रियता अधिक उपयोगी पाई गई।
- पारम्परिक खेती पद्धति की तुलना में ड्रिप सिंचाई तथा प्लास्टिक मल्च के साथ धान घनत्वीकरण की प्रणाली (SRI) को अपनाने से धान की पैदावार में 33 प्रतिशत तथा ड्रिप सिंचाई की तुलना में 17 प्रतिशत की वृद्धि देखी गई।
- पारम्परिक खेती की तुलना में टपक सिंचाई तथा प्लास्टिक मल्च के साथ गेहूँ घनत्वीकरण की प्रणाली (SWI) को अपनाने से गेहूँ की पैदावार में 37 प्रतिशत तथा ड्रिप सिंचाई प्रणाली की तुलना में 12 प्रतिशत की बढ़ोत्तरी देखी गई।
- खुले खेत में उगाने की तुलना में शत प्रतिशत टपक सिंचाई तथा उर्वर सिंचाई (फर्टीगेशन) के साथ पॉलिहाउस मे शिमला मिर्च उगाए जाने पर पैदावार 80 प्रतिशत अधिक हुई। साथ ही फल की लम्बाई, फल का व्यास (व्यास), फल व पौधे का वजन तथा पैदावार अधिकतम पाई गई। खुले खेत में खेती करने की तुलना में इस पद्धति में जल की बचत 40 प्रतिशत पाई गई।
- शेड नेट तथा खुले खेत में उगाए जाने की तुलना में शत प्रतिशत ड्रिप सिंचाई तथा उर्वरसिंचाई (फर्टिगेशन) के साथ पॉलिहाउस में उगाए जाने पर टमाटर की सर्वाधिक पैदावार (93.1 टन प्रति हेक्टेयर) प्राप्त हुई।
- ड्रिप सिंचाई की अवस्था में काली मल्च पट्टी के उपचार के साथ 60 दिनों पश्चात पट्टी हटाए जाने पर आलू की अधिकतम पैदावार 30.17 टन प्रति हेक्टेयर देखी गई। चांदी के रंग की मल्च पट्टी उपचार को 60 दिनों पश्चात हटाए जाने पर 29.26 टन प्रति हेक्टेयर तथा बिना मल्च अवस्था में आलू की पैदावार 20.82 टन प्रति हेक्टेयर पाई गई।
- पारम्परिक विधि की तुलना में 150, 200 तथा 250 मि.मी. गहराई के मोल ड्रेनेज के साथ चौड़ी क्यारी पद्धति (BBF) के लिए गेहूँ की पैदावार क्रमशः 9.96, 12.86 तथा 13.32 प्रतिशत तक बढ़ी हुई पाई गई।
- छिड़काव (स्प्रिन्क्लर) सिंचाई प्रणाली के अंतर्गत सिंचाई को समयबद्ध करने के लिए जिग्बी (Zigbee) प्रोटोकॉल का प्रयोग करते हुए टेलीमेट्री आधारित स्वचालित नियन्त्रक एवं संवेदक नेटवर्क की स्थापना की गई।
- डबल आर्च प्रकार के ग्रीनहाउस में ट्रस, पाइप, फ्रेम, फसल, लाइव लोड तथा हवा के कारण दबाव क्रमशः 250, 100, 200, 250 तथा 770 N/m^2 (न्यूटन प्रति मीटर^2) पाया गया। ग्रीनहाउस पर लगने वाले कुल दबाव में वायु के दबाव का योगदान लगभग 50 प्रतिशत पाया गया। सुरक्षित संरचना निर्माण के लिए पर्लिन्स तथा कॉलम्स के डिज़ाइन आकार का इष्टतमीकरण किया गया, जिससे ज्ञात हुआ कि 2 मि.मी. मोटाई वाले 63 मि.मी. बाहय व्यास को 2.6 मि.मी. मोटाई वाले 1.35 मि.मी. चौकोर पाइप से प्रतिस्थापित किया जा सकता है। कॉलम्स में मोटाई को 2.0 मि.मी. से बढ़ाकर 3.2 मि.मी. किया जाना उपयुक्त पाया गया।
- जल में घुलनशील उर्वरकों का प्रयोग करते हुए शत प्रतिशत सिंचाई तथा उर्वर सिंचाई के प्रयोग/उपचार से आम (आम्रपाली किस्म) तथा अमरूद (L–49 किस्म) की सर्वाधिक उपज प्राप्त की गई। इसके पश्चात् 80 प्रतिशत सिंचाई एवं 100 प्रतिशत उर्वर सिंचाई से उच्च पैदावार प्राप्त की गई।

प्रसंस्करण प्रक्रिया का विकास एवं मूल्य संवर्धित उत्पाद

- अनाज आधारित (ज्वार, पर्ल मिलेट, कोदो मिलेट, लिटिल मिलेट तथा बार्नयार्ड मिलेट) हाइड्रोकोलॉइड्स मिलाई गई ग्लूटन रहित ब्रेड बनाई गई।
- विभिन्न प्रकार के एन्जाइम्स (ट्रिप्सिन, पेप्सिन तथा पैपेन) का वसारहित सोया आटे, सोया प्रोटीन कान्सन्ट्रेट (SPC), सोयाप्रोटीन आइसोलेट (SPI), ओकारा से सोया प्रोटीन आधारित हाइड्रोलाइसेट्स तैयार करने के लिए प्रौद्योगिकी का विकास किया गया।
- लचीली पॉलिमेरिक फिल्म/लैमिनेट्स में सोयादूध पाउडर तथा प्रोबायोटिक सोया चीज़ स्प्रेड को संग्रहित व पैकेज करने की तकनीक का विकास किया गया। दोनो मेटालाइज्ड पॉलीएस्टर पैकेट में निर्वात की अवस्था में 10^8cfu/g का प्रोबायोटिक कल्चर पाया गया। स्प्रे ड्राइड

पाउडरों में उन्हे 2 माह तक 4 °C तक संग्रहित करने पर प्रोबायोटिक बैक्टीरिया के संख्या की गणना स्थिर पाई गई।

- केले के तने के रस को तैयार करके भंडारण (संरक्षित) करने की एक प्रक्रिया विकसित की गई जिसमें रस की भंडारण अवधि लगभग छः माह पाई गई। केले के तने से निकाले गए रस को चीनी मिलाकर 2 प्रतिशत ब्रिक्स से अधिक उन्नत बनाया जा सकता है।
- बहु–पोषणयुक्त आटा मिक्स (रागी, अंकुरित अमरंथ तथा अंकुरित सोया) से ग्लूटन एवं अण्डारहित केक तैयार किए गए। मिश्रित आटे में लगभग 11–13 प्रतिशत प्रोटीन, 5–7 प्रतिशत वसा तथा 9–11 मि.ग्रा. प्रति 100 ग्राम लौह, 82–85 मि.ग्रा. प्रति 100 ग्राम फॉस्फोरस, 73–75 मि.ग्रा. गैलिक एसिड (प्रति 100 ग्राम फेनोलिक्स के समतुल्य) , 2. 8 से 3.2 मि.ग्रा. (क्वेरेसिटीन) (E प्रति 100 मि.ग्रा. फ्लेवॉनाइड्स के समतुल्य) तथा 89–93 प्रतिशत DPPH के एन्टीऑक्सीडेन्ट का RSA था। इस मिश्रण से तैयार किए गए केक में उच्च मात्रा मे फाइबर, लौह तत्व, एन्टीऑक्सीडेन्ट, फ्लेवॉनाइड्स तथा फेनोलिक्स थे, साथ ही यह किसी भी प्रकार के त्रिम मिलावट से रहित था तथा इसमें गेहूँ का आटा, अण्डा तथा संतृप्त वसा का उपयोग नही किया गया।

सॉफ्टवेयर विकास एवं अन्य अध्ययन

- बारह राज्यों के इस डाटाबेस में 12525 भारतीय षि श्रमिकों (8025 पुरूष एवं 4500 महिलाएं) के 79 मापदण्डों संबंधी आंकड़ों का संग्रहण कर एक ऑनलाइन डाटाबेस तैयार किया गया। छः राज्यों से 5937 भारतीय खेत श्रमिकों (3423 पुरूष एवं 2514 महिलाओं) के 16 मापदण्डों पर संबंधी आंकड़े भी इस डाटाबेस में उपलब्ध हैं।
- देश के विभिन्न षि जलवायु क्षेत्रों में भाड़े पर उपयुक्त षि मशीनरी पैकेज दिए जाने के लिए एक वेब आधारित सॉफ्टवेयर विकसित किया गया है। सॉफ्टवेयर से चयनित मशीनरी पैकेज की आर्थिक व्यवहार्यता का विश्लेषण किया जा सकता है।
- मध्यप्रदेश के रायसेन, देवास, खण्डवा, छिन्दवाड़ा, सिवनी, मण्डला एवं अशोक नगर जिलों में चयनित फसल पद्धति में यांत्रिकीकरण के स्तर का अध्ययन किया गया। यांत्रिकीकरण सूचकांक का स्तर गेहूँ में 57.61 प्रतिशत तथा चना में 44 प्रतिशत पाया गया जबकि यह धान में 40 प्रतिशत, सोयाबीन तथा मक्का में 43.50 प्रतिशत में तुलनात्मक रूप से कम पाया गया।
- ग्राम काछी बरखेड़ा में चौड़ी उत्थित क्यारी में बुआई तथा लेज़र भू समतलक के आर्थिक प्रभाव का मूल्यांकन किया गया। धान के लिए बुआई का क्षेत्र 2013 में 1.8 हेक्टेयर से बढ़कर वर्ष 2015 में 49 हेक्टेयर हो गया जिसमें 42 किसानों द्वारा इस प्रकार के समतलक का प्रयोग किया। किसानों को धान की फसल में औसत विशुद्ध लाभ 61,512 रूपए प्रति हेक्टेयर हुई जबकि सोयाबीन की फसल में विषम जलवायु परिस्थितियों के कारण यह केवल 8080 रूपए प्रति हेक्टेयर थी।
- सोयाबीन के उत्पादन के लिए खेती के विभिन्न प्रचालनों हेतु ऊर्जा के निवेशों का ऊर्जा की प्रत्यक्ष एवं अप्रत्यक्ष खपत के आधार पर विश्लेषण किया गया। ऊर्जा की कुल प्रचालनीय खपत 7119.3 से 9325.6 मेगाजूल में प्रति हेक्टेयर तक पाई गई। सोयाबीन की खेती के लिए कुल प्रत्यक्ष ऊर्जा का योगदान 23.9 तथा 39.66 प्रतिशत था, जबकि अप्रत्यक्ष ऊर्जा 60.34 तथा 76.1 प्रतिशत पाई गई।
- ऊर्जा उपयोग की दक्षता में सुधार लाने के लिए सोयाबीन तेल निष्कर्षण संयंत्र (600 TPD) का ऊर्जा आंकलन (ऑडिटिंग) किया गया।

अन्य गतिविधियां

- भारतीय षि अनुसंधान परिषद द्वारा प्रायोजित 21 दिवसीय ग्रीष्मकालीन प्रशिक्षण का आयोजन किया गया जो "जैव पदार्थ एवं जैव ईंधन" पर था।
- कृषि मे ऊर्जा हेतु संघीय मंच पर एक विशाल परियोजना प्रारम्भ की गई

प्रौद्योगिकी प्रसार

- विभिन्न हितधारकों को 53.7 लाख रूपए मूल्य की विविध 2890 प्रोटोटाइप इकाइयों का निर्माण एवं प्रदाय किया गया।
- सोया मक्खन उत्पादन के लिए मेसर्स सना वेगन प्रॉडक्ट्स, विशाखापटनम एवं मेसर्स लवसोया फूड प्रॉडक्ट्स, एल एल

पी, मैसूर के साथ अनुज्ञापत्र एवं समझौता ज्ञापन इकरारनामे (एम ओ ए) पर हस्ताक्षर किए गए।

- मोरिंगा लीफ स्ट्रिपर, एलोवेरा जैल एक्स्ट्रेक्टर तथा मल्टीप्लायर ऑनियन पीलर के लिए मेसर्स नेक्सजेन ड्राइंग सिस्टम प्रा. लिमिटेड, पुणे के साथ समझौता ज्ञापन इकरारनामे (एम ओ ए) पर हस्ताक्षर किए गए।
- पश्चिमी अफ्रीका षि उत्पादकता कार्यक्रम (डब्ल्यू.ए.ए.पी. पी.) द्वारा प्रायोजित अफ्रीका–एशियाई राष्ट्रों के लिए एक अन्तर्राष्ट्रीय प्रशिक्षण कार्यक्रम (2 नाइजीरियाई नागरिक), एक ग्रीष्मकालीन प्रशिक्षण (14 प्रतिभागी), डी.ओ.ए.सी. द्वारा प्रायोजित माडल प्रशिक्षण कार्यक्रम (21 प्रतिभागी) किराये पर मशीनरी चलाने का उद्यमिता विकास संबंधी आठ प्रशिक्षण कार्यक्रम (295 प्रतिभागी) तथा म.प्र. शासन द्वारा प्रायोजित कटाई उपरान्त प्रौद्योगिकियों पर उद्यमिता विकास संबंधी दो प्रशिक्षण कार्यक्रम (92 प्रतिभागी) आयोजित किए गए।
- सोयादूध, सोयापनीर एवं सोया आधारित अन्य उत्पाद तैयार करने संबंधी दस प्रशिक्षण (163 प्रतिभागी) आयोजित किए गए।
- देश के विभिन्न षि अभियांत्रिकी महाविद्यालयों से आए 196 विद्यार्थियों के लाभार्थ 4 से 8 सप्ताह के चौदह प्रशिक्षण कार्यक्रम आयोजित किए गए।
- देश के विभिन्न स्थानों पर आयोजित व्यापार मेले, किसान मेले, 23 अन्तर्राष्ट्रीय, राष्ट्रीय एवं क्षेत्रीय स्तरीय प्रदर्शनियों में संस्थान की प्रौद्योगिकियों का प्रदर्शन किया गया।
- हितधारकों के समग्र लाभ हेतु एवं संस्थान की उपस्थिति को अधिक प्रभावी रूप से दर्शाने हेतु संस्थान द्वारा विकसित प्रौद्योगिकियों, गतिविधियों एवं सुविधाओं के बारे में एक नवीन वृत्तचित्र "CIAE-A Profile" का निर्माण किया गया।
- कृषि अभियांत्रिकी प्रौद्योगिकियों के बारे में एक प्रौद्योगिकी सूचना पोर्टल षियन्त्रा को परस्पर प्रयोग हेतु एवं SMS के लिए उपयुक्त बनाया गया है ताकि उपयोगकर्ता द्वारा यह आसानी से उपयोग में लाया जा सके।

अन्य उपलब्धियां

प्रकाशन

वर्ष 2015–16 के दौरानसंस्थान के वैज्ञानिकों द्वाराराष्ट्रीय एवं अन्तर्राष्ट्रीय पत्रिकाओं (जर्नल्स) में 41 शोध पत्र प्रकाशित किए गए। इनके अतिरिक्त तीन पुस्तकें, सात पुस्तक अध्याय, 48 लोकप्रिय लेख तथा 25 तकनीकी बुलेटिन भी प्रकाशित किए गए।

पुरस्कार एवं सम्मान

संस्थान के वैज्ञानिकों को एक एन.ए.एस.आई.–भाकृअनुप पुरस्कार, एक इन्स्टीट्यूशन ऑफ इन्जीनियर्स (इण्डिया) द्वारा आउट स्टैन्डिग इन्जीनियर अवार्ड– 2015, आई.एस.ए.ई. से 2015 में एक सम्मान स्वरूप पदक, आई.एस.ए.ई. से आउट स्टैन्डिंग बुक अवार्ड, दो श्रेष्ठ शोध पत्र, चार श्रेष्ठ पोस्टर प्रदर्शन पुरस्कार तथा एक श्रेष्ठ लोक प्रिय लेख पुरस्कार विभिन्न अन्तर्राष्ट्रीय व राष्ट्रीय, संगोष्ठियों, अधिवेशन, सभाओं, बैठकों में प्राप्त हुए।

पेटेन्ट तथा कॉपीराइट

संस्थान द्वारा प्रोबायोटिक सोया चीज़ स्प्रेड, ग्लूटेन मुक्त अण्डा रहित केक की प्रसंस्करण प्रौद्योगिकियों तथा ऑवले के बीज निकालने व टुकड़े करने के उपकरण के लिए तीन पेटेन्ट आवेदन प्रस्तुत किए गए हैं। साथ ही विभिन्न कम्प्यूटर सॉफ्टवेयर के लिए चार कॉपीराइट आवेदन भेजे गए हैं।

आयोजन

वर्ष के दौरान आयोजित कुछ मुख्य कार्यक्रम थे–कोयंबटूर मे संस्थान के क्षेत्रीय केन्द्र का उद्घाटन, कृषि संगोष्ठीयां, विश्व खाद्य दिवस समारोह, खाद्य सुरक्षा एवं पोषण पर शालेय छात्रों के लिए कार्यशाला, संरक्षित खेती पर राष्ट्रीय कार्यशाला, अन्तर्राष्ट्रीय महिला दिवस कार्यक्रम, संस्थान का स्थापना दिवस, दलहन विकास पर राष्ट्रीय कार्यशाला, विकलांगता पर राष्ट्रीय संगोष्ठी, अखिल भारतीय समन्वित अनुसंधान परियोजना एवं सी.आर.पी. की वार्षिक समीक्षा बैठकें एवं कार्यशालाएं।

Executive Summary

New prototypes/ gadgets

- A tractor drawn five row seed-cum-fertilizer drill with provision to apply fertilizer at two stages (first stage at seed depth and second stage 50 mm below the seed) in single pass gives field capacity of 0.53 ha/h at forward speed of 3.5 km/h. Cost of operation is Rs.600/h.
- Six different designs of seed planters for sowing of small seeds viz., millet, jute and carrot using two types of metering mechanism(s) have been identified/ developed. These are manually operated single row, bullock drawn three rows (two prototypes with different metering devices) and tractor drawn six row machine (two prototypes with different metering devices) and an attachment to power tiller. Use of the multi millet seed cum fertilizer planter saved 90% seeds as compared to broadcasting and 70% seeds as compared to drilling by traditional methods and better weed management due to line sowing gave added advantage in obtaining higher productivity.
- A GPS based variable rate fertilizer applicator (VRFA) for granular fertilizer application as basal dose, consists of micro-controller and actuator integrated with nine-row seed cum fertilizer drills to use it as prescription maps based system. The variability for nine outlets of granular fertilizer was in the range of 11.7-15.0%.
- An 'on-the-go variable rate urea application system integrated with spectral reflectance based sensor'(Green Seeker) for mid-season top dressing urea in rice and wheat crop has been developed. The applicator is capable of metering 8.5-30 kg/ha N (18.5-65 kg of urea/ha) at 2 km/h forward speed with 25 mm wide fluted roller.
- A manually operated nursery seeder suitable for sowing of vegetable seeds such as chilli, brinjal and tomato in 104 cells portrays (13 x 8 rectangular arrays) is a small gadget useful for ease of operation. Cost of operation and labour saving was found in the range of 67-68% when compared with manual seeding by traditional method.
- A double headed sugarcane single bud sett cutting machine consisting of two pairs of circular blades made of high carbon steel, rotating at 2800 rpm. Capacity of the machine is 3000 single buds/h with two operators working simultaneously.
- A tractor front mounted hydraulic operated single row sorghum harvester has been developed. The earhead cutting and earhead collection efficiency was found to be 96 and 90%, respectively, at the forward speed of 3 km/h. Field capacity and cost of operation of the machine was observed in the range of 0.12-0.15 ha/h and Rs.3000/ha, respectively.
- A handheld equipment to measure the fibre content of sugarcane consists of a force sensitive resistor coupled with a microprocessor and suitable software. The force required to compress sugarcane rind has been correlated with fibre content of the crop, a parameter frequently measured by breeders.
- A complete mechanization package for banana central core processing for making minimally processed diced product and banana central core juice has been successfully developed and transferred to some end users. The machine package consists of (i) an automatic slicing equipment of 45-50 kg/h capacity for obtaining banana central core slices, (ii) a dicer for obtaining dices (capacity: 35 kg/h), (iii) a fiber removing unit (capacity: 60 kg/h), (iv) a spin dryer (capacity: 50 kg/h), (v) a tilting type juicer/grinder for extraction of juice (capacity: 40 kg/h), and (vi) a juice squeezer (capacity: 40 kg/h).
- A package of equipment to mechanize the rope making process from outer sheath of banana pseudo stem consists of (i) equipment for splitting the outer

sheath of banana pseudostem into different width of strands (2, 3 and 4 mm) as required, and (ii) equipment for twisting and winding of splitted strands. The new system produces 20% higher output than manual method of twisting.

- A hybrid (solar - biomass) hot air dryer for drying of pigeon pea and other grains with a capacity of 200 kg and a cost of Rs.1.20 lakh has been installed. The temperature in solar tunnel area and in the plenum chamber can be achieved upto 70±10 °C and 50±10 °C, respectively. Moisture content of wet pigeon pea was found to reduce from 35.8 % (w.b) to 8% (w.b.) in 20 solar hours (8h/d) compared to 32 solar hours in open sun drying.
- A millet flaking machine for preparing flakes from pre-treated whole sorghum grains with flaking efficiency of about 92% is capable to produce flakes of 0.5 mm thickness.
- A package of equipment to obtain the juice concentrate from *Garcinia combogia* consisting of (i) a juicer/grinder (40 kg/h), (ii) a juice squeezer (30 l/h) and (iii) a juice concentration unit (30 l/batch). From about 100 kg of *Garcinia combogia* fruits, 30 litre of juice can be extracted by using juicer/grinder and this can be further concentrated to 5-6 litres. The cost of production is Rs.300/l against selling price of about Rs.700-750/l.
- A reactor system for preparation of biochar from crop residues using briquettes as fuel has been developed. The vapour generated during the process is again fed into the system. Temperature inside the reactor can be maintained in the range of 450 – 500 °C using briquettes and vapour. Recovery of the biochar from pigeon pea stalk is 26.8%.

Evaluation and refinement of technology

- A mechanization package for kodo and little millet crop consists of machinery for seed bed preparation, planting, interculture, harvesting and threshing operation employing different power source options such as manual, bullock and tractor/self-propelled.
- Performance of 11 commercially available primary, secondary and conservation tillage implements were measured with 60 and 35 hp tractors at recommended speed of operation as per BIS with different gear and throttle position combinations. Based on the various performance parameters, it could be more economical to operate 2 and, 3 bottom MB plough, 1.8 m rotavator, 2.1 m rotavator, large rigid shovel cultivator, subsoiler, sweep cultivator and spring shovel cultivator with 60 hp tractor whereas operation of 1.5 m rotavator, single shank subsoiler, spring shovel cultivator, small rigid shovel cultivator and zero till drill could be more economical with 35 hp tractor in vertisol.
- Different tillage methods using draught animal were evaluated under conservation agriculture practice of soybean-gram and soybean-wheat crop rotation. With the use of conservation agriculture using animal energy, 6-13% total energy expenditure, 22 to 60% of operational cost (animal, labour, implements) and 10 to 15% input cost (seed, fertilizer and chemical) can be saved.
- Anthropometric data on 79 parameters for 12,525 Indian agricultural workers (8,025 male and 4,500 female) from 12 states and strength data on 16 parameters for 5,937 Indian agricultural workers (3,423 male and 2,514 female) from 6 states, was compiled and online databank was created.
- Rice yield in System of Rice Intensification under drip irrigation with plastic mulch was found to increase by 33% over the conventional system of cultivation and 17% over drip irrigation. Wheat grain yield in System of Wheat Intensification under drip irrigation with plastic mulch was found to increase by 37% over the conventional system of cultivation and 12% over drip irrigation.
- Capsicum, grown in poly-house with 100% drip irrigation and fertigation, gave 80% higher fruit yield, as well as the highest fruit length, fruit

diameter, individual fruit weight, fruit weight/plant and fruit yield over capsicum, grown in open field condition. 40% water was saved in covered cultivation over capsicum grown in open field cultivation. Tomato gave the highest yield (93.1 t/ha) in polyhouse with 100% drip irrigation and fertigation compared to cultivation under shed-net and open field.

- Potato yield under drip irrigation was found to increase from 29.26 t/ha under no mulch condition to 30.17 t/ha and under black mulch film. However, when silver mulch film was used, the yield was 20.82 t/ha. In both the cases, mulch film was used during first 60 days of growth.
- Wheat grain yield was found to increase by 9.96, 12.86 and 13.32%, respectively, when cultivated under broad bed farming with 150, 200 and 250 mm depths with mole drainage over the conventional practice.
- Solar PV powered refrigeration system (2.5 TR) for storage of horticultural crops was evaluated by storing fresh unripe mature mango, tomato, capsicum and marigold flower. The Shelf life of the matured unripe *Dasheri* mango, tomato (cv. NS 503), capsicum and marigold flower was increased up to 15, 14, 21 and 15 days as compared to 4, 5, 4 and 3 days stored at ambient conditions, respectively.
- In the double arch type greenhouse, the load due to truss, pipe frame, crop, live load and wind were found to be 250, 100, 200, 250 and 770 N/m^2, respectively. The wind load was found to contribute around 50% of the total load of greenhouse. The design of purlins and columns has been optimized for a safe polyhouse structure. Accordingly, it is recommended that perlins should e made using 35 mm square pipe with 2.6 mm thickness, while the columns should use 3.2 mm thick pipe of 76 mm outer diameter.

Value added products and processes

- Process has been developed for millet based (sorghum, pearl millet, kodo millet, little millet and barnyard millet) gluten-free leavened bread with the addition of hydrocolloids.
- Technology is now ready for preparation of soy protein based hydrolysates from okara, soy protein isolate, soy protein concentrate and defatted soy flour using different types of enzymes (trypsin, pepsin and papain).
- Various packaging and storage techniques for probiotic soy-cheese spread and soymilk powder in flexible polymeric films/laminates were evaluated. The viable counting of probiotic culture was found to be more than 10^8 cfu/g in both metalized polyester packet under vacuum. The viable cell counting of probiotic bacterial strains in spray-dried powders were stable during storage at 4 °C up to 2 months.
- A protocol for preparation and preservation of banana central core juice has been finalized. Shelf life of the juice is about six months. The extracted banana central core juice can be raised from 2% brix to the required brix by adding sugar.
- Gluten-free eggless cakes have been prepared from multi-nutrient gluten free flour mix (finger millet, sprouted amaranth and sprouted soy). The flour mix contains approximately 11-13% protein, 5-7% fat, and 9-11mg/100g of iron, 82-85mg/100g of phosphorus, 73-78 mg gallic acid equivalents/100 g of phenolics, 2.8-3.2 mg (querecitin equivalents) QE/100 g flavonoids and 89-93% radical scavenging activity of DPPH of antioxidants. The product is high in fibre, iron, anti-oxidants, flavonoids and phenolics, without any artificially added fortifications, free from wheat flour, egg and saturated fats.

Software development and studies

- Web based software has been developed to ascertain the farm machinery package suitable for custom hiring business in different agro-climatic regions of

the country. Economic feasibility of the selected machinery package such as net present value, benefit cost ratio, payback period, internal rate of return and breakeven analysis can be carried out using it.

- Agricultural mechanization studies conducted for selected cropping pattern of Madhya Pradesh in Raisen, Dewas, Khandwa, Chhindwara, Seoni, Mandla & Ashok Nagar districts found the mechanization index to be higher in crops like wheat (57.61%) and gram (44%) and lower in paddy (40%), soybean (40.4%) and maize (43.5%).
- Economic impact of laser land levelling and broad bed sowing in village Kachhi Barkheda was evaluated. The cultivation area for paddy has increased from 1.8 ha in 2013 to 49 ha (42 farmers) in the year 2015 after introduction of levelling. As a whole a farmer got average net return of Rs.61,512/ha in cultivation of paddy crop while it was only Rs.8,080/ha from soybean crop (due to vagaries of the climate).
- The energy inputs for different farm operations for production of soybean was analysed based on the direct and indirect energy consumption. The total operational energy consumption was observed in the range from 7,119.3 to 9,325.6 MJ/ha. The contribution of total direct energy for soybean cultivation was found between 23.9 and 39.66%, whereas indirect energy contribution was between 60.34 and 76.1%.

Technology transfer activities

- Manufacturing and supply of 2,890 units of different prototypes worth Rs.53.7 lakhs to various stakeholders.
- License Agreement and Memorandum of Agreement (MoA) signed with M/s Sana Vegan Products, Visakhapatnam and M/s Lovsoy Food Products LLP, Mysoreuru for soy butter
- MoAs signed with M/s Sankoh Process Equipment, Hosur-TN, M/s Grenera Nutrients Pvt. Ltd., Erode-TN for Moringa leaf stripper
- MoAs signed with M/s Nexgen Drying System Pvt. Ltd., Pune for moringa leaf stripper, Alovera aloveragel extractor, and multiplier onion peeler.
- One international training programme for two African nationals (two Nigerian Nationals)– sponsored by West Africa Agricultural Productivity Programme, one Summer School (14 participants), one Winter School (22 participants), one Model Training Course sponsored by Deptt. of Agriculture, Cooperation & Farmers Welfare (21 participants), eight training programmes on entrepreneurship development on custom hiring (295 participants) and two training programmes on entrepreneurship development on post-harvest technologies (92 participants) sponsored by Govt. of MP were the major training activities.
- Ten training programmes were conducted on production of soy milk/paneer and preparation of soy based other products (163 participants).
- Fourteen training programmes of 4-8 weeks duration were facilitated which benefited 196 students from different agricultural engineering colleges across the country.
- Display and demonstration of CIAE technologies in 23 International, National and Regional level exhibitions/farmers' fair and trade fairs at different places all across the country.
- A new documentary "CIAE-A Profile" has been released. The documentary tells about activities, facilities and technologies of CIAE and helps increase visibility of the Institute and also serves for the overall benefit of the stakeholders.
- *Krishiyantra* – A Technology Information Portal for agricultural engineering technologies is now more interactive, SMS enabled and user friendly.

Other achievements

- **Publications:** Scientists of the institute published 41 research papers in international and national journals. Apart from these, three books, seven book chapters, 48 popular articles and 25 technical bulletins were published.
- **Awards & Recognition:** Scientists of the institute received NASI – ICAR 2014 Award, Outstanding Engineer Award - 2015 from Institution of Engineers (India), Commendation Medal-2015 of ISAE, Outstanding Book Award of ISAE, two Best Paper Awards, four Best Poster Presentation awards and Best Popular Article Award during various national and international seminars, conferences and symposia.
- **Patents and Copyrights:** The institute filed three patent applications for process technologies for pro biotic soy cheese spread and gluten-free eggless cake and *aonla* deseeding and segmentation equipment and four software copyrights were applied.
- **Events:** Some of the major events conducted during the year were: inauguration of ICAR-CIAE Regional Centre at Coimbatore, Farmers' Interactive meeting (*Krishi Sangoshthi*), celebration of World Food Day, Workshop on Food Safety and Nutrition for school children, National Seminar on Protected Cultivation Technology, International Women's Day, Foundation ay of the Institute, National Workshop on Pulses Development, National Symposium on Disability and Annual Review Meeting/ Workshops for AICRPs/CRPs.

Introduction

ICAR-Central Institute of Agricultural Engineering (CIAE), Bhopal, a premier agricultural engineering institute in India is devoted to promote agricultural mechanization leading to enhancing agricultural productivity; reducing drudgery of agricultural workers; minimizing post-harvest losses, producing value added quality products and creating employment opportunities in the rural sector.

The Institute was established on 15th February, 1976. The activities of the Institute have been strengthened/restructured subsequently. Various activities of the Institute are organized through five divisions (Agricultural Mechanization, Agricultural Energy and Power, Irrigation & Drainage Engineering, Agro Produce Processing and Technology Transfer); four AICRP coordinating centres (Farm Implements & Machinery, Utilization of Animal Energy, Energy in Agriculture & Agro Industries and Ergonomics & Safety in Agriculture); two centres at Bhopal Centre of Excellence on Soybean Processing and Utilization and Krishi Vigyan Kendra (KVK) and a regional centre at Coimbatore.

The mandate of the institute are:

- Research on appropriate mechanization of production and post-production agriculture and effective utilization of renewable and animal energies for agriculture
- Networking of research with state agricultural universities and ICAR institutes for generating location-specific technology in Agricultural Engineering
- Human Resource Development and capacity building through outreach and training programs in the area of Agricultural Engineering
- Technical support for commercialization and utilization of engineering technologies in agriculture

The Institute has 93.85 ha land being used for research, office and residential purpose. Six open wells; eight tube wells and five farm ponds are the major water sources. All the water sources are connected through underground irrigation grid to irrigate 21 ha of cropped area and 15 ha of orchards of guava, mango, aonla and ber. It has weather station to record and store climatic parameters automatically. The Institute also has well-furnished hostel and guest house facilities for 80 guests. The International Training Centre of the Institute has facilities for conducting international meetings and training programmes. The Research Workshop provides the facilities for fabrication of research prototypes and the Prototype Production Centre for multiplication; Computer Aided Design cell develops computer aided models and drawings of research prototypes, Agricultural Knowledge Management Unit assists in database creation and conducting online examinations; instrumentation cell supports instrumentation in various research projects. The Institute library is equipped with computerized cataloguing facility, with around 21000 books and bound journals and a large collection of CD ROMs on journals in agricultural engineering and related disciplines. The library subscribes to about 70 Indian and foreign journals and provides e-subscription of some journals. The infrastructure created at the Institute caters to various research & development and technology transfer activities.

The regional centre at Coimbatore addresses the engineering intervention needs of southern states of the country. To address the wider region specific technological issues, CIAE is linked with the whole country through All India Co-ordinated Research Projects (AICRP). The institute KVK serves to demonstrate the technologies for wider adoption by the farmers, in general and of Bhopal district, in particular.

Budget

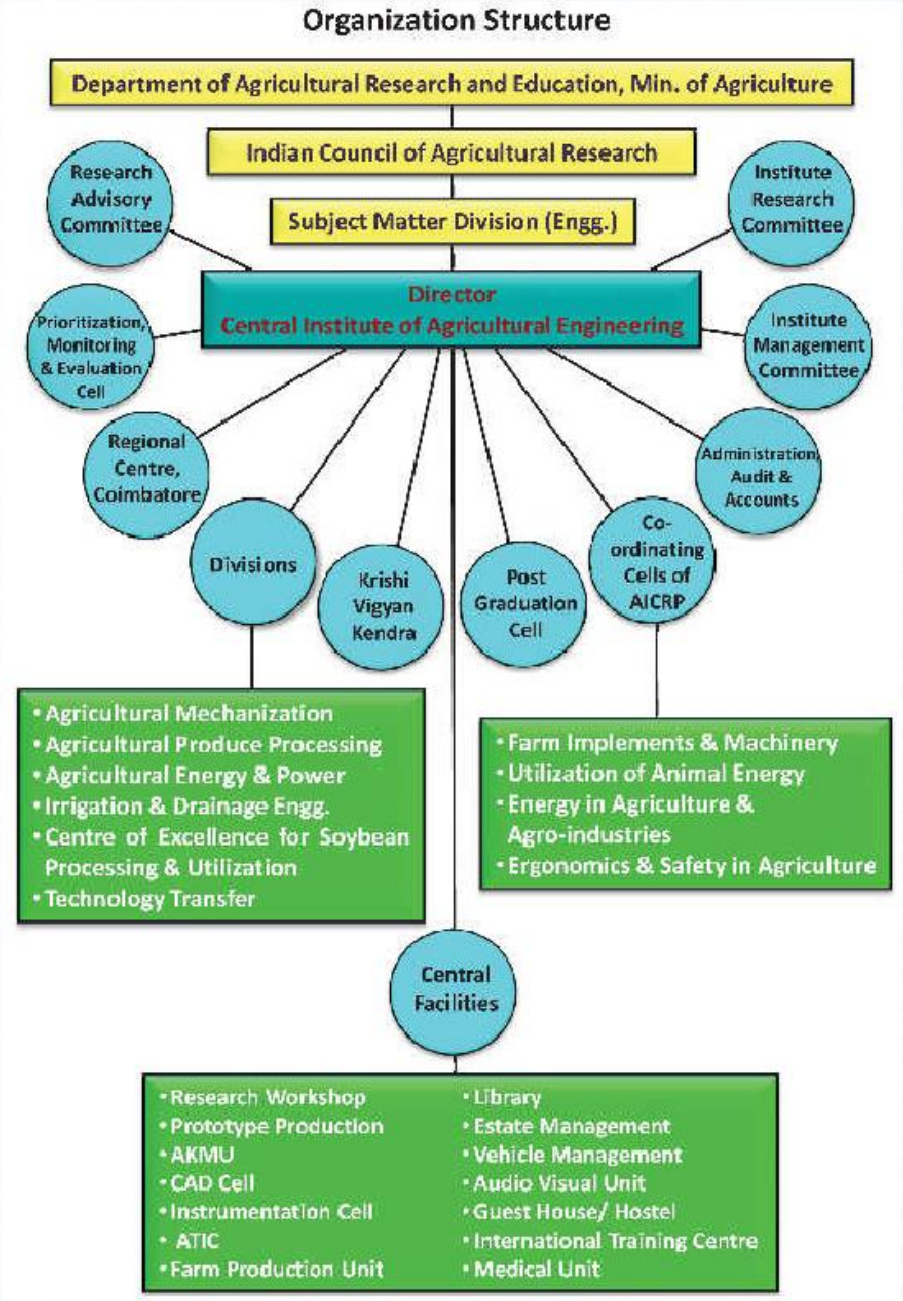
(Rs. in lakh)

Scheme	Sanctioned (RE)		Expenditure	
	Plan	Non-Plan	Plan	Non-Plan
ICAR-CIAE	671.00	4020.79	670.69	4018.65
AICRP on FIM	1304.00	47.40	1303.86	47.34
AICRP on EAAI	725.00	36.60	724.90	36.40
AICRP on ESA	330.00	3.49	329.94	3.44
AICRP on UAE	520.00	53.00	519.97	52.78
CRP on FM&PF	61.00	--	60.13	--
CRP on EA	108.00	--	106.99	--
National Fellow	--	32.25	--	25.25

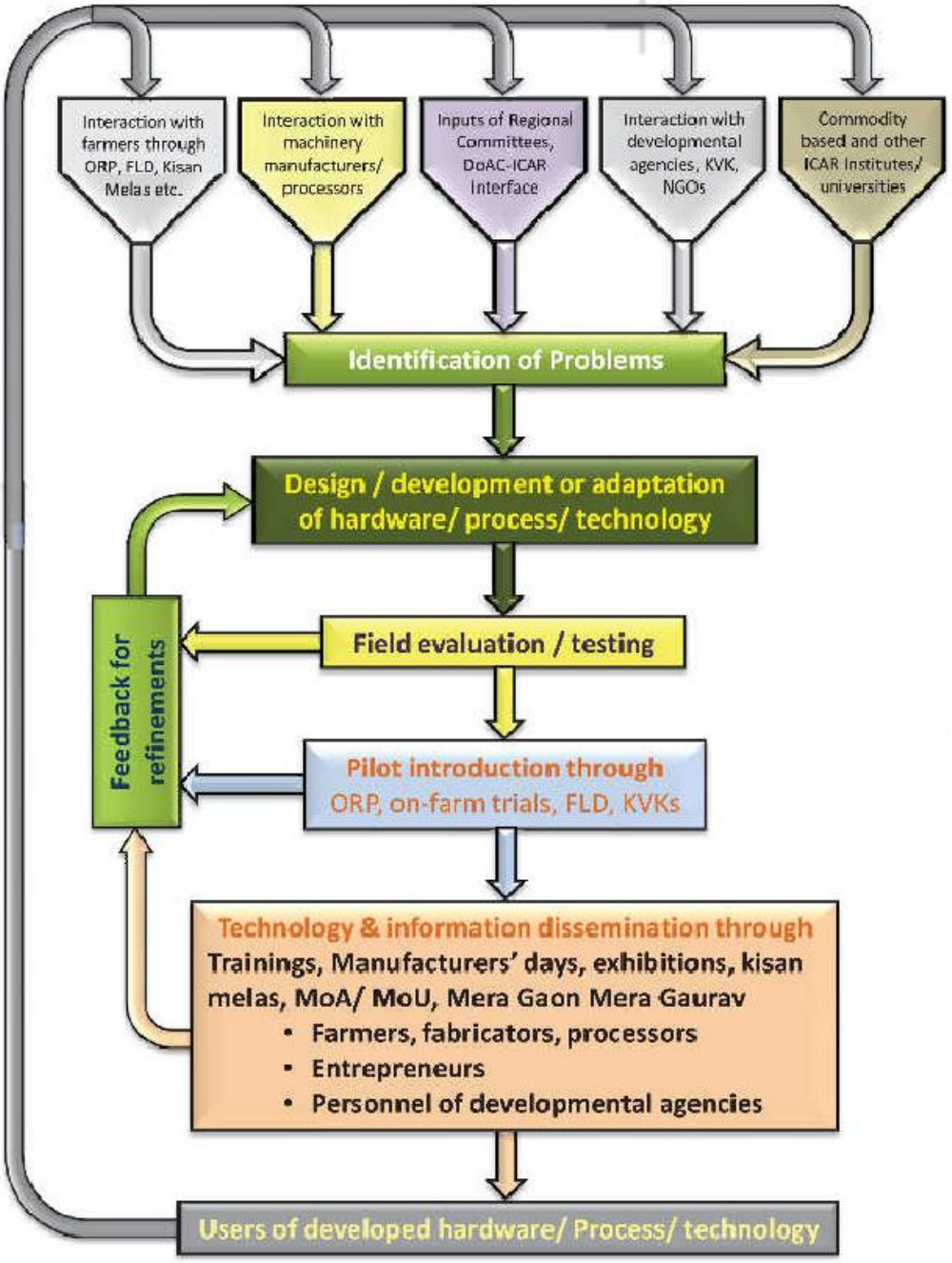
Staff position

Sl. No.	Posts	Sanctioned	In position	Vacant
1	RMP	01	01	--
2	Scientific	90	70	20
3	Technical	150	123	27
4	Administrative	73	58	15
5	Skilled Support Staff	83	52	31
	Total	**397**	**304**	**93**

Organization Structure



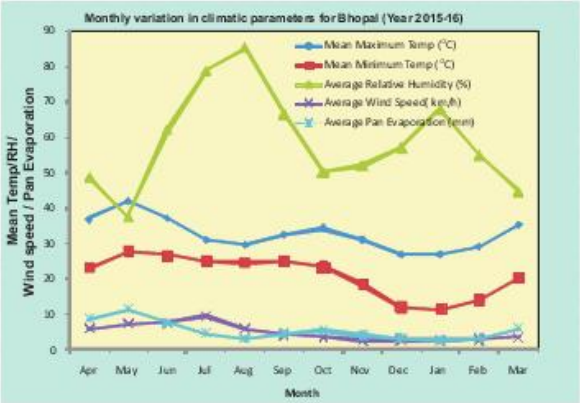
Technology Development Process of CIAE

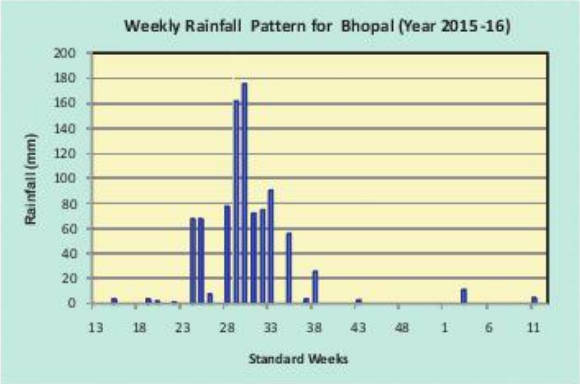


Meteorological observations

Agro meteorological weather station of the institute is located at 77°25' E longitude and 23°16' N latitude at an elevation of 498.7 m above mean sea level. Rainfall, minimum and maximum temperatures, relative humidity, pan evaporation and wind velocity are recorded on daily basis. Salient meteorological observations for 2015-16 are:

- Monsoon started on June 16 and withdrew on September 23, 2015. The heaviest rainfall of the season (112.0 mm) was recorded on July 19, 2015. Annual rainfall of 906.4 mm occurred in 37 rainy days during the year 2015-16.
- The maximum temperature of the year (45.2°C) was recorded on May 29, 2015 while minimum (5.5°C) was recorded on January 24, 2016. Humidity in the morning (7:20 a.m.) varied from 26 to 100% while in afternoon (2:20 p.m.) it varied from 12 to 97%.
- The highest average wind velocity of 15.9 km/h was recorded on July 06, 2015while the lowest was 1.1 km/h on December 30, 2015.
- The highest pan evaporation of 15.8 mm/day was recorded on May 25, 2015 while the lowest was 1.4 mm/day on July 22, 2015.





Research and Development

Technologies ready for commercialization

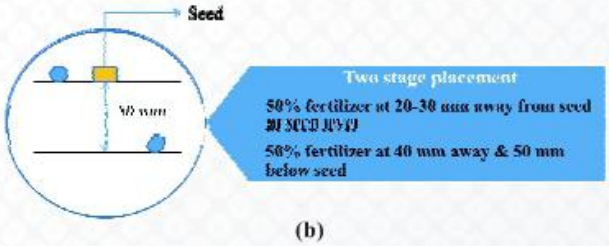
The research pursuit has succeeded in the form of technologies for increased input use efficiency, timeliness of operations, reduction in drudgery, energy generation, reduction of losses and value addition, etc. The technologies – hardware, processes, protocols etc. – matured during the current year are presented below.

Equipment/hardware

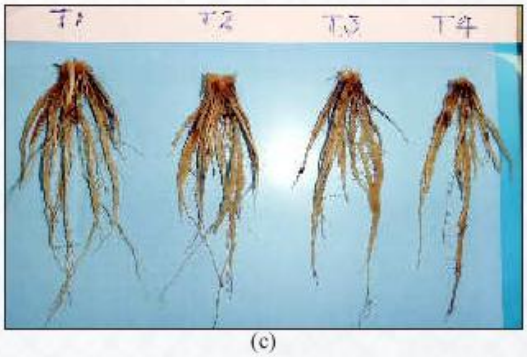
Seed-cum-ferti drill with two stage fertilizer placement system

Fertilizer application at two depths has been reported beneficial by agronomists; however no equipment was available for such fertilizer placement in single pass for soybean and wheat. A tractor drawn five row seed-cum-fertilizer drill has been developed that can place fertilizer at two stages (first stage at seed level and second stage 50 mm below the seed) in single pass (Fig. 1). Overall dimension of the machine is 2070×1445×1340 mm. Weight and working width of the machine are 200 kg and 1500 mm, respectively. Field capacity of the machine is 0.53 ha/h at forward speed of 3.5 km/h. Cost of operation is Rs. 600/h. Machine was evaluated for sowing of wheat and soybean. Four treatments viz. T1 (placement of 50% fertilizer at 20-30 mm lateral distance from seed and rest 50% fertilizer at 40 mm away and 50 mm below seed), T2 (40 mm away and 50 mm below the seed), T3 (20-30 mm away at same depth of seed) and T4 (placement of fertilizer in contact with seed) were evaluated. Two years experimental results on wheat-soybean crops, cultivated on permanent broad bed, revealed that maximum yield can be achieved by applying the fertilizer at two stages i.e. 40 mm away and 50 mm below the seed (Fig. 1 b). Such placement has resulted in marked improvement in root growth of wheat (Fig. 1 c) and soybean crops, that subsequently resulted in an increased 15 % yield of wheat and 22% yield of soybean, compared to traditional practices of using same fertilizer dose. Equipment was also demonstrated in Kachhi Barkheda, a village adopted by the institute.

(a)



(b)



(c)

Fig. 1. a) Seed cum fertilizer drill with two stage fertilizer placement system, b) Schematic representation of recommended fertilizer placement, c) Root growth of wheat under different treatments

- An estimated saving of 5-7% in phosphorus and potash fertilizers can be achieved.
- Using the same fertilizer dose a farmer can get additional income of Rs. 8000/- per ha in wheat and Rs. 7000/- per ha in soybean crop.

Planting system for small seeds

Based on two selected metering mechanisms viz., vertical rotor type and inclined plate type, six different configurations of seed planters have been developed. These are; manually operated single row, bullock drawn three-row (two prototypes with different metering devices) and tractor drawn six-row machine (two prototypes with different metering devices) and an attachment to power tiller. These equipment are suitable for sowing of small seed such as Kodo millet, Little millet, Porso millet, Foxtail millet, Barnyard millet, Finger millet, Mustard and Jute. The seed and fertilizer metering plates are 120 mm in diameter with 24 equally spaced slots on its periphery. The metering device is operated by ground wheel of 400 mm diameter through chain and sprocket drive. Specifications of the machines and its field performance parameters are given in Table 1. Use of the multi millet seed cum fertilizer planters can save upto 90% seeds as compared to broadcasting and 70% seeds as compared to drilling by traditional methods. The developed equipment can be used by millet growers of Madhya Pradesh, Chhattisgarh, Andhra Pradesh and Maharashtra depending upon available farm power source.

Table 1. Specifications of developed planting system for small seeds with different power sources

Multi millet planters	Parameters
	**Manual drawn single row multi-millet seed cum fertilizer planter** (vertical rotor type for seed and fertilizer) Overall dimensions, mm (L x W x H) : 1170x450x1100 Overall weight, kg : 20 Draft, N : 100-200 Field capacity, ha/h : 0.05-0.06 Field efficiency, % : 62-70 Cost of operation, Rs./ha : 600-700 Cost of machine, Rs. : 5000/-
	**Bullock drawn three row multi-millet seed cum fertilizer planter** Metering mechanism for seed : vertical rotor/ inclined plate Metering mechanism for fertilizer: vertical rotor Overall dimensions, mm (L x W x H) : 700x1000x900 Overall weight, kg : 35 Draft, N : 400-500 Field capacity, ha/h : 0.12-0.14 Field efficiency, % : 65-70 Cost of operation, Rs./ha : 800-900

Six row multi-millet seed cum fertilizer planter

Power source: Tractor/Power tiller (with proper attachments)

Metering mechanism for seed : vertical rotor/ inclined plate

Metering mechanism for fertilizer: vertical rotor

Overall dimensions, mm (LxWxH)	:700x2100x1000
Overall weight, kg	: 75
Fuel consumption, l/h	: 3-4
Draft, N	: 800-900
Field capacity, ha/h	: 0.52-0.62
Field efficiency, %	: 70-82
Cost of operation, Rs./ha	: 1,000-1,200
Cost of equipment, Rs.	: 35,000/-

GPS based variable rate granular fertilizer applicator for basal dose application

A GPS based variable rate fertilizer applicator (VRFA) has been developed for basal dose application (Fig. 2). It consists of a differential global positioning system (DGPS) receiver, electronic control unit (ECU), DC motor actuator, threaded screw arrangement and fluted roller type metering mechanism. The fertilizer application rate can be varied from 5 to 300 kg/ha by changing the fluted roller exposure length through threaded screw arrangement actuated by DC motor.

The control signals to the DC motor actuator are sent from the control software running on Windows OS to the ECU based upon the prescription map data and GPS location used for identifying the grid point.

To synchronize time lag (80 to 550 ms) with forward speed of travel and grid identification, the distance between the DGPS receiver and fertilizer drop tubes was kept such that operating speed can be adjusted within the range of 1.8 to 4.5 km/h. The coefficient of variation or variability for nine outlets of granular fertilizer was in the range of 11.7-15.0%. The minimum and maximum time lag was observed as 910 and 2280 ms for varying fertilizer application rate of 5-100 and 5-300 kg/ha, respectively. The fertilizer application

Fig. 2. GPS based variable rate granular fertilizer applicator system

accuracy ranged from 89.3 to 98.1% at different discharge rates. The system accuracy was 15% of the recommended rate for grid resolution of 8×8 m. The developed VRFA, micro-controller and actuator could be integrated with conventional seed cum fertilizer drills to use it as a VRFA system based on prescription maps.

- VRFA technology can save 13-15% of fertilizer over conventional method.

Spectral reflectance based variable rate top dress urea application system

For mid-season top dressing urea in rice and wheat crop, an on-the-go variable rate urea application system, integrated with spectral reflectance based sensor (Greenseeker) (Fig. 3) has been developed. The applicator can be mounted on back of operator (weight 5.5 kg without urea) and covers swath width of 4 m.

Fig. 3. Variable rate urea application in wheat

The applicator consists of two Greenseeker sensors which sense the crop health through normalised difference vegetation index (NDVI), two metering units (fluted roller) and dispensing (spinning disk) units mounted on aluminium frame. The applicator needs GPS enabled android based smart phone (android version 2.3- 5.0) with USB-OTG for its operation. A "Variable Rate Controller" app (Fig.4) has been developed to control the applicator. The applicator is capable of metering 8.5-30 kg/ha N (18.5-65 kg of urea/ha) at 2 km/h forward speed with 25 mm wide fluted roller. The operator's workload to operate the developed variable rate urea application system was found to be "Moderate" with 9 kg of urea load.

- An estimated 8-15% savings in urea can be achieved with use of NDVI based variable rate fertilizer applicator in wheat and rice crops in areas with spatial nitrogen variation.

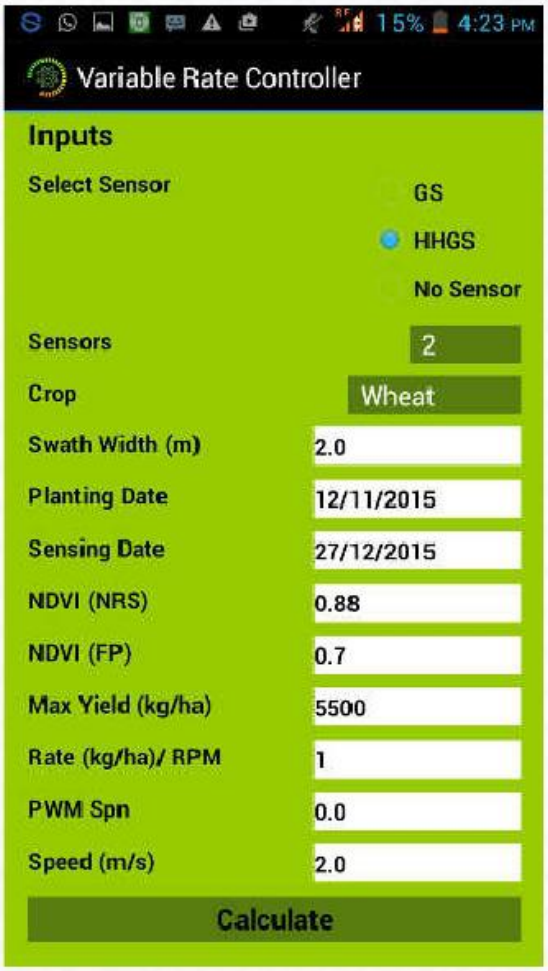


Fig. 4. Screenshot of variable rate controller app

Annular core biochar reactor for generation of char in nitrogen ambient

To achieve oxygen free pyrolysis environment during slow pyrolysis, an annular inner core biochar reactor was developed to accomplish charring under nitrogen environment (Fig. 5). The annular inner core biochar reactor was evaluated with pyrolysis of gram stalk under air and nitrogen environment. Material was charred at 500°C in air and in nitrogen, and compared for the adsorbent ability in terms of iodine number (IN). The char must be stable to act as biochar for the purpose of carbon sequestration, i.e., its IN should be low. It was found that the activation level of biochar under nitrogen environment (IN: 250 ± 5 mg/g) was comparatively lower than the levels obtained using similar process condition under air environment (IN: 260 ± 10 mg/g). Recovery of the biochar was more or less similar in the air and nitrogen environment to the tune of 25-35%. The process conditions for biochar preparation from gram stalk were optimized to be 500°C, 45 min of process time and nitrogen ambience using annular inner core bio-char reactor.

Fig. 5. Annular core biochar reactor

Post harvest mechanization package for banana central core processing

Banana central core is an abundant natural resource in tropical and subtropical regions, which is a good source of nutrition. The central core contains around 1.2% carbohydrate, 0.3% protein, 0.7% fibre, 1% mineral, and is rich in potassium. It also contains other minerals such as calcium, iron, magnesium and phosphorus in substantial quantities. The material, which is otherwise wasted, can be converted into value added products for human consumption, thus helping in generating additional revenue to banana farmers and entrepreneurs.

- It is estimated that about 5 tonnes of banana central core can be obtained from one ha of banana plantation, which when value added as diced product, would be valued as Rs. 1.25 lakh.
- If it is further processed into banana central core juice, it would fetch a value of Rs. 2.25 lakh
- By using this package of equipment, one can save time and cost upto 65% and labour by 75% for minimal processing/ juice extraction of banana central core.

Currently, manually made products like diced banana central core, banana central core pickle, candy, soup mix, etc., are available in the market. A complete post harvest mechanized package for making of minimally processed diced product from banana central core and banana central core juice has been developed in collaboration with National Research Centre for Banana, Tiruchirapalli.

The set of machinery (Fig. 6) consists of; i) an automatic slicing equipment of 45-50 kg/h capacity, ii) a dicer of 35 kg/h capacity, iii) a fiber removing unit of 60 kg/h capacity, iv) a spin dryer of 50 kg/h capacity, v) a tilting type juicer/grinder of 40 kg/h capacity, and vi) a juice squeezer of 40 kg/h capacity. Protocol for extraction and bottling of juice from banana central core has been standardized. Shelf life of the juice is about six months

Fig. 6. Set of equipment for banana central core processing

The package of equipment has been extensively demonstrated and five entrepreneurs are now commercially producing banana central core juice and other related products.

Mechanization package for rope making from outer sheath of banana pseudo stem

Each banana pseudostem contains about 14-18 sheaths. The outermost 4-6 sheaths yield coarse fibre, the next 6-8 sheath give soft lustrous fibre, and the rest of the middle sheaths yield very soft fibres. Ropes from outer sheath of banana pseudostem are in high demand. At present, hand spinning or ratt machines are used for making these ropes which is labour intensive and drudgerous process. The twisted rope is used for production of various eco-friendly handicraft materials like bags, curtains, table mats etc. which has huge demand both in local and international market. The Institute has given a solution to these problems in the form of a package of equipment for splitting of outer sheath into strands and twisting and winding of splitted strands. ICAR-NRC Banana, Tiruchirapalli collaborated in this work.

The equipment (Fig. 7) for splitting consists of a pair of rotating nylon rollers with arrangement of blades and grooves. One roller is operated at a preset speed by a 0.5 hp motor. The outer sheath of banana pseudostem is fed in between the two rotating rollers, rotating at 150 rpm. As the outer sheath passes between the two rollers, the sheath is split into various strands. Different sets of rollers are used for different width of strands viz., 2, 3 and 4 mm.

Fig. 7. Banana sheath splitting equipment

The equipment for twisting and winding of splitted strands has a mechanism for twisting and another mechanism for winding the twisted strands on four bobbins through a bobbin building mechanism (Fig. 8). Provision is made to vary the number of twists with the help of speed control mechanism, based on the requirement of the end product. The optimum feed inlet to get the twist of 160- 190/m was obtained at the feed inlet of about 3-3.5 m/min. The machine is operated by two 0.25 hp single phase motors. The equipment has been evaluated in collaboration with M/s. Rope Production Centre, Melakkal, Madurai, Tamil Nadu.

- The banana pseudostem from one heatare land when processed for rope making would give about 2.4 lakh meter of banana sheath rope valued at Rs.1.0 lakh

Advantages of the equipment over manual method of twisting and winding

- Uniform twist
- Less space requirement
- Need not depend on skilled labour and can work continuously
- Cheaper than manual labour (Rs. 20/100 m, whereas the traditional method out cost Rs. 30/100 m of twisting and winding)
- 20% higher output than manual method (600 m/h, against 500 m/h by traditional method)

Fig. 8. Equipment for twisting and winding of splitted strands

Process and protocol

System of crop intensification under drip irrigation with plastic mulch

A system of crop intensification under drip with plastic mulch was developed for rice and wheat. Conventional rice cultivation practice (Fig.9) was compared with System of Rice Intensification (SRI), SRI plus drip irrigated rice, and SRI plus drip irrigated rice under plastic mulch conditions. Ten-days old singulated seedlings were transplanted at a spacing of 30 x 30 cm. The study indicated that with drip and plastic mulch, the rice yield increased by 33% over the conventional system of cultivation and only 17% over drip irrigation (Table 2). Under the system of wheat intensification (SWI), in which singulated seeds were sown at a spacing of 25 X 25 cm, experiment was laid with four treatments viz., SWI, SWI irrigated with drip system, SWI irrigated with micro sprinkler irrigation, SWI irrigated with drip system under plastic mulch conditions(Fig.10) and conventional cultivation practice as control. Results (Table 3) have indicated superior performance of wheat irrigated with drip

Fig. 9. Coventional, SRI, SRI+Drip+Mulching, SRI+Drip irrigated rice crop

irrigation under plastic mulching conditions not only in terms of morphological parameters but also in terms of yield. This indicates technical feasibility of adopting plastic mulch in SWI cultivation under drip irrigation system. In the first year of experiment, grain yield with plastic mulch increased by 37% over the conventional system of cultivation and 12% over drip irrigation.

Table 2. Yield and yield contributing parameters of rice influenced by different irrigation practices

Treatments	Effective tillers /m^2	No. of grains/ panicle	Panicle length, cm	Panicle weight, g	Yield, t/ha	Straw yield, t/ha	Harvest index, %	Quantity of water applied, m^3/ha	Water productivity, kg/m^3
Conventional	215.30	133.10	26.67	2.82	4.75	4.25	52.86	17800	0.26
SRI	218.00	134.0	26.97	3.36	5.15	4.22	54.94	13200	0.39
SRI + Drip irrigation	232.45	143.75	27.52	3.56	5.43	4.43	55.04	5600	0.96
SRI + Drip + Plastic mulching	236.78	146.05	28.45	3.93	6.36	4.96	56.18	5100	1.24

Fig. 10. Coventional, SWI + micro sprinkler irrigated, SWI+Drip+Mulching, SWI+Drip irrigated wheat crop

Table 3. Growth and yield parameters of wheat under SWI with drip

Treatments	Plant height, cm	No. of tillers/ m^2	No. of effective tillers/m^2	Ear head length, cm	No. of grains, / ear	1000 grain weight, g	Grain yield, t/ha	Straw yield, t/ha	Harvest index, %
Conventional irrigation	81.75	410	402	10.4	40.0	41.00	4.88	5.87	45.40
Micro-Sprinkler irrigation	82.00	480	472	11.9	53.0	44.15	5.88	6.19	48.68
Drip irrigation	84.25	560	545	12.5	61.0	45.20	6.00	6.54	47.82
Drip irrigation with mulch	86.25	800	789	14.0	79.0	46.21	6.70	6.83	49.50

- At present low land rice production in India is in about 36.0 million hectare. In each hectare of low land rice production we could save approximately 13,000 m^3 of water by adopting SRI + Drip + Plastic mulch technique
- Wheat is cultivated in about 32.0 million hectare area in India. By adopting SWI+Drip+Plastic mulch we could save about 3900 m^3 of water per hectare, when compared with conventional practice of cultivation.

Multigrain and defatted soy based nutritionally balanced functional foods for children

Two new products namely, gluten-free eggless cakes and eggless refined flour free cake rusks have been added to the basket of nutritional products for school children. The process for gluten-free eggless cakes comprises a series of manufacturing steps to prepare multi-nutrient gluten free flour mix (suitable quantities of finger millet flour, sprouted amaranth flour and sprouted soy flour), and utilizing the flour mix to produce cake. The flour mix contains approximately 11-13% protein, 5-7% fat, and 9-11mg/100g of iron, 82-85mg/100g of phosphorus, 73-78 mg gallic acid equivalents/100 g of phenolics, 2.8-3.2 mg (querecitin equivalents) QE/100 g flavonoids and 89-93% radical scavenging activity (RSA) of DPPH of anti-oxidants.The cake, thus produced, is high in fibre, iron, anti-oxidants, flavonoids and phenolics, without any artificially added fortifications, free from wheat flour, egg and saturated fats. The rusk was developed by drying the cakes prepared without using egg and refined wheat flour. The drying temperature and time were optimized based on quality parameters of the product viz., hardness, colour, aroma, texture, taste, mouth-feel and overall acceptability. The quality parameters of the developed rusks were compared to commercially available rusks. Overall acceptability of the product scored 8.5 against 9.0 of hedonic scale.

- Innovative processes for enrichment of the diet relished by school children
- Incorporation of all five functional diet groups

Solar PV based vapour compression refrigeration system (2.5 TR) for short duration transient/on-farm storage of fresh horticultural produce

The solar PV powered refrigeration system (2.5 TR) for storage of horticultural crops, developed earlier, was evaluated by storing fresh unripe mature mango, tomato, capsicum and marigold flower (Fig. 11). The physico-chemical parameters of the produces during storage period and enhancement in their shelf life were assessed (Table 4).

Shelf life of the mature unripe mango (cv. *Dasheri*) stored at 12±1°C and 90±2% RH was increased up to 15 days as compared to only four days in case of ambient storage (Table 4, Fig. 12). The mangoes stored in cold storage maintained firmness of 95.12 N even after 15 days as compared to 43.14 N after four days when stored at ambient conditions. The total soluble solid of mangoes increased slowly from initial values of 8.8 to 13°Brix in cold storage. The physiological loss in weight of mangoes was 3.1% in cold storage as compared 14.5% in ambient storage. Similarly, firmness of the cold store tomato (Fig. 13) decreased from 99.04 N to 44.13 N and that of ambient stored to 32.06 N. The capsicum firmness was decreased from 77.67 N to 53.45 N in cold storage after 21 days as compared to 30.60 N stored at ambient temperature in four days. Weight loss of marigold flower in cold storage was 33.7% as compared to 57.5% stored at ambient. The freshness and colour of the capsicum and flowers remain intact in cold storage (Fig. 14), whereas flower stored at ambient temperature was partially dried and turned brownish.

Energy generated by the solar PV power plant (25 kWp) was sufficient to meet the required energy (46-68 kWh per day) for operating refrigeration system of 2.5 TR capacity in different months. During one year of operation, solar powered cold storage system required very little maintenance like weekly pond cleaning and battery water topping. Thus, total operating cost of solar powered cold storage system was 40-50% less compared to the conventional grid operated system.

Fig. 11. Unripe mangos stored in solar powered cold storage

- The solar power system has 2-3 days autonomy for running the cold storage during cloudy days/ off sunshine hours.
- The energy generated and average efficiency of the solar PV array (25 kWp) per day was found between 67-110 kWh and 9.3-11.4%, respectively
- The running cost of solar powered cold storage system got reduced by 40-50% as compared to the conventional grid operated system.

Table 4. Physico-chemical parameters of mango, tomato and capsicum during storage

Particulars	Mango (cv. *Dasheri*)		Tomato (cv. NS 503)		Capsicum	
	Cold storage	Ambient	Cold storage	Ambient	Cold storage	Ambient
Storage temperature, °C	12±1	27-40	11±1	21-37	7±1	19-34
Storage RH, %	90±2	40-55	93±2	30-90	94±2	36-85
Safe storage life, days	15	4	14	5	21	4
Loss in weight (PLW),%	3.10	14.50	3.96	6.48	3.71	10.38

Fig. 12. Mangoes after 15 days in cold storage (left), mango stored at ambient after 4 days (right)

Fig. 13. Tomato (cv. NS 503) after 14 days in cold storage (left), tomato stored at ambient after 5 days (right)

Fig. 14. Capsicum in cold storage after 21 days (left), marigold flowers in cold storage after 15 days (right)

Technologies under development stage

Many research endeavours were underway in different divisions, some of which have yielded noteworthy results. Some of these would be taken up further for perfection to suit the requirements of different stakeholders.

Equipment

Mechanization package for kodo and little millet

A package of machinery was desired for mechanization of production operations of kodo and little millet. An attempt was made to identify existing appropriate machines for this purpose. Equipment not available to complete the package have been developed. The package consists of machinery for seed bed preparation, planting, intercultural, harvesting and threshing operations according to different power sources such as, manual, bullock and tractor/self-propelled. The developed set of machinery and its field performance parameters are summarized in Table 5a & b. Based on the available power source, farmers can select the set of machinery for seed bed preparation sowing/planting, weeding, interculture, harvesting and threshing operations.

Table 5a. Mechanization package for kodo and little millet

Power source	Seed bed preparation machinery	Planting machinery	Intercultural machinery	Harvesting machinery	Threshing machinery
Manual	-	Manual drawn single row multi-millet seed cum fertilizer planter	Twin wheel hoe	Improved sickle	-
Bullock drawn	Improved Plough Improved blade harrow	Bullock drawn three row multi-millet seed cum fertilizer planter	-	-	-
Power operated	Sweep tyne cultivator with cold crusher Roto tiller Power tiller	Tractor/power tiller operated Six row multi-millet seed cum fertilizer planter	Power weeder	Vertical conveyor reaper Reaper binder	CIAE Multi millet thresher

Table 5b. Specifications of mechanization package developed/identified for kodo and little millet

Sl. No.	Equipment	Power Source	Overall dimensions, m	Weight, kg	Speed, km/h	Field capacity , ha/h
1	Improved plough	Pair of bullock	0.35 x 0.2 x 0.8	25	1.8	0.039
2	Improved blade harrow	Pair of bullock	1.2 x 0.85 x 0.65	30	1.8-2	0.062-0.075
3	Sweep tyne cultivator with cold crusher	Tractor	1.6 x 1.5 x 0.8	450	3.4	0.48
4	Roto tiller	Tractor	2.0 x 0.74 x 1.2	462	2.1	0.38
5	Power tiller	Power tiller	1.0 x 0.7 x 0.9	140	2.4	0.079
6	Twin wheel hoe	Manual	0.2 x 0.25 x1.1	4.5	1.2	0.027
7	Power weeder	SI engine	0.45 x 0.25 x 1.0	12	1.7	0.039
8	Improved sickle	Manual	0.4 x 0.15 x 0.04	0.2	0.5	0.018
9	Vertical conveyor reaper	CI engine	2.4 x 1.2 x 1.0	245	2.0	0.15-0.17
10	CIAE multi millet thresher	Electric motor	1.2 x 1.0 x 1.5	100	--	80-150 kg/h

Real time precision irrigation using sprinkler system for field crops

The technology of real time irrigation scheduling has direct impact and importance with the increasing pressure on available arable land and water resources. To improve the techniques for an early detection sensitively at given plant growth stage, monitoring and diagnosis of the environment and to allow effective management responses in the crops are desired, which could be achieved through a sensors network for soil moisture of the field crops in real time. Telemetry based automatic controller for real time irrigation scheduling (Fig.15) was installed for the sprinkler irrigation system in the experimental field B-6 in wheat crop. Management zones have been created after field preparation with crops to address spatial variability of the soil moisture in the field. Twenty soil moisture sensors at different locations were installed and a sensor network was established using zigbee protocol to deliver water in precise quantity based on soil moisture sensor prescription using sprinkler irrigation system. Continuous monitoring of soil moisture sensors using sensor network has been done for the spatial variability studies in the experimental area.

Fig. 15. Sensor installation and real time irrigation scheduling

Hand held instrument for on field fibre content measurement in sugarcane

Fibre, an important component in sugarcane is used directly as raw material for cogeneration and indirectly responsible for better sugar extraction form sugarcane. Estimation of fibre is laborious, time consuming and involves destructive sampling. Hence, effort was made in developing hand held instrument for non destructive large scale estimation of fibre content in short time in collaboration with ICAR-Sugarcane Breeding Institute, Coimbatore. High correlation coefficient observed between fibre content and rind hardiness was the hypothesis for developing indirect method of estimation of fibre content. Electronic system was employed to measure the force required to puncture sugarcane rind. This system consists of a Force Sensitive Resistor (FSR) coupled with a microprocessor and a suitable software. When force is applied on FSR, it changes its resistance corresponding to the level of force. This change in resistance is converted into digital values through microprocessor. A working basic prototype was made by integrating the mechanical and electronic components. The mechanical component consists of a needle attached to a piston-like arrangement. The end of the piston lands on a force sensor, interfaced with a microprocessor. Appropriate algorithm was developed to convert the force value to fibre unit.

Tractor front mounted hydraulic operated single row sorghum harvester

The earhead cutting and collection efficiency of tractor front mounted hydraulic operated single row sorghum

harvester prototype (Fig. 16) were found to be 96 and 90%, respectively, at forward speed of 3 km/h. Stalk cutting efficiency was found to be 100% and conveying efficiency of stalk conveyor and windrower was found to be 99 and 97%, respectively. The field capacity and field efficiency of the machine were observed in the range of 0.12-0.15 ha/h and 80-83%, respectively, while cost of operation was Rs.3000/ha.

Fig. 16. Tractor front mounted hydraulic operated single row sorghum harvester

Double headed single bud cutting machine for sugarcane

Double headed sugarcane single bud sett cutting machine (Fig. 17) consists of two pairs of circular blades, made of high carbon steel, operating at 2800 rpm. A spacer is provided between the two blades to vary the size of single bud sett. Capacity of the machine is 3000 single buds/h with two operators working simultaneously. The machine is operated by 0.75 kW (1 hp) electric motor and costs about Rs. 25,000.

Fig. 17. Prototype model of double headed single bud cutting machine for sugarcane

Post-harvest mechanization package for *Garcinia combogia*

A package of equipment consisting of juicer/grinder (40 kg/h) (Fig. 18), juice squeezer (30 l/h) (Fig. 19) and juice concentrator (30 l/batch) (Fig. 20) has been developed to obtain the juice concentrate from *Garcinia combogia,* which is used in healthcare products and as a substitute for tamarind in culinary preparation. In traditional method, the juice is

Fig. 18. Evaluation of Garcinia juicer/grinder

Fig. 19. Evaluation of Garcinia juice squeezer

Fig. 20. Evaluation of Garcinia juice concentration unit

concentrated by heating the juice in an earthen pot for 1-2 days, but by adopting the developed mechanization package, the whole process can be completed under hygienic conditions within 5-6 h.

From about 100 kg of *Garcinia combogia* fruits, 30 litres of juice can be extracted by using juicer/grinder and this is further concentrated to 5-6 litres. The cost of production is Rs.300/l and selling cost is about Rs. 700-750/l. The package of equipment has been evaluated and established at the entrepreneur's place at Hakatur Village, Madikere, Karnataka, which is one of the major production areas of this fruit.

Process and protocol

Production of fermented flaked millets

A process was developed for preparation of sorghum flakes by fermenting the grains with suitable cultures, steaming and then mechanically pressing into flakes.

Fig. 21. Millet flaking machine

Dried flakes were later cooked for five minutes to observe the texture of final product. Sensory evaluation of developed flakes was carried out by trained judges. Fermentation was found to improve appearance and texture of flakes. A product, 'sorghum stalks' was prepared using fermented and non-fermented sorghum flour. Prepared product was analysed by trained sensory panel for its acceptability. Stalks prepared using fermented sorghum flour scored the highest in all sensory parameters.

The developed millet flaking machine (Fig. 21) produces flakes from pre-treated whole sorghum grains. The machine comprises of two sets of stainless steel rollers running at a differential speed, in opposite direction. Power is drawn from a 0.5 hp single phase motor. A polygonal teflon feeder has been provided for controlled feeding of the raw materials into the flaking rolls. The minimum flake thickness achievable by the machine is about 0.5 mm with flaking efficiency of about 92%.

Process technology of leavened bread from minor millet flour

Millet based (sorghum, pearl millet, kodo millet, little millet and barnyard millet) gluten-free leavened bread was prepared with the addition of hydrocolloids (guar gum, acacia powder, tragacanth gum and xanthum gum) to mimic the action of gluten in millet dough system. Experiments were conducted for rheological characterization of selected millet flours based on the dough-forming capability with water volume, water

Table 6. Properties of developed breads

Bread	Expansion, cm	Specific volume, ml/g	Hardness, N	Resilience	Springiness	Cohesiveness
Refined wheat (control)	1.2	2.6	1.6	0.38	0.97	0.80
Pearl millet	0.8	1.4	3.4	0.52	0.50	0.53
Little millet	0.9	1.2	3.1	0.39	0.50	0.52
Kodo millet	0.6	1.2	4.2	0.43	0.42	0.47

temperature, dough temperature and dough standing time as dependent variables. Refined wheat flour (*maida*) was used as control. The optimized conditions include proofing time of 2.2-4.3 h, baking time of 32-42 min. and baking temperature of 165-172°C. Noted qualities parameters of the breads are given in Table 6.

Technology for preparation of soy protein based hydrolysates

Process parameters were optimized for preparation of soy protein based hydrolysates from *okara*, soy protein isolate (SPI), soy protein concentrate (SPC) and defatted soy flour (DFSF) by using three different proteolytic enzymes i.e., trypsin, pepsin and papain. Hydrolysates obtained from SPI, SPC, DFSF and okara were characterized for emulsification, solubility, water absorption and binding, fat absorption, foaming and colour values (Table 7).

Table 7. Functional properties of soy protein hydrolysates

Protein Substance	Enzyme	Bulk Density, g/cc	Water Absorption Index	Water Holding Capacity, %	Fat absorption Index	Foaming Stability, %	Protein Digestibility, %
SPI	Untreated	0.67	209.86	1.91	217.5	9.09	64.51
	Trypsin	0.64	268.65	2.65	240.12	45.45	67.44
	Papain	0.73	369.24	3.99	259.42	50.00	69.7
	Pepsin	0.38	204.80	4.52	328.28	90.00	64.06
SPC	Untreated	0.53	269.57	2.51	277.32	25.00	60.22
	Trypsin	0.58	269.7	3.76	267.04	30.00	65.41
	Papain	0.64	205.79	3.06	208.42	60.00	62.7
	Pepsin	0.67	384.57	4.10	198.43	50.00	61.35
DFSF	Untreated	0.47	302.10	2.36	318.03	10.00	62.25
	Trypsin	0.65	234.46	2.35	256.7	10.00	69.02
	Papain	0.64	278.27	3.56	238.95	30.00	68.34
	Pepsin	0.65	219.96	2.35	237.91	70.00	60.45
Okara	Untreated	0.37	324.40	3.05	346.37	ND	64.73
	Trypsin	0.54	223.54	3.41	241.68	9.09	68.34
	Papain	0.51	239.18	3.76	238.65	10.00	60.00
	Pepsin	0.44	219.18	4.10	208.56	30.00	58.42

Shelf-life of probiotic soy-cheese spread and soy-milk powder

The shelf-life and probiotic culture viability of two probiotic products *viz.,* soy-cheese spread and soy-milk powder were studied under different storage conditions. Probiotic soy-cheese spread was prepared from soymilk using *Lactobacilli* strain as the probiotic culture. Sucrose and *okara* were added in soymilk for stimulation of growth of the probiotic culture. The soy-cheese spread was allowed to mature for a period of 30 days in metalized polyester film (30 micron) and low density polyethylene film (50 micron) pouches with

and without vacuum at room temperature and 4°C. In case of vacuum packaged sample, high viability count of probiotic culture and low count of microbial contaminants was observed in comparison to normal packaging. The viability of probiotic microorganism was found to be high in soy-cheese spread with okara and sucrose, indicating high efficiency of prebiotic properties of *okara* and growth stimulating properties of sucrose. The viable counting of probiotic culture (MRS count) was found to be more than 10^8cfu/g in both metalized polyester packet and LDPE packets under vacuum.

Probiotic soy-milk powder was prepared using *Lactobacilli* strain as the probiotic culture and sucrose and/ malto-dextrin as the cryo-protectant of probiotics culture. The soymilk was both spray-dried and freeze-dried and packed in metalized polyester pouch, LDPE pouch and glass bottles. Higher survival of lactic acid bacteria was found in case of freeze-dried soy milk powder in metalized polyester pouch stored at 4°C. Sucrose and maltodexrin were both found to be good growth stimulant of probiotics. The viable cell counting of probiotic bacterial strains in spray-dried powders were stable up to two months during storage at 4°C. In freeze-drying culture, the probiotic bacteria exhibited a survival percent of 57% higher than in spray-dried powder stored in a glass bottle.

Potato (*Solanum tuberosum* L.) cultivation under drip irrigation with plastic mulch

Experimental trials were conducted to study the effect of plastic mulching duration and mulch colour on soil temperature, growth parameters and yield parameters of potato *(*var: *kufri badhsha)* under drip irrigation. Silver and black colour plastic films of 0.03 mm thickness were used for varied duration from zero (no cover on the bed) to entire span of the crop. Thus, the treatments of no cover, silver colour mulch, black colour mulch were imposed and replicated seven times. Plastic mulch films were removed after 60 and 70 days of sowing and in one treatment continued till the end of crop duration i.e., 90 days. Study indicated that the plastic mulching had a significant influence on potato growth and yield (Fig. 22).

The treatment of black mulch film removed after 60 days produced the maximum yield (30.17 t/ha) followed by silver mulch removed after 60 days (29.26 t/ha) and no mulch (20.82 t/ha). Similar yield trends were also observed incase of mulch film removed after 70 and 90 days. Black mulching gave the highest average number of potatoes per plant (13.2) and weight of tubers per plant (1.37 kg) over no mulch. Soil temperature was recorded higher in black mulch by about 2-4°C over no-mulch condition. Water use efficiency was found highest under black plastic mulch removed after sixty days (50 kg tuber/ha-mm) over no mulch condition (34 kg tuber/ha-mm). Similar results were found when the mulch film was removed after 70 and 90 days. The B:C ratio was higher under black mulch (1.89) followed by silver mulch (1.76) and without mulch (1.30).

Fig. 22. Potato grown in black (first column), silver (second column) mulch and no-mulch conditions

Miscellaneous

Manually operated portray type nursery seeder

Manually operated nursery seeder (Fig. 23) for sowing of vegetable seeds in portrays consists of a set of plates such as base plate, media firming-cum-watering plate, hole forming plate and set of seeding plates (2 Nos.). This is suitable for sowing of 104 cells portrays (13 x 8

rectangular arrays). For sowing of single chilli, brinjal and tomato seeds, the orifice diameter of 3.5, 2.9 and 3.5 mm, respectively were found suitable. Total saving in time for filling of portrays was found to be 68% with developed set-up over traditional method. Cost of operation was found to reduce by about 67-68% when compared with manual seeding by traditional method. Cost of the developed manually operated portray type nursery seeder is approximately Rs.2,000 and weight is 15 kg. The developed system facilitates uniform watering and firming of the media, thus reducing the water requirement and media washout.

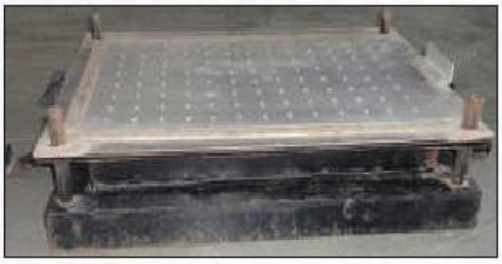
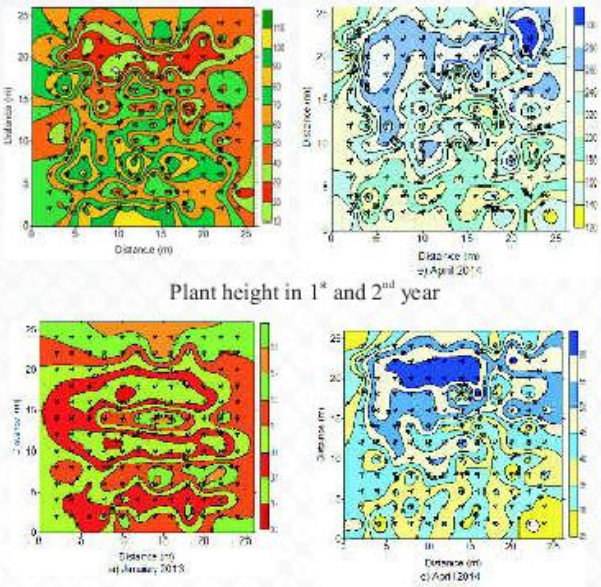


Fig. 23. Manually operated portray filling device

Spatio-temporal variability of biometric parameters of banana under drip irrigation

Plant height and girth contours were drawn from the observations using universal point kriging technique to assess the spatio-temporal distribution of plant height and the girth at collar for two year of observations. All the contour maps, thus drawn, had different patterns due to the variation of plant height and girth which increased temporally. At the same time, the plant height remained spatially distributed over the entire field as apparent from the less number of contours and, as a result, there was lesser variability over the entire banana field. It was noticed from Fig. 24 that over time particularly from the initiation of the experiment, the numbers of loops and contours had increased that resulted in an increased variability which turned distributed at the later stage. This could mainly be attributed to the fact that when banana plants



Plant height in 1st and 2nd year

Plant girth at collar in 1st and 2nd year

Fig. 24. Spatial distribution of the plant height and girth of banana under drip irrigation

were in growing stage in the first year, a higher level of heterogeneity was present due to inherent variability in drip discharge as well as genetic variation in the plant variety. But in a drip irrigated field having spatial variation of the discharge, as the plant reached towards maturity and attained varietal height and girth, the variability turned distributed. The uniformity coefficients computed from different models for these parameters of plant height and girth at collar have confirmed that their spatial variability reduces in drip irrigated fields.

Hybrid dryer for pigeon pea dal

A hybrid (solar biomass) hot air dryer was installed in agro processing centre. The dryer is covered on the outside with UV stabilized solarization sheet (double-fold) for intake of solar radiation during day, and is insulated on the inside with polyurethane foam for heat retention (Fig. 25). External heating arrangement for

Fig. 25.The hybrid (solar biomass) hot air dryer

operation during the night and under cloudy weather is also provided using two downdraft inverted gasifier stove and conduction tubes, placed in plenum chamber. The equipment is equipped with dehydration chamber with six partitioned double-tray racks. During testing, the temperature in solar tunnel area and in the plenum chamber was recorded as 70±10 and 50±10 °C, respectively, when the outside ambient temperature was 34±2 °C. The temperature drop measured inside tunnel during night (evening to morning) was 10±2 °C. Approximate cost of the unit is Rs.1.20 lakh. The dryer was tested with full load (200 kg soaked pigeon pea) at an average ambient temperature of 36±5 °C. Moisture content of wet pigeon pea was found to reduce from 35.8 to 8% (wet basis) in 20 solar hours (8 h/d) compared to 32 solar hours under open sun drying. The dryer also provided dust and contamination free drying environment.

Refinement of two row tractor operated single bud settling planter

Two row tractor operated sugarcane settling planter (Fig. 26) has been modified for various spacing and depth of planting adjustments. The row to row spacing can be adjusted to 900, 1200 and 1500 mm. Depth of planting can be adjusted from 60 to 100 mm. Plant to plant spacing can be adjusted to 450, 600 and 900 mm. The machine was evaluated in the field condition. The field capacity of the machine was 0.2 ha/h at 1200 mm spacing with a field efficiency of 70%. Missing percentage was about 2-3 %.

Fig. 26. Two row tractor operated sugarcane single bud settling planter

Protocol, software and studies

Web based software of farm machinery package and custom hiring business model for different agro-climatic regions of India

The selection of package of farm machinery to establish a farm machinery custom hiring centre is a decision, which depends not only on cost and economic considerations but also on other parameters such as agro-climatic region, soil type and crops grown. The broad guidelines were formed and a logical and physical design of the software was finalized after discussion with farm machinery expert, agricultural economist, progressive farmers and interested entrepreneurs willing to establish the custom hiring centre of farm machinery. Accordingly, the software (Fig.27) establishes the economic feasibility of the selected machinery package using net present value, benefit cost ratio, payback period, internal rate of return and breakeven analysis. Normally, banks provide loan (maximum up to 10 years), however, option for selection of years for repayment and amount of loan to total capital cost has been provided. The 'Repayment schedule' screen shows capital cost and details about year-wise outstanding loan, surplus, principal repaid, interest repaid, total repayment, net available and debt service coverage ratio. The feasibility report required for sanction of the loan from the bank or financial agencies can be generated using this software.

Fig. 27. Home page of web based software of farm machinery package and custom hiring business models

Mechanization index of selected cropping pattern in Madhya Pradesh

Mechanization level was studied for selected cropping pattern of Madhya Pradesh. Multi-stage stratified sampling technique was used to select the districts, blocks, villages and cultivators. Data was collected from 280 farmers spread over seven districts (Raisen, Dewas, Khandwa, Chhindwara, Seoni, Mandla and Ashok Nagar) of Madhya Pradesh. Average power availability was found to be 1.80 kW/ha which ranged 1.63 to 2.05 kW/ha across the selected villages. Mechanical power contribution was in the range of 80 to 88%. The level of mechanization index was found higher in crops like wheat (57.61%) and gram (44%) while it was comparatively low in paddy (40%), soybean (40.4%) and maize (43.5%). Production function fitted well with a value of the coefficient of multiple determinations (R^2) ranged from 0.80 to 0.97 across the crops and statistically significant use of machinery showed a positive response with size of holding. Ratio of marginal value product/ marginal factor cost for human labour, machinery & miscellaneous were highly sensitive and contributed more than one while animal labour showed a marginal contribution

Online database of anthropometric and strength parameters of agricultural labourers

An online database (Fig. 28) consisting of data on 79 anthropometric parameters for 12,525 Indian agricultural workers (8,025 male and 4,500 female from 12 states) and strength data on 16 parameters for 5,937 Indian agricultural workers (3,423 male and 2,514 female from six states) was created. The database can be accessed through CIAE website. The online data will be useful for research engineers, designers, academicians at different stakeholding organizations.

Fig. 28. Online database for anthropometric and strength parameters of agricultural workers

Evaluation of selected tillage implements under vertisol for tractor implement-matching

Performance of 11 commercially available primary, secondary and conservation tillage implements (Fig. 29) were measured with 35 and 60 hp tractor. These tests were carried out in vertisols, having average cone index of 2-3 MPa at working depth and moisture content of 15 to 22% (d.b.). Field performance evaluation of implements listed in Table 8 was carried out as per BIS recommended speed with various combinations of gear and throttle positions. All the parameters were recorded through HBM QuantumX universal data acquisition system.

Fig. 29. Evaluation of selected tillage implements under vertisols for tractor implement matching

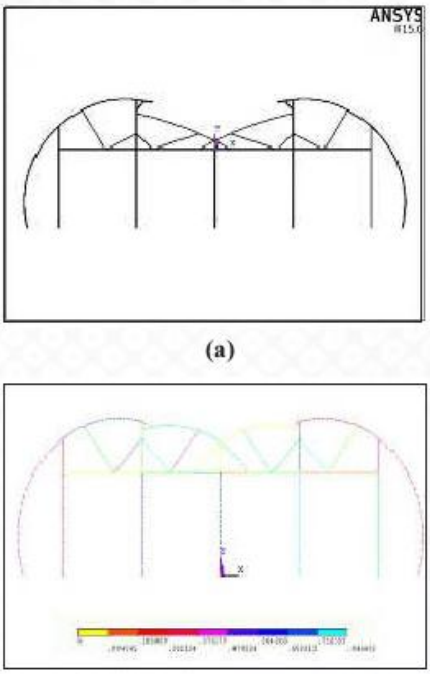
Table 8. Performance evaluation of selected implements

Implement	Description	Required draft range, kN	Fuel consumption, l/h	
			35 hp tractor	60 hp tractor
Subsoiler	Single Shank	7.55 - 11.44	1.96 - 4.08	2.84-7.16
MB plough	2 Bottom (size: 700 mm)	5.38 - 9.24	2.69 - 4.47	2.52 - 7.15
	3 Bottom	7.85 - 11.47	-	3.29 - 7.72
Rotavator	1.5 m	-	-	4.58 - 9.51
	1.8 m	-	-	3.69 - 8.24
	2.1 m	-	-	5.15 - 7.75
Cultivator	Small rigid shovel (tyne width: 50 mm; cutting width: 2070 mm)	8.39 - 9.58	2.83 - 5.66	-
	Rigid shovel (tyne width: 80 mm; cutting width: 2300 mm)	8.72 -12.08	4.55 -5.68	2.82 -7.74
	Sweep (tyne width: 460 mm; cutting width: 2100 mm)	6.89 - 13.20	3.20 - 5.64	2.57 -7.62
	Spring shovel (tyne width: 50 mm; cutting width: 2000 mm)	8.63 - 13.52	3.08 - 5.54	-
Zero till drill	11tyne	2.34 - 4.92	-	0.9 -3.59

Based on the various performance parameters, it was concluded that it will be more economical if two bottom MB plough, three bottom MB plough, 1.8 m rotavator, 2.1 m rotavator, large rigid shovel cultivator, subsoiler, sweep cultivator and spring shovel cultivator are operated by 60 hp tractor whereas for 1.5 m rotavator, operation by 35 hp tractor is more economical with single shank subsoiler, spring shovel cultivator, small rigid shovel cultivator and zero till drill, within the tested field and implement condition.

Structural design of greenhouse using finite element method

Structural stability of the double arch type, naturally ventilated greenhouse with 560 m^2 floor area with 40 and 14 m length and width, respectively, was evaluated for varying load condition [as per IS-875 (part 3)-1987) using finite element analysis 3D modelled frame structure under variable wind load conditions. In the double arch type greenhouse, the load due to truss, pipe frame, crop, live load and wind load were found to be 250, 100, 200, 250 and 770 N/m^2, respectively.



(a)

(b)

Fig. 30. Original double arch type frame, (a) without load and (b) deflection under all load

The limiting value of deflection of the truss (with member length L), is recommended to be in the range from L/300 to L/500. If the deflection is more than the limiting, the cross section needs to be changed. For the basic wind speed at Bhopal (140 km/h), the deflection of the structure is within the limit. The deformed and undeformed simulated frames are shown in Fig. 30a and Fig. 30b.

For basic wind speed, the size of purlins and columns has been optimized. The purlin of 63 mm outer diameter (OD) round pipe and two mm thickness can be replaced by a 35 mm square pipe of 2.6 mm thickness. While for columns, the thickness of 76 mm OD pipe can be increased to 3.2 mm from 2.0 mm.

Economic impact of laser land levelling and broad bed sowing in village Kachhi Barkheda

Levelling of farmer's field by laser guided land leveller was introduced in the adopted village, Kachhi Barkheda, in the year 2013. After introduction of levelling, the area under paddy has increased from 1.8 ha in 2013 to 49 ha (42 farmers) in 2015. Undulated fields and improper distribution of rainfall (excess/scanty) during the kharif seasons of 2013-2015 have badly affected the soybean crop. Broad-bed Former cum Seeder equipment was demonstrated to the farmers growing soybean crop, which has been found a climate resilient technology with a yield of 9.47 q/ha as compared to 6 q/ha on farmers' field. Thus, farmers are getting average net return of Rs.61,512/ha for the cultivation of rice while it was giving a return of Rs. 8,080/ha from soybean crop. Details of economic evaluation are given in Table 9.

Table 9. Economic evaluation of soybean and paddy in village Kachhi Barkheda

Particulars	Farmers' field		Demonstrated field	
	2013	2014	2015	2015
Paddy crop				
Area under paddy (transplanted),ha	1.80	33.60	35.70	13.30
Paddy yield, q/ha	35.50	46.50	47.20	52.50
Gross return, Rs./ha	1,24,250	83,700	92,984	1,01, 285
Sale rate, Rs./q	3,500	1,800	1,970	1,970
Operating cost, Rs./ha	41,680	39,265	43,755	40,570
Net return, Rs./ha	**82,570**	**44,435**	**52144**	**57,530**
BCR	2.98	2.13	2.29	2.32
Soybean crop				
Yield, q/ha	6.50	3.70	6.00	9.47
Sale rate, Rs./q	3,200	3500	3,555	3,555
Gross return, Rs./ha	20,800	12,950	21,330	33,666
Operating cost, Rs./ha	14,560	13,325	15,288	15,404
Net return, Rs./ha	**6,240**	**-375**	**6,042**	**18,262**
BCR	1.42	0.97	1.38	2.20

Thermal and chemical activation of char generated from soybean crop residues and lantana

The char prepared at 550 °C from soybean straw and lantana stalk was studied for its activation through thermal and chemical process. Potassium hydroxide treatment was used in chemical process treatment of biochar. The activation temperature and activation time were varied and the influences on the activated char yield, bulk density, pH, Iodine value, volatile matter, ash content and total carbon were studied. Activation conditions were optimized maximizing yield, Iodine value, volatile matter, ash content and total carbon. The activation level of biochar under both the treatments was comparable. Recovery from chemical activation process was 55±5% for soybean whereas it was 50±3% for lantana. The pH of thermally activated char varied from 10-12 and for chemical activated was 11±1%. Chemical activation was found better in terms of recovery and sustained variation in pH. However, thermal activation was better in terms of simplicity of process.

Energetics of soybean crop production

Energy input data for different farm operations for production of soybean in Bankhedi, Khandera, Pathari and Banpurgarhi villages of Raisen district was analysed. Total energy requirement values for seed bed preparation, sowing, fertilizer application, interculture, plant protection, harvesting and threshing operation are given in Table 10. Total operational energy (direct and indirect energy) input for Bankhedi, Khandera, Pathari and Banpurgarhi was observed to be 7173.3, 7119.3, 7519.2 and 9325.6 MJ/ha, respectively. Bhapurgarhi village showed more energy consumption of fertilizer and chemicals followed by Pathari, Khandera and Bankhedi. Table 7 shows that the farmers of above villages are more dependent on farm power and machinery for production agriculture due to scarcity of labour.

The average energy consumption for soybean cultivation in Raisen district was 7679.7 MJ/ha which included total mechanical power contribution of 65.73%.

Table 10. Operational energy consumption (MJ/ha) for soybean cultivation

Farm operations	Villages of Raisen district, MP			
	Bankhedi	Khandera	Pathari	Bhanpurgadi
Seed bed preparation	1742.34	1372.61	1940.47	1364.84
Sowing	2311.88	2633.89	2298.19	2686.21
Fertilizer application	1878.81	2013.83	1898.47	3881.29
Interculture	294.02	293.77	427.85	417.12
Plant protection	298.88	384.12	335.74	537.95
Harvesting and threshing	647.39	421.11	618.43	438.54
Total direct energy consumption, %	37.72	31.33	39.66	23.90
Total indirect energy consumption, %	62.26	68.67	60.34	76.10

Energy efficiency, energy productivity, specific energy and energy intensiveness were 4.68, 0.12 kg/MJ, 8.30 MJ/kg and 0.33 MJ/INR, respectively.

Fertigation strategies for tomato and capsicum crops in open / covered cultivation

Experiments were carried out to investigate the effect of growing environment, irrigation and fertigation levels on the vegetable crops (tomato and capsicum) with six treatments: T1: 100% drip irrigation and fertigation in open field; T2: 80% drip irrigation and fertigation in open field; T3: 100% drip irrigation and fertigation in shade net; T4: 80% drip irrigation and fertigation in shade net; T5: 100% drip irrigation and fertigation in polyhouse, and T6: 80% drip irrigation and fertigation in polyhouse.

Tomato

Flowering, fruit setting, fruit maturity and temperature were recorded earlier under polyhouse and shade net house compared to the open field (Fig.31). Treatment T5 gave the highest fruit weight, number of fruits/plant and fruit yield. Plant height (170.4 cm), number of flowers per plant (12), SPAD value (56.87), yield per plant (2.66 kg) and yield (93.10 t/ha) were maximum under T5 followed by T6 (88.90 t/ha).

Fig. 31.Tomato crop in open field, shade net house and in polyhouse (L-R)

Capsicum

The highest crop yield (117.2 t/ha) was obtained in the treatment T5 followed by T6 (112.7 t/ha). There is no significant difference between crop yield obtained in polyhouse with 100 and 80% irrigation and fertigation treatments. The study revealed that under polyhouse the capsicum crop yield was increased by 80% over open field cultivation along with water saving of about 40% in covered cultivation (Fig. 32).

Fig. 32. Capsicum in open field, shade net house and in polyhouse (L-R)

Irrigation and fertigation scheduling on guava and mango

An experiment was laid under drip irrigation in complete block design with six treatment combinations comprising three irrigation levels (100, 80 and 60%) with two fertigation level (100 and 75% water soluble fertilizers) and replicated thrice with guava (Var: *L-49*) and mango (Var: *Amrapali*).

The investigation indicated that the maximum plant height, circumference of rootstock and scion, yield per plant (26.1 kg/plant) and yield (7.2 t/ha) were higher under 100% irrigation with 100% fertigation (D1F1) followed by 80% irrigation with 100 % fertigation. The minimum yield was obtained under the treatment of 60% irrigation with 75% fertigation (D3F2). Physico-chemical properties like fruit diameter (6.05 cm), fruit weight (164 g) and pulp weight (123 g) were significantly higher in D1F1 compared to others, but fruit length (cm), TSS (%) and ascorbic acid (mg/100 g pulp) did not vary significantly among different treatments. On the economic comparison, D1F1 and D2F1 were at par, hence, adoption of 80% irrigation and 100% fertigation could be recommended for cultivation of Guava in vertisols.

In mango experiment the plant height, circumference of rootstock and scion, yield per plant, productivity and TSS were the highest under D1F1 (100% irrigation with 100% fertigation) followed by D2F1 (80% irrigation with 100 % fertigation) and minimum under D3F2 (60% irrigation with 75% fertigation).

Broad bed and furrow with mole drainage system for crop sensitive to water logging

The experiment to investigate the effect of broad bed furrow (BBF) (Fig. 33) coupled with mole drainage on productivity of crops sensitive to waterlogging was undertaken. BBFs were constructed in 70 m length and four treatments of varying depths(150, 200and 250 mm and control as the farmers' practice) with mole drains of 85 mm diameter at 4.0 m spacing and 500 mm depth were installed with sump in experimental field (C-4) of the institute as shown in Fig.33. The crops of maize crop (Var: *NSC-1009*) and wheat (Var*: HI 8498*) were grown. The treatments were replicated thrice. During Kharif 2015 the maize crop suffered on account of bad environmental conditions. Though the crop yield was low, the yield values under treatments comprising BBFs, indicated increasing trend with increasing depth of BBFs, which were relatively higher than the control treatment.

Fig. 33. Experiment on BBF with mole drain in maize and wheat crops

The grain yield of wheat obtained under different treatments of BBFs with mole drainage was observed to be higher than conventional practice (control).The increase in grain yield among different treatments of BBFs and mole drainage over the control was found 9.96, 12.86 and13.32%, respectively, for the BBFs with 150, 200 and 250 mm.

Study on health response of differently processed soy foods consumed in India

A study was undertaken to find effect of different soy products namely; unprocessed soy flour, full fat soy flour (sprouted and blanched), medium fat soy flour, defatted soy flour, nuts (roasted and fried), soy milk, tofu, soy sattu, and soy biscuits on health response of *Wistar* albino rats (*Rattus norvegicus).* The diet for rat was prepared as per standard method with protein source as casein and different soy products along with control (only unprocessed soybean as protein source termed as raw) for four weeks. Blood biochemical parameters were analysed for blood glucose, serum urea, serum uric acid, serum creatinine, bilirubin, SGOT, SGPT, alkaline phosphatase, total cholesterol, LDL, HDL and triglycerides. Food intake per day and the body weight per week were also recorded during the experimentation. Health response of soy products on rat showed mixed response on various parameters.

Effect of consumption of soy products on Lipid profile:

Change in the levels of lipid profile from initial day of food consumption viz., total cholesterol, HDL, LDL and Tri Glycerides is presented in Table 11.

Table 11. Variation in different parameters of lipid profile

Parameters	Products that increased the value from Initial day	Products that decreased the value from Initial day
Total Cholesterol	Raw, Sprouted full fat soy flour, Nut (roasted; fried), Full fat soy flour (unprocessed), Soy biscuits	Tofu, Soy milk, Medium fat soy flour, Soy *sattu*, Defatted soy flour, Blanched full fat soy flour
HDL	Nut (fried), Full fat soy flour (unprocessed), Tofu	Raw, Sprouted full fat soy flour, Nut (roasted) Soy biscuits.Soy milk, Medium fat soy flour, Soy sattu, Defatted soy flour, Blanched full fat soy flour
LDL	Raw, Sprouted full fat soy flour, Nut (roasted; fried), Unprocessed full fat soy flour, Medium fat soy flour, Soy *sattu*	Soy Biscuits, Tofu, Soy milk, Medium fat soy flour, Defatted soy flour, Blanched full fat soy flour
Tri Glycerides	Nut (fried)	Raw, Sprouted full fat soy flour, Nut (roasted), Unprocessed full fat soy flour, Soy biscuits, Tofu, Soy milk, Medium fat soy flour, Soy *sattu*, Defatted soy flour, Blanched full fat soy flour

Effect of consumption of soy products on liver function:

Change in the levels of different parameters responsible for liver function from initial day of food consumption viz., Bilirubin, GOT and Alkaline Phosphatase is presented in Table 12.

Table 12. Variation in different parameters of liver function

Parameters	Products that increased the value from initial day	Products that decreased the value from initial day
Bilirubin	Raw, nut (roasted; fried), unprocessed full fat soy flour, defatted soy flour, soy biscuits	Blanched full fat soy flour
GOT	Raw, unprocessed full fat soy flour, soy biscuits, tofu, defatted soy flour	Sprouted full fat soy flour, nut (roasted; fried), unprocessed full fat soy flour, s oy milk, medium fat soy flour, soy *sattu*, blanched full fat soy flour
Alkaline Phosphatase	Raw, soy biscuits, soy milk, soy *sattu*, defatted soy flour	Sprouted full fat soy flour, Nut (roasted; fried), Unprocessed full fat soy flour, Tofu, Medium fat soy flour, Blanched full fat soy flour

Variation in the levels of various parameters related to lipid profile, liver profile and kidney profile from initial day to fourth week were statistically analyzed. A scoring method was devised to assess the overall effect of consumption of soy products. Sum of total variation reflects the response of soy product on particular parameters. Based on scoring pattern, it was observed that blanched full fat soy flour showed the highest positive response. It is recommended that only processed soy products should be consumed. Unprocessed soybean is not at all recommended for consumption.

Table 13.Variation in different parameters of kidney function

Parameters	Products that increased the value from initial day	Products that decreased the value from initial day
Glucose	Raw, sprouted full fat soy flour, nut (roasted), unprocessed full fat soy flour, soy biscuits, medium fat soy flour, soy *sattu*	Soy milk, nut (fried), defatted soy flour, blanched full fat soy flour
Urea	Unprocessed full fat soy flour, defatted soy flour, Soy biscuit	Raw, sprouted full fat soy flour, nut (roasted; fried), tofu, soy milk, medium fat soy flour, soy *sattu*, blanched full fat soy flour
Creatinine	Raw, nut (roasted; fried), unprocessed full fat soy flour, soy biscuits soy milk, medium fat soy flour, soy *sattu*, defatted soy flour, blanched full fat soy flour	sprouted full fat soy flour, tofu

Salient Achievements under AICRPs

AICRP on Farm Implements and Machinery

Tractor operated check basin former

A tractor operated check basin former was developed at MPKV, Rahuri. The machine scrapes, collects and distributs the collected soil uniformly to form side bunds and cross bunds at regular interval of 6 m in a single pass. Size of the check basin formed was 2 x 6 m, having 0.15 ha/h effective field capacity. Cost of the machine is Rs.50,000/-. Cost of the operation was Rs.3,070/ha and results in 96% saving over the conventional manual method.

Power operated sugarcane sett cutter

Power operated (0.75 kW, 1440 rpm, single phase electric motor) sugarcane sett cutter was developed at MPKV, Rahuri to cut single eye bud or double eye bud setts of sugarcane. Capacity of the developed cutter was 3360 setts/h. Time required to cut setts for one hectare by the developed machine was 8.24 h. Cost of the machine, cost of operation and time saving over manual operation were Rs.75,000/-, Rs.98/h and 80%, respectively.

Tractor operated small seed planter

Tractor (26.11 kW) operated six row planter was designed and developed for planting small seeds like onion by PAU, Ludhiana. It consisted of inclined plate type metering mechanism, seed hopper for each row, shovel type furrow openers and three point hitch system. The capacity of the seed hopper was1.5 kg and metering plate of 130 mm diameter was made of plastic. The row to row spacing of the machine was 150 mm whereas plant to plant spacing can be changed either by changing the plate with different number of notches or by changing the sprockets. Tractor operated small seed planter was evaluated for seeding onion (Punjab Naroya variety) in the field using 24 groove plate at forward speed of 2.0 km/h. Average number of plants/m^2 area was 88. Average percentage of single, multiple, and missing was 59.7, 35.0 and 5.3%, respectively. Average yield of the onion crop was 38 t/ha. There was saving of about 50.40% in cost of operation and 81.12% in labour requirement as compared to traditional method of onion cultivation. Field capacity and cost of operation of the machine were 0.16 ha/h and Rs.5,090/ha, respectively.

Tractor operated garlic planter

Tractor operated six row garlic planter was developed with actuating spoon (size of 23 mm diameter and 2.5 mm depth) type metering mechanism at PAU Centre of AICRP on FIM for planting of garlic at 150 mm row

spacing to suit local seed varieties and agronomic practices. It consisted of seed metering plate, seed hopper, agitator and seed covering device. Power to the metering mechanism was provided from the ground wheel with the help of chain and sprockets. Field capacity of the machine was 0.18-0.21 ha/h at forward speed of 2.00 to 2.25 km/h. Average percentage of missing and multiples were 9.13 and 26.70%, respectively with tractor operated garlic planter. There was saving of 82% in labour requirement and 57% in cost of operation compared to manual planting. Approximate cost of the machine is Rs.1,50,000/- and cost of operation is Rs.6,168/ha.

Seed cum fertilizer drill for sowing wheat in cotton-wheat relay cropping

Existing power weeder of BCS make was modified to attach a four row seed drill for sowing of wheat in cotton-wheat relay cropping system by CCSHAU, Hisar Centre of AICRP on FIM. The crop pushing mechanism was also made by providing wired aerodynamic cage so that the existing crop does not hinder its movement. The experiments were conducted at Directorate of Cotton Research, Sirsa to evaluate different methods of sowing in cotton-wheat relay cropping system in collaboration with DWR, Karnal.

Timely and late sowing of wheat by conventional method gave maximum yield of 51.2 and 41.7 q/ha, respectively. Timely sowing of wheat using broadcasting method after using power weeder and sowing wheat by using seed drill attachment in the existing cotton crop were found to be 44.8 q/ha and 43.1 q/ha, respectively which was 3.4% more than the late sown wheat.

Similar results were obtained at Research Farm, Wheat Section, CCSHAU, Hisar. Maximum yield of 52.3 q/ha has been recorded in relay sowing by broadcasting method (timely sown). Average yield of 47.6 q/ha has been recorded in early sowing whereas the average yield was 48.3 q/ha in late sowing by using seed drill attachment in cotton-wheat relay cropping. Though there is numerical variation in the yield among different treatments, but statistically it has been found to be non-significant.

Performance of seed drill attachment with power weeder

Parameters	Values
Theoretical field capacity, ha/h	0.17
Average forward Speed, km/h	1.73
Average working depth, mm	84
Average Fuel consumption, l/h	1.10
Average actual field capacity, ha/h	0.12
Average field efficiency, %	70.50

Paddy transplanter as an attachment to four wheel drive tractor

Paddy transplanter, as an attachment to 4WD tractor, was developed by PJTSAU Hyderabad Centre to overcome the problem of higher unit price of self-propelled rice transplanter which restricts its promotion in the region. VST China make Yanji 8 row paddy transplanter was identified for developing as an attachment to VST 4WD 16.41 kW mini tractor. Power from tractor PTO was transmitted to drive the planting mechanism of the transplanter. Four wheels of the VST

mini tractor were replaced with front and rear wheels of Kubota transplanter to avoid sinkage in field condition. Height of the gear box and height of the top link were increased for more lifting height through hydraulic system. Effective field capacities of machine were 0.19, 0.24 and 0.29 ha/h with field efficiency of 52.80, 60.22 and 60.50% at an operating speed of 1.87, 2.09 and 2.5 km/h respectively. For all combinations, the seedlings per hill were 2-4 and the floating hills varied 1-3%.

Power operated garlic stem and root cutter

Power operated garlic stem and root cutter equipped with 0.75 kW electric motor was developed by MPUAT Udaipur centre of AICRP on FIM. It consisted of main frame, feeding unit, clamping unit, cutting unit, power transmission unit and garlic bulb dropping chute. Feeding unit consisted of two feeder boxes on opposite side of the machine to feed the garlic for cutting stem and root. Clamping unit was provided inside the feeder box to hold the garlic bulb and stem. Cutting unit consisted of four pair of counter rotating root and stem cutters below each of the feeder box. Garlic bulb dropping chute was provided just below the cutting unit in such a way that when the root and stem is cut, the garlic bulb falls and passes through a chute in the collecting tray. Test trials on two varieties viz; G-282 (large size bulb) and *Mahadev* (small and medium size bulb) variety were conducted for cutting stem and root. The bulb diameter varied from 33.33 to 62.02 mm for small, medium and large sizes bulbs, respectively. The mean output capacity with plain type cutter only for one side of the feeder box was found as 33.89 kg/h, while with serrated type cutter, it was found as 31.15 kg/h. The mean cutting efficiency was 99.23, 99.14 and 98.9% for small, medium and large size bulbs, respectively. Power requirement of cutting stem and root was observed as 1.2 kWh.

Power operated onion detopper cum grader

Presently in our country, detopping and grading of onion are done manually which are very time consuming and labour intensive operations. A power operated onion detopper-cum-grader was developed at MPKV, Rahuri. The machine consisted of feeding mechanism, detopping mechanism and grading mechanism. Onions, after detopping, were graded in five grades of < 35 mm, 35-50 mm, 50-60 mm, 60-85 mm and > 85 mm. Average feeding rate, detopping capacity and efficiency were found to be 277 kg/h, 238 kg/h and 86%, respectively. Average power requirement at load was 0.9 kW. Average onion leaf neck length, before and after detopping, was 314.8 mm and 23.43 mm, respectively. It was observed that 1.88, 44.73, 33.08, 20.29 and 0% onions were graded in grades of < 35, 35-50, 50-60, 60-85, > 85 mm, respectively. Average output capacity of manual onion detopping and grading was 30 kg/h and 100 kg/h, respectively. Approximate cost of the power operated onion detopper cum grader is Rs.85,000/-. Average cost of operation was Rs.256/- per tonne compared to Rs.813/- per tonne during manual onion detopping and grading.

AICRP on Ergonomics and Safety in Agriculture

Package of safety gadgets/practices for women working in fish processing activities

Health hazards survey was done by Dr. BSKKV, Dapoli Centre of AICRP on ESA in fish processing industries and it indicated that women workers are mostly employed in fish processing industries. There were several operations in fish processing industries such as peeling, dressing, descaling etc. All these operations are being done manually by women workers without any protection devices. Hence, five different types of hand protection devices (gloves) were ergonomically evaluated and it was recommended to use surgical gloves (inside) and cotton gloves (outside) during fish dressing operation for higher work output and better safety of hands.

It was observed that the average capacity of dressed fish without gloves and five different hand protection devices viz; finger coats, medical examination gloves, sterile surgical gloves, cotton gloves and combination of medical examination gloves (inside) and cotton gloves (outside) were 36.55, 31.8, 34.45, 36.7, 38.7 and 42.4 kg/h, respectively. The highest output of 42.4 kg/h for dressing fish was obtained with the use of a combination of medical examination gloves (inside) and cotton gloves (outside).

Solar collector (air heater) integrated with smoke dryer

The performance of solar collector (air heater) integrated with smoke dryer, developed under AICRP on EAAI TNAU Coimbatore centre was evaluated and it was efficient for natural rubber drying. Drying time for rubber sheets was reduced to 3-4 days in this dryer compared to 5-7 days required in traditional method. Initial moisture of rubber sheets was 24.8% (w.b), which was reduced to 0.8% (w.b), with the drying temperature of 60°C. Due to use of this dryer, fuel wood consumption is reduced from 45 kg/day to 15 kg/day for drying 150 sheets.

Hybrid dryer based on solar & biogas for mushroom drying

The MPUA&T, Udaipur centre developed hybrid dryer based on solar and biogas for mushroom drying. Mushrooms dryed using this dryer appeared good when rehydrated. During organoleptic evaluation of the dried mushrooms, commercially available samples and sun dried samples scored less than the samples dried in this hybrid dryer.

Hybrid solar/biogas refrigeration system

SPRERI, VV Nagar centre optimized the design parameters of grid independent hybrid solar/biogas refrigeration system for transient storage of horticultural produce. The thermal efficiency of the solar thermal field was found in the range of 36 to 46% for the average daily solar radiation varying in the range 450-850 W/m^2. The cold room temperature dropped from 27 °C to 12 °C within 40 min of circulation of the chilled water (8 °C). Storage of three varieties of green mangoes and brinjals during July and August indicated that the shelf-life of the green mangoes stored in the cold room was 18-19 days compared to 6-7 days when stored under ambient conditions, these values for brinjals were nine and five days, respectively.

Wood gas cook stove with TEG module

MPUA&T, Udaipur centre developed of wood gas stove with thermoelectric power generation system. This cook stove has thermal efficiency of about 35%, its average CO and CO_2 emissions are in the range of 61.46 - 208 ppm and 4900-7100 ppm, respectively. The stove generates total particulate matter of 6.22 - 17.82 mg/m^3. The power output from TEG module was is 1.65 W and 2.05 W with *babool* wood and groundnut shell pellet, respectively.

Solar operated knapsack sprayer

The UAS, Raichur centre evaluated solar operated knapsack sprayer for spraying in cotton and compared with traditional knapsack sprayer. The effective field capacities of solar powered knapsack sprayer and traditional knapsack sprayer were 0.15 and 0.11 ha/h with a field efficiencies of 88.23 and 78.57%, respectively. The cost of operation of the solar powered sprayer and traditional sprayer works out to be Rs.265/- and Rs.330/- per ha, respectively.

Package of animal drawn implements for cotton crop

UAS, Raichur centre adopted a package of bullock drawn equipment for cotton crop. The package comprised Balaram plough, cultivator, blade harrow and inter-culture hoe. Field capacity of the Balaram plough, three tyne cultivator and blade harrow were 0.04, 0.18 and 0.22 ha/h, respectively. For Balaram plough, the average draft for ploughing operation was 590 N at forward speed of 2.20 km/h with the power output of 0.37 kW. Cost of the operation for ploughing with Balaram plough was estimated to be Rs.3450/ha. For three tyne cultivator, the average draft requirement and field capacity were found to be 500 N and 0.18 ha/h, respectively. Similarly, for blade harrow, field capacity of the implement was found to be 0.22 ha/h and draft requirement was observed as 399 N at forward speed of 2.60 km/h.

This package was found suitable for Khillar, Ongole and other breeds of bullocks used in Karnataka. Field trials and demonstrations were conducted in farmer's field in Ganmur village of Raichur district for the adoption of set of package of implements for cotton crop.

Bullock drawn earthing-up cum inter-culturing implement for sugarcane and turmeric crop

MAU, Parbhani centre developed an earthing-up cum inter-culturing implement to remove weed as well as for placement of fertilizer simultaneously in the crop. It consists of main frame, tynes, coulter, ridger assembly, handle, hitching unit, fertilizer box support and fertilizer box. Coulter serves the function of weeding and earthing-up. Speed of operation for bullock drawn implement for inter-culturing, light earthing-up and final earthing-up was 3.0, 2.8 and 1.89 km/h, for sugarcane and 3.13, 2.88, and 2.25 km/h, respectively, for turmeric crop. Similarly, field capacity of frontier-culturing, light earthing-up and final earthing-up operation were 0.15, 0.15, 0.12 ha/h, for sugarcane and 0.20 ha/h, 0.18 ha/h and 0.13 ha/h, respectively, for turmeric.

Bullock drawn solar powered high clearance sprayer

UAS, Raichur centre developed a bullock drawn solar powered sprayer to utilize the available solar energy. Solar energy is used as power source for the operation of sprayer unit and bullock power used for pulling the cart. It was observed that as the discharge rate increased, droplet size decreased and spray angle increased by increasing the operating pressure from 3 to 7 kg/cm^2. Spray angle range was varies from 36.9° to 146.5°. The sprayer has high clearance and therefore useful for spraying in tall field crops as well.

Animal drawn turmeric digger

IGKV, Raipur centre developed animal drawn turmeric digger, matching to the draught capacity of bullocks of Chhattisgarh. The modified turmeric digger has 21° blade angle. The theoretical field capacity was calculated as 0.104 ha/h, at a speed of 3 km/h. The unit costs approximately Rs.1,500/- and digging cost is around Rs.748/ha.

Technology Transfer

Commercialization

The institute aims to commercialize agri-engineering technologies through small and large sized business units to ensure their availability at national level for effective transfer and adoption at farmers' level. During the year, three technologies, as given below, were commercialized through Licensing and Memorandum of Agreement with:

Sl. No.	Name of the firms
1.	M/s. Sana Vegan Products, Visakhapatnam and M/s. Lovsoy Food Products LLP, Mysore for soy butter
2.	M/s. Sankoh Process Equipment, Hosur-TN, M/s Grenera Nutrients Pvt. Ltd., Erode, Tamil Nadu for *moringa* leaf stripper
3	M/s. Nexgen Drying System Pvt. Ltd., Pune for *moringa* leaf stripper, alovera gel extractor and multiplier onion peeler

Krishiyantra: A technology information portal for agricultural engineering technologies

CIAE website for technology information dissemination was upgraded, making it user-friendly, interactive and SMS enabled. It has provision for database of experts in the area of agricultural engineering besides the data base on agricultural technologies and their suppliers. It contains data on indigenous agricultural equipment commercialized and ready to be commercialized. About 200 technologies and 1,500 addresses of manufacturers have been uploaded on this website. A user can directly access the information about agricultural engineering technologies. It also functions as single window information portal on product/technology suppliers, and as advisory on feasibility of some agri-businesses. The web-site can be accessed through CIAE home page as well as through web address namely 'krishiyantra.ciae.res.in.'

Video film on CIAE Profile, FIM, UAE & ESA

A new documentary, 'CIAE-A Profile', was released on February 15, 2016, the foundation day of the institute. The documentary showcases prominent activities, facilities and technologies developed by CIAE.

Package of equipment for millet processing

A millet pocessing centre (MPC), was established in May, 2015 at tribal area, Aasanur, District Erode, Tamil Nadu. This MPC processed 2,232 kg of foxtail millet, 2,366 kg little millet (cleaned and dehulled), 1,344 kg dehulled finger millet and 293 kg finger millet flour production using the millet processing machinery so far. Revenue generated by the MPC is Rs.16,668/-. The tribal farmers saved 72% in cost of processing of one kg of millet.

Memorandum of Understanding was executed between CIAE and M/s. Madhya Pradesh Vigyan Sabha, Bhopal for setting up of millet processing centre at Patalkot, District Chhindwara, Madhya Pradesh.

Prototype supply

Availability of quality machines developed by R&D institution through manufacturers has been one of the bottlenecks in mechanization. The Institute is addressing this issue through in-house mass production of prototypes and supply of the same throughout the country. During the year, 2890 units of different designs of prototypes worth Rs.53.7 lakh, were manufactured and supplied as detailed below:

Sl. No.	Implements	Qty	Amount(Rs.)
1.	Manual maize sheller	924	55,440
2.	Manual *Naveen* sickle	1,383	82,980
3.	Manual hand ridger for women	22	15,400
4.	Manual *Naveen* dibbler	33	23,100
5.	Manual rotary dibbler	17	39,100
6.	Manual groundnut decorticator	75	1,80,000
7.	Manual groundnut stripper	04	4,800
8.	Manual double screen grain cleaner	25	1,12,500
9.	Manual *paneer* pressing device	01	4,000
10.	Manual twin wheel hoe	108	86,400
11.	Manual cycle wheel hoe	13	14,300
12.	Manual peg type dry land weeder	04	3,200
13.	Manual grubber weeder	23	9,200
14.	Manual cono weeder	05	9,500
15.	Manual 4-row rice transplanter	07	84,000
16.	Manual 4-row rice seeder	10	36,000
17.	Animal drawn *patella* puddler	05	30,000
18.	Animal drawn 3-row inclined plate planter	11	1,65,000
19.	Power tiller drawn sweep cultivator	05	40,000
20.	Power tiller drawn augur digger	01	22,000
21.	Pedal cum power operated seed cleaner with motor	48	9,60,000
22.	Pedal operated potato slicer	42	5,04,000
23.	Pedal operated potato peeler	42	7,14,000
24.	Portable charring kiln	01	8,000
25.	Tractor operated precision plot drill –6 row	05	4,50,000
26.	Tractor drawn broad-bed former cum seeder	01	59,000
27.	Motorized multi crop plot thresher	09	2,52,000
28.	Motorized single ear head thresher	05	1,30,000
29.	Motorized dal mill with 2.0 hp motor	02	60,000
30.	Multipurpose grain mill 1 hp motor	02	38,000
31.	Multi fuel cook stove	18	18,000
32.	Motorized soybean dehuller	11	1,98,000
33.	Motorized millet mill	01	38,000
34.	Motorized briquetting machine with motor	03	1,02,000
35.	Hand operated potato peeler	03	24,000
36.	Hand operated potato slicer	04	38,000
37.	Integrated small scale lac processing unit	01	4,00,000
38.	Solar cabinet dryer	03	60,000
39.	Self propelled power weeder	01	50,000
40.	Power operated expanding belt type fruit grader	01	25,000
41.	Filter unit	01	4,000
42.	Double reflector solar cooker	07	31,500
43.	Annular core biochar rector	01	45,000
44.	Tractor drawn two row sugarcane settling planter	02	1,44,000
	Total Rs.	**2,890**	**53,69,420**

Media activities

Radio Talks

Presenter	Date	Topic
RS Singh	13 May, 2015	*krishi utpadan lagat ghatane me unnat krishi yantron ka yogdan*
SD Kulkarni	16 Aug, 2015	*soybean ki khadya gunavatta evam prasanskaran*
RS Yadav	17 Sep, 2015	Use of plastic mulch in horticultural crops
UC Dubey	21 Oct, 2015	Sowing machinery for Rabi crop
RD Soni	27 Dec, 2015	Live telecast on *rabi phasalon me sam samyik krishi karya*
S Deshpande	8 Jan, 2016	*soybean utpad swarojgar hetu*
SD Kulkarni	8 Jan, 2016	*soybean ke khadyopayog*
RS Singh	29 Feb, 2016	Custom hiring of farm machinery

TV Programmes

Presenter	Date	Topic
SD Kulkarni	1 Jul, 2015	Soybean processing and related issues
RD Soni	3 Aug, 2015	Management of yellow mosaic in soybean & paddy field
RD Soni	10 Aug, 2015	Management of yellow mosaic in soybean & paddy field
RS Yadav	5 Oct, 2015	*udyaniki phasalon mein samsamayik karya*
RD Soni	4 Jan, 2016	Live telecast programme on Rabi crop management & essential farm machineries in *phasal sangosthi* held at village Sahaganj (Sehore)
UR Badegaonkar	18 Feb, 2016	*rabi phaslon ki katai hetu yantra*
UR Badegaonkar	18 Feb, 2016	*rabi phaslon ki gahai*
UC Dubey	3 Mar, 2016	*narwai na jalayen*
RS Yadav	3 Mar, 2016	Care and pest management in mango orchards
RS Yadav	3 Mar, 2016	Care and pruning of guava orchards

Field days/ field demonstrations

Field Days: Krishi Vigyan Kendra organized field days on soybean, onion, paddy crop on 22 October, 2015 and 26 October, 2015 in Jamunia kala village, Bhopal. On 28 January, 2016, demonstration for transplanting of vegetable crops; tomato and cauliflower was organized in village Dewalkhedi and Shyampur, Bhopal in which 31 farmers and farm women participated. Cultivation of vegetable on flat and raised bed, equipment for vegetable cultivation, seedling treatment and vegetable production technology were explained to the farmers. Zinc sulphate (2 kg/farmer) and humic acid (1 l/farmer) were distributed to 10 farmers under On- farm testing programme in tomato.

Front line demonstration on improved farm machines at KVKs

Under Consortium Research Platform on Farm Mechanization and Precision Farming, 'Field Day' was

Demonstration and Exhibition

Sl. No.	Title	Duration	Venue
International			
1.	India-International Trade Fair	14-27 Nov, 2015	*Pragati Maidan*, New Delhi
National			
2.	*krishi vikas* 2015	25-27 May, 2015	Indore
3.	*krishi vigyan mela*	13 Jun, 2015	Rajgarh, Biaora, MP
4.	National Exhibition by National Horticulture Board	27-28 Jun, 2015	Jharkhand
5.	National Exhibition by National Horticulture Board	4-08 Jul, 2015	Muzaffarnagar, UP
6.	Agri Intex 2015	17 Jul, 2015 & 19 Jul, 2015	CODISSIA Complex, Coimbatore, TN
7.	National Agriculture Exhibition	20-21 Aug, 2015	Bihar
8.	National Agricultural Fair	26-28 Dec, 2015	Raipur, CG
Regional			
9.	Horti Fair/ Horti *sangam*-2015	10-12 Apr, 2015	Bihar
10.	*krishi mela*	19 Jun,2015	Raisen, MP
11.	One day workshop on *garcinia* species	20 Aug, 2015	Chettalli, Karnataka
12.	Agricultural Fair cum Exhibition on Soybean	25 Aug, 2015	Indore, MP
13.	*jan soochna abiyan*-PIB	13-15 Oct, 2015	Dewas, MP
14.	Science Fiesta-2015	9-10 Nov, 2015	Bhopal, MP
15.	World Soil Day	5 Dec, 2015	IISS, Bhopal
16.	Farmers' interact meet	22 Dec, 2015	Elur village, Coimbatore.
17.	Farmers' Day celebration	8 Jan, 2016	TNAU, Coimbatore, TN
18.	State level seminar on Protected Cultivation Technologies	29 Jan, 2016	Bhopal, MP
19.	16th IND EXPO	6-8 Feb, 2016	Indore, MP
20.	Bhopal *vigyan mela*	19-22 Feb, 2016	BHEL, Bhopal, MP
21.	*krishi unnati mela*-2016	19-21 Mar, 2016	New Delhi
22.	Mega Farm Machinery *mela*	21 Mar, 2016	TNAU, Coimbatore, TN
23.	Bundelkhand *krishi pradarshani and ghosthi*	29-30 Mar, 2016	Lalitpur, UP

organized on 3 March, 2016 at the institute campus. In this programme, in all 67 farmers (48 from 16 villages of Madhya Pradesh and 19 from 15 villages of Maharashtra) participated. Interaction was held with farmers on issues like availability of improved farm equipment and tools, ways for conservation of natural resources like water and soil (more crop per drop), safety in agriculture etc.

The participants visited Precision Farming Development Centre and saw the crop production and vegetable production in covered condition. Improved

farm tools and implements were demonstrated to these framers.

Training-cum-demonstration on mechanized rice transplanting

One day training-cum-demonstration on mechanized rice transplanting was organized by the institute on 29 June, 2015 for 47 farmers from five villages adopted by KVK and NICRA project. A presentation on improved machinery for rice cultivation and mechanized transplanting covering method of growing mat type nursery was made. This was followed by practical training on raising of mat type nursery and field demonstration of riding type six row rice transplanter. As a follow up activity, field demonstration on 0.40 ha field of a farmer in village Kachhi Barkheda, Bhopal was also organized on 6 July, 2015.

Agricultural machinery and technology demonstration day

AICRP on Farm Machinery and Implements, CIAE Bhopal Centre in co-ordination with other AICRPs and different divisions of the institute celebrated the agricultural machinery and technology demonstration day on 18 March, 2016. About 400 participants, including 185 farmers, 54 custom hiring enterprise aspirants, 34 agribusiness and agri-clinic enterprise aspirants and about 100 students from rural background of nearby villages participated in the programme. A film on technologies developed by CIAE Bhopal was also shown to the participants to sensitize the field

demonstration of the machinery and technology. Visit of the farmers from *yantradoot* villages from the district of Bhopal, Chattarpur and Dewas was organized by Directorate of Agricultural Engineering, Government of Madhya Pradesh. Live demonstration of tillage, seeding and planting, intercultural machinery, precision farming technologies, conservation agricultural and animal drawn machinery were also conducted. Energy enclave centre and technology display hall of CIAE were shown to the participants.

Field Day for sugarcane setts/buds

A field day on newly developed equipment for treatment of sugarcane setts / buds was organised on 13 July, 2015, jointly by the Coimbatore Regional Centre of the institute and ICAR Sugarcane Breeding Institute, Coimbatore at M/s. Ambiga Sugars, Kottur, Kumbakonam, Tamil Nadu. Ninety cane officers, cane inspectors, sugarcane mills and scientists attended the programme.

Sl. No.	Name of the equipment	Date	Place	Number of farmers / scientists attended
1	Pneumatic planter, inclined plate planter, cultivator mounted seed drill, ridger seeder (tractor operated) andseed planter (bullock drawn)	11 Aug, 2015	CICR, RS, Coimbatore	10 scientists
2	Tractor drawn inclined plate planter	10 Sep, 2015	Kollapalayam, Erode district	50
		29 Sep, 2015	Kurumanthur kadu, Erode district	25
3.	Tractor drawn pneumatic planter	26 Sep, 2015	Kollapalayam, Erode district	35
4	Manually guided power weeder	17 Oct, 2015	Elur, Madhurkarai taluk, Coimbatore	30
5	Power weeder	20 Oct, 2015	Kollapalayam, Erode	35
		21 Nov, 2015	Kurumanthur kadu,Erode	30
6	Manual seed cum fertilizer broadcaster, animal drawn ridger, animal drawn leveller, wheel hoe, long handled weeder, manually operated chaff cutter, tractor drawn chisel plough	2 Dec, 2015	Bejeletty, Erode district	50
9.	Tractor operated sugarcane settling planter	2 Feb, 2016 8 Feb, 2016	Sugarcane Breeding Institute, Coimbatore	18 scientists
10.	Tractor operated air sleeve boom sprayer	9 Feb, 2016	Kurumanthur kadu, Erode	30
11.	Cotton picker	10 Feb, 2016	Vazhuku parai village, Coimbatore	40
12.	Tractor operated cassava harvester	25 Feb, 2016	Ariyagoundanpatti, Namakkal District	35

Mera Gaon Mera Gaurav scheme activities

Under the scheme *'Mera Gaon Mera Gaurav'*, launched by Government of India to develop direct linkage between farmers and the scientists, the institute formed 16 groups of four scientists each, including two groups adopted by CIAE Regional Centre, Coimbatore. These 16 groups comprised scientists from different disciplines and each group visited the adopted villages frequently and interacted with the farmers and the village head (*Sarpanch*) to discuss and identify the problems being faced by the farmers and the village in agriculture and allied sectors.

The scientists organized interaction meets (*kisan sangosthis*) with farmers along with local agricultural and rural extension officers. In these meets, scientists sensitized the farmers and the local extension officers on available agricultural engineering technologies suitable for farmers as well as the village. The technological gaps/needs for engineering intervention were also identified. In addition, the training/skill development needs for employment and income generation were also identified. The scientists created awareness about suitable technologies and made suggestions and extended support to improve their production, processing and value addition, energy savings and to improve soil and water management practices for enhanced productivity, reduced drudgery and minimizing cost of production.

The 16 groups formulated by the institute have adopted 80 villages. A total of 38 interface meetings, 39 demonstrations and five videos shows on biomass utilization technologies; presentation and demonstrations of using soybean in daily diet were held. A few groups of farmers were brought to the institute campus and demonstrated the equipment and technologies for raised bed cultivation of soybean crop. Gadgets and tools, such as groundnut decorticator, maize sheller, pedal-cum-power operated cleaner, smokeless chula and several hand tools for weeding were much appreciated by farmers.

Some of the major problems / issues raised by these farmers during interactions with scientists included spoilage of crops due to wild birds, erratic electric power supply, non-availability of certified seeds and fertilizer in time, need for custom hiring of agricultural machinery, non-disbursement of subsidy and demand for gadgets for renewable energy sources at village level, scarcity of irrigation and safe drinking water, soybean crop failure due to bad weather conditions, poor road accessibility for transport of agro-produce and lack of adequate number of cleaners/graders for food grains.

Training and Capacity Building

Participation in trainings

Employees of different categories participated in taininig programmes held at different places of the country and abroad. These are summarised as follows:

Sl. No.	Category of Employees	Number of trainings attended
1	Scientific	20
2	Technical	3
3	Administrative and Finance	4
	Total	27

Eight scientists of the institute attended training programmes of 90 days duration as their professional attachment training. Seven scientists and one staff from administration attended training programmes of 21 days at different places. One scientist attended an international HRD programme at IAARTD Serpong, Indonesia. Rest of the training programmes were of one week duration or less. The institute incurred expenditure of Rs.9.91 lakh against allocation of Rs.9.92 lakhs.

Educational activities

Post Graduation (PG) Centre at CIAE, Bhopal is an outreach programme of PG School, Indian Agricultural Research Institute, New Delhi for carrying out the academic activities in Agricultural Engineering (Farm Power and Equipment, Soil and Water Conservation Engineering and Agricultural Processing and Structures). Director of CIAE, Bhopal is the Professor for the PG programme. Presently eight PG students of Agricultural Engineering (3 from Academic Session 2014-2015 and 5 from Academic Session 2015-2016) are pursuing their doctoral programme. Various activities for strengthening the PG studies viz; establishment of PG Cell, smart class rooms, seminar hall, accommodation, mess facility, etc. have been taken up.

International training programme

Certificate Course in Food Science and Technology

Two Nigerian nationals, Mrs.Umanah Tope Joyce and Mrs. Ajijola Wuraola Rachael attended six months (24 week) certificate course on food science and technology at the institute from June 15, 2015.The programme was sponsored by West Africa Agricultural Productivity Programme (WAAPP) and facilitated by Agrinnovate India ltd., New Delhi. The certificate course consisted of lectures, demonstrations, discussions, and practical on food microbiology, food biochemistry, food engineering, food processing and visits to concerned institutes and industries.

Summer School on Biomass and Biofuel

A summer school on "Biomass and Biofuel: Technologies, Climate Change and Environment" was organized during 22 July-11 August, 2015 for NARS

researchers and other concerned stakeholders. The summer school participants were from the discipline of Agricultural Engineering, Soil Science, Biotechnology and Chemical Engineering working in State Agricultural Universities, Indian Council of Agricultural Research and Krishi Vigyan Kendras. During the training 39 lectures on different areas of bio-energy were delivered. Technologies available in Energy Division were demonstrated. Practical exercises on bio-oil, biochar, gasifier, biogas were also conducted.

Winter School on Precision Farming

Winter school on "Advanced tools and techniques for precise input application systems" was organized during January 5-25, 2016. During this 21 days Winter School, 22 participants from 10 states representing ICAR Institutes, SAUs and KVKs underwent lectures and practical on sensors and applicators, assessment of temporal and spatial variability of resources, site-specific management of input application, wireless sensor networking, techniques for management of soil nutrient quality, remote sensing-concepts and its application, image processing and its application, spectroscopy and spectro-radiometry applications in Indian agriculture, artificial neural network and wavelet transformation for data analysis and handling, application of decision support system and expert system for precision farming and computer aided designing of precision machinery were conducted to provide hands-on experience to the participants.

National/ regional level training programmes

Model Training Course

Model Training Course on "Improved agricultural machinery for farm mechanization and entrepreneurship through custom hiring of self-employment opportunities", sponsored by Directorate of Extension, Ministry of Agriculture, was organized during 27 October to 3 November, 2015 for 21 extension functionaries of different states. During the training, the participants were imparted training on management of agricultural machinery for optimal performance, scope of entrepreneurship with agri-clinic and agri-business and agricultural machines suitable for custom hiring, processing and value addition and energy utilization.

Training on Custom Hiring

Eight entrepreneurship training programmes on custom hiring of agricultural machinery were conducted for upcoming entrepreneurs during October, 2015 to March, 2016. The training programme focussed on identification of region- specific machines, their operation and maintenance, economic viability and decision support system to help these budding entrepreneurs run their enterprises successfully. During these programmes, the participants were imparted training on operation and maintenance of tractors, land preparation, tillage machinery, sowing and planting, plant protection, harvesting and threshing machinery.

Two hundred ninety five youths from various districts across the state were trained in eight batches during this

Training for extension functionaries and farmers of NEH region

Sensitization workshop-cum-training on Agril.Engg Tech. for extension functionaries of NEH Region was organized in collaboration with ICAR-NEH-RC Umiam, Meghalaya during 15-17 March, 2016. Dr. UR Badegaonkar, Er. MB Tamhankar and Dr SK Chakraborty from CIAE were deputed to Umiam, Meghalaya as resource persons for organizing the programme. Extension officers from four north east states viz., Manipur, Meghalaya, Nagaland and Sikkim participated in the programme.

Training-cum-Workshop on Agricultural Engineering Technologies for the farmers of NEH Region was also organized during 18-19 March, 2016. About 250 farmers from twenty five villages attended the training.

They were educated on value addition techniques and machinery (pineapple slicer, pineapple juice extractor), turmeric processing operations (blanching, slicing, drying, sifting, grinding and packaging), banana sheath fibre extraction and thread making, oil expeller, CIAE - cleaner and grader and CIAE - soybean dehuller, etc.

Skill Development Programme on Manufacturing of Agricultural Equipment

Skill Development Programme on "Manufacturing of Agricultural Equipment" was organized during 18 Nov. to 3 December, 2015. Twenty trainees from different states Sikkim (5), Uttar Pradesh (4), Meghalaya (3), Andhra Pradesh (2), Punjab (2), Orissa (2), Delhi (1), and Madhya Pradesh (1) participated in the programme. The course consisted of hands-on training demonstration, discussions on various workshop related issues, installation & maintenance of the workshop machine.

Skill development training programme CAD/CAM in manufacturing of agricultural equipment

Under skill development programme, the institute organized training programme on "CAD/CAM in manufacturing of agricultural equipment" during December 10 to 24, 2015. Fourteen participants representing ICAR institutes, Agriculture Universities & entrepreneurs from six states (Madhya Pradesh -4, Meghalaya -3, Uttar Pradesh -2, Delhi -2, Rajasthan -2 and Uttarakhand -1) successfully completed the course.

Short course on ready-to-eat foods using extrusion processing

Wenger-USA and ASSOCHAM-India, with the support of CIAE, organized a short course on "Ready-to-eat foods using extrusion processing technology and innovations for the domestic and export market" during 25-27 January, 2016 at Bhopal. Around 80 entrepreneurs and engineers from industries and academia participated in the course which covered the latest innovations in extrusion processing technology. It included hardware and ingredients, with focus on 'ready-to-eat' processed food applications for soy based products in India and export markets.

Farmers' professional training on improved agricultural implements and machinery

Consortia Research Platform on Farm Mechanization and Precision Farming organized three training programmes on improved agricultural implements and machinery. Objectives of the training programmes were to promote and strengthen agricultural mechanization, to cultivate different crops to increase profitability of farmers besides saving in labour and time, transfer of technology to the farmer's field, upgrade their skill for minor repair, maintenance and adjustment of farm implements, cultivation under covered condition, increase the production and productivity of different crops, promote the efficient use of resources and inputs like energy, land, water, chemicals, fertilizers, seeds etc. In these training programmes, 89 progressive farmers (including 11 women) participated from Madhya Pradesh, Maharashtra and Uttar Pradesh.

National/ Regional level trainings

S.No.	Title of trainings	Duration	No. of participants
National – Model Training Programme sponsored by DoAC, Govt of India			
1.	Model Training Course on "Improved Agricultural Machinery for Farm Mechanization and Entrepreneurship through Custom Hiring for Self-Employment Opportunities"	27 Oct - 3 Nov, 2015	21 Extension officers of different states
State Level – sponsored by Govt of MP			
1	'Entrepreneurship Development for Custom Hiring of agricultural machinery as an enterprise' sponsored by Govt of MP	5-10 Oct, 2015 3-9 Nov, 2015 1-7 Dec, 2015 2-8 Jan, 2016 23-29 Feb, 2016 7-12 Mar, 2016 16-21 Mar, 2016 25-30 Mar, 2016	295 prospective entrepreneurs
2	Students' Field Training in Agril. Engg. (Under Graduate& Post Graduate)	14 batches of 4-8 weeks duration	196 students
3.	Sensitization Workshop for Subject Matter Specialists (SMS) of KVK & State Govt.	29 Feb - 3 Mar, 2016 5-7 Jan, 2016	35 SMS
4.	Training in NEH Region for extension functionaries	15-17 Mar, 2016	17 extension functionaries
5.	Training for DoAC Technical officers	4 courses of 4 weeks duration	6 DOAC officials
6.	Entrepreneurship development programme on soymilk and tofu	20-25 Jul, 2015 17-22 Aug, 2015 31 Aug-5 Sep, 2015 20-25 Oct, 2015 17-22 Nov, 2015 14-19 Dec, 2015 11-16 Jan, 2016 1-6 Feb, 2016 14-19 Mar, 2016	159 prospective entrepreneurs
7.	Training on production of soy flour, soy based bakery products and soy snacks	23-26 Nov, 2015	4 prospective entrepreneurs
8.	Training on post-harvest agro processing and management	26-31 Oct, 2015 18-23 Jan, 2016	92 rural youths and farmers
9.	Improved Technology under Protected Cultivation	24-25 Apr, 2015	21 farmers and horticulture officers
10.	Protected cultivation for horticulture crops	3-4 Aug, 2015 6-7 Aug, 2015 18-19Feb, 2016 20-21Feb, 2016 10-11 Mar, 2016	126 farmers and prospective entrepreneurs
11.	Protected cultivation of vegetable crops	15 Mar, 2016	23 farmers and horticulture officers
12.	Awareness on 'Importance and Benefits of Agricultural Drainage Technologies'	23 Sep, 2015	11 farmers
13.	Field Day at Village Raipur, Bhopal District	26 Dec, 2015	25 farmers

Trainings organized by CIAE Regional Centre -Coimbatore

Sl.No.	Title of trainings	Duration	Participants
1	Farm Machinery and Process Engineering	7 Aug - 5 Sep, 2015	12 B.Tech students
2	Operation and Maintenance of Agricultural machines	14-15 Dec, 2015	25 farmers/ rural entrepreneurs
3	Farm Machinery and Process Engineering	8 Sep - 5 Oct, 2015	8 B.Tech. students
4	Application of Response Surface Methodology	22 Jan, 2016	Students & faculty
5	Operation and Maintenance of Agricultural machines	28-29 Jan, 2016	21 farmers/ rural entrepreneurs
6	Operation and Maintenance of Agricultural machines	2-3 Feb, 2016	20 farmers/ rural entrepreneurs
7	Operation and Maintenance of Agricultural machines	11-12 Feb, 2016	20 farmers/ rural entrepreneurs
8	Fabrication of new farm implements	15-24 Feb, 2016	5 rural artisans
9	Establishment of Agro Processing Centres	5 Mar, 2016	18 entrepreneurs
10	Advances in Farm Machinery Manufacturing Techniques	14 Mar, 2016	18 ITI students
11	Innovative strategies for marketing of Agricultural Equipment	19 Mar, 2016	10 manufacturers
12	Quality Management in Manufacturing	22 Mar, 2016	8 manufacturers

Farmers' professional training

A farmers' professional training on "Improved Agricultural Implements and Machinery" was organized during 28-30 December, 2015. Twenty five farmers from different states (10 from Maharashtra, two from UP and 13 from MP) participated in this training programme.

Training programmes organized by KVK, Bhopal

The Krishi Vigyan Kendra (KVK) of CIAE organized 44 training programmes addressing integrated crop management and pest management issues, crop production technology, women-friendly technologies etc. These need-based training programmes for the farmers, rural women and rural youths were intended to update their knowledge and skills in modern agricultural technologies and creating awareness about adoption of improved technologies. Details of the training programmes organized are as follows:

Sl.No.	Title of trainings	Duration	No. of participants
1	Kharif crop production technology	12 Apr, 2015	35
2	Cultivation of green gram technology	16 Apr, 2015	10
3	ICM and IPM in tomato	21 Apr, 2015	14
4	Soybean processing technology	6-8 May, 2015	10
5	Mechanized soybean production technology	19 Jun, 2015	26
6	Mechanized paddy transplanting and improved production technology for higher production crop	20 Jun, 2015	26
7	Mechanized crop cultivation of onion	27 Jun, 2015	18
8	Women operated equipment in the Telakhedi	30 Jun, 2015	30

Sl.No.	Title of training	Duration	No. of participants
9	Farm mechanization and crop cultivation	8-9 Jul, 2015	30
10	Mechanized crop cultivation of onion	14 Jul, 2015	29
11	Women operated equipment	20-21 Jul, 2015	13
12	Mechanized soybean production technology	23-24 Jul, 2015	26
13	Mechanized paddy transplanting and improved production technology for higher production crop	28 Jul, 2015	40
14	Women operated equipment	30 Jul, 2015	42
15	Crop related problems visit in CIAE	31 Jul, 2015	10
16	Farm mechanization and crop Production in CIAE, visit	10 Aug, 2015	35
17	Mechanized crop cultivation of onion	11 Aug, 2015	23
18	Crop production technology & production machinery	17 Aug, 2015	31
19	Crop production technology & women operated equipment and machinery	19 Aug, 2015	75
20	Crop Management technology and machinery	03 Sep, 2015	56
21	Farm equipment and technology	15-17 Sep, 2015	50
22	Mole plough training for farmer	24 Sep, 2015	6
23	Organic farming	01 Oct, 2015	65
24	Soybean processing & it utilization	5-9 Oct, 2015	22
25	Organic farming	16 Oct, 2015	35
26	Crop production technology of rabi onion	4 Nov, 2015	36
27	Crop production technology of fruit and vegetable	4 Nov, 2015	25
28	Crop production technology of gram	17 Nov, 2015	10
29	Soil health management & role of soil testing in sustainable production of field crops	22 Nov, 2015	17
30	Crop production technology of gram	24 Nov, 2015	10
31	Crop production technology of irrigated wheat	26-27 Nov, 2015	20
32	Improved agricultural technology, post -harvest techniques and mechanized agriculture management	15-16 Dec, 2015	52
33	Crop production technology & mechanized agriculture management	18 Dec, 2015	39
34	IPM in vegetable crops	5 Jan, 2016	16
35	Planting techniques and nutrient management in onion	18 Jan, 2016	11
36	IPM in vegetable crops	28 Jan, 2016	31
37	Production technologies for *sharvati* wheat & gram (rain fed irrigated crop & for new the technology farmer of Vidisha district	02 Feb, 2016	53
38	Extension functionaries on crop production based women friendly technologies for income generation & value addition	10 Feb, 2016	24
39	Students training on vermin culture and vermin compost.	22-29 Feb, 2016	18
40	Soil health card programme	23 Feb, 2016	44
41	Training cum workshop on agricultural Engineering	04 Mar, 2016	22
42	Cultivation technology of bottle gourd	07 Mar, 2016	10
43	IPM in onion	07 Mar, 2016	14
44	Soil health card programme	17-18 Mar, 2016	28
	Total		1,237

Awards and Recognition

- Dr. T Senthil Kumar was awarded 'Best Paper Award in Agricultural Engineering', by Agricultural Scientific Tamil Society, New Delhi during the First National Conference on Agricultural Scientific Tamil, jointly organized by TANUVAS and Agrl Scientific Tamil Society: New Delhi during 24-25 June, 2015 at Madras Veterinary College, Chennai.
- Dr. Ravindra Naik received the 'NASI – ICAR 2014 Award' at the 87th ICAR Foundation day and ICAR award ceremony held in Patna on 25 July, 2015.
- Er. Ajit Kumar Nayak and Dr. CK Saxena received the 'Best Paper Award' in the oral presentation category for the paper presented on "Estimation of wind load on a double arch type greenhouse and evaluation of its structural stability" in International Conference on "Innovative Agriculture for Rural Prosperity" by Search and Research Development Society, Bhopal held during 27-28 November, 2015.
- Dr. Sandip Gangil was awarded second prize in 'Best Poster Presentation' category for paper entitled "Biochar: Sustainable Management of Agricultural Crop residues" in International Conference on Innovative Agriculture for Rural Prosperity during 27-28 November, 2015, Bhopal.
- Dr. S Balasubramanian was bestowed with 'Outstanding Engineer Award-2015' by IEI, Coimbatore Chapter.
- Dr. Ravindra Naik was awarded second prize in the Best Poster Presentation in the processing session for his poster presentation for the paper entitled "Package of equipment for juice extraction for banana central core"during the 50th annual convention of Indian Society of Agricultural Engineers (ISAE), held at OUAT, Bhubaneswar during 19 – 21, January, 2016.
- Dr. S Mangaraj received 'Outstanding Book Award of ISAE (2015)' for the book entitled "Principles and Practices of Agricultural Processing" during the 50th ISAE Convention.
- Dr. KV Ramana Rao was conferred with 'Commendation Medal-2015' by the Indian Society of Agricultural Engineers, New Delhi during the 50th ISAE Convention.
- Dr. S Mangaraj received ISAE Award for the 'Best Poster Presentation' for the paper entitled "Development of an efficient fruit and vegetable grader for spherical commodities" during the 50th ISAE Convention.
- Dr. CD Singh, Dr. Ramadhar Singh and Er. Himashu H. Tripathi received third prize in Best Poster Presentation on "Development of telemetry system for real time irrigation scheduling based on soil moisture sensor" during the 50th ISAE Convention.

Recognition

KK Singh	Member, United Nations Environment Programme-Food & Agriculture Organizations (UNEP-FAO) Agri-Food Task Force on Sustainable Consumption and Production (ATF on SCP). Chairman, Agricultural Tractors and Power Tillers Sectional Committee (FAD-11), Food & Agriculture Division, BIS, New Delhi. Member, Executive Council and Sectional Committee-Agricultural Engineering of the National Academy of Agricultural Sciences (NAAS), New Delhi. Member, Board of Management, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, MP. Member, Research Adivsory Committee, Sardar Patel Renewable Energy Research Institute (SPRERI), Vallabh Vidyanagar, Gujarat.
CR Mehta	Member - Core Group of Agricultural Engineering Division Board of the Institution of Engineers (India). Member - Executive Committee, Indian Society of Ergonomics for 2015-2018
SD Kulkarni	Member of International Editorial Board "Agricultural Engineering" Faculty of Agriculture Institute of Agricultural Engineering, Belgrade - Zemun, Serbia. Member of Advisory Board of The Society for Disability and Rehabilitation Studies (SDRS), New Delhi. Member on ICMR - ICAR Committee on Soybean.
S Balasubramanian	Member Board of Studies, Baradhiyar University, Coimbatore for PSG Arts & Science College, Coimbatore
Ravindra Naik T Senthilkumar	Fellow of Institute of Engineers (India)

Linkages and Collaboration

Organization	Collaboration
International	
West Africa Agricultural Productivity Programme (WAAPP)	Certificate course on food science and technology for Nigerian nationals facilitated by Agrinnovate India ltd., New Delhi.
Centre for sustainable agricultural mechanization (CSAM-UN-ESCAP), Beijing, P.R.China	CIAE is a focal point under CSAM programme on Asian and Pacific Network for Testing of Agricultural Machines (ANTAM)
Kansas State University, USA, Wenger-USA and ASSOCOM-India	Organization of training programme on extrusion processing
National	
ICAR Institutes -	
DOPR, Pedavegi, A.P	Multiplication and evaluation of tools and machinery for harvesting in oil-palm under programme of Ministry of Agriculture and Farmers' Welfare, New Delhi.
ICAR-IIPR , Kanpur	To provide technological inputs for farm planning and land development and scientific management of water resources at ICAR-IIPR, *Phanda* Farm, Bhopal.
Sugarcane Breeding Institute, Coimbatore; Central Institute of Cotton Research, Nagpur; Central Tuber Crop Research Institute, Thiruvananthapuram; Indian Institute of Soil Science, Bhopal; Central Tobacco Research Institute, Rajamundry.	For collaborative projects and technical handholding.
Central and State Government Organizations	
Department of Agriculture Cooperation and Farmers' Welfare, Govt. of India	Testing of agricultural machinery, National workshop on Pulses Development and addressing various issues related to agricultural mechanization.
National Horticultural Board	Technical support and guidance in horticultural mechanization.
Directorate of Agricultural Engineering, Govt. of MP and Tamilnadu	Addressing various issues related to agricultural mechanization in the respective states, viz. training of officials/ farmers/ entrepreneurs, establishment of custom hiring centres.
State Agricultural Universities	Providing professional training to students in agricultural engineering and extending laboratory facilities to students and faculty.
State Horticultural Mission, Govt. of MP	Technical guidance and awareness programmes related to promotion of protected cultivation technology
Industry	
M/s. Sana Vegan Products, M/s. Lovsoy Food Products; M/s. Sankoh Process Equipment, M/s Grenera Nutrients Pvt. Ltd., M/s. Nexgen Drying System Pvt. Ltd.; M/s. SRF Ltd.; M/s. JVS Foods; M/s. TAFE; M/s Bio Nutrients;	Memorandum of understanding for licensing of institute technologies and contract/ collaborative research.
M/s. CLAAS; M/s. Mahindra & Mahindra; M/s. John Deere; M/s. Robert Bosch	Collaboration for researchable issues in farm mechanization and allied areas.
SOPA Indore; Soy food promotion and welfare association, New Delhi; State Govt. (MP, MS); Ministry of Small and Micro Enterprises.	Technology dissemination, promotion of soy foods, etc.

Intellectual Property and Consultancy

Patents filed

Application Number	Date of filing	Title	Innovator(s)
3525/MUM/2015	15 Sep, 2015	Process technology for gluten-free eggless cake	Dipika Agrahar-Murugkar
4562/MUM/2015	3 Dec, 2015	Aonla deseeding and segmentation equipment.	Ravindra Naik, SJK Annamalai and Dawn CP Ambrose.
201621001885 (e-filing)	19 Jan, 2016	Process technology for production of pro-biotic soya cheese spread	MK Tripathi SK Giri

Copyrights filed

Application Number	Date	Title	Applicant(s)
12887/2015-CO/SW	24 Nov, 2015	Software for Economic-Financial Viability Analysis of Agro Industrial processing unit.	PP Ambalkar, PC Bargale, KP Saha
14108/2015-CO/SW	31 Dec, 2015	Software for analysis of performance parameters of seed metering device.	BM Nandede, T Senthil Kumar, Ranjeet Kumar
702/2016-CO/SW	18 Jan, 2016	Online Database for specific plant parts images of selected varieties of Rice, Okra, Mustard and Chickpea.	N Kotwaliwale Karan Singh
708/2016 - CO/SW	18 Jan, 2016	Software Applications on images of plant parts and plant Varieties	N Kotwaliwale Karan Singh

Consultancy / Contract Projects

- Advisory consultancy project with M/s. SRF Pvt. Ltd. Chennai.
- Advisory consultancy project with M/s. JVS Foods Pvt. Ltd. Jaipur.

Commercial testing of farm machinery

Sl. No.	Name of Equipment	Manufacturers
1.	Battery cum hand operated sprayer	• M/s Neptune Packaging Pvt. Ltd., Janaki Nagar, Indore • M/s Sun Tech Agro Pvt. Ltd., Bengaluru • M/s Chaturbhuja Agro Farm, Mallihyari, Purnea, Bihar
2.	Hand operated knapsack sprayer	• M/s Neptune Packaging Pvt. Ltd., Janaki Nagar, Indore
3	Power operated knapsack sprayer	• M/s George Maijo Industries Pvt. Ltd., 5 Nungambakkam High Road, Chennai • M/s RSR Pvt Ltd., Noida • M/s Sun Tech Agro Pvt. Ltd., Bangalore • M/s Ratnagiri Impex Pvt. Ltd., Bangalore

Sl. No.	Name of Equipment	Manufacturers
4	Spiral seed grader	• M/s. Jay Welding Works, Barwani • M/s. ViswakarmaKrishi Yantra, Ujjain
5	Tractor operated post hole digger	• M/s.Metalweld Engineering Pvt. Ltd., Indore
6	Tractor operated seed cum fertilizer drill	• M/s. Patidar Enterprises, Indore
7	Tractor operated seed drill	• M/s. Laxmi Steel Fab, Nishatpura railway crossing, Bhopal • M/s. Patidar Enterprises, Indore • M/s. Gayatri Industries, Satna • M/s. Ashoka Industries Pvt. Ltd., Guna M/s.Viswakarma Thresher, Nagda , Ujjain • M/s.Viswakarm KrishiYantra, Ujjain • M/s.Patel Agro Industries, 11th Mile, Hoshangabad Road, Bhopal • M/s.Patidar Engineering Works, Indore • M/s. Hedapati Sarkar Agro Pvt. Ltd., Dewas • M/s. Balaji Agro, P.O. Talen, Rajgarh, MP • M/s. Saraf Industries, Khimlasa Road, Khurai • M/s. Rahul Industries, Khimlasa Road, Khurai • M/s. Sunit Engineering Corporation, Guna
8	Tractor operated rotary tiller	• M/s. ViswakarmaKrishiYantra, Juna Naka, Ujjain • M/s. Atlantis Agro Tech Pvt. Ltd., Gujarat • M/s. Metalweld Engineering Pvt. Ltd., 54/1 sk-1, Lasudiya Mori, Indore
9	Tractor operated seed cum fertilizer drill	• M/s. Shivshakti Agros, Ujjain • M/s. Viswakarma Laghu Udyog, Sanwer • M/s. Saraf Industries, Khimlasa Road, Khurai • M/s. Rahul Industries, Khimlasa Road, Khurai • M/s. Gayatri Industries, Satna • M/s. Sona Agro Industries, Sehore
10	Tractor operated straw reaper combine	• M/s. Metalweld Engineering Pvt. Ltd., 54/1 SK-1, Lasudiya Mori, Indore • M/s. Satkartar Agro Engineering Pvt. Ltd., New Kabarkhana, Bhopal • M/s. NR Industries, Datia
11	Tractor operated raised bed planter	• M/s. Laxmi Steel Fab, Nishatpura railway crossing, Bhopal
12	Tractor operated two bottom reversible plough	• M/s. Metalweld Engineering Pvt. Ltd., 54/1 SK-1, Lasudiya Mori, Indore • M/s. Anil Agro Industries, Industrial Area, Bina

Publications

Research Papers

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Events

A number of events were organized in the institute. Brief of significant events held are given below chronologically:

Krishi Sangoshthi

A *Krishi Sangoshthi* and farmers' meet was organized jointly with Department of Agriculture, Govt. of MP, Bhopal on 12 June, 2015 as part of the *Krishi Mahotsav* of the Govt. of Madhya Pradesh during 25 May- 15 June, 2015. About 300 farmers from Berasia Block participated in the meeting. Hon'ble Shri Alok Sanjar, Member of Parliament, Bhopal inaugurated the event.

DG-ICAR Inaugurates ICAR-CIAE Regional Centre, Coimbatore

Dr. S Ayyappan, the then Secretary, Department of Agricultural Research & Education and the then Director-General, ICAR inaugurated Coimbatore Regional Centre of the ICAR-Central Institute of Agricultural Engineering and its new building on 27 August, 2015. Dr. K Alagusundaram, DDG (Engg.), ICAR and Dr. K Ramasamy, Vice Chancellor, TNAU were also present on this occasion. Dr. Ayyappan in his inaugural speech exhorted the farmers to adopt the mechanization technologies developed by CIAE RC and other ICAR Institutes/ SAUs to make field operations cost effective and to achieve higher productivity. A technical bulletin on achievements of this centre during 1983 to 2015 and three extension pamphlets were also released on this occasion.

Inauguration of CIAE-RC new building

Farmers' Interactive Meeting

An interactive meeting of scientists and farmers was organized on 27 August, 2015, which was moderated by Dr. N Gopalakrishnan, former ADG and Principal Scientist, ICAR-CICR Regional Centre, Coimbatore. The issues, raised by the farmers, were answered by the panel of scientists from TNAU, CICR, SBI, NRCB, IISWC and State Agricultural Engineering Department. About 400 farmers participated in the event.

World Food Day

CIAE, in association with Bhopal Chapter of Indian Society of Agricultural Engineers (ISAE), celebrated the World Food Day on 16 October, 2015. On this

occasion, students from different colleges of Bhopal participated in article writing competition, poster presentation and culinary display competitions based on the FAO theme *Social protection and agriculture: breaking the cycle of rural poverty*. There was also an open quiz for the participants in which the students participated actively. A visit to various facilities of the institute was also arranged for the students to make them aware of the activities of the institute and inculcate in them a feeling to fight hunger.

Workshop on food safety and nutrition for school children

Workshop on Food Safety and Nutrition was organized for school children at Regional Science Centre, Bhopal on 28 October, 2015. Besides delivering presentations on food safety and importance of nutrition, live demonstration on preparation of soymilk and tofu at domestic level was also organized.

Interactive meeting with different stake-holders of millet

An interactive meet with different stake holders of millet processing was organized by Regional Centre, Coimbatore under NABARD sponsored project 'Design and development of improved millet mill' on 2 November, 2015. About 60 participants including manufacturers, entrepreneurs, research scholars and government officials participated in the meet.

Nutritional programme for school children

A nutritional program was held in Government Higher Secondary School, Entkhedi on 9 November, 2015. Dr. Dipika Agrahar-Murugkar delivered a talk on "Nutrition and Health and its importance" to the children. Products like nutribar, nutri-laddoo, extruded snacks and cake developed under the National Fellow project were distributed to the children. Children of class 11 and 12 were also counselled on the career opportunities available in the field of Food Science, Agriculture and Agricultural Engineering under the

Swami Vivekananda Career Counselling program.

Interactive Meetings with Tamil Nadu State Departments of Agriculture and Agricultural Engineering officials

An interactive meeting with Agriculture Department officials of Coimbatore district was held on 17 November, 2015. CIAE technologies were presented to the Agriculture Department officials. The crop and location specific field problems existing in Coimbatore district were discussed on the occasion. Three interactive meetings with Agricultural Engineering Department officials to identify the location specific field problems were conducted at Coimbatore, Tirupur and Erode districts of Tamil Nadu on 19 and 26 November and 3 December, 2015, respectively.

Interactive Meeting with Farmers' Scientists and Stake-holders

A farmers', scientists', industry and other stake-holders interaction meet for the adopted villages of the centre under CRP on Farm Mechanization and Precision Farming was held at Elur, Madhukarai Block on 22 December, 2015. About 150 farmers from adopted villages Elur, Mampalli, Thoppampalayam, Valukkuparai and Menakshipuram of Madhukarai block, Coimbatore, Tamil Nadu attended the meeting. An exhibition was arranged for the benefit of the farmers, where the technologies developed by the centre were showcased. A few collaborative manufacturers also displayed their products during the meet.

Interaction meet on seed production

Farmers, CIAE scientists and the officials of National Seeds Corporation Ltd, Bhopal interacted on the theme 'Agricultural Machinery for Seed Production" on 29 December, 2015 at the institute. The programme was part of Govt. of India sponsored one week programme 'jai kisan jai vigyan' to celebrate the birthdays of two former Prime Ministers of India; Late Shri Choudhry Charan Singh and Bharat Ratna Shri Atal Bihari Vajpayee.

Educational tour for women staff

An educational tour to Adani Wilmar Ltd., Vidisha was organized for women staff of the Institute on 16 January, 2016. Adani Wilmar Limited is one of the leading soybean processing industries in the country. Women staff members were taken around the premises of soy plant and were explained about various available facilities. The solvent extraction processing of oil was demonstrated. The staff visited the packaging unit consisting of pouch and jar filling facility. The visit also included a tour of quality analysis lab, soy lecithin plant and texturized soy protein plant.

National seminar on Protected Cultivation Technology

Precision Farming Development Centre (PFDC), ICAR-CIAE, Bhopal, jointly with State Horticulture and Food Processing Department of Madhya Pradesh, organized two days National Seminar on protected cultivation technologies during16-17 January, 2016. During the inaugural ceremony, Dr. KK Singh, Director, CIAE, Bhopal emphasized on the role of

engineering interventions for timely field operations. Shri MS Dhakad, Mission Director, SHM & Horticultural Commissioner, MP explained, in detail, about the state government initiatives in promoting protected cultivation technologies. In her inaugural address, the Chief Guest, Hon'ble Sushri Kusum Singh Mahadele, Minister for Horticulture and Food Processing stressed upon the need for protected cultivation and urged the scientists to develop farm strategies for minimizing post harvest losses of perishable horticultural produce. The Seminar was attended by about 350 participants representing progressive farmers from various districts of Madhya Pradesh, Bihar and Maharashtra along with Madhya Pradesh State Horticultural department officials and personnel from industries working in protected cultivation technologies.

Foundation Day

The 41st Foundation Day of the institute was celebrated with two-day special programmes during 15-16 February 2016. On the first day, Farmers' day was organized which was participated by about 400 farmers of Madhya Pradesh. Seven each of farming innovators and successful agri-business entrepreneurs, operating custom hiring centres, trained at CIAE, Bhopal, were felicitated for their outstanding achievements, leading to agricultural mechanization. Shri Rajeev Choudhary, Director, Agricultural Engineering, Govt. of MP, Bhopal was the Chief Guest. Speaking on the occasion Shri Chaudhary appreciated the contribution of farmers and entrepreneurs in agricultural mechanization due to which MP was conferred with

'Krishi Karman Award' for the fourth time. Dr. KK Singh, Director, CIAE Bhopal lauded the efforts of farmers and entrepreneurs for enhancing mechanization in agriculture.

On the second day, a gathering of retired and present staff of the Institute was held in which some of the former DDGs and ADGs of ICAR as well as former Directors of CIAE also participated.

In his welcome address, Dr. KK Singh congratulated all present on the 41st Foundation day and took the audience down the memory lane of CIAE. He appreciated the efforts of all the staff involved in bringing the institute to the current shape and hoped that the progress of CIAE would increase by leaps and bounds. Dr. Gyanendra Singh, former Director, CIAE; Dr. RP Kachru, former ADG-ICAR, Dr. NSL Srivastava, former Director, CIAE and Dr. MM Pandey, Ex. DDG (Engg.) and former Director-CIAE spoke during the event. On this occasion, the awardee scientists, staff having completed 25 years of service in CIAE as well as distinguished sports persons of the institute were honoured with mementos.

National Workshop on Pulses Development

To commemorate the year 2016 as 'International Year of Pulses', National Workshop on 'Pulses Development: Challenges and Opportunities in Central and Southern States' was organized during 3-4 February, 2016. About 100 participants from Chhattisgarh, Gujarat, Maharashtra, Tamil Nadu, Telangana, Karnataka, Andhra Pradesh, Rajasthan and international and national organizations like ICRISAT, ICARDA, STC, CWC, ICAR-CIAE, ICAR-IIPR, ICAR-IISS, ICAR-CAZRI, ICAR-CRIDA, CSIR-CFTRI, Mahabeej Ltd., ICAR-ATARIs, State Agricultural Universities, KVKs, Departments of Agriculture of different states and Directorate of Agricultural Engineering, Madhya Pradesh, Directorates of different crops under DACFW, GoI, etc. attended the workshop. The workshop was inaugurated by Dr. SK Malhotra, Agriculture Commissioner, Govt. of India, New Delhi.

Three technical sessions on; 'Developmental Planning', 'Production strategy and Technology Transfer' and 'Issues and Policies relating to Milling; Procurement; Branding & Marketing; PHM & Value Addition' were conducted during the workshop. The participants presented relevant information and work done on different aspects of pulses like production, post-harvest management, processing and value addition and marketing. A field visit was also organized showcasing live demonstration on dal milling and different farm machinery related to cultivation, spraying, harvesting and threshing in the pulse crops.

Visit of Dr.Trilochan Mohapatra, Secretary (DARE) & Director-General, ICAR

Honorable Secretary, DARE and Director General-ICAR, Dr. Trilochan Mohapatra visited ICAR-Central Institute of Agricultural Engineering, Bhopal on 24 Feb 2016 after taking over the reins of DARE and ICAR. Dr. Mohapatra addressed a gathering of scientists and staff of the institute and National Institute of High Security Animal Diseases (NIHSAD), Bhopal. He was accompanied by Dr. JS Sandhu, DDG (Crop Science), ICAR and Dr. BB Singh, ADG (OP), ICAR. Dr. KK Singh, Director, CIAE welcomed him and presented a brief about the developed technologies and efforts of the institute towards improving Indian agriculture through mechanization. Dr. VP Singh, Director, NIHSAD spoke about important achievements of ICAR-NIHSAD.

Dr. Mohapatra in his address emphasised the need of mechanization in Indian agriculture. He lauded the efforts of ICAR-CIAE especially in establishment of more than 300 custom hiring centres in Madhya Pradesh and hoped that a similar feat would be achieved in other parts of country. He pointed out that the developed pre and post-production technologies should be novel and robust to be able to compete with the international competitive market. Dr. Mohapatra also appreciated the contribution of NIHSAD in the area of animal disease diagnostics and vaccine development. He advised all the scientists to bring out quality research publications and to commercialize their technologies.

International Women's Day

International Women's Day was celebrated on 8 March, 2016 with great enthusiasm and fervor. The Women's Cell of CIAE organized a program on this occasion for women staff of ICAR-CIAE, ICAR-IISS, ICAR-NIHSAD and women residing in the CIAE staff quarters. Dr. Nidhi Jain, MD (Gynaecology) and Ms. Seema Verma, Fitness Expert were special guests on the occasion. Dr. Nidhi Jain spoke on women's health issues and how timely interventions and care could prevent serious diseases, specially related to women. Ms. Seema Verma emphasized on the need for fitness and strength in women to enable them carry out daily activities with ease as well and to remain healthy. A quiz program was also organized and all the participants took part actively in it and won many prizes. On this occasion, a lady entrepreneur Mrs. Rajput was felicitated for her efforts in starting a Soybean Processing Unit after undergoing training at CIAE. Women sports-persons who won the ICAR Inter-zonal sports tournament at Jodhpur were also felicitated.

Annual Review Workshop of the Consortia Research Platform(s) under Agricultural Engineering Division

The Annual Review Workshop of the Consortia Research Platform(s) under Agricultural Engineering Division of ICAR was held at ICAR-CIAE, Bhopal during 9-11 March, 2016. The inaugural session of the workshop was chaired by Dr. K Alagusundaram, Dy. Director General (Engg), ICAR New Delhi and co-

chaired by Dr. Kanchan K Singh, Asstt. Director General (FE), ICAR, New Delhi and Dr. KK Singh, Director, CIAE, Bhopal. Dr. KK Singh informed that 15 CRPs have been approved by the Council during XII Plan, out of which five are operating in the Engineering Division, showing importance of engineering technologies and its need in present scenario. Dr. Kanchan K Singh informed the house that Subject Matter Division was making all efforts to fund research in frontier areas of research. He informed that out of five CRPs under the Engineering Division, four are in the Farmer's Centric Approach outlined by Government of India. Dr. K Alagusundaram appealed to all Principal Investigators of the CRPs to bring out tangible outputs. He called upon them to take up new and challenging problems. He also advised that participation of students in the research problem solving should be encouraged. During the technical sessions, progress of various activities under different platform projects, were discussed, in detail, and activities for next year were finalized.

National Symposium on Disability, Assistive Technology and Farming in India

Two days National Symposium on Disability, Assistive Technology and Farming in India was organized at the institute during 15-16 March, 2016.The symposium, organized jointly by Society for Disability and Rehabilitation Studies (New Delhi) and the CIAE, Bhopal, was inaugurated by Dr. KK Singh, Director, CIAE, Bhopal.

Distinguished Visitors

(At CIAE Bhopal and RC, Coimbatore)

Date of visit	Name of the dignitary	Designation
12 May, 2015	Shri Amit Bhatnagar	DGM Tribal Department, New Delhi
15 May, 2015	Shri Arun Kumar Singh	Deputy CAG
21 May, 2015	Shri J Shrivastava	Commissioner, DoAC&FW
1 Jun, 2015 27 Aug, 2015 5 Jan, 2016	Dr. K. Alagusundaram	DDG (Agril. Engg.) , ICAR, New Delhi
1 Jun, 2015	Dr. Kanchan K Singh	ADG (FE), ICAR, New Delhi
4 Jun, 2015	Shri T Vijay Kumar	Special Chief Secretary to Govt. of Andhra Pradesh, Hyderabad
20 Jun, 2015	Shri Sreenivasan UM	Senior General Manager, Robert Bosch Engineering and Business Solutions Pvt. Ltd. Bangalore
3 Jul, 2015	Mr. Prasenjeet Mukherjee	President,Turk Blue Management Pvt. Ltd., Gurgaon
18 Jul, 2015	Dr. Gajendra Singh	Former DDG (Engg.) & Ex.Vice Chancellor,Doon University
18 Jul, 2015	Dr. VM Mayande	Ex. Vice Chancellor, PDKV, Akola
10 Aug, 2015	Shri Nandan Dubey	Director General of Police, M P State (Retd.)
27 Aug, 2015	Dr. SAyyappan	Secretary, DARE and Director-General, ICAR
27 Aug, 2015	Dr. K Ramasamy	Former Vice Chancellor, TNAU and Member, Tamil Nadu Planning Commission (Agriculture),
27 Aug, 2015	Dr. PG Patil	Director, CIRCOT, Mumbai
27 Aug, 2015	Dr. Bakshi Ram	Director, SBI, Coimbatore
27 Aug, 2015	Dr. B Padmanaban	I/c Director, NRC-Banana, Trichy
29 Aug, 2015	Dr. SR Singh	Ex. Vice Chancellor, RAU Pusa
29 Aug, 2015	Dr. Sitaram Singh	FNA INSA Honorary Scientist, Lucknow
8 Sep, 2015	Mr. F Jafri	Manager Marketing, Meghalaya Govt.
16 Sep, 2015	Shri Pradeep Waugh	ACP, Nanded

Date of Visit	Name of the dignitary	Designation
28 Oct, 2015	Er. S Bhardwaj	Director, Credit Cooperation (DoAC&FW), Ministry of Agriculture, Govt. of India, Krishi Bhawan, New Delhi
26 Nov, 2015	Mr. D Baneerjee	Regional Director, Indian Chamber of Commerce and Industries, New Delhi
30 Nov, 2015	Mr. B Krishna Reddy	AGM, Indian Bank, Bhopal
30 Dec, 2015	Mr. Kripal Singh Verma	Assistant Director (Horticulture), Sanchi University of Buddhist
4 Jan, 2016	Dr. RK Gupta	Director, ICAR-CIPHET, Ludhiana, Punjab
7 Jan, 2016 3-4 Feb, 2016	Dr. SN Jha	ADG (Process Engg.), ICAR
14 Jan, 2016	Hon'ble Smt. Vimla Pradhan & Hon'ble Shri Hari Krishan Singh, Hon'ble Shri Jitu Charan Ram) and Officials (Mr. Manoj K. Singh, Under Secy.of Govt. of Jharkhand	MLAs of Jharkhand Vidhansabha and Officials
16 Jan, 2016	Hon'ble Sushri Kusum Mehdele	Minister of Horticulture and Food Processing, Govt. of MP
3 Feb, 2016	Dr. SK Malhotra	Agriculture Commissioner & Horticultural Commissioner, Govt. of India
4 Feb, 2016	Mr. Arun B Unhale	MD, Maha Beej, Maharashtra State
4 Feb, 2016	Dr. NP Singh	Director, ICAR-IIPR, Kanpur
4 Feb, 2016	Dr. AK Patra	Director, ICAR-IISS, Bhopal
24 Feb, 2016	Dr. Trilochan Mohapatra	Honourable Secretary (DARE) and Director General, ICAR,
24 Feb, 2016	Dr. JS Sandhu	Deputy Director General, Crops Sci., ICAR
25 Feb, 2016	Dr Fillippom Bassi,	Durum Breeder, ICARDA, Morocco

Dr. S Ayyappan, the then Secretary (DARE) and Director General, ICAR and dignitaries

Shri Arun Kumar Singh, Deputy CAG

Dr. Trilochan Mohapatra, Secretary (DARE) and Director General, ICAR

MLAs and officials of Jharkhand Vidhansabha

Dr. K. Alagusundaram, DDG (Engg.), ICAR, New Delhi

Hon'ble Sushri Kusum Mehdele, Minister of Horticulture and Food Processing, Govt. of MP

Important Committees

Research Advisory Committee

1.	Dr. BS Pathak, Ex. Director, School of Energy, PAU, Ludhiana	Chairman
2.	Dr. Jaskaran Singh Mahal, Dean, College of Agricultural Engineering & Technology, Punjab Agricultural University, Ludhiana	Member
3.	Dr. DC Joshi, Dean, Faculty of Food Processing and Bioenergy, Anand Agricultural University, Anand	Member
4.	Dr. Murari Shyam, Director, Sardar Patel Renewable Energy Research Institute, Vallabh Nagar	Member
5.	Dr. Rajendra Singh, Dean - UGS, Indian Institute of Technology, Kharagpur	Member
6.	Dr. KK Singh, Director, Central Institute of Agricultural Engineering, Bhopal	Member
7.	Dr. Kanchan K Singh, Assistant Director General (Farm Engineering), Indian Council of Agricultural Research, New Delhi	Member
8.	Dr. PC Bargale, Head, Technology Transfer Division, Central Institute of Agricultural Engineering, Bhopal	Member Secretary

Institute Management Committee

1.	Dr. KK Singh, Director, CIAE	Chairman
2.	Dr. Kanchan Kumar Singh, ADG (Farm Engg.), ICAR, New Delhi	Member
3.	Shri Rajiv Choudhary, Director, Directorate of Agril. Engg., Bhopal	Member
4.	Shri KN Khandelwal, Executive Engineer, Directorate of Agriculture, Jaipur	Member
5.	Dean, College of Agril. Engg., JNKVV, Jabalpur	Member
6.	Dr. Man Singh, Principal Scientist, Directorate of Water Technology Centre, IARI, New Delhi	Member
7.	Dr. Anil Kumar Dubey, Principal Scientist, CIAE, Bhopal	Member
8.	Dr. G. Senthil Kumaran, Principal Scientist, IIHR, Bengaluru	Member
9.	Sh. AK Maheshwari, FAO, Directorate of Soybean Research, Indore	Member
10.	Director, CFMTTI, Tractor Nagar, Budni	Member
11.	Shri Ravi Kumar, Chief Administrative Officer, CIAE, Bhopal	Member Secretary

Institute Research Committee

1	Dr. KK Singh, Director, CIAE	Chairman
2	All scientists and Head of Divisions, CIAE	Member
3	Dr. Sandip Gangil, Principal Scientist (upto 28/01/2016)	Member Secretary
4	Dr. BM Nandede, Scientist (w.e.f 29/01/2016)	Member Secretary

Institute Technology Management Committee

1	Dr. KK Singh, Director (CIAE)	Chairman
2	Dr. CR Mehta, PC (FIM)	Member
3	Dr. PS Tiwari, Head (AMD)	Member
4	Dr. Tarun Kapur, PS (APPD) and I/c, PME Cell	Member
5	Dr. RC Singh, Head (AEP)	Member
6	Dr. N Kotwaliwale, Head (APPD)	Member
7	Dr. S. Gangil, PS (AEP) and Secretary, IRC	Member
8	Dr. UR Badegaonkar, SS (TTD)	Member
9	Dr. Sanjay Shrivastava, PS (IISS)	External Member
10	Dr. PC Bargale, Head, TTD	Member Secretary

w.e.f. 26/03/2016

1	Dr. KK Singh, Director, CIAE	Chairman
2	Dr. CR Mehta, PC, FIM	Member
3	Dr. PS Tiwari, Head, AMD	Member
4	Dr. RC Singh, Head, AEP	Member
5	Dr. Nachiket Kotwaliwale, Head, APPD	Member
6	Dr. Ramadhar Singh, Head, IDED	Member
7	Dr. Dipika A Murugkar, ICAR-National Fellow & I/c, PME Cell	Member
8	Dr. UR Badegaonkar, Sr. Scientist & I/c, ATIC	Member
9	Dr. BM Nandede, Scientist & Secretary, IRC	Member
10	Dr. Sanjay Shrivastava, PS, IISS, Bhopal	External member
11	Dr. PC Bargale, Head, TTD	Member Secretary

Institute Joint Staff Council

1	Dr. KK Singh, Director, CIAE	Chairman
	Official Side	
2	Dr. RC Singh, Head, AEP	Member
3	Dr. KN Agrawal, Principal Scientist, AMD	Member
4	Dr. GS Chouhan, Senior Scientist, AMD	Member
5	Shri SK Dwivedi, CTO	Member
6	Sr. Finance & Accounts Officer	Member
7	Chief Administrative Officer	Member Secretary
	Staff Side	
8	Shri LK Manikpuri, Tech. Officer	Member Secretary, IJSC
9	Shri AC Gupta, Tech. Officer	Member

3	Shri PK Dukhande, Tech. Officer	Member
4	Shri GP Waghmare, UDC	Member
5	Shri PV Sahare, LDC	Member & Member, CJSC
6	Shri Ashok Kumar Kumre, SSS	Member
7	Shri Shrikrishan Bagde, SSS	Member

Women Cell

1	Dr. Sumedha S Despande	Chairperson
2	Dr. Debabandya Mohapatra	Member
3	Dr. Neeraja Lalan	Member
4	Smt. Jolly John	Member
5	Smt. Deepa Shinde	Member
6	Shri MK Raut	Ex-officio Member Secretary

w.e.f. June 18, 2015

1	Dr. Dipika Agarhar-Murugkar, Principal Scientist (National Fellow)	Chairperson
2	Dr. Sadvatha R.H, Scientist	Member
3	Smt. Shivkumari Bharti, Sr. Tech. Officer	Member
4	Smt Kushal Suri, Assistant	Member
5	Smt Jolly John, T-4 (Staff Nurse)	Member
6	Mr. MK Raut, Asstt. Admin. Officer (Admin.)(Ex. Officio)	Member Secretary

PME Cell

1	Incharge-PME Cell	Dr. Tarun Kapur
2	Secretary, IRC &Nodal Officer (PIMS and HYPM)	Dr. Sandip Gangil
3	Nodal Officer (RFD and MPR)	Dr. KN Agrawal
4.	Nodal Officer (Data Management) Dr. Karan Singh	Dr. RS Singh
5.	Nodal Officer (Training, Consultancy, Contract research and Contract Service)	Dr. UR Badegaonkar
6	Nodal Officer (HRD)	Dr. Dipika Agrahar-Murugkar

w.e.f. January, 2016

1.	Incharge-PME Cell	Dr. Dipika Agrahar-Murugkar
2.	Nodal Officer (RFD and MPR)	Dr. KN Agrawal
3.	Nodal Officer(Data Acquisition System and Website Management)	Dr. Karan Singh
4.	Nodal Officer(Training, Consultancy, Contract esearch and Contract Service)	Dr. UR Badegaonkar
5.	Nodal Officer(HRD)	Dr. KP Saha

Ongoing Research Projects

Sl. No.	Title of the projects	Investigators
Agricultural Mechanization Division		
1	Economic evaluation and impact assessment of sele cted farm equipment	RS Singh
2	Development of multi -purpose vehicle for various operations in vegetable crops	Ajay K Roul Dushyant Singh
3	Automated control system for tractor-implement combination (under Extra-mural fund).	AK Roul HS Pandey
4	Design and development of three row vegetable transplanter for potted seeding	Er. AP Magar BM Nandede
5	Development of transplanter for onion seedling	AP Magar BB Gaikwad
6	Development of tractor front mounted cotton stalk puller	AP Pandirwar HS Pandey
7	Development of a tractor operated front -mounted two-row harvester for grain sorghum	BM Nandede AK Roul Dushyant Singh
8	Development of tractor drawn 3-row automatic vegetable transplanter for plug type seedlings	BM Nandede A P Pandirwar
9	Development of animal lifting devices for bullocks and equines	GS Chouhan Vijay Kumar, NRCE, Bikaner RA Legha, NRCE, Bikaner
10	Development of metering mechanism for ginger and turmeric	HS Pandey CP Sawant
11	Design and development of zero till planter cum residue mulcher under maize wheat cropping system	KP Singh A C Saxena S. Ganesan
12	Design and development of potato combine harvester suitable for Indian conditions	K P Singh V K Bhargava P S Tiwari
13	Adoption of package of animal drawn implement for different cropping system of Madhya Pradesh	Manish Kumar AP Magar
14	To develop a climate smart village in Kachi Barkheda of Bhopal district ofMP	RS Singh Manish Kumar
15	Development of a mechanical intra and inter row weeder for wide spaced deep rooted field crops	NS Chandel A Khadatkar AK Roul
16	Development of an image based herbicide applicator system	KN Agrawal Karan Singh
Agriculture Energy & Power Division		
17	Energetics of production and post - systemsof Madhya Pradesh production of major cropping	S Mandal PC Jena PL Singh RC Singh KP Saha

Sl. No.	Title of the Projects	Investigators
18	Design and Development of reactor for biocharproduction its characterization	VK Bhargav PC Jena S Gangil
19	Development of pyrolysis system for increased oil recovery from selected biomass.	VK Bhargav S Gangil PC Jena S Mondal Harsha Wakudkar M K Tripathi
20	Development of microalgae production and harvesting system for bio-fuel	Anil K Dubey PL Singh S Jadhav
21	Micro-planning and management of rural energy system	S Gangil H Wakudkar VB Babu
22	Development of biomass briquette based rapid combustion system for thermal applications	S Jadhav
23	Development of portable briquetting machine for paddy straw	H Wakudkar AK Dubey VK Bhargav
24	Biochar on soil properties and crop performance	A K Dubey S Gangil
Agro Produce Processing Division		
25	Value chain for fermented millet based products	D Mohapatra SS Deshpande MK Tripathi Sadvatha RH
26	Development offlax seed fortified functional foods for management of diabetes and cardiovascular conditions	A Yadav D Agrahar-Murugkar
27	Adoption/evaluation of sensor based flexible hermetic storage system for grains	D Mohapatra N Kotwaliwale
28	A value chain for minimally processed fresh cut vegetables	SK Giri Sadvatha RH MK Tripathi
29	Development of an automated packing line for spherical horticultural cropsfor a pack house	SK Chakraborty N Kotwaliwale Karan Singh
30	Development of complementary foods for undernourished children – under CRP on health food	MK Tripathi SK Giri S Deshpande
Centre for Excellence, SPU		
31	Development of draft Indian standards for different soy based food products	SD Kulkarni P Chandra
32	Assessment of the impact of entrepreneurship development training on soybean processing	LK Sinha Punit Chandra RS Singh

Sl. No.	Title of the Projects	Investigators
33	Development of diagnostic tool for identification of soy protein and its constituents in soy based food products	Punit Chandra
34	Development of Starch/PLA based biodegradable films for packaging of fresh produce	S Mangaraj Ajay Yadav
35	Development of pilot scale modified atmosphere storage system for selected fruits and vegetables	S Mangaraj A Yadav
Irrigation and Drainage Engineering Division		
36	Feasibility study on use of broad bed furrow (BBF) and mole drainage system for crop sensitive to water logging in vertisols	Ramadhar Singh KVR Rao
37	Development / adoption of efficient agricultural water management technologies / systems for enhanced productivity in vertisols	CD Singh Ramdhar Singh
38	Establishment of PFDC and its operation in MP	KVR Rao
39	Design of low cost structurally safe greenhouse using Finite element	AK Nayak
40	Development of package of practices for horticultural crops under open and covered cultivation in vertisols	KVR Rao CK Saxena CD Singh
41	Development and testing of subsurface drip lateral laying machine	CK Saxena KVR Rao AK Nayak
Technology Transfer Division		
42	Development of manufacturing and entrepreneurship solution to promote commercialization of CIAE equipment	AC Saxena S. Ganesan Dushyant Singh
43	Design and development of zero till drill for sowing in heavy residue conditions	UR Badegaonkar
44	Study of performance of agricultural machinery custom hiring business enterprises in MP	UR Badegaonkar KP Saha MB Tamhankar
45	Enhancing floatability and water stability of aqua feed through pellet mill die design and optimization of feed formulations	PP Ambalkar PC Bargale
46	Information dissemination through capacity building and interaction meets and outreach programme	MB Thamankar UR Badegaonkar PC Bargale
Krishi Vigyan Kendra		
47	ORP on improved equipment and machinery in soybean -wheat crop rotation at farmers' field	UC Dubey AK Dubey
48	Adoption and development of package of mechanization equipment for cassava cultivation (Collaborative project with CTCRI, Thiruvananthapuram)	T Senthil Kumar SJK Annamalai

Sl. No.	Title of the Projects	Investigators
Regional Centre, Coimbatore		
49	ORP on package of equipment for high density cultivation of cotton in selected villages in Tamil Nadu (Collaborative project with CICR-Regional Centre, Coimbatore)	T Senthilkumar K. Sankara Narayanan, CICR
50	Adoption and modification of specific gravity separator and CIAE milletmill	S.Balasubramanian
51	Development and adoption of mechanization package for sugarcane single bud technology (Collaborative project with SBI Coimbatore)	SJK Annamalai RavindraNaik Govindaraj,SBI T Arumughanathan, SBI
52	Linkage with farm and processing equipment manufacturers for process and product refinement and Commercialization.	SJK Annamalai S. Balasubramanian Ravindra Naik Dawn CP Ambrose T. Senthilkumar

Scientific Staff & Senior Officers

Director

Krishna Kumar Singh

Head of Divisions

Nachiket Kotwaliwale, APPD
PC Bargale, TTD
PS Tiwari, AMD
Ramadhar Singh, IDED
RC Singh, AEP

Project Co-ordinators

CR Mehta, AICRP on FIM
KC Pandey, AICRP on EAAI
Maharani Din, AICRP on UAE

Principal Scientists

AC Saxena, Mech. Engg.
AK Dubey, FMP
Anil K Dubey, FMP
CD Singh, EI
Dawn CP Ambrose, ASPE
Dipika Agrahar Murugkar, Food & Nutrition
Karan Singh, Com. App.
KN Agrawal, FMP
KV Ramanna Rao, SWCE
LK Sinha, ASPE
Punit Chandra, Bio.Chem.
Radheshyam Singh, Ag. Economics
Ravindra Naik , ASPE
S Balasubramanian, ASPE
S Ganesan, FMP
S Gangil, FMP
SD Kulkarni, ASPE
SJK Annamalai, FMP
Sumedha S Deshpande, Home Sci. Exte.

Senior Scientists

CK Saxena, SWCE
Debabandya Mohapatra, ASPE
Dushyant Singh, Mech.Engg.
GS Chouhan, FMP
KP Saha, Ag. Eco
Krishana Pratap Singh, FMP
MK Tripathi, Bio.-Che
PC Jain, EI
S Mangaraj, ASPE
SK Giri, ASPE
SK Chakraborty, ASPE
T Senthil Kumar, FMP
UC Dubey, FMP
UR Badegaonkar, FMP
Vinod Kumar Bhargav, FMP

Scientists

Abhijit Khadatkar, FMP
Ajay Yadav, Food Tech.
Ajit Kumar Nayak, SWCE
Ajit P Magar, FMP
AK Roul, FMP
Aleksha Kudos, ASPE
Ankur Nagori, Mechanical Engg.
AP Pandirwar, FMP
Balaji M Nandede, FMP
BB Gaikwad, FMP
Chetankumar P Sawant, FMP
Deepak Sabaji Thorat, FMP
Harsha M Wakudkar, FMP
HS Pandey, FMP
Manish Kumar, FMP
Manoj Kumar, Ag. Statistics
Manoj Kumar, FMP
NS Chandel, FMP
Prakash Chandra Jena, FMP
R Senthil Kumar, Veterinary Extn.
RR Potdar, FMP
Sadvatha RH, ASPE
Sandip Mandal, FMP
Swapnaja K Jadhav, FMP
Sweeti Kumari, FMP

Incharges

AC Saxena, PPC
AP Shilarkar, Library
CD Singh, Instrumentation
Dipika Agrahar-Murugkar, PME
Karan Singh, AKMU
KP Singh, CAD
Ravinder Singh, Farm Section
RK Pajnoo, VMS
SK Chakraborty, Guest House
SK Dwivedi, EMS
VK Bhargav, RW

Chief Administrative Officer

Ravi Kumar

Sr. Administrative Officer

Kumar Vivek

Sr. Finance & Accounts Officer

Prashant Kumar

Assistant Administrative Officers

AP Tirkey
GT Daniel
MK Raut
RK Raina

Jr. Accounts Officer

Sanjay K Singh

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किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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