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Annual Report

2017-18

ICAR

CIAE

भाकृ.अनुप-केन्द्रीय कृषि अभियांत्रिकी संस्थान
नबीबाग, बैरसिया रोड
भोपाल- 462038

ICAR-CENTRAL INSTITUTE OF AGRICULTURAL ENGINEERING
Nabi Bagh, Berasia Road
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ISO 9001 : 2005 Certified

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Annual Report
2017-18

हर कदम, हर डगर
किसानों का हमसफर
भाकृअनुप कृषि अनुसंधान परिसर

Agrisearch with a human touch

ICAR-Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road, Bhopal- 462 038

ICAR-CIAE Annual Report
No. CIAE/2018/37

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Preface

Farmers and farming have always been on the socio-economic focus of India. Machines/tools have also been integral part of Indian farming since almost inception of agriculture. However, with the changing national economic emphasis, social status, food safety and security related issues, land resources limitation and environmental factors; mechanization has become the key issue in the Indian agriculture. The ICAR-Central Institute of Agricultural Engineering has been a flag-bearer of agricultural mechanization related research in the ICAR and the nation looks towards us to provide efficient, cost effective, drudgery free, safe, field worthy and economically viable technologies. During the year 2017-18, attention of the institute has been on development of technologies related to precision farming, conservation agriculture, horticultural mechanization, post-harvest processing and value addition to millets, horticultural crops and soybean, energy generation and optimal water management through micro irrigation, protected cultivation and drainage. During development of technologies, emphasis has been given to application of sensors, electronic controls, programmable devices, etc. in the production as well as processing machines. This field has opened up new paradigm in the agricultural machine design and bringing out opportunities for introducing "Artificial Intelligence" and "Internet of Things" in the agricultural mechanization domain.

During the current year several new research projects have been initiated in the area of production and processing of horticultural crops. This is a follow up of brain storming with horticultural crop institutes of ICAR. Many such projects are being operated on collaborative mode with appropriate commodity institute. Utilization of crop residue to address the challenge of environmental pollution has also got attention of the Institute; and research has been initiated for development of economic and environmental friendly technologies. Millets are now getting attention among the consumer as well nutraceutical market; and the institute is ready with technologies for commercial production of many ready to eat/cook products with superior shelf life.

Transferring the successful technologies to stake holders is being addressed through demonstration, exhibition, publication, training and licensing of technologies. It has been estimated that impact of 17 ICAR-CIAE technologies licensed to 29 manufacturers is around Rs. 4500 Crore per annum on the national economy. Stake holders like farmers, machine manufacturers, entrepreneurs, students, academicians, researchers, extension workers, policy makers and others related to technology dissemination have been benefitted. Popularization of machines developed at this Institute has also been done through supply of prototypes to various stake holders and extension agencies. During this year, the Institute conducted two International training programmes for USAID and AARDO. For the national diaspora of academicians and researchers; one summer school, two winter schools and three training programmes of 21-days each have been conducted by the Centre for Advance Faculty Training in Food Processing at the Institute. Training has been provided to agricultural officers and functionaries of various states through Model Training Courses sponsored by Department of Agricultural Cooperation and Farmers' Welfare. Protected cultivation, ergonomics in agriculture, repair and maintenance of agricultural machines, entrepreneurship development on utilization of soybean as food, millet processing, banana by-product processing are some other areas under which training programmes have been conducted during the year. Establishment of farm machine custom hiring centres and soybean processing centre are the two flagship training programme of the Institute which have resulted in establishment of approximately 1000 custom hiring centre in MP. It has been found out that around 200 soybean processing units established by the trainees of this Institute are contributing

approximately 768 tonnes of additional vegetable based protein to the consumer and these units earn around Rs. 22.2 crore per annum. The Institute actively participated in various exhibition of International, national and regional importance to showcase its technologies. In addition, this year two big extension activities have been conducted in the name of 'Agro-Tech Fair' and 'Nutri-Mela'.

To strengthen the linkages with ICAR commodity institutes, a brain storming session has been held with crop institutes during the year. This resulted in identification of research gaps and areas where ICAR-CIAE can provide hand holding support to concerned Institutes in pre and post-harvest mechanization. Four AICRPs and two CRPs being coordinated at the Institute; have helped develop and strengthen linkages throughout the country. These projects have also helped in showcasing institute technologies to appropriate users in various parts of the country. At International level, the Institute has very good reputation among Asian-African countries since our technologies are very much suitable for their socio economic conditions. The institute is active member of various programmes conducted by UN-ESCAP-CSAM, USAID, AARDO, ASEAN & SAARC.

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. K. Alagusundaram, Deputy Director General (Engg.), ICAR; Dr. Kanchan K. Singh, Assistant Director General (FE) and Dr. SN Jha, Assistant Director General (PE).

The institute is thankful to all staff of ICAR headquarters, in general, and Engineering Subject Matter Division, in particular, for all the substantial support provided during the year. Institutions like Department 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 acuities. Achievements included in this report are all due to the persistent efforts put in by the scientific, technical, administrative and supporting staff of the institute. This report is put forth with a hope that it provides useful information to different stake holders of Indian agriculture.

Krishna Kumar Singh
Director

Content

कार्यकारी सारांश

भा.कृ.अनु.प.–केन्द्रीय कृषि अभियांत्रिकी संस्थान, भोपाल द्वारा अप्रैल 2017 से मार्च 2018 की अवधि में कृषि में यांत्रिकीकरण से संबंधित अनेक प्रकार की गतिविधियां सफलतापूर्वक संचालित की गई। संस्थान द्वारा नवीन उपकरणों व यंत्रों का विकास, पूर्व में विकसित प्रौद्योगिकियों का मूल्यांकन व परिशोधन, अनेक नवोन्मेषी मूल्य सवंर्धित उत्पादों व प्रक्रियाओं का निर्माण, चयनित हितधारकों को सफल प्रौद्योगिकियों का हस्तांतरण, सर्वेक्षण व अध्ययन आयोजित करने जैसे कार्य किये गए। उपर्युक्त अवधि में इस प्रकार के विकास कार्यों व कुछ उपलब्धियों संबंधी सारांश निम्नानुसार है:

नए प्रोटोटाइप/उपकरण/ प्रौद्योगिकियां

- उच्च भू–निर्बाधन वाला स्वचालित हाइड्रॉलिक प्रचालित बहुउद्देशीय वाहन जिसमें बागवानी फसलों के अनुकूल विविध प्रचालन करने परिवर्तनीय ट्रैक चौड़ाई (1.5–2 मीटर) तथा (2–2.6 मीटर) ग्राउण्ड क्लियरेन्स का प्रावधान है ताकि विभिन्न दूरी वाली कतारों तथा बागवानी फसलों में विभिन्न ऊँचाईयों पर विभिन्न प्रचालन किए जा सकें। यह लम्बवत तथा पार्श्व दोनों प्रकार की ढलानों पर 400 व 200 तक क्रमशः अपरिवर्तनशील तथा कार्यशील अवस्था में स्थिर रह सकता है।

- जीरो टिल (बिना जुताई) की अवस्था में क्यारियों में मक्का तथा गेहूँ की बुवाई के लिए जीरो टिल रोपाई सह अवशिष्ट यंत्र उपयुक्त है। इस मशीन द्वारा 200 से 1200 मि.मी. तक आकार वाली संकरी तथा चौड़ी दोनो प्रकार की क्यारियां बनाई जा सकती हैं। इस यंत्र द्वारा 12 टन प्रति हेक्टे. मल्च लोड के लिए मक्का का अवशिष्ट तैयार किया जा सकता है जिसके पश्चात् गेहूँ की बुवाई की जा सकती है।

- एक यंत्रीकृत अंतःकतार तथा एकल कतार में निराई गुड़ाई करने वाले खरपतवारनाशी यंत्र का विकास किया गया है जो गहरी जड़ों वाली एवं दूर–दूर बोई गई फसलों जैसे अरहर, कपास आदि के लिए उपयुक्त है। एक ही कतार तथा कतारों के बीच निराई गुड़ाई करने के लिए क्रमशः सक्रिय व निष्क्रिय औजारों अर्थात् कांटे (260 मि.मी. लम्बाई) तथा (250 मि.मी. चौड़ाई) स्वीप का उपयोग किय जाता है। एक ही कतार तथा कतारों के बीच निराई गुड़ाई करने की दक्षता क्रमशः 90 प्रतिशत तथा 71 प्रतिशत तथा प्रभावी कार्य क्षमता 0.26 हेक्टे प्रति घंटा पाई गई।

- अण्डाकार या गोल फलों के स्वचालित चित्र व भार पर आधारित श्रेणीकरण हेतु एक मशीन का विकास किया गया है। यह मशीन एक–एक फल का वजन व रंग के आधार पर श्रेणीकरण करती है। मशीन की समग्र क्षमता लगभग 200 कि.ग्रा. प्रति घण्टा है तथा इसकी छंटाई की दक्षता 88–92 प्रतिशत के बीच है।

- ट्रैक्टर चालित परिवर्तनीय चौड़ाई वाले उत्थित क्यारी निर्माण यंत्र में 600, 700 तथा 900 मि.मी. चौड़ाई तथा 150 मि.मी. ऊँचाई की उत्थित क्यारियों के निर्माण का प्रावधान है। इसके प्रचालन की लागत ₹ 770 है तथा इसमें पारम्परिक उत्थित क्यारी निर्माण यंत्र की तुलना में लगभग ₹ 2700 प्रति हेक्टे. (78%) बचत करने की क्षमता है। इसकी कार्य क्षमता तथा कार्य दक्षता/क्रमशः 0.64 हेक्टे प्रति घण्टे तथा 90 प्रतिशत है।

- उपसतही ड्रिप लेटरल लेइंग मशीन के प्रयोग से लगाई जाने वाली सिंचाई प्रणाली के कार्यनिष्पादन का मूल्यांकन क्रिस्टियनसेन एकरूपता गुणांक द्वारा उत्कृष्ट से अच्छे के बीच किया गया है। उपसतही ड्रिप पाइप एवं टेप लेटरल स्थापन के मूल्यांकन गुणांक क्रमशः 0.95 तथा 0.87 के मध्य पाया गया।

- स्वचालित प्लग प्रकार के सब्जी पौध प्ररोपक टमाटर तथा हरी मिर्च के पौध का 2.0 कि.मी. प्रति घण्टे की गति पर प्रतिरोपण करने के लिए उपयुक्त है। इसकी कार्य क्षमता 0.23 हेक्टे प्रति घण्टा तथा कार्य दक्षता 63.13 प्रतिशत देखी गई तथा इससे 97 प्रतिशत श्रम तथा पारम्परिक प्ररोपण विधि की तुलना में 98 प्रतिशत प्रचालन समय की बचत हुई।

- टैक्टर से जुड़े हुए अदरक रोपाई यंत्र में 51 प्रतिशत प्रचालन लागत तथा पारम्परिक विधि की तुलना में 88 प्रतिशत श्रम की लागत की बचत करने की सम्भावना है। उपकरण का मूल्य ₹ 60,000 तथा इसकी प्रचालन लागत ₹ 1435 प्रति हेक्टे है। इसकी कार्यक्षमता एवं कार्यदक्षता 02 कि.मी. प्रति घण्टे की गति पर क्रमशः 0.32 हेक्टे. प्रति घण्टा तथा 85 प्रतिशत है।

- कसावा स्टेक (डंठल) कटाई व रोपाई यंत्र में मेड़ पर 24 से.मी. मोटाई के कसावा के डंठल को 45 से.मी. की

दूरी पर रोपने का प्रावधान है। इसकी कार्य क्षमता, मूल्य–लाभ अनुपात तथा भुगतान वापसी की अवधि क्रमशः 0.18 हेक्टे. प्रति घण्टा, 2.06 तथा 4.31 वर्ष है। इसकी प्रचालन लागत ₹ 3,125 प्रति हेक्टे. है तथा हाथ से रोपाई की तुलना में इससे प्रचालन लागत में 60.4 प्रतिशत की बचत होती है।

- एक छिड़काव प्रणाली द्वारा एकसमान छिड़काव किए जाने के लिए ट्रैक्टर की आगे की प्रचालन गति को समायोजित किया गया ताकि छिड़काव की दर को स्थिर रखा जा सके। 02 कि.ग्रा./से.मी.^{2} के दबाव पर 300 मीटर प्रति हेक्टेयर की छिड़काव दर को प्रचालन गति 2.43 से 4.53 कि.मी. प्रति घण्टा करके 293.8 से 298.4 लीटर प्रति हेक्टेयर किया जा सकता है।

- फसलों में कीटनाशी एवं खरपतवार नाशी के प्रयोग हेतु सौर ऊर्जा चालित 3 नोज़ल वाले नैपसैक स्प्रेयर (छिड़काव यंत्र) का विकास किया गया। इस छिड़काव यंत्र से 1–2 हेक्टेयर प्रतिदिन में लगभग एक तिहाई कार्य दिवसों की बचत की जा सकती है।

- मोटे अनाजों की कटाई किए जाने के लिए धान वर्टिकल कन्वेयर रीपर (उर्ध्व वाहक कटाई यंत्र) को संशोधित किया गया। इस यंत्र को 3.5 कि.मी. प्रति घण्टे की गति से प्रचालित किए जाने पर 98.5 से 99.5 प्रतिशत कटाई दक्षता प्राप्त होती है तथा कटाई में होने वाली हानियाँ लगभग 0.75 से 0.90 प्रतिशत होती हैं। हाथ से फसल कटाई किए जाने की तुलना में इस मशीन की प्रचालन लागत 28.3 से 31.4 प्रतिशत तक कम है तथा हाथ से कटाई (285 कार्यदिवस प्रति हेक्टेयर) की तुलना में इससे 81–89 प्रतिशत श्रम (39 कार्यदिवस प्रति हेक्टे) की बचत होती है।

- कटी हुई सब्जियों के न्यूनतम प्रसंस्करण के लिए पायलट संयंत्र विकसित किया गया है। इस संयंत्र में कटर/स्लाइसर, धुलाई सह उपचार टैंक, बास्केट, सेन्ट्रीफ्यूज, ओजोन उपचार प्रणाली, पैकेजिंग प्रणाली तथा पैकेज की गई सब्जियों के पराबैंगनी उपचार प्रणाली की सुविधा है। संयंत्र की क्षमता 100 कि.ग्रा. प्रति घण्टा है तथा इसमें कटी हुई सब्जियों का प्रसंस्करण करके प्रशीतलन अवस्था में 9 से 12 दिन एवं सामान्य कमरे के तापमान पर 2–3 दिनों तक भण्डारण किया जा सकता है।

- ब्रिकेट्स के उत्पादन के लिए 50–60 कि.ग्रा. प्रति घण्टे की क्षमता वाले धान के चारे के लिए सुबाह्य ब्रिकेटिंग मशीन विकसित की गई है। इस इकाई का परिवहन आसान है तथा ब्रिकेट्स उत्पादन की लागत ₹ 4.81 रू. प्रति कि.ग्रा. है।

- ऊष्मीय प्रयोग के लिए 8–10 किलो वॉट क्षमता वाली त्वरित ज्वलन प्रणाली का विकास किया गया है। इस इकाई में 6–8 मि.मी. जैव पदार्थ ब्रिकेट को जलाये जाने पर 35 प्रतिशत ऊष्मीय दक्षता प्राप्त हुई जबकि सी.आई.ए.ई. उन्नत तथा पारम्परिक चूल्हों में यह क्रमशः 22 तथा 13 प्रतिशत थी। इनका उपयोग पारम्परिक ईंधनों जैसे – एल.पी.जी. एवं डीज़ल के स्थान पर किया जा सकता है तथा ऊष्मीय प्रयोगों के लिए फसल अवशिष्ट आधारित ब्रिकेट्स के प्रयोग को बढ़ावा दिया जा सकता है।

- खेतों से पक्षियों को दूर रखने के लिए सौर ऊर्जा चलित यंत्र विकसित किया गया है ताकि फसल को हानि से बचाया जा सके। इस इकाई की कीमत ₹ 2200 है तथा इससे प्रत्येक फसल के मौसम में 480 कार्यघण्टों की बचत हो सकती है।

मूल्यवर्धित उत्पाद एवं प्रक्रियाएं

- मोटे अनाज पोषकता का भण्डार हैं किन्तु इनमें पाये जाने वाले कुछ पोषकतारोधी तत्वों के कारण ये मानवीय उपयोग के लिए उपयुक्त नहीं पाये गये। इन तत्वों को दूर करने तथा अनाज की सुरक्षित उपयोगिता अवधि (शेल्फ लाईफ) को बढ़ाने के लिए किण्वन (फर्मेन्टेशन) पर आधारित प्रौद्योगिकी का विकास किया गया। एक पायलट संयंत्र विकसित किया गया है जिसमें समूह प्रकार का फर्मेन्टर, न्यूमेटिक कन्वेयर ड्रायर, पोहा बनाने की मशीन, पोहा कन्वेयर (वाहक), शुष्कक, लघु बॉयलर तथा गर्म पानी की टंकी लगाई गई है। विकसित की गई किण्वन प्रौद्योगिकी व पैकेजिंग प्रक्रिया को अपनाऐ जाने पर प्रसंस्करित मोटे अनाजों/उत्पादों की सुरक्षित उपयोगिता अवधि (शेल्फ लाईफ) में 2.5 गुना या अधिक की वृद्धि हुई।

- विभिन्न प्रसंस्करित मोटे अनाजों पर आधारित नवीन उत्पाद जैसे कोदो चावल से बनी भोजन हेतु तैयार खीर तथा उपमा मिक्स तैयार किया गया है। इसी प्रकार ज्वार का उपयोग कर पकाने हेतु तैयार मसाला ज्वार तथा ज्वार उपमा मिक्स विकसित किए गए हैं। अधिकांश उत्पाद

ग्लूटन मुक्त है तथा इनमें मुक्त वसा अम्ल (फ्री फैटी एसिड). तथा टेनिन जैसे पोषकतारोधी यौगिक की मात्रा भी कम पाई गई। ये उत्पाद प्रोटीन, खनिज, खाने योग्य रेशे, एन्टीऑक्सीडेन्ट तथा ऊर्जा से भरपूर है। इन सभी उत्पादों का संवेदी स्कोर 7.5 से अधिक है। मानकीकृत प्रक्रियाओं व पैकेजिंग का अनुपालन किए जाने पर इन सभी रेडीमिक्स उत्पादों की सुरक्षित उपयोगिता अवधि (शेल्फ लाईफ) लगभग 03 माह होती है।

- बीटाकेरोटिन जैसे प्राकृतिक रूप से उपलब्ध खनिज को प्रसंस्करित खाद्य उत्पादों जैसे – चिप्स में मिश्रित करने का प्रयास किया गया है। अंतिम उत्पाद में 1.6 मि.ग्रा. केरोटिन प्राप्त करने के विचार से बीटाकेरोटिन के प्राकृतिक स्त्रोत के रूप में तीन उत्पादों अर्थात्– गाजर आधारित, शकरकंद आधारित तथा कद्दू आधारित चिप्स का विकास किया गया है। ये उत्पाद खनिज लवणों जैसे फैनोलिक्स, फ्लेवोनॉइड्स तथा बीटा केरोटिन से भरपूर हैं।

- अलसी के बीज से ओमेगा–3 युक्त खाद्य पदार्थ विकसित किया गया। उत्पादों की श्रृंखला में क्रेकर्स, बिस्किट तथा एक्स्ट्रूड किए गए स्वल्पाहार, फ्लेक्सी बार, फ्रूट्स स्प्रेड, मधुमेह रोगियों के लिए चॉकोबॉल, फ्लेक्सी कोको स्प्रेड हैं। सभी उत्पाद खाने योग्य तैयार व मधुमेह तथा हृदय रोगों के प्रबंधन में उपयोगी है।

- प्रोटीन युक्त सोया आधारित फोर्टीफाइट खाद्य बार विकसित किए गए है जिनमें गेहूँ, चावल, तिल तथा साबूत मूंग का प्रयोग किया गया है। इसी प्रकार शिशुओं व बच्चों के लिए फ्रूट प्यूरी जैसे सम्पूरक आहार तैयार किए गए है।

अध्ययन

- वर्तमान में अनाजों के बड़े स्तर पर भण्डारण हेतु स्वचालन की आवश्यकता है अतः अनाज की गुणवत्ता युक्त अनुश्रवन हेतु एक स्वचालित सतर्कता प्रणाली का विकास किया गया है। भण्डारण के सूक्ष्म वातावरण की अनुश्रवन करने के लिए एक रॉड सहित DHT-22 संवेदक लगाए गए हैं जो कि सापेक्ष आर्द्रता तथा कार्बनडाइऑक्साइड के स्तरों की अनुश्रवन करते हैं। भण्डारण के इस वातावरण में यदि कोई विपरीत परिस्थिति उत्पन्न होती है तो उसकी सूचना मोबाईल पर संदेश के माध्यम से प्राप्त होती है।

- संस्थान द्वारा लाईसेंसी 29 मशीनरी निर्माताओं को चयनित कर 17 प्रौद्योगिकियों के प्रभाव का मूल्यांकन करने हेतु अध्ययन किया गया। विशेष प्रौद्योगिकी द्वारा लागत तथा श्रम में होने वाली कमी अथवा बचत, तथा अधिक दक्षता व पैदावार को आर्थिक लाभ हेतु आंकलन किया गया। संस्थान द्वारा विकसित प्रौद्योगियों से पढ़ने वाले प्रभाव का आर्थिक लाभ लगभग ₹ 4500 करोड़ प्रति वर्ष आंका गया है।

- सोयाबीन प्रसंस्करण उद्यमिता विकास कार्यक्रम के प्रभाव का विश्लेषण करने के लिए किए गए अध्ययन से ज्ञात हुआ कि लगभग 200 उद्यमी इस कार्यक्रम के आधार पर उद्यम संचालित कर रहे हैं। इनमें से सर्वाधिक इकाईयां पंजाब में तथा इसके पश्चात् महाराष्ट्र व उत्तर प्रदेश में स्थित हैं। विभिन्न सोया उत्पादों में लगभग 53 प्रतिशत सोया दूध तथा 42 प्रतिशत टोफू है जो कुल उत्पाद का केवल 5 प्रतिशत है। इन उद्यमों का आर्थिक प्रभाव वर्तमान में 50 करोड़ रू. प्रतिवर्ष है तथा सोया आधारित खाद्य उत्पादों की लोकप्रियता के साथ इसमें वृद्धि हो रही है।

- संस्थान मध्य प्रदेश में कार्यरत कस्टम हायरिंग केन्द्रों की स्थापना में उत्कृष्ट तकनिकों तथा बेहतर गुणवत्ता की मशीनों के चुनाव द्वारा महत्वपूर्ण भूमिका निभा रहा है। 2012 से 2017 के मध्य लगभग 1786 कस्टम हायरिंग केन्द्रों की स्थापना हुई, जिनमें से 55 प्रतिशत (986 प्रतिभागी) के आई सी ए आर–सी आई ए ई द्वारा प्रशिक्षित किये गए। इन केन्द्रों की प्रतिस्थापना से वर्तमान में कृषकों को विशिष्ट कृषि कार्यों में लगने वाली महंगी मशीनों की उपलब्धता सहज हो रही है, साथ ही ग्रामीण क्षेत्रों में उद्यमिता का विकास हो रहा है।

- सौर ऊर्जा का प्रयोग सूक्ष्म सिंचाई प्रणालियों को संचालित करने में सफलतापूर्वक किया जा सकता है। सौर वाटर पम्प की प्रवाह दर 11400 से 24120 लीटर प्रति घण्टा देखी गई। इस दौरान सौर विकिरण प्रातः 8.00 से सायं 4.00 बजे तक 164 से 808 वाट प्रति वर्ग मी. थी।

- धान के अवशिष्ट से बायोगैस उत्पादन के लिए क्षैतिज मिश्रण व्यवस्था वाले बायोमीथेनेशन रियेक्टर वाली इकाई का विकास किया गया है। इस रियेक्टर में धान अवशिष्ट से 266 लीटर प्रति कि.ग्रा. बायोगैस का उत्पादन किया गया। इस गैस में मीथेन तथा कार्बन डाईऑक्साइड का अंश क्रमशः 55 तथा 40 प्रतिशत मापा गया।

- टपक सिंचाई (ड्रिप) के उपयोग से धान की फसल (पी.एस. 1121) की पैदावार 4.38 टन प्रति हेक्टेयर तथा जल की उत्पादकता 0.79 कि.ग्रा. प्रति घन मीटर पाई गई जो रेन होज़ (उत्पादकता 3.92 टन प्रति हेक्टेयर तथा जल उत्पादकता 0.63 कि.ग्रा. प्रति घन मीटर) की तुलना में बेहतर पाई गई। पारम्परिक विधि से धान की खेती में फसल पैदावार 3.42 टन प्रति हेक्टेयर तथा जल उत्पादकता 0.36 कि.ग्रा. प्रति घन मीटर देखी गई।
- रेन होज़ द्वारा सिंचाई किए जाने पर गेहूँ की फसल (एच.आई.1544) की पैदावार सर्वाधिक (5.55 टन प्रति हेक्टेयर) तथा जल उत्पादकता (1.52 कि.ग्रा. प्रति घन मीटर) पाई गई। टपक सिंचाई विधि द्वारा फसल की पैदावार तथा जल उत्पादकता क्रमशः 5.20 टन प्रति हेक्टेयर तथा 1.8 कि.ग्रा. प्रति घन मीटर पाई गई। सबसे कम पैदावार पारम्परिक विधि द्वारा गेहूँ की खेती में देखी गई जहां फसल पैदावार 4.36 टन प्रति हेक्टेयर तथा जल उत्पादकता 0.62 कि.ग्रा. प्रति घन मीटरदेखी गई।
- मोनो फिलामेंट (एक तन्तु) काले रंग के शेडनेट्स (35 प्रतिशत शेड) में ब्रोकली की पैदावार अधिकतम (9.25 टन प्रति हेक्टेयर) पाई गई, जबकि उतने ही (शेड फैक्टर) छाया में लाल रंग के शेडनेट (7.87 टन प्रति हेक्टेयर), हरे रंग में (7.36 टन प्रति हेक्टेयर) तथा सफेद रंग के शेडनेट में (5.54 टन प्रति हेक्टेयर) पैदावार प्राप्त की गई।
- ब्रॉकली की अधिकतम पैदावार 7.36 टन प्रति हेक्टेयर टेप फिलामेन्ट वाले काले रंग के शेड नेट्स में (35 प्रतिशत छाया) के साथ देखी गई जबकि समान छाया (शेड फैक्टर) में लाल शेड नेट में (4.25 टन प्रति हेक्टेयर) पैदावार पाई गई।
- काले रंग के मोनो फिलमेन्ट (एक तन्तु)शेडनेट में 50 प्रतिशत (शेड फैक्टर) छाया में स्ट्रॉवेरी में प्रति सर्वाधिक सोलह (16) फल तथा फलों का औसत वजन 8. 4 ग्राम प्राप्त किया गया जबकि उतनी ही छाया में सफेद में (क्रमशः 13 तथा 7.9 ग्राम) लाल शेड नेट में (क्रमशः 11 तथा 7.3 ग्राम) तथा हरे रंग के शेड नेट में (क्रमशः 10 तथा 6.6 ग्राम) प्राप्त किया गया।
- पॉली हाउस के अंदर पर्यावरणीय मापदण्डों का रियल टाइम प्रबंधन पी.एल.सी. तथा संवेदकों को अपनाकर किया जा सकता है।
- भोपाल के गनियारी गांव के ग्रामीण पर्यावरणीय प्रणाली की ऊर्जा स्थिति का आंकलन किया गया। इस गांव में ऊर्जा की कुल खपत 4TJ प्रतिवर्ष पायी गई। ग्रामीण परिवारों द्वारा घरों में खाना बनाने के लिए ब्रिकेट्स को अपनाया गया है। खाना पकाने के लिए 50–80 प्रतिशत जलाऊ लकड़ी के स्थान पर ब्रिकेट्स के प्रयोग से 20–25 प्रतिशत ऊर्जा की बचत हुई।
- मानव श्रम, मशीनरी, ईंधन, बीज, उर्वरक तथा रसायनों के आधार पर होशंगाबाद जिले में सोयाबीन के उत्पादन हेतु प्रयुक्त ऊर्जा निवेशों का विश्लेषण किया गया। हाईस्पीड डीज़ल, मशीनरी, उर्वरक, मानव श्रम तथा रसायनिक ऊर्जा की तुलना में बीज–ऊर्जा के निवेश अधिक पाये गये। ऊर्जा के प्रयोग की दक्षता तथा ऊर्जा उत्पादकता क्रमशः 1.76 तथा 0.05 कि.ग्रा./एम.जे. पाई गई। सोयाबीन के उत्पादन की कुल लागत ₹ 16500 से 17500 प्रति हेक्टेयर आंकी गई।

प्रौद्योगिकी हस्तांतरण

- 2017–18 के दौरान, प्रौद्योगिकी हस्तांतरण के माध्यम से तेरह प्रौद्योगिकियों का व्यावसायीकरण किया गया और प्रौद्योगिकी हस्तांतरण के लिए समझौते के तीन ज्ञापनों (एम.ओ.ए.) पर हस्ताक्षर किए गए।
- वास्तविक स्थिति में प्रदर्शन का आकलन करने के लिए किसानों के खेतों में विकसित प्रोटोटाइप प्रौद्योगिकियों का व्यवहार्यता परीक्षण किया जाता है। 2017–18 के दौरान, किसानों के क्षेत्र में चार प्रोटोटाइप के चार व्यवहार्यता परीक्षण किए गए जिससे 250 से अधिक किसान लाभान्वित हुए। इसके अलावा 13 फ्रंटलाइन प्रदर्शन और 03 क्लस्टर प्रदर्शन भी किये गये।
- यू.एस.ए.डी. (23 प्रतिभागियों) और आर्डो (09 प्रतिभागियों), एक ग्रीष्मकालीन विद्यालय, दो शीतकालीन विद्यालय और तीन सी.ए.एफ.टी. प्रशिक्षण के साथ 15 दिनों की अवधि के दो अंतरराष्ट्रीय प्रशिक्षण वर्ष 2017–18 में आयोजित किए गए हैं।
- मानव संसाधन विकास कार्यक्रम के तहत परिषद् के संस्थानों के तकनीकी कर्मियों को एक सप्ताह की अवधि और दस दिन का प्रशिक्षण देने वाले डी.ओ.ए.सी. द्वारा प्रायोजित दो मॉडल प्रशिक्षण पाठ्यक्रम आयोजित किए गए।

- परिषद् संस्थानों/हेड क्वार्टर के ड्राइवरों (31 प्रतिभागियों) के लिए प्रशिक्षण, सुरक्षित मशीनों (14 प्रतिभागियों) के डिजाइन के लिए एर्गोनोमिक डिजाइन दिशानिर्देश और विनिर्माताओं के लिए प्रसंस्करण मशीनरी के विनिर्माण (17 प्रतिभागियों) जैसे विशेष समूहों को कुछ विशेष प्रशिक्षण दिया गया है।
- बेहतर कृषि उपकरणों और मशीनरी पर व्यावहारिक प्रशिक्षण लगभग 700 लाभार्थियों सहित किसानों के 12 बैचों को दिया गया है।
- आयोजित कौशल विकास कार्यक्रमों में शामिल हैं : ग्रीन हाउस ऑपरेटर (52 प्रतिभागियों), ट्रैक्टर ऑपरेटर (20प्रतिभागियों) और कटाई मशीन ऑपरेटर (20 प्रतिभागियों)।
- सोयामिल्क और टोफू (8 बैच) एवं कस्टम हायरिंग (6 बैच) पर उद्यमिता विकास प्रशिक्षण क्रमशः 194 और 125 प्रतिभागियों के लिए आयोजित किए गए।
- संस्थान में कृषि विज्ञान केंद्र ने वर्ष के दौरान 1017 किसानों, कृषि महिलाओं, छात्रों, सेवा प्रदाताओं और विस्तार कार्यकर्ताओं के लिए 36 प्रशिक्षण कार्यक्रम आयोजित किए।
- वर्ष 2017–18 के दौरान, 52 विभिन्न उपकरणों की कुल 2463 इकाइयों की विभिन्न हितधारकों को आपूर्ति की गई, जिससे लगभग रु 27 लाख कुल आय हुई।
- मध्य प्रदेश के किसानों के लिए संरक्षित खेती की प्रक्रियाओं विषय पर सात प्रशिक्षण कार्यक्रम आयोजित किए गए।
- मध्य प्रदेश के बावन (52) ग्रामीण युवाओं एव विद्यार्थियों के लिए ग्रीन हाउस प्रचालक के कौशल विकास संबंधी दो कार्यक्रम आयोजित किए गए।

अन्य उपलब्धियां

प्रकाशन

- संस्थान के वैज्ञानिकों द्वारा राष्ट्रीय व अन्तर्राष्ट्रीय पत्रिकाओं में 61 शोध पत्र प्रकाशित किए गए। इनके अतिरिक्त तीन पुस्तकें, 49 लोकप्रिय लेख तथा चौबीस तकनीकी बुलेटिनों का भी प्रकाशन किया गया।

पुरस्कार एवं सम्मान

- डॉ. कृष्ण कुमार सिंह को प्राकृतिक संसाधन प्रबंधन तथा कृषि अभियांत्रिकी के क्षेत्र में उत्कृष्ट योगदान हेतु भा.कृ.अनु.प. के रफी अहमद किदवई पुरस्कार से सम्मानित किया गया।
- डॉ. आशुतोष पंदिरवार को म.प्र. विज्ञान एवं प्रौद्योगिकी परिषद के युवा वैज्ञानिक पुरस्कार तथा फेलोशिप से सम्मानित किया गया।
- संस्थान के वैज्ञानिकों को विभिन्न पुरस्कारों से सम्मानित किया गया जिनमें आई एस ए ई कमेन्डेशन मेडल, श्रेष्ठ शोध पत्र तथा अन्तर्राष्ट्रिय एवं राष्ट्रीय संगोष्ठीयों, अधिवेशनों, सभाओं व बैठकों में पोस्टर प्रदर्शनों पर प्राप्त पुरस्कार शामिल है।

गतिविधियां

- वर्ष के दौरान संस्थान की प्रमुख गतिविधियों में:: फसल संस्थानों के साथ बौद्धिक चिंतन सत्र, संकल्प से सिद्धी, न्यूट्री मेला, निर्माता बैठक, स्वच्छता पखवाड़ा, मध्य क्षेत्र खेल–कूद प्रतियोगिताऐं, अंर्तराष्ट्रीय योग दिवस, अंर्तराष्ट्रीय महिला सप्ताह, हिंदी पखवाड़ा, अखिल भारतीय समन्वित परियोजनाओं की वार्षिक कार्यशालाऐं आदि प्रमुख थी।

Executive Summary

The ICAR-Central Institute of Agricultural Engineering, Bhopal during the period from April 2017 to March 2018 successfully carried out variety of activities towards mechanization of agriculture. The efforts of the institute could be summarized as development of new equipment and gadgets, evaluation and refinement of previously developed technologies, devising innovative value added products and processes, conducting studies/ survey and transfer of successful technologies to appropriate stakeholders. Salient points on these developments, some achievements and summary of the events carried out during this period are given following section.

New Equipment and Machinery

- A self-propelled hydraulically actuated high clearance multi-purpose vehicle has a provision of variable track width (1.5- 2 m) and ground clearance (2-2.6 m) to match different row spacing and height of horticultural crops to carry out various operations. It is stable at both longitudinal and lateral slopes up to 40° and 20° in static and dynamic conditions, respectively.
- A zero-till bed planter-cum-residue mulcher is suitable for planting of maize and wheat seeds on beds under zero-till condition. The machine can form broad and narrow bed of size 200 to 1200 mm. It can mulch maize residue for mulch load of 12 t/ha followed by wheat seeding.
- A mechanical intra and inter row weeder suitable for widely spaced deep rooted crops such as pigeon pea, cotton etc has been developed. Combination of active and passive tool viz, spring tyne (length 260 mm) and sweep (width 250 mm) are used for intra and inter row weeding operation, respectively. The intra row and inter row weeding efficiencies are about 90% and 71%, respectively with effective field capacity of 0.26 ha/h.
- A machine has been developed for simultaneous weight and image based automatic grading of spherical fruit. The machine grades the commodity in four grades as per the colour and weight of individual fruit. The overall capacity of the machine is about 200 kg/h sorting efficiency of the machine is in the range of 88-92%.
- The tractor operated variable width raised bed former has provision to make raised beds of 600, 700 and 900 mm in width and 150 mm in height. Its cost of operation is ₹ 770, which has a potential to save approximately ₹ 2700/ha (78%) compared to conventional raised bed former. It gives field capacity and field efficiency of 0.64 ha/h to 90%.
- The subsurface drip lateral laying machine has been developed and tested in the field which is having a field capacity up to 0.2 ha/h. It can place the drip laterals up to 30 cm depth at a high uniformity.
- The hydraulic performance of the irrigation system installed using subsurface drip lateral laying machine have been evaluated to be excellent to good as the Christiansen's Uniformity Coefficient of the subsurface drip lateral placement was evaluated at 0.95 and 0.87.
- The transplanting and overall efficiency of tractor operated automatic potted seedlings transplanter is 92 ad 85%, respectively. Its cost of operation is ₹ 6492/ha. It saves 72% labour and 86% time of operation over manual transplanting method.
- Automatic plug type vegetable seedlings transplanter suitable for transplanting tomato and chili seedlings at 2.0 km/h forward speed, which gives field capacity and field efficiency of 0.23 ha/h and 63.13%, respectively. It saves 97% labour and 98 % of operating time over the conventional method of transplanting.
- The tractor mounted ginger planter has potential to save 51% operational cost and 88% labours cost compared to traditional planting method. The equipment costs ₹ 60,000 and its

operational cost is ₹ 1435/ha. It gives field capacity and field efficiency of 0.32 ha/h and 85%, respectively at forward speed of 2 km/h with average miss and multiple indices of 0.9 and 0.26, respectively.

- Cassava stake cutter planter has provision to plant cut cassava stem of 24 cm at 45 cm distance on ridge. Its field capacity, cost benefit ratio and payback period are 0.18 ha/h, 2.06 and 4.31 year, respectively. Its cost of operation is ₹ 3125/ha, which saves 60.4% operational cost compared to manual planting.
- A spraying system is capable for uniformly spraying by synchronizing forward speed of tractor to keep the application rate constant. It can apply 293.8 to 298.4 l/ha when forward speed changed from 2.43 to 4.5 km/h as against target application rate of 300 l/ha at 2 kg/cm^2 operating pressure.
- Solar powered three nozzle knapsack sprayer has been developed for pesticides and herbicides application in the field crop. The sprayer can save total man hours upto 1/3rd having area coverage of 1.0-2.0 ha/day.
- Paddy vertical conveyor reaper modified to harvest millet. It has 98.5 to 99.5% cutting efficiency and about 0.75-0.90% harvesting losses at forward speed of 3.5 km/h. The cost of operation of this machine is 28.3-31.4% lower than manual harvesting and it saves 81-89% labour (39 man-h/ha) compared to manual harvesting (285 man-h/ha).
- Pilot plant for minimal processing of cut vegetables has been developed. The plant includes the facility of different commodity based cutters/slicers, washing cum treatment tank, basket centrifuge, ozone treatment system, packaging system and UV treatment system for packaged vegetables. The plant has 100kg/h capacity and the cut vegetable processed through this plant, can be stored around 9-12 days under refrigerated conditions and 2-3 days under normal room conditions.
- Portable briquetting machine for paddy straw with capacity 50-60 kg/h has been developed for producing briquettes. The unit is easy to transport and cost of briquettes production is ₹ 4.81 per kg.
- A rapid combustion system of capacity 8-10 kW for thermal application has been developed. Combustion of 6-8 mm biomass briquettes in this unit has resulted 35% thermal efficiency as compared to CIAE, improved and conventional cook stoves 22% and 13%, respectively. This is suitable for replacing conventional fuels such as LPG and diesel and promotes the use of crop residue based briquettes for steam application can be emphasized.
- The solar powered bird scarer has been developed to disperse bird from the field by creating unpleasant sound to protect the crop damage. The cost of unit is ₹ 2200 and it can save 480 man-hours per crop season.

Value Added Products and Processes

- The millets are harbinger of nutrition but at the same time it contains various antinutritional constituents not recommended for human consumption. The fermentation based technology for reductions of such constituents and enhancement of shelf life has been developed. A pilot plant which consists of batch type fermenter, pneumatic-conveyor-dryer, flaking machine, flakes conveyor, dryer, mini boiler, and hot water tank also been set up. The processed millets products has increased shelf life by 2.5 times or more when following the developed fermentation and packaging protocols.
- Various processed millets based novel products like Kodo rice based ready to cook mixes (keer and Upama), Sorghum based ready to cook mixes (masala sorghum and sorghum upma mix) has been developed. Most of the products are gluten free and low in anti-nutritional compounds like FFA and Tannin. The products are rich with protein, minerals, crude fiber, antioxidants and energy value. All products gave

overall sensory score more than 7.5. The shelf life of the ready mixes is about 3 months at standardized process and packaging protocol.

- An approach for incorporation of beta-carotene abundantly found in natural sources in to the processed food products like chips has been carried out. As per the source of beta-carotene three types of products i.e. carrot bases, sweet potato based and pumpkin based chips are developed with due consideration to attend 1.6 mg of carotene in the final product. The products are rich in minerals phenolics, flavonoids and carotene.

- An omega 3 fatty acid rich food product from flaxseed has been developed as functional foods. The range of products includes crackers, cookies and extruded snacks, flaxibar, flaxi fruit spread, diabetic choco balls, flaxi coco spread. All products are ready to eat and useful for management of diabetic and cardiovascular disease.

- Protein rich soy based fortified compressed food bars developed with incorporation of soya and cereals like wheat, rice, sesame and mung bean. Similarly, ready to Eat fruit puree has been prepared by targeting complementary food supplement for babies and child. Both the products rich in minerals and energy value and recommended for undernourished children.

Studies

- Automation in the bulk storage of grains is the need of hour. Hence an automatic alert generation system for grain health monitoring has been developed. The DHT-22 sensors integrated with the rod precisely monitor the temperature, relative humidity and carbon-dioxide levels inside the storage micro-environment. The massage has been communicated on the mobile phone if any alarming situation is found in storage environment.

- The impact of 17 selected technologies developed by ICAR-CIAE and commercialized was assessed through survey of 29 manufactures with whom MoA were signed. Saving of input cost, increased yield, labour saving and enhanced efficiency were evaluated for economic benefits. Presently, the impact of these selected technologies are estimated to be ₹ 4500 crore/annum.

- The study conducted for analyzing the impact of soybean processing entrepreneurship development programme revels that based on this programme about 200 entrepreneurs running their enterprise. Maximum units are located in Punjab followed by Maharashtra and Uttar Pradesh. Among various soy products, about 53% is soy milk and 42 percent is in the form of tofu while covers only 5% of total produce. The economic impact due to these enterprises is presently ₹ 50 Crore per annum and increasing with popularity of soy based food products.

- ICAR-CIAE has been playing crucial role in providing wider exposer and selection for quality and advanced machineries for establishment of custom hiring centres. Of 1786 custom hiring enterprises established in MP during 2012-17; 55% (986 participants) were trained at ICAR-CIAE. Farmers who do not own costlier machineries for various agricultural operations have easy access to such machines, besides development of entrepreneurship among rural youth.

- Solar Power can be successfully utilized to operate micro-irrigation systems. The discharge rate of solar water pump has been observed as 11400 to 24120 l/h at a dynamic head of 2.5 m corresponding to solar insolation range of 164 to 808 W/m^2 during time period from 8 am to 4 pm.

- A unit of bio-methanation reactor with horizontal stirring arrangement has been developed to produce biogas from paddy residues. The reactor resulted cumulative biogas production of 266 l/kg of paddy straw. Methane and carbon dioxide content in the gas has been measured as 55 and 40%, respectively.

- Rice crop (*PS-1121*) performance under drip irrigation treatment was found superior in terms of yield (4.38 t/ha) and water productivity (0.79 kg/m^3) followed by rain hose irrigated crop where the yield and water productivity are (3.92 t/ha) and (0.63 kg/m^3). Lowest yield (3.42 t/ha) and water productivity (0.36 kg/m^3) were observed under conventional rice cultivation.
- Wheat crop (*HI-1544*) performance under rain hose irrigation treatment was found superior in terms of yield (5.55 t/ha) and water productivity (1.52 kg/m^3) followed by drip irrigated crop where the yield and water productivity are (5.20 t/ha) and (1.8 kg/m^3). Lowest yield (4.36 t/ha) and water productivity (0.62 kg/m^3) were observed under conventional wheat cultivation.
- In mono filament black coloured shade nets (35% shade factor) highest broccoli yield (9.25t/ha) was observed as compared to red (7.87 t/ha), green (7.36 t/ha) and white (5.54 t/ha) respectively for the same shade factor.
- In tape filament black coloured shade nets (35% shade factor) highest broccoli yield (7.36 t/ha) was observed as compared to red (7.03 t/ha), green (6.24 t/ha) and white (4.25 t/ha) respectively for the same shade factor.
- Strawberry under black coloured mono filament shade net having 50% shade factor produced highest no of fruits and weight of fruits (16 & 8.4) as compared to white (13 &7.9g), red (11 & 7.3) and green(10 & 6.6g) respectively for the same shade factor.
- Strawberry under black coloured tape filament shade net having 50% shade factor produced highest no of fruits and weight of fruits (13 & 4.6g) as compared to green (11 & 4.2 g), red (10 & 4.0) and white (8 & 3.9g) respectively for the same shade factor.
- Adoption of PLC and sensors will provide real time management of environmental parameters inside a polyhouse.
- The energy scenario of rural eco-system of a village Ganiyari, Bhopal has been assessed. The total energy consumption of the village has been found 4 TJ per annum corresponding domestic to crop production. Interventions of briquettes are well accepted by rural families for domestic cooking. The replacement of 50-80% of the fuelwood by briquettes for cooking has been resulted into energy saving of 20-25 %.
- Energy inputs for production of soybean in the Hoshangabad district has been analyzed based on human, machinery, fuel, seed, fertilizer and chemicals. The seed energy input has been found higher as compared high-speed diesel,machinery, fertilizer, humanand chemical energy. The energy use efficiency and energy productivity found to be 1.76 and 0.05 kg/MJ, respectively. The total cost of production for soybean has been observed in the range of Rs. 16,500-17,500 per ha.
- Cultivation of capsicum and tomato under polyhouses with 100 per cent fertigation will give techno-economically viable results over shadenet house and open field cultivation.
- **Technology Transfer**
- During 2017-18, thirteen technologies were commercialized through technology licensing and three memorandum of agreement (MoA) were signed for technology transfer.
- Feasibility testing of developed prototype technologies is carried out in the farmers' field to assess its performance in real situation. During 2017-18, ten feasibility trials of four prototypes were conducted in the farmers' field benefitting more than 250 farmers. Apart from this 13 frontline demonstration and 03 cluster demonstration also been carried out.
- Two international training of 15 days duration supported by USAID (23 participants) and AARDO (09 participants, one summer school, two winter school and three CAFT training has been conducted during the year 2017-18.

- A model training courses (02 nos) sponsored by DOAC having one week duration and ten days training imparted to Technical Personnel of ICAR Institutes under human resources development programme.
- Some special training has been imparted to specialized groups like training for drivers of ICAR Institutes/Head Quarters (31 participants), ergonomic design guideline for design of safe machines (14 participants) and Manufacturing of Processing Machinery for manufactures (17 participants).
- Hands on training on improved agricultural implements and machinery has been imparted to 12 batches of farmers with about 700 beneficiaries.
- The skill development programs organized includes: green house operator (52 participants), tractor operator (20 participants) and harvesting machine operator (20 participants).
- An entrepreneurship development training on custom hiring (6 batches) and EDP on soymilk and tofu (8 batches) with total participants of 194 and 125 respectively.
- Krishi Vigyan Kendra at the institute organized 36 training programmes during the year, for 1017 farmers, farm womens', students, service providers and extension functionaries.
- During 2017-18, a total of 2463 units of 52 different equipment were supplied to various stakeholders thereby, earning revenue of about Rs. 27 lakhs.
- Seven Training programmes on Protected Cultivation practices were organized to farmers of MP
- Two Skill Development Programmes on "Greenhouse Operator" organized to 52 rural youth and students of MP.

Other Achievements

Publications

- Draft Indian standards for soy based food products have been submitted to BIS New Delhi.
- Scientists of the institute have published 61 research papers in international and national journals. Apart from these three books, eighteen book chapters, forty nine popular articles and 24 technical bulletins have been published.

Awards & Recognition

- Dr. Krishna Kumar Singh, Director ICAR-CIAE has been conferred "Rafi Ahmed Kidwai Award" for outstanding research in Natural Resource Management and Agricultural Engineering.
- Dr. Ashutosh P. Pandirwar has been awarded the Young Scientist Award and Fellowship by MP Council of Science and Technology.
- Scientists of the institute have received ISAE commendation medal and many best paper awards during various national and international seminars, conferences and symposia.

Events

- Some of the major events conducted during the year are: Brain Storming Session with crop institutes and experts from outside ICAR, Sanklap Se Siddhi, Nutri Fair, Manufacturers' Meet, Central Zone Sport Meet, Swachhta Pakhwara, International Yoga Day, International Women's Week and Annual Review Meetings/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 that leads to enhancing agricultural productivity; reducing drudgery of agricultural workers; generating and managing energy in agriculture, resource conservation, minimizing post-harvest losses, producing value added quality products and creating employment opportunities in the rural sector.

The institute was established on 15th Feb, 1976. 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 centers (Center of Excellence on Soybean Processing and Utilization and Krishi Vigyan Kendra - KVK) and a regional centre at Coimbatore. The regional centreat 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 Coordinated Research Projects (AICRP). The institute Krishi Vigyan Kendra (KVK) serves to demonstrate the technologies for wider adoption by the farmers, in general and of Bhopal district, in particular.

The mandates of the institute are:

- Research on agricultural mechanization, post-harvest food processing, and energy management in agriculture
- Human resource development and capacity building through outreach and training programs; commercialization and utilization of agricultural engineering technologies.

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. It 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. The Institute also has weather station, well-furnished hostel and guest house facilities for 80 guests. Research workshop provides facilities for fabrication of research prototypes and the prototype production centre for their 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 of journals in agricultural engineering and related disciplines. The library subscribes to about 60 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. Besides this the institute also hosts lead centres of two Consortia Research Platforms namely, 'Farm Mechanization and Precision farming' and 'Energy from Agriculture'. The institute provides international leadership in the agricultural mechanization domain through its prominent activities in the programmes like UN-ESCAP – CSAM, AARDO, SAARC, etc.

Over the years, the institute has developed many successful technologies. 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 has also being continued. Details of personnels and finance during the year 2017-18 are shown below:

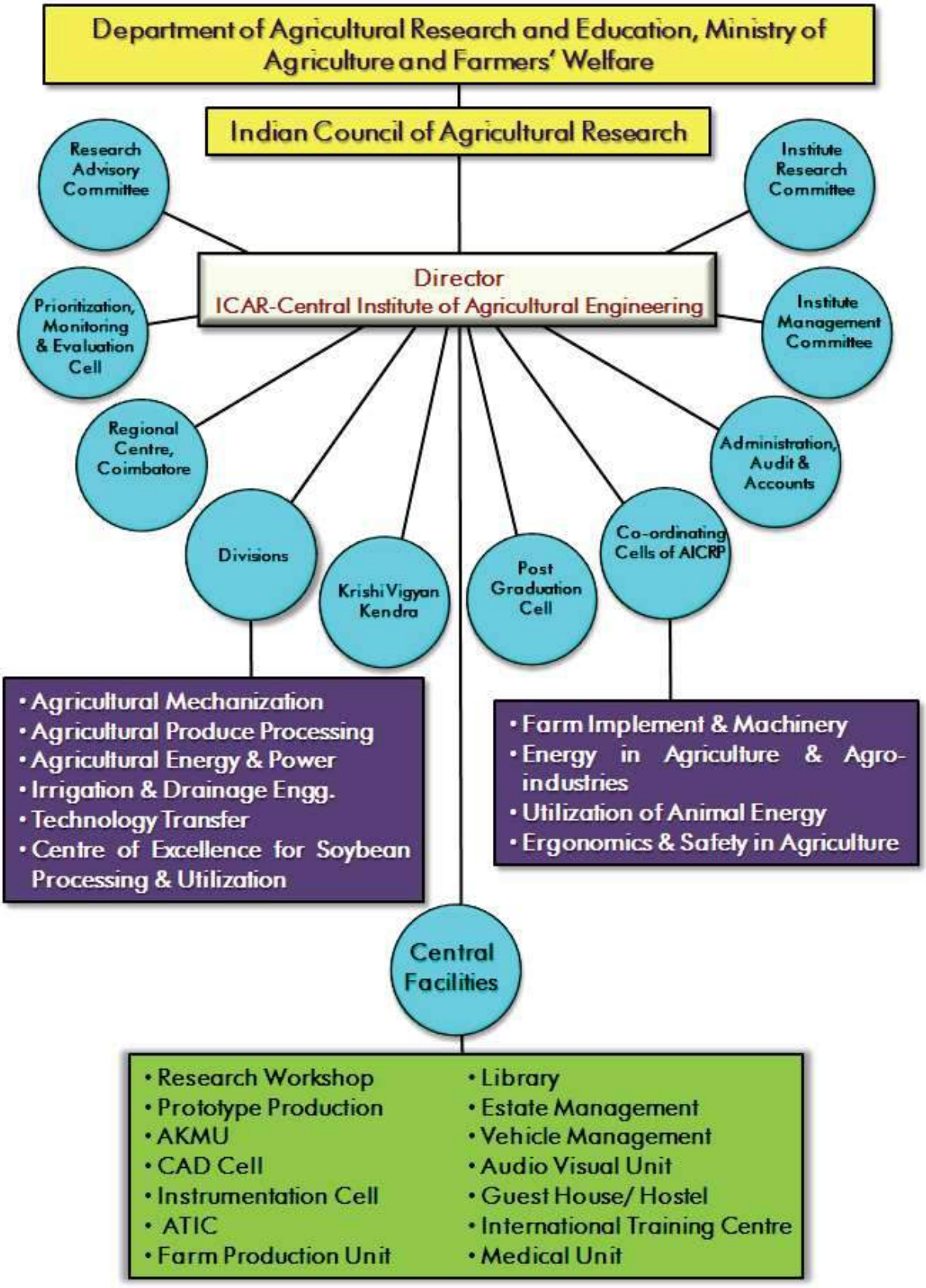
Staff Position

Posts	Sanctioned	In position	Vacant
RMP	1	1	–
Scientific	90	76	14
Technical	143	100	43
Administrative	73	56	17
Skilled Support Staff	83	35	48
Total	**390**	**268**	**122**

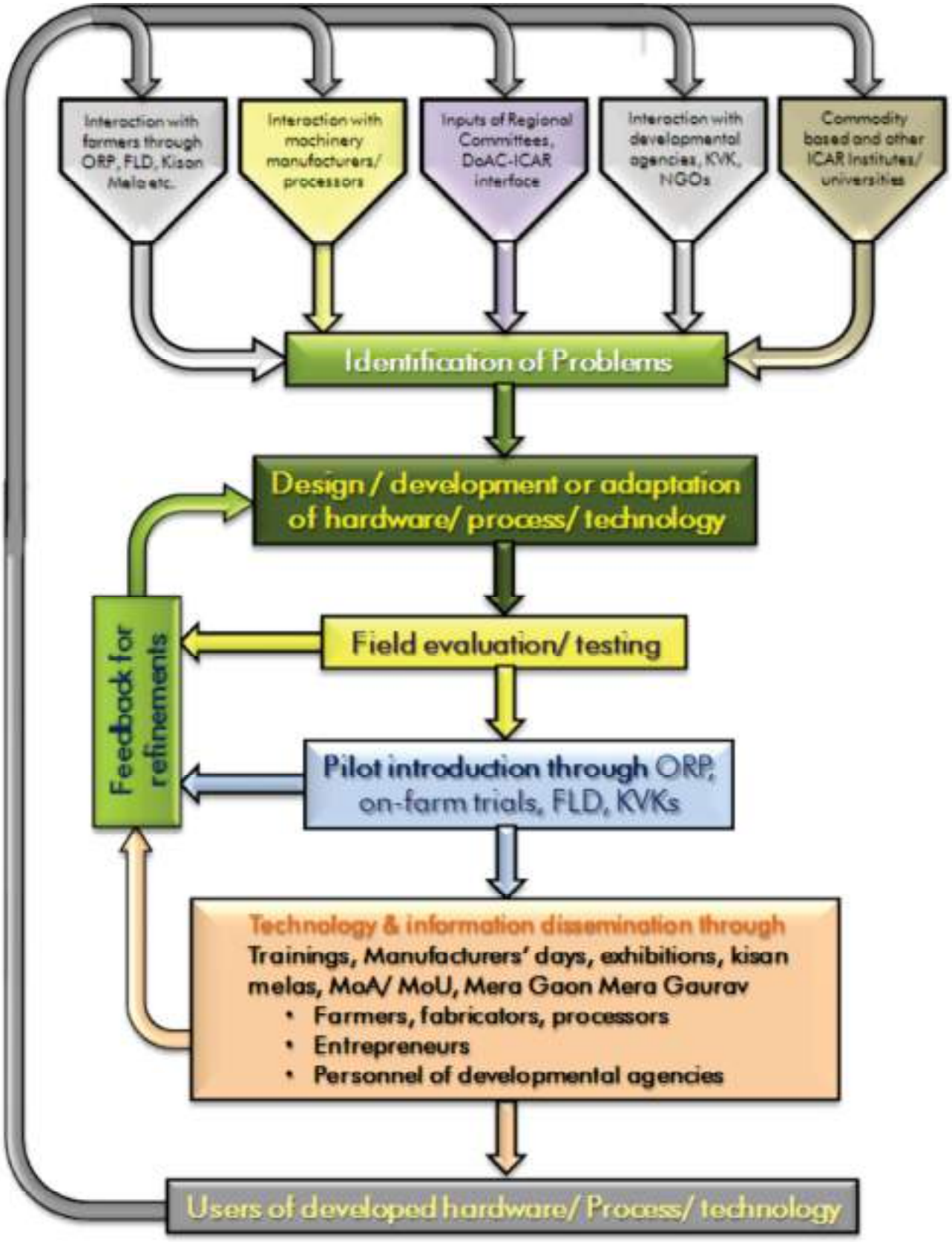
Budget (Rs in lakh)

Scheme	Sanctioned	Expenditure
ICAR-CIAE	5609	5607.74
AICRP on FIM	1301	1300.99
AICRP on EAAI	879.2	824.97
AICRP on UAE	548	547.78
AICRP on ESA	392	391.96
CRP on FMPF	100	99.51
CRP on EA	77	76.98

Organizational Structure



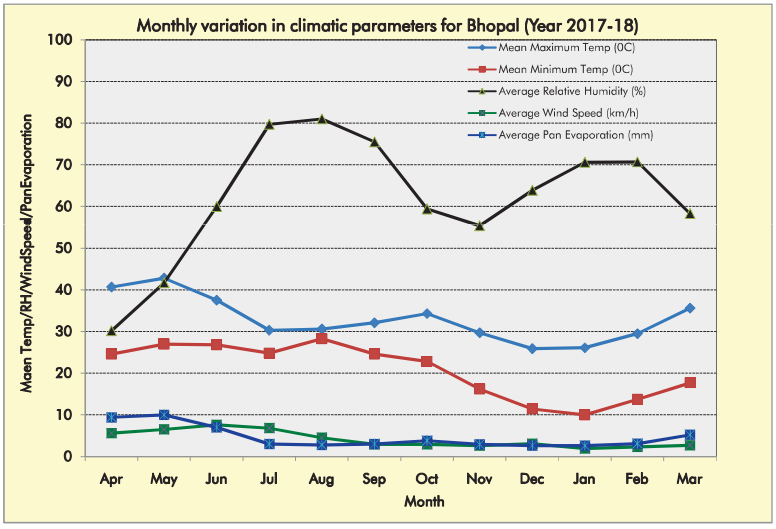
Technology Development Process of ICAR-CIAE

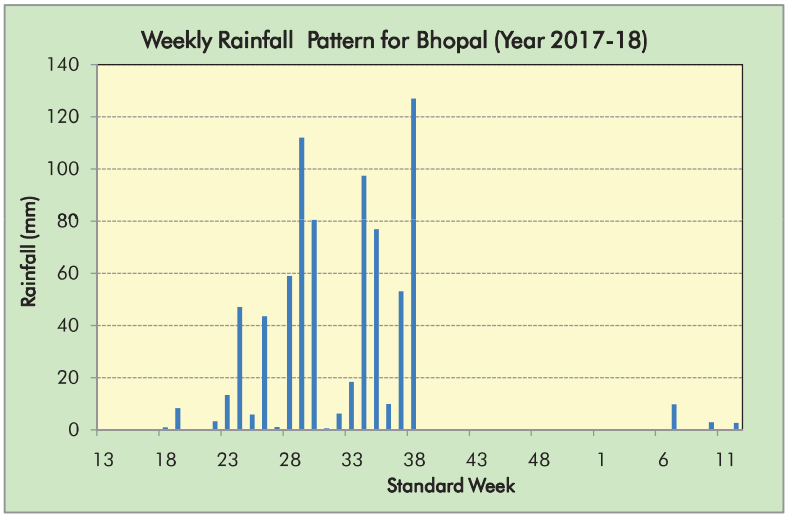


Meteorological Observations

Agro meteorological observatory of institute records rainfall, minimum and maximum temperatures, relative humidity, pan evaporation and wind velocity. Salient meteorological observations for the year 2017-18 are:

- Monsoon started on June 26 and withdrew on September 23, 2017. The total rainfall during the monsoon was 686.3 mm. The heaviest rainfall of the season (81.6 mm) was recorded on 19 Sep 2017. Annual rainfall of 781.2 mm occurred in 46 rainy days.
- The maximum temperature of the year (46.2 °C) was recorded on 28 May 2017 while the minimum temperature (6.5 °C) was recorded on 26 Jan 2018. Humidity in the morning (7:20 AM) varied from 28 to 97 per cent while in the afternoon (2:20 PM) it varied from 9 to 92 per cent.
- The highest average wind velocity of 11.3 km/h was recorded on 29 May 2017, while the lowest was 1 km/h on 12 Jan 2018.
- The highest pan evaporation of 13.2 mm/day was recorded on 27 May 2017 while the lowest was 1.2 mm/day on 19 Sep 2017.





Research and Development

Technologies Developed

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 – equipment/ machinery/ tools, processes, protocols, etc. and results of impact studies emanated during the current year are presented below:

Equipment and Machinery

High clearance multipurpose vehicle

Certain operations like weeding, spraying and harvesting cannot be conveniently performed using normal tractors/ power tillers in tall crops with varying crop geometry. Expensive solutions are being imported, which have variable ground clearance and track width. An indigenous self-propelled hydraulically actuated multipurpose vehicle is an appropriate solution. The machine has been designed to carry out various operations like spraying, weeding, harvesting, etc. in field and horticultural crops like; cotton, pigeonpea, sugarcane, okra,tomato, brinjal, chilli, etc. It consists of hydraulically powered cooling, differential and disc type fail-safe brake system. It has provision for ground clearance (2 – 2.6 m) and track width adjustments (1.5 – 2 m). The developed vehicle is stable up to 45° and 20° at static and dynamic conditions, respectively on longitudinal slope and 39° and 22° at static and dynamic condition, respectively on lateral slope. The Turning radius of the vehicle is 3.1 m and maximum speed of operation is 20 km/h. Maximum torque generated per wheel of the vehicle is 2500 Nm. The developed vehicle has been tested in okra field with an average height of 1.1 m that gives field capacity of 1.4 ha/h for spraying operation.

- **Adjustable track width (1.5- 2 m) and ground clearance (2-2.6 m)**
- **Suitable for various operations in tall crops**

Mulcher-cum-bed planter

To conserve soil moisture, planting of crop is needed to be performed soon after harvesting of previous crop. This operation is difficult due to residue of previous crop which interferes with the soil opening tools and machine parts coming in contact with soil. A zero-till bed planter-cum-residue mulcher has been developed for planting of maize and wheat seeds on beds under conservation agriculture. Overall dimensions of equipment are (L×B×H) 2800×1750×1375 mm and it weighs 6300 N. The machine can also form both broad as well as narrow beds of varying width from 200 mm to 1200 mm. Inclined plate type metering mechanism is used for metering of maize and wheat seeds. It mulches maize residues left over after combine harvesting followed by planting. It works satisfactorily under the maize residue of 12 t/ha. It gives field capacity of 0.3 ha/h at a forward speed of 2.7 km/h.

- **Capable for mulching and planting under residue load of 12 t/ha**
- **Field capacity: 0.3 ha/h**

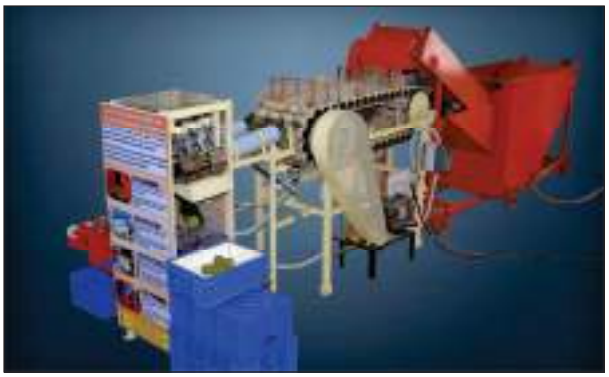
Mechanical intra and inter row weeder for wide spaced field crops

Several mechanical options are available for inter-row mechanical weeding, however these machines leave weeds between plants in a row. Therefore, even after mechanical weeding, manual operations are performed which are tedious, time taking and expensive. A mechanical intra and inter row weeder is used for weeding in deep rooted wide spaced field crops. The combinations of active and passive tools are used to develop an intra and inter row weeder. Spring tyne (length 260 mm) and sweep tyne (width 250 mm) are used for intra and inter row weeding operation, respectively. The intra row weeding tool rotates around a horizontal axis parallel to the direction of travel, which is positioned directly above the crop row and it moves along the crop row. Maximum torque required for operating the intra row weeding mechanism is 21.6 Nm at a compaction level of 600 kPa. Hydraulic motor of 50 cc displacement and 100 Nm capacities are used to operate intra row tools. Final u/v ratio of 3.7, arm length of 260 mm, 6 arms at a weeding depth 30 mm has been found suitable for maintaining a higher weeding index. It is found that about 71% of the weeds get destroyed by uprooting or cutting and field capacity of an equipment is 0.26 ha/h.

- **Weeding efficiency: 71 per cent**
- **Field capacity: 0.26 ha/h**

Automated packing line for spherical horticultural produce

Activities of a fruit pack-house involve washing, sorting based on colour, blemishes and estimated weight and packaging in appropriate packaging material. The operations are performed manually and their automation is required to achieve better capacity and efficiency. An Automated packing line for spherical horticultural produce has been developed which can carry out real time sorting of spherical horticultral crops on the basis of three weight categories and colour. The packing line is attached with a water jet washer and perforated cylindrical LDPE heat sealing packing unit. The overall capacity of the machine is about 200 kg/h (assuming average fruit weight to be 120 g). The colour and weight based real time sorting efficiency of the machine is 92 and 88 per cent, respectively. Colour and weight based sorting algorithms are individually programmable to accommodate variety of spherical fruits like oranges, sweet lime, apple, etc.



- **Colour and weight based real time sorting of spherical horticultral crops**
- **Sorting efficiency: 92 and 88 per cent based on colour and weight, respectively**
- **Packing capacity: 200 kg/h**

Variable width raised bed former

Raised bed cultivation is now gaining popularity since it saves on input cost and gives higher yields. Different cropping conditions may require different bed width and it is not economical to maintain different machines, each for formation of a specific bed width. A tractor operated variable width raised bed former for vertisol has been developed. Overall dimensions (L×B×H) of variable width raised bed former are 1000×2000×1000 mm and it weighs

3000 N. It consists of main frame, bed shaper and two adjustable side wings, which collects the soil in the shaper and makes compact raised bed of variable widths of 600, 800 and 1000 mm with 15 cm height. The field capacity and field efficiency of machine is 0.64 ha/h and 90%, respectively at a forward speed of 4.5 km/h with maximum horizontal draft of 4500 N and vertical force of 3000 N. The cost of operation of conventional raised bed former is ₹ 3500/ha, whereas it is ₹ 770/ha in case of variable width raised bed former, which saves approximately 78 per cent cost of operation per hectare.

- **Saves Rs. 2700/ha**
- **Field capacity: 0.64 ha/h**

Subsurface drip lateral laying machine

Drip irrigation offers several advantages in agriculture and therefore gaining popularity among farmers. Laying of sub-surface drips is an arduous task and currently perfomed manually. The manual practice is time consumming and inaccurate in terms of depth of laying. Tractor drawn subsurface drip lateral laying machine is suitable for installation of drip laterals up to 30 cm below the soil surface to irrigate wide range of agronomic, horticultural and fruit crops. Machine laid lateral pipes are placed rather uniformly at pre-decided depth, saves time and minimizes use of manual labour. The machine weighs about 350 kg. It can be mounted on a 40 HP tractor or above and lay up to four sub-surface drip lateral pipes simultaneously to a coverage width of 1.8 m. The field capacity of the machine is assessed to be 0.2 ha/h. A field experiment was laid using drip lateral pipe and tape, both of 16 mm diameter, while each at two placement depths of 15 and 20 cm. Each lateral and placement depth were thus considered as four treatments and replicated thrice. The uniformity of installation depth has been assessed by establishing a methodology. The soil around the lateral pipe has carefully been dug without disturbing the lateral pipe and the depth from the surface was recorded by vertically placing a measuring scale. The observations so obtained were analysed to evaluate various coefficients of uniformity.

- **Field capacity: 0.2 ha/h**
- **It can place drip laterals up to a depth of 30 cm with high uniformity**

Treatment wise uniformity for the depth of installation.

Uniformity coefficient	Pipe		Tape	
	15 cm	20 cm	15 cm	20 cm
Christiansen's Coefficient of Uniformity (CCU)	0.95	0.87	0.93	0.92
Wilcox-Swailes Coefficient of Uniformity (WSCU)	0.94	0.84	0.91	0.90
Statistical Coefficient of Uniformity (SCU)	0.95	0.87	0.92	0.91
Low Quarter Distribution Uniformity (SDU_{lq})	0.93	0.79	0.88	0.87

Tractor operated vegetable transplanters

Transplanting is major unit operation in cultivation of many vegetables. With dwindling work force for farm operations, farmers find it very difficult to perform this operation within stipulated time and budget. Some semi-automatic machines are available which require trained manpower for operation and therefore there is great demand for automatic machines. Two variants of automatic vegetable transplanters have been developed, which are suitable for variety of vegetable crops.

Three row automatic vegetable transplanter for potted seedlings

An automatic vegetable transplanter is developed based on morphological characteristics of tomato and chilli seedlings grown in cylindrical paper pot of volume 90 cc and pot diameter of 54 mm. It consists of a main frame, seedling metering units (inclined cut cup magazine), reversible shovel type furrow openers, soil covering device, seedling tray shifter, seedling trays, ground wheels and chain and sprocket type power transmission system. The overall dimensions and weight of the transplanter are 1700×1800×990 mm and 150 kg, respectively. The labour requirement and fuel consumption of an equipment are 18 man-h/ha, 3.5 l/ha, respectively. The average field capacity and field efficiencyof the transplanter are 0.11 ha/h, 56%, respectivelyat the forward speed of 1.2 km/h, whereas transplanting efficiency and overall efficiency are 92 and 85%, respectively. The operational cost of the transplanter is ₹ 6492/ha. It saves 72% labour and 86% time as compared to manual transplanting.

- **Saves: 72% labour and 86% time**
- **Cost of operation: ₹ 6492/ha**

Automatic vegetable transplanter for plug type seedlings

The process of feeding plug type seedlings has been automated in automatic vegetable transplanter. A tractor drawn 3-row plug type automatic vegetable transplanter consists of split cell type metering device suitable up to 2 km/h forward speed for transplanting plug seedlings. It gives field capacity and field efficiency of 0.23 ha/h and 63.13 per cent, respectively. The planting rate of the developed vegetable transplanter is 168 seedlings per min. It saves 97 per cent labour and 98 per cent of operational time over manual transplanting method.

- **Transplants 168 seedlings per min**
- **Saves 97 per cent labour and 98 per cent operational time over manual transplanting method**

Tractor mounted ginger planter

Due to its irregular shape, it is very difficult to plant ginger using available mechanical planters. The manual operation, presently performed, involves placement of rhizomes and making ridges, which is a time and labour intensive task. A tractor mounted ginger planter is suitable for ginger rhizome planting of size 25 to 50 mm at mean depth of 8 cm and at seed rate of 1200 kg/ha. The overall dimensions (L×B×H) of equipment are 1450×2200×1241 mm. It consists of main frame, ginger rhizome planting mechanism and ridger

bottom. The planting mechanism includes rhizome hopper, cup type metering mechanism, agitator, metering shaft, chain and sprocket type power transmission system, runner type furrow opener and ground wheel. It gives capacity and field efficiency of 0.32 ha/h and 85%, respectively at the forward speed of 2 km/h with average miss and multiple indices of 0.9 and 0.26, respectively. The equipment costs ₹ 60,000 and its cost of operation is ₹ 1435 /ha. The break-even point and payback period of the planter are 32 ha/year and 0.78 years, respectively. It requires 6.25 man-hour/ha. There are savings of 51% and 88% in cost of operation and labour, respectively as compared to traditional method of planting.

- **Saves 88% labour and 51% cost of operation**
- **Cost: ₹ 60,000**
- **Cost of operation: ₹ 1435 /ha**

Tractor operated cassava stake cutter planter

Cassava is an important crop of southern India. The crop is cultivated through planting of stakes. The planting operation requires cutting of stakes and then placement of cut stake in a vertical orientation. Tractor operated cassava stake cutter planter developed during last years has now been tested at farmer's field in an area of 4 ha. The equipment operates by 35-40 hp tractor to form single ridge, cut cassava stem of 24 cm and plants on ridge top at a metered distance of 45 cm. The germination count of stakes on 28 days after planting is found to be 99.54%. The field capacity of planter is 0.18-0.20 ha/h. The cost of equipment is ₹ 90000 and cost of operation is ₹ 3125/ha, which saves 60% operational cost compared to manual planting. The cost benefit ratio and payback period of developed planter worked out are 2.06 and 4.31 year, respectively.

- **Saves: 60% cost of operation**
- **Payback period: 4.31 year**

Real time uniform spraying system for field crops

Maintaining uniformity of spray volume during plant protection operations is very difficult and inaccurate operations result in over or under application of the agro chemicals. Real time uniform spraying system maintains uniform spray volume throughout the field irrespective of speed of operation. It consists of hall effect sensor IC, magnetic ball, micro-controller, servo motor, flow rate controller, HTP pump, tank, hoses, boom, nozzle, etc. The micro-controller receives input signals for forward speed through hall effect sensor, which is installed on the front wheel of the tractor. The error of speed measurement with hall effect sensor is found to be 0.64±0.08%. The input signals send to the micro-controller for flow control, the output singles from the micro-controller sends to the servo motor and servo motor controls the flow rate according to the forward speed of the tractor. The developed system has been evaluated in the field for application rate of 300 l/ha at 2 kg/cm^2 pressure. With change in forward speed between 2.43 to 4.5 km/h, the application rates are found to be in the range of 293.8 to 298.4 l/ha corresponding to the targeted application rate of 300 l/ha. The effective field capacity of the machine is 0.7 ha/h at 3 km/h.

- **Maintains uniform spray volume irrespective of forward speed**
- **Field capacity: 0.7 ha/h**

Solar powered knapsack sprayer

Solar photovoltaic panels are very good source of power for field operations and their cost is also now affordable. Solar powered machines offer convenience, comfort and drudgery and pollution free operations. Some solar powered sprayers have been developed earlier, but there has been a scope of increasing coverage of the equipment. Therefore, solar powered three nozzle knapsack sprayer has been developed to apply pesticides and herbicides in the cropped field. It consists of a PVC tank (capacity: 20 l), a solar panel of 20 Wp, DC pump and spray lance with nozzles. The solar panel mounting frame arrangement has been made in such a way that it acts as roof to provide shade to the operator. The operator carries the sprayer on his back having 10-14 litres solution comfortably. The sprayer through these three nozzles covers a linear distance of 1350 mm which is almost three times of the conventional knapsack sprayer. The sprayer was operated in different crops and output of the operator has been observed to increase by 2.5 times in comparison to the conventional knapsack sprayer. The area coverage is 1.0-2.0 ha/day.

- **Total man hours of spraying reduced to 1/3rd**
- **Useful to develop high pressure without human effort**
- **Ergonomically designed, high work rate and economical**

Millet harvester

A tractor front mounted millet harvester is developed by improvising paddy vertical conveyor reaper to harvest barnyard millet, kodo millet, proso millet, little millet and foxtail millet. It cuts the crop and lays it in the form of windrow for easy picking. It consists of a conventional cutter bar assembly, crop row dividers with star wheels, covers, pressure springs and vertical conveyor belts. The equipment is operated by 35-45 hp tractor with mean forward speed of 3.5 km/h. Cutter bar speed keeps in the range of 1500-1650 stroke/min based on straw-grain ratio. The width of cut, field capacity and field efficiency of the equipment is 2.1 m, 0.40 ha/h and 72.1%, respectively. Cutting efficiency and harvesting losses ranges between 0.75-0.90% and 98.5-99.5%, respectively at 12% (db) grain moisture. Cost of operation of this equipment is 28.3-31.4% lower than manual harvesting and it saves 81-89% labours (39 man-h/ha) compared to manual harvesting method (285 man-h/ha). The break-even point and payback period are 31-35 ha/year and 2 years, respectively.

- **Saves 81-89% labours**
- **Cost of operation: 28.3-31.4% lower than manual harvesting**

Pilot plant for minimal processing of cut vegetables

Processed cut vegetables are gaining popularity among the urban consumers especially in the families where both spouses are working. Currently, the cut vegetables available in supermarket are processed manually and their shelf life is limited to 1-2 days due to inappropriate processing conditions and lack of hygiene during manual handling, more so, the process is labour intensive and time consuming. In order to address the above issues, a pilot plant for minimal processing of cut vegetables has been developed using adopted/developed machinery with a capacity of around 100 kg/h. Machinery like a vegetable cutter, cauliflower floret cutter, washing cum treatment tank, ozone generation system, basket centrifuge, UV chamber and belt conveyors have been developed/adapted for production of minimally processed fresh cut vegetables (carrot, cabbage, cauliflower) with a capacity of around 100 kg/h. Process protocol have been developed for treatment of cut vegetables in ozonated water, surface moisture removal in a basket centrifuge, packaging and UV treatment of packaged products that increasestheir shelf-life as compared to traditional chlorine treatment. The cut vegetable processed through the developed pilot plant can be stored up to around 9-12 days under refrigerated conditions and 2-3 days under normal room conditions. The process utilizes no harmful chemicals and hence effects of harmful chemical residues are eliminated. Pilot plant is suitable for establishing an enterprise in peri-urban areas of vegetable production catchment.

Portable paddy straw briquetting machine

Managing paddy straw is a great challenge. Many farmers burn the straw in fields which results into loss of soil nutrients and environmental pollution. One of the envisaged solution could be using the straw in fuel. The developed portable briquetting machine for paddy straw with capacity 50-60 kg/h comprised of feeding hopper, screw auger, die and motor (10 hp). Mixture of paddy straw and soybean stalk are taken at a ratio of 70:30 and cow dung at the rate of 20% w/w has been added to the mixture as binder. The moisture content of feedstock is maintained in the range of 50-60 per cent by adding water. The density of produced briquettes has been obtained in the range of 520-550 kg/m^3 having excellent resistance to shattering and durable as well. Calorific value of paddy straw briquettes is 3600 kcal/kg. The cost of operation has been found to be ₹ 4.81 per kg. The produced briquettes can fetch a price of ₹ 6 per kg. The equipment can be used at farm site and utilization briquets as a domestic fuel can reduce dependency on conventional fuel.

- **Portable and easily transportable briquetting machine**
- **Cost of production is ₹ 4.81 per kg**
- **Suitable for briquettes production from paddy straw**

Biomass briquette based rapid combustion system

Rapid combustion system of capacity 8-10 kW for thermal application has been developed. The system comprised a combustion chamber, feeding auger with screw conveyor and a horizontal grate of 130 mm diameter at the bottom of combustion chamber. A sliding ash bin has been provided at the bottom for easy removal of ash. 12 W DC motor with axial fan has been used for air supply to ignite the biomass briquettes in combustion chamber. The combustor worked satisfactorily with 6-8 mm biomass briquettes and has resulted in 35% thermal efficiency compared to 22% and 13% thermal efficiencies of ICAR-CIAE improved cook stove and conventional cook stoves, respectively. The system has been successfully tested with the steam boiler of soy paneer plant. The average LPG and biomass briquette requirement to produce onekilogram of paneer is 0.39 and 2.13 kg, respectively. The average time taken to complete the operation has been observed as 1.05 and 1.27 h for operating the unit by LPG and rapid combustion system, respectively. The total LPG and biomass briquettes consumption per operation has been 0.97 and 5.3 kg, respectively. The system offers an alternative to save conventional fuels such as LPG and diesel in unit operations where rapid heating is desired.

- **Rapid combustor is capable to increase the temperature in short time**
- **Portable, can be retrofitted in any system**

Solar powered bird scarer

Birds are serious threat to standing crop. It has been reported that 20-22% of sorghum and pearl millet (bajra) get damaged due to birds. The extent of damage is normally higher in isolated fields. A gadget to scare away the birds has been developed. The solar powered bird scarer comprised a solar panel (20 Wp), battery (12 V, 7Ah), motor (5W), a steel pan, a watch movement unit and two speakers. The unit produces both mechanical and musical sounds for 20 seconds at interval of 3 minutes to restrict birds' entry in the crop field. Noise produced by the unit is 98.5 and 109 dB by mechanical and musical means, respectively at source. However, the noise produced at a distance of 100 meter distance has been observed as 45 and 58 dB, respectively for mechanical and musical means, respectively. The device has been tested in maize crop for 45 days without any damage to crop on account of birds. The cost of unit is approximately ₹ 2600 and it can save 480 man-hours per crop season.

Process, Protocols and Products

Technology package for processing of millets for enhanced shelf-life

Millets including sorghum are endowed with nutraceuticals such as antioxidants, minerals and vitamins, further they have low glycemic index. The major impediment in consuming millets is the presence of antinutritional compounds and low shelf life of products. Process protocols have been developed to enhance shelf life and nutritional availability of processed millets like kodo and sorghum using submerged fermentation, where tofu whey based LAB culture was used for fermentation. A processing line has been developed which comprising of (i) a batch type fermenter (150 l capacity), (ii) pneumatic-conveyor-dryer (50 kg/h), (iii) flaking machine (100kg/h) (iv) flakes conveyor (100 kg/h), (v) dryer, (vi) mini boiler, and (vii) hot water tank (116 L). The fermenter has attachments for temperature indicator, pH and conductivity measurement. The pneumatic conveyor cum dryer, has a 2 hp blower and heating attachments (2 KW heaters), for removing the surface moisture of the fermented and steamed grains, while maintaining the grain temperature above 60°C, so as to prevent retrogradation of starchy grains. The flaking machine having two sets of stainless steel rolls (304 SS) is provided for flaking the treated sorghum. The shelf life of fermented sorghum and pearl millet flour could be increased by 2.5 times or more when stored in sealed 100 μ LDPE pouches at 25°C and by following the developed fermentation and packaging protocols.

Kodo rice based ready to cook mixes

Kodo millet *(Paspalum scrobiculatum)* is one of the rich sources of nutrients with very good shelf life in undecorticated form. However, on decortication, its shelf life decreases drastically, characterized by darker colour and off-flavour development. In the most kodo consuming community, it is consumed in the form of rice, where the whole grain is decorticated and used to prepare various products. Fermentation is one of the ways to increase the shelf life of grains; therefore ready to cook kheer and

halwa mix have been developed using decorticated and fermented kodo rice. Kodo kheer mix contains about 4% fat, 10% protein, 2% minerals, 0.12% crude fiber, 81% carbohydrate and has an energy value of 396 kcal/100g raw mix. Kodo halwa mix contains about 11% fat, 9% protein, 2% minerals, 0.2% crude fiber, 78% carbohydrate and has an energy value of 441 kcal/100g raw mix. The shelf life of the Kodo kheer and halwa mix is about 3 to 6 months, when packed in 100 micron thick LDPE sealed pouches, and stored at 25 °C.

Sorghum based ready to cook mixes

Processes has been developed for sorghum based ready to cook mixes for improving nutritional bioavailability of sorghum based products. Two such mixes namely masala sorghum and sorghum upma mix have been found highly acceptable by consumers.

Sorghum upma mix

Sorghum upma mix has been developed using fermented, steamed and flaked sorghum grain. These grains are dried and coarse ground, with addition of fat, chickpea flour, tamarind powder, spices and condiments. The shelf life of the ready mix is about 3 months, when packaged in 100 micron thick LDPE sealed pouches, and stored at 25 °C. The uncooked sorghum upma mix

contains about 3.2 g moisture, 8.3 g fat, 11.7 g protein, 6.8 g minerals, 2.3 g crude fibre, 67.8 g carbohydrate in 100 g ready mix and has an energy value of 393 kcal. The product has been well received by a sensory study conducted considering 83 consumers, having an overall sensory score of 7.8.

Masala sorghum mix

Masala sorghum dry mix has been prepared by mixing dried sorghum flakes, dried vegetables, skim milk powder, roasted defatted soybean flour and condiments. The sorghum flakes has been prepared using whole sorghum grain, which has undergone fermentation process, followed by steaming, flaking and drying. The shelf life of the ready mix is about 3 months, when packaged in 100 micron thick LDPE sealed pouches, and stored at 25 °C with an FFA value of 0.073% at the end of storage. The uncooked masala sorghum contains about 6 g moisture, 1 g fat, 10.2 g protein, 5.5 g minerals, 3.2 g crude fibre, 74.2 g carbohydrate in 100 g ready mix and has an energy value of 346 kcal. The product has 21% antioxidant activity. Sensory studies conducted considering 112 consumers as well as sensory panel, show that the product is liked by both female and male respondents with an overall sensory score more than 7.5.

Automatic alert generation system for grain health monitoring

Monitoring of micro-environment inside a storage system is imperative to control insect activity and restrict spoilage of stored grains. Temperature, relative humidity and carbon-dioxide concentration are major indicators of environmental conditions inside storage structures. An in-house tailored sensor rod mounted with 3 DHT-22 sensors for monitors temperature, relative humidity and carbon-dioxide levels inside a storage system. Sensors, LED indicators and LCD with a data logger are mounted on the microcontroller. A specially designed program generates alert message and sends to a mobile, when any of these parameters are deviates from the threshold value. The sensor rods have been tested in a flexible PVC coated fabric bag to monitor wheat grain health for a period of 8 months. It has been observed that heightened insect activity increases the CO_2 level indicating that CO_2 sensors are more suitable in detecting the grain health as compared to conventional temperature and relative humidity level of the interstitial environment of a bagged grain storage system.

- **Sensor based real time indicators and mobile SMS based alert generation system**
- **Suitable for installation in bulk storage system as well**
- **Sensitive to detect 406-5764 ppm of CO_2**

Beta-carotene enriched chips

Beta-carotene is a red/orange pigment that has nutritional as well as functional importance because of its various roles in our body. Thus with an objective to develop beta carotene enriched chips using natural sources rich in carotene like carrot, pumpkin, sweet potato, papaya , etc. three variant of chips viz. carrot based, pumpkin based and sweet potato based have been developed to attain a level of 1.6mg of carotene which is 33% of the RDA for school going children. The fat content of test chips ranges from 23.25 to 24.78 g/100g, mineral content ranges from 6.24 to 6.93 g/100g. The levels of phenolics, flavonoids and Beta-carotene are significantly higher in test chips as compared to control chips. The highest amount of Beta-carotene is in sweet potato fortified chips (2.7 mg/100g) followed by carrot fortified chips (1.9 mg/100g) which takes care of approximately 50% of the requirement of Beta-carotene.

- **Natural plant based sources of Beta-carotene**
- **Rich in minerals, phenolics and flavonoids**

Carrot based chips

Sweet potato based chips

Pumpkin based chips

Flaxseed fortified products

Flaxseed is known as functional food because of omega-3 fatty acid (Olinolenic acid (ALA, 18:3n-3), phytochemicals such as lignans, high quality protein and dietary fiber (both soluble and insoluble). Considering the potential of flaxseed as functional ingredients, its exploration on incorporation in seven food matrixes namely crackers, cookies and extruded snacks, flaxibar, flaxi fruit spread, diabetic choco balls, flaxi coco spread are developed and investigated for its quality parameters in terms of nutritional and functional properties. All the developed products are ready to eat and specially designed to provide 2.2 g of omega-3 fatty acids (recommended by Indian Cardiological Society of India) for the management of diabetic and cardiovascular disease. Flaxseed concentration across all the developed products is in the range of 15-30 % in the final product. Analysis of omega-3 revealed products namely crackers, cookies and extruded snacks, flaxibar, flaxi fruit spread, diabetic choco balls, flaxi coco spread contains 3.62, 3.12, 2.98, 3.23, 3.16, 3.98, 4.16 g/100g respectively. All the products maintains a balanced ratio of omega 3:omega 6 less than 1:4 as per World Health Organization (WHO) recommendation. Apart from omega-3 fatty acids all products are rich in protein (8-15 g) and fibres (13-4 g). The products have been made using natural sweetener stevia and do not contain artificial preservatives and additives. Moreover, the anti-nutritional content in terms of hydrocyanogenic acid is less than 22 mg/kg in the all developed products.

- **Roasted flaxseed for reduction of HCN, stevia as a natural sweetener.**
- **Rich in Omega-3 fatty acids, protein and fiber**
- **Balanced ratio of Omega-3: Omega-6 less than 1:4**

Ready to eat fruit puree for undernourished children

Process for ready to eat papaya puree (strained food) targeted as complementary food supplement for babies and children's (aged 9 months and above) has been developed. The optimized process includes fruit sorting, washing with lime, steam blanching, addition of sugar and cooking at about 82°C, followed by deaeration and sterilization in sealed container. Processed and packaged product can be kept for 3 months under refrigerated storage condition. Developed strained food is rich in Vitamin C (96 mg/100g), Calcium (35mg/100g), Magnesium (70 mg/100g) and fiber (1.7g/100g). Calorific value of products is 98-100 which is comparable to commercial Garber first baby food having net calorific value of 91.

- **Fully natural fruit based product**
- **Rich with vitamin C, calcium, magnesium and fiber**

Protein rich soy based fortified compressed food bars for undernourished children.

A protein rich formulation of composite cereal bar has been developed based on soya and cereals like wheat, rice, sesame and mung bean. The developed soya composite cereal bar contains cocoa powder, coconut milk, skimmed milk powder, butter and sugar having protein and fat contents are 18-19% and 24-25%, respectively. Compressed protein bar with acceptable sensory quality, peroxide value, FFA content and microbial stability, has a shelf life of 3 months, when packed in polypropylene (PP) and 4-5 months in metallized packing (MP) stored at ambient temperature as well as 37 °C.

- **Composite mixture of soybean and cereals**
- **Rich with fat and protein**

Impact Analysis

Impact of ICAR-CIAE technologies on the Indian production agriculture

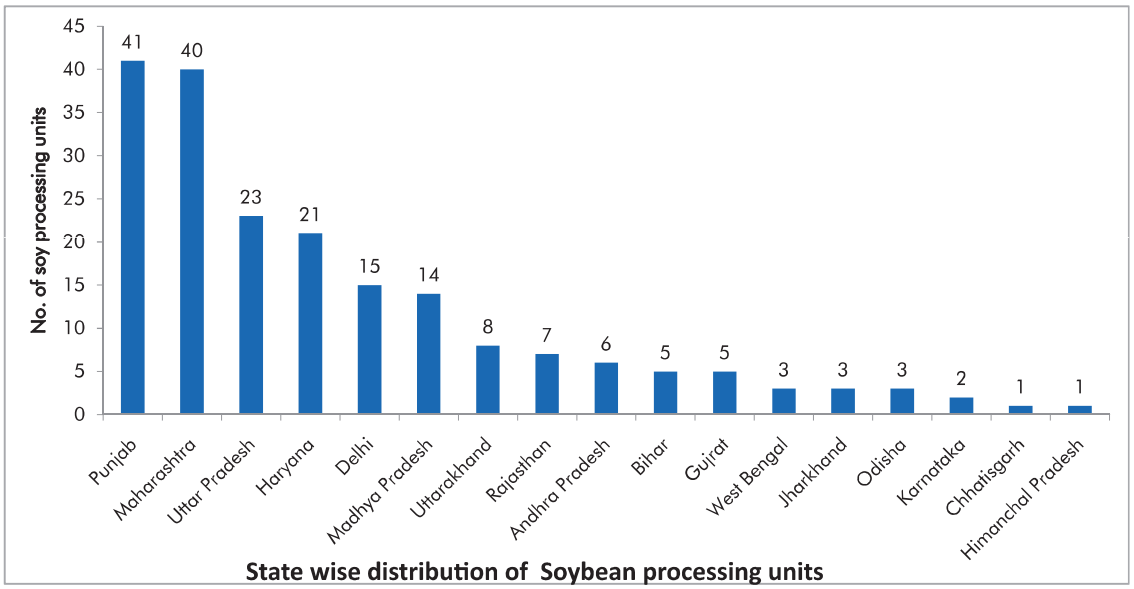
Institute has supplied designs and entered in MoA with different manufactures for manufacturing of developed equipment and thus made contribution towards mechanization of different facets of Indian agriculture. To assess impact of these technologies in monetary terms, a study on selected farm equipment developed by the institute and manufactured by private manufacturers has been carried out. Data has been collected through survey of 29 private manufacturers who have signed MoA with the institute for manufacturing of 70 ICAR-CIAE technologies. Major benefits derived from these selected technologies could be mainly grouped as reduction in cost of operation (due to enhanced capacity or saving of inputs like seed, fertilizer, labour because of their better application) and yield advantage due to increased inputs efficiency. For the post-harvest/agro-processing technologies, profits made by the users/entrepreneurs by selling the value-added products is the benefit. These benefits have been converted into economic value using Economic Surplus Method that provides a relatively simple, flexible approach for specifying the value of research, by comparing the situations with and without it. Results revealed that among the equipment developed by ICAR-CIAE, Manual cono-weeder with plastic cones (Approx. 2.2 Lakh units in use, monetary impact ₹ 1763.85 crores per annum), Improved Direct paddy seeder/ Drum seeder (Approx. 58 thousand units in use, monetary impact ₹ 1669.70 crores/annum), Inclined Plate Planter (Approx. 17 thousand units in use, monetary impact ₹ 535.88 crores/annum), Animal drawn three row seed-cum-fertilizer drill (Approx. 7 thousand units in use, monetary impact ₹ 127.70 crores/annum) and Twin wheel hoe weeder (Approx. 1.5 lakh units in use, monetary impact ₹ 115.43 crores/annum) have maximum impact on Indian agriculture in terms of visibility, economic viability and increasing the net return to the farmers. At present the impact of these technologies are estimated to be ₹ 4500 crore/ annum. Besides, ₹ 1.88 lakh man-days of employment is being generated every year in manufacturing sector. The cumulative impact of all technologies is around ₹ 12,700 Crores for the past 8 years. Major visible impact of ICAR-CIAE technologies has been seen in the states of Andhra Pradesh, Assam, Haryana, Kerala, Madhya Pradesh, Maharashtra, North-eastern regions, Odisha, Puducherry, Tamil Nadu, Telangana and West Bengal.

- **Economic impact : ₹ 4,500 Crore per year**
- **Ergonomic, gender-frindly machines**
- **Time and cost saving**




Impact of soybean processing entrepreneurship development programme

The institute has been conducting entrepreneurship development training since 1995. Approximately 2500 persons took training under this programme. To assess the impact of traininig programme, a survey has been conducted among selected trainees. The information related to the cottage scale units established by the persons trained under EDP (Entrepreneurship Development Programme) on soybean processing (soy milk & tofu and soy flour & biscuit) have been collected. Based on the survey and information collected, it has been found that around 200 units are working commercially. The information has been compiled in the form of Directory. The average annual production of Tofu and soy milk is found 2700 ton and 3400 kilolitres, respectively. Among various soy products, about 53% is Soy milk and 42% is in the form of tofu while the rest products cover only 5% of total produce. The distribution across the country indicated that units are located in 17 states with maximum of 41 units in Punjab state followed by Maharashtra (40 unit), UP (23 units), Haryana (21 units), Delhi (15 unit) and Madhya Pradesh (14 units). These units are not only generating employment of more than 1.78 lakh man-days/annum across the country but also providing nutritious product in the area. The training programme has been significantly contributing to nation's economy as well in combating malnutrition by adding 768 tons of edible protein every year at affordable cost. The economic impact due to these enterprises is presently ₹ 50 Crore per annum and increasing with popularity of soy based food products.



State wise distribution of Soybean processing units

- **About 200 entrepreneurs running their enterprise**
- **Among various soy products about 53% is soy milk and 42% of tofu and 5% are others**
- **The economic impact due to these enterprises is approximately ₹ 50 Crore per annum**

Performance of agricultural machinery custom hiring business enterprises in MP

Custom hiring of agricultural machinery is one of the best institutional innovations established in recent years as a panacea for all these problems. For the first time, Govt. of MP has made an attempt to accelerate setting up of custom hiring enterprises in private sector with the help of financial assistance from the banks, with adequate training assistance, wherein ICAR-CIAE has extended lead expertise. During 2012-13 to 2016-17, 1786 enterprises have been established, out of which 55% (986 participants) were trained at ICAR-CIAE. Out of 409 participants trained during 2012-2015, sample size (110 No., including 330 beneficiary farmers) were surveyed through personal visit.

The data collected from various custom hiring enterprises and famers broadly include the financial details of the enterprise, machines owned, crops and operations for which custom hiring services being offered, custom hiring rates, their feedback, requirements and constraints of entrepreneurs and farmers both.

According to ownership pattern, about 64 percent of the entrepreneurs belonged to medium and large farmers category and 36 percent entrepreneurs belonging to marginal and small farmers category. The average capital investment on farm power sources and implements was observed to be ₹ 19.20 lakhs per entrepreneur, ranging between ₹ 10 to 25 lakhs. On an average, the entrepreneurs were earning a net profit of ₹ 2.51 lakhs from their custom hiring centre. Average area coverage and family coverage was observed to be 153.2 hectare and 103 farmer families per year, respectively. 97% of the custom hiring entrepreneurs said that the training at ICAR-CIAE has been immensely helpful to them in terms of getting wide exposure to advanced agricultural machinery, selection of quality machines for their enterprise and also for future planning and expansion.

About 32 percent of the farmers availing the facility were having a land holding of less than 2 hectare. Overall nearly 60 percent of the farmers availing custom hiring services owned less than 4 hectare of land, which showed that the small and marginal farmers who cannot afford to buy costly agricultural machines, have been benefited. Average increase in production, reduction in losses, saving in farm inputs, time and cost has been found to be the tune if 26.1, 21.1, 28.4, 51.0 and 33.2 percent, respectively, as reported by the farmers.

Popularization of protected cultivation

With the combined efforts of Government of India, Madhya Pradesh (MP) State Horticulture Mission and Precision Farming Development Centre (PFDC) established at ICAR-CIAE, Bhopal, the protected cultivation practices are gaining momentum in Madhya Pradesh. The area under drip irrigation in MP has increased from about 90,000 ha in 2012-13 to over 2.5 lakh ha in 2017-18, and the total area under shadenet house and polyhouses has increased from 26 ha to about 300 ha. Regular training programmes have been organized on drip irrigation, plastic mulching technology and covered cultivation by the PFDC through which around 1500 farmers have been benefited. The institute is also providing need based support on crop and system management to about 35 farmers who adopted protected structures and 50 farmers who adopted drip irrigation mulching systems in different districts of Madhya Pradesh. Depending on area and type of intervention, the farmers have been able to earn about ₹ 1 to 10 Lakh per year in addition to their previously earned profits.

Technology Under Development Stage

Equipment and Machinery

Fertilizer placement attachment to sugarcane settling planter

Farmers have desired that ICAR-CIAE sugarcane planter,developed earlier should also have provision to dispose fertilizer while planting. Therefore, a fertlizer attachemnt is being developed with major components as hopper, fertilizer metering unit and transmission system. The attachment is designed to deliver fertilizer application rate of 140 kg/ha. Vertical disc metering mechanism with three cell sizes has been tested for diammonium phosphate. Preliminary tests have been conducted with row and plant to plant spacing of 1.2 x 0.45, 1.2x 0.60 and 1.5x 0.6 m. The results indicate that spacing of 0.46, 0.61 and 0.61 m between fertilizer drop has been achieved with average uniformity of spacing as 96.82%, 98.11% and 99.10%, respectively. The average depth of placement is recorded as 7.37 cm, while field capacity is 0.15 ha/h. Extensive on-field trials have been scheduled during next planting season.

Subsurface drainage trenching machine

Making of subsurface drainage trench is a labourious task. Development of a tractor operated drainage trencher using a three point hitched has been initiated. This machine is expected to dig a trench at the depth of 80-100 cm at desired grade and place the drainage pipe at the bottom of the trench in a single pass. Design requirements and specifications of drainage trencher machine components have been finalized based upon the

input data of tractor power 60 hp, PTO speed 540 rpm, tractor forward speed 0.72 to 2.16 km/h, length of cutting operation 1400 to 2000 mm, RPM of rotor shaft 200 to 250 and number of teeth on sprocket 17. Conceptual design and fabrication of different functional components of the tractor operated drainage trencher machine such as trencher frame, power transmission system, rotor shaft assembly, chain, cutting blades, boom assembly and arrangement of placing the drainage pipe have been completed. The principle of laser guided leveller will be used to control the desired grade of trenching (about 0.2-0.3% slope) for laying sub-surface pipes.

Site specific fertilizer applicator for widely spaced crops

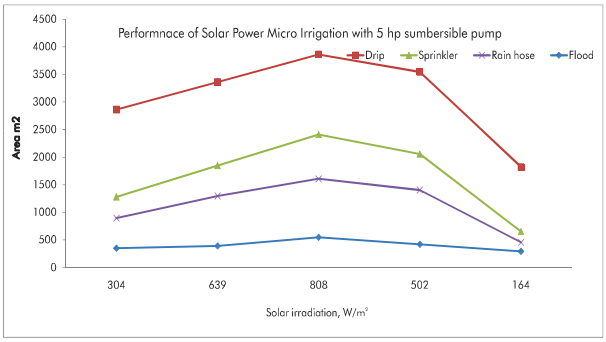
At present, fertilizer application in widely spaced field crops is being done manually. A self-propelled site specific fertilizer applicator has been developed for top dressing of urea in cotton crop. It consists of main frame, 3.6 kW petrol start kerosene run engine, fertilizer boxes each of capacities 8 kg (2 No.), fluted roller metering mechanism, triggering mechanism to detect plant and actuate

fertilizer delivery to target plant and sweeps are provided for weeding operation. It performs two operations simultaneously i.e. urea top dressing and weeding. It has potential of reducing the cost of cultivation of cotton crop. It is suitable for site specific delivery of granular fertilizer to cotton plants spaced at 90×60 cm at a forward speed of 1.5 km/h. The machine can be effectively used in widely spaced crop like pigeon pea, maize and sugarcane, etc. for application of granular fertilizer. Trials on other crops viz. cotton, pigeon pea etc. are being carried out.

Solar powered micro irrigation systems for field crops

To evaluate the efficacy of solar powered micro-irrigation system a field based study has been initiated for irrigating rice in nearly one acre area. Three micro-irrigation systems viz. drip, portable sprinkler and perforated pipe and conventional irrigation operated with solar powered pump set have been evaluated. The discharge rate of pump has been observed as 3.16 to 6.70 l/s at 2.5 m head, corresponding to solar insolation range of 164 to 808 W/m^2 during time period from 8 am to 4 pm. The total power generated from the panel during this period has been observed as 3013.5 W. For drip, sprinkler, rain hose and flood irrigation system the excess power availability range per season per ha have been calculated as 235-1160, 246-1213, 246-1213 and 220-1084 kWh, respectively. The relation between the pump discharge and power generated to the solar irradiation has been established so far.

Power generated from SPV panel and discharge of pump is shown below:



Potato combine

Several attempts have been made for developing prototype of potato combine, which could not reach to commercial production for the reasons like low efficiency in cleaning haulms, large clods reaching at the end with potatoes, high bruising of potatoes, absence of storage unit, etc. An effort is being made to develop potato combine suitable for Indian conditions. It has digging unit, conveying unit, cleaning unit, storage and bagging unit mounted on a chassis. The machine would dig potatoes from a single row of 60 cm width. A 60 hp tractor would be used as power source for travel as well for driving hydraulic power pack. The machine is expected to have field capacity of 0.15 to 0.20 ha/h.Fabrication of digging and conveying units have been completed and fabrication of other units are underway.

Tractor operated cassava harvester

An experimental unit of tractor operated single row cassava harvester-cum-collector is being developed. It consists of main frame, digging unit,

lifting and conveying units and power transmission system. The main frame (2000 x 100 mm) is designed to provide sufficient strength under torsional stresses. It is used for mounting digger bottoms, hitch frame and conveying system. The conveying system involves two parallel endless belts fitted in the rectangular frame of size 1500 × 40 cm with guide pulleys, tensioning pulleys and set of counter rotating rubber wheels. The equipment operates by 50-60 hp tractor. It digs and lifts cassava tubers from the ground and conveys and collects at end. An effective field capacity of the harvester is 0.22 ha/h. It is estimated to save 60% cost compared to manual harvesting.

Tractor operated grass seed harvester

Harvesting time and duration is one of the most crucial decisions that is made while harvesting grass seeds. To carry out the operation efficiently in time, a tractor drawn front mounted grass seed harvester suitable for harvesting seeds of 'Dinanath grass' *(Pennisetum pedicellatum)* has been developed. It consists of a front mounting frame, seed bruising brush roller, seed collection chamber, hydraulic motor (to power bruising roller) and double acting hydraulic cylinder (to adjust machine height as per crop height). The working width of machine is 1902 mm. The machine operates satisfactorily at forward speeds ranging from 1.5 to 2 km/h depending on the crop conditions. Harvesting cost of grass seed with the newly developed machine could be as low as 1/10th of manual harvesting. The equipment is being evaluated at ICAR-IGFRI, Jhansi.

Technology for cotton stalk management

Cotton stalk puller

Two row tractor front mounted cotton stalk puller consist of two cotton stalk pulling units with adjustable row widths. Each cotton stalk pulling unit consists of a pair of 400 mm long counter rotating tapered drums covered with 12 mm thick rubber sheet. Each unit is driven by hydraulic motor which powers 28 teeth gear mounted on larger section of each drum by means of 20 teeth gear mounted on hydraulic motor. During preliminary trials, field capacity and field efficiency of the machine have been found to be 0.16 ha/h and 72%, respectively at a forward speed of 1.4 km/h. It uproots 43-54 cotton plants per min with uprooting efficiency, percent breakage in the range of 91.2-95.33% and 4-8%, respectively at plant moisture content of 49.46- 65.76%, soil moisture content of 4.23 - 6.70% and soil cone index of 2680-3008 kPa. More field trials are to be conducted to establish machine efficacy and benefits.

Cotton stalk rake

Collection and disposal of uprooted stalks or left straw from the field is a serious problem in crop

residue management. Therefore a straw rake is being developed, which has 2 m wide frame mounted with 16 tines and spaced at 112 mm. The actual field capacity of tractor mounted straw rake is 0.56 ha/h at 3.6 km/h forward speed with the field efficiency of 81.94%. The straw collection efficiency of straw rake is found to be 95-100%. The cost of operation with the machine is ₹ 420 per hour with labour requirement of 1.69 man-h/ha. Further studies are being carried out.

Multi crop thresher for hills

It is very difficult to carry heavy threshing machines in the hilly regions. Efficient light-weight machines are in demand for threshing of major crops of NW Himalaya. A multi-crop power thresher (having 1 hp single phase electric motor) has been developed. Initial trials indicate that the developed equipment can thresh wheat, paddy and millets at capacities of 30, 45 and 41 kg/h, respectively and threshing efficiencies of 98, 98 and 99%, respectively. Weight of the machine is 80 kg. Testing of machine in the hilly region in to be taken up by ICAR-VPKAS, Almora in coming seasons.

Package of selected machinery for banana crop

Machinery package under development consists of pseudo stem injector, bunch harvester and sucker paring device suitable for the banana crop. These machines are not available commercially. The package of machines would undergo field evaluation during next cultivation season.

Banana pseudo stem injector

The pseudo stem injector is required for providing plant protection treatment against pest attack and insect growth into the pseudostem of banana. Additionally it helps to avoid indiscriminate application of the chemical on the pseudostem sheath. It is being developed for injecting chemicals in banana pseudo stem. It consists of chemical tank, peristaltic pump, control unit with non-return valve and injector. The injector is made of SS Material 304 Grade of 7.5 cm length and 2 mm sharp tip. The chemical tank is made of plastic with storing capacity of 16 l. The peristaltic pump is attached to pump the liquid from chemical tank to injection system. The control unit is attached with electronic embedded system to control chemical quantity and depth of injection by 8 mm I/P & O/P screw variable valve.

Banana bunch harvester

Banana bunch harvester consists of main frame (70×60×1450 mm), harvesting boom (70×60×2650 mm), bunch holding system, bunch cutting system, hydraulic system and power transmission system. The main frame is designed to attach in front of the mini tractor chassis. Harvesting boom and bunch holding and cutting assembly are

operated through a hydraulic cylinder powered by tractor PTO.

Banana sucker paring

Banana sucker paring device is being developed with an aim to remove the outer sheath of various sizes of suckers, trim and make them ready for sucker treatment. The equipment consists of rotating conical holder that holds banana suckers firmly against rotating blades mounted on conical drum and operated through an electical motor. A holding mechanism is provided with the sliding provision for proper adjustment of the sucker. The size of the equipment is 1080×550×1250 mm.

Manually operated palmyra endosperm remover

At present, Palmyra *(Borassus flabellifer L.)* tender fruit is being processed by the road side vendors using traditional knife in an unhygienic way, which needs specialised skill for cutting and reducing drudgery. The manually operated palmyra endosperm remover consists of the main frame, cutting assembly, tray holder with tray for endosperm collection and fruit waste dropping chute. Hollow bottom fruit holder prevents any contact between blade and operator's hand while cutting the fruit. Blade cuts open the endosperm socket and subsequently endosperm can be scooped out of the fruit using a stainless steel spoon. The equipment weighs about 22 kg with overall dimensions of 900x450x1600 mm. Initial testing shows that the endosperm removing capacity of the equipment is 50 fruits/h.

Grape debuncher

In the process technology of grape raisins, pre-treatment is one of the important unit operation. In order to avoid the intensive use of chemicals in existing practices and also to reduce the total drying time, a novel abrasive pre-treatment is being developed. It is necessary to detach intact grape berries from the bunch for its further processing in abrasive pre-treatment and drying. Therefore, a grape debuncher has been developed for separation of intact berries from the bunch. It consists of central rotor mounted with fingers in helical pattern. The tip of fingers has been kept flexible to avoid damage to the grape berries. The rotor assembly is surrounded by

perforated trough through which the detached berries drop and get collected in discharge trough. All the contact parts of the machine made of food grade stainless steel (SS-304). The machine works successfully with de-bunching efficiency of 96% and intact berries more than 95 %. The operating speed of 55-60 rpm was found suitable for detachment berries. The capacity grape debuncher is more than 150 kg/h. The developed grape de-buncher may also be applicable in minimal processing and IQF technology of table grapes.

Semi-continuous bio-methanation reactor for crop residue

Bio-methanation reactor with horizontal stirring arrangement has been developed to produce biogas from paddy residues. The unit comprised digester; inlet and outlet for substrates; filtration and recirculation of digested slurry water; biogas outlet, water level indication, gas storage unit. The stirring setup is operated by using 1 hp electric motor

controller using a variable frequency drive. The total volume of the reactor is 0.5 m^3 and suitable for digestion of 10-15 kg of ground biomass having particle size of 0.2 to 2 mm. The reactor is insulated to maintained the inside temperature. Provision for adding hot water from solar water heater is provided in the reactor. Temperature sensor and controller was fitted in the reactor to monitor the reactor temperature. The reactor resulted cumulative biogas production of 266 l/kg of paddy straw. Methane and carbon dioxide content in the gas has been measured as 55 and 40%, respectively. The stirring was found very effective in enhancing the biogas production up to 5-10%. Crop residues can be utilized to produce biogas as well as compost. The residue burning can be avoided with reduced air pollution.

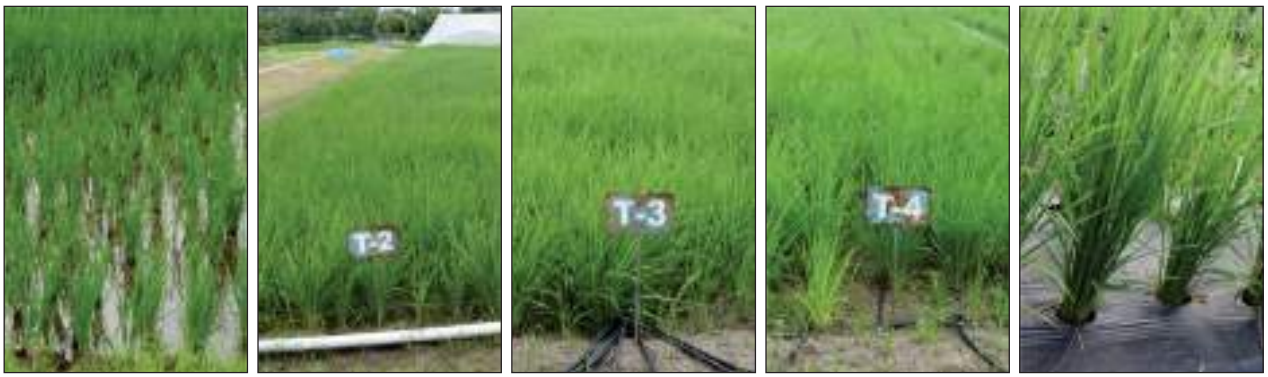
Process/ Protocols/ Studies

Micro irrigation systems in rice and wheat cultivation

The treatments of conventional irrigation; drip irrigation; rain hose; portable sprinkler and drip irrigation with plastic mulching were applied to study the effect of various micro-irrigation systems on rice and wheat crop production have been continued in the second year.

Rice crop

In case of rice (Var: PS1121), all the conventional crop cultural practices were followed in the first treatment, whereas among the rest of the treatments, System of Rice Intensification practices were adopted till transplanting of the crop and after that irrigation application method and duration varied as per the treatments. Drip with plastic mulching gave the highest yield of 4.89 t/ha with water productivity of 1.28 kg/m^3 followed by drip



irrigation that resulted in 4.38 t/ha yield at a water productivity of 0.79 kg/m^3. Whereas, the yield and water productivity under the rain hose irrigated rice have been recorded at 3.92 t/ha and 0.63 kg/m^3 respectively. The lowest yield of 3.42 t/ha and water productivity of 0.36 kg/m^3 were observed under conventional rice cultivation. Findings of two consecutive years have indicated enhanced yield of rice under drip irrigation plus plastic mulching besides saving in water.

Wheat crop

In case of wheat (Var: HI 1544) crop, sowing was done with the raised bed seeder by maintaining 22.5 X 5 cm spacing among the first four treatments whereas single seed was dibbled at 25x25 cm spacing in the last treatment. Drip with plastic mulching gave the highest yield and water productivity of 5.80 t/ha and 1.93 kg/m^3 respectively for wheat. Under rain hose irrigated treatment the crop yield of 5.55 t/ha and water productivity (1.52 kg/m^3) was observed. Drip irrigated wheat crop resulted in yield and water productivity of 5.20 t/ha and 1.8 kg/m^3 respectively. The conventional cultivation of wheat crop gave the lowest yield (4.36 t/ha) and water productivity (0.62 kg/m^3).

Assessment of roofing materials for rainwater harvesting

Monitoring of roof runoff quantity and quality provides information for design of rain water harvesting and groundwater recharging systems.

Experimental setup (2.4 m ×1.2 m) of four different roofing materials viz. asbestos, galvanised iron (GI), clay tiles, fibre reinforced plastic (FRP) has been developed and installed for quality and quantity assessment of harvested rain water. The runoff coefficients for various roofing materials have been determined for desired slope of 35° and event based rainfall-runoff observations. Runoff coefficients for GI sheet, FRP, asbestos sheets and clay tiles are found to be 0.94, 0.91, 0.87, 0.8, respectively against 0.75 for flat concrete. Various water quality parameters like pH, electrical conductivity, total dissolved solids, turbidity, cations and anions of collected roof water samples are under evaluation.

Assessment of coloured shade net houses on fruits and vegetables

The investigations have been conducted to access the effect of shade factors (35, 50 and 75%) along with shade colors (Black, White, Green and Red) on strawberry and broccoli. Two types of nets i.e., monofilament and tape were considered in the study for all the above combination of shade net colour and shade factors. The strawberry under black colored mono filament shade net having 50% shade factor produced highest no of fruits and

weight of fruits (16 & 8.4) as compared to white (13 & 7.9 g), red (11 & 7.3 g) and green (10 & 6.6 g) respectively for the same shade factor; Strawberry under black colored tape filament shade net having 50% shade factor produced highest no of fruits and weight of fruits (13 & 4.6 g) as compared to green (11 & 4.2 g), red (10 & 4.0 g) and white(8 & 3.9 g) respectively for the same shade factor; In mono filament Black colored shade nets (35% shade factor) highest broccoli yield (9.25 t/ha) was observed as compared to red (7.87 t/ha), green (7.36 t/ha) and white (5.54 t/ha) respectively for the same shade factor; In tape filament Black colored shade nets (35% shade factor) highest broccoli yield (7.36 t/ha) was observed as compared to red (7.03 t/ha), green (6.24 t/ha) and white (4.25 t/ha) respectively for the same shade factor.

Edible film for food packaging applications

The composite edible films have been prepared from the aqueous extract of soybean with different combination such as soybean extract, lipid content, pH and plasticizer, using solution casting method. A film applicator has been developed, which is made up of 304 stainless steel of thickness 2 mm with a dimension of 500 mm× 400 mm ×150 mm. To and fro motion mechanism of the applicator for the casting of film can be controlled by a stepper motor, microcontroller and two leave switches. The thickness of the film can be adjusted using a vernier head mounted on the top of the applicator. The machine has the provision to make film of dimension of 300 mm× 25 mm. The edible films from soy milk with variation of TSS (6-10 °brix), plasticizer (3-6%) and pH (7-9) have been developed having film thickness varying from 140- 250 μm.

Cast film applicator Edible films

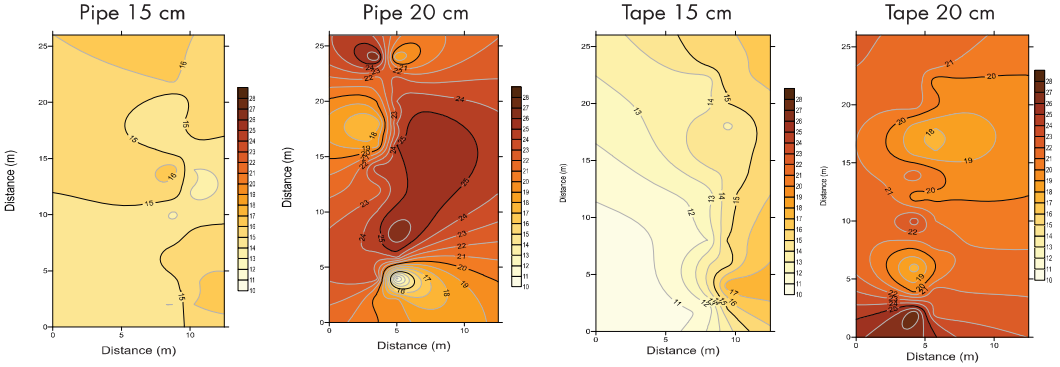
Environmental parameters monitoring under forced ventilated polyhouse

The environmental parameters inside the polyhouse monitored using PLC, temperature and humidity sensors. When the temperature of polyhouse increases from a desired limit then these analog values exceed the reference limit and finally PLC activates, SSR relay which in turn activates the contactor. The contactor is connected with a single phase 230 V, when it turns ON, it starts the motor of fan as well as pad resulting in flushing out of hot air from inside to outside and sucking of cold air through pads. The operation of fan and pad continues till the desired temperature levels are attained. Irrigation is provided by soil moisture sensor based (MP406- dielectric based sensor)

switching on the water pump. PLC continuously checks the readings of sensors and when these values attain the set value, the motors turns off automatically. These readings are stored in CPU through wireless antenna, USB port, SD card. Zigbee chip converts these signals into electromagnetic waves and transmits them through antenna which finally reaches the workstation. The temperature, soil moisture are measured for controlled and uncontrolled conditions. Soil moisture has been measured before and after irrigation. The temperature controllers maintained temperature of 30 °C inside the polyhouse.

Modelling of spatial variability of machine installed subsurface drip lateral

Machine installed subsurface drip system has been studied and evaluated for spatial variability of installation depth, its quantification and semi-variogram modelling. The spatial variability of the data set obtained by resulting grid of the installation depth of laterals has been mathematically modelled and specified by using point kriging and Gaussian variogram model/variogram autocorrelation estimators, which has pointed out the presence of small scale variability in small drip field. The same model has been fitted to the lateral pipes and lateral tapes at 15 and 20 cm separately. The semi variance analysis has revealed that its values leveled off at 5 lag distance which was at 50 cm. This could further be explained by the fact that after a distance of 50 cm or higher the variability has been computed in the placement depth mainly due to the presence of two different kinds and placement depths of drip pipe or tape laterals at 1 m apart at two depths in the experimental layout.



Micro-planning and management of a rural energy system

The energy scenario of rural eco-system of village Ganiyari, Bhopal has been assessed. The total energy consumption of the village has been found 4 TJ per annum corresponding to all four sectors (crop production, livestock raising, domestic sector and post-harvest). The cooking activity consumed highest energy in the village. The share of fuel wood and dung cake has been observed 53 and 18%, respectively which are majorly used in this village. Intervention of briquettes has been tried with 15 rural families to fulfil their daily cooking needs. Briquettes are well accepted by rural families for domestic cooking and the energy supplements by briquettes are estimated 60±20 MJ/day/family. The replacement of 50-80% of the fuelwood by briquettes for cooking has been resulted into energy saving of 20-25%.

Energetics of soybean crop production in Hoshangabad district

Energy inputs for production of soybean in the Hoshangabad district has been analyzed based on human, machinery, fuel, seed, fertilizer and chemicals. The seed energy input has been found to be higher (3912 MJ/ha) followed by high-speed diesel (1778 MJ/ha), machinery (1421 MJ/ha), fertilizer (1355 MJ/ha), human (234 MJ/ha) and chemical energy (82 MJ/ha). The direct, indirect energy, renewable and non-renewable energy contribution in the total energy matrix have been found to be 23.4, 76.5, 48.8 and 51.2%, respectively. Gross production value, gross return, benefit cost ratio, energy use efficiency and energy productivity found to be ₹ 13355 per ha, ₹ 6724 per ha, 0.82, 1.76 and 0.05 kg/MJ, respectively. The total cost of production for soybean has been observed in the range of ₹ 16580-17438 per ha.

AICRP on Farm Implements and Machinery

The project operates pan India with 25 research centers. Major activities of the project are to develop geography specific equipment and protocols, prototype production, multi-location trials, technology demonstration and aid in skill development in the area of farm machinery.

Power operated red-gram protray seeder

The transplanting of red gram involves labour for nursery raising operations and transplanting. Typically 74100 seedlings are required for transplanting one hectare. Hence, preparation of the nursery medium, filling in protrays and dibbling seeds in the protray are to be mechanized for reducing labour requirement. Development of a red gram protray seeder that can be flexibly configured to suit different tray sizes and cell layout has been done at TNAU, Coimbatore. The main components of the seeder are 300 mm wide slat conveyer in two sections, media dispenser hopper, configurable two row seeder for sowing both straight and staggered patterns, and covering media dispenser. The conveyer is designed to be driven by an electric motor of 1.1 kW. The protray seeder, with modular seed pickup unit, is suitable for bold seeded crops as well as small seeded crops. Conveyer speed controller enables sowing of different seeds and cell geometries. The entire unit is automated through suitable PLC. At 200 trays sowing per hour, the machine can be used to sow protrays required for transplanting one hectare of redgram in one day. Cost of sowing is ₹ 0.5 per tray.

Tractor operated potato cum sugarcane bud planter

The planting of potato and sugarcane are labour intensive operation and requires two different equipments. The labour requirement for manual planting of potato and sugarcane is 125 man–hours per hectare and 150 man-hours, respectively. Therefore, the cost effective and time saving equipment suiting to soil and variety prevailing in Haryana has been developed to increase use of equipment for planting two major crops.The potato cum sugarcane bud planter, developed for planting of both sugarcane bud and potato by CCSHAU Hisar, consists of seed box, fertilizer box, ridger, ground wheel, furrow opener, depth control wheel, cup belt, tyne and feeding chute. For sugarcane bud planting, the speed of operation, field capacity and field efficiency are 3.2 km/h, 0.49 ha/h and 75%, respectively. Similarly for potato planting, the speed of operation, field capacity and field efficiency are 3 km/h, 0.47 ha/h and 75%, respectively. The developed equipment resulted into net saving of ₹ 5141/ha and ₹ 6433/ha for potato and sugarcane planting, respectively. The labour requirement with the developed planter reduced to 3 man–h/ha. The break-even point is 180 hours, while payback period and benefit cost ratio of the planter are one year and 2.06, respectively.

Tractor operated multi-crop planter for sowing on beds

In traditional practice of bed cultivation, first ridges are formed with the help of bund maker or ridger and then seeds/seedlings are planted manually. It is a time consuming and expensive practice for the farmers. The plant to plant spacing is also difficult to maintain, affecting the crop yield. Raised bed planters are used for some crops but these equipment are crop specific. A tractor drawn multi-crop planter having provision of sowing different crops has been developed especially for direct seeding of rice (DSR), Bt cotton and small seeds. The machine developed at CCSHAU, Hisar consists of trapezoidal hopper, 12 furrow openers, 4 ridgers, notched inclined plate type sed metering mechanism, lugged ground wheel for transmitting power and one bed shaper and weighs 425 kg. The planter has been evaluated for sowing of pea, coriander, mustard, gram, and carrot seeds of different variety in field. Seed rate can be controlled by varying the angle of inclined seed plate and average width of sowing could be varied from 2.1 to 2.13 m in all five crops. The field capacity of planter has been found to vary from 0.29 to 0.31 ha/h. The field efficiency of planter has been observed as 78.62% in pea, 79.17% in coriander, 80.80% in mustard, 81.57% in gram and 81.11% in carrot.

Tractor operated sorghum and pearl millet earhead separator

Harvesting and threshing of sorghum and pearl millet crops (height ranging from 1450 to 2100 mm) by conventional method involve number of manual operations such as cutting of crop plants by sickles, tying of bundles, transport of bundles to yard, separation of earheads and threshing. Out of total labour involved for harvesting and threshing, nearly 42 to 45% is required for separation of ear heads which is done by breaking the stem at the neck by hand or cutting by sickle. It is time consuming and labour intensive operation (80 man hours per hectare). Because of involvement of too much human labour, separation of ear head becomes of costly operation. The tractor operated sorghum and pearl millet earhead separator has been developed at MPKV Rahuri. Conveyor linear speed of 0.48 m/s has been adequate to feed the material to its maximum cutting capacity. Output capacity of the machine is 0.8 t/h. The equipment resulted in 42-45% saving in total labour requirement for harvest and threshing the above referred crops. Earhead cutting efficiency has been 95%. Time, cost and drudgery reduction are the major benefits of this machine.

Mechanical feeding system of axial flow paddy thresher

Commercially available axial flow paddy threshers require manual feeding, which needs lot of labour and output of thresher depends on efficiency of labour. The output capacity of the axial flow paddy threshers can be increased by mechanical feeding system thereby also reducing labour requirement. A conveyor belt type mechanical feeding system has been developed at PAU, Ludhiana for commercially available tangential fed axial flow spike tooth type thresher. It consists of 2700 mm long and 430 mm wide flat belt type endless conveyor and a pressing

roller of diameter 124 mm having vertical movement to adjust mat thickness of fed crop. Eight fins/lugs of 25 mm height protruding radially outward provided on this roller. The flat belt conveyor consists of two cylindrical rollers of diameter 125 mm on which the endless conveyor rotates. One of these two rollers, nearer to threshing cylinder is powered from central shaft of thresher through a gear box like in Harambha thresher. The pressing roller is also powered by the same gearbox. The thresher has been evaluated at three feed rates (5100, 6000 and 6900 kg/h), three cylinder speeds (12.01, 14.13 and 16.24 m/s) and three conveyor belt speeds (2.71, 3.19 and 3.66 m/s). The optimum combination of the operational parameters has been observed at feed rate of 6900 kg/h, cylinder speed of 12.01 m/s and conveyor speed of 2.71 m/s. At this combination, the threshing efficiency, non-collectable loss, broken grains, cleaning efficiency, sieve overflow and torque are 99.08%, 0.52%, 0.34%, 97.96%, 0.40% and 354.8 Nm, respectively. Use of this feed system is expected to result in annual benfit is ₹ 75000/unit.

Torque measurement sensor for 2WD tractor

Tractor selection and implement matching for any specific field operation has been largely based on prior experience rather than analysis of performance parameters. Measurements of wheel torque is important for study of tractive performance and is done by using strain gauges with a slip ring mounted at the outer end of the axle to stationary recording equipment. A transducer for measurement of axle torque has been developed at IIT, Kharagpur. It consists of extension shaft on which the strain gauges are mounted to measure the strain during twisting. This shaft is placed between the wheel axle flange and tire rim of a tractor. A 10 bit analog to digital amplifier circuit has been developed to interface with the micro-controller. A telemetry system, consisting of two RF wireless modules, transmits the signals corresponding to axle torque to the data logging unit for data storage. After development of the transducer extension shaft, it has been calibrated for static loads in laboratory to check the sensitivity and the accuracy of the system. The developed device was mounted on the test tractor with the tillage implements and tested in field. It was observed that the drive torque of the tractor increased with the increase of draft force. It has been able to measure the real time torque of an implement with a variation of ± 5 to 8% on both the wheels.

Planter cum herbicide applicator for direct sowing of paddy

A commercial 9-rows planter having vertical rotor type metering mechanism has been converted in a planter cum herbicide applicator suitable for direct sowing of paddy at CAE, Bapatla. Based on the design calculation, boom sprayer of 2700 mm length having 4 nozzles with swath width of 700 mm and 240 l water capacity tanks have been used as attachment to planter. Two tanks having capacity of 120 l each are mounted on planter platform on both sides of seed cum fertilizer hopper. A 2.24 kW pump of 36 l/s capacity is mounted on planter frame in between top and lower links and connected to PTO shaft of tractor to run the spraying unit. The planter cum herbicide applicator has been evaluated at farmer's field in clay loam and black cotton soils for direct sowing of paddy. It planted and applied herbicide in a single pass. The effective field capacity and field efficiency of planter were 0.4 ha/h

and 90% for both soils at 15-20% (db) moisture content. The fuel consumption of 34 kW tractor was 3 l/h. The cost of operation of planter cum herbicide applicator was ₹ 1200/ha. The annual benefit of machine is ₹ 76000/unit.

Manually operated gladiolus planter

A manually operated gladiolus planter for planting gladiolus corms has been developed by PAU, Ludhiana. Major components of the equipment are; a frame, seed box, seed tube, ground wheel, cup feed metering mechanism, shovel type furrow opener and handles. Cup feed type metering unit, controlled by a vertical disc/plate driven by ground wheel, picks the gladiolus corm individually into the cups and delivers it into seed pipe. The planter was evaluated at three forward speeds viz. 1.0, 1.25 and 1.50 km/h. Best results have been observed at 1 km/h with percent single, multiple and miss values of 73.36, 19.74 and 6.90%, respectively. Percent seed in upright, inclined and downward position vary from 36.67-38, 53.27-58.67 and 3.33-10.06%, respectively at this speed. Compared to traditional practice, there could saving in labour and cost of operation up to 44.44% and 39.44%, respectively due to use of developed planter.

AICRP on Energy in Agriculture and Agro-based Industries

The project operates through 16 cooperating centres throughout the country. It is mandated to develop renewable energy technologies including solar, bio-chemical conversion, thermo-chemical conversion and liquid bio-fuel technologies. The project also looks into the energy management aspect in the field of agriculture besides technology dissemination in various parts of the country.

Automatically controlled re-circulatory solar dryer

An automatically controlled re-circulatory solar dryer comprising of solar air heater, drying chamber

and electric air blower has been developed at PAU, Ludhiana centre. The moisture reduction in bitter gourd slices from 91.7 to 6.7% (wb) took 20 hours corresponding to 3 days as compared to 26.5 hours when spread over for four days for control sample. Enhancement in overall moisture removal rate for drying of bitter gourd has been 1.33 thereby indicating 33% improvement in performance due to controlled air recirculation.

Solar compound parabolic concentrating (CPC) air heater

TNAU, Coimbatore centre developed a solar compound parabolic concentrating (CPC) air heater with concentration ratio of 4.5 for drying of high value commercial cash crops/agro-products of Western Ghats like areca nut or betel nut *(Areca catechu* L.) and evaluated its performance. Solar CPC collector consisted of transparent cover as

polycarbonate (3 mm thick) with transmissivity of 0.9, aluminium as receiver surface (27.5 cm× 178 cm×0.3 mm) with reflectivity of 0.87, aluminum used as absorber het pipe (internal diameter of 5.5 cm and length of pipe as 242 cm) and polyurethene foam (10 cm thick) used as insulation. The no-load performance testing of the dryer revealed that the hot air temperature was observed as 92 °C and where the ambient temperature was recorded as 37 °C.

Batch type continuous torrefaction unit

The MPUA&T, Udaipur centre developed a batch type continuous torrefaction unit using a suitable gear motor. It was found that during the torrefaction process considerable amount of combustible gases are generated. Developed continuous torrifaction unit is in position to produce 15 - 20 kg of torrefied crop residues per hour.

Paddy straw based biogas plants

The PAU, Ludhiana designed, developed and installed paddy straw based biogas plants. The plant has two separate parts namely digester and gas holder made up of brick masonry. Feeding of the

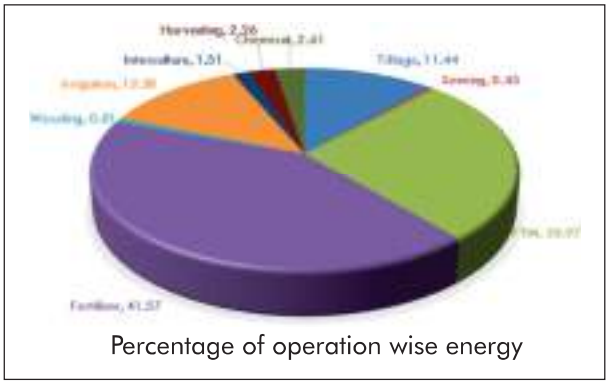

Digester

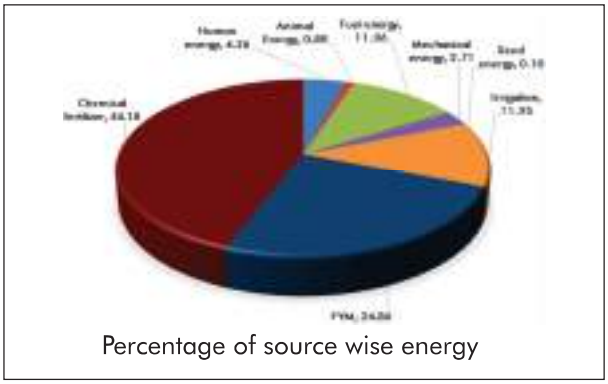

Gas Holder

plant with paddy straw and cattle dung is done in layers. Quantity of paddy straw required per batch for the designed plant of 2.0 MT digester capacities is 1.6 MT whereas that required for cattle dung is 0.40. Gas production starts after about 7-10 days after feeding and about 4–5 m^3/day biogas is produced from the plant. The gas production continues for 3 months and the plant is reloaded after three months by emptying the digester. Cost for construction of biogas this plant is approximately ₹ 1.3 Lakh per unit.

Energy use pattern in cotton farmers

The energy audit of cotton farming was conducted by the SPRERI, VV Nagar and the common varieties of cotton grown in the Anand district included Bayer-BT, Nirmal-222 and Navbharat. The energy audit revealed that seed rate used of these varieties was 3.70 kg/ha. The primary data of various field operations of cotton crop cultivation was collected through survey in 3 villages. The data were converted into energy equivalents and were further analysed to investigate the direct & indirect energy, total input energy for both source wise and operation wise along with total output energy as depicted in figure below:


Percentage of operation wise energy


Percentage of source wise energy

Energy use pattern in cotton grown area of Gujarat

AICRP on Utilization of Animal Energy

The project is devoted for animal based agricultural mechanization through development of machines, gadgets, tools to harness animal energy with or without aide of conventional energy sources for different unit operations of agriculture viz. land preparation, seeding/ planting, interculture operations, plant protection, etc. besides off-field operations like agro processing. Through twelve centers, the project develops equipment of appropriate size so that they can be efficiently used with different kinds of animals and their breeds.

Bullock drawn multipurpose tool carrier

The multipurpose tool carrier facilitates the integration of improved implements to the animal based farming with added advantage of providing comfort to the animal and the operator (AICRP on AES, MAU, Parbhani). It has the provision of

attachment of an inclined plate planter, sprayer and three tyne ferti-hoe. The average draft required for operating the planter-cum-sprayer with seed covering device is 620 N. The field capacity for the planter-cum-sprayer with seed covering device and three tyne hoe having two furrow opener is 0.19 and 0.30 ha/h, respectively. The average discharge from each nozzle is in the range of 195.9 and 197.6 ml/min. The uniformity coefficient of the sprayer has been observed as 74% with weeding efficiency of 84% in soybean.

Bullock drawn fertilizer applicator-cum-ridger for maize crop

A bullockdrawn fertilizer applicator-cum-ridger has

been developed at OUAT, Bhubaneswar to accomplish application of fertilizer and ridge making simultaneously in line sown maize crop under dry land condition. This device consists of fertilizer box, two cup type metering mechanisms, drive wheels and ridger. It helps to cover the bands of fertilizer, which reduces labour requirement compared to deshi wooden plough. It gives field capacity is 0.05 ha/h and field efficiency of 67.94% at average depth of operation of 11.8 cm. Since the overall fatigue score of the bullocks has been found to be 14.5 after one hour of continuous operation, the bullocks are in comfort while pulling equipment. The cost of implement is ₹ 2760.

Animal drawn bio-fertilizer applicator-cum-maize planter in hilly region.

CAE&PHT, Gangtok evaluated the performance of seed–cum–fertilizer drill for sowing of maize crop. The average field capacity of the machine is 0.084 ha/h at an operating speed of 2.4 km/h. Average draft of the machine is 185.7 N at a seed sowing depth of 45 mm.

Animal drawn mulch laying machine

A refinement has been made in tractor drawn plastic mulch laying machine at MPUAT, Udaipur to make it animal drawn. It consists of a beam, tool frame, two pneumatic wheels, and two ridgers. A roll of plastic mulch sheet is being hold by shaft, while the pneumatic wheels press the plastic on either side in soil. Two ridgers cover the film's both end with soil. Circular clamps are provided for adjusting hitch angle, working width and depth of operation. Testing has been done at the instructional farm of CTAE and it has been found that at 2.5 km/h speed of operation draught requirement is 280 N while the average working width is found to be 60 cm.

Pneumatic wheeled bullock cart

To overcome the shortcoming of the traditional carts and to reduce the drudgery of animal during transportation, a pneumatic wheeled bullock cart has been developed by IGKV, Raipur under AICRP on UAE for rural areas of Chhattisgarh. The developed bullock cart consists of Chassis, frames, pneumatic rubber wheels, carrier and hitch system. The performance parameters of bullock drawn pneumatic wheeled cart have been studied at various loads. Study reveals that as the average payload increases from tare load to 1100 kg payload, average draft increases from 18.45 to 36.78 kg, average speed decreases from 3.70 to 3.20 km/h, power requirement increases from 0.15 to 0.33 kW and wheel slippage decreases from 2.68 to 1.09 %.

Bay leaves (Tejpatta) grinder for rotary mode operation

An animal drawn rotary mode gear operated grinder for bay leaf has been developed at GBPUAT, Pantnagar. The cyclone type hammer mill grinder is used in rotary gear reduction unit in this study. It consists of cyclone separator, frame, cutting blade and rotary gear power system. Efficiency of the animal drawn hammer mill ranges from 35.78 to 57.71%, average particle size varies from 0.143 to 0.227 mm, minimum value of flow-ability varies from 7.56 to 8.27 s and hygroscopic varies from 3.65 to 4.79%. Colour of ground bay leaf sample has not being effected due to use of animal drawn grinder.

AICRP on Ergonomics and Safety in Agriculture

This project is mandated to apply of ergonomic principles and anthropometric data for increasing productivity, reducing drudgery, and minimizing accidents and occupational health problems of workers in agriculture and allied sectors. Operating through twelve centers in different parts of country, the project works mainly to study human – machine - environment interactions, develop safety devices, practices, and strategies and assessing occupational health hazards.

Health hazards of workers of coir industries and interventions

A study has been conducted to assess the health hazards of workers of coir industries in Odisha by OUAT, Bhubaneswar centre of AICRP on ESA. Women are a major work force in the coir industry contributing to 63% of the total workforce and are engaged by 200 days in a year at labour cost of ₹ 200/day. Respiratory problems (57%), finger injuries, water blistering on hand as well as foot palms (29%) are major health hazards of coir workers. Musculoskeletal disorders in neck, shoulder, upper and lower back problems have also been found. Dust has been found to be a major problem in all coir industries. It affects both workers as well as community living in nearby areas. The main sources of dust are identified at crushing as well as beating unit, the inhalable and respirable dust concentration have been found to be 42 and 21 mg/m^3. A dust collection chamber of size 6 m x 3 m x 3 m (LxBxH) made of galvanised iron pipe and covered with Agroshednet has been installed at one industry. Water buckets have been provided inside chamber to collect the settled dust. The dust collection chamber reduces the respirable dust concentration to 9.8 mg/m^3. Earplugs have been provided to workers of crushing unit to reduce the effect of noise level from 98 dB(A) to 62 dB(A). Improved lighting conditions on workstations were provided to reduce the stress felt by workers. Safety gadgets such as dust mask, hand gloves, boots and carrying basket with handle have been provided to reduce the drudgery of operation and avoid cuts/bruises.

Air pressure brakes for tractor trailer

An air brake or a compressed air brake system is a type of friction brake for trailer in which compressed airpressing on a piston applies the pressure on the brake pad to stop the tractor-trailer. Air brakes are used in large heavy vehicles especially having a heavy load. The air compressor is driven by the engine crankshaft pulley via a belt. The air pressure brake system has certain distinct advantages, especially over a hydraulic pressure brake system. The supply of air is unlimited, so the brake system can never run out of its operating fluid, as hydraulic brakes can. Minor leaks do not result in brake failures. Air brake systems include an air tank that stores sufficient energy to stop the vehicle, if the compressor fails. So these brakes are better in efficiency and safety. A tractor-trailer air pressure brake system has been developed by PAU, Centre.

The system mainly consists of air compressor, air reservoir, pressure regulator, brake pedal for trailer, dial gauge, connectors, air boosters, rotating adjusters, cam system and expanding type leather brakes. The developed system is fabricated by local manufacturer. The tractor-trailer was tested at tar-macadam road and the stopping distance in different gears and engine speed was measured. The average stopping distance after application of sudden brake has been found as 3.0-3.5 m.

Assessment of occupational issues in tea leaf plucking and development of tea leaf plucking aid

The occupational problems and issues have been studied with 30 tea leaf plucking workers (10 male and 20 female) from the Banderdewa and Ialuk tea garden. The postural discomfort in the tea plucking operation has also been assessed using RULA analysis. The subjective analysis for body part discomfort is also being conducted to know the discomfort at different body parts like neck, shoulder, upper arm, elbow, forearm, wrist , etc. Approximately 80% of worker raised their concern regarding finger injury and discomfort due to basket used for collecting the tea.

A finger mounted plucking aid has been developed, which helps in cutting the leaf instead of tearing with bare hand. A thin metal circular guard has been provided in the forefinger and a sharp cutting mechanism in thumb. With the help of these two fingers the tea leaf is being plucked. Further, the tea collecting basket is also made of cloth with bigger radius opening and shoulder support instead of bamboo basket is being used. The design of the plucking aid is shown in Figure. The basket is also fitted with a sun protective aid.

Improved basket holder for load carrying in sherpa and backpack mode

In hills, manual load carrying is very common and manual load is carried in Sherpa mode and locally designed baskets are used to carry these loads. An adjustable basket holder has been developed by NERIST centre of AICRP on ESA. The newly designed adjustable basket holder can grip different sizes of basket. The study has been conducted at various load carrying capacities at 15, 25, 35 and 45% body weight (BW), respectively and slopes such as no slope, 5%, 10%, 15% and 20%, respectively for male and female agricultural workers in Sherpa mode. It is observed that the workers can carry more loads, 7-44% for male and 22-43% for female workers with improved basket holder at different slopes as compared to traditional holders.

CRP on Farm Mechanization and Precision Farming

This consortia research platform is mandated to fast-track the process of farm mechanization through development of need based machinery and functional networking of stakeholders. Development of precision farming equipment and technologies is the major area of research besides promotion and transfer of successful technologies in different part of the country. The project operates with eight centers for farm mechanization activities. A new programme for micro irrigation activities has been started under the project from 2018-19 with five centers.

High ground clearance platform for small tractor

The government is promoting mini tractors to decrease initial investment on farm power sources in drylands. Availability of matching implements is a problem for small tractors. To address these problems, ICAR-CRIDA, Hyderabad centre of CRP FMPF has developed a high ground clearance (165 cm) and track width(90 cm) platform for mini tractors in the range of 13-16 kW. It has been evaluated in castor and pigeon pea crops for inter culture operation. The weeding efficiency varies from77 to 80% and 79 to 84% for castor and pigeon pea, respectively. The weeding efficiency for pigeon pea decreases with increase in crop canopy. The machine helps for timely completion of field operations and drudgery reduction.

Variable width raised bed planter

In-situ conservation of rain water in rainfed area has vital importance for crops during their maturity.

Raised bed helps to conserve soil moisture and improve water use efficiency. A variable width raised bed planter is developed at ICAR-CRIDA, Hyderabad Centre of CRP-FMPF to suit the crop geometry of crops such as pigeon pea, cotton, sorghum etc. It consists of two ridger bottoms, which make furrows in the soil and a shaper that makes the little compact raised bed of 35-40 cm width and 20-25 cm. The wings of ridgers are specially designed so that the top soil disturbance is minimized to reduce the germination loss. The bed shaping board can be adjusted for 60 cm, 80 cm, 100 cm and 120 cm to suit the different crop geometry. The machine is designed in such a way that in wider row spaced crops the tractor wheels follows the furrow so that the weeding and other operations can be done easily without disturbing bed configuration.

Solar powered dual energy water pumping system for rainfed eco-systems

Farm pond is a viable technology in rainfed eco-system.Dual energy based water lifting system suiting to pressurized irrigation was developed for 3 hp solar (PV) pump set. The flow of solar powered submersible pump is boosted with 1.1 kW portable diesel pump. The outlet of solar pump acts as inlet of portable pump and water exits through outlet of diesel pump. Pressurized flow of solar pump further accelerates and water is delivered with substantial pressure through diesel pump. The performance of three pumping systems viz., (i) photovoltaic (PV) pump (ii) hybrid PV and portable diesel pump and

(iii) diesel pump have been evaluated. PV+diesel pump gives 38% and 8% higher flow rate than PV pump and diesel pump alone, respectively at

ambient temperature of 26 ^{0}C. The flow rate increases with increase in solar radiations. The pressure increased substantially (more than 2.5 kg/cm^{2}) in case of PV+diesel system which is suitable for pressurized irrigation.

Motorized protray, poly bag and pot filling machine for horticultural nursery

Vegetable seedlings raising is one of the important but time consuming and laborious activities. It involves cleaning, mixing and filling of media. Therefore efforts have been taken to develop motorized growing media siever, mixer and protray/bag filling machine by IIHR, Bangalore under CRP-FMPF. It consists of growing media elevator, growing media siever-cum-protray filler and growing media mixer-cum-bag filler. All the components are fitted on a 4 wheeled trolley frame for transportation. The growing media gets filled in the loader of the growing media elevator. Bucket elevator lifts the growing media from the loader to the sieving unit. The bucket elevator has 1.5 – 2 tonne/h capacity. The growing media siever consists of stationary drum, rotating cylindrical screen and growing media quantity controller. Three operators can sit near the control valve to fill the cleaned media in the bags or portray. The growing media siever-cum-protray filler is operated with a

2 HP, 3 phase, geared electrical motor. The growing media mixer has 225 cm length with a cross section of 80 cm top width and 45 cm bottom width. It has helical blades fitted for mixing and conveying the media. Three numbers of bag filling outlets are provided at the end of the mixer with oscillating type valve control. The capacity of the machine is around 1.5–2 tonnes/h of growing media. Almost 60% of man power can be saved per day compared to manual method. The cost of the machine is ₹ 5 lakhs.

Establishment of Custom Hiring Centre (CHC)

A Custom Hiring Centre (CHC) was established at KVK, Buxar by ICAR-RC ER, Patna centre of CRP-FMPF to provide services to the farmers. The important farm machinery and implements like 45 hp tractor, rotavator, seed drill, multi crop thresher, MB plough etc. are available at the centre on hiring basis.

CRP on Energy from Agriculture

The project operates to facilitate basic research on biomass based energy generation and conduct the research and demonstration on energy efficiency in agricultural operations with a view to enhance the share of renewable energy use in Indian agriculture and resulting into lower carbon foot print. Activities are carried out through seven research centers spread across the country.

Storage studies of bio-oil produced from selected crop residues

Bio-oil produced from different agro residues have been upgraded with addition of polar solvents. Methanol has been observed best solvent to stabilize the bio-oil with an optimized solvent to bio-oil ratio of 20 and with 23 percent water content. Storage stability of upgraded bio-oil was investigated and it was observed that raw bio-oil stored at room temperature and 80 °C has shown the phase separation within 15 days and 1 day, respectively. The study revealed that upgraded bio-oil with addition of 20% methanol at room temperature has the better stability and it does not shown any phase separation within 240 days of aging time but the same time when bio-oil is aged at 80 °C, phase separation appeared after 125 days. This result clearly indicates that bio-oil stabilized with methanol can be used for storage and transportation purpose for its end application.

Hydrothermal liquefaction reactor for bio-oil production from lingo-cellulosic biomass

The hydrothermal liquid reactor (HTL) has been developed at TNAU, Coimbatore to study the bio oil recovery under different operating conditions. Biomass having moisture more than 50% and cellulose content more than 25% selected for bio-oil production. The study conducted at 200 to 350 °C with pressure up to 20 MPa and residence time up to 60 minute in a wet environment for bio-oil production. Bio-oil yield of 60% has been achieved from biomass with 25% total solids loading in 20 minute retention time.

Continuous pyrolysis reactor system for bio-oil production

SPRERI, VV Nagar developed a vertical moving bed reactor consisting of continuous feeding facility,

discharging unit, vapour cleaning and condensation system to produce bio-oil from crop residues. The study conducted with saw dust showed a bio-oil yield of 44 and 47% at 400 °C and 450 °C, respectively. The developed system showed a higher bio-oil yield of 8% as compared to lab scale batch type pyrolysis reactor.

Continuous biochar production, characterization and economics

MPUAT, Udaipur centre has developed system of continuous screw type biochar production unit of 20 kg/h capacity has been evaluated using groundnut shells. The biochar production rate has been observed 6 kg/h. The calorific value of the biochar is 5936 kcal/kg which is 58.3% higher than the raw material. Elemental analysis of biochar

showed presence of carbon, hydrogen and oxygen of 82.9, 2.80 and 9.35%, respectively. Other elements such as calcium, iron, zinc, sodium, potassium, sulphate and nitrate are also present in the biochar. Cost of production for biochar has been ₹ 31/kg. Benefit to cost ratio, net present value, internal rate of return and payback period has been calculated as 1.94, ₹ 48.28 lakh, 121% and 11 months, respectively. The biochar produced was used as soil amendments to study its effect on crop yield. The soil pH and electrical conductivity (EC) was found to be reduced to support the growth of plants with biochar application rate of 2 t/ha. The organic carbon in soil was also found to be increase by 23% on application of biochar. The nitrogen (325.13 kg/ha), phosphorus (23.03 kg/ha) and potassium (395.11 kg/ha) present in soil were also analyzed after application of biochar.

Techno-economic evaluation of SPRERI cellulosic technology using selected crop residues for ethanol production

Low strength sodium hydroxide pre-treated rice straw was hydrolysed at 10% solid loadings (w/v) with in-house cellulases produced by Aspergillus terreus along with commercial cellulases using batch and fed batch hybrid simultaneous saccharification and fermentation process (SSF). Pre-hydrolysis was done at 50 °C and fermentation was performed at 42 °C for 108 h in a bench scale horizontal rotary drum reactor of 50 l capacity with enzyme loading of 9 and 21 FPU/g substrate, respectively. Maximum ethanol yields were achieved with CellicCtec2 enzyme supplied by Novozymes i.e. 26.83 g/l with a conversion efficiency of 81%. While the in-house cellulases enzyme ethanol yields concentration was slightly lowered (23.45 g/l) with a conversion efficiency of 70.8%. Total energy requirement to produce 1 l ethanol from rice straw is approximately 8.4 kWh and the production cost for 1l ethanol is ₹ 270.

Green technology for production of cellulosic ethanol from crop residue

A natural deep eutectic solvents (NADES) were evaluated for the pretreatment efficiency of rice straw. After pretreatment with NADES, the cellulose content was increased from 40% to 68%, with a delignification efficiency of 72%. The high-purity lignin was extracted in a single step. Enzymatic hydrolysis and ethanol fermentation were carried out with neutral NADES reagents where the biocompatibility of cellulose degrading enzymes and ethanol fermenting yeast strains were established. Maximum concentration of reducing sugars reached up to 169 g/l and glucose 90.3 g/l with a saccharification efficiency of 51.7%, while the ethanol content were 36.7 g/l was obtained within 36 h with a conversion efficiency of 79.9%. The NADES reagent was recovered and reused for 3-pretreatment cycles and no significant loss in pretreatment efficiency was observed. An integrated green technology for biomass pretreatment and cellulosic ethanol production with other value added by-products such as lignin and xylan was established.

Crop cultivation under solar PV panels

Feasibility study of crop cultivation under solar panels has been carried out at JAU, Junagadh. Panel capacity of 7.2 kW (48 numbers) has been

installed in the field and spacing between each panel is adjusted to ensure maximum light intensity under the PV panels. The SPV structure installed had density of panel wattage of 46 W/m^2, which is around 44% less than that of conventional 1 kW rooftop system. Tomato crop (variety GT-1) has been cultivated with four treatments i.e. raised bed with drip, raised bed with mulching and drip, furrow cultivation with drip and control underneath structure and open field. Total tomato production inside and outside the structure were measured to be 315.33 kg and 309.33 kg, respectively. The cumulative electricity generated by the Agri-voltaic system during crop duration was observed to be 3026 kWh in five months with monthly electricity production variation of 736.7-874.3 kWh.

Technology Transfer

Technology Commercialization

Commercialization of agricultural engineering technologies through manufacturers, entrepreneurs and agro-industries is the prioritized activity of the institute to ensure their easy availability to the end-users for adoption at national level. During 2017-18, thirteen technologies were commercialized through technology licensing and three memorandum of agreement (MoA) were signed for technology transfer.

License agreement

Sl.No.	Name of Technology	Name of License/firm
1	Two-row tractor drawn mechanical planter for sugarcane bud chip/single bud settling raised in protrays	M/s Rohit Krishi Industries Pvt. Limited, Plot No. 3B + 3 Part / 2, D-1 Block, Opposite Ador Welding, Near Akurdi Chowk MIDC Chinchwad, Pune, MS
2	CIAE Stepwise Expanding Pitch Fruit Grader CIAE Power cum manual Operated Fruit and Vegetable Grader	M/s Shubham Agricultural Implements Private Ltd., Hardoi, UP
3	Three row seed cum fertilizer drill Two row seed cum fertilizer drill Power tiller drawn seed drill Power tiller drawn auger digger CIAE pedal cum power operated grain cleaner cum grader with or without motor	M/s Vasundhara Krishi Yantra, Bhopal Plot no. 4, Lambakheda, Berasia Road, Bhopal, MP
4	CIAE multipurpose grain mill CIAE pedal cum power operated grain cleaner cum grader with or without motor CIAE dal mill Pedal operated potato peeler Pedal operated potato slicer Solar cabinet dryer Groundnut decorticator (sitting type) Groundnut / sunflower decorticator with feeder & separator Maize Sheller	M/s Maa Durga Plastic Products, J-19, MIDC Phase 3, Akola-444 104 (MS)
5	Multipurpose Grain Mill 1 hp motor Motorized Dal Mill with 2 hp	M/s Shri Manak Industries, Bhopal, MP
6	Solar cabinet dryer	M/s Pragat Akshya Urja Ltd. Indore, MP
7	Solar cabinet dryer	M/s Hingloj Energy System Private Limited, Bhopal, MP
8	Pedal operated potato peeler Pedal operated potato slicer Multipurpose grain mill 1 hp motor Motorized dal mill with 2 hp motor	M/s Vasundhra Krishi Yantra, Bhopal, MP

Sl.No.	Name of Technology	Name of License/firm
9	Pedal cum power operated grain cleaner with motor Multipurpose grain mill 1 hp motor Manual 4 row rice drum seeder Manual hand ridger for women Manual rotary dibbler Manual twin wheel hoe weeder Manual double screen grain cleaner	M/s Swastik Agro Industries, Rajnandgaon, CG
10	Cono weeder Pedal Operated Potato Peeler Pedal Operated Potato Slicer Solar Cabinet Dryer & Motorized Dal Mill with 2 hp motor	M/s Swastik Agro Industries, Rajnandgaon, CG
11	Manual cono weeder Pedal cum power operated grain cleaner with motor Pedal operated potato peeler Pedal operated potato slicer Multipurpose grain mill with motor Motorized dal mill with 2 hp motor Manual 4 row rice drum seeder Manual double screen grain cleaner Sack holder	M/s Laxmi Steel Fabs., Sehore, MP
12	Multipurpose grain mill with motor Motorized dal mill with 2 hp motor	M/s Chaurasia Agro Industries, Chhatarpur, MP
13	Manual cono weeder Pedal cum power operated grain cleaner with motor Pedal operated potato peeler Pedal operated potato slicer Multipurpose grain mill with 1 hp motor Motorized dal mill with 2 hp motor Sack holder Manual double screen grain cleaner	M/s Ganga Industries, Dewas, MP

Memorandum of Agreement (MoA)

Sl.No.	Name of the Equipment/ Technology	Name of the Firm(s)
1	Moringa leaf stripper	• M/s Kancor Ingredients Ltd, Angamoly South, Ernakulam, Kerala
2	Millet mill – prototype II	• M/s Perfura Technologies (I) Pvt. Ltd., 7, Maruthamalai Gounder Layout, Ramakrishnapuram, Ganapathy, Coimbatore – 641 006, Tamil Nadu • M/s AVM Engineering Industries, No. 1/191, Vanniar Nagar, Meyyanur Main Road, Meyyanur, Salem – 636 004, Tamil Nadu

Sl.No.	Name of the Equipment/ Technology	Name of the Firm(s)
3	Solar lightening system with centralised battery charging unit.	• M/s Valampuri Industries, 2, Thiyagi Kumaran Street, PN Pudur, Coimbatore – 641 014, Tamil Nadu • MP Vigyan Sabha, Bhopal, MP

Linkages and Collaboration

Sl. No.	Organization	Collaboration
1	ICAR-VPKAS, Almora, Uttrakhand	For development of multi millet thresher for hills
2	ICAR-DMR, Ludhiana, Punjab	For development of mulcher-cum-planter for maize and wheat
3	Directorate of Health Services, Govt. of Madhya Pradesh	Memorandum of Understanding (MoU) for collaborative work on malnutrition of children
4	Women and Child Development Department, Government of Madhya Pradesh	Memorandum of Understanding (MoU) for strengthening the quality of nutritional care provided to children
5	Collectorate, Hoshangabad, Government of Madhya Pradesh	Memorandum of Understanding (MoU) for enhancing the nutritional status of local population by setting-up soybean processing centres in MP
6	NCPAAH, New Delhi	PFDC and Solar Powered Micro Irrigation Systems

Prototype Feasibility Testing

Sl. No.	Name of the Equipment/ Technology	No. of demonstrations/ feasibility trials conducted	Area covered in ha or hours of use	No. of farmers/ users familiarized/ benefitted
1	Millet mill – prototype II	5	19.5 h	~ 150
2	Multi millet thresher	2	60 h	100
3	Broad bed former-cum-seeder	1	2 ha	2
4	Tractor operated Pant - ICAR sub-soiler cum differential rate fertilizer applicator	2	1 ha	2

Frontline Demonstration

Sl. No.	Name of the Equipment/ Technology	No. of demonstrations conducted	Area covered in ha or hours of use	No. of farmers/ users familiarized
1	Package of practices for soybean JS-95-60	10	4	10
2	*Kharif* onion variety ADR	10	2	10
3	Demonstration of improved wheat variety RVW-4106	13	5.2	13
4	Tractor operated raised bed planter	10	5	50
5	Tractor operated inclined plate planter	5	5	15
6	Zero-Till Drill for heavy residue conditions	5	2.5	15
7	Zero-till drill	15	5	75
8	Garlic planter	15	8	75
9	Deep ploughing	20	15	125
10	Pedal cum power operated grain cleaner	25	12	60
11	Groundnut decorticator	35	15	90
12	Rotavator	15	5	50
13	Straw reaper	11	6	110

Cluster Demonstrations

1	Oilseed crop -Soybean JS-95-60	15	5	15
2	Oilseed crop – Soybean JS- 97-52	39	15.6	39
3	Oilseed crop – Soybean RVS 2001-4	18	7.2	18

Academia-Industry-Interaction Meets

Nagpur Meet

An Academia-Industry Interaction Meet was jointly organized by ICAR-CIAE and ICAR-CIRCOT, Mumbai at Ginning Training Centre, ICAR-CIRCOT, Nagpur on 11 January, 2018. The meet was organized under the aegis of Consortia Research Platform on Farm Mechanisation and Precision Farming (CRP on FM & PF) to provide a common platform for one-one interaction between researchers, industries, policy makers and other

stake holders. About 110 agricultural machinery manufacturers, researchers and policy makers from State and Central Government Ooganisations participated in this meet.

Raipur Meet

Another meet was organized in collaboration with Agricultural Engineering wing of the Department of Agriculture & Biotechnology, Govt of Chhattisgarh and the Indira Gandhi Agricultural University at Raipur during Rashtriya Krishi Mela 2018 on 25 January, 2018. The main aim of the meet was to prepare strategies and road map to provide boost to agricultural mechanization in the state of Chhattisgarh through deliberation among stakeholders including state Govt officials, scientists and faculty of ICAR and the State Agricultural University and the manufacturers of agricultural machinery. About 100 delegates participated in the interaction meet. Shri Brijmohan Agrawal, Hon'ble. Minister for Agriculture, Water Resources, Animal Husbandry and Fisheries, Govt of Chhattisgarh, was the Chief Guest.

Participation in Exhibitions

During 2017-18, ICAR-CIAE has participated in nine fairs and exhibitions organized in different parts of the country as shown below:-

Sl. No.	Conference, Seminar, Event and Place	Dates
1	Feed The Future – India Triangular Training programme Meet (FTT-ITT), at MANAGE Hyderabad	02 July 2017
2	National Skill Development Workshop, at NITTTR, Bhopal.	22 July 2017
3	Nutrition Mela: Nutrition Mela organized by Department of Integrated Child Development Department, Govt. of MP at Hoshangabad district.	11 Aug 2017

Sl. No.	Conference, Seminar, Event and Place	Dates
4	World Food India 2017: ICAR. New Delhi	03-04 Nov 2017
5	EIMA AGRIMACH INDIA 2017- Conference, held at IARI Pusa, New Delhi.	06-08 Dec 2017
6	India Industrial Fair (IIF) -2018 at Jaipur, Rajasthan	05-08 Jan 2018
7	Nutri Mela On International Women's Day at CIAE Bhopal	08 Mar 2018
8	National Conference on Promoting Entrepreneurial Growth through Innovative Approaches in Food Processing Sector held at ICAR-CIPHET, Ludhiana.	16-17 Mar 2018
9	*Krishi Unnati Mela* – 2018:at IARI, New Delhi	16-18 Mar 2018

Prototype Supply

During 2017-18, a total of 2463 following units of 52 different equipment were supplied to various stakeholders thereby, earning revenue of about ₹ 27 lakhs.

Implements	Implements
Maize Sheller	Animal drawn Inclined Plate Planter without Fertilizer Box
Manual Sickle	Animal drawn 3-row seed cum fertilizer drill
Manual Hand Ridger for women	Animal drawn Groundnut Digger
Manual Naveen Dibbler	Animal drawn two row seed drill
Manual Rotary Dibbler	Animal drawn two row seed drill (with Inverted T type furrow opener)
Manual Twin Wheel Hoe	Motorized Single Ear Head Thresher
Manual 4-row Rice Seeder	Motorized Multi crop Plot Thresher
Manual Cono Weeder	Motorized Dal Mill
Manual Peg Type Dry Land Weeder	Motorized Millet Thresher
Manual Groundnut Decorticator for women	Motorized Millet Mill
Manual Groundnut Decorticator (standing type)	Multipurpose Grain Mill with 1 hp motor
Manual Sack Holder	Multi fuel cooking stove
Manual Groundnut Stripper	Pedal cum power operated grain cleaner with motor
Manual Seed Drill PAU	Pedal operated Potato Peeler
Manual Grubber Weeder	Pedal Operated Potato Slicer
Manual Paneer Pressing Device	Fruit Grader
Manual Double Screen Grain cleaner	Solar Cabinet Dryer
Manual Cycle Wheel Hoe	Solar Tunnel Dryer
Manual Stalk Uprooter	Double Reflector Box type Solar Cooker
Hand Held Single Row Vegetable Transplanter	Vegetable Dryer
Hand Held Two Row Vegetable Transplanter	Tractor operated 6-row Inclined Plate Planter
Hand operated Potato Peeler	
Hand operated Potato Slicer	
Areca nut Sheath-Shredder	

Implements	Implements
Tractor operated 6-row Inclined Plate Planter without Fertilizer Box	Single row vegetable transplanter
Rotary assisted broad bed former-cum-seeder	Double row vegetable transplanter
Multi millet thresher	Manually operated protray type nursery seeder
	Hydraulically operated cone penetrometer

Radio Talks

Sl.No.	Name of institution	Subject	Date	Person
1	AIR, Bhopal	जल संचयन एवं सिंचाई प्रबंधन में संरक्षित खेती का योगदान	23 Mar 2017	DK Dwivedi
2	AIR, Bhopal	Orchard management in summer season	12 Apr 2017	RS Yadav
3	AIR, Bhopal	खरीफ फसलों की तैयारी और बुवाई हेतु उन्नत कृषि यंत्र	28 Apr 2017	DK Dwivedi
4	AIR, Bhopal	Vegetable and flower cultivation in green house	25 Sep 2017	RS Yadav
5	AIR, Bhopal	रबी फसलों की बुवाई हेतु उन्नत कृषि यंत्र	26 Sep 2017	DK Dwivedi
6	AIR, Bhopal	Importance of Mechanization in Agriculture	09 Jan 2018	UR Badegaonkar
7	AIR, Bhopal	किसान क्यों अपनाएँ ड्रिप सिंचाई पध्दति	09 Jan 2018	CK Saxena
8	AIR, Bhopal	1. Hello Gram Sabha (Live telecast) Jayad Phashalon Ki Unnat Kishme Evam Samayik Khrishikarya (Duration 30 minuts) 2. Recording on Irrigation and nutrient management in wheat crop to telecast for the farmers in Khrishi Charcha programme. (Duration 5 minuts)	11 Feb 2018	RD Soni

TV Talks

Sl. No.	Name of programme	Subject	Date	Person
1	*Anndata*, ETV MP	Insect and pest management in cucurbitaceous crop	25 May 2017	RS Yadav
2	*Anndata*, ETV MP	Composting of Biomass by NADEP PITS.	26 May 2017	RD Soni
3	*Anndata*, ETV MP	Improved production of technology of Black gram (Recording)	13 June 2017	RD Soni

Sl. No.	Name of programme	Subject	Date	Person
4	*Anndata*, ETV MP	Improved production of technology of Groundnut (Recording)	13 June 2017	RD Soni
5	*Anndata*, ETV MP	Weed control and nutrient management in groundnut	03 June 2017	RD Soni
6	*Anndata*, ETV MP	Fertilizer, weed,irrigation and pest management in Tomato	07 July 2017	RS Yadav
7	*Anndata*, ETV MP	Fertilizer, weed,irrigation and pest management in Brinjal	07 July 2017	RS Yadav
8	*Anndata*, ETV MP	Weeds, insets, diseases and water managements in sesamun (Til)	24 July 2017	RD Soni
9	*Anndata*, ETV MP	Weeds inset, disease and water managements in sesamun (Til) Black gram (urd) crop	24 July 2017	RD Soni
10	DDK Bhopal	Protected Cultivation	07 Sep 2017	KV Ramana Rao
11	*Anndata*, ETV MP	Advisory for the farmers on crops' protection from winter rains and hail storm (ओला वृष्टि) and contingency crop planning to reduce losses in yield and quality of crop produces	13 Feb 2018	RD Soni
12	DDK Bhopal	Live telecast programme on Zayad Ki Pramukh fasale Evam Sam Samayik Krsihi Karya (30 Minuts)	19 Feb 2018	RD Soni

Training and Capacity Building

International Training Programmes

An International Training Program on "Farm Mechanization for Small Farmers" was organized during 11 – 25 Apr 2017. The training program was part of the USAID sponsored "Feed the Future-Indian Triangular Training (FTF-ITT) Programme in which USAID, Government of India along with 11 African and 6 Asian countries are members.

Twentythree participants from nine countries namely, Botswana (3)Ghana (2), Kenya (3), Liberia (2), Malawi (3), Mozambique (2), Uganda (3), Afghanistan (2) and Mongolia (3), participated. The training emphasized sharing of knowledge related to appropriate mechanization of small farms in the developing countries using machines and technologies developed under ICAR umbrella. During the training, participants were exposed to various manual, animal operated, power tiller operated, tractor drawn and self-propelled machines along with post-harvest machinery and renewable energy gadgets suitable for the small farmers.

Another International Training Programme for African-Asian Rural Development Organization (AARDO) was organized on "Agricultural Engineering Technologies for Enhancing Productivity and Profitability in Agriculture Sector" during 24 Oct 2017 to 06 Nov 2017. The training programme jointly sponsored by AARDO and Ministry of Rural Development, GoI was attended by eight participants; one each from Bangladesh, Egypt, Lebanon, Malaysia, Palestine, Sri Lanka, Sudan and Zambia. During the training programme, the participants were exposed to technologies and equipment for agricultural production, irrigation and drainage, processing

and value addition and renewable energy through lectures, presentations, practical sessions, hands-on experience and field visits.

Summer School

ICAR sponsored Summer School on "Analytical, Instrumental and Imaging Techniques Relevant to Food Safety Management" was organized during 6 to 26 July 2017. A total of 23 scientists/ assistant professors from different ICAR institutes, SAUs, KVKs of varied disciplines (agricultural processing, food science and technology, microbiology, entomology and nutrition) belonging to 9 states participated in this program. Some of the major topics covered during the training programme were quality evaluation of food and agricultural products, various imaging techniques for food quality and safety evaluation, VOC sensors and their

application, mycotoxin control strategies for agricultural commodities, novel non thermal technologies for food safety, nanotechnology and food safety, sensory evaluation techniques, application of e-nose for food quality and safety evaluation, application of e-tongue and e-vision for food quality analysis, molecular biological techniques in food toxin/quality determination, anti-nutritional factor analysis in food, microbial evaluation of food, hyperspectral imaging technique for aflatoxin determination, traceability in food chain, food laws and regulation in India, near infrared spectroscopy-theory, instrument design and its application in food analysis.

Winter Schools

Winter School on "Climate Smart Agricultural Machinery for Conservation Agriculture" was organized during 06 to 26 Nov 2017. Eighteen participants ofdifferent disciplines such as farm machinery and power, soil and water conservation engineering, agronomy, soil science and plant physiologyfrom ICAR Institutes, SAUs and KVKs participated in this programme. Some of the major topics covered during the training programme were

conservation agriculture and residue management, climate smart agricultural machinery, conservation agriculture and climate change, no-tillage technology, watershed management and climate resilient sustainable farming, climate smart integrated farming systems, remote sensing, effect of elevated CO_2 and temperature on productivity, sensors and instrumentation for measurement of performance parameters of equipment, management of soil fertility for conservation agriculture, decision support and expert systems, biomass management, and field demonstration of climate smart agricultural machinery.

Winter School on "Start-up Opportunities Based on Agricultural Engineering Technologies" was organized during 01 to 21 Feb 2018. Fourteen participants of different disciplines from ICAR Institutes, SAUs and KVKs participated. The trainees were exposed to technologies and start-up opportunities related to farm mechanization, agro-processing and value addition, management and inter-personal skills as well as management of intellectual rights and properties from a galaxy of master trainers, management experts and subject matter specialists. The programme also offered plenty of hands-on practical sessions on agricultural engineering technologies and live demonstrations for confidence building and visit to various industries and market places for witnessing the functioning of start-up ventures.

Centre for Advanced Faculty Training

Centre for Advanced Faculty Training in the area of Food Processing has been sanctioned to ICAR-CIAE for capacity building of faculty and scientists of

NARS in the cutting edge areas of agricultural processing. Three training programmes were conducted under CAFT during this year.

The first CAFT training titled "Design and Manufacturing of Agro Processing Machines" was organized during 01 to 21 Aug 2017. Thirteen participants having engineering and technology background took part in this programme from ICAR institutes and SAUs belonging to 9 different states. Some of the major topics covered during the training programme were basic properties required for machine design, model development and their simulation, design consideration and methodologies of cleaner, grader, separators, dryers, material handling equipment, pulse milling and millet milling machinery, expellers and extractors, etc. Also the integration of sensors and controllers with prototype, basics of image processing, application of CAD and FEM in quality manufacturing of machines, advanced materials for food processing machines, material testing, BIS standards for selection of materials, applications of ergonomics for safe and proper design of machines, IPR of design and prototype of food processing machines. Various practical classes were conducted on software-based designing of components, image processing, sensor interface with software programs, advanced manufacturing process like CNC, EDM, plastic manufacturing , etc. prototype development in CAD, measurement of ergonomic parameters required for machine design.

The second CAFT training was organized during 04 to 24 Jan 2018 on "Advanced Storage and Packaging Technologies for Durable and Perishable Foods", attended by 10 participants. Major subjects covered were drying and handling of food grains for safe storage; modern grain storage structures; design of grain storage structures & associated equipment; effective fumigation for safe storage of grains in bagged/ bulk cargo; cold storage & evaporative cooled storage structures; pack house design and developments; types and applications of different packaging materials; controlled & modified atmosphere, active and intelligent packaging for perishable foods; aseptic packaging techniques; cryo-preservation of foods; storage techniques for onion and potato; packaging of dairy and flesh foods; use of sensor networks and other instrumentation in storage; quality control & pest management in grain storage warehouses; microbial safety in stored foods; food safety standards and regulatory frameworks in India.

The third CAFT training was organized during 20 Feb 2018 to 12 Mar 2018 on "Improved Nutritional Outcomes through Integrated Approaches of Processing", it was attended by 10 participants from ten different states of varied background.

Lectures and practical, covered subject area of food processing, food nutrition, food safety and other relevant areas like entrepreneurship in food industries, food plant economics, food microbiology, etc. There were external faculties from reputed Institutes to offer lectures to the participants. Besides lecture and practical classes, visit to food industries was also organized.

Model Training Courses

Two Model Training Courses (MTC) of one week each were organized during 04 to 11 Oct 2017 and 15 to 22 Dec 2017 for total 37 agricultural officers and extension functionaries of Agriculture and line departments of various States represented 11 States such as: Assam, Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Tamil Nadu, Uttarakhand, Uttar Pradesh & West Bengal. The trainings were sponsored by the Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture" andFarmers Welfare, Government of India, New Delhi. The first training entitled as "Advanced Agricultural Machinery for Production and Post Production Agriculture' in which 20 participants were participated. During the course of the programmes, the trainees were exposed to technologies related to farm mechanization, agro-processing and value addition. The second training entitled as "Women Friendly Technologies for Agricultural Production and Processing Operations" in which 17 participants were participated. During this training the trainees were get acquainted with the women friendly agricultural production and processing technologies suitable for women workers. Both the programmes were included with plenty of hands-on practical sessions and live demonstrations which were very much helpful to participants to learn the technologies.

HRD Programme for Technical Personnel of NARS

A ten-days training programme on "Selection, adjustment, operation and maintenance of agricultural implements for field and horticultural crops" was conducted during 1-10 Aug 2017, participated by 30 technical staffs from fifteen ICAR institutes and one from State Agricultural University participated in this training programme. The training programme consisted of lectures,

laboratory visits and field demonstration, hands-on practical training as well as group discussions on improved farm machinery for conducting all major agricultural and horticultural operations including conservation agriculture, post-production technology, efficient energy utilization, modern irrigation and drainage technology, protected cultivation technology, testing of agricultural implements for quality control and custom hiring of agricultural machinery. The participants had the opportunity to visit e-Chaupal of ITC Ltd.; CFMT&TI, Budni; Eicher Tractors Ltd., Mandideep, Bhopal and ICAR-IISS, Bhopal.

HRD Programme for Drivers of ICAR

Training programmes on "Automobile Maintenance, Road Safety and Behavioural Skills" were organized for drivers in technical grades of ICAR institutes/HQ for three batches during 18-22 July, 2017 (31participants); 19-23 Sep, 2017 (30 participants) and 27 Nov to 1 Dec, 2017 (26 participants). Different sessions of the training program covered issues like road safety and traffic management, insurance claim guidelines, effective maintenance of motor vehicles, effective behavioural and communication skills for vehicle drivers, fuel economy and conservation, general traffic rules, road safety guidelines and motor vehicles act, periodical and preventive maintenance of vehicles, breakdown diagnostic management during outside running of vehicles and management of vehicle section with logbook, indent and route management and interaction with automobile manufacturers.

Training on Ergonomical Design Guidelines

Training programme on Ergonomical Design Guidelines for Agricultural Tool, Equipment and Work Places was organized during 16-18 May, 2017. Total 14 participants including 4 from industry, 5 from ICAR institutes, 4 from SAUs and one from national institute attended the training programme. The training programme comprised of exposure to holistic approach of designing agricultural implements, and workplaces of tractors and self-propelled implements. Special emphasis was given on ergonomical considerations during the design process with due incorporation of limits with respect to anthropometric body dimensions and strength values of Indian workers, safe limits of environmental aspect such as vibration, noise, dust, chemical and ambient conditions. Participants were provided first-hand experience through examples of designing the machinery or workplace using ergonomic principles through participatory learning.

Training on Manufacturing of Processing Machinery for manufactures of Rajasthan

This training for seventeen small-scale manufactures of agricultural machinery from Rajasthan was organized during 24–29 July 2017. Manufactures were updated in understanding CAD drawings, measuring systems, marking, manufacturing aids and material selection. They were provided inclusive hands-on training in fabrication of tubular maize sheller, power operated grain cleaner, fruit grader, power operated dal mill, manually operated cleaner, sack holder, pedal operated potato peeler and slicer,

manually operated groundnut decorticator, vegetable dryer, soybean dehuller, cottage scale soy paneer plant, manually operated paneer pressing device using latest manufacturing technologies. Beside this, live demonstration of processing machinery was also arranged at the Agro-Processing Centre.

Hands-on Training for Farmers on Improved Agricultural Implements and Machinery

About 700 farmers in 12 different batches from states such as Madhya Pradesh, Gujarat, Bihar, Jharkhand, Maharashtra, Andhra Pradesh, Uttar Pradesh, Kerala, West Bengal and Odisha participated in 'Hands-on Training for Farmers on Improved Agricultural Implements and Machinery'. During the training, participants were updated on farm mechanization and agro-processing technologies. Operation-wise implements required for seed bed preparation, sowing/planting and transplanting, spraying, interculture as well as harvesting and threshing were demonstrated. Women-friendly tools/ implements, conservation agriculture machinery, and bullock drawn machinery and covered cultivation techniques for crop production were also demonstrated.

Asimilar training was organized on 5-7 Oct, 2017 at Regional Centre, Coimbatore. About 90 farmers/ custom hiring operators/ entrepreneurs of Coimbatore, Erode and Thirupur districts of Tamil Nadu participated.

Training on Operation and Maintenance of Agricultural Machinery

At Regional Centre, Coimbatore, training on "Operation and Maintenance of Agricultural

Machinery" was organized during 5-7 Oct, 2017. About 90 farmers/ custom hiring operators/ entrepreneurs of Coimbatore, Erode and Thirupur districts of Tamil Nadu participated. During the training, participants were briefed on updates of technologies on farm mechanization and agro-processing. They were given hands-on training including demonstrations of improved agricultural technologies, necessary adjustments as well as visits to different laboratories to get exposure to different available agricultural technologies. Demonstration of operation-wise implements required for seed bed preparation, sowing/planting and transplanting, spraying, interculture as well as harvesting and threshing were given. Women-friendly tools/ implements, conservation agriculture machinery, and bullock drawn machinery were also demonstrated. Covered cultivation techniques for crop production were also demonstrated.

Skill Development Programmes

During this year, three skill development training programmes as per the guidelines of Agricultural Skill Council of India, NSDC were organized.

Green House Operator: The first skill development programme on 'Green House Operator' was organized in two batches during 15 Jan to 13 Feb, 2018 and 6 Feb to 9 Mar, 2018. Total 52 rural youth from Bhopal and neighbouring districts participated. The participants were provided with class room lectures followed by practical classes on

various operations involved in green house cultivation and management of crop canopy under greenhouse conditions. They were also taught about occupational health issues, basics of computers, precautions to be taken up while connecting electrical systems, etc. Three exposure visits were organized by taking them to greenhouse manufacturing industry, drip lateral manufacturing industry and to farmers' field where the green house cultivation is being practiced. These programmes are organized as per the guidelines of Agricultural Skill Council of India, NSDC.

Tractor Operator: The second skill development programme on 'Tractor Operator' was organized during 27 Feb to 24 March, 2018, attended by 20 participants. The skill development programme was targeted to impart skill of operation and

maintenance of tractor and field operation of primary tillage, secondary tillage, Sowing & Planting, Interculture & plant protection, harvesting & threshing machinery and tractor trailer. The participants themselves practically carried out all the field operations using tractor and farm machinery facility available at the Institute. Exposure visits were also conducted during 200 h training programme, spread over 25 days. For certification of participants, Assessment of participants was conducted, through agency designated by Agricultural Skill Council of India (ASCI).

Harvesting Machine Operator: The third skill development programme on 'Harvesting Machine Operator' was organized during 27 Feb to 24 Mar, 2018. 20 farmers participated in the training from Bhopal, Devas, Vidisha dist. The training programme consisted of lectures, laboratory visits and field demonstration, hands-on practical training as well as group discussions on combine harvester. Major topics covered were operation of advanced features of modern Combine Harvester, on-field repair and maintenance, pre-operational checks adjustments and setting of cutter bar, thresher drum and other movable parts according the crop to be harvested, driving skills, etc.

Enhancement of awareness of food uses of soybean for nutrition purpose

To enhance the nutritional status of pre-school children of Hoshangabad district, a presentation entitled 'Food uses of soybean to enrich food products for malnourished children of Hoshangabad district' in the 'Sneh Sarokar Sammelan' at Itarsi was made to educated Atal Bal Palak and officials of WCD organised. The

interactions convinced the District Collector and WCD officials to provide soybased nutritious foods in nutrition feeding programmes. SHG members of study area were trained to prepare soybased food products for Aanganwadi children. To create awareness regarding processing of soybean for food uses, two programmes were organized for rural women and official of WCD in study area (Hoshangabad rural and Pipariya block).

Conservation Agriculture

Seven training cum demonstration programme were conducted under Consortium Research Platform on conservation agriculture during 21 Sep, 2017 to 17 Mar 2018. A total 467 farmers from Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Madhya Pradesh, Maharashtra, Rajasthan and Uttarakhand participated in the programme. Machinery like laser leveller, no-till drill, happy seeder, rotary disc bed farmer cum seeder planter, stubble saver (rotary chopper cum spreader) and rotary slit till drill were demonstrated to them.

Other Trainings

Sl. No.	Title of the Training Programme	Dates	No. of participants
1	Entrepreneurship Development for custom hiring of agricultural machinery as an enterprise(sponsored by Government of MP).	04-09 Sep 2017 03-09 Oct 2017 06- 11 Nov 2017 18- 23 Dec 2017 05-10 Feb 2018 12-17 Mar 2018	Total 194 participants in 6 batches.
2	Entrepreneurship Development Programme on soymilk and tofu	24-29 Apr 2017 12- 17 June 2017 31 July- 05 Aug 2017 21-25 August, 2017 23- 28 Oct 2017 11-16 Dec 2017 19-24 Feb 2018 19-24 Mar 2018	Total 125 participants in 8 batches.
3	Entrepreneurship Development Programme on soy-atta and bakery products.	12-17 June 2017 19- 22 July 2017 19- 24 Feb 2018 19-24 Mar 2018	Total 5 participants in 5 batches.
4	Farm mechanization for established agripreneurs (in collaboration with National Institute of Agricultural Extension Management, Hyderabad).	28 June-01 July 2017 06-09 Nov 2017	Total 52 participants in 2 batches.
5	Protected cultivation of horticultural crops.	17 - 18 Aug 2017 23-24 Aug 2017 26 Aug 2017	Total 78 participants in 2 batches. Total 51 farmers in 1 batch.
6	Field Days on Conservation Agriculture Machinery	17 Oct 2017 13 Dec 2017 28 Feb 2018	A total 244 farmers in 3 batches.

Training Organized by Krishi Vigyan Kendra (ICAR-CIAE, Bhopal)

Sl. No.	Title of programme	Dates	Duration, days	Total
1	Farm machinery, post-harvest technology, High tech horticulture and crop cultivation,	19 May 2017	1	50
2	Farm machinery, post-harvest technology, High tech horticulture and crop cultivation,	30 May 2017	1	39
3	Utilization of crop residue for nutrient management in kharif crops and drainage management in crops field	20 May 2017	1	39

Sl. No.	Title of programme	Dates	Duration, days	Total
4	Soybean production technology and utilization of polluted water and crops residue in kharif crops at village *Barkhedi Abdulla* (*Phanda*) Bhopal	22 May 2017	1	37
5	Red gram production technology and water management practices	23 May 2017	1	20
6	Farmers training on crops residue management and efficient utilization of agro chemicals in kharif crops	25 May 2017	1	16
7	Seed treatment and sowing techniques of kharif crops and its advantages	22 June 2017	1	27
8	Improved soybean production technologies	24 June 2017	1	14
9	Cultivation technology of kharif onion	27 June 2017	1	10
10	Production technologies of soybean and utilization of improved machineries	28 June 2017	1	08
11	Improved production technologies of soybean and red gram	29-30 June 2017	2	26
12	Training on seed treatment, sowing techniques and weed control of soybean and maize crop	03-04 July 2017	2	19
13	Training on soybean and maize production technologies	05-06 July 2017	2	19
14	Farmers training on improved production technology of soybean and black gram crops	07 July 2017	1	22
15	Farmers training on agronomic practices and improved technology of soybean & maize crops	10-11 July 2017	2	22
16	(i) Role of soil testing in soil fertility management with practical (ii) Cropping system based nutrient management and role of balance nutrition on soil health management, crop production and quality of produces under rice wheat cropping system	17-18 July 2017	2	30
17	Kharif crop management techniques and field crops inspections for trainees of agri clinic Agri Business (ACBC)	28 July 2017	1	31
18	Pest management in sponge gourd	28 Sep 2017	1	11
19	Onion cultivation technology in this training programme	15 Nov 2017	1	15
20	Training of field staff of department of agriculture Bhopal on oil seed crop production technologies and crops mechanization	21-22 Dec 2017	2	25
21	Advanced agricultural technology and mechanization to increase agricultural income	27-31 Jan 2018	5	22

Sl. No.	Title of programme	Dates	Duration, days	Total
22	सोयाबीन का दुध, पनीर, सोयाबीन का दैनिक भोजन में उपयोग, विषय पर ग्रामीण महिलाओं को प्रशिक्षण।	20 Feb 2018	1	35
23	Advanced agricultural technology for agricultural production and processing.	23-27 Feb 2018	5	15
24	दैनिक आहार में सोयाबीन का उपयोग, न्यूट्रीस्मार्ट विलेज की महिलाओं को प्रशिक्षण	26-27 Feb 2018	2	33
25	Advanced agricultural technology for soybean production and processing district Usmanabad, MS organized by Development Foundation, New Delhi	05-07 Mar 2018	3	27
26	Capacity Building Training Programme on "Enhancing farm income through farm mechanization and custom hiring entrepreneurship". 30 KVKs Officers were participated. it was jointly organized by RVSKVV, Gwalior & KVK Bhopal	13-14 Mar 2018	2	30
27	Farmers training on plant production jointly organized by Hindustan Insecticide Ltd. and KVK CIAE, Bhopal	28 Mar 2018	1	165
28	Farmers training on soybean production technologies and mechanized sowing of soybean on raised bed system in village Tarawali kala	23 June 2017	1	27
29	Weeds & pest control in soybean crop	29 July 2017	1	28
30	Plant protection techniques in soybean	06 Aug 2017	1	12
31	Plant protection techniques in soybean	06 Aug 2017	1	13
32	Eradication of parthenium awareness	19 Aug 2017	1	35
33	Farmers training on horticulture crops production technology organized by PD, ATMA, Bhopal & KVK, Bhopal	17 Nov 2017	1	70
34	Training of woman farmers & school dropout girls on Vermicomposting & vermi culture	12 Feb 2018	1	25

Other Activities

Mera Gaon Mera Gaurav activities

Under this activity, the 16 groups of scientists from ICAR-CIAE covered 5029 farmers in 64 villages. One hundred thirteen visits; 129 demonstrations of different machinery and technology and 132 meetings with farmers were carried out by all groups. Total numbers of beneficiaries covered were 5029.An awareness and sensitization programme on sanitation was organized in the MGMG adopted village. Demonstration of rotavator, maize sheller, cono weeder, straw collection through straw combine, drip and fertigation, spiral grader, safety gadgets for operating tractor and farm equipment besides other improved equipment were conducted in the adopted villages.Farmers were advised to wear safety goggles, hand gloves, nose mask during fertilizer and chemical applications.

Many technologies were demonstrated to the farmers at the institute during mela and other visits at campus. On campus demonstrations of renewable energy technologies were conducted to the farmers of MGMG villages on Improved cook stoves, solar power potato slicer, solar pumping system, solar photovoltaic electricity generation and

storage systems, biogas plants and their maintenance, electricity generation from biogas, biomass charring and briquetting technologies, solar dryers, etc. about 150 farmers participated in demonstration. Awareness programme on solar pump operation and maintenance andnutritional camp for children and women were also organized. Scientists of regional centre at Coimbatore also conducted visits and demonstrations of appropriate machines to villages covered under MGMG programme.

Sl. No.	"Mera Gaon Mera Gaurav"	Number	Beneficiaries (No.)		
			SC/ST	Others	Total
1	No. of villages covered	64	307	1595	1931
2	No. of visits made	113	230	1057	1287
3	No. of demonstrations	129	144	613	757
4	No. of farmers' meeting	132	132	923	1054
	Total	**535**	**813**	**4188**	**5029**

Human Resource Development

Scientists

Sl. No.	Name of employee	Designation	Name of training programme attended	Duration	Place
1	AE Kate	Scientist	Ergonomical design guidelines for agricultural tools and equipment	16-18 May 2017	ICAR-CIAE, Bhopal
2	AE Kate	Scientist	Innovative food processing and packaging technologies	04-09 Dec 2017	NIT, Rourkela
3	Ajesh Kumar	Scientist	Innovative food processing and packaging technologies	04-09 Dec 2017	NIT, Rourkela
4	AK Nayak	Scientist	Advanced remote sensing & GIS applications in ILRM	17-29 July 2017	ICAR-NBSS&LUP, Nagpur
5	AP Pandirwar	Scientist	Experimental designs and statistical data analysis	11-20 Sep 2017	ICAR - IASRI, New Delhi
6	BM Nandede	Scientist	advanced statistical tools and techniques for modelling and forecasting of agricultural data	08-28 Nov 2017	ICAR - IASRI, New Delhi

Sl. No.	Name of employee	Designation	Name of training programme attended	Duration	Place
7	Bikram Jyoti	Scientist	Professional attachment training for ARS probationers	22 May-01 Aug 2017	CSIR-NPL, New Delhi
8	CP Sawant	Scientist	Machinery for conservation agriculture for mitigation and adaptation of climate change	05-25 Sep 2017	ICAR-IIFSR, Modipuram
9	Dileep Jat	Scientist	Climate Smart Agricultural Machinery for Conservation Agriculture.	06-26 Nov 2017	ICAR-CIAE, Bhopal
10	HS Pandey	Scientist	Machinery for conservation agriculture for mitigation and adaptation of climate change	05-25 Sep 2017	ICAR-IIFSR, Modipuram
11	KV Ramana Rao	Pr. Scientist	Training of Technical Members of BIS	01-02-Feb 2018	NIT, Noida
12	Manoj Kumar	Scientist	Statistical Advances for Agricultural Data Analysis	03-23 Mar 2018	ICAR - IASRI, New Delhi.
13	Harsha Wakudkar	Scientist	Production of Bio CNG and Organic Manure through Anaerobic Agro-waste Decomposition Technique	10 -30 Aug 2017	DFRS, Bhilwara, Rajasthan
14	Mukesh Kumar	Scientist	Advances in Nutrient dynamics for improving nutrient and water use efficiency of crops	05-14 Sept 2017	ICAR-IISS, Bhopal
15	NS Chandel	Scientist	ANTAM test code on rice transplanting	11-16 Sept 2017	CSAM, Nanning, China
16	NS Chandel	Scientist	Advanced Statistical Tools and Techniques for Modelling and forecasting of agricultural Data	8-28 Nov 2017	ICAR - IASRI, New Delhi.
17	Yogesh Rajwade	Scientist	Agricultural System Modelling to Assess Climate Change Impact in Soils and Crops	16-25 Jan 2018	IISS Bhopal
18	Swapnaja Jadhav	Scientist	Design and Manufacturing of Agro-processing Machines	01-21 Aug 2017	ICAR - CIAE, Bhopal
19	Sweeti Kumari	Scientist	Design and Manufacturing of Agro-processing Machines	01-21 Aug 2017	ICAR - CIAE, Bhopal
20	Sweeti Kumari	Scientist	Ergonomical design guidelines for agricultural tools and equipment	16-18 May 2017	ICAR-CIAE, Bhopal
21	Syed Imran	Scientist	Climate Smart Agricultural Machinery for Conservation Agriculture	06-26 Nov 2017	ICAR-CIAE, Bhopal

Sl. No.	Name of employee	Designation	Name of training programme attended	Duration	Place
22	Uday R Badegaonkar	PS & I/c KVK	Conservation Agriculture Facilitating Entrepreneurship through Skill Development for Augmenting Farm Family Income	17-19 Nov 2017	KVK, Jhabua
23	Abhishek Waghaye	Scientist	Agricultural System Modelling to Assess Climate Change Impact on Soils and Crops	16-25 Jan 2018	ICAR-IISS, Bhopal

Technical Staff

Sl.No.	Name	Designation	Name of training programme attended	Duration	Place
1	Prabir Kumar Das	Technical Officer	Electrical Control & Relay Logic Application	15-19 May 2017	CRISP, Bhopal
2	G Muruganandam	Sr. Technical Officer	Selection, Adjustment, operation and maintenance of Agricultural Implements for field and Horticultural crops	01–10 Aug 2017	ICAR-CIAE, Bhopal
3	M Mohan	Sr. Technical Officer	Selection, Adjustment, operation and maintenance of Agricultural Implements for field and Horticultural crops	1–10 Aug 2017	ICAR-CIAE, Bhopal
4	Ragini Choudhary	Sr. Technician	KOHA for Library Staffs of ICAR	05-09 Feb 2018	ICAR – NAARM, Hyderabad
5	RD Soni	Sr. Technical Officer	Enhancing from Income though farm Mechanization and custom hiring entrepreneurship jointly organized by DES, RVSKVV, Gwalior and KVK, ICAR-CIAE, Bhopal	13-14 Mar 2018	KVK (ICAR-CIAE), Bhopal
6	RD Soni	Sr. Technical Officer	Recent Extension approaches for effective transfor of technology organized by EEI, AAU, Anand, Gujrat and RVSKVV, Gwalior	19-21 Mar 2018	KVK, Indore

Administrative Staff

Sl. No.	Name	Designation	Name of training programme attended	Duration	Place
1	Lokendra Soni	Stenographer Grade III	Workshop on MS-Excel	13-15 Sep, 2017	ISTM, New Delhi
2	Haridas G Menon	Personal Assistant	Enhancing Efficiency and Behaviour Skills for Stenographers, PSs, PAs, etc.	25-31 Oct 2017	ICAR-NAARM, Hyderabad

PG School Activities

Twelve students were added during the session 2017-18, six in Farm Machinery and Power and six in Agricultural Processing and Structures disciplines. The course work for new students and research work for senior students is going on with their allotted research guides. The monitoring and timely submission of Plan of Proposed Work (PPW) and Outline of Research Work (ORW) is being ensured by PG School coordinators on the allotted topics. PhD scholars participated in various activities other than academics such as participation in national and international conferences and seminars, celebration of CIAE Foundation day and Agricultural Education day. One student gave presentation in International conference entitled "Twenty Ninth Annual Congress-2017 of the Post Graduate Institute of Agriculture (PGIA)" at University of Peradeniya, Sri Lanka. One student gave oral presentation in 30th National Convention of Agricultural Engineers and National Seminar and received first prize. Eight students delivered oral and poster presentations in 52nd ISAE Annual Convention at AAU, Anand, Gujarat.

Awards and Recognition

- Dr. Krishna Kumar Singh, Director of the Institute has been awarded Rafi Ahmed Kidwai Award for Outstanding Research in Agricultural Sciences for the year 2016 for Natural Resource Management & Agricultural Engineering. Dr. Singh has made original contributions on the application of cryogenics in food processing for retention of aroma in spice grinding. He developed number of need based food processing machines like, small capacity dryer for fruits and vegetables, potato peeler and slicer, power operated peanut sheller, expanding pitch type fruit grader for small entrepreneurs/ farmers. These machines have been helpful in reducing the drudgery and enhancing efficiency of operations, and some of these machines have been adopted by the small scale processors/ farmers.

- Dr. Ashutosh P. Pandirwar received "Young Scientist Award" as well as "Fellowship of Young Scientist Training" of Madhya Pradesh Council of Science and Technology for development of automatic vegetable transplanter for plug type seedlings.

Name	Award/ Recognition name	Sponsor
CR Mehta	Vice President (Technical Council)	ISAE, New Delhi
T Senthilkumar	ISAE Commendation Medal	ISAE, New Delhi
SK Chakraborty	Distinguished Service Award	ISAE, New Delhi
Ravindra Naik	Best Poster award	ISAE, New Delhi
AK Nayak	Best oral presentation	National conference on Digital and Engineering Technologies for Precision Agriculture and Value Addiction held in CAE, Bapatla
Dawn CP Ambrose	First prize in the Poster presentation	National Conference on "New Vistas in Vegetable Research towards Nutritional Security under changing climate Scenario' held at TNAU, Coimbatore
D Mohapatra	Outstanding Reviewer	Journal of Food Chemistry, Elsevier
Harsha Wakudkar	Best oral presentation	National seminar on climate change EPCO, Bhopal
R Senthil Kumar	Gold Medal for Best Research compendium (Agri. Extension discipline)	Third National Conference on Agricultural Scientific Tamil held at TNAU, Coimbatore
RK Sahani	Best oral presentation	National conference on Digital and Engineering technologies for Precision Agriculture and Value at CAE, ANGRAU, Bapatla, AP
Sadvatha RH	First prize in the Oral presentation	International conference on Emerging Synergies in Agriculture, Food process Engineering and Bio Technology" at Karunya Institute of Technology and Sciences, Coimbatore

Ph.D. Awarded to staff

Name and Designation	University	Thesis title	Date of award
AE Kate, Scientist	G. B. Pant University of Agriculture and Technology, Pantnagar	Development of microwave assisted leaching based integrated oil and protein extraction technology and its kinetics for black soybean	06 July 2017
Bikram Jyoti, Scientist	ICAR – IARI, New Delhi	Design and Development of Electrostatic Sprayer	02 Dec 2017
Dilip Jat, Scientist	MPUAT, Udaipur	Influence of Different Parameters of Dual Tyne on Two Stage Fertilizer Application for Broad Bed Cultivation in Vertisols	13 Sep 2017
DA Pawar, Scientist	Mahatma Phule Krishi Vidyapeeth, Rahuri	Standardization of Process Technology for Jaggery Granules and Cubes	26 Mar 2018

Intellectual Property and Consultancy

Patents filed

Sl. No.	Application no. allotted by the Patent Office	Title	Progress Made
1	1711/MUM/2013	Process Technology for Utilization of Digested Biogas Slurry for Cellulose Production	Examination fee is paid vide CBR No. 10999 dated 09 May 2017
2	1714/MUM/2013	Power cum manual operated fruits and vegetables grader developed	Examination fee is paid vide CBR No. 11167 dated 11 May 2017
3	2435/MUM/2013	Process technology for multi nutrient composite mix for biscuits	Examination fee is paid vide CBR No. 14874 dated 17 July 2017
4	2436/MUM/2013	Continuous feed aloe vera whole gel extraction equipment	Examination fee is paid vide CBR No. 14875 dated 17 July 2017
5	4562/MUM/2015	AONLA seed removing and segmentation equipment - Mechanical Model	Abstract published in official journal of patent office Issue No. 23/2017, dated 09 June 2017
6	201621001885	Process Technology for Production of Pro-Biotic Soya Cheese Spread	Abstract published in official journal of patent office Issue No. 29/2017, dated 21 July 2017

Consultancy/ Contract/ collaborative Projects

The institute has signed Memorandum of Understanding (MoU) with following six organisations for undertaking research and commercialisation of technology in collaborative mode

Sl. No.	Institutions signed MOU	Collaborative Research
1	National Health Mission (NHM), Govt. of MP, Bhopal	Improving micro-nutrient content and calorific provisions for the child with SAM during stabilization phase
2	Department of Women and Child Development, Govt. of MP, Bhopal	For strengthening of quality of nutritional care provided to children through AWC's by strengthening and improving the Supplementary Nutrition programme (SNP)
3	Integrated Child Development Services (Hoshangabad district), DWCD, Govt. of MP	To enhance the nutritional status of local population of the selected area on sustainable basis. This would include information on concepts of nutrition, soybean utilization, and available modern soybean processing equipment, dissemination of technology / machinery, their availability and operation. Training and capacity building of rural women, extension functionaries, self-help group members and potential rural youth willing to set-up soybean processing centres in the state of Madhya Pradesh

Sl. No.	Institutions signed MOU	Collaborative Research
4	ICAR - NRC Banana, Tiruchirapalli.	For Development of banana sucker paring equipment, pseudo stem injector, bunch harvester and pseudo stem outer sheath plate making equipment
5	Madhya Pradesh Vigyan Sabha, Bhopal	Establishment of Solar Powered Village Lighting system at Gaildubba, Tamia Block, Chhindwara District of MP
6	Directorate of Agril Engg., Govt. of MP and M/s Veda Farms Implements, Bhopal and	For popularization and commercialization of CIAE technologies through Govt. of MP, Directorate of Agricultural Engg. Followed by their commercialization through M/s Veda Farm Implements Ltd

Copyrights

Sl. No.	Title	Author	Owner	Registration No. / Date	Status
1	Software Applications on Images of Plant Parts and Plant Varieties	Karan Singh & N Kotwaliwale	ICAR-CIAE, Bhopal	SW-9939/2018, Dated 09 Oct 2018	Granted
2	Software for capturing the image, shape and size features of plant part"	N Kotwaliwale & Karan Singh	ICAR-CIAE, Bhopal	11423/2017-Co/SW, Dated 02 Aug 2017	Filed

Commercial testing of farm machinery

The institute is recognised by Department of Agriculture and Cooperation, GoI as a Farm Machinery Testing Centre. Machine manufacturers, large as wel as small, of all over India approach the institute to get their machines tested according to BIS standards. Testing facility is available at Bhopal main campus as well as at its regional center at Coimbatore. The facility is well equipped with a broad range of instruments to provide precision measurement capabilities. The areas of expertise of CIAE are tillage, sowing/planting, plant protection equipment, harvesting, threshing machinery and variety of manualy operated small tools and equipment testing. The center has tested 95 agricultural machinery under different equipment category and generated revenue of Rs. 54.72 lakhs at Bhopal and Rs. 9.88 lakh at Coimbatore during financial year 2017-18.

Equipment category	Number
Land development, tillage & seedbed preparation	35
Sowing and planting	28
Inter-cultivation	2
Plant protection equipment	9
Harvesting and threshing	8
Residue management	3
Post-harvest and agro processing	5
Hand tools	5
Total equipment tested	**95**

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Events

Swachhta Pakhwada

The Swachhta Pakhwada was observed twice in 2017-18, i.e during 16-31 May, 2017 and 15 September to 2 Oct, 2017. Following were the major activities conducted during these programmes:

Swachhta Pledge; Cleanliness drive in the institute,nearby government school, police station and tourist spot; Awareness programmes on sanitation and agricultural waste management in village Nabi Bagh, Barkhedi Abdullah and Prempura; Programme on sanitation and effective use of impure water in agriculture for farmers of village Pipaliya Dhakad and Borkhedi; Tree

plantation; Debate, slogan, poster and banner competitions; Address by the dignitaries like Shri Alok Sanjar, Hon'ble Member of Parliament, Bhopal, Shri Rodmal Nagar, Hon'ble Member of Parliament from Rajgarh and MLAs from Biaora, Rajgarh, and Khilchipur and other senior government officials.

Manufacturers' Meet

Manufacturers' Meet with the manufacturers of Madhya Pradesh was organized on 2 Aug, 2017 in collaboration with Directorate of Agricultural Engineering, Government of Madhya Pradesh, Bhopal. Over 250 delegates including 150 manufacturers, officials from Directorate of Agricultural Engineering and Scientists from the CIAE participated. The participants were made aware of various technologies available with the institute for technology licensing. Shri Rajiv Choudhary, Director, Agricultural Engineering, Govt. of MP was the Chief Guest.

Sankalp Se Siddhi: New India Manthan

Krishi Vigyan Kendra, ICAR-CIAE organized "Sankalp Se Siddhi: New India Manthan (2017-2022)" programme on 29 Aug, 2017. Shri Alok Sanjar, Hon'ble Member of Parliament, Bhopal graced the occasion as Chief Guest. Government officials from different departments were present as

Experts for delivering a talk on different avenues for doubling the farmers' income. The programme was attended by about 800 farmers from different villages of Bhopal district, besides more than 100 participants from State Government, Private organizations, Non-Government and press and media.An exhibition for the farmers was also organized at this occasion, where agriculture, agricultural engineering, veterinary and horticulture department of State Government also displayed various technologies and details of different programmes and schemes of Government and provided the leaflets/folders of those schemes.

हिन्दी पखवाड़ा का आयोजन

संस्थान में दिनांक 14 से 28 सितम्बर 2017 तक हिन्दी पखवाड़ा का आयोजन किया गया। प्रथम दिन पखवाड़े के उद्घाटन के अवसर पर बोलते हुए संस्थान के निदेशक डॉ. के. के. सिंह ने कहा हिन्दी विश्व की चौथी सर्वाधिक प्रयोग किये जाने वाली भाषा है जिसे देश के शिक्षित प्रदेशवासी कामकाज के तौर पर प्रयोग करते है। कृषि तथा कृषि संबंधी कार्यलयीन कार्यो में हिन्दी का प्रयोग निरन्तर किया जा रहा है, अतः कृषि संबंधी अधिकाधिक लोकप्रिय लेख, शोध पत्र व अन्य साहित्य हिन्दी में अनुवाद कर तैयार किया जाना चाहिए। इस पखवाडे के दौरान हिन्दी का वैज्ञानिक कार्यों मे बढावा देने के लिए विभिन्न कार्यक्रमों जैसे – प्रश्न मंच, सामान्य

हिन्दी (लिखित प्रतियोगिता), वाद–विवाद, तात्कालिक भाषण प्रतियोगिता, तकनीकी अधिकारियों व कर्मचारियों के लिए हिन्दी प्रतियोगिता, अहिन्दी भाषियों के लिए श्रुतिलेख, महिला कर्मचारियों के लिए हिन्दी प्रतियोगिता तथा हिन्दी शोध पत्र एवं पोस्टर प्रदर्शन प्रतियोगिताओं का आयोजन किया गयाजिसमें संस्थान के सभी अधिकारियों एवं कर्मचारियों द्वारा उत्साहपूर्वक भाग लिया गया।

Brain Storming Sessions

To identify researchable areas and technological interventions required for efficient utilization of crop residues for generation and utilization of biomass energy and thereby address the challenge of food, energy and environment security, a brain storming

session on "Recent Advances in Biomass Energy Research and Management" was organized on 9 Nov 2017. The programme was inaugurated by Dr. Kanchan Kumar Singh, Assistant Director General, (Farm Engineering), ICAR, New Delhi. Invited experts presented status of biomass availability in India, field burning and its consequences on human health and appropriate existing technologies and process for its efficient utilization. The presentations were followed by panel discussion with focus on adoption/ adaptation of available technologies for efficient

utilization of rice-wheat residues to mitigate the environmental problem which is highly prevalent in New Delhi, Punjab, Haryana, and several other states of India. The major action points emerging from the session were: conduct research on conversion of lignocelluloses biomass into bio-oil, bio-char and thermo/ electricity generation and biomass energy interventions with a specific view on biomass management for future; and need for creation of database on (i) assessment of availability and utilization of crop residues/ biomass in India, (ii) collection, transportation and storage of crop residue, and (iii) status of technologies available for bio-oil refinement, bio-ethanol, briquetting and power generation.

A brainstorming Session cum Interaction Meet on 'Engineering Interventions for Production & Processing of Different Crops' was organized during 26-27 Feb, 2018. Purpose was to identify crop specific problems that need engineering interventions and also to explore the possibility of collaborative mode research between crop institutes and ICAR-CIAE to provide the engineering solutions for mechanization/ processing/ energy problems for enhancing the input use efficiency, productivity and value addition aiming at doubling the farmers' income, Directors and scientists from different institutes under crop science division of ICAR and RVSKVV, Gwalior attended this meeting with all the scientists of ICAR-CIAE. During the technical sessions, lead presentations on available engineering technologies for crop production and processing and presentations on specific requirements for different crops/ commodities viz. wheat, barley, maize, millets, tobacco, pulses, fodder crops, sugarcane, soybean, oilseeds, fiber

crops, cotton, etc. were made. Some of the priority areas identified during deliberations were: residue management in rice-wheat cropping system, production and post-harvest mechanization in maize, tobacco, oilseed, pulses and millets; production mechanization in fibre crops, fodder crops, sugarcane and cotton. The outcome of the event will be beneficial to policy planners and researchers for new R&D initiatives at the national level for profitable agriculture.

World Soil Day

World Soil Day was celebrated on December 5, 2017. The programme was attended by about 400 farmers and participants from state government, private organizations, ICAR institutes, non-government organizations, press and media. Dr. AK Patra, Director, IISS, Bhopal was the Guest of honour and Expert who emphasised that soil testing can help the farmers in judicious use of fertilizers, thereby decreasing the cost of production, maintaining soil health, and improving the productivity of the soil.He also explained interpretation of the information given in the soil health cards.This was followed by distribution of Soil Health Cards to the beneficiary farmers.

Talk on Food safety, Quality and Nutrition innovation in food industry

A talk of Dr. TSR Murali, Chief R&D officer and Quality Head - Mother Dairy, New Delhi was held on 3 Jan, 2018 at the Institute. Scientists engaged in food processing R&D activity and Ph.D. students of ICAR-CIAE attended. The event was co-hosted by Association of Food Scientists and Technologists

(AFST (I)) Bhopal Chapter. Dr. Murali talked about Food safety, Quality and Nutrition innovation in dairy processing industries. He also shared the key features of successful "SAFAL" model of mother dairy that could attain to reduce the post-harvest losses in horticultural sector to as low as 0.5%. He emphasized the development of innovative products like incorporation of probiotics, prebiotics, synergenetics in products, replacement of conventional sweeteners, use on non-thermal processing technologies and non-destructive methods of quality analysis.

Central Zone Sports Meet -2017

The ICAR- CIAE, Bhopal successfully organized the Central Zone Sports Meet-2017 during 10-13 Nov, 2017. The Meet was inaugurated at ICAR-Central Institute of Agricultural Engineering, Nabi Bagh, Bhopal by Dr. K Alagusundaram, Deputy Director General (Agril. Engg.), ICAR, New Delhi. The ICAR-CIAE, Bhopal organized the events at its own campus for the first time, wherein 536 sportspersons from 18 ICAR Institutes of ICAR Central Zone participated in individual as well as team events viz., athletics, football, kabaddi, basketball, volleyball (shooting and smashing), badminton, table tennis, carrom, and chess organized for men and women. Dr. Nawab Ali, Former Deputy Director General (Engg), ICAR distributed prizes to the winners during the concluding function.

Foundation Day

Institute organized two day programme to celebrate its 43rd Foundation Day and farmers fair during

15-16 Feb, 2018. The institute level programme on 15 Feb, 2018 was celebrated during a function attended by all the staff of institute. Dr. Ramakrishna Kusmaria, Member, ICAR Governing Body and former Minister of Agriculture and Farmers' Welfare, Govt. of Madhya Pradesh was the chief guest. Dr. K. K. Singh, Director, ICAR-CIAE, Bhopal

made a presentation about various achievements of the institute and highlighted about various technologies developed during 2017-18. Dr. Kusmaria lauded contribution of ICAR-CIAE in the field of Agricultural Engineering at regional, national and international perspective. He encouraged the scientists to develop technologies keeping in mind the interest of the small and marginal farmers. A poster competition was also organized for scientists and doctoral students.

A Farmers' meet and agricultural machinery exhibition was organized on 16 February, 2018 that was themed at "Role of Mechanisation in Doubling the Farmers' Income". About 1500 farmers and entrepreneurs from neighbouring districts participated in the programme. Different machines and technologies were showcased by ICAR-CIAE, ICAR-IISS, ICAR-NIHSAD, Directorate of Agricultural Engineering and various commercial manufacturers. On this occasion a tripartite agreement was signed between ICAR-CIAE, Bhopal, Directorate of Agricultural Engineering, Madhya Pradesh and M/s Veda Farms & Implements Pvt. Ltd., Bhopal to manufacture quality agricultural machinery at Sehore district, Madhya Pradesh. Successful entrepreneurs and progressive farmers who undertook training at ICAR-CIAE in the areas of management of custom hiring centre, soybean processing and utilization and protected cultivation technology were also felicitated for their innovative ideas and adoption of new technologies.

Nutri Fair

The Institute organised Nutri Fair on 8 Mar, 2018 to commemorate International Women's Day. The event witnessed an overwhelming participation of around 1200 rural women from across the state and provided a platform for cross learning, encouraging rural women in agriculture and recognising the efforts of women leaders and entrepreneurs. The event was jointly organised through a consortium of stakeholders and partners viz. Solidaridad, New Delhi, Madhya Pradesh State Rural Livelihood Mission, M/s Mahindra, M/s ITC Ltd, Reliance foundation and M/s Vippy Industries. The event also hosted an exhibition of stalls by the participating organizations and rural entrepreneurs on soy food

processing technology.

Women's cell activities

The women's cell at the institute organized programmes for female employees of ICAR-CIAE and ladies residing in CIAE campus. An educational tour to ICAR-Indian Institute of Pulse Research, Funda was organised for the women employees of ICAR-CIAE on 09 Feb, 2018. Lady employees of CIAE visited various facilities at IIPR, Funda, and interacted with the scientists to gain first-hand

knowledge on pulse production. International women's day was celebrated on 15th Mar 2018. Dr. Anita Tilwari from MPCST was chief guest and Mrs. Usha Singhwas the guest of Honour. Dr. Anita Tilwari delivered a lecture on "Women Empowerment" and Mrs. Usha Singh felicitated the women sports persons, who won medals in 2017 ICAR Zonal sports Meet. Several games and quiz competitions were also part of the function.

Webcast Programme of Honourable Prime Minister

Hon'ble Prime Minister of India Sh. Narendra Modi ji inaugurated the National Conference of Krishi

Vigyan Kendras on 17 Mar, 2018 at ICAR-IARI, New Delhi. At this occasion 25 New KVKs in the country were also inaugurated. He also addressed the farmers and agricultural scientists about doubling farmer's income, through live telecast, reaching out to 7 lakhs progressive farmers through 681 KVKs throughout the country.

The Institute arranged farmers gathering to watch the live webcast programme, in which more than 1000 farmers, scientists, state departments and other stakeholders participated. Shri Vishvas Sarang, Honourable Minister, Govt. of MP graced the occasion as Chief Guest and Dr. Sasikala Pushpa, Honourable Member of Parliament (Rajya Sabha) as the Guest of Honour. Chief Guest Shri Vishvas Sarang in his address urged that all efforts should be made to reduce the input costs at the level of farmers and increase their income, as continuously being highlighted by Hon'ble Prime Minister. He also appreciated the work done by CIAE Bhopal in the field of farm mechanization. Guest of Honour, Dr. Sasikala Pushpa, highlighted about the seven point agenda of Prime Minister to double farmers income. She told that ICAR and other R&D organization have been playing important role to improve the livelihood of farmers.

Distinguished visitors

Mr. P Nageshwar Rao, Chief Technology Officer, R&D CoE; Mr. M. Suresh, Principal Member, R&D and Mr. S. Manikandan, Sr. Member, R&D, Tractor and Farm Equipment (TAFE) Ltd., Chennai visited Institute on 24 July 2017 to discuss the Precision Farming Technologies/equipment developed by CIAE, Bhopal.

Dr. Lalit R Verma, Professor and Head, Biological and Agricultural Engineering, University of Arkansas, USA, interacted with the scientists on 25 July 2017.

Shri SK Singh, Additional Secretary & Financial Advisor (DARE/ICAR) reviewed financial status and other activities of the ICAR institutes located in

Bhopal. Shri Singh convened a meeting of the senior officials of the three institutes viz. ICAR-CIAE, ICAR-IISS, and ICAR-NIHSAD at ICAR-CIAE, Bhopal on 29 July 2017.

Dr. Shaikh Mohammed Bokhtiyar, Director and Dr. Tayan Raj Gurung, Senior Programme Specialist (NRM), SAARC Agriculture Centre (SAC) visited CIAE on 6 August, 2017 and had discussions with Director and Heads/Project Coordinators regarding publication of a book on Agricultural Mechanization and organization of a Seminar as part of Commemoration of SAARC Charter Day.

Shri Chhabilendra Roul, Additional Secretary (DARE) and Secretary (ICAR) conducted a meeting of administrative, finance and vigilance officers of selected ICAR institutes on 18 Aug 2017 at ICAR-

CIAE, Bhopal. During the visit, he addressed staff of ICAR institutes and visited facilities of the three institutes viz. ICAR-CIAE, ICAR-IISS, and ICAR-NIHSAD.

Secretary General of African-Asian Rural Development Organization (AARDO)His Excellency Eng. Wassfi Hassan El Sreihin visited the institute on 6 Nov 2017 to take part in valedictory session of International Training of African-Asian Rural Development Organization (AARDO) on "Agricultural Engineering Technologies for Enhancing Productivity and Profitability in Agriculture Sector"

Dr Anwar Alam, former DDG (Engg), ICAR and former Vice Chancellor, SKUAS&T visited the institute on 27 Dec 2017 and interacted with Director, Head of Divisions and Project Coordinators.

Dr. Prem Kumar, Hon'ble Minister of Agriculture, Bihar and Shri Ravindra Nath Ray, Special Secretary (Agriculture), Government of Bihar visited the

Institute during 3-5 Feb, 2018. To witness various facilities and to discuss about setting up of Directorate of Agricultural Engineering in the State of Bihar.

Shri Parshottam Rupala, Hon'ble Union Minister of State for Agriculture & Farmers Welfare and Panchayati Raj visited ICAR-SBI, Coimbatore on the 21 Feb, 2018 and Sugarcane Settling transplanter developed by the Regional Centre, CIAE, in collaboration with ICAR-Sugarcane Breeding Institute, Coimbatore was demonstrated to him during his visit.

Important committees

Quinquennial Review Team

Quinquennial Review Team was constituted by the Council on 18 May, 2017 to review the work done by the Institute and its AICRPs (FIM, UAE, EAAI and ESA) and CRPs (FMPF and EA) during the period 2012-17. The following has been the composition of the QRT:

1	Dr. Gajendra Singh Former VC, Doon University and Former DDG (Engg), ICAR	Chairman
2	Dr. MK Garg Former Dean & Prof. CAET, CCSHAU, Hisar	Member
3	Dr. Surendra Singh Former PC, AICRP on FIM & Advisor AIAMMA	Member
4	Dr. Divakar Durairaj Dean, AEC&RC, TNAU, Coimbatore	Member
5	Dr. HS Sidhu Senior Research Engineer, BISA, Ludhiana	Member
6	Dr. KN Tiwari Professor, A&FED, IIT, Kharagpur	Member
7	Dr. Sukhpal Singh Former Professor (Economics), IIM Ahmedabad & DG CRRID, Chandigarh	Member
8	Dr. KN Agrawal Project Coordinator, AICRP on ESA, ICAR-Central Institute of Agricultural Engineering, Bhopal	Secretary

Research Advisory Committee

1	Dr. VM Mayande Former VC, PDKV, Akola	Chairman
2	Dr. Debraj Behera Prof & Head Deptt of Farm Machinery & Power, OUAT, Bhubneswar	Member
3	Dr. Man Singh Project Director, WTC, ICAR-IARI, New Delhi	Member
4	Dr. VVN Kishore Former Head, Department of Energy & Env., TERI University, New Delhi	Member
5	Dr. JIX Antony New Health Platform Lead, NESTLE, Gurgaon	Member
6	Dr. KK Singh Director, ICAR-CIAE, Bhopal	Member
7	Dr. Kanchan Kumar Singh Assistant Director General(Farm Engineering), ICAR, New Delhi	Member
8	Dr. PC Bargale, Head, Technology Transfer Division, ICAR-CIAE, Bhopal	Member Secretary

Institute Management Committee

1	Dr. KK Singh, Director, ICAR-CIAE	Chairman
2	Dr. Kanchan Kumar Singh, Assistant Director General (Farm Engineering), Indian Council of Agricultural Research, New Delhi	Member
3	Dr. Man Singh, Principal Scientist, Project Director, WTC, ICAR-IARI, New Delhi	Member
4	Dr. G Senthil Kumaran, Principal Scientist, ICAR-IIHR, Bengaluru	Member
5	Dr. Ashish Kumar Singh, Principal Scientist, ICAR-NDRI, Karnal	Member
6	Director, CFMTTI, Budni	Member
7	Sh. Ravindra Kumar, F&AO, ICAR-IISR, Indore	Member
8	Dr. Anil Kumar Dubey, Principal Scientist, ICAR-CIAE, Bhopal	Member
9	Shri Ravi Kumar, Chief Administrative Officer, ICAR-CIAE, Bhopal	Member Secretary

Institute Research Committee

1	Dr. KK Singh, Director	Chairman
2	All scientists and Head of Divisions	Member
3	Dr. BM Nandede, Scientist	Member Secretary

Institute Technology Management Committee

1	Dr. KK Singh, Director	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. PC Bargale, Head, TTD & PI, ZTMC	Member
7	Dr. Ramadhar Singh, PS, IDED	Member
8	Dr. Dipika A Murugkar, I/c, PME Cell	Member
9	Dr. KVR Rao, Pr. Scientist &PI, ABI	Member
10	Dr. Sanjay Shrivastava, PS, ICAR-IISS, Bhopal	External member
11	Dr. V Bhushan Babu, Sr. Scientist	Member Secretary
12	Dr. BM Nandede, Scientist & Secretary IRC	Member

Institute Joint Staff Council

1	Dr. KK Singh, Director	Chairman
	Official Side	
2	Dr. Nachiket Kotwaliwale, Head, APPD	Member
3	Dr. M Din, PC(UAE)	Member
4	Dr. KV Ramana Rao, PS, IDED	Member
5	Dr. RK Pajnoo, CTO	Member
6	Shri MK Mulani, Sr. Finance & Accounts Officer	Member
7	Shri Ravi Kumar, Chief Administrative Officer	Member Secretary (Official side)
	Staff Side	
1	Shri AC Gupta, TO	Member
2	Shri Ganesh Prasad, UDC	Member
3	Shri PV Sahare, LDC	Member & Member, CJSC
4	Shri AN Pawar, SSS	Member
5	Smt. Chandrakala Bai, SSS	Member
6	Shri RC Maheshwari, Sr. Technician	Member Secretary, (Staff Side)

Women Cell

1	Dr. Debabandhya Mohapatra, Senior Scientist	Chairperson
2	Ms. Swapnaja Jadhav, Scientist	Member
3	Ms. Shivkumari Bharti, ACTO	Member
4	Ms. Madhuri Umredkar, LDC	Member
5	Ms. Jolly John, Sr. Technical Assistant (Staff Nurse)	Member
6	Shri MK Raut, Asstt. Admin. Officer (Admin.) (Ex. Officio)	Member Secretary

PME Cell

1	Dr. Dipika Agrahar-Murugkar	Incharge-PME Cell
2	Dr. Karan Singh	Nodal Officer (Data Acquisition System and Website Management)
3	Dr. KP Saha	Nodal Officer (HRD)
4	Dr. Debabandya Mohapatra	Editor, News Letter
5	Dr. V Bhushana Babu	Nodal Officer (Training, Consultancy, Contract research and Contract Service)
6	Dr. BM Nandede	Secretary, IRC and Nodal Officer HYPM & PIMS
7	Dr. AP Pandirwar	Secretary, Institute Seminar & Nodal Officer MPR

Committee for Prevention of Sexual Harassment of Women at Workplace

1	Dr. SS Deshpande, PS	Chairperson
2	Mrs. Swapna Jadhav, Scientist	Member
3	Mrs. Shivkumari Bharti, ACTO	Member
4	Mrs. Bindu Prasad, Steno-III	Member
5	Mrs. Bindu Oberoi	Member (Non-Government Organization)
6	Mrs. Kushal Suri, Assistant	Member Secretary

Hindi Rajbhasha Committee

1	Dr. KK Singh, Director	Chairman
2	Dr. Anil Kumar Dubey, PS	Member
3	Dr. KP Singh, PS	Member
4	Dr. RS Singh, PS	Member
5	Dr. KN Agrawal, PS	Member
6	Sh. Ravi Kumar, CAO	Member
7	Sh. MK Mulani, F&AO	Member
8	Dr. SP Singh, CTO	Member Secretary

Board of Studies (PG School)

1	Dr. Krishna Kumar Singh, Professor	Chairman
2	Dr. Nachiket Kotwaliwale, Head APPD	Member
3	Dr. CR Mehta, Project Coordinator (FIM)	Member
4	Dr. Karan Singh, PG School Coordinator	Member
5	Dr. KP Singh, Senior Scientist	Member
6	Dr. Debabandya Mohapatra, Senior Scientist	Member
7	Dr. Subir Chakraborty, Senior Scientist	Member
8	Dr. PC Jena, Scientist	Member
9	Dr. Ajay Kumar Roul, Scientist	Member
10	Ms. Hema John, III year Student	Student Representative

Ongoing Research Projects

Project No.	Project Title	Investigators
Agricultural Mechanization Division		
EXT	Hyper-spectral remote sensing approaches to evaluate soil quality and crop productivity of central India" a DST networked project on "Big Data Analytics-Hyperspectral Data (BDA-HSRS)	CP Sawant
730	Development of multipurpose vehicles for various operations in vegetable crops	AK Roul D Singh
749	Design and development of potato Combine harvester suitable for Indian condition	KP Singh VK Bhargav PS Tiwari AK Roul
765	Development of transplanter for onion seedling	AP Magar BB Gaikwad
767	Automated control system for tractor-implement combination (under Extra-mural fund)	AK Roul HS Pandey
776a	Development of seed metering mechanism for high speed seeding or planting	Manoj Kumar (FMP) KN Agrawal RK Sahani
776c	Development of integrated system for harvesting and conveying of bunch crops	Manoj Kumar (FMP) Sweeti Kumari
778	Development of smart sprayer for pomegranate young orchard	CP Sawant Bikram Jyoti N Gaikwad
779	Development of site specific fertilizer applicator for cotton crops	DS Thorat Manoj Kumar (FMP) A R Raju
780	Development of light weight multi-crop thresher for Uttarakhand hills	KP Singh /Sweeti Kumari Shyam Nath
782	Development of tractor operated drip lateral and plastic mulch layer cum planter for raised bed	CP Sawant BB Gaikwad AP Magar
783	Gender friendly tractor operators workplace layout for Indian worker	RR Potdar/Sweeti Kumari
784	Development of tractor operated grass seed harvester	CS Sahay DS Thorat PK Pathak
791	Package of machinery for orchard crops suitable for mini tractor	SP Kumar BM Nandede AK Roul
792	Development of automated soil nutrient sensing system (NASF Project)	PS Tiwari RK Sahni Vijay Kumar
796	Design and Development of tools and gadgets for floriculture (CC-PI)	Vijay Kumar
798	Design and development of tools and gadgets for floriculture	RS Yadav Vijay Kumar TN Saha GB Kadam
799	Characterization and substitution of existing materials for selected machinery	Dushyant Singh NS Chandel RK Sahni

Project No.	Project Title	Investigators
800	Status of farm machinery manufacturers in Madhya Pradesh	Manoj Kumar (Stat.) V Bhushana Babu MB Tamhankar
811	Development of mechanized CA model farm for major cropping systems in vertisol of Central India	HS Pandey CP Sawant KP Singh RS Singh
812	Retrofitting urea solution spraying system on paddy straw baler	SP Kumar Dilip Jat
813	Development of controlled-release fertilizer applicator as an attachment to rice transplanter	S Imran SP Kumar
814	Mechanization package for pigeon pea cultivation for raised bed and ridges	BM Nandede Dilip Jat
815	Mechanization package for garlic cultivation on raised beds	Dilip Jat S Imran
816a	Mechanization package for grapes (A) Development of side trencher-cum-FYM applicator for grapes orchard	AP Magar
816b	(B) Design and development of induction based air assisted electrostatic sprayer	Bikram Jyoti AP Pandirwar
816c	(C) Development of tractor operated fertilizer applicator for grape vineyard	DS Thorat AP Magar
Agricultural Energy and Power Division		
751	Energetics of production and post production of major cropping system of Madhya Pradesh-	PC Jena RC Singh KP Saha S Mondal PL Singh A Nagori
752	Development of microalgae production and harvesting system for bio-fuel	AK Dubey PL Singh S Jadhav A Nagori
763	Micro planning management of rural energy system	S Gangil H Wakudkar V Bhushana Babu
805	Solar powered prime mover for spraying and weeding operations	PC Jena A Nagori
Irrigation and Drainage Engineering Division		
620a	Establishment of PFDC and its operations in Madhya Pradesh States	KV Ramana Rao
747b	Feasibility study on use of board bed and furrow (BBF) and mole drainage system for crop sensitive to water logging in vertisols	R Singh KV Ramana Rao
762	Development and evaluation of real time precision irrigation using sprinkler system for field crops	CD Singh Ramadhar Singh
795	Development of tractor operated Trencher	RD Randhe AM Waghaye BM Nandede
796	Design and development of automatic irrigation system for rice	Mukesh Kumar AM Waghaye RK Sahani
797	Assessment of quality and quantity and harvesting efficiency of roof water under different type of roofing materials	AM Waghaye RD Randhe Mukesh Kumar

Project No.	Project Title	Investigators
806	Design of horizontal subsurface flow filter for agricultural run-off / wastewater for irrigation	YA Rajwade CK Saxena MV Coumar (ICAR-IISS, Bhopal)
820	Optimization of ventilation in naturally ventilated greenhouse using computational fluid dynamics	AK Nayak M Kumar
821	Ext. fund: Pilot project on solar powered micro irrigation system	KV Ramana Rao PC Jena
Agro Produce Processing Division		
EXT1	Development of soy and multigrain based nutritionally balanced functional foods for children (National Fellow project)	D Agrahar Murugkar
785	Development of Hyperspectral imaging protocol for rapid and non-destructive detection of aflatoxins on maize and groundnut	SK Chakraborty MK Tripathi
793	Development of mechanized system for bulk storage of onion	Adinath Kate D Pawar SK Chakraborty G Kalyani (ICAR-DOGR, Pune)
801	Technology package for the production of quality grape raisins	Dilip Pawar SK Giri AK Sharma (ICAR-NRC, Grapes, Pune)
802	Development of infrared pre-treatment system for pulse milling	Adinath Kate SK Giri
818	Post-harvest management of medicinal root crops (Ministry of Aayush Project)	D Mohapatra Dilip Pawar
Centre of Excellence for Soybean Processing and Utilization		
794	Enhancement of awareness of food uses of soybean for nutrition purpose	SS Deshpande
803	Development of process technology for production of soy chaap	P Chandra
804	Development and characterization of edible films for food packaging application	Ajesh Kumar S Mangaraj M Hassan
819	Development of process and pilot plant for extraction of dietary fibre from soybean and chickpea hull	Ajesh Kumar S Mangaraj Muzaffar Hasan
EXT2	Effect of elevated CO_2 and temperature on nutritional composition, functional properties of soybean and wheat (NASF project)	P Chandra
Technology Transfer Division		
822	Assessment of draught animal power availability for selection of suitable package of animal drawn implements in MP	UC Dubey M Kumar
823	Development of bullock drawn planter for ridge and furrow sowing of soybean and chickpea cropping system	UC Dubey MB Tamhankar
Regional Centre, Coimbatore		
786	Development of Pelletizing techniques on small seeds for mechanized sowing	MM Selvan Ravindra Naik P Masilamani (TNAU, Coimbatore)
788	Development of quinoa pearler	SK Aleksha Kudos S Balasubramanian
790	Design and development of sugarcane rind removing equipment for hygienic extraction and bottling of juice (in collaboration with SBI, Coimbatore)	Ravindra Naik SJK Annamalai K Hari Bakshi Ram
807	Development of Banana sucker paring equipment, pseudo stem injector, bunch harvester and pseudostem outer sheath plate making equipment	Ravindra Naik
808	Development of power operated carrot harvester cum detopper for hilly region	T Senthilkumar

Project No.	Project Title	Investigators
809	Development of farm machinery mobile app for major crops of Tamil Nadu	R Senthilkumar MM Selvan
810	Technology commercialization and Entrepreneurship development in Farm Mechanization in Tamil Nadu	R Senthilkumar
824	Design and Development of Mechanized slicer for cashew apples	Ravindra Naik T Senthilkumar DCP Ambrose V Kumar (NRCB) KN Siva (NRCB) Suresh Kumar (NRCB)

Scientific Staff & Senior Officers (as on 31 Mar 2018)

Director

Krishna Kumar Singh

Head of Division

Nachiket Kotwaliwale, APPD
PC Bargale, TTD
PS Tiwari, AMD
RC Singh, Head, AEP
Ravindra Naik, RC-Coimbatore

Project Coordinator

CR Mehta, FIM
KC Pandey, EAAI
KN Agrawal, ESA
Maharani Din, UAE

Principal Scientist

Anil K Dubey, FMP
CD Singh, EI
Dawn CP Ambrose, ASPE
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DS Thorat, FMP
HS Pandey, FMP
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Manish Kumar, FMP
Manoj Kumar, Ag. Stat
Manoj Kumar, FMP
Mukesh Kumar, LWME
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Prakash Chandra Jena, FMP
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Ramesh Kumar, FMP
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Ravi Kumar

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MK Mulani

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MK Raut
Tara Dhabarde
RK Tripathi
Mustafa Kamal
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Incharges
AP Shilarkar, Library
CD Singh, Instrument Cell
Dipikar Agrahar Murugkar, PME Cell
Dushyant Singh, PPC
KP Singh, CAD Cell
Karan Singh, AKMU
MK Raut, I/c. Dispensary
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Acronyms

Acronyms	Description
AARDO	African-Asian Rural Development Organization
AICRP	All India Coordinated Research Project
AKMU	Agricultural Knowledge Management Unit
ASIAN	Association of South East Asian Nations
CRP	Consortia Research Platform
CSAM	Centre for Sustainable Agricultural Mechanization
DARE	Department of Agricultural Research and Education
DoAC	Department of Agriculture Cooperation and Farmers Welfare
EAAI	Energy in Agriculture and Agro Industries
EDP	Entrepreneurship Development Programme
ESA	Ergonomics and Safety in Agriculture
FIM	Farm Implements and Machinery
FLD	Front Line Demonstration
FMPF	Farm Mechanization and Precision farming
HRD	Human Resource Development
ICAR	Indian Council of Agricultural Research
ISAE	Indian Society of Agricultural Engineers
KVK	Krishi Vigyan Kendra
MoA	Memorandum of Agreement
MoU	Memorandum of Understanding
NARS	National Agricultural Research System
NICRA	National Innovation Consortia for Research in Agriculture
OFT	On-Farm Trial
PFDC	Precision Farming Development Centre
PME	Prioritization Monitoring and Evaluation
PPC	Prototype Production Centre
R&D	Research and Development
RMP	Research Management Position
SAARC	South Asian Association for Regional Cooperation
SAU	State Agricultural University
SHG	Self Help Group
SMS	Subject Matter Specialist
UN-ESCAP	United Nations- Economic and Social Commission for Asia and the Pacific
USAID	United States Agency for International Development

Pioneering Director of the Institute Passes Away

Prof. AC Pandya, the Pioneering Director of CIAE (May 1977 to April 1981), left for his heavenly abode on July 22, 2017.

Born on January 15, 1921 in Surat (Gujarat), Prof Pandya completed his graduation in Electrical and Mechanical Engineering from Bombay University in 1946. Thereafter he was awarded his Post-graduation degree in Agricultural Engineering from Iowa State University, Ames, Iowa, USA. He served the Agricultural Engineering community in various capacities as Head of Agricultural Engineering Department IIT, Kharagpur; Technical Director NDDB; Director Gujarat Energy Development Agency; Director CIAE and Director SPRERI, VV Nagar.

During his illustrious career spanning 38 years he contributed not only in professional research but also in institution building, administration and management. He guided 110 post-graduate and 22 Ph.D. students. He also served as the President and member of many professional societies related to Agricultural Engineering.

He laid the foundation and was one of the pioneering fathers of Agricultural Engineering in general and CIAE in particular. His love for CIAE was reflected throughout his life, even when he was not serving as its Director. He was the chairman of QRT (1994-2000) and participated actively in the growth and development of CIAE.

Prof. Pandya shall always be remembered fondly for his devotion, discipline, vision and valuable contribution to Agricultural Engineering.