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2019

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PREFACE

Agriculture is the backbone of the Indian economy and socio-economic upliftment of about 14 crore farmers is a major concern of the country. To improve the income of farmers, using cost effective technology with judicious use of resources is the need of the hour. Major sectors identified for doubling farmer's income by 2022 are farm mechanization, reduction of post-harvest losses and value addition. The ICAR-Central Institute of Agricultural Engineering, Bhopal has been working on development of engineering technologies for farm mechanization, post harvest processing of farm produce and their value addition, enhancement of water and energy use efficiency since its inception. With growing challenges of changing climatic pattern and socio-economic scenario and requirement of fast pace mechanization, the institute is trying to become a nodal point for different stakeholders such as farmers, agri-entrepreneurs, machinery manufacturers, rural youth along with National Agricultural Research System for providing engineering solutions in agriculture.

During the year 2019, the institute focused on development of technologies related to precision agriculture, mechanization of horticulture, post harvest processing and value addition of coarse cereals, horticultural produce and soybean, renewable energy utilization gadgets and optimal water utilization through micro-irrigation, protected cultivation and drainage. The use of advance technologies in the fields of computation, sensors and telecommunication has been emphasized for development of controls, monitoring systems and equipment. The efforts have been initiated for application of IoT, AI and mechatronics in agriculture through engineering solutions. The institute has been taking concentrated efforts to develop complete mechanization package for different field and horticultural crops and cropping pattern and a complete value chain for handling and procession of farm produce such as banana, grapes, cassava, sugarcane and a few more vegetable crops. The institute has partnered with commodity based ICAR institutes of Crop Science and Horticulture SMDs to address mechanization and post-harvest issues of particular crop/commodity.

Four AICRPs and two CRPs are being coordinated from the institute, which helped in addressing location, crop and area specific mechanization issues and strengthening linkages throughout the country for efficient dissemination of developed technologies. The AICRP on Farm Implements and Machinery with its centres located in Punjab and Haryana states was associated in formulation and implementation of a GOI scheme on Promotion of Agricultural Mechanization and Machinery for In-situ Management of Crop Residue in the states of Punjab, Haryana, Uttar Pradesh and NCT of Delhi with an outlay Rs. 1152 crore during 2018-19 and 2019-20. The project was awarded by ICAR with Chaudhary Devi Lal Outstanding All India Coordinated Research Project Award – 2018 during the year 2019.

The institute is working on transferring technology to stake holders through multi-facet approach comprised of creating awareness (through Front Line Demonstration and Exhibitions), capacity building and technology licensing to manufacturers. An International training of African-Asian Rural Development Organization (AARDO) was organized by the institute beside two winter schools and two CAFT programmes for the academicians and researchers. During the year, 11 technologies were licensed to manufacturers. The impact of 17 selected technologies of the institute has been estimated as Rs. 4500crore per annum. The institute hosted brain storming sessions on Cotton Harvesting Events like World Food Day, International Yoga Day, Constitution Day, Nutrition Mela, Mahila Kisan Divas, etc. were organised and celebrated with great enthusiasm. Institute also participated whole heartedly in the Prime Ministers national initiative on Swachh Bharat Abhiayan and Promotion of Yoga.

I express my sincere gratitude to our mentors Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR; Dr. K. Alagusundaram, Deputy Director General (Engg.), ICAR; Dr. K.K. Singh, Member, ASRB and Ex-Director, CIAE, Bhopal; Dr. Kanchan K. Singh, Assistant Director General (FE), ICAR and Dr. S.N. Jha, Assistant Director General (PE), ICAR for encouragement, inspiration, guidance and support to institute for carrying out R&D and other activities presented in this Annual Report. I also thankfully acknowledge the contribution of my colleagues

Dr. Nachiket Kotwaliwale, Head, APPD, Dr. M. Din, Project Coordinator, Utilization of Animal Energy and Dr. P. S. Tiwari, Head, Mechanization Division for their contribution in guiding the activities of the institute during the year as Director (Actg.). We are thankful to all officers and staff of ICAR Headquarters, in general, and Engineering Subject Matter Division, in particular for all the physical, financial and intellectual supports provided during the year. Institutions like Department of Agriculture Cooperation and Farmers Welfare, Govt. of India; Directorate of Agricultural Engineering, Govt. of Madhya Pradesh, Bhopal; State Agricultural Universities and sister ICAR Institutions deserve our special appreciation for their support and inputs in various activities of the institute. Achievements presented in this report are due to the dedicated and persistent efforts of all scientific, technical, administrative and supporting staff of the institute, and are thankfully acknowledged. This annual report is put forth with the hope that it provides useful information to different stakeholders.

March, 2020 **(C. R. Mehta)**

CONTENTS

कार्यकारी सारांश

वर्ष 2019 के दौरान भारतीय कृषि अनुसंधान परिषद–केन्द्रीय कृषि अभियांत्रिकी संस्थान द्वारा कृषि में उत्पादन एवं कटाई उपरान्त प्रसंस्करण की तकनीकी विकास हेतु विभिन्न अनुसंधान कार्य किये गये। इस दौरान संस्थान द्वारा नवीन उपकरण, मशीनरी व प्रौद्योगिकी का विकास, पूर्व में विकसित प्रौद्योगिकीयों का मूल्यांकन एवं उन्नयन, मूल्य सवंर्धित उत्पादों एवं प्रकियाओं का विकास, विकसित प्रौद्योगिकी का प्रसार एवं चयनित हितधारकों को सफल प्रौद्योगिकीयों का हस्तांतरण एवं अन्य अध्ययन किए गये। इस वर्ष के दौरान कुछ महत्वपूर्ण उपलब्धियों सम्बंधी सारांश निम्नांकित है–

नवीन उपकरण, मशीनरी व प्रौद्योगिकी का विकास

- सोयाबीन एवं इसी प्रकार की अन्य फसलों की बुवाई को त्वरित गति से करने एवं समयबद्धता सुनिश्चित करने हेतु एक त्वरित गति बुवाई यंत्र का विकास किया गया जिसमें ब्लोअर एवं फ्रेम के साथ छः रोपाई ईकाईयां है। इस यंत्र की कार्यकारी चौड़ाई 2110 मिमी, क्षमता 0.9 हेक्टेयर प्रति घंटा एवं दक्षता 68% (7 किमी प्रति घंटे की गति एवं 100 मिमी बीज से बीज की दूरी) है। इस यंत्र के उपयोग से साधारण बुवाई यंत्र की तुलना में समय की लागत में 64.3% की बचत होती है।

- एक संवेदक नियंत्रित गहराई में उवर्रक डालने के यंत्र का विकास किया गया जिसे चढ़कर चालाये जाने वाले धान प्रतिरोपक यंत्र पर लगाया गया है। इस यंत्र को आरडिनो कंट्रोलर, संवेदक, 10A रिले, 12V वोल्ट की दो मोटर, 12V 1A की एक मोटर एवं मीटरिंग प्लेट लगाई गई है। उवर्रक डालने की दक्षता, क्षमता एवं प्रक्षेत्र दक्षता क्रमशः 71%, 0.16 हेक्टेयर / घंटा एवं 82% है।

- फसल में जल तनाव की निगरानी हेतु RGB एवं इंफ्रारेड आधारित ऊष्मीय प्रतिबिम्वबक (thermal imager) का विकास रियल टाइम सिंचाई हेतु किया गया। यह यंत्र तापमान के 2.5 °C एवं 0.25 °C शुद्वता पर मापन कर सकता है।

- गेहूँ एवं धान के भूसे की बेलिंग के दौरान भूसे के बेलर के साथ एक यूरिया मिश्रण छिड़काव प्रणाली विकसित की गई जो समयबद्धता एवं श्रम लागत को कम करने में मदद करती है। धान के भूसे (50% नमी) और गेहूँ के भूसे (70% नमी) को 8 किलोग्राम / 100 ली. यूरिया मिश्रण के साथ उपचारित करने पर, उपचारित भूसे की पोषण गुणवत्ता जैसे राख, कंटेट, न्यूटल डिटर्जेंट फाइबर, एसिड डिटर्जेंट फाइगर, शुष्क पदार्थ पाचन क्षमता, कार्बनिक अवयव पाचन क्षमता एवं उपापचय ऊर्जा में वृद्धि होती है।

- बागबानी फसलों में पेड़ों की छंटाई, छिड़काव एवं फल तोड़ने हेतु छोटे ट्रैक्टरों द्वारा चलित एवं ट्राली आरोहित हाइड्रोलिक प्लेटफार्म का विकास किया गया है। ट्रैक्टर में हाइड्रोलिक सिलेंडर को 150 किलोग्राम का भार 10 फीट ऊंचाई तक ले जाने योग्य बनाया गया है। इस यंत्र की प्रक्षेत्र क्षमता एवं दक्षता क्रमशः 0.3 हेक्टेयर प्रति घंटा एवं 85% है एवं इसकी संचालन लागत 6250 रूपये प्रति हेक्टेयर है।

- आलू की खेती हेतु एक ट्रैक्टर संचालित कम्बाइन हार्वेस्टर का विकास किया गया है जो 600–650 मिमी चौड़ाई की उत्थित क्यारियों हेतु उपयुक्त है। इस यंत्र की प्रक्षेत्र क्षमता, दक्षता एवं खुदाई दक्षता क्रमशः 0.16 हेक्टेयर / घंटा, 94% एवं 90% है। इस यंत्र की संचालन लागत रूपये 1270 प्रति घंटा है।

- कसावा हार्वेस्टिंग मे कठिन श्रम को कम करने के उद्देश्य से एक ट्रैक्टर संचालित कसावा हार्वेस्टर–कम–लिफ्टर का विकास किया गया है इस यंत्र की प्रक्षेत क्षमता 0.22 हेक्टेयर प्रति घंटा है एवं इसके प्रयोग से मजदूरों द्वारा की गई कटाई की तुलना में 82% कम लागत आती है।

- पर्वतीय क्षेत्रो के सीढीदार खेतों में छोटे एवं मध्यम आकार के बीजो की बुवाई हेतु एक बहुफसलीय बुवाई यंत्र (जिसे हल्के वजन वाले टिलर पर लगाया जा सके) का विकास किया गया है। इस यंत्र की प्रक्षेत्र क्षमता एवं दक्षता मक्के की बुवाई मे क्रमशः 0.05–0.06 हेक्टेयर / घंटा एवं 78.82% पाई गई है। इसकी प्रचालन लागत रूपये 1850 प्रति हेक्टेयर है जिससे वुबाई की लागत में 46.5% की बचत होती है।

- टिशु कलचर किये गये केले की पौध को प्रत्यारोपित करने हेतु एक ट्रैक्टर चलित रोपाई यंत्र का विकास किया गया इस यंत्र की प्रक्षेत्र क्षमता 0.19 हेक्टेयर / घंटा है। प्रचालन लागत रूपये 3500 हेक्टेयर एवं इसके उपयोग से पारंपरिक विधि की तुलना में 81% लागत कम होती है।

- गेहूँ की कटाई उपरांत बचे हुए भूसे को इक्ट्ठा करने हेतु एक मशीन का विकास किया गया। इस यंत्र की प्रक्षेत्र क्षमता, भूसा एकत्रीकरण क्षमता एवं एकत्रीकरण दक्षता क्रमशः 0.26 हेक्टेयर / घंटा, 1.04 क्विंटल / घंटा एवं 55.88% (1.75 कि. मी. घंटा की प्रचालन गति पर)है।

- अंगूर के बागों के लिए एक ट्रैक्टर चलित द्विपक्षी क्षैतिज के निर्वहक श्रेडर का विकास किया गया। इस यंत्र की प्रक्षेत्र क्षमता एवं दक्षता क्रमशः 0.40 हेक्टेयर / प्रतिघंटा एवं 67 प्रतिशत है। इस यंत्र की प्रचालन लागत रूपये 1225 हेक्टेयर एवं बचत रूपये 2775 हेक्टेयर है।

- एक ट्रैक्टर चलित हाइड्रो–मैक्निक्ली नियंत्रित मोल्डबोर्ड प्लाऊ का विकास बागों के लिए किया गया। इस यंत्र की प्रक्षेत्र क्षमता एवं दक्षता क्रमशः 0.07 हेक्टेयर / घंटा एवं 72% है इसकी प्रचालन लागत रूपये 7650 है एवं शुद्व बचत रूपये 3350 प्रति हेक्टेयर है।

- दूरस्थ एवं अधिक ऊंचाई वाली फसलों जैसे कपास, मक्का इत्यादि में निदाई हेतु एक ट्रैक्टर चलित उच्च निकासी निदाई यंत्र का विकास किया गया एवं इसकी निदाई दक्षता,

पौध क्षति एवं प्रक्षेत्र दक्षता क्रमशः 88%, 5% एवं 0.65 हेक्टेयर प्रति घंटा है।

- छिड़काव एवं निदाई के कार्य हेतु एक सौर चलित प्राइम मूवर का विकास किया गया। इसकी छत पर लचीले सौर पैनल एवं बैटरी (48 वोल्ट, 100 एम्पीयर–घंटा) का प्रयोग किया गया है। इसका वजन 450 किलोग्राम (चालक का वजन 70 किलोग्राम सहित) है।

- धान के पुआल की गांठों को तोड़कर बिछाने हेतु एक ट्रैक्टर चलित श्रेडर सह मल्चर का विकास किया गया। इस मशीन की कार्य क्षमता 0.31 हेक्टेयर/ घंटा (2.95 किमी/घंटा की गति पर) एवं प्रचालन लागत 2395 रूपये है।

- ईमली फोड़ने एवं बीज निकालने हेतु एक शक्ति चलित यंत्र का विकास किया गया है। इस यंत्र की उत्पादकता ईमली फोड़ने में 32 किलोग्राम/घंटा एवं बीज निकालने में 64 किलोग्राम/घंटा है। इसकी डिहस्किंग दक्षता 91% एवं बीज निर्गम दक्षता 94% है।

- ट्रैक्टर चलित एक कतारी भुट्टे तोड़ने की मशीन का विकास किया गया जो छोटे ट्रैक्टर पर आसानी से लगाई जा सकती है। इस यंत्र की कार्यक्षमता 0.16 हेक्टेयर/घंटा (3 किमी/घंटा गति पर) है एवं भुट्टा तोड़ने की लागत रूपये 5000 प्रति हेक्टेयर है।

- पहाड़ी क्षेत्रों में अदरक की रोपाई हेतु पावर टिलर चलित एक रोपक यंत्र का विकास किया गया। इस यंत्र की कार्यक्षमता 0.074 हेक्टेयर/घंटा (बीजों के बीच की दूरी 250 मि.मी. एवं गहराई 25–45 मि.मी. पर) है।

- एक 0.5 हॉर्सपावर मोटर चलित मूंगफली स्ट्रीपर सह डिकोंटिकेटर यंत्र का विकास किया गया, जिसकी क्षमता 12 कि.ग्रा./घंटा एवं सफाई दक्षता 90% है।

- पाँच विभिन्न प्रकार के फिल्टर पदार्थ से तैयार मास्कों का परीक्षण उनकी फिल्टरिगं दक्षता एवं श्वास प्रतिरोध हेतु किया गया। इनमे से सबसे उपयुक्त मास्क जो सूती कपड़े, द्वारा वुना हुआ कपड़ा एवं फलालिन कपड़े के स्तरों का बना था सबसे उत्तम पाया गया जिसकी फिल्टरिंग दक्षता 94.8% एवं श्वासप्रतिरोध सबसे कम था।

- गर्म मौसम में कार्य करने वाले मजदूरों को उष्मीय तनाव से बचाने हेतु एक 3 वॉट सोलर पैनल से चलने वाले हेडगीयर का विकास किया गया। इसके उपयोग से उष्मीय तनाव, शरीर का तापमान, हृदय गति एवं अन्य शारीरिक मापदण्डों को कम किया जा सकता है।

- फलों को तोड़ने एवं संकलन में कार्य में मदद करने हेतु महिलाओं की शारीरिक संरचना के अनुसार एक हार्वेस्टिंग बैग का विकास किया गया। इसमें एक बार में 6 किलोग्राम तक फल इक्टठे किये जा सकते है।

- जैविक खेती करने वाले किसानों हेतु एक पशुचलित यंत्रो के पैकेज का विकास किया गया जिसमें विंग हल, जेट हल खेत तैयार करने हेतु समतलक यंत्र एवं मचाई हेतु यंत्र अनुशंसित किये गये है।

- खेतों से अवशेष इक्ट्ठा करने हेतु एक पशुचलित यंत्र का विकास किया गया। इस यंत्र की कार्य चौड़ाई 1067 मि.मी. एवं आवश्यक बल 490.5 न्यूटन है। एक बार में इससे 5.8 किलोग्राम अवशेष इक्ट्ठे किये जा सकते है। इसकी कार्यक्षमता 0.18 हेक्टेयर/घंटा है।

- गन्ने की रोपाई हेतु बैल चलित एक कतारी यंत्र का विकास किया गया। इस यंत्र की कार्य क्षमता एवं दक्षता क्रमशः 0.06 हेक्टेयर/घंटा एवं 61 प्रतिशत है। इस यंत्र का मूल्य रूपये 39,500 एवं आवश्यक बल 612 न्यूटन है।

- एक पशुचलित प्लास्टिक मल्च बिछाने की मशीन का परीक्षण किया गया जिसकी कार्य क्षमता 0.11 हेक्टेयर /घंटा एवं ऊर्जा आवश्यकता 177 मेगाजूल/हेक्टेयर है।

- बुवाई यंत्र के ग्रांउड पहिए के घिसटने के कारण बीज गिरने की दर में समानता नहीं रह पाती इस विचलन को कम करने हेतु एक इलेक्ट्रानिक बीज निगरानी प्रणाली का विकास किया गया।

- एक मोटर चलित नर्सरी हेतु मीडिया मिश्रण छानने का यंत्र, मिश्रण बनाने का यंत्र एवं पाली बैग मे भरने का यंत्र विकसित किया गया यह यंत्र 2 हार्सपावर 3 फेज की मोटर द्वारा संचालित है एवं इसकी क्षमता 1.5–2.0 टन प्रतिघंटा है। इस मशीन की लागत रूपये 5 लाख एवं इसके उपयोग से 60% तक मानव श्रम की बचत की जा सकती है।

- एक संवेदक आधारित प्रणाली का विकास किया गया है जिसका उपयोग भंडारण के दौरान कीड़ो की उपस्थिति की निगरानी हेतु किया जा सकता है। इस प्रणाली में ध्वनि संवेदकों का उपयोग किया गया हैं एवं इसका प्रयोग अनाजो एवं दालो के थोक भंडारण में किया जा सकता है।

मूल्य सवंर्धित उत्पाद एवं प्रक्रियांएं

- अंगूर से किशमिश बनाने की प्रक्रिया के यंत्रीकरण हेतु एक प्रौघोगिकी प्रणाली का विकास किया गया इसके अंतर्गत अंगूरों को गुच्छे से निकालने का यंत्र, अपघर्षण द्वारा ऊपरी परत को घिसने की प्रक्रिया हेतु यंत्र एवं सुखाने के लिए आवश्यक प्रोटोकाल बनाये गये। अपघर्षित अंगूर की सूखने की दर (0.734–0.789 मिनिट प्रति 100 ग्राम थी जो रासायनिक विधि द्वारा उपचारित अंगूरों की तुलना में (0.191–0.089 मिनिट प्रति 100 ग्राम) अधिक है। इस संपूर्ण मशीनों की लागत रूपये 3.85 लाख एवं किशमिश की प्रसंस्करण लागत रूपये 21.75 प्रति किलोग्राम पाई गई जो रासायनिक प्रसंस्करण विधि की तुलना में 37% कम है।

- एक फाइबर रेनफोर्सड प्लास्टिक आधारित प्याज भंडारण संरचना विकसित कि गई जिसकी भंडारण क्षमता 1 टन है। इस संरचना में भंडारण पर किए गए अध्ययन में 180 दिन के भंडारण के पश्चात वजन में 20.3% की कमी, 5.07% सड़न

एवं 0.67% अंकुरण पाया गया।

- औषधीय जड़ वाली फसलों को छीलने हेतु एक यंत्र का विकास किया गया। इस यंत्र से सफेद मूसली, अश्वगंधा जैसी फसलों को छीलने की दक्षता 90% से अधिक एवं यह पूर्णतया स्वस्थकारी है ।

- दानेदार अनाजों के सतह पर अवरक्त किरणों द्वारा देने हेतु एक एन.आई.आर. ऊष्मीय उत्पादक प्रणाली का विकास किया गया। अनाज की सतह को आकस्मिक ऊष्मीय प्रवाह एवं इसके समयांतराल को बदल कर आवश्यक प्रभाव प्राप्त किए गये। एक चार आवृति चलित मोटर एवं एक कंपित सतह की मदद से अनाज की एकल सतह को एक समान गर्म किया जा सका। इस प्रणाली की क्षमता 200 किलोग्राम/घंटा है।

- गर्म पानी द्वारा उत्सर्जित अवरक्त ऊष्मीय ऊर्जा का उपयोग रिफ्रैक्टेंस विंडो शुष्कक को चलाने हेतु किया गया जिससे गर्मी संवेदी जैविक पदार्थो को सुखाया जा सकता है। इसके लिए एक विशेष माइलर परत को शुष्कक में लगाया गया है।

- सन के बीज एवं चिया जेल का उपयोग कर एक अंडा रहित केक बनाया गया इस केक में ओमेगा 3 वसीय अम्ल की मात्रा 7.84% ओमेगा 6 वसीय अम्ल की मात्रा 47.40% एवं प्रोटीन की मात्रा 8.5 ग्राम/100 ग्राम पाई गई जो साधारण केक की तुलना में ज्यादा थी।

- एन आई आर हाइपरस्पेक्ट्रल इमेजिंग प्रणाली में तरंग दैर्ध्य 400–1000 नैनोमीटर का उपयोग त्वरित गति से मूंगफली में एफलाटॉक्सिन के संक्रमण की पुष्टि के लिए किया गया। 662, 668 एवं 680 का तरंग दैर्घ्य मूंगफली के दानो में स्वस्थ एवं संक्रमित का वर्गीकरण करने में सफल रहा।

- अरहर से दाल उत्पादन की दक्षता बढाने हेतु एक नये तरीके जिसमे अरहर के दानो को 10% आर्द्रता पर खरोंचने के बाद अवरक्त किरणों के ऊष्मीय प्रवाह से गुजारने पर पाया गया कि अरहर के भूसे एवं बीजपत्रक के बीच का आसंजन बल कम हो गया जिससे दाल मीलिंग के दौरान 78% दाल की प्राप्ति एवं डिहलिंग दक्षता 97% पाई गई।

- जड़ीय औषधीय फसलों जैसे सफेद मूसली, शतावरी, अश्वगंधा इत्यादि को सुखाने से पहले 5% फिटकरी के घोल में 30 मिनिट तक रखने के पश्चात 45 डिग्री सेल्सियस तापमान पर सूखाने पर उत्पाद में जैविक सक्रिय यौगिक अधिक तथा जीवाणुओं की संख्या कम पाई गई।

- वाष्पशील कार्बनिक यौगिकों का मापन जीसी–एमएस पद्धति द्वारा करके संक्रमण को पता लगाने की तकनीक का प्रयोग आलू, प्याज, एवं टमाटर में विनिमा कैरटोबोरा के संक्रमण का पता लगाने हेतु किया गया। भंडारण के समय वाष्पशील कार्बनिक यौगिकों की सांद्रता का अध्य्यन कर ऐसे यौगिकों की पहचान की गई जिनका उपयोग ई–नोज विकसित करने में किया जा सकता है।

- जैव ईधन के उत्पादन हेतु एवं प्रायोगिक प्रतिरूप का विकास किया गया इसमे धीमी पाइरोलिसिस विधि का उपयोग कर जैविक पदार्थ से लगभग 48% जैव ईधन प्राप्त कर सकते है। इसके स्टील के रिएक्टर की क्षमता 2 किलोग्राम है एवं इसमे 700 डिग्री सेन्टीग्रेड सेल्सियस तापमान तक गर्म किया जा सकता है।

- संस्थान द्वारा विकसित सुवाहय गैसीफायर का उपयोग स्थानीय स्तर पर उपलब्ध जैविक पदार्थ से ईंजन चलाने हेतु ईधन के उत्पादन के लिए किया जा सकता है। इस गैसीफायर में उत्पन्न टार को साफ करने हेतु एक उत्प्रेरक स्तंभ का उपयोग किया गया है। इससे उत्पन्न गैस में 19% कार्बन मोनो ऑक्साइड, 8% हाइड्रोजन, 16% मिथेन एवं 9% कार्बन डाई ऑक्साइड पाई गई है।

- यूरिया द्वारा पूर्व उपचारित धान के फसल की गांठो का उपयोग बायोगैस उत्पादन हेतु किया जा सकता है। इस पुआल के साथ गोबर को 50:50 के अनुपात में मिलाकर 10 प्रतिशत (1.1 धन मीटर लगभग) कुल ठोस पदार्थ वाला मिश्रण एक बायो मिथेनेरोन डाइनेस्टर में डालने पर 250 लीटर बायोगैस प्राप्त की जा सकती है।

- धान के पुआल से हाइड्रोलाइजेट का निर्माण कर इससे ग्रोथ मीडिया का उत्पादन किया गया तथा इनका उपयोग सूक्ष्म शैवाल के उत्पादन हेतु आवश्यक वयवसायिक ग्रोथ मीडिया के 50% प्रतिस्थापन हेतु किया गया। इस पद्वति से उत्पादित सूक्ष्म शैवाल में लिपिड की मात्रा 17% पाई गई ।

अध्ययन

- पुरूष एवं महिला चालकों के हाथ एवं पैरो की पहुँचने की क्षमता के आधार पर ट्रैक्टर एवं स्वचलित यंत्रो के चालकों हेतु लिंग तटस्थ कार्यस्थल की सीमाओं का निर्धारण किया गया। इस कार्यस्थल के आकलन हेतु एक प्रतिकृति का निर्माण किया गया इस कार्य स्थल का उपयोग पुरूषों एवं महिलाओं की 90% जनसंख्या कर सकती है।

- भारत के विभिन्न कृषि जलवायु क्षेत्रों में किसानों की सुविधा हेतु एक फार्म मशीनरी चयन ऐप का विकास किया गया। इसका उपयोग कर किसान अपने फसल चक्र, ऊर्जा स्त्रोत की उपलब्धता इत्यादि के आधार पर उपयोगी मशीनों का चयन कर सकते है। चयनित मशीनों के विवरण, निर्माता, इनकी लागत, परिचालन लागत एवं लाभ इत्यादि का गणना कर किसान या भाड़ाक्रय व्यवसायी लाभ प्राप्त कर सकते है।

- मध्यप्रदेश में वर्तमान कृषि यांत्रिकरण के परिदृश्य में 45 विभिन्न प्रकार की फार्म मशीनरी की बाजार में वर्तमान उपलब्धता, उत्पादन क्षमता एवं भविष्य में आवश्यकता का एक अध्य्यन किया गया। राज्य में फार्म मशीनरी के बाजार का आकार 7.05 अरब रू. है एवं लगातार बढ़ रहा है।

- चौड़ी क्यारियों एवं कुंड पद्धति एवं मोल जल निकासी पद्धति के उपयोग से सोयाबीन की पैदावार में पारंपरिक पद्धति की

तुलना में 5% के महत्व पर उल्लेखनिय वृद्धि दर्ज की गई। सोयाबीन की पैदावार में यह वृद्धि 23.8 से 67.8% तक दर्ज की गई।

- गेहूँ की खेती में टपक सिंचाई के साथ मल्च का उपयोग करने पर उत्पादकता 6 टन/हेक्टेयर एवं जल उत्पादकता 2.2 किलोग्राम/मी^{3} पाई गई जो अन्य पद्धतियों जैसे पारंपरिक सिंचाई, टपक सिंचाई, स्प्रिंकलर सिंचाई से उल्लेखनीय रूप से अधिक है।

प्रौद्योगिकी हस्तांतरण

- वर्ष के दौरान लाइसेंसिग एवं सहमति ज्ञापन के माध्यम से कुल 11 प्रौद्योगिकियों का व्यवसायीकरण किया गया।
- वर्ष के दौरान 1 समूह प्रदर्शन तथा 11 प्रथम पंक्ति प्रदर्शन/खेत पर परीक्षण किए गए।
- वर्ष के दौरान एएआरडीओ द्वारा समर्थित 15 दिवसीय अंतर्राष्ट्रीय प्रशिक्षण 2 लघु अवधि प्रशिक्षण कार्यक्रम, 1 सीएएफटी प्रशिक्षण तथा डीओएसी द्वारा प्रायोजित एक आदर्श प्रशिक्षण कार्यक्रम आयोजित किए गए।
- मानव संसाधन विकास कार्यक्रम के तहत परिषद के संस्थानों/मुख्यालय में पदस्थ वाहन चालकों के लिए 5 समूहों में 156 प्रतिभागियों के लिए प्रशिक्षण कार्यक्रम आयोजित किये गये। परिषद के तकनीकी कार्मिकों (11 प्रतिभागी) के लिए एक अन्य दो सप्ताह का प्रशिक्षण कार्यक्रम आयोजित किया गया।
- उन्नत कृषि उपकरणों एवं मशीनरी पर किसानों के 5 समूहों के लगभग 351 हितकारकों को व्यावहारिक प्रशिक्षण दिया गया।
- कस्टम हायरिंग पर उघमिता विकास प्रशिक्षण (2 समुह), सोया खाघ प्रौघोगिकियों पर ईडीपी (4 समूह) में प्रशिक्षण कार्यक्रम आयोजित किए गए जिसमें क्रमशः 72 तथा 25 प्रतिभागियों ने भाग लिया।
- वर्ष के दौरान विभिन्न हितधारकों को 37 विभिन्न उपकरणों की लगभग 6331 इकाईयां प्रदाय गई जिनसे 66.87 लाख रूपये की आय हुई।
- वित्तीय वर्ष के दौरान केन्द्रीय कृषि अभियांत्रिकी संस्थान भोपाल स्थित कृषि मशीनरी परीक्षण केन्द्रों तथा इसके कोयम्बटूर स्थित क्षेत्रीय केन्द्र द्वारा उपकरणों के विभिन्न वर्गो के अंतर्गत संयुक्त रूप से 126 कृषि मशीनरी का परीक्षण किया गया एवं 122.46 लाख रूपये की आय अर्जित की गई।

अन्य उपलब्धियां

प्रकाशन

- वर्ष के दौरान संस्थान के 54 शोधपत्र अंतर्राष्ट्रीय तथा राष्ट्रीय पत्रिकाओं द्वारा 08 पुस्तकें, 45 लोकप्रिय लेख एवं 8 तकनीकी बुलेटिन प्रकाशित किए गए।

विभिन्न शासकीय संगठनों एवं निजी उघोगों के साथ अनुबंध

- विभिन्न शासकीय संगठनों एवं निजी उघोगों के साथ संस्थान द्वारा 4 विभिन्न सहभागिता अनुसंधान/परामर्श सेवाओं/ अनुबंध संबधी समझौता ज्ञापनों पर हस्ताक्षर किए गए।

पुरस्कार एवं सम्मान

- कृषि उपकरण एवं मशीनरी पर अखिल भारतीय समन्वित अनुसंधान परियोजना को वर्ष 2018 का चौधरी देवी लाल उत्कृष्ट अखिल भारतीय समन्वित अनुसंधान परियोजना का पुरस्कार प्राप्त हुआ।
- संस्थान के वैज्ञानिकों को वर्ष 2019 का एन ए एस आइ–आई सी ए आर इनोवेशन पुरस्कार, श्रेष्ठ पीएचडी हेतु जवाहर लाल नेहरूपुरस्कार, जीबीपीयूएटी, पंतनगर द्वारा श्रेष्ठ पीएचडी विघार्थी पुरस्कार 2018, भारतीय कृषि अभियंता संघ द्वारा 2 फेलो, 1 कमेंडेसन पदक, 1 श्रेष्ठ पुस्तक पुरस्कार, एवं 1 उत्कृष्ट सेवा पुरस्कार प्रदान किया गया। 3 श्रेष्ठ पोस्टर/ शोधपत्र एवं अन्य संघों द्वारा प्रदत्त 2 युवा वैज्ञानिक पुरस्कार प्राप्त हुए।

आयोजित कार्यक्रम

- वर्ष 2019 के दौरान आयोजित कुछ प्रमुख कार्यक्रमः ''भारतीय मानको का कृषि यंत्रों के परीक्षण, गुणवता नियंत्रण एवं सुरक्षा में योगदान'' विषय पर राष्ट्रीय कार्यशाला'' सोयाबीन के उत्पादन एवं प्रसंस्करण'' एवं '' कपास की चुनाई का यांत्रिकीकरण''विषय पर कार्यशाला, कृषि मशीनरी निर्माता संघ के अधिकारियों के साथ विचार विमर्श, माननीय प्रधानमंत्री जी की किसानों के साथ वीडियो कान्फ्रेसिंग का वेबकास्ट कार्यक्रम, अंतराष्ट्रीय योग दिवस, विश्व खाद्य दिवस, अंर्तराष्ट्रीय महिला दिवस, स्वच्छता पखवाड़ा, सर्तकता जागरूकता सप्ताह कार्यक्रम, 24वी आरएसी बैठक, 52वी आईएमसी बैठक, 102 एवं 103 वी आईआरसी बैठक।

EXECUTIVE SUMMARY

The ICAR-CIAE, Bhopal carried out various research activities for mechanization of production and post production agriculture during the year 2019. Various efforts of the institute have been summarized as development of new equipment and machinery, evaluation and refinement of previously developed technologies, development of innovative value added products and processes, studies/surveys, transfer of successful technologies to stakeholders, IPR, trainings organized and publications. Salient achievements and summary of the events carried out during this period are given in following sections.

New Equipment and Machinery

- A high speed planter for soybean and similar crops can be operated at a speed of 7 km/h and ensures timeliness in sowing. It consists of frame, blower and six modular planting units. The width of operation field capacity, field efficiency of the machine is 2100 mm, 0.9 ha/h, 68%, respectively at 7 km/h speed of operation for 100 mm spacing. It saves 64.3% of time in comparison to conventional planter with 2.5 km/h speed of operation.
- A sensor based deep placement fertilizer applicator as an attachment to ride-on rice transplanter can apply urea at 150 mm depth on puddled field. It consists of electronic metering mechanism system having Arduino UNO micro-controller, proximity sensor, 10A relay, 12V 2A two wiper motors, 12V 1A one motor and metering plate with orifice hole. The fertilizer application efficiency, field capacity and field efficiency are found to be 71%, 0.16 ha/h and 82%, respectively.
- RGB and infrared thermal imager has been developed to monitor the crop stress for real time application of irrigation water to field crops with temperature resolution of 0.25 °C.
- Urea solution spraying system as an attachment to straw baler during baling of wheat and paddy straw help in timeliness in operation and reduce labour cost. Treating the straw with 8 kg/100 l urea solution for paddy straw (50% moisture content) and wheat straw (70% moisture content) enhances nutritional value of treated straw in the recommended range of ash content, neutral detergent fiber, acid detergent fiber, dry matter digestibility, in vitro organic matter digestibility and metabolizable energy of the feeds.
- A hydraulic platform mounted on a trailer of a small tractor has been developed for performing horticultural operations like pruning, spraying and fruits plucking. The hydraulic system of the tractor provides power to the platform for raising and lowering and can be actuated by a double acting hydraulic cylinder having 150 kg of load carrying capacity. It can be operated up to a height of 3m. The field capacity and field efficiency of the machine are 0.3 ha/h and 85%, respectively for orchards having 6 × 6 m plant geometry. The operating cost of the machine is Rs. 6520/ha.
- A tractor operated single-row potato combine suitable for 600 to 650 mm bed size consists of digging unit, soil separation unit, haulm separation unit, clod separation unit, potato collection and bagging unit. The field capacity, field efficiency and harvesting efficiency of the potato combine have been observed as 0.16 ha/h, 94% and 90%, respectively. The cost of operation is about Rs. 1270/h.
- Tractor operated cassava harvester-cum-lifter has been developed to dig the cassava tubers. The effective field capacity of the equipment is 0.22 ha/h and it saves 82% in cost as compared to manual harvesting.
- A light weight power tiller operated multi-crop seed drill-cum-planter suitable for hilly region for sowing small as well as bold seeds under terrace conditions has a effective field capacity and field efficiency of 0.05-0.06 ha/h and 78-82%, respectively. The cost of operation of the equipment is Rs. 1840/ha and saves 47% cost of planting as compared to traditional practice.
- A tractor operated planter for tissue culture banana has a field capacity of 0.19 ha/h and cost of operation of Rs. 3500/ha. It saves about 81% of the cost of operation as compared to the conventional method of planting.
- The tractor operated wheat straw collector can collect the left over wheat straw from a combine harvested field. The effective field capacity, straw collection capacity and collection efficiency of the machine are 0.26 ha/h, 1.04 q/h and 55-58%, respectively.
- Tractor operated horizontal two side discharge shredder developed for the grape orchards has an effective field capacity and field efficiency of 0.40 ha/

h and 67%, respectively. The cost of operation and net saving of machine over traditional method is Rs. 1225/ha and Rs. 2775/ha, respectively.

- A tractor operated hydro-mechanically controlled MB plough for cutting of roots and breaking hard pan in orchards has a effective field capacity and field efficiency of 0.07 ha/h and 71%, respectively. Its cost of operation is Rs.7650/ha with net saving of Rs. 3350/ha.
- A tractor operated high clearance weeder suitable for weeding in wide spaced tall crops like cotton, maize etc. has been developed. The weeding efficiency, plant damage and field capacity of the weeder are found to be 88%, 3%, and 0.65 ha/h, respectively in cotton crop.
- A solar powered prime mover has been developed for spraying and weeding operations. It is equipped with a roof mounted semi-flexible solar panel (48V, 100Ah). The gross weight of the prime mover is 450 kg including weight of the driver (70 kg).
- A tractor operated paddy straw bale shredder-cum-mulcher has a field capacity of 0.31 ha/h at 2.95 km/h forward speed. The cost of shredding is Rs. 2935/ha, which increases the average return by Rs. 15,600/- and net savings by Rs. 6,665/ha.
- Power operated machines for tamarind dehusking and seed extraction have been developed with an output capacity of 32 kg/h and 64 kg/h, respectively, with 91% dehusking efficiency and 90% deseeding efficiency.
- A tractor operated single row corn cob picker has been developed as an attachment to small tractors. It snaps cobs and delivers at the rear of the picking head. The equipment has an effective field capacity of 0.16 ha/h at forward speed of 3 km/h. The cost of harvesting is Rs. 5000/ha.
- A power tiller operated mini-rhizome planter having cup feed type metering mechanism has been developed for ginger crop. Its field capacity is 0.07ha/h at an average seed spacing of 250 mm and depth of operation of 25-45 mm.
- Five different dust masks have been developed with the combination of different filtering materials. The filtration efficiency of these masks has been assessed from 92 to 95%. Mask made from raw cotton sheet, double woven cotton and flannel napped cloth having low breathing resistance has been recommended.
- Harvesting bag for fruits and vegetables has been designed based on anthropometric body dimensions of female workers. Evaluation with 6 kg load in the bag gave more stability by lowering the centre of gravity.
- Animal drawn straw collector collects 5-8 kg of straw from harvested field in a single pass with a field capacity of 0.18 ha/h.
- A 3-row multi-crop planter-cum-herbicide applicator has been developed for soybean, green gram and fodder maize crops. The effective field capacity and field efficiency of the implement for soybean, green-gram and fodder maize are 0.18, 0.12 and 0.12 ha/h; and 78.2, 70.7 and 72.5%, respectively. The average cost of sowing by this machine is Rs. 573/ha.
- Bullock drawn single row sugarcane planter having hopper capacity of 100-125 sugarcane sets per hour has been developed. The field capacity and field efficiency of planter are 0.06 ha/h and 61%, respectively at an operating speed of 1.34 km/h. The cost of the planter is Rs. 39,500.
- Animal drawn plastic mulch laying machine lays the plastic film and can operate at an average speed of 1.35 km/h. The effective field capacity of the machine is 0.11 ha/h. The cost of operation of the machine is Rs. 135/h.
- An animal operated solar powered sprayer has been developed for tall and widely spaced field crops such as maize, sorghum, red gram, cotton having height of 450-1500 mm and row spacing of 400-1500 mm. The field capacity and field efficiency of this sprayer are 1.14 ha/h and 80%, respectively. The cost of animal operated sprayer is Rs. 1,13,500/- and operating cost is Rs. 310/ha.
- A tractor operated variable width raised bed planter-cum-herbicide applicator has been developed to suit geometry of crops such as pigeon pea, cotton, sorghum etc. It reduces the energy requirement by 35% as compared to the conventional seed drill. About 15-35% increase in yield is reported with this equipment in black and sandy loam soils.
- An opto-electronic seed monitoring system has been developed for sensing the seed flow from seed metering unit of the planter with the seed uniformity ranged between 97.8 - 99.3%.
- A rotary weeder for low horse power tractor (18-20 hp) has been developed and tested. Its weeding

efficiency in pigeon pea is 82.5% and in maize crops is 73.9%. The cost of the machine is Rs. 30,000/- and its operating cost is Rs. 600/h.

- A pro-tray or bag filling machine operated by an electrical motor (1.5 kW, 3-phase) has been developed for media sieving and mixing. It has a media filling capacity of 2.0 t/h. The cost of the machine is Rs. 5.0 lakhs. About 60% of man power can be saved by this machine per day as compared to manual method of poly bag and pot filling.
- A sensor based automated, real-time system has been developed for non-destructive monitoring of different vital parameters of storage structures i.e., temperature, relative humidity, insects sound, etc.

Value Added products, processes and softwares

- A technology package for production of chemical free grape raisins consisting of a grape de-buncher for detaching intact berries from the bunch, abrasive pre-treatment system for removal of waxy cuticle layer from surface of berries and drying protocol. It was observed that abrasive treated grape berries dried at faster rate (0.73-0.18 g/min-100g) in comparison to chemically treated (0.19-0.09 g/min-100g) with an average reduction in drying time by 2-3 times than the drying of untreated berries. The total cost of machinery is about Rs. 3.85 Lakh. The processing cost of raisins is Rs. 22/kg which is 37% lesser compared to existing chemical process (Rs. 34/kg).
- An FRP material based modular onion storage structure of 1 tonne capacity consists of a storage cage, sensor based automated aeration unit, fumigation unit and gravity discharge system. The weight loss of 20.3%, rotting of 5.07% and sprouting of 0.67% of onion have been observed during storage study at optimized protocol of aeration and fumigation for 180 days.
- A batch type, surface abrasion based peeler has been developed for medicinal root crops. The machine has 5 kg/batch capacity and compatible to crops like safed-musali, aswagandha etc. The peeling operation is hygienic and the peeling efficiency has been observed above 90%.
- Grain treatment system of 200 kg/h output capacity with changing incidental heat flux and exposure time consists of a mid-infrared heating module and conveying system. Variable Frequency Drive (VFD) operated vibratory deck maintained the single layer and uniform heating of grains during conveying.
- Refractance window dryer which works using the principle of heat generation through infrared thermal energy of hot water. This continuous flow dryer is suitable to dry heat sensitive biological materials. A specialized Mylar sheet film fitted in dryer is the key element of heat transfer as well as material carrier.
- Eggless cake has been developed with fortification of flaxseed and chia gel. The developed cake has higher amount of omega 3 fatty acids (7.8%), omega 6 fatty acids (47.4%) and protein content (8.5 g/100g) over conventional egg based cake taken as control for the study. Sensory score of the developed cake was 7.2 on the 9 point hedonic scale.
- A rapid method for aflatoxin detection, based on Vis-NIR hyperspectral imaging system with wavelength between 400-1000 nm has been successfully used to classify the groundnut kernels based on the concentration of aflatoxin.
- An infared radiation pre-tretment protocol has been optimized for dal milling of pigeon pea. The infrared radiation heat reduces the adhesion between husk and cotyledon and among the cotyledons of the pigeon pea grain and hence enhanced the split dal recovery and dehulling efficiency up to 78% and 97%, respectively. The method considerably saves the treatment time and cost compared to conventional practice.
- The drying protocol for medicinal root crops like *Safed musli*, *Shatavari* and *Ashwagandha* has been developed. It involves pre-treatment of drying material with 5% alum for 30 minutes followed by drying at low temperature (45°C).
- The protocol for sample collection of volatile organic compounds (VOC) and their quantification using GC-MS has been standardized. The key VOC's generated due to the infection of *Erwinia carotovora* on onion, potato and tomato has been identified. The identified compounds then fed to the selection of appropriate MOS sensors to be fitted in e-nose.
- Locally available biomass can be utilized in the CIAE developed portable gasifier for engine applications. The gasifier has been equipped with dry type tar cleaning system which consists of a catalyst loaded column for tar cracking. The average gas composition from the gasifier was found to be 19% CO, 8% H_2, 16% CH_4 and 9% CO_2 when char based catalysts made from pigeon pea stalks loaded with 2% Ni was used for tar cracking.

- Production of biogas from in-situ mechanized urea pre-treated paddy straw bales is possible. The urea treated baled paddy straw and cow dung at 10% total solid loading (50:50 ratio)has been fed to a batch bio-methanation digester of 1.1 m^3. The biogas potential of baled paddy straw was observed to be 250 l/ kg of paddy straw.
- Paddy straw can be utilized for cultivation of micro-algae strains to produce bio-fuel. The production process of 'paddy straw hydrolysate based growth media' has been developed. Paddy straw hydrolysate can be used up to 50% with commercial growth media for micro-algae cultivation having 17% of lipid content.
- The efficiency of the solar thermal flat plate collector with nano-fluids increases by 5% when Al_2O_3 nano-particles having 0.02% concentration and 0.01% surfactant have been used.

Studies

- Mobile App on Farm Machinery Package for different Agro-climatic Zones in India has been made. It provides state wise, agro-climatic zone wise, district wise, cropping pattern wise and power source wise model farm machinery package including economic parameters, machine specifications and available manufacturers details. This mobile app can help farmers/Custom Hiring Centres in selection of proper implements, maximize their utility and benefits.
- The demand forecasting of 45 farm implements and machinery in Madhya Pradesh has been done using Structural Time Series Modelling technique. There is an increasing trend in demand of most of farm implements and machinery except for manual and bullock operated implements. The total market size of farm implements in Madhya Pradesh has been estimated at Rs.7.05 billion with 95% confidence limit.
- A laboratory model of batch type bio-crude production unit has been developed. It converts biomass to bio-crude in slow pyrolysis process with a recovery of ~ 48%. The stainless steel reactor has 1 kg biomass loading capacity and can maintain precise temperature up to 700 °C.
- The grain yields of soybean increased significantly in treatments comprising broad bed and furrow (BBF) and mole drainage as compared to the control at 5% level of significance. The increase in soybean grain yields under treatments comprising BBFs and mole drains varied from 23.8 to 67.8% over the control (0.78t/ha).
- Drip irrigation with mulch for wheat has given the highest yield at 6.1 t/ha and the water productivity of 2.2 kg/m^3, it has been assessed over the other treatments of conventional irrigation; surface drip irrigation; rain hose and portable sprinkler irrigation systems.

Technology Transfer, training and capacity building

- A total of 11 technologies were commercialized through licensing and Memorandum of Agreement.
- One cluster demonstration and 11 front line demonstrations/onfarm trials have been conducted.
- One International training programme of 15 days duration supported by AARDO, two short courses, one CAFT training and a model training programme was conducted.
- Under Human resource development programme, training on "Automobile maintenance, road safety and behavioural skills" for drivers of ICAR institute/HQ has been organized in five batches (156 participants).
- Hands on training on improved agricultural equipment have been imparted to farmers in 05 batches for about 351 beneficiaries.
- Entrepreneurship development training on custom hiring (2 batches) and soy food technologies (4 batches) with total participants 72 and 25 respectively has been conducted.
- A total 6331 units of 37 different types of implements were supplied to various stakeholders thereby earning revenue of 66.87 lakhs.
- The farm machinery and post harvest machinery testing centre at ICAR-CIAE, Bhopal and regional centre at Coimbatore tested a total 126 machines under different equipment category and generated revenue of Rs. 122.46 lakhs.

Other achievements

Publication

- The institute published 54 research papers in international and national journals, 8 books, 45 popular articles and 8 technical bulletins.

- The institute has signed MoU with 3 different government and private organizations for undertaking research in collaboration/consultancy/contract mode.

Award and Recognition

- AICRP on FIM received Chaudhary Devi Lal Outstanding All India Coordinated Research Project Award – 2018.
- Scientists of the institute received NASI-ICAR innovation award, Jawahar Lal Nehru best Ph. D. Thesis award, Best Ph. D. Student award from GBPUAT, Pant Nagar, 2 ISAE Fellow, 1 ISAE Commendation Medal, 1 ISAE distinguished service award, 2 Best paper award and 3 best poster/paper presentation award in different seminar and conferences. Two scientists received young scientist award from different societies.

Event

During the year institute organized major events such as National Seminar on "Role of Indian Standards in Testing, Quality Control and Safety of Agricultural Machinery", Workshop on "Mechanization of Cotton Harvesting" and "Soybean Production and Processing"; meeting with Agricultural Machinery Manufacturers, Webcast of Prime Minister's Programme, Nutri Mela 2019, International Yoga day, World Food Day, Vigilance Awareness Week, Swacchta Pakhwada, 150th Birth Anniversary of Mahatma Gandhi, meetings of Institute bodies such as 52nd IMC, 24th RAC and 102 & 103rd IRC.

INTRODUCTION

ICAR-Central Institute of Agricultural Engineering (CIAE), Bhopal, a premier agricultural engineering institute in India, is devoted to promote agricultural mechanization for 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 February, 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 centre at Coimbatore addresses the engineering intervention needs of southern states of the country. To address the wider region specific technological issues, ICAR-CIAE is linked with the whole country through All India Coordinated Research Projects (AICRPs). The institute 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 meteorological observatory, well-furnished hostel and guest house facilities for 80 guests. The Research Workshop provides the facilities for fabrication of research prototypes and the Prototype Production Centre for multiplication. Computer Aided Design cell develops computer aided models and drawings of research prototypes, Agricultural Knowledge Management Unit assists in database creation and conducting online examinations; Instrumentation Cell supports instrumentation in various research projects. The institute library is equipped with computerized cataloguing facility, with around 21000 books and bound journals and a large collection of CD-ROMs (full form) on 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, 'Engineering Interventions in Precision Farming and Micro Irrigation Systems' 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. Trainings and skill enrichment programmes of different type of stakeholders *viz*., farmers, manufacturers, upcoming entrepreneurs, extension functionaries, teachers, students, etc. of either gender has been 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 is being continued. The details of personnel and finance during the year 2019 are shown below.

Staff Position (as on 31.12.2019)

Posts	Sanctioned	In position	Vacant
RMP	1	0	1
Scientific	89	76	13
Technical	144	90	54
Administrative	73	49	24
Skilled Support Staff	42[#]	26	16
Total	**349**	**241**	**108**

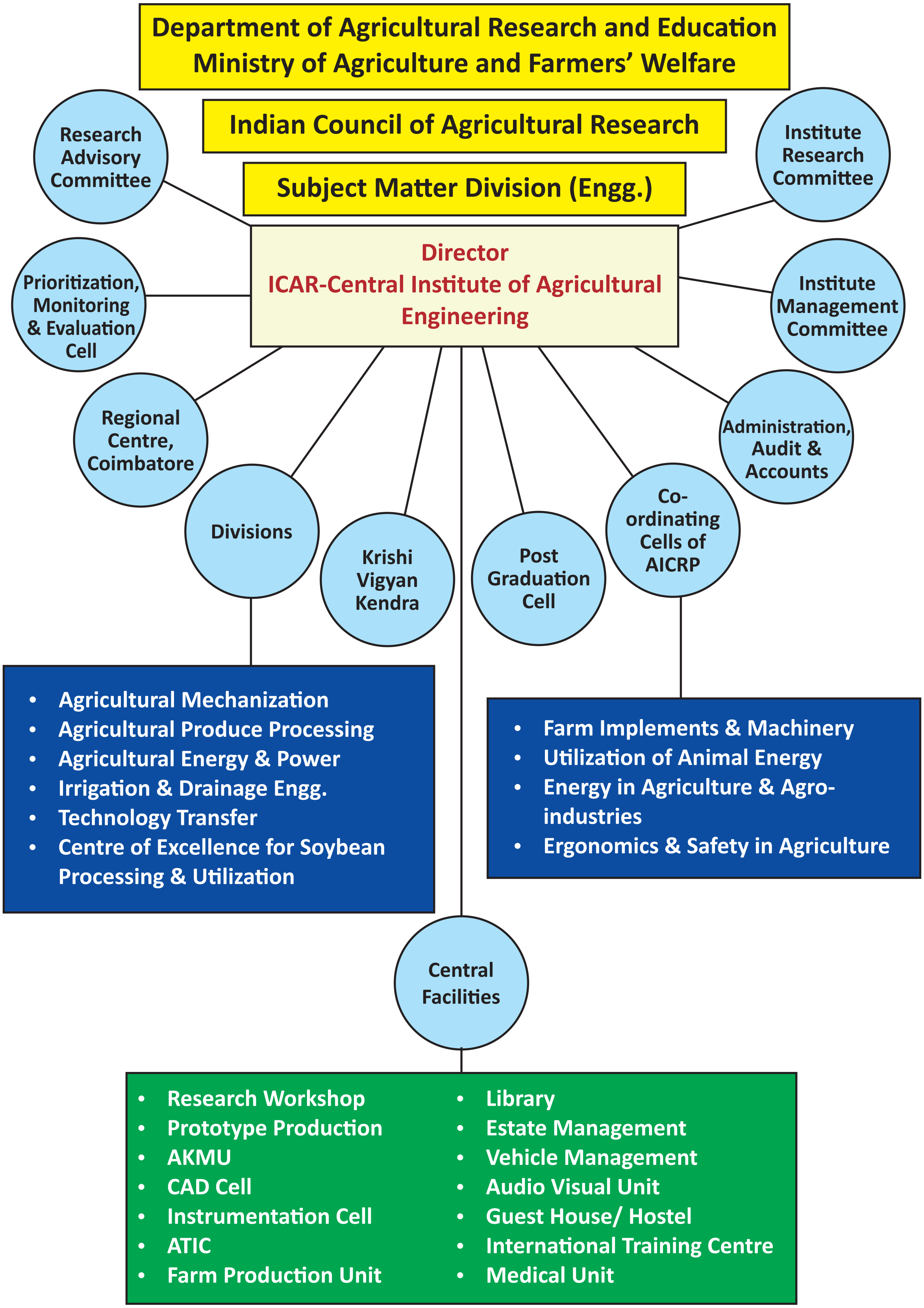
As per council letter no F. No. 14-2/2017/E-I(R&P) dated 17thJune, 2019

Budget 2019-20 (Rs in lakh)

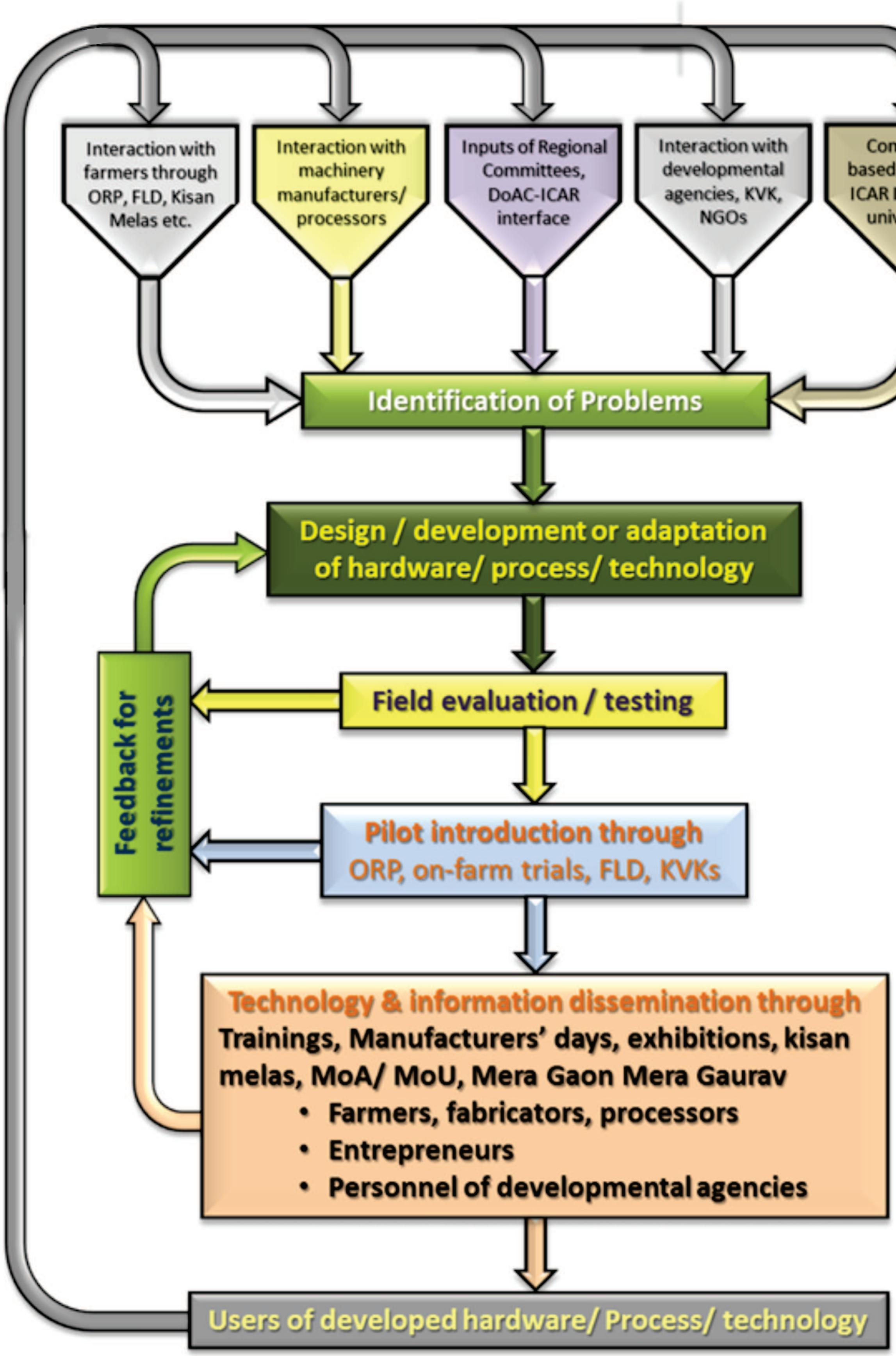
Scheme	Sanctioned	Expenditure*
ICAR-CIAE	6135.00	4701.10
AICRP on FIM	1413.03	1212.03
AICRP on EAAI	1207.60	945.87
AICRP on UAE	477.80	389.56
AICRP on ESA	585.36	544.84
CRP on FMPF & MIS (formerly FM & PF)	150.80	113.98
CRP on EA	125.51	75.87

* Expenditure till 31 Dec, 2019

Organization Structure



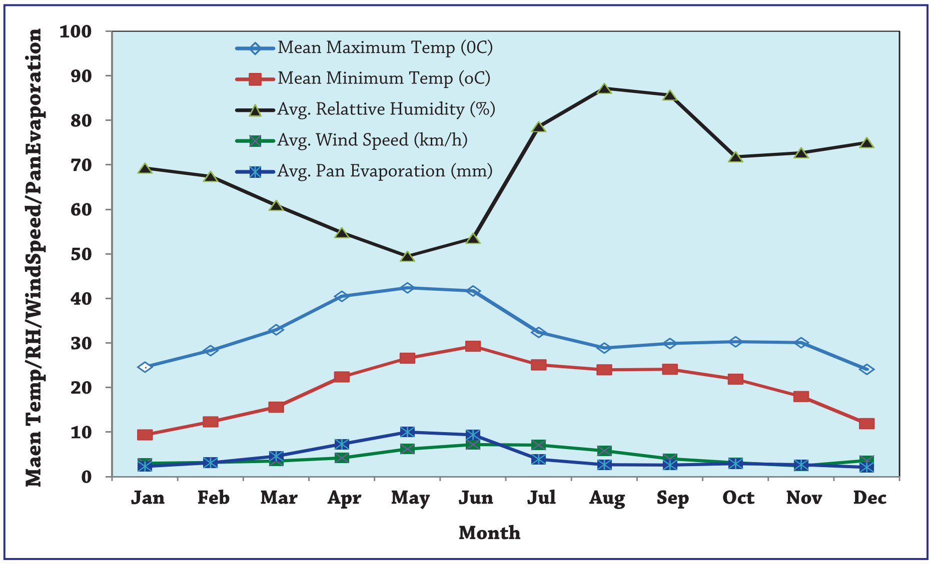
Technology Development Process of ICAR-CIAE

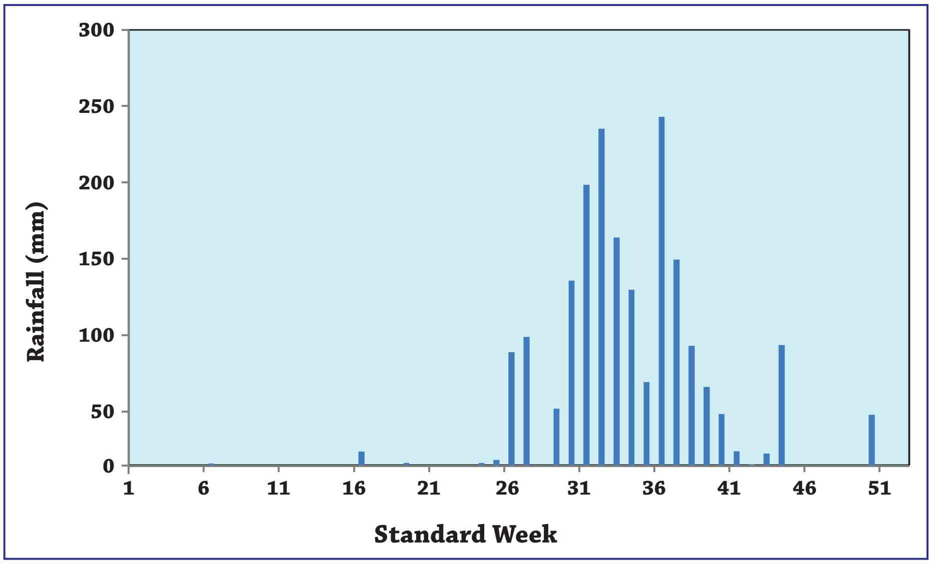


Meteorological Observations

Agro-meteorological observatory of the institute is located at 77°25' E longitude and 23°16' N latitude at an elevation of 498.7 m above mean sea level. Rainfall, minimum and maximum temperatures, relative humidity, pan evaporation and wind velocity are recorded on regular basis. Salient meteorological observations for 2019 are:

- Monsoon started on 27 June and withdrew on 14 Oct, 2019. The highest rainfall of the season (147.6 mm) was recorded on September 09, 2019. Annual rainfall of 1805.6 mm occurred in 70 rainy days during the year 2019.
- The maximum temperature of the year (45.0 °C) was recorded on 28 May, 2019 while minimum temperature (3.8 °C) was recorded on 29 Dec, 2019. Humidity in the morning (7:20 AM) varied from 41 to 100 per cent while in afternoon (2:20 PM) it varied from 16 to 98%.
- The highest average wind velocity of 11.4 km/h was recorded on 16 Aug, 2019, while the lowest was 1.2 km/h on 15 Oct, 2019.
- The highest pan evaporation of 15.2 mm/day was recorded on 08 June, 2019 while the lowest was 1.2 mm/day on 17 Dec, 2019.





RESEARCH AND DEVELOPMENT

AGRICULTURAL MECHANIZATION

Technologies Developed

Tractor operated high speed planter for soybean

Soybean–wheat is the dominant cropping system of central India and is being currently practiced in 4.5 million ha on vertisols. The time available for sowing of soybean during *Kharif* season is very small due to rainfall pattern. The conventional seed drills for soybean operates at the forward speed of 3-4 km/h, which reduces the area covered per unit time. The timeliness in sowing can be achieved by increasing either width or speed of sowing machine. Since more width requires more headlands, efforts have been made to develop high speed planter for soybean and like crops. The developed high speed planter has a size of 2400×1560×1350 mm and row to row spacing is adjustable between 200-900 mm. The planting unit consists of a seed hopper of 7 kg capacity, metering mechanism, tine, shaft and accessories. The planting mechanism is driven by ground wheel using chain and sprocket system. The machine has two provisions of 100 mm and 50 mm spacing for soybean planting. The miss index, multiple index, quality of feed index and precision index are found to be 1.67, 14.38, 83.95, and 22.34, respectively at 7 km/h speed of operation and 100 mm spacing of soybean, whereas the width of operation, field capacity, field efficiency of the machine are found to be 2100 mm, 0.9 ha/h, 68%, respectively. The cost of operation is Rs. 740/h. The break-even point and payback period of the machine are 48 h and 2.9 year, respectively. It saves 64.3% of time with respect to conventional planter at 2.5 km speed of operation.

Deep placement fertilizer applicator as an attachment to ride-on type rice transplanter

To overcome the loss of nitrogenous fertilizers a sensor based deep placement fertilizer applicator as an attachment to ride-on type rice transplanter has been developed. It consists of electronic metering mechanism system, which involves Arduino Uno micro-controller, proximity sensor 10A relay, 12V 2A two DC motors and metering plate with orifice hole. The proximity sensor attached near to the planting unit detects the movement of rotary arm. Signals received to the programmed Aurdino Uno gives commands to two wiper rotors, which makes the metering plate to meter urea for the selected distance. The orifice holes size of 8 mm diameter are made in the metering plate to meter the urea. The power to the electronic control system is provided through the rice transplanters battery. The blower is attached with the fertilizer unit to avoid the blockage of urea in the delivery end and to ensure easy flow of fertilizer at required amount and depth. The battery operated 7 kg rotary type fertilizer (potash-phosphorus) spreader was attached backside of the rice transplanter to distribute potash and phosphorous at the time of transplanting. The performance parameters of rice transplanter with deep placement fertilizer applicator such as fertilizer application efficiency, field capacity and field efficiency are found to be 71%, 0.16 ha/h and 82%, respectively.

RGB-Infrared thermal imaging camera

The crop stress monitoring is an important component for real time application of irrigation to field crops. The commercially available thermal imagers have limitations for their application in spatial data collection along with location coordinates and real time data processing. In addition, they are costly and cannot be integrated with actuation system for real time communication. To overcome these issues, a RGB and infrared thermal imager (FoV: 60°) has been developed. The developed module is tested under laboratory as well as field condition. The RGB and thermal images of wheat crop has been captured and their GPS locations are stored in Raspberry Pi board. Serial communication protocol is used for transferring of pixels to micro-controller. The RGB and temperature pixels are processed in software and pixels are plotted in the form of image. These pixels display real time RGB and thermal images with max., min. and mean temperature

on screen. The maximum, minimum and mean temperatures in winter wheat crop at CRI stage are found to be 22, 14 and 14.75 °C, respectively. The temperature resolution is 0.25 °C and measurement accuracy is 2.5 °C. The developed imager can be utilized for crop stress monitoring and real time application of irrigation scheduling.

Small tractor mounted hydraulic platform

The development of suitable matching equipment for small tractor is of prime importance due to small fragmented land holdings, hill agriculture, shifting cultivation and lack of mechanization for leading horticultural sector. The hydraulic platform is one of the several matching equipment for small tractor developed and evaluated at ICAR-CIAE, Bhopal. It

consists of trailer, frame with four bar linkage mechanism, Fibre reinforced plastic (FRP) bucket, gear housing, double acting hydraulic cylinder, hydraulic motor and hydraulic valve. Hydraulic system of the tractor is modified to provide power to the platform. Gear housing is coupled with a hydraulic motor to give rotational movement of 180° to FRP bucket arm installed on the trailer to cover the left and right side of the orchards crop. The raising and lowering of the platform is actuated by a double acting hydraulic cylinder. The operating height of the machine is 3 m. Overall dimension of the system is 3000×1500×1450 mm, it weighs 700 kg and its load carrying capacity is 150 kg. Spraying system (500 l tank capacity) has been attached with platform for application of fungicides/ pesticide from top of the plant aiming at uniform distribution over the canopy. The time required for spraying is 30 s/plant and turning time is 60 s. The field capacity and field efficiency of the machine are found to be 0.3 ha/h and 85%, respectively for orchards having 6 × 6 m plant geometry. Cost of and equipment is Rs. 4,00,000/-. Operating cost of the equipment is found to be Rs. 6520/ha. The developed system can also be used for other operations in orchard crops like pruning, spraying and fruits plucking.

Tractor operated potato combine

A tractor (50 hp) operated single-row potato combine suitable for 600-650 mm bed size has been designed and developed at the institute. The equipment consists of digging unit, soil separation unit, haulm separation unit, clod separation unit, potato collection unit and bagging unit. Soil-potato mass after digging by a V-scoop type blade passes over the soil separation unit where loose soil gets separated. Haulm gets separated from the potatoes at the top most section of soil separation unit where potatoes with clods fall over counter rotating cylinders. The counter rotating cylinder passes the potato clod mixture over a conveyor belt, where the clods are separated from the potatoes by manual picking and the clean potatoes are delivered

into a temporary storage tank. The clean potatoes are then transferred to gunny bags, which are passed on to ground after stitching. The field capacity and field efficiency of the potato combine are found to be 0.16 ha/h and 94%, respectively. The harvesting efficiency of the machine is 90% to 97% depending on field conditions. Total weight of the machine is 3000 kg. The cost of the potato combine is Rs. 7,50,000/- and the operational cost of the developed potato combine comes around Rs. 1,270/h.

Liquid urea spraying system retrofitted on straw baler

One of the possible ways to increase the digestibility of poor quality roughages like rice and wheat straw is urea treatment. Urea treated straw is liked by cattle and it helps to increase the milk production and body weight of animal. Conventionally, the straw is mixed with urea solution manually; handling task could be minimized substantially by treating straw with retrofitted urea

solution spraying system on straw baler. Therefore, a urea solution spraying system is developed and used for real time spraying of urea solution while baling of wheat and paddy straw. The working capacity and size of bales remains same, however after application of urea solution the weight of bales and moisture content increase in the range of 50 to 70%. Urea treated bales have been wrapped with polyethylene sheet and stored for three weeks at room temperature. The baled wheat and paddy straw samples have been subjected to nutritional analysis for crude protein (CP), total ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), dry matter digestibility (DMD), in vitro organic matter digestibility (IVOMD) and metabolizable energy (ME) of the feeds. The bales have been treated with three levels of urea solution i.e. 6, 8 and 10 kg urea have been mixed with 100 l of water. Due to treatment of urea solution, the CP content has increased in all the treatments and ranging from 9.14 to 13.41% for wheat and 8.93 to 12.28% for paddy straw. The nutritional analysis shows the enhancement of nutritional value of treated straw in the recommended range of ash content, NDF, ADF, IVDMD, IVOMD and ME. On the basis of overall nutritional analysis, treating the straw with urea solution (8 kg/100 l) for paddy straw (50% moisture content) and wheat straw (70% moisture content) is recommended for urea spraying system of straw baler.

Tractor operated cassava harvester-cum-lifter

The tractor operated cassava harvester has been developed by ICAR-CIAE regional centre for harvesting of cassava and lifting of the tuber. The equipment consists of main frame, digging unit, conveying unit, transmission system and cluster breaking system. The conveying system consists of two endless gripper belt (counter rotating) of 3700 mm length. The power is transmitted from tractor PTO to transmission gear box through universal shaft. The power is then transmitted from gear box to conveying mechanism and cluster

breaking blade through suitable belt drives. The cost of the equipment is Rs. 80,000. The effective field capacity of the planter is 0.22 ha/h. The cost of operation of the equipment is Rs. 2,265/ha and it saves 82% cost as compared to manual harvesting.

Gender friendly operators work place layout of Indian operators

Designing an operators work place layout on self-propelled machines (e.g. tractor, combine harvester etc.) involves placing of various controls within optimum reach of the operator. Hand and leg reach envelopes, constituted of optimum and maximum area provides the basis for placement of various hand and leg operated controls at the proper location, have been developed for Indian operators. Ten tractor models of different makes, which are widely used on Indian farms in the power range of 23 to 50 kW, have been selected randomly for evaluation of operators' workplace. The locations of different hand and leg operated controls and their actuating forces on the selected tractors have been measured. The measured locations of frequently operated controls on selected tractors have been superimposed on the gender-neutral reach envelopes to know whether the controls placed within or beyond reach. It has been observed that 8 to 58 % of the controls on selected tractors were either in optimum area or in maximum area based on side view of reach envelope. Similarly, 15 to 54% of the controls are either in optimum area or in maximum area of the plan view of reaches envelopes. Rest controls are found to be outside the optimum reach area and needs careful consideration for better comfort to operators. A gender-neutral tractor operators' workplace mock-up has also been developed to accommodate 90% population of both male and female tractor operators. The workplace mock-up has been evaluated with 10 male and female operators each, which revealed that the body-joint angles such as angle of upper arm to vertical (25-40°), wrist angle (172-186°), elbow angle (95-120°), knee angle (100-115°), ankle angle (87-96°) are well within comfortable range. By considering the suitability of workplace for a 5^{th} percentile female and 95^{th} percentile male operators, it is recommended that on a gender friendly tractor, the hand controls should be placed between 186 mm and 380 mm in the vertical direction above SIP and within ± 424 mm from SIP in lateral direction. The hand controls should not be located nearer than 318 mm and farther than 430 mm in the horizontal direction from SIP. Similarly, the leg controls may not be located nearer than 410 mm and farther than 452 mm in the horizontal direction from SIP and nearer than 261 mm and farther than 373 mm downward from SIP, respectively.

Mobile App for selection of farm machinery package for different agro-climatic zones of India

Many factors like soil, climate and cropping pattern are different across the the country in different agro-climatic zones. Similarly, availability of farm power source with farmers and custom service providers could be different in various parts of the country. Selection of proper implements requires expert decision to maximize the utility and benefit to cost ratio. Therefore, the institute has developed a Mobile App on Farm Machinery Package for different Agro-climatic Zones in India. It is freely available on the Google play store. Developed product is able to provide state wise, agro-climatic zone wise, district wise, cropping pattern wise and power source wise model farm machinery package economic parameters (machine cost, per hour operating cost, hiring rate, total annual cost and net return, break-even analysis, payback period), machine specifications and available manufacturers details for different agro-climatic zones/districts of India.

Market potential and demand forecasting of farm implements and machinery

Availability of quality farm Implements affects the level of farm mechanization in a region. To know the status of farm machinery manufacturers, a study has been carried out at ICAR-CIAE, Bhopal. The total market size of farm implements in Madhya Pradesh with 95% confidence limit has been estimated to be Rs.7.05 (6.79-7.31) billion. The information on gap in production potential and demand of farm implements helps in formulating the farm mechanization schemes/programs. To tackle this, production potential and demand of 45 different farm implements have been estimated for the year 2018-19. It is found that production potential of the implements like rotavator, laser leveler, reaper, combine harvester, chaff cutter and spray pump are less than its demand. The implements like mould board plough, reversible mould board plough, cultivator, seed drill, seed cum fertilizer drill, maize planter, multi-crop thresher etc. are having more production potential as demand. The demand forecasting of all the 45 farm implements has been done using Structural Time Series Modelling technique. Decreasing trend in demand of bullock operated implements like seed drill, bakhar, blade harrow and bund former have been observed. Decreasing trend has also observed for manually feeding potato planter because this is being replaced by automatic potato planters. Except for these implements, all the implements show increasing trend in demand.

Technologies under development

Induction based air assisted electro-static nozzle

Electrostatic spraying helps to increase pesticide droplet deposition on biological surfaces of living crops and increase input use efficiency of chemicals used for plant protection. An induction based air assisted electrostatic nozzle has been developed. The chargeability of electrostatic nozzle is a function of electrode geometry, dimension, position, material and applied voltage.

Different conductors have different electric conductivity and it also varies with the shape, dimension and location of the electrode from the tip of the nozzle. Flow of liquid is actuated by the hydraulic switch with separate air assisted arrangement in the nozzle. The charge to mass ratio is being determined using faraday cylinder test setup.

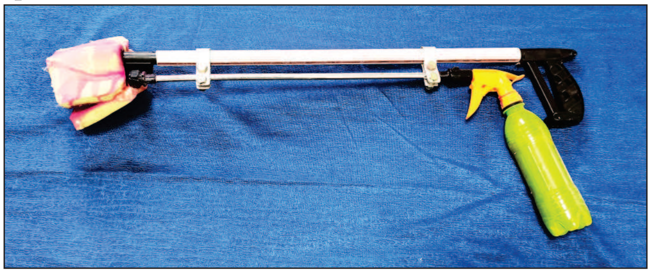
Manually operated liquid injector for orchard crops

Based on the anthropometric design parameters, a manually operated hand sprayer has been developed for spraying kerosene, petrol, insecticides or for maline in the caterpillar holes present on the litchi and guava trees. This tool consists of spraying pump and flexible rod which is having pointed edge, outer diameter of 2 mm, inner diameter of 1 mm and length of 300-550 mm. It has overall dimensions of 28 mm × 33.7 mm × 24.3 mm and capacity of 100 ml. An extension of the nozzle has been provided to kill the

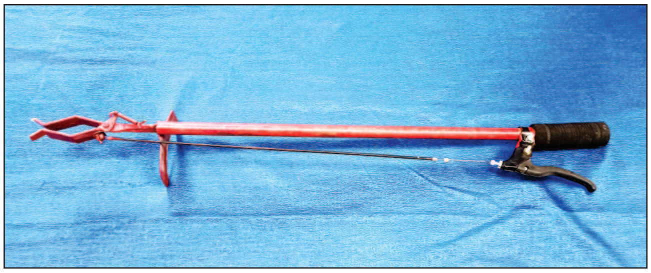
caterpillar that lives in boring holes of a litchi tree. Preliminary trial of the injector has been conducted on guava tree since similar kind of caterpillar infection has been found in litchi tree. The average application time per tree has been found to be less than a minute. The spraying system is handy and safer in operation than conventionally adopted spraying system.

Manual tools for chemical swabbing and bark removing operations in grape cultivation

In grape cultivation, the chemical swabbing operation involves application of highly toxic hydrogen cyanamide to induce bud break in grape vines, which is done within 48 h after pruning. This operation required about 25-30 man-days/ha and carried out twice in a year. It involves high risk to workers because exposure to chemical produces skin damage, itching, hypertension, nausea and vertigo in workers. To avoid the growth of pest and insect especially mealy bugs under loose bark, bark is removed from grapevine manually, that required about 100 to 125 man-days/ha. In order to make these operations, viz. chemical swabbing and bark removing safer and comfortable hand tools and equipment for these operations have been developed. The chemical swabbing tool consists of the lever, handle, spray pump, jaws and weighs 0.35 kg. Its length, width and height are 770, 140 and 300 mm, respectively. The bark removing tool has length of 900 mm, width of 100 mm and height of 70 mm. The jaws operate between 20 -80 mm.



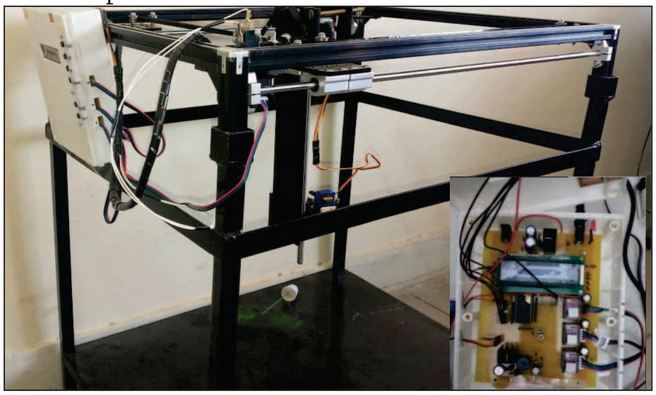
Chemical swabbing tool



Bark removing tool

Seedling pick-up mechanism for robotic transplanter

Manual transplanting of vegetable seedling in field is time consuming as well as labour intensive operation. Due to lack of manpower during transplanting operation and to ensure timeliness in operation, a seedling pick-up mechanism using robotic arm is being developed for robotic transplanter for plug-type vegetable seedlings. The mechanism consists of main frame for XY-axis, stepper motor, manipulator, end-effector and control unit. The stepper motor attached to main frame moves the manipulator in XY-axis whereas the manipulator moves in the Z-axis.



The end-effector attached on the manipulator has a gripper which is mounted on the servo motor. The seedling picking mechanism is integrated with the manipulator using computer programming using a microchip. The end-effector grasps the seedling, picks-up and moves to the XY (0,0) coordinate, and release the seedling. The developed mechanism can extract 3 seedlings/min. The potential use is to enhance input use efficiency for sustainable productivity and reduce drudgery by avoiding manual practice.

Tractor operated side trencher

The FYM application in grapes is being done manually by digging a continuous trench near the plant, which is a drudgery prone activity. A side trencher-cum-FYM applicator has been developed in collaboration with ICAR-NRCG, Pune to introduce the mechanized practice of FYM application in grape orchards to enhance input use efficiency for sustainable

productivity and reduce drudgery by avoiding manual practice. The side trencher has adjustable width as well as depth. The width can be varied from 2.4-3.0 m as per the cropping pattern. The trencher can dig upto a depth of 300 mm.

Tractor operated drip lateral-cum-plastic mulch laying machine for raised bed

The application of plastic mulch along with drip irrigation system is getting popularized in many parts of the country. The manual practices of drip lateral laying, plastic mulch laying and covering, punch making in sheets and seed placement are drudgery prone and time consuming operations. Therefore, a drip lateral-cum-plastic mulch layer has been developed as a mechanized solution to the above problem. Based on the selected crops' geometry (okra, green pea, sweet corn) and design considerations, a variable width raised bed former has been developed and integrated in the machine. The maximum draft of 5274 N and vertical force of 3438 N is required for pulling the equipment.

The drip lateral-cum-plastic mulch layer is suitable for variable width of raised bed, plastic mulch (1000-1500 mm), various drip lateral diameter different width of (<30 mm), soil properties, etc. It has been found that the field capacity and field efficiency of developed machine are 0.26 ha/h and 65%, respectively.

Tractor operated three-row garlic dibbler

In garlic sowing, the cloves are placed in line at a depth of 30-40 mm and maintaining the desired spacing between the rows and plants. About 65-85 man days are required for planting of garlic cloves in one hectare. Existing garlic planters are not maintaining the seed to seed spacing. Due to higher seed rate and uneven seeding by existing seed drills, the farmers prefer manual sowing. To address this problem, a small tractor drawn three row dibbler has been developed for precise dibbling of garlic cloves on broad beds. It can maintain the seed to seed spacing of 100 mm and row to row spacing of 150 mm. It consists of main frame, dibbling unit, metering unit, stationary cups, seed box, cam and guide, depth control wheel, power transmission unit, and three point hitching system.

Sixteen cups are mounted on a rod attached to the periphery of disc. The cups are attached to the rod in such a way that they will remain in vertical position during operation. An offset disc arrangement is used to provide the vertical position to the cups. The opening and closing of cups is done with the help of cam

arrangement. Leveling roller is attached to the main frame in the front of the dibbling unit for leveling the soil and providing the uniform soil surface to the cups of dibbling unit. The chain and cup-type metering unit is being fabricated for picking the garlic cloves from the seed box and dropping in to the cups of dibbling unit. Precision planting with minimum losses of seeds can be done with this machine to achieve the higher productivity of garlic.

Tractor operated garlic harvester for raised beds

Harvesting is one of the most laborious and time consuming operation in garlic production. It is done manually by pulling the plants by hand in a bending posture and requires about 50-60 man-days/ha. The garlic bulbs are difficult to harvest manually under black cotton soil condition. To overcome the problem, a tractor operated garlic harvester has been developed. The machine is suitable for harvesting of garlic crop sown on broad beds of 150 mm height and 1200 mm top width with 300 mm furrow width. The cutting discs have been provided to cut the furrow slice vertically. The triangular point blade having 10 knives is attached in front of conveying unit to loosen the soil, easy penetration and less draft requirement. The machine has chain type conveying mechanism made of mild steel bars of 12 mm at spacing of 38 mm attached to the belt. The conveying unit is rotated through belts and pulleys after getting drive from tractor PTO and gear box.

Self-propelled carrot harvester cum de-topper for hilly region

The developed self-propelled carrot harvester consists of digging unit, conveying unit, de-topping unit, collecting unit, main frame and prime mover with power transmission system. The de-topping unit consists of circular blade to de-top the crop canopy from the carrot root. The digging efficiency, conveying efficiency and de-topping efficiency are found to be 92.16%, 97.14% and 97.84% respectively. The average crop damage has been observed as 7.35%. The actual

field capacity and field efficiency are 0.028 ha/h and 78.7%, respectively.

Manually operated EPN (Ehtyl p-nitrophenyl thino benzene phosphonate) applicator

Developed unit consists of chemical tank, pump, lance, injection mechanism and punching mechanism. Siphon mechanism has been used for the application of EPN solution in to the root zone. The manually operated EPN applicator injects the required quantity i.e 50 ml per plant. The actual field capacity is recorded as 0.02

ha/h with field efficiency of 69.4%.

Equipment package for banana cultivation

Following equipment have been developed for mechanized cultivation and drudgery reduction of banana.

Banana sucker paring equipment

The equipment consists of a holder on which the banana sucker is placed. The spring loaded holder from the top gives the grip on the sucker to be trimmed and it can be locked in the required position. The holder is rotated with the help of 0.73 kW (1 hp) motor at the required speed. The trimming knife is placed such that banana sucker placed on the rotating holder is trimmed to the desired shape to get the paired banana sucker ready for planting. An additional knife is mounted on the working platform, which can be used to cut the bottom

roots before placing it on the holder for trimming. The equipment is best suited for large size suckers. The capacity of the equipment is about 120-150 suckers per hour, the overall size of the equipment is 1145 × 515 × 1825 mm. The cost of the equipment is Rs. 80,000/-.

Banana pseudo stem injector

The equipment consists of a chemical tank (16 l capacity), peristaltic pump, control unit with non-return valve. The unit has been field tested at ICAR National Research Centre for Banana, Trichy. The quantity of liquid injected per tree is 2-4 ml and coverage is 140-150 trees/h. The spillage percentage and injector efficiency are recorded as 2% and 95%, respectively.

Banana bunch harvester

The developed bunch harvester consists of main frame, harvesting boom, bunch holder, cutting system and power transmission system. The unit has been field tested at ICAR-National Research Centre for Banana, Trichy. From the field observations, it is found that the height of reach is 1.1 to 2.7 m, weight of bunch handled is 18-25 kg and the coverage of harvester is 25-32 trees per hour.

Technologies developed

Solar powered prime mover for spraying and weeding operations

A solar powered e-prime mover for spraying and mechanical weeding operation has been developed.

This is a facility to provide complete solar solution with modular components having smart battery charging system for better maneuverability in different farm operations. The prime mover is powered with semi-flexible solar panel mounted on roof of the prime mover and batteries (48V, 100AH) for spraying and weeding. Pump for the spraying unit is DC diaphragm pump of 14 V which can develop 10 bar (150 psi) pressure at 7.5 l/min. For weeding, a 350 W DC motor has been used. The system has provision for switching between battery and solar. The unit is ergonomically designed with all safety features for increasing maneuverability. The gross weight of the prime mover and all other accessories including driver of 70 kg has been maintained below 450 kg. Chemical storage tank is placed behind the driver seat at a height of 455 mm. The steering wheel has the king pin inclination of 5° and camber angle of 3°. Workplace design of prime mover has been conducted to locate different controls as per 5^{th} and 95^{th} percentile of operators. The overall dimension (1060×950×1300 mm) of workstation has been made to suit most of the drivers. All the controls in the workstation are suitably placed within operator reach envelope. Driver seat has been provided with adjustment of 100 mm in order to facilitate the shorter operators.

Batch type bio-crude production unit

A laboratory level batch type bio-crude production unit capable of converting biomass to bio-crude in slow pyrolysis mode has been developed. The stainless steel reactor has a loading capacity of one kg powdered biomass. Precise temperature control of ambient to 700 °C can be achieved. The unit has been tested with recovery of approximately 48% biocrude. The condenser has been designed with concept of tube-cell heat exchanger with provision of cleaning in case of excessive tar deposition. There is also provision for injecting nitrogen for maintaining inert atmosphere during pyrolysis process. Pyrolytic behaviour of biomass can be studied in this unit.

Technologies under development

Portable gasifier with in-built tar cracking system

The portable gasifier has been designed to deliver clean gas with average tar content of 28 mg/Nm^3. The gasifier unit consists of a reactor with inbuilt tar cracking system. The catalysts bed has been made outside the periphery of the oxidation zone so as to maintain a temperature of catalyst bed around 700°C which is necessary for maximum tar cracking. The air flow rate in the gasifier can be varied for an output of 15-20 kW depending on the biomass and gas composition. The unit is equipped with two gas cleaning columns. In the first stage, gas is passed through a cyclone separator to separate the large particles of char and then passed through a cooling column filled with steel sponges. The cooling tower is jacketed and water is used for indirect cooling. By this method, gas temperature can be

lowered down to 55°C and major part of tar is condensed here. In the second stage, the gas is allowed to pass through a column filled with wood chips and saw dust, and finally through a bag filter for separation of smaller char particles. The unit has been tested with 8 mm pellets made from chick pea stalks with an average calorific value of 18 MJ/kg. The average gas composition was found to be 19% CO, 8% H_2, 16% CH_4 and 9% CO_2. Char based catalysts made from pigeon pea stalks and loaded with 2% Ni was used for tar cracking.

Biogas production from urea pretreated paddy straw bales

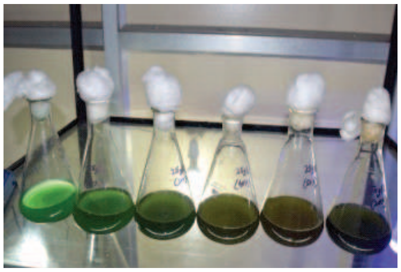
Whole value chain approach to utilize paddy straw for exploring its biogas production potential and addressing the mechanization issues in collection of paddy straw at plant site has been adopted. The production process used is co-digestion method. A 75:25 ratio of urea treated baled paddy straw and cow dung at 10% total solid loading is fed in a batch bio-methanation digester of 1.1 m^3. Daily biogas production has been observed for a period of 150 days and cumulative biogas yield is found to be 22,450 litre. The biogas potential of baled paddy straw has been observed to be 250 l/kg of paddy straw. Temperature variation in the treatment is observed to be in the range of 21-42 °C. The methane content in the gas has been measured to be in the range of 50-56 % along with CO_2 and other trace gases. The bio-fertilizer produced from the unit is in the range of 60 - 70 kg per batch. This study indicates that anaerobic digestion technology is a most efficient way in terms of energy output/input ratio for handling paddy straw to produce energy and bio-fertilizer.

Micro-algae production using crop residue hydrolysate based growth media

Microalgae based third generation bio fuels are getting attention in recent years. There are few strains of microalgae which utilize plant substrate. Paddy straw is abundantly available in India and creating environmental issues. This can be utilized for cultivation of microalgae strains to produce bio fuel. The production process of paddy straw hydrolysate based growth media has been developed. Utilization of paddy straw for microalgae production increases economic feasibility of biofuel generation from microalgae. Process of hydrolysate production from paddy straw is optimized based on experiments carried out by varying parameters such as concentration, temperature and shape of paddy straw. Depending on the growth of microalgae *Chlorell vulgaris*, duration for hydrolysis and ratio of paddy straw to water are decided. Selected water treatments have proportion of whole paddy straw: water as 0.25 g: 10 litre (T_1) and 0.5 g: 10 litre (T_2). It is observed that paddy straw hydrolysate can be used up to 50% with commercial growth media for microalgae cultivation having 17% of lipid content.

Paddy

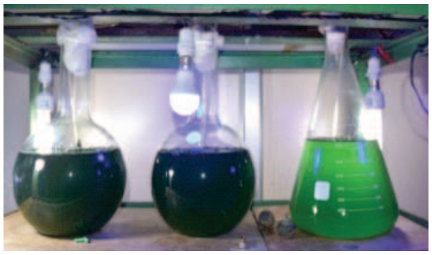
Hydrolyzate media



Microalgae

Microalgae

Race way pond



Up scaling of inoculums

IRRIGATION AND DRAINAGE ENGINEERING

Technologies developed

Set up for determination of retention properties of filter media

An experimental setup has been established to understand the interaction and process of filtration with different solute concentration and media sizes. Different sizes of media (sand, grit, gravel) based on d10size were selected (sizes of media obtained by sieve analyzer). The particle size for the experiments have thus been kept as 15-25 mm for gravel, 5-8 mm for grit and 0.3-0.8 mm for sand. The filter media column made of PVC pipe of 110 mm diameter and 1.2 m height (1 m test height) has been used. The wastewater is pumped using peristaltic pump at lower end of the column, passed through vertical column and discharge is collected at the top end of the column. Experiments have been conducted to determine retention capacity of media fractions among different flow rates established for 12 h, 24 h, 48 h and 72 h retention periods as per the porosity of the selected media. Three samples from the output for each experiment have been analyzed for various physico-chemical parameters. The removal efficiency of heavy metals and other pollutants has been optimized and found to be maximum at 48 h retention period.

Wheat under different micro-irrigation systems

Studies on the effect of different micro irrigation systems on wheat (Var: HI-1544) crop production was conducted for three consecutive year. The details of the experimental treatments are; conventional irrigation; drip irrigation; rain hose; portable sprinkler and drip irrigation plus plastic mulching. While the first four treatments of wheat crop sowing have been done with the raised bed seeder by maintaining 225 × 50 mm spacing, the last treatment single seed has been dibbled at 250 × 25 mm spacing.

Data on wheat crop performance under different micro irrigation systems has been analyzed. The different crop growth and yield parameters under different treatments are presented in the following table. The highest plant height and effective number of tillers per m^2areobserved under drip with mulch (965 mm & 492) followed by drip irrigation (954.2 mm & 478) and lowest observation is recorded in flood irrigation (862.6 mm & 380).The yield contributing characters viz., ear head length (mm), ear head weight (g), no of grains per ear, 1000 grain weight (g) are also recorded highest in drip with mulch. The highest yield of 6.05 t/ha was obtained under drip irrigation with mulch and lowest yield was recorded under flood irrigation (4.62 t/ha). The highest water productivity of 2.20 kg/m^3 has been obtained under the treatment drip irrigation with plastic mulch wheat crop. Perusal of the data indicates that for enhanced water use efficiency and yield over conventional system of wheat cultivation, micro irrigation systems can be adopted.

Performance of wheat under different treatments

Parameter	Flood Irrigation	Drip Irrigation	Sprinkler Irrigation	Rain hose Irrigation	Drip+ Mulch
Plant height at maturity, mm	862.6	954.2	863.0	925.0	965.0
No of effective tillers	380	478	445	471	492
Ear head length, mm	111.6	132.0	112.0	113.0	115.2
Ear head weight, g	3.24	3.36	3.19	3.50	3.62
No of grains/ear head	62	75	66	79	81
1000 grain weight, g	42.63	44.25	43.73	45.47	45.90
Yield, t/ha	4.62	5.15	4.79	5.67	6.06
Water productivity, kg/m^3	0.66	1.78	1.49	1.67	2.20

Technologies under development

Feasibility of broad bed and furrow and mole drainage system in Vertisol

A study has been carried out to investigate the effect of broad bed furrow (BBF) with mole drainage on productivity of crops sensitive to waterlogging. Field experiment has been carried out with BBF and mole drainage consisting eight treatments and three replications in RBD alognwith standard recommended cultivation practices for soybean crop (Var: JS-2034) during Kharif 2019. BBFs of 70 m length and varying depths (150 mm, 200 mm and 250 mm) were laid out. The mole drainage system of 85 mm diameter drains at 4.0 m spacing and 500 mm depth and drainage sump well were constructed in experimental field (C-4) of

Institute farm. As shown in figure, the seasonal monsoon rainfall in Kharif 2019 was above normal (1618 mm rainfall occurred in 64 rainy days against 950 mm monsoon season rainfall). During crop growth period continuous rainfall resulted in low yield values on account of severe weed growth in absence of intercultural operation and continuous cloudy weather. The grain yields of soybean are found to be significantly higher in treatments comprising BBFs and mole drainage as compared to the control at 5 per cent level of significance. Increase in soybean grain yields under treatments comprising BBFs and mole drains over the control (0.776 t/ha) varied from 23.8 to 67.8%.

Micro-irrigation methods for rainfed multiple cropping systems

A field crop experiment has been conducted to evaluate multiple cropping systems under rainfed and irrigated agriculture for improving the livelihood of farmers with soybean cropping system. Crops namely soybean, pigeonpea, cotton and cluster bean have been sown as per the experimental layout and soybean and clusterbean crops have been harvested. Besides rainfed, drip and sprinkler irrigation systems were imposed at 66 and 100 per cent level of ETc. The Plant growth parameters such as plant height, dry matter content, SPAD values, plant height were recorded periodically at 30, 60, 90 days after sowing & at harvest. The average values of the data and its analysis have presented in following tables. Cotton and pigeonpea were in the field and not harvested till the preparation of this report. The plant height and dry matter accumulation was found highest under the treatment rainfed farming of soybean on flat bed. Whereas, the SPAD value which is an indirect indication of chlorophyll content was found the highest for soybean under the treatment of soybean intercropped with pigeon pea and irrigated at 66% irrigation level.

The data of grain yield/pod yield as well as straw yield/biomass yield for soybean and clusterbean has been analyzed and the soybean yield was found highest under soybean-wheat cropping pattern with irrigation level of 66% of ETc and sown on raised beds. There has been no significant difference in the yield as observed between 66% of ETc and 100% of ETc for soybean-wheat sown on raised beds, however, with other cropping systems, significant difference in yield was observed. The straw yield of soybean however, was found highest under soybean-wheat sown on flat bed with complete rainfed farming. Though, this value is insignificant when compared with raised bed sowing of these crops at irrigation levels of 66% and 100% Etc. The total quantity of water applied includes effective rainfall as well as the irrigation provided through different irrigation methods and levels. A close perusal of the table indicates that highest water productivity has been obtained under soybean-wheat cropping system at irrigation levels of 100% and 66% with not much significant difference found for the same cropping system sown on flat bed. However, under soybean+pigeonpea-wheat, cotton+soybean-wheat the values of water productivity were significantly lower. Soybean grown under pigeonpea and cotton cropping systems has yielded significantly lower than the sole crop. It could mainly be due to shadow effect of

Mean plant growth, yield parameters and water productivity of soybean and clusterbean during *Kharif* 2019

Soybean under different cropping systems	Irrigation method and Irrigation level	Plant height (cm)	Dry matter/ 25 cm row length (g)	SPAD Value	Grain/ Pod yield (t/ha)	Straw/ Biomass yield (t/ha)	Water productivity (kg/m³)
Soybean-Wheat(control)	Farmers'practice (Rainfed)	44.6	75.08	42.33	1.51	2.69	0.11
Soybean –Wheat	Drip (66 %)	40.8	66.45	43.00	1.86	2.68	0.14
Soybean –Wheat	Drip (100 %)	40.5	64.50	43.67	1.85	2.64	0.14
Soybean+Pigeonpea-Wheat	Drip (66 %)	29.1	46.41	44.57	1.05	1.57	0.08
Soybean+Pigeonpea-Wheat	Drip (100 %)	26.0	40.00	43.00	0.99	1.38	0.07
Cotton+Soybean-Mungbean	Sprinkler (66 %)	33.6	70.08	43.14	1.10	2.12	0.09
Cotton+Soybean-Mungbean	Sprinkler (100 %)	34.7	69.66	42.30	1.00	1.62	0.07
Integrated Farming System	Drip (100 %)	60.2	56.33	42.38	1.70	3.90	0.13

pigeonpea as well as exhaustive nature of cotton. It has ultimately resulted in lower water productivities of soybean among these cropping systems.

Effect of filtered waste water on soil properties and yield of wheat

The design of filters for the reuse of wastewater in the form of wetlands has been optimized and on that basis an experimental study was conducted to assess the effect of treated wastewater in irrigation. Wheat (var. HI 1544) crop was grown for experimental study that

was laid in randomized block design with four treatments and five replications. The amount of irrigation water was applied based on the crop evapotranspiration and different levels of filtration. The results indicated that the highest yield has been recorded in wheat irrigated with raw wastewater. This might be due to the beneficial effects of wastewater on the availability of all macro and micronutrient contents in the soil as well as the absence of any significant adverse effect on soil properties in short period.

Polyhouse Plant Pollinator

Greenhouse environment poses a challenge of pollination for the plant. It is because of the fact that natural pollination process occurring out of wind, water, insects, birds as well as honey bees are restricted in the greenhouse. Fruiting plants such as tomato, capsicum, melon etc. do not bear enough fruits inside a poly-house unless the flowers of their plants have been pollinated substantially. A portable handheld plant pollinator has been developed for such crops grown under the greenhouse. Its body is primarily made of CPVC pipes of 32 mm and 20 mm diameter and weighs around 2.5 kg. It has approximately 1m long main arm that house a 6 Volt battery which triggers a DC vibrator motor to a horizontal vibrating arm of 0.9 m. when the plant branches come in contact with to the entire length of horizontal arm, they also mildly vibrate and this action causes pollination.

Mean parameters of wheat under different treatments

Treatment	No. of effective tillers per m²	Grain yield, t/ha	Straw yield, t/ha
Raw wastewater	48	4.88	6.23
Treated (without plants)	43	3.31	6.12
Treated (with plants)	41	2.90	6.03
Fresh water	45	3.38	6.54

AGRO PRODUCE PROCESSING

Technologies developed

Technology for production of chemical free grape raisins

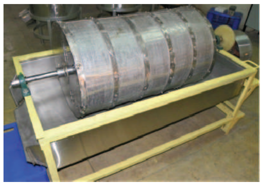
The existing farmer's practices of grape raisins are heavily influenced by the use of chemicals right from spraying of pesticides on vineyard to raisin making. The chemicals such as ethyl oleate, potassium carbonate, booster and sulphur as drying aids and bleaching agents are used in huge quantities during preparation of raisins. The existing process also requires washing thus demanding more number of unit operations, cumbersome and laborious tasks and take about 15-20 days to complete the drying. A process technology for the preparation of chemical free grape raisins has been developed as a package of equipment and process protocol. It includes a grape de-buncher for detaching intact berries from the bunch, abrasive pre-treatment system for removal of waxy cuticle layer from surface of berries and drying protocol. The abrasive system has capacity of 120-150 kg/h at the optimum condition of machine. During the drying experiments it was observed that the abrasive treated grape berries dried at faster rate (0.73-0.18 g/min-100g) in comparison of chemical treatment (0.19-0.09 g/min-100g). Also the total drying time is lesser for abrasive treatment (Solar dryer- abrasive: 4-7 days, chemical: 11-15 days; hot air dryer- abrasive: 2-2.5 days, chemical: 7 days).

Among the quality parameters of prepared raisins, the values of cap stems, immature, damaged, sugared raisins and moisture content of prepared raisins are 05 nos, 2.6%, 1.5%, 0% and 18% (wb), respectively. The samples have been found to be free from sulphur dioxide, mineral oil and sorbitol. The total cost of machinery is about Rs. 3.85 lakh. The processing cost of raisins is Rs. 22/kg which is 36.88% lesser compared to existing chemical process (Rs. 34/kg). The significant reduction in cost is due to low variable cost on account of chemicals and labour.

Modular onion storage structure

The storage of onion becomes difficult especially during rainy season due to its perishable nature, and farmers suffer huge storage losses. These losses could be in tune of 30 to 40% in terms of fungal rot, sprouting and physiological weight loss during a period of 4 months of storage. Therefore, a rust proof, high strength, UV resistant FRP material based modular onion storage structure of one tonne storage capacity has been developed. The system consists of a storage structure, sensor based aeration unit and fumigation unit. The system has been evaluated for storage of *Rabi* onion harvested in month of April. The storage study has been conducted for 180 days, up to the harvesting of *Kharif* season onion i.e. till first week of October. The storage protocol of onions included intermittent airflow @ 0.045m^3/s (this has been previously optimized in a separate experiment) and sulphur fumigation @50g/m^3 for 6 h. The results indicates 9.97 % of weight loss, 1.73 % rotting and 0.16 % sprouting in the stored lot of onion at 120 days storage while it has been 20.30% weight loss, 5.07% rotting and 0.67% sprouting at 150 days in control storage. At the same time losses are 26.66% weight loss, 14.20% rotting and 5.88 % sprouting reported by other studies after 120 days storage. The structure is rust proof and hence expected to have long life and durability due to FRP material as major construction material. The time required for filling up and emptying the storage cage is about 0.83 man-h/t and 0.4 man-h/t, respectively as compared to 1 man-h/t and 3 man-h/t in case of conventional Chawl structures.

Grape de-bunching machine



Abrasive pre-treatment machine

Treatment/washing

Drying

Prepared raisins

Omega-3 rich eggless chocolate cake

Essential poly-unsaturated fatty acids cannot be produced in the human body, it is only obtained from the diet. Flax seed (*Linum usitatissimum* L.) is an important oilseed crop which is rich source of α–linolenic acid (Omega-3 fatty acid) and fiber in the diet of vegetarian people. Flaxseed consumption in the diet prevents serious diseases like coronary diseases, cancer, diabetes, obesity, gastrointestinal, renal and bone disorders. Chia (*Salvia hispanica* L.) seeds are rich in protein, dietary fiber, minerals, vitamins and antioxidants. Chia gum is also an important food ingradient due to its emulsifing and stabilizing potentials. To utilize nutrients in flax seed and chia especially α–linolenic acid, chocolate cake is fortified with flaxseed meal and chia gel. Eggless cake has been developed using chia gel as traditional egg replacer and whole wheat flour cake (control). The recipes of two combinations like whole wheat flour cake based cake (T1) and other wheat flour+5% flaxseed meal (T2) have

been developed. The cake batters and prepared cake have been tested for physical, colour, rheological, textural, nutritional and organoleptic properties to study the effect of chia gel as egg replacer with wheat flour and combination of wheat flour-flaxseed meal in comparison with traditional whole wheat flour cakes with eggs. Texture analysis of the batter shows that the firmness, consistency, cohesiveness and index of viscosity of T2 are similar to the control cake. Inclusion of flaxseed meal in the formulation results into higher protein content in T2 cakes (8.5 g/100g) compared to T1 cakes (8.5 g/100g). The total omega-3 content (ALA) is found to be the highest for T2 treatment (7.84%) followed by T1 (4.95%) and control. The omega-6 content has been highest for T2 (47.40 %) combination followed by control cakes (46.84 %) and T1 (24.05 %). As per the sensory analysis the acceptability of test cakes T2 has been high (8.2 on the 9 point-Hedonic scale). Therefore whole wheat eggless cakes with chia and flax seeds are a tasty and good way to boost the omega-3 fatty acid and antioxidants in the diet.

Technology under development

Continuous Infrared heating system for free flowing grains

A low depth-controlled penetration of infrared heat radiations created the desirable physical and biochemical changes on the surface of grains. This desirable changes act as pre-treatment for various secondary unit operations like milling, expelling etc. An infrared treatment system is developed which consists of infrared heating module with five Mid-Infrared range heaters of 2000 W each fastened beneath a concave shaped polished metallic reflector to maintain the appropriate flux, material conveying deck driven by vibration motor, and specialize designed feed hopper to maintain a single layer of grain during treatment. The exposure time of the grains under infrared is controlled in the range of 1 to 3 min by controlling vibrations of conveying deck with the help of VFD driven vibratory motor. Also the power density/heat flux can be maintained through upward and downward movement

of IR heating module. The system is suitable to adjust spacing in the range from 25 mm to 120 mm. Developed prototype is suitable for infrared treatment of all types of free flowing grains at desired experimental conditions. Based on type of grains the machine has a output capacity of about 200-250 kg/h.

Infrared pretreatment protocol and optimization for pigeon pea dal milling

Removal of husk from the cotyledon is the foremost requirement to utilize any legume in the form of dal. The husk is tightly bound with cotyledon via natural gums and polysaccharides. The bonding strength of such bond is highest in pigeon pea among the commonly consumed pulses. Therefore, it is required to give proper pre-treatment for loosening of biological bonds prior to milling. Hydro-thermal treatment is commonly, commercially used treatment for pigeon pea but it is time and energy consuming, expensive and poses some other quality and safety issues. Therefore, controlled infrared radiation based pre-treatment protocol has been developed to reduce time, drudgery and cost. The treatment parameters are optimized for maximum dehulling efficiency and dhal recovery with minimization of broken loss. The optimum operating condition was found to be 10% moisture content, 120 mm of heater to grain surface distance and 1 min of exposure time. The treatment is given to the pigeon pea grains in two passes. Present treatment yields 91.08 % of degree of dehulling, 78.0 % dhal recovery with 2.0% broken and 17.4 % mealy waste losses. The maximum

Raw pigeon pea | Scratched pigeon pea | IR treated pigeon pea dal

surface temperature of the grain reaches up to 83°C with 0.13 % weight loss due to moisture. The Energy cost for this treatment on pigeon pea is about Rs. 350 /t.

Cleaner for multiplier onion

Small onion (*Allium cepa L Var.Aggregatum*) is one of the most important commercial vegetable crops grown in Southern India. Cleaning of the stored onions prior to marketing is an essential unit operation in the processing of multiplier onion. At present, cleaning is done manually which is labour and cost intensive. The developed cleaning equipment for multiplier onion consists of main frame, material flow bed, air distributor, engine operated blower, feeding inlet, and collecting tray. An engine operated blower of 0.187 kW supplies air for cleaning. Air from the blower is allowed to pass through the inclined material flow bed. The air distributor is made up of PVC material of diameter 75 mm and length 700 mm. Air duct of 450x15 mm size is provided for the passage of air. Collecting tray is provided at the bottom end of the equipment for collecting the cleaned onions and a rectangular slot is provided at the side for removal of the dust, dried and dead skin of onion. The maximum cleaning efficiency of 98% is obtained at 10.41m^3/s air flow. The capacity of the cleaner is found to be 800 kg/h.

Multi-blade type cashew apple slicer

The regional centre of ICAR-CIAE in collaboration with ICAR Directorate of Cashew Research Puttur, Karnataka has developed a multi-blade cashew apple slicer consisting of nine blade of 165 mm diameter coupled to 0.75 kW motor. Motor is coupled to a variable speed drive where in the speed of the cutting blade could be controlled. The gap between two blades has been kept at 2 mm. There is an ejector mechanism kept on the rear end side of multi blade, where in the cashew apple is sliced. The output capacity of the equipment is about 70 kg/h.

Cashew Apple Slicer - Vertical feed and horizontal slicing blade model

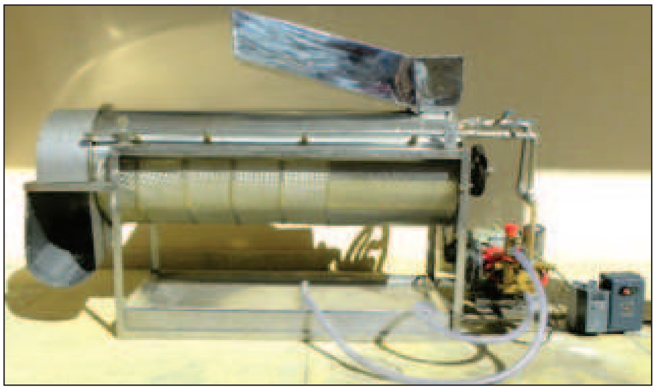
Cashew apple to be sliced is fed vertically. The blade is rotated by 0.73 kW motor at about 2000 rev/min. The pair of blades have placed in such a way that the thickness of about 1.9 to 2.0 mm could be obtained. There has been a brushing arrangement placed so that the blades can be cleaned at the end of one cutting cycle. The output capacity of the equipment is 75-80 kg/h. Since there is no separate ejector mechanism the sliced cashew apple slicer is directly collected through the outlet rather than being ejected out with the help of ejector. The cleaning of the developed equipment is easy.

Hybrid energy curing barn for tobacco leaves

The curing of tobacco leaves in a traditional barn is an energy intensive operation. Regional centre of the institute in collaboration with ICAR-CTRI, Rajamundry and M/s Cochin Energy System, Trivandrum have been developed an energy curing barn with closed loop heat pump dehydrator/dryer. The requirement of indoor condition- temperature, humidity condition and duration of drying were set using heat pump dryer The weight loss of the tobacco leaves was faster and gradually reduced from 1.03 kg to 0.12kg. Initial moisture content of 80.6% wb was reduced to 4.9% wb.

Peeler for medicinal roots

Peeling of medicinal tuber crops like *Shatavari* and *Safed musli* involves lot of drudgery, since they are peeled manually; hence mechanization of this operation is need of hour. Traditionally, pre-treatments like steaming or boiling is practiced for peeling *Shatavari* roots, which nevertheless destroys some of the bioactive compounds. To address this issue, a machine of 5 kg/batch capacity, for peeling of fresh medicinal tuber root crops like *Safed musli* and *Shatavari*, has been developed. The machine works on principle of abrasion and is operated by a 2.2 kW, 3 phase AC motor. The motor speed can be varied using a variable frequency



drive, as per the requirements of individual crop. The machine can peel 5 kg of freshly harvested *Shatavari* or *Safed musli* tuber roots in 10-20 min, thus significantly reduces the peeling time as compared to manual peeling. It also eliminates requirement of any kind of pre-treatments. The peeling efficiency has been observed as more than 90%, with minimum breakage to the crops. The machine can significantly reduce drudgery, labour cost and time.

Refractance window dryer

A continuous Refractance Window (RW) dryer has been developed that utilizes the infrared thermal energy from the hot water, to dry heat sensitive biological materials. The dryer consists of a Mylar (Biaxially-oriented polyethylene terephthalate, a polyester film made from stretched polyethylene terephthalate) belt, which is driven by a 1 hp motor-reduction gear assembly to cover a distance of 2 meter in 20 minutes. The dryer has a hot water tank in which, hot water of set temperature is circulated through a recirculatory pump. Toughened glass windows are provided through out the

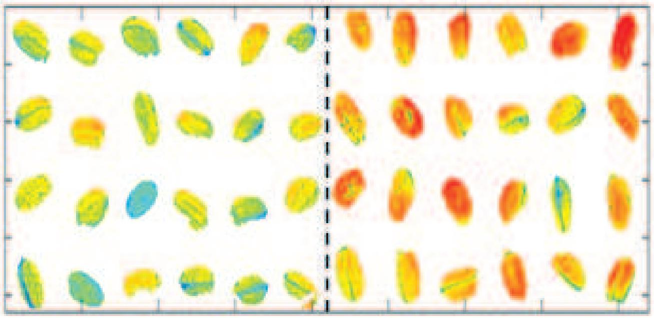
drying section, for visual inspection. An exhaust fan provided at the top of the drying cabinet ensures expulsion of water vapour removed from the drying material so as to prevent condensation of vapour. Wheels are provided at the base of dryer frame for its easy movement.

Drying protocols for medicinal root crops

Drying protocols for three medicinal tuber root crops, *Safed musli, Shatavari* and *Ashwagandha* have been developed. The roots pretreated with 5% alum for 30 minutes show higher drying rate, resulting in reduction in total drying time when dried in convective cabinet dryer and solar dryer. Quality of the dried product has been ascertained through proximate composition, antioxidant activity (DPPH scavenging activity) and bioactive compounds (determined employing GC-MS protocol). Analysis of the result shows that increase in drying temperature from 45 to 65°C significantly reduces the antioxidant activity whereas, alum water treatment shows non-significant effect on the parameter. Alum water, ozone and UV treatment cause reduction in total microbial load in the peeled tuber roots and help increase the shelf life of the peeled roots under refrigerated storage. Therefore, 5% alum water treatment for these root crops is recommended to reduce the microbial load and facilitate drying. A low drying temperature (45°C) is recommended for drying of medicinal crops for better retention of bioactive compounds.

Classification of groundnut kernels using Vis-NIR hyperspectral imaging

Presence of aflatoxins in groundnut is a serious threat to food safety. Currently acceptable methods for detection of aflatoxin concentration on food products are laboratory based and require high time, skilled personnel and hence expensive. In order to develop a rapid and on-line deployable method for aflatoxin detection, Vis-NIR hyperspectral imaging system with wavelength between 400-1000 nm has been successfully used to classify the groundnut kernels based on the concentration of aflatoxin. The aflatoxin has been deposited on groundnut kernels in six different concentrations 25, 40, 70, 200, 300 and 500 ppb. The spectral data was pre-processed using four pre-processing techniques to reduce the spectral noise and light scattering. The raw and pre-processed data were classified using PLS-DA and k-NN. It was observed that at 662nm, 668 nm and 680 nm, groundnut kernels can be distinguished between sterile and infected. The best prediction was obtained with five factor PLS with R^2 of 0.965. The highest classification rate was observed for raw data using SVM with an error rate of 0.05. Application of defined protocol could enable detection of aflatoxin infected groundnut kernels within a few seconds.



Sterile grains **Infected grains**

Collection and profiling of VOCs generated by *Erwinia carotovora* in stored onion, potato and tomato

Onion, tomato and potato are the most consumable vegetable in India. To fulfil the round year demand of these commodities they has to be stored at appropriate conditions. During the storage these crops encounter various internal biochemical changes which causes alteration of the biosynthetic pathways and leads to huge storage losses. This is expressed externally as spoilage symptoms or release of some specific gaseous compounds i.e. VOC. Volatile organic compounds (VOCs) act as signature sequence of the condition as concentration and type of VOCs changes with the type of microbial genera, species, even with metabolism. *Erwinia carotovora* is one of the major causes of spoilage of these crops under cold storage. As the collection and analysis of VOC is challenging task, the protocol for the sampling of gas samples from headspace of container has been standardized for the experimentation. To assess the type of VOC generated due to *Erwinia carotovora*, selected crops were stored in air tight jars with silicon septum and VOCs sampling was done by solid phase micro extraction (SPME) fiber and the same was analyzed by Gas chromatography-Mass spectroscopy (GC-MS) to explore emitted VOC. 4,6-Diethyl-1,2,3,5-tetrathiolane (19300 ppm), Ethyne, fluoro- (63500 ppm), 2-Propanol, 1-methoxy- (15100 ppm) were found specific to onion bulbs, Hexanoic acid and butyl ester (20320 ppm), 1-Butanol (37800 ppm) specific to potato and 1-Butanol, 3-methyl-acetate (261800 ppm), n-Tridecan-1-ol (20000 ppm), ethanol (61000 ppm) specific to tomato inoculated with *Erwinia carotovora*. The concentration of all the compounds was increased with storage time of 1 to 4 week. The identified groups of the VOCs could use for selection and development of sensor array for in-situ detection of infection during storage of onion, potato and tomato under storage.

SALIENT ACHIEVEMENTS UNDER AICRPs AND CRPs

AICRP ON FARM IMPLEMENTS AND MACHINERY

Major activities of the scheme are to develop agro-climatic zone specific farm implements and machinery, protocol, multi-location trials of technology, prototype production, technology demonstration and aid in skill development in the area of farm mechanization. The project operates pan India with 25 centres.

Light weight multi-crop seed drill cum planter for hilly region

In the North-eastern hilly region, sowing of seeds is either performed by broadcasting followed by traditional wooden leveler or manual sowing behind country plough. Both methods are labour intensive, drudgery prone and require 20-30% more seeds. The light weight, labour saving and cost effective multi-crop seeding equipment is in demand under hilly states for line sowing. Keeping in view, CAEPHT Gangtok centre has developed light weight tiller operated multi-crop seed drill cum planter for sowing small as well as bold

seeds under terrace condition. It consists of a main frame, two furrow openers, ground wheel, planter cum seed drill, handle, chain and sprockets for power transmission. The metering mechanism of the equipment consists of plastic rotor with cells on its periphery to pick up the seeds. Its weight is 26 kg. The equipment has been evaluated for maize planting in Lingzey, Sajong and Rongli villages of East Sikkim. The effective field capacity and field efficiency of the equipment are observed in the range of 0.05-0.06 ha/h and 78-82%, respectively. It saves 10-12% of maize seeds as compared to sowing behind country plough and 45-55% time due to sowing of two rows in single pass. The cost of operation is Rs. 1,840/ha and net saving of 46.5% in cost of operation for maize planting as compared to traditional practice of sowing behind country plough.

Tractor operated transplanter for tissue culture banana

Conventional planting of banana is a labour intensive and tedious operation. Therefore, a tractor operated planter for tissue culture banana has been developed at TNAU, Coimbatore Centre. The planter can plant tissue culture banana seedlings at a spacing of 1.82 x 1.52 m. It consists of chisel type furrow opener, with wings, plants dispensing unit, earthling up assembly, operator seat and press wheel. Chisel type furrow opener opens the furrow to a depth of 300 mm. The wings made of M S sheet enlarge the furrow to 120 mm width and 200 mm depth behind the chisel. The seedlings grown in the grow bag of 60 mm diameter and 150 mm height are placed in the split spoon type valve arrangement by the operator after removing the grow bag. The valve is designed to open automatically at fixed plant to plant spacing of 1.52 m through ground wheel measuring

system with help of cam and lever. Seedlings are earthed up by a suitable shovel and the soil around the plant is compacted by the set of press rollers. The field capacity of the machine is 0.19 ha/h. The cost of operation of machine is Rs. 3,500/ha, whereas the cost of operation for the conventional method of planting is Rs. 18,500 at the rate of Rs. 6/plant. The cost of the machine is Rs. 50,000/-. The machine saves 50% of time and 90% of man hours. This equipment also saves 81% of cost of operation as compared to the conventional method.

Tractor operated wheat straw collector

In Punjab, left over wheat straw is collected or burnt in combine harvested fields for performing puddling operation for subsequent crop. Manual collection is labour intensive and drudgery prone with very low output capacity, which results in delay of next

operation i.e. puddling. Keeping in view of the requirement, a tractor operated wheat straw collector has been developed at PAU, Ludhiana centre. The equipment consists of a harvesting unit and a collection unit. Straw harvesting unit consists of 18 flail blades mounted over a rotor shaft for harvesting left over straw stubbles. The width of straw harvesting unit is 1880 mm. The straw collection unit is fitted with hydraulic cylinder lift arms for opening and unloading the collected straw. The perforated sheet (16770 holes/m^2) having perforation of 4.69 mm size is provided on the collection unit to reduce dust concentration in collected wheat straw. The effective field capacity of the tractor operated wheat straw collector is 0.26 ha/h at forward speed of 1.75 km/h. The straw collection capacity of the machine is 1.04 q/h and collection efficiency is 55-58%.

Tractor operated horizontal two side discharge shredder for orchards

Tractor operated shredders being used in orchards and grape vineyards have vertical throw of shredded material results in erratic and non-uniform deposition of the shredded material. MPKV, Rahuri centre has addressed the issue after studying the traditional practice prevailing in the region. The tractor operated horizontal two side discharge shredding unit has been developed and evaluated in light medium soil. The main parts of shredder consist of main frame, gear box, hydraulic oil reservoir, hydraulic pump, hydraulic hoses, pulleys, hydraulic motor, conveyer, rotary shaft. The tractor PTO power gets transmitted to left hand side driving pulley which actuates driven pulley through gear box. Driven pulley in turn imparts rotary movement to rotary hammer shaft equipped with 16 nos. of flail mower hammer blades, which are used for shredding of cut branches of grape vineyard during pruning. The gear box also transmits power to hydraulic pump which runs the conveyer of 1575 mm length for discharge of shredded branches to either side of the machine thus, forming uniform heap of shredded

material of pruned branches around the tree trunk. The working width, speed of operation and fuel consumption of machine are 1200 mm, 5 km/h and 11.54 l/ha, respectively. The field trial of equipment has been conducted in total 4.50 ha area for grape vineyard at Bambawade village in Sangli district. The effective field capacity and field efficiency are found to be 0.40 ha/h and 67%, respectively. The cost of operation and net saving of equipment are Rs. 1,225/ha and Rs. 2,775/ha, respectively over traditional method.

Tractor operated hydro-mechanically controlled mould board plough for orchards

The cutting of roots and breaking of hardpan formed between inter spaces of adjacent trees help in new root formation and proper aeration to root zone of the trees, this operation is labour and time consuming as well as drudgery prone. A hydro-mechanically controlled MB Plough has been developed by MPKV, Rahuri centre. It works on the hydro-mechanically controlled sensor mechanism, which tilt the equipment according to the intra row spacing between two adjacent trees without causing damage to the tree. The main parts of equipment are main frame, one stationary plough bottom and one swinging plough bottom, hydraulic oil reservoir (60 l), hydraulic pump, hydraulic hoses, control valves, sensor bar, etc. When sensor rod touches the trunk of tree, it retracts and after wrap up action around tree trunk, it is extended due to hydraulic relief valves, during this process rear mounted plough

bottom breaks the hardpan. Hydro-mechanically controlled MB Plough has been tested in total 2.08 ha at soil moisture content of 16% (db) in light medium soil. The working width, depth, speed of travel, wheel slip and fuel consumption are observed as 300 mm, 290 mm, 2.98 km/h, 7.6% and 71.18 l/ha, respectively. The effective field capacity and field efficiency of the equipment are found to be 0.07 ha/h and 71.18%, respectively. The cost of operation of the equipment is Rs. 7,650/ha with net saving of Rs. 3,350/ha.

Tractor operated high clearance weeder

Most of the crops with tall morphology are planted in wide spacing of 600 to 900 mm. Weeding in crops like cotton, maize, etc. becomes difficult after 45 DAS due to canopy spread. TNAU, Coimbatore centre developed a tractor operated high clearance weeder based on regional agronomical requirements suiting to cotton and maize crops for accomplishing efficient weeding up to plant height of 700 mm. It consists of main frame of size 1070 × 2220 × 717 mm (L×W×H) and is extended

on both sides by 785 mm to increase the width of coverage. These extended frames are hinged to the main frame which facilitates to fold it during transportation. A 'C' type shovel of 60 mm width is attached to the cultivator tines and sturdy rigid tines are attached to the shovel as weeding tool. Based on the crop height during the 3rd stage of weeding, it is decided to keep high clearance of 700 mm so the height of the shovel is kept as 700 mm. The fifteen tines are clamped with the main frame for accomplishing the weeding operation in between standing rows of crops. The performance parameters of weeder while testing in cotton crop (750×750 mm plant spacing and 650 mm height) at 13% (db) soil moisture content weeding efficiency, plant damage and field capacity are found to be 88%, 3%, and 0.65 ha/h, respectively. This weeder can be adopted for weeding even after 60 days.

Tractor operated paddy straw bale shredder-cum-mulcher

In Punjab, paddy straw is being spread as mulch in vegetable crops to reduce weed emergence, conserve soil moisture and reduce temperature fluctuations in the top soil. To address the problem of paddy straw bale shredding and then mulching for cultivation of vegetable crops, a tractor operated paddy straw bale shredder-cum-mulcher has been developed by PAU, Ludhiana centre. It consists of a shredding rotor with shredding blades, an adjustable concave grate, a bale drum, restrainers to rotate bale drum, deflector with guide vanes and power transmission components. Bales are fed into bale drum, which rotates bales continuously for uniform shredding of bale. The concave grate controls the feeding of bale to the shredding rotor. Shredding rotor is mounted with 'M' shaped shredding blades. Two rows of counter shredding blades are provided below the rotor inside the casing. These counter blade rows help in reducing straw size. Power to the rotor is provided from tractor

PTO using gearbox (11:20 gear ratio) and belt drive mechanism (26:1). A deflector with guide fins is provided at the outlet for uniform spreading of straw. A bale spread in length of 7.2-8.7 m covers about 2.0 m wide strip. Mat thickness varies from 10.3-12.4 cm. The guide vanes help in controlling the shredded straw spread. The field capacity (0.24-0.31 ha/h) of the machine increases with increase in forward speed (2.25-2.95 km/h). The cost of shredding of the equipment is found to be Rs. 2,935/ha, which increases the average return by Rs. 15,600/- and net savings by Rs. 6,665/ha.

Power operated tamarind dehusker and seed extractor

Farmers pay high wages for manual dehusking and seed extraction during peak season of tamarind in Maharashtra. Tamarind dehusking and seed extra-

Tamarind dehusker | Tamarind seed extractor

ctions are labour intensive and tedious operations. Therefore, the tamarind dehuskar and seed extractor have been developed by MPKV, Rahuri centre. Tamarind dehuskar consists of main frame, feed hopper, counter rotating roller, main pulley, two single phase electric motors (0.37 kW), outlet chute and blower unit, etc. The output capacity of power operated tamarind dehusker is 32 kg/h with 91% dehusking efficiency. The tamarind seed extractor consists of roller (245 × 470 mm) and a rasp bar which is pressed against the rotating roller. The rotating roller with rasp bar mechanism detaches the seeds from dry dehusked tamarind pods, which are finally discharged from outlet chute and collected in the plastic tray placed beneath the outlet chute. The output capacity of power operated tamarind seed extractor is 64 kg/h with 90% deseeding efficiency. The tamarind dehusker and seed extractor can save Rs. 6,150/- per tonne and Rs. 4,250/- per tonne, respectively over traditional methods.

Tractor operated single row corn cob picker

Harvesting of corn cobs is one of the tedious, labourious, drudgery prone and time consuming operation. TNAU, Coimbatore centre has developed, a tractor mounted single row corn cob picker. The equipment can be mounted to a small tractor. The harvester consists of picking head, elevating conveyor and collection-cum-loading bin. The picking head is side mounted to the tractor. The corn cob conveyor is designed to operate at a linear speed of 16 m/min and transport the cobs to the collection box. The volume of bin is 0.93 m^3 and hence, can hold 260 kg of cobs. The cobs are snapped and delivered at the rear of the picking head. The speed of operation during test trial is 3 km/h and effective field capacity is 0.16 ha/h. The unit price is Rs. 2.5 lakh and cost of harvesting is Rs. 5,000/ha.

AICRP ON ENERGY IN AGRICULTURE AND AGRO-BASED INDUSTRIES

The scheme through its sixteen centres conducts research on development of gadgets for harnessing renewable energy sources for its application in production and post production agriculture, multi location trial of the developed technologies and studies on energy management in agriculture. The major achievements of the scheme are presented below;

Efficiency enhancement of solar thermal collectors by nano-fluids

Two similar solar flat plate collectors are developed for water heating and evaluated at SPRERI, VV Nagar Centre, Gujarat. One of the collectors is tested with the nano-fluid and other without nano-fluid. The nano-fluid is used in two ways viz(i) direct solar absorption medium and (ii) heat transfer medium. The nano-fluids used in the experiments have been prepared in the lab using Al_2O_3 nano-particles with 0.02% concentration and Fe_2O_3 nano-particle in 0.5% concentration. Among

the various samples prepared, the best stable Al_2O_3 nano-fluid is found for the combination of Al_2O_3 (0.02%) + surfactant (0.01%) with four hour sonication. In case of Fe_2O_3 nano-fluid, the stability period has been significantly short. The efficiency of the collector with nano-fluids is found over 40%, while the efficiency of the collector without nano-fluid remains 5% lower than the nano-fluid based collector.

Hydrothermal liquefaction system to extract essential oil from herbal biomass

The hydrothermal liquefaction system has been designed and developed at MPUAT, Udaipur Centre, to extract essential oil from herbal biomass. The designed system is capable to handle 5-6 kg of herbal biomass. The system comprises of combustor cum low pressure steam generator, water feeder, hydrolysis reactor, condenser, and hydrosol collector. The thermal performance of developed system has been experimentally evaluated with dried lemon grass having moisture content of about 7.80%. The steam temperature at hydrolysis reactor can be maintained upto 150ºC. About 6.20 kg of wood is consumed during the whole experiment. The essential oil yield from lemongrass is in the range of 1.0–1.50 %.

Reactor for activated bio-char production for purification of gaseous biofuels

A lab scale reactor for activated bio-char production of one kg capacity has been designed and developed for single step steam activation process with diameter and height of 120 and 340 mm, respectively, at TNAU, Coimbatore centre. Activated bio-char has been produced at the activation temperature of 600–1000°C with the time duration in the range of 30–150 minute from ten types of biomass. The activated bio-char yield of the three selected biomass varied from 4.2 to 32.2 %. Further, the gas adsorption system of 50 g capacity has been designed for gas adsorption studies on activated bio-char with diameter and length of 5 cm and 26.5 cm, respectively. For 1 m^3 biogas containing 40:60 ratio of CO_2:CH_4, about 2.5 kg of activated bio-char is required. The developed system will be very useful for both biogas and natural gas purification.

Lipid extraction from micro-algae

The SPRERI, VV Nagar centre, cultivated the micro-algae in pilot pond and pre-treated the algae using microwave for ten minutes followed by solvent extraction method. Different solvents viz. hexane, chloroform, diethyl ether, petroleum ether and isopropyl alcohol have been tested for laboratory-scale lipid extraction. A 100 l capacity fractional distillation unit is installed for bulk lipid extraction and solvent recovery. Initially, dried micro-algae powder and chloroform have been mixed in 1:30 ratio and are run for 3 hour duration. Post run-time, 80% solvent has been condensed, recycled and collected in the collection vessels, to be used for subsequent cycles. Order of lipid extraction efficiency for different solvents is as follows: Chloroform (28%) > Hexane (25%)> Petroleum ether (23%)> Isopropyl alcohol (20%)> Diethyl ether (19%). The maximum recovery has been observed in Chloroform followed by Hexane, Petroleum ether and Isopropyl alcohol.

Manure production from phycoremediated algal biomass

The wastewater grown micro-algae are exceptional in providing the NPK to the soil after phycoremediation and biofuel extraction. In the present study, carried out at IARI, New Delhi Centre, a microalgae, *Chlorella minutissima* species has been selected for phycoremediation experiment. The *Chlorella minutissima* reduces nitrate, ammonium, phosphate and potassium content in sewage wastewater by 89%, 48.2%, 67.4%, and 66.3%, respectively. The reduction in BOD, COD, and TDS has been found as 93.2 %, 80.5 % and 94.3%, respectively. The nitrate reductase activity in soil supplied with algae manure is maximum (0.13 mg NO_2-N produced g^{-1} soil 24 h^{-1}) and significantly higher than other treatments in baby corn grown soil. Nitrate leaching has been analyzed during the experiment from 0-15 cm, 15-30 cm, 30-45 cm depth soil in column. The cumulative nitrate leaching is found to be low (17.19 mg/l) in algae applied treatment, while highest (24.69 mg/l) in plot supplied with recommended dose of NPK.

AICRP ON UTILIZATION OF ANIMAL ENERGY

The scheme is devoted to 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. The project through its nine centres develops equipment of appropriate size that can be used with different kinds of location specific animals and their breeds.

Mechanization of wet land rice and rice based cropping system using animal power

OUAT, Bhubaneswar centre has tested CIAE bullock drawn 3-row seed drill for sowing of green gram during *rabi*. The average actual field capacity of the implement is found to be 0.13 ha/h with 64.5% field efficiency and the average seed rate is 22.50 kg/ha. The draft requirement is about 445 N when operated at 1.71 km/h forward speed. The cost of operation is found to be Rs. 982/- per ha as compared to Rs. 3,800/- per ha in case of conventional method of ploughing. The average grain yield and benefit to cost (B:C) ratio with crop sown by conventional method were 750 kg/ha and 1.82 whereas grain yield and B:C ratio with Zero till seed drill were 775 kg/ha and 2.25, respectively. During *Kharif* season, paddy was sown with 8-row bullock drawn drum seeder and also seedlings were transplanted manually. The field capacity, field efficiency and average seed requirement of the implement were 0.16 ha/h, 58.4% and 31.4 kg/h, respectively. The average cost of operation and B:C ratio by the implement were found to be Rs. 2,378/- per ha and 1.84, respectively whereas cost of operation and B:C ratio by manual transplanting were Rs. 16,900/- per ha and 1.48, respectively. The saving in labour and cost with the implement were observed to be 46 man-days/ha and Rs. 14,522/- per ha, respectively. Thus, mechanization of wetland rice through use of 8-row bullock drawn drum seeder during *Kharif* season followed by use of bullock drawn 3-row zero till for sowing of green gram during Rabi season in rice based cropping system for small farms are found suitable and economical.

Animal drawn equipment for organic farming of small farms in hills

CAEPHT, Gangtok centre has developed a package of animal drawn implements for organic farming for small farmers. The package consisted of wing plough, light weight-planker-cum-leveler and jet plough. The wing plough is used to prepare seed bed for sowing of seed after operation of wedge plough in dry condition and also used for field preparation for transplanting of paddy seedlings in wet condition. It consisted of handle, share and beam (overall dimension: handle height 760 mm; width of wing 240 mm; length of share 320 mm; weight 6.3 kg). The work rate of wing plough is 0.022 ha/h at average draft of 400 N corresponding to depth of operation of 100 mm.

A light weight planker-cum-leveler made of MS sheet has been used for puddling operation. The field capacity and draft were found to be 0.07 ha/h and 377 N, respectively. A jet plough is used to prepare seedbed for showing seed without much inversion of soil slice. It consisted of handle, jet, share and beam (overall dimension: handle height 790 mm; width of jet on front 50 mm and rear side 250 mm with length 235 mm; length of share 90 mm; weight: 6.9 kg). The field capacity is found to be 67% higher than the traditional plough. The average draft requirement of jet and traditional plough is 420 N and 450 N, respectively. This showed that the cultivable area covered by package of improved implements is more and draft requirement is less as compared to traditional plough.

Animal drawn straw collector

IGKV, Raipur has developed an animal drawn straw collector for collecting loose straw from combine harvested rice field. The working width and the draft of the implement were 1067 mm and 539 N, respectively. It can collect 5-8 kg straw from harvested field in a single pass. The field capacity of implement is 0.18 ha/h.

Animal drawn multi-crop planter-cum-herbicide applicator

IGKV, Raipur has developed a 3-row multi crop planter-cum-herbicide applicator for planting of seeds as well as applying herbicide simultaneously in order to save time and cost. It consisted of a frame, seed hoppers, seed metering devices, seed delivery tubes, inverted T-type furrow openers, sprayers, boom and nozzles. The row spacing can be adjusted from 230-240 mm. The performance is evaluated for soybean, green gram and fodder maize crop. The average draft and speed of operation is found to be 440 N and 1.8 km/h, respectively. The average power required is 0.22 kW. The actual field capacity of the implement for soybean, green gram and fodder maize are found to be 0.18ha/h, 0.12 ha/h and 0.12 ha/h, respectively. The field efficiency for soybean, green gram and fodder maize are 78.2%, 70.7% and 72.5%, respectively. The cost of the implement is about Rs. 15000/-. The average cost of sowing and operational energy is estimated as Rs. 573/ha and 103.55 MJ/ha, respectively.

Single row sugarcane planter

VNMKV, Parbhani has developed bullock drawn single row sugarcane planter. It is operated by one pair of bullock. It has rotary type metering mechanism and shovel type furrow opener at specified distance of 600 mm. The total weight of planter with beam and seed is 65 kg. The capacity of hopper is 100-125 sugarcane setts. The field capacity of planter is about 0.06 ha/h at an operating speed of 1.34 km/h with field efficiency of 61%. The average draft and power required to operate the planter were 612 N and 0.17 kW, respectively. The cost of the planter is Rs. 39,500/-.

Animal drawn plastic mulch laying machine

IGKV, Raipur has developed and evaluated animal drawn plastic mulch laying machine for growing vegetables. The draught requirement to pull the machine is 459 N and the power output has been observed as 0.16 kW at an average operational speed of 1.35 km/h. The operational energy has been estimated as 177 MJ/ha. The effective field capacity of the machine in actual field condition is 0.11 ha/h. The cost of operation of the machine Rs. 135/h (Rs. 1,205/- per ha) for mulch laying as compared to manual mulching (Rs. 9,615/- per ha).

Animal operated solar powered sprayer

VNMKV, Parbhani has developed a bullock drawn solar powered sprayer. It consists of solar photovoltaic (PV) modules, chemical tank, DC motor, spray boom with hollow cone nozzles and cart. All working components have been fitted on a bullock cart for mobility in the cropped field for spraying. Due to high clearance, it is useful for spraying tall field crops. The average discharge of each nozzle at 4 kg/cm^2 is 690 ml/min. The total discharge capacity of spray boom is 7.5 – 9.0 l/min at 4 kg/cm^2. The average power required to operate the sprayer is 0.25 kW and can be operated easily by a pair of bullocks. It is suitable to spray all kind of crops having spacing of 400-450 mm such as soybean, maize, sorghum, red gram and wide spaced (900-1500 mm) crop such as cotton having heights from 450-1500 mm. In this sprayer, operator's exposure to pesticides are minimized as sprayer applies pesticides behind the operator. The present cost of bullock drawn sprayer is Rs. 1,14,000/-. The field capacity, field efficiency and operating cost of this sprayer are 1.14 ha/h, 80% and Rs. 310/ha, respectively.

AICRP ON ERGONOMICS AND SAFETY IN AGRICULTURE

The scheme is mandated to apply ergonomic principles for increasing productivity, reducing drudgery and minimizing accident and occupational health problems of workers in agriculture and allied sectors. Operating through twelve centres in different parts of the country, the scheme works mainly to develop ergonomically improved tools, safety devices and practice and assessment of occupational health hazards.

Power operated mini rhizome planter

Ginger is grown in almost all the states of north eastern region (NER) of India, but the leading states are Assam, Meghalaya and Arunachal Pradesh. In NER region, traditional tools are used for ginger cultivation which includes a spade, *dao, khurpi,* hoe, etc. A power-operated mini rhizome planter with cup feed type metering mechanism has been developed by NERIST centre as an

attachment to a walk-behind type of power tiller. Adjustment has been provided in furrow opener to operate at different depth. An average seed spacing of the planter has been observed as 250 mm, depth of operation as 25-45 mm and actual field capacity of 0.074 ha/h.

Power operated groundnut stripper-cum-decorticator

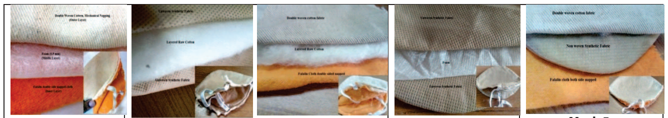
Groundnut is one of the major crops in Odisha. Stripping of the ground nut pods from vines and removal of kernel from pod (decortications) are labour intensive operation. An effort has been made by ICAR-CIWA, Bhubaneswar centre to combine the stripping and decortication operation and has developed a small 0.5 hp motor operated groundnut stripper-cum-decorticator. The equipment can be used as striper or decorticator for both purposes. The height of the hopper has been kept as 930 mm considering the anthropometric body dimensions of female agricultural workers. The developed machine has average output capacity of 12.1 kg/h with one operator.

The threshing efficiency is about 95% with total pod losses with 5%. The cleaning efficiency is about 70%, which can be enhanced by adding a blower.

Dust protecting mask for agricultural purpose

Dust is a major problem during on-farm agricultural operations and agro-based industries. Long term exposure to dust leads to many chronic diseases to workers. Dust mask is personal protective equipment recommended to reduce the dust exposure to workers. A dust mask testing setup consisting of dust chamber of size 650 x 650 x 650 mm as per IS 9473 (2002) has been developed by MPUAT, Udaipur centre. The chamber is made of 5 mm thick transparent acrylic sheet in order to see the turbulence of dust created in the chamber. The test rig consists of a centrifugal blower (90 m^3/h), dust samplers, dust monitor, pressure gauge, manikin head with mask and agitator. The test rig is being used for measuring filtration efficiency and breathing resistance (pressure drop) of different filtering materials. Five different dust masks were designed and developed with the combination of different filtering material. The filtration efficiency and breathing resistance of developed dust mask is assessed at 75, 90 and 105 l/min air flow rate and it is found to be decreasing with increase in air flow rate.

The filtration efficiency for all the dust masks is between 91.7 to 94.8 % at an air flow rate of 75 l/min. The results show that the breathing resistance of all mask except Mask 5 was ≤ 4 mbar (40 mm water column) whereas Mask 5 (non-woven synthetic + double woven cotton mechanically napped + flannel) has higher breathing resistance. There is no significant



Mask 1 (non-woven foam + woven cotton + falalin)	Mask 2 (raw cotton + non-woven synthetic)	Mask 3 (raw cotton sheet + double woven cotton + falalin napped cloth)	Mask 4 (unwoven synthetic fibre)	Mask 5 (non-woven synthetic + double woven cotton mechanically napped + falalin)

difference in filtration efficiency of Mask 1, Mask 5 and Mask 3 at low air flow rate. Where as the breathing resistance is found to be minimum for Mask 3 (raw cotton sheet + double woven cotton + flannel napped cloth). Effect of washing these masks is also studied and observed that filtration efficiency of all of the masks decreases with dry wash than easy wash condition. Based on the filtration efficiency, Mask 1, Mask 5 and Mask 3 were found at par with no significant difference whereas, Mask 3 was superior among the others based on breathing resistance.

Solar fan assisted headgear for reduction of environmental heat stress

Working under the open sun during summer is tedious job and worker often suffered due to heat stress. To reduce the occupational hazards due to scorching heat, a headgear with air circulation system is developed by MPUAT, Udaipur centre to reduce the risk of heat stress and improve the comfort of agricultural workers. It consists of 3 W solar panel, DC motor, fan and battery. A comparative study in similar climatic condition i.e. WBGT 28, 30 and 32 °C has been carried out with other popular head gear viz. bamboo hat, white pagdietc. The result indicated that by using of headgear, the effect of heat stress significantly reduce thermal parameters (oral, head, forehead, and mean skin temperature), physiological parameters (working heart rate and working oxygen consumption rate) and physical discomfort parameters (overall discomfort rate). The increase in body temperature with air circulation velocity is found to be 0.23 °C to 2.99 °C during wheat harvesting operation.

Harvesting bag for women workers

Manual harvesting involves cutting, picking, plucking, digging or a combination of these operations for removing the edible parts from the plant which is mostly done by farm women. During this process, the harvested parts like vegetable, fruits, etc. needs to be temporarily stored in a basket or on ground. Extended reach, bending and squatting posture are commonly adopted during these operations, which increases the time requirement and drudgery to worker involved in harvesting operation. Therefore, a harvesting bag has been designed considering the anthropometric body dimensions of female workers by ICAR-CIWA, Bhubaneswar centre. The harvesting bag can be tied by a worker at the waist height for collection. The size of the harvesting bag has a working height of 440 mm, unloading height of 700 mm, width of 200 mm and shoulder strap length of 1300 mm.

Farm safety app

Lack of awareness and non adoption of safety gadgets and practices leads to accidents during farm operations. The agricultural accidents often lead to serious injuries and sometimes fatal to agricultural workers. Adoption of some precautions and safety gadgets can reduce the risk of these accidents and consequential losses. Therefore, a Farm Safety App has been developed. This App provides information about agricultural accidents and their causes, precautions and safety gadgets for its preventions. The app also provides information about first aid in case of emergency and available schemes offered by different state governments to provide compensation to agricultural workers. This app is available on Google play store.

CRP ON FARM MECHANIZATION AND PRECISION FARMING

The consortia research platform (CRP) on Farm mechanization and precision farming 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 parts of the country. The project operates with eight centres for these activities. A new programme on micro-irrigation has been started in year 2018-19 with five centres.

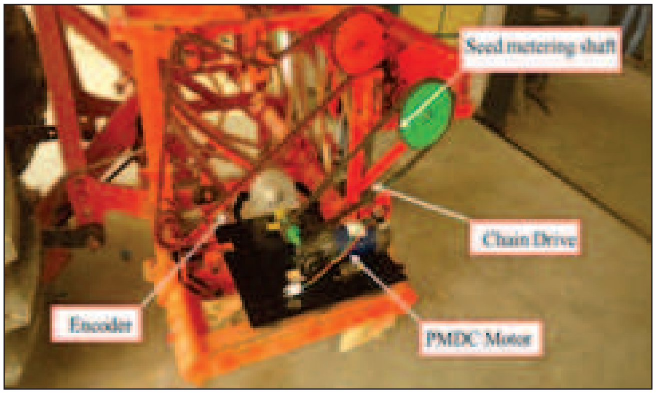
Tractor operated variable width raised bed planter-cum-herbicide applicator

A variable width raised bed planter-cum-herbicide applicator has been developed at ICAR-CRIDA, Hyderabad centre to suit the crop geometry of different crops such as pigeon pea, cotton, sorghum etc. The machine is designed in such a way that tractor wheels follow the furrows in wider row spaced crops, so that

the weeding and other operations can be done easily without disturbing the bed configuration. About 15-35% increase in yield has been reported with the use of this equipment in black and sandy loam soils across different villages. It reduces the energy requirement by 35% compared to the conventional seed drill followed by weeding operations.

Uniform rate seed metering mechanism

Uniformity of seed rate along the crop row is an important parameter which affects the crop yield. Due to skidding of ground drive wheel the uniformity of seed rate gets affected. An opto-electronic seed monitoring system has been developed by IIT, Kharagpur centre for sensing the seed flow from the seed metering unit of the planter. Performance evaluation of the developed system has been conducted at four operating speeds of 2.0, 3.0, 4.0 and 5.0 km/h. The seed detection range varied from 97.8 to 99.3%. The



developed seed sensing system is capable of detecting the metered seeds.

Small tractor operated rotary weeder

A rotary weeder matching to low horse power tractor (18-20 hp) has been developed at ICAR-CRIDA, Hyderabad centre by considering the crop row spacing and other machine parameters. The weeder has been

tasted in castor, pigeon pea and maize crops. The weeding efficiency of rotary weeder is found to be 82.5%. The approximate cost of the machine is Rs. 30,000/- and its operating cost is Rs. 600 /h.

Motorized protray, poly bag and pot filling machine

Raising orchards/vegetable seedlings is one of the important but time consuming and laborious activities. It involves cleaning, mixing and filling of growing media. Therefore, a motorized growing media siever, mixer and protray/bag filling machine has been developed by IIHR, Bangalore centre. 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 wheel 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 – 2.0 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 sieve-cum-protray filler is operated with a 2.0 HP, 3-phase, geared electrical motor. The growing media mixer has 2.25 m length with a cross section of 8 m top width and 0.45 m 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 – 2.0 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 Rs. 5,00,000/-. In order to reduce the cost of machine, a miniature version of the machine has been also developed as per demand from Department of Horticulture, Government of Karnataka.

CRP ON ENERGY FROM AGRICULTURE

The major aim of this consortia research platform is to facilitate basic research on biomass based energy generation and conduct of demonstration of energy efficient agricultural operation with a view to enhance the share of renewable energy use in Indian agriculture to lower the carbon footprint.

Fluidized bed pyrolysis reactor for production of bio-oil from biomass

A continuous type fluidized bed reactor has been designed to process 5 kg/h powdery biomass to produce bio-oil by MPUAT, Udaipur centre. The system comprises of fluidized bed reactor, cyclone separator, condenser and cooling tower. Performance of developed system has been carried out with wheat straw, maize straw, and sugarcane bagasse as feedstock. The maximum bio-oil was obtained with biomass particle size of 1 mm at 450-500 °C.

Agrivoltaic net house for cultivation of capsicum

The JAU, Junagadh Centre has developed an agrivoltaic net house. The experimental agrivoltaic structure has 24 solar panels, each of 150 W capacity, with a total installed rating of 3.6 kWSPV power. The solar panels occupy over 76.94 m^2 area. Under this agro-voltaic net house, capsicum crop has been grown. Total nine harvestings of capsicum have been done during the crop season and the highest crop yield of 15.29 t/ha is found the of combination of agrivoltaic insect net house with raised bed with silver black mulch+ bio fertilizers. The overall energy efficiency of the system has been found to be 8.5%.

Solar assisted electro flocculation system for micro algae harvesting

A solar assisted electro flocculation system has been developed at ICAR-CIAE, Bhopal for harvesting of micro algae bio-mass from raceway pond. The system is suitable for 2 m^3 of micro-algae water and can be up scaled up by adding the designed set of solar panels keeping the voltage and current constant as 60 V and 6.9 A, respectively. Time required for harvesting is 4 h to bring down optical density of microalgae from 0.98 to 0.16 and harvesting efficiency varies from 81 to 86% during the different harvestings throughout the year. Averege energy consumption for electro-flocculation is found to be 3 kWh/kg of dry microalgae biomass.

Enhanced biomass productivity of algae cultivated in raceway ponds using agro-industrial wastewater

The TANU, Coimbatore has experimented for heterotrophic growth of *T. wisconsinensis* (micro algae) resulted in high production of biomass and accumulation of high lipid content in cells. Mixotrophic growth of *T. wisconsinensis* has resulted not only in the disappearance of chlorophyll in cells but also accumulation of high lipid content in cells. Lipid content in heterotrophic cells has reached as high as 54.70%. The maximum area and volumetric biomass productivity attained from raceway is found to be 0.5 g m^2/day and 0.028 g/l per day. The dissolved oxygen, total nitrogen and phosphorus content of community waste water has reduced at 96.7, 94.6 and 91.6 % level, respectively.

TECHNOLOGY TRANSFER

Technology commercialization

Commercialization of agricultural engineering technologies through industries is the priority activity of the Institute to ensure their rapid transfer at user's level. During the year 2019, a total of 11 technologies were commercialized through licensing and Memorandum of Agreement.

License Agreement

Name of the Firm	Equipment/ Technology Licensed
M/s Swastik Agro Industries, 32, Industrial Estate,Rajnandgoan, Chattisgarh.	• Hand held Vegetable Transplanter (Model-I Single row & Model-II Two row) • Manually Operated Protray Type Nursery Seeder. • Manually Operated Pull Type Three Row Planter for Millets Multi-Crops (Model I -Inclined Plate Type & Model II -Vertical Plate Type). • Bullock Drawn Three Row Planter with Fertilizer Drill for Millets - multi-crop (Model I - Inclined Plate Type & Model-II Vertical Plate T ype). • Manual Naveen Dibbler. • Manual Peg Type Dry Land Weeder • Manually Operated Push Type Single Row Vertical Plate Planter with Fertilizer Drill for Millets – Multi-Crops. • Tractor Drawn Six Row Planter With Fertilizer Drill for Millets/Multi-Crop (Model - I Inclined Plate Type & Model-II Vertical Plate Type) • ICAR-CIAE Power Tiller Attachment to Six-Row Planter with Fertilizer Drill.
M/s Vasundhara Krishi Yantra, Plot no. 4, Lambakheda, Berasia Road, Bhopal – 462 038, M.P.	• Hand held Vegetable Transplanter (Model-I Single row) • Manually Operated Protray Type Nursery Seeder. • Manually Operated Pull Type Three Row Planter for Millets Multi-Crops (Model I - Inclined Plate Type & Model II -Vertical Plate Type). • Tubular Maize Sheller. • Manually Operated Push Type Single Row Vertical Plate Planter with Fertilizer Drill for Millets–Multi-Crops. • Tractor Drawn Six Row Planter With Fertilizer Drill For Millets/Multi-Crop (Model- I Inclined Plate Type & Model-II Vertical Plate Type)
M/S Agro Soya Milk Organic Plant, Gambho wal, PO -khudda, Tehsil - Dasuya, Dist. Hoshiarpur- 144305, Punjab.	• Soy Fortified Nutritious Healthy Noodles. • Extruded Functional Snacks Foods.

Frontline/cluster Demonstration Programme

Name of the Equipment/ Technology	No. of demonstrations conducted	Area covered in ha or hours of use	No. of farmers/ users
Cluster Demonstra tion on Oilseed (Soybean, RVS 2001-4)	25	10	25
Frontline Demonstration on Oilseed (Soybean, RVS 2001-4)	10	04	10
Package Demonstration on Wheat (HI-1544)	10	04	10
Mole Drainage Technology	20	45	130
Women Friendly Implements & Machineries comprising of CIAE rotary dibbler, pull type manual transplanter, manual seed cum fertilizer broadcaster, battery operated sprayer, manually guided power weeder, wheel hoe, improved direct paddy seeder, conoweeder, groundnut decorticator and maize sheller	12	01	700
Millet Mill	01	-	55

On-Farm Trials/Demonstration at Farmer's field

Name of Equipment/Technology	No. of Demonstration	Area covered ha
OFT- Soybean (JS 2029)	10	4.0
OFT- Raised bed seeder for sowing of soybean	03	1.2
Maize seed planting on raised bed under *Kisan Khet Pathshala* (ATMA)	02	2.0
OFT- wheat (HD-2967)	10	4.0
OFT- Chickpea(RVG- 202)	10	4.0
OFT - Strip till drill for sowing of Wheat	03	1.2

Participation in exhibition

Agri Fair/Agri-Tech Exhibition	Duration
International Level	
Krishi Vigyan Mela, IARI, Pusa, New Delhi	5-7 Mar, 2019
National Level	
Agri-Exhibition at Motihari, Bihar	9-11 Feb, 2019
Purvanchal Kisan Mela and Agricultural Exhibition at Chaukmafi, Peppeganj, Gorakhpur, UP	02-03 Mar, 2019
Agri Exhibition Smart Agro Tech.-2019, Raipur, CG	01-02 Mar, 2019
Akhil Bharati Kisan Mela evam krishi Udhoyog Pradarshni, CSAU, Kanpur, UP	16-19 Oct, 2019
Farm Machinery Entrepreneurship Seminar & Expo-2019, Indian Institute of Sugarcane Research Lucknow, UP	24 Oct, 2019
The Science-Fiesta-2019, Regional Science Centre, Bhopal, MP	13-14 Nov, 2019
Regional Level	
Farmer's Fair Karunya Institute of Engineering, Science and Technology, Coimbatore	27 Feb, 2019
Good Farming –Good Food Balance for Better a mega event organized by Solidaridad (Asia) with knowledge support of various institutes to commemorate the International Women's Day at Village Kheda Khajuri, Distt.-Dewas, MP	08 Mar, 2019
Agri-Expo-2019, Millennium College of Technology, Neelbad, Bhopal, MP	18-19 June, 2019
Agri Intex 2019 CODISSIA Trade Fair Complex, Coimbatore, TN	12-15 July, 2019
8th Bhopal Vigyan Mela-2019 (BVM-2019), organized jointly by CSIR	13-16 Sept, 2019
AMPRI, Bhopal and Vigyan Bharti (VIBHA), Bhopal, MP Krishi Mela at UAS, GKVK, Bangalore, Karnataka	24-27 Oct, 2019
Krishi Manthan-5, National Agri Business Summit -2019 at Samrat Ashok Technological Institute, Vidisha, MP	13-14 Dec, 2019

Radio Talk

Name of the Media	Subject	Date	Name of the presenter
AIR	Measures for health and nutrition in the summer season	28 Mar, 2019	Dipika Agrahar Murugkar
AIR	Fasal prabandhan hetu Unnat Krishi Yantra	10 Apr, 2019	KP Singh
AIR	Katai evam Gahai hetu unnat krishi yantra	27 Sep, 2019	DK Dwivedi

TV Talk

Name of the Programme/Media	Subject	Date	Name of the presenter
News -18	Crop management in vegetable (onion)	08 Feb, 2019	RD. Soni
	Crop management in vegetable (Garlic)	08 Feb, 2019	
	Recording on "Lauki me Samayik Phasal Prabandhan" for Telecast in Annadata programme.	19 Mar, 2019	
DDK, Bhopal	Saamayik Krishi Karya	25 Feb, 2019	D.K. Dwivedi
DDK, Bhopal	Pradhan Mantra KisanSamman Nidhi programme (Krisak Charcha)	28 Feb, 2019	
News-18	Gehu katai yantra par vistarpurvak jankari (Anndata program)	21 Apr, 2019	
	Krishi sambandhitvishayo par Krishi Salahakar Samiti Baithak	22 Oct, 2019	
DDK Bhopal	Pump Selection	15 May, 2019	CK Saxena
DDK Bhopal	Protected cultivation	26 Aug, 2019 4 Dec, 2019	KVR Rao
DDK Bhopal	बुवाई के लिए उन्नत कृषि यंत्र	8 Nov, 2019	KP Singh
DDK Bhopal	Food processing and value addition	21 May, 2019 29 Nov, 2019	N Kotwaliwale

Prototype Production and Supply

During year 2019 a total of 6331 units of following 37 different types of implements were supplied to various stakeholders with total revenue of Rs. 66.87 lakh.

Name of the Equipment/ Technology	Quantity
Manual twin wheel hoe	2108
Manual conoweeder	623
Manual hand ridger for women	539
Manual naveen dibbler	558
Manual rotary dibbler	5
Manual peg type dry land weeder	576
Manual cycle wheel hoe	8
Manual 4-row rice seeder	3
Manual maize sheller	1058
Manual grubber weeder	59
Manual paneer pressing device	5
Manual double screen grain cleaner	8
Manual sack holder	5
Manual stalk uprooter	14
Nursery seeder	1
Multi fuel cooking stove	58
Serrated sickle	530
Double reflector solar cooker	1
Manual groundnut decorticator for women	95

Name of the Equipment/ Technology	Quantity
Manual groundnut decorticator for standing type	6
Pedal cum power operated grain cleaner with motor	3
Hand held single row vegetable transplanter	4
Hand held two row vegetable transplanter	11
Animal drawn inclined plate planter	1
Solar cabinet dryer	1
Self-propelled power weeder	5
Motorized millet thresher	1
Motorized dal mill	16
Multi-purpose grain mill with 1 hp motor	5
Motorized multi crop plot thresher	2
Manually operated pull type three row planter for Millets-multi-crops (model-1-inclined plate type)	1
Manually operated push type single row vertical plate planter with fertilizer drill	1
Manually operated pull type three row planter for millet-multi crops	1
Tractor drawn inclined plate planter with pre-emergence herbicide applicator	3
Tractor drawn broad-bed former-cum-seeder	2
Tractor drawn plastic mulch laying machine	1
Tractor drawn mole plough	3

TRAINING AND CAPACITY BUILDING

International Training

Agricultural Engineering Technologies for Enhancing Productivity and Profitability in Agriculture Sector

An international training programme on "Mechanization Technologies for Sustainable and Profitable Agriculture in African-Asian Region" under theme of "Agricultural Engineering Technologies for Enhancing Productivity and Profitability in Agriculture Sector" was conducted during 17-30 Sep, 2019 for 10 participants from 9 different member countries of African-Asian Rural Development Organization (AARDO), namely Egypt, Ethiopia, Jordan, Malaysia, Oman, Republic of China (Taiwan), Sri Lanka, Tunisia and Zambia. The programme was jointly sponsored by AARDO, New Delhi and Ministry of Rural Development, GoI, New Delhi. The training programme was imparted through lectures, presentations, practical sessions, hands-on experience and field visits covering

information on agricultural mechanization inclusive of precision agriculture, manual, animal, power operated and automated farm equipment, irrigation and drainage, processing and value addition and renewable energy.

National Training

Centre for Advanced Faculty Training

With an objective to create awareness on emerging prospects of agro-based processing techniques, strength and pitfalls, their applications for entrepreneurship development and possible role in new business opportunities for economic security among the faculty members and researchers, a 21-days course titled "Prospects of Emerging Agro-based Processing Techniques and Business Opportunities" was conducted during 14 Nov to 04 Dec, 2019. The course was attended by 15 participants from different SAUs, KVKs and ICAR Institutes of seven states of India. The participants had their specific background from agricultural processing, food and nutrition, entomology, economics, home-science, animal nutrition, extension, etc. The course content included

lectures, demonstrations, hands-on practical and visits related to topics covering recent trends and opportunities for entrepreneurship development in food processing industry, management of agri-business units, novel thermal and non-thermal processing techniques, advances in food processing technologies, food safety and regulations: FSSAI (Requirements and certification), advanced techniques for food analysis and IPR related issues in Food sector.

Short Courses

Short course on "Recent Advances in Solar Energy Utilization for Agro-Produce Processing and Production System" was organized during 10-19 December, 2019. Fourteen participants from Madhya Pradesh, Tamilnadu, Maharasshtra and Odisha were participated in the short course. Dr. Mukesh Pandey, Director, SoEEM, RGPV was blessed the inaugural

function as Chief Guest. A total 22 lectures, 14 practicals and 2 visits were made during this course.

The ICAR Short Course entitled 'Entrepreneurship Development through Agro Food Processing Centres' was organized at ICAR-CIAE Regional Centre,

Coimbatore during 12-21 Dec, 2019, in which 16 scientists and assistant professors from NARS attended this program.This program was inaugurated by Shri. R. Amalorpavanathan, Former Deputy Managing Director, NABARD. For this program, Principal Scientists of this Centre *viz*., Dr. S. Balasubramanian and Dr. Ravindra Naik were the Course and Co-Course Directors, respectively. A total of 21 lectures and practicals were organized during the course.

Rice Mechanization and Post-harvest Technology

A ToT program was arranged for extension officers of AAV, Assam in CIAE, Bhopal under Assam Agribusiness and Rural transformation Project (APART) in collaboration with ICAR- CIAE, Bhopal and International Rice Research Institute (IRRI). Agricultural Mechanization Division, ICAR-CIAE, Bhopal organized a 3-days training on "Rice Mechanization and Post-harvest Technology" during 02-04 Aug, 2019. A group of 20 extension functionaries of Assam Agriculture University (AAU) from the state of Assam had undergone the training programme. During the training, participants were exposed to various technologies available for rice mechanization like mat-type rice nursery raising, ride-on rice transplanter, drum seeder, conoweeder, rotary weeder, reaper and combine harvester. Hands on training was imparted on mat-type nursery raising, seed bed preparation, sowing and transplanting, spraying, weeding, harvesting, straw baling and post-harvest processing of rice. Ex-situ utilization of rice straw to make wealth from waste by making briquettes was also demonstrated.

Model Training Course

A model training course on 'Establishment of Agro processing and Farm Machinery custom hiring centres' was organized during 1-8 Aug, 2019. The programme was attended by 20 state level Officers from different states viz. Bihar, Odisha, Goa, Telengana, Andhra Pradesh, Kerala and Tamilnadu. This MTC comprised of lectures and industrial visits/ exposure/ field level interactions etc. This program was coverage of concept and establishment of Custom Hiring Centre, Opportunities in farm machinery and power engineering, Post harvest/Agro processing technologies, renewable source of energy etc.

HRD Training Programme for Drivers of ICAR Institutes and Headquarter

Training programme on "Automobile Maintenance, Road Safety and Behavioural Skills" for drivers of ICAR institutes/ HQ was organized in five different batches during 16-22 Jan 2019, 19-25 Feb, 2019, 26 July-01

Aug, 2019, 24-30 Sep, 2019 and 27 Nov- 03 Dec, 2019. A total of 156 drivers in different technical positions from ICAR institutes and Headquarter participated in these training programme. Lectures and practical sessions were organized on various aspect of vehicle maintenance, safety, traffic rules, insurance guidelines, fuel economy,etc. Resource persons from different institutions such as M/s CI-Hyundai, Bhopal; New India Assurance Co. Ltd.,Bhopal; CRISP, Bhopal; MANIT, Bhopal; Traffic police, Bhopal, Petroleum Conservation Resarch Association, Bhopal; Maruti Driving School; M/s TATA Motors, M/s Mahindra Automobiles helped in organizing various sessions of the training programme. Local visit to local workshops, dealer show rooms and educational trip were also organized for benefit of the participants.

HRD Training Programme for ICAR Technical Personnel

A two weeks training programme for technical personnel of ICAR was organized at ICAR-Central

Institute of Agricultural Engineering, Bhopal during 12-25 March 2019 on topic "Selection, Adjustment, Operation and Maintenance of Agricultural Implements for Field and Horticultural Crops". Eleven technical staff from five ICAR institutes participated in the training programme. Theory and practical's were conducted on selection, adjustment, maintenance, operation of tillage implements, seeding & planting machinery, transplanters, plant protection equipment, harvesting and threshing machinery. Lectures and field practicals on testing and quality control of agricultural machinery; farm implements for conservation agriculture; power tiller operation and matching implements; modern agro-processing machinery, energy gadgets; protected cultivation; irrigation and drainage systems were covered in depth. Practical exposure to DSS in custom hiring, ergonomics and safety in agriculture with women friendly engineering technologies were conducted. Four off-campus educational field trips to e-Chaupal of ITC Ltd., Eicher tractor company, Mandideep, CFMTTI, Budni and ICAR-IISS, Bhopal were also included in this training programme.

Training on Ergonomical Design Guidelines

A three days training programme on Ergonomical Design Guidelines for Agricultural Tool, Equipment and Work Places was organized at the institute during 9-11

July, 2019. Total 16 participants attended the training programme. The programme comprised of exposure on using the ergonomic principles for design of agricultural tools and implements and workplaces of tractors and sel-propelled equipment. The emphasis was given to take holistic approach of designing and incoprate the limits with respect to body dimensions and strength values of the Indian workers, environmental factors such as noise, vibration, dust, chemical and ambient conditions. Participants especially from industries felt that such training is higly useful.

Farm Mechanization Training for Subject Matter Specialists

KVK, ICAR-CIAE, Bhopal conducted five days training programme from 14-18 Oct, 2019 on the "Role of Agriculture Implements in Farm Production" sponsored by State Institute for Management of Agriculture (SIMA), Rahmankheda, Lucknow, Uttar Pradesh. The on-campus sponsored training programme was conducted under Sub Mission on Agricultural Extension (SMAE) scheme of SIMA. 21 Participants from different districts of UP state attended this training. The training programme was coordinated by Er. DK Dwivedi, CTO.

Training on Agricultural Marketing for ATMA Officials

KVK, ICAR-CIAE, Bhopal organized a three days training programme on "Agricultural Marketing for ATMA Officials" during 11-13 Sep, 2019. The training was sponsored by CCS-National Institute of Agricultural Marketing, Jaipur, Rajasthan an autonomous organization under the aegis of the Ministry of Agriculture and Farmers' Welfare, Government of India. Total 19 participants participated in this training. The participants were selected from Bhopal, Sehore, Hoshangabad, Vidisha, Betul and Rajgarh districts by the respective Project Directors of ATMA. The topics covered in the training programme were marketing of agricultural produces, production of high valued crops under covered cultivation and contract farming, storage for cost effective marketing and reduction in post-harvest losses, market information and benefits of agricultural extension services, value addition and entrepreneurship development, processing, packaging and storage for value addition, marketing of value added health products from soybean etc.

Other training programme

Training Title	Duration/Dates	No. of participants
Hands on training for farmers on improved agricultural implements and machinery	09-11Jan,2019 20-22 June, 2019 17-19 Sep, 2019 17-19 Dec ,2019 24-26 Dec, 2019	351 in 5 batches
Enterpreneurship development for custom hiring of agricultural machinery as an enterprise	01-07 Feb, 2019 01-07 Mar, 2019	72 in 2 batches
Enterprenurship development programme on soybean processing and utilization	1-6 Apr, 2019 17-22 June, 2019 19-24 Aug, 2019 14-19 Oct, 2019	25
Protected cultivation for horticultural crops	2 days duration	
CAD training	17-31 May, 2019 1-30 June, 2019 19 June-8 July, 2019	10 in 3 batches.
Students' Experiential learning Training for UG &PG students in Agril. Engg	1 to 3 months duration	196 from Agricultural Engineering colleges at Bhopal and 94 from Coimbatore

Training organized by KVK

Title of training programme	Date (Period)	No. of Participants
On campus		
Improved farm machinery techniques	05 Jan, 2019	49
Food preservation and women friendly tools	09-11 Jan, 2019	30
ग्रामीण महिलाओं हेतु खाद्य प्रसंस्करण एवं संरक्षण	28 Feb, 2019	50
Oil Seed crop production technology under Oilseed mission programme	28 Feb, 2019	155
Farmers training programmes on crop management and post-harvest techniques of grains, NFL, Bhopal.	27 Mar, 2019	62
Production technology of oilseed crops and its mechanization for Dept. of Agriculture Bhopal	29-30 Mar, 2019	20
Soybean cultivation on raised bed/ broadbed/ ridge & furrow techniques	25 June, 2019	45
डीबीटी योजना के अर्न्तगत पीओस मशीन पर उर्वरक विक्रेताओं का एक दिवसीय प्रशिक्षण	19 June, 2019	35
Automobile maintenance, road safety and behavioural skills	27 July-1 Aug, 2019	31
Agricultural Marketing for ATMA Officials	11-13 Sep, 2019	19
Foot & Mouth disease and Brucellosis disease of bovine along with artificial insemination programme and its procedure for animals	11 Sep, 2019	60
Automobile maintenance, road safety and behavioural skills	24-30 Sep, 2019	35
Role of agriculture implements in farm production	14-18 Oct, 2019	21

Title of training programme	Date (Period)	No. of Participants
Fertilizer application	22 Oct, 2019	80
Rabi crop workshop for extension functionaries of Department of Agriculture, Government of M.P.	07 Nov, 2019	114
Automobile Maintenance, Road Safety and Behavioural Skills	27 Nov-03 Dec, 2019	27
Off Campus		
Women friendly tools	03 Jan, 2019	20
Oil Seed crop production technology under oilseed mission programme	28 Feb, 2019	155
Management & field visit no Capacity building programme to farmer group	07 Feb, 2019	42
Nutrient management through agriculture waste	06 Feb, 2019	35
कृषकों को रेज्डबैड/ब्रांड बैड (Raised bed/ Broad bed) कृषि यंत्रो द्वारा सोयाबीन बुवाई की तकनीकी जानकारी	27June, 2019	50
कृषकों को रेज्डबैड/ब्रांडबैड (Raised bed/Broad bed) कृषि यंत्रों द्वारा सोयाबीन बुवाई की तकनीकी जानकारी	29 June, 2019	68
फार्मर केयर कार्यक्रम के अंतर्गत कुपोषण उन्नमूलन हेतु सोयाबीन आधारित खाद्य–पदार्थ की जानकारी	12 July, 2019	45
Nutrition awareness programme	03 Oct, 2019	18
Farm School for maize crop	10- 11 Oct, 2019	80
घरेलू स्तर पर सोयाबीन उपयोग पर प्रशिक्षण	23 Oct, 2019	35
सोयाबीन का उपयोग पर प्रशिक्षण	01 Nov, 2019	25
Training programme on programs conceptualizing production of items	27-28 Nov, 2019	110
Management of Rabi crops	16 Dec, 2019	35
घरेलू स्तर पर सोयाबीन उपयोग पर प्रशिक्षण	18 Dec, 2019	30

Mera Gaon Mera Gaurav Activities

Under the Mera Gaon Mera Gaurav acitivity at the institute, 16 groups of scientists have been formed and each group has adopted a cluster of five villages in cluster approach method. During the period 61 interaction meetings cum visits with farmers were conducted by the groups. Total number of beneficiaries covered was 3159. Each group identified problems being faced by farmers in Agriculture and allied sector during the interactions. A total of 56 demonstrations on improved farm machinery were conducted by the groups at their adopted villages as well as at the institute. Farmers were advised to adop improved machinery for cultivation of soybean, paddy, wheat and gram, use safety measures during chemical application and women friendly tools. Awareness cum sensitization workshop cum training on swachhta was organized in selected MGMG villages.

Name of activity	No.of activities conducted	No. of beneficiaries
Visit to village by teams	61	1832
Interface meetings/ Goshtis	28	425
Training organized	7	178
Demonstration conducted	56	377
Mobile based advisories	6	162
Awareness created	7	185
Total	**165**	**3159**

SCSP Activities

The Scheduled Caste Sub-Plan (SCSP) program is intended to provide support to Scheduled Caste (SC) families or individuals below the poverty line (BPL) for their livelihood support and economic development. Total eleven villages have been selected under this programme. Out of which, seven village in Bhopal district namely Sukaliya, Nipaniyajat, Kurana, Barodi, Kachi Barkheda, Raipur, Balampur and 3 three villages in Coimbatore district namely Irumporai, Chinna Kallipatti and Muduthurai have been selected based on criteria of having SC-BPL population more than 25%. Bench mark survey was conducted in these villages. Approximately, 500 families (2500 beneficiaries) have been identified for providing direct benefit transfer under this programme for improvement of their livelihood. Thirteen field days/nutritional fair/demonstration programme were conducted at different villages for creation of awareness, sensitization and for skill development to the beneficiaries. Based on the livelihood needs of families support in terms of seeds of wheat and vegetables, fertilizer and improved tools and equipment were provided. Wheat Seed (HI 8713), fertilizer (NPK) and vegetable kits were provided to 42 farmers. Manually operated and gender friendly tools/equipment such as improved sickle, hand ridger, dibbler, wheel hoe weeder, dry land weeder, sack holder, grain cleaner, improved cooking stove, stalk uprooter, single and double row vegetable transplanter, etc were provided to about 900 farmers.

Field days/nutritional fair/demonstration programme in different villages under SCSP programme.

Programme Name	Date	Place	Number of beneficiaries
A Field day-cum-demonstration on “Small hand tools for agricultural operations”	30 Sep, 2019	Chanderi	100
Woman farmer’s day	15 Oct, 2019	Sukaliya	150
Field day and demonstration of women friendly equipments	13 Nov, 2019	Kurana	100
Field day on Demonstration of agricultural implements and distribution of seeds and vegetable kits	15 Nov, 2019	Barodi	150
Food processing, nutrition mela and demonstration of agricultural implements	05 Dec, 2019	Nipaniya Jat	150
Field day on Demonstration of agricultural implements and distribution of fertilizer	06 Dec, 2019	ICAR-CIAE	60
Demonstration cum awareness programme on agricultural implements and nutrition	09 Dec, 2019	Kurana	150

Programme Name	Date	Place	Number of beneficiaries
Field day on Demonstration of agricultural implements and distribution of agricultural equipment/ tool	12 Dec, 2019	Kachhi Barkheda	120
Distribution of agricultural equipment/tools	28 Dec, 2019	Nipaniya Jat	56
Sensitization meet on 'Women-Friendly Agri. Engineering Technologies for Empowerment	2 Nov, 2019	ICAR-CIAE, Coimbatore	45

Implements provided to SCSP beneficiaries

Name of equipment	Nos.
Manual double screen grain cleaner	11
Manual twin wheel hoe weeder	44
Multi fuel cooking stove	54
Manual peg type dry land weeder	11
Hand ridger	56
Maize sheller	22
Manual Naveen dibbler	04
Cono weeder	03
Groundnut decorticator	07
Sickle	753
Manual cycle wheel hoe	3
Manual stalk uprooter	3
Single row vegetable transplanter	4

HUMAN RESOURCE DEVELOPMENT

Scientists

Name and Designation	Name of Training programme attended	Duration	Place
Abhijit Khadatkar, Scientist	Summer Faculty Development Programme on Robotics & AI	24-28 June, 2019	Indian Institute of Information Technology, Design and Manufacturing (IIITDM), Jabalpur
Abhishek Waghaye, Scientist	Winter school on Artificial Intelligence	18-21 Jan, 2019	IIIT, Delhi
AP Pandirwar, Scientist	Summer Faculty Development Programme on Robotics & AI	24-28 June, 2019	Indian Institute of Information Technology, Design and Manufacturing (IIITDM), Jabalpur
Bikram Jyoti, Scientist	IoT and its Application	26-30 Mar, 2019	RGPV, Bhopal
Chirag Maheswari, Scientist	Plant tissue culture technique	20-24 Aug, 2019	MPCST, Bhopal
Manoj Kumar, Scientist	Deep Learning & Applications Robotics and AI	27-31 May, 2019 24-28 June, 2019	IIITDM, Jabalpur MANIT , Bhopal
Mukesh Kumar, Scientist	Winter school on Artificial Intelligence Sensors Network, Internet of Things(IoT) and Internet of Everything	18-21 Jan, 2019 5-14 Nov, 2019	IIIT, Delhi MANIT, Bhopal (M.P.)
Muzaffar Hasan, Scientist	Plant tissue culture technique	20-24 Aug, 2019	MPCST, Bhopal
PC Bargale, Incharge-Head, TTD	Intellectual Property & Management	15-19 Oct, 2019	ICAR-NAARM, Hyderabad
Ravindra Naik	Science, Technology and Emerging Trends in Governance	21- 25 Oct, 2019	Indian Institute of Public Administration , New Delhi
Ravindra Randhe, Scientist	Winter school on Artificial Intelligence	18-21 Jan, 2019	IIIT, Delhi
RK Sahni, Scientist	Application of Advanced Instrumentation and Hydraulic Systems in Precision Agriculture for Crop and Environmental Sustainability	15 Feb - 7 Mar, 2019	ICAR-CIAE, Bhopal
Sandip Mandal, Scientist	IoT and its Application Intellectual Property Rights & Business for SMEs and Startups Training on "Developing Winning Research Proposal Short Course on Recent Advances in Solar Energy Utilization for Agro-Produce Processing and Production System	26-30 Mar 2019 4-6 Sept, 2019 19-23 Nov, 2019 10-19 December, 2019	RGPV, Bhopal ICAR-IARI, New Delhi ICAR-NAARM, Hyderabad ICAR-CIAE, Bhopal

Name and Designation	Name of Training programme attended	Duration	Place
Satya Prakash Kumar, Scientist	Summer Faculty Development Programme on Robotics & AI	24-28 June, 2019	Indian Institute of Information Technology, Design and Manufacturing (IIITDM), Jabalpur
SK Giri, Principal Scientist	Management Development Programme for HRD Nodal Officers of ICAR for Effective Implementations of Training Functions	14 -16 Mar, 2019	ICAR-NAARM, Hyderabad
Sweeti Kumari, Scientist	Environmental Leadership & Life skills	11-15 Feb, 2019	IIFM, Bhopal
Syed Imran S, Scientist	IoT and its Application	26-30 Mar, 2019	RGPV, Bhopal

Technical Staff

Name and Designation	Training Title	Duration	Place
Krishna Mairade, Technical Officer	Gas Tungsten Arc Welding on Stainless Steel Plate	7-11 Jan, 2019	ATI, Mumbai
Banmali Bhaskar, Technical Officer	Bearing and Lubrication	7-11 Jan, 2019	ATI, Mumbai
PK Das, Senior Technical Officer	Instrumentation and Control	21-25 Jan, 2019	CRISP, Bhopal
SK Bharti, ACTO	Information and Communication Technologies for Empowering Farm Women	1-6 Feb, 2019	ICAR-NAARM, Hyderabad
Ravindra Singh, CTO	Farm Management	13-19 Feb, 2019	ICAR-IIFSR Modipuram
AP Silarkar, ACTO	KOHA for Library Staff of ICAR	21-26 Feb, 2019	ICAR-NAARM Hyderabad
Mrs. Deepika Shende Channe, ACTO	Motivation, Positive Thinking and Communication Skills for Technical Officers (T-5 and above) of ICAR Institutes	2-7 May, 2019	ICAR-IISWC, Dehradun
M Mohan, Sr. Technical Officer	Motivation, Positive Thinking and Communication Skills for Technical Officers (T-5 and above) of ICAR Institutes	2-7 May, 2019	ICAR-IISWC, Dehradun
Anju Kumar Pathak, Sr. Tech. Assistant	Farm Management	17-23 Sept, 2019	ICAR-IIFSR, Modipuram
Raj Kumar Yadav, Sr. Tech. Assistant	Farm Management	17-23 Sept, 2019	ICAR-IIFSR, Modipuram
Raj Kumar Yadav, Sr. Tech. Assistant	Capacity Building Programme Towards A Secure and Resilient ICAR	25-27 Nov, 2019	ICAR CPRI, Shimla
AP Silarkar, ACTO	J-Gate @CeRA	28 Dec, 2019	ICAR-NRC Grapes, Pune

Administrative Staff

Name	Training Title	Duration	Place
MK Mulani, SF & AO	ICAR-ERP Training	11-16 Mar, 2019	ICAR-IASRI, New Delhi,
Kumar Rajesh, CAO	MDP on Admn. & Financial Management to Deputy Secretaries	24-27 Sept, 2019	ICAR-NDRI, Karnal
Kumar Rajesh, CAO	Trainers Development Programme for various Cadres of Administrative and Finance Staff	04-09 Dec, 2019	ICAR-NAARM Hyderabad

Ph. D. Awarded to Staff

Name and Designation	University	Thesis title	Date of award
Abhijit Khadatkar, Scientist	College of Technology and Engineering (CTAE), MPUAT, Udaipur	Development of tractor operated vegetable transplanter for plug-type seedlings	8 Feb, 2019
Syed Imran, Scientist	Tamil Nadu Agricultural University, Coimbatore	Development and evaluation of a battery powered knapsack air-assisted sprayer	12 Apr, 2019

Foreign Deputation

- Dr. Debabandya Mohapatra, Senior Scientist was deputed to Mynmar for teaching post graduate students under the programme of ACARE, Mynmar under bilateral agreement between DARE and MEA at YAU, Mynmar during Feb 15 to 4 March , 2019.
- Dr. C. R. Mehta, Project Coordinator, AICRP on Farm Implements and Machinery participated in 5th meeting of the Technical working group on power tillers of the Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM) at Changsa from 9-12 Sep, 2019.
- Dr. M. Din, Project coordinator, AICRP on UAE and Dr. B. M. Nandede, Scientist attended 5th Training of Trainers of Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM) at Beijing and Changsa from 4-11 Sep, 2019.
- Dr. Sandip Mandal, Scientist, AEP has attended 46th International Conference of the Slovak Society of Chemical Engineering, Slovakia during 20-23 May, 2019 at High Tatra, Slovakia.
- Er. Ramesh Kumar Sahni, Scientist deputed to Washington State University, USA on study leave to pursue his Ph. D. programme w.e.f. 19 Aug, 2019 for three years.

PG School Activities

Fourteen students were enrolled during the session 2019-20, four in Farm Machinery and Power, six in Agricultural Processing and Structures and four in Soil and Water Conservation Engineering disciplines. This year Ph D degree has been awarded to two students. The course work and research work for students are going on with their allotted research guides as per schedule. The monitoring and timely submission of Plan of Proposed Work (PPW) and Outline of Research Work (ORW) are being ensured by PG School coordinators on the allotted research projects.

The Ph. D. scholars also participated in various activities other than academics such as participation in national conferences and seminars, celebration of CIAE foundation day, world food day and agricultural education day. Students published five research papers, out of which, two were in international journals. In addition to research papers, students also published four abstracts, four book chapters and ten popular articles. One student has also qualified Gate examination.

AWARDS AND RECOGNITION

- AICRP on FIM was awarded by ICAR with Chaudhary Devi Lal Outstanding All India Coordinated Research Project Award – 2018.
- Dr. NS Chandel received NASI-ICAR Award for Innovation and Research on Farm Implements-2018 for the development of Mechanical Inter and Intra Row weeder for deep Rooted Field Crops.
- Dr. NS Chandel received Jawaharlal Nehru Award for Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences 2018 – Agricultural Engineering. Topic of his PhD. thesis was Electronic control unit and digital nutrient map integrated variable rate fertilizer application technology.
- Dr. Sandip Mandal awarded Best PhD Student of the year 2018 by GB Pant University of Agriculture and Technology, Pantnagar.
- Dr. Bikram Jyoti received Best Agricultural Equipment Innovation Award, NIRMAAN 2019 from Mechanical Engineering Department (SISTec Mechanical Engineer's Association).
- Dr. Adinath Kate received "Governors Research Award-2019" from Hon. Governor Uttarakhand state for "Development and testing of apricot (*Prunus armeniaca* L.) pit decorticator".

Name	Award/Recognition	Awarding Organization
Nachiket Kotwaliwale	ISAE Fellow	ISAE, New Delhi
KVR Rao	ISAE Fellow	ISAE, New Delhi
KN Agrawal	ISAE Commendation Medal	ISAE, New Delhi
S Mangraj	Best Book Award	ISAE, New Delhi
PC Jena	Distinguished Service Certificate	ISAE, New Delhi
NS Chanel and KN Agrawal	Best paper award in Journal of Agricultural Engineering	ISAE, New Delhi
PC Jena	Young Scientist Award	Royal Association for Science-led Socio-cultural Advancement (RASSA), New Delhi
Mukesh Kumar	Rashtriya Gaurav Award	IFS, New Delhi (Society)
Sandip Mandal	Best Oral presentation	International Conference on Advances in Renewable Energy (ICARE-2019) at VIT, Vellore
Ravindra Naik	Best Poster	Agriculture Science Congress, New Delhi
T Senthilkumar	Best oral presentation	National Conference on doubling farmer's income, TNAU, Coimbatore
R Senthil Kumar	Best Book Award	Tamil Book by Agriculture Scientific Tamil Society, New Delhi
R Senthil Kumar	Fellow	Bose Scientific Society, New Delhi

LINKAGE AND COLLABORATION

International	
AARDO-African Asian Rural Development Organization	Training on technologies for Mechanization Technologies for Sustainable and Profitable Agriculture in African Asian Region
Asia Pacific Network of Testing of Agricultural Machinery, CSAM, China	Developmentof test codes and capacity building
Institute of Chemical and Environmental Engineering, Faculty of Chemical and Food Technology, Slovak University of Technology, Radlinského 9, 812 37 Bratislava, Slovakia	Scientific and technical reports, research papers writing and works
National	
ICAR-IISS, Bhopal	Joint research projects in the area of conservation agriculture, sewage water, NASF projects, etc
ICAR-SBI Coibatore	Joint research project in sugarcane mechanization
ICAR-NRC, Banana, Trichy	Joint research project for mechanization of banana cultivation
ICAR-DCR, Puttur	Joint research project on development of cashewnut apple slicer
ICAR-CTRI, Rajamundry	Joint research project on mechanization of production and post productin of tobacco leaves
ICAR-NRC Grapes, Pune	Joint research projects on mechanization of grape cultivation
ICAR NIANP, Bangalore	Collaborative project on urea treatment of straw
ICAR-NIAP, New Delhi	For impact analysis of CIAE technologies

Central and State Government Organization	
DoAC & FW, New Delhi	Testing centre activities of farm machinery and post harvest machinery, skill development and capacity building programme
DST, New Delhi	Sponsored research Projects
Dept of MSME, New Delhi	Joint capacity building programme
TERI, New Delhi	Collborative project in NASF and CRP on EA
National Medicinal Plant Board	Sponsered research projects
MANIT, Bhopal	Collaborative research project
Women and Child Development Department, Govt. of MP	Organization of awareness camp, Nutri Mela
National Committee on Plasticulture in Horticulture (NCPAH)	Activities of PFDC
MP state Department of Horticulture, Govt. of MP, Bhopal	Horticultural mechanization
MP state Department of Agricultural Engineering, Govt. of MP	Mechanization of state and capacity building of custom hiring enterprenures
Department of Scientific and Industrial Research, Govt. of India	Sponsored project on technology forecasting and projecting market trends of agriculture machnery
MP Council of Science and Technology, Govt. of MP, Bhopal	Joint organization of agri-fairs
MP state Agro industries Corporation, Bhopal	Commercialization of CIAE Technologies in MP state
M/s. MP Vigyan Sabha (NGO), Bhopal	CIAE outreach programme for millet processing in tribal area at Tamia Block of Chhindwara District

Central and State Government Organization	
M/s. Adhimalai Pazhanudiyinar, Erode	Establishement of solar lighting system in Galidubba Tamia block, Chhindwara district
M/s. Thumbithakaadu Tribal People Welfare Society, Bangalathoti, Erode, Tamil Nadu	Establishment of Millet Processing Centre at Bangalathoti, Erode, TN under Tribal Sub Plan (GoI)
Industries	
International Paper APPM Limited, Rajahmundry; Bajaj Steels Pvt. Ltd, Nagpur, Mahindra and Mahindra, ITC, Veda Farms Limited, John Deere, Pune; TAFE Ltd,, Chennai; Eicher (TAFE Ltd), Bhopal; International Tractors (Sonalika); Burgeon Agri Pvt. Limited, Nasik, M/S Grindwell Norton Limited, Mumbai	Commericalization of ICAR-CIAE technologies, collaborative projects, training and capacity building

Commercial Testing of Farm Machinery

Testing facility for farm machinery and post harvest machinery is available at main campus and its regional station at Coimbatore. The facility is well equipped with broad range of instruments for precise measurement capabilities. The institute has tested 126 agricultural machinery under different category as mentioned below. The institute has generated revenue of Rs. 86.14 lakh at institute and 36.32 lakh at Coimbatore through commercial testing during the year 2019.

Equipment category	Number Tested
Land development and seed bed preparation	38
Sowing and planting	26
Plant protection	17
Harvesing and threshing	12
Crop residue management	6
Hand tools	2
Post harvest machinery	21
Others	4
Total	**126**

Intellectual Property and Consultancy

Patent filed

Application No.	Date of filing	Title	Inventors
201921001701	15 Jan, 2019	Process technology for production of protein-energy rich, stable and ready to eat complimentary food spread (RTE Comfo spread)	Dr. M.K. Tripathi

Consultancy/contract/collaborative projects/Technologies incubated

Organization	Collaborative Project with CIAE	Date
M/s. Watershed Support Services and Activities Network (WASSAN), Secunderabad, Telangana	Development and promotion of small scale manufacturers of animal drawn implements.	05 Apr, 2019
M/s. Thumbithakaadu Tribal People Welfare Society, Bangalathoti, Erode, Tamil Nadu	Establishment of millet processing centre at Bangalathoti, Erode, TN under Tribal Sub Plan (GoI)	13 July, 2019
Animal Husbandry Polytechnic Karnataka Veterinary Animal Fisheries Sciences University, Hassan, Karnataka.	Batch type biooil production unit	17 June, 2019
Contract research		
M/s.Burgeon Agri Pvt. Limited, Nasik	For design, development and commercialization of "Modular Backyard Poultry Cage"	14 Mar, 2019
Contract service		
M/s.Grindwell Norton Limited, Mumbai	For testing of rice whiteners	18 Mar, 2019

ICAR-CIAE technologies incubated under NAIF

Technology Incubated	Incubated enterprise	Period	
		From	To
Minimally processed fresh-cut vegetable production plant	Ms. Latika Suryavanshi, M/s. Avi'sHazfree Farm Products, 101, Soma Vihar, Chunabhatti, Kolar Road, Bhopal – 462 042	06 Dec, 2018	05 June, 2019
Onion paste processing	Mr. Adil Khan, A-314, Housing Board colony, Aishbagh, Bhopal	10 Jan, 2019	09 July, 2019
Covered cultivation technology for nursery raising	Mr. Manoj Kumar Yadav, 1 M-151/1 Sanjay Nagar, Anuppur-484 120	04 Feb, 2019	03 Aug, 2019

PUBLICATIONS

Research Papers

International Journal

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- Mangaraj S, Yadav A and Bal LM. 2019. Development and evaluation of pilot scale Modified atmosphere storage and Modified atmosphere packaging systems for tomatoes. Journal of Packaging Technology and Research, 3(1), 11-26
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EVENTS ORGANIZED

National Seminar on Role of Indian Standards in Testing, Quality Control and Safety of Agricultural Machinery

One-day National Seminar on Role of Indian Standards in Testing, Quality Control and Safety of Agricultural Machinery was organized by Bureau of Indian Standards, New Delhi in collaboration with ICAR-Central Institute of Agricultural Engineering, Bhopal at ICAR-CIAE, Bhopal on 18 Mar, 2019. The seminar provided a platform for exchange of ideas and information on recent developments on various issues relating to the standardization of agricultural machinery and equipment, ensuring consumers get good quality products, besides creating awareness among stakeholders such as farmers, manufacturers, NGO, etc about the Indian standards for agricultural machinery and equipment. The seminar was attended by about 100 delegates representing various organizations of the country including manufacturers and farmers. The policy issues related to

standardization of quality checks in agricultural machinery, constraints in testing of agricultural machinery, capacity building on advanced manufacturing technology and mechanism for sharing of information on recent technologies developed by the R&D institutes and industries were also discussed. The programme was coordinated by Dr. C.R. Mehta, Project Coordinator, AICRP on FIM, ICAR-CIAE, Bhopal.

Foundation Day Celebration

To commemorate its 44th foundation day, the Institute organized two-day programme during 15-16 Feb, 2019. The programme was chaired by Dr. Panjab Singh, Chancellor, Rani Laxmibai Central Agricultural University, Jhansi and President, National Academy of Agricultural Science (NAAS), New Delhi; Dr. Nawab Ali, Former Deputy Director General, Engineering was the Guest-of-Honour. The programee was attended by all present and past employees of the institute.

The second day of the programme (16 February, 2019)

was celebrated by organizing 'Agri-Tech-Expo' themed at 'Farmers' Prosperity through Agricultural Mechanization', Farmers' interaction meet and Academia-Industry Interaction Meet in the premises of the Institute. Er. J.R. Narware, Director, CFMTTI, Budni was the chief guest. He stated that in addition to tractors country also needs matching good quality agricultural machines. Around 40 manufacturers from different parts of the country displayed their products in the' Agri-Tech-Expo'. A large number of local manufacturers of agriculture and processing

machinery and members of small farm machinery manufacturers association of the state of Madhya Pradesh also participated in the leadership of Shri Abhay Malaiya, President, MP Krishi Yantra Nirmata Sangh. Shri P.S. Shyam from Joint Director, Directorate of Agricultural Engineering, Govt. of MP, Bhopal elaborated that there has been progress on use of new agricultural machines such as mulcher, shredder, straw combine and raised bed planter with increase in custom hiring centres in MP. He also described about various schemes run by the Govt. of MP for promotion and popularization of agricultural mechanization such as Yantra Doot and Kissan Sarthi etc. Farmers in large number from Bhopal and surrounding districts visited the stalls and learned about new technologies.

Webcast Programme of the Prime Minister

At ICAR-CIAE, Bhopal, live webcast program of Hon'ble Prime Minister, Shri Narendra Modi was arranged on 24th February, 2019. Not only the women staff but also

the male employees attended the webcast program. The success stories of women and the motivational speech of Hon'ble Prime Minister has inspired the staff. Dr. Debabandya Mohapatra, Women's cell Chairperson coordinated the programme, which was attended by Heads of divisions, PCs, Incharges of various sections and all administrative and technical staff.

Nutrimela

A Nutrimela was organized to commemorate the International Women's day on 8 Mar, 2019. Around 3000 rural women and their family members participated in it. The event was organized in the district of Dewas, Madhya Pradesh through a consortium of stakeholders and partners representing government and private sector organizations engaged in advancement of sustainable agriculture, livelihood and women empowerment in the state. The key partners being Solidaridad and ICAR-Central Institute of Agricultural Engineering (CIAE) along with partners Vippy industries and East-West Seed Industries, Mahindra, Bio-Nutrients and Reliance foundation and key government agencies i.e. Integrated Child Development Services (ICDS), Mid-Day-Meal Council and Madhya Pradesh and State Rural Livelihood Mission (MPSRLM). Based on the theme of "good farming, good food", the day was celebrated for voicing call-to-action to drive gender balance supporting the theme of International Women's Day 2019; Balance for Better, which means creating balance in socio-economic, cultural, educational and political sphere of life by giving equal role and participation to women. It was a multi stakeholders' participatory event to jointly discuss and work-together towards improving the availability of safe and nutritious foods, increasing the accessibility and affordability and improving the acceptability and consumption of nutritious foods. The event witnessed an overwhelming participation of rural women and their family members from across the state which provided a platform for cross learning and encouraging rural women in agriculture. The occasion was also dedicated to felicitate women leaders, entrepreneurs who have created a niche place for themselves and set an example for others to emulate. Deliberations by subject experts on nutritional health, importance of soy based diet, women leaders' role in decision making, financial inclusion, development programme and participation of women marked the daylong event. Women community leaders, service providers, elected women representatives shared their experiences of struggles and achievements in pursuit of their chosen paths. A series of panel discussions took place with the participation of women leaders, development practitioners, government officials and subject specialists like nutritionists and dieticians. Technical experts from CIAE shared knowledge on women friendly farm tools, soy nutrition and the potential it holds. Fourty different participating organizations and rural entrepreneurs including KVK, ICAR-CIAE Bhopal displayed their products in the exhibition stalls. The event was organized under the tutelage of Resource Centre of Women in Agriculture (RCWIA). The event facilitated development of common understanding on issues and challenges to derive strategic approaches and way forward towards "good farming- good food"

Webcast on Launching of National Animal Disease Control Programme (NADCP) and National Artificial Insemination Programme (NAIP)

KVK, ICAR-CIAE, Bhopal organized the webcast of Launching of National Animal Disease Control Programme (NADCP) and National Artificial Insemination Programme (NAIP) and Address of Hon'ble Prime Minister before a group of 60 farmers (45 male and 15 female) and 28 aspiring entrepreneurs at the training hall of KVK on 11 Sep, 2019. After the webcast, a Kishan Sangosthi was organized for creating awareness on Foot & Mouth Disease and Brucellosis Disease of bovine along with Artificial Insemination Programme and its procedure for animals. The experts

of this programme were Drs. Swati Tiwari and Dipti Singh Parihar, Veterinary Assistant Surgeons, Animal Husbandry Department and Dr. Sangeeta Dhamija, Addl. Director, Veterinary Services, Govt. of MP. After the programme, a vaccination programme was organized at Shelter Home for Stray Cattle (Kanji House), Nabibagh, Bhopal.

Sensitization workshop for progressive farmers on Soybean production and processing

Sensitization workshop on 'Soybean production and processing' was organized for progressive farmers in collaboration with Solidaridad on 7 June, 2019. Thirty progressive farmers from Phanda Block, Sehore district participated in the program. This workshop is the first in the series of workshops designed specifically to sensitize farmers regarding the opportunities in production and processing through incubation at ICAR-CIAE. The technologies developed in ICAR-CIAE are showcased such that the interested farmers can turn entrepreneurs bringing in profit in their chosen

enterprise. In the inauguration of the programme, Dr Dipika Agrahar Murugkar, ICAR National Fellow welcomed the participants. She emphasized on importance of soybean production followed by latest engineering interventions and the variety of process technologies available at ICAR-CIAE for soybean and millet utilization. Director, ICAR-CIAE Dr. M. Din, mentioned that several entrepreneurs in the country had become very successful by utilizing the soybean

processing training taken at ICAR-CIAE. Dr. KVR Rao, PI, NAIF-Agri Business Incubation Center, spoke about the uniqueness and importance of incubation as a hand holding method for new entrepreneurs' venturing into business of food processing. He urged the farmers to make use of this unique opportunity to become successful entrepreneurs. The one day training included lectures by Dr. PS Tiwari on engineering interventions to improve soybean production, Dr. Dipika Agrahar Murugkar on processing technologies available for incubation, Dr. KVR Rao on incubation facilities and opportunities available. Visits to ATIC, soymilk and tofu plant as well as PFDC field were also organized.

Agricultural Machinery Manufacturers Interaction Meet

Scientists of ICAR-CIAE, Bhopal and its Regional Centre at Coimbatore participated in Institute & Agricultural Machinery Manufacturers (TN Chapter) Meet on 21 June 2019 at Coimbatore. During the meet, manufacturers were explained about the objectives and

benefits of the DSIR funded project ”Technology forecasting and projecting market trends for agricultural machinery manufacturing Sector in India” being operated at ICAR-CIAE. Outcomes of the project will help to build up the policy to boost agricultural machinery manufacturing sector in India, based on the input from Agricultural Machinery manufacturers.

International Day of Yoga

Institute celebrated “International Day of Yoga” on 21 June 2019 with great enthusiasm. The programme started at 6.50 AM with mob flash (Prabhat Pheri) around residential area of the Institute. Practice of different Yoga Asanas, Pranayam and Dhyan was performed by the Institute staff. On this occasion, a lecture on 'Importance of regular yoga practices for good health and balanced diet' was delivered by Smt Rita Chaudhary, Area Head of Bhartiya Yog Sansthan, Bhopal.

On this occasion, Quiz on Yoga was conducted. The programme concluded with certificate-prize distribution to the participants of Yoga training programme and winners of the quiz programme. To commemorate the International Yoga Day, Institute also organized 15 days Yoga Training Programmes for the staff of the Institute during 7-21 June 2019. Yoga instructors from Bhartiya Yog Sansthan conducted yoga sessions.

हिन्दी पखवाड़ा

भारत सरकार के दिशानिर्देशानुसार भा.कृ.अनु.प.–केन्द्रीय कृषि अभियांत्रिकी संस्थान, भोपाल, में दिनांक 13 से 28 सितम्बर 2019 तक हिन्दी पखवाड़े का आयोजन किया गया। पखवाड़े के अंतर्गत विभिन्न प्रतियोगिताओं का आयोजन किया गया जिसमें संस्थान के अधिकारियों/कर्मचारियों, आर.ए., एस.आर.एफ. व शोध विद्यार्थियों ने बढ़–चढ़कर हिस्सा लिया।

कार्यक्रम का शुभारंभ दिनांक 13 अगस्त, 2019 को किया गया जिसमें संस्थान के कार्यवाहक निदेशक महोदय द्वारा दीप प्रज्जवलित कर पखवाड़े की प्रतियोगिताओं का औपचारिक उद्घाटन किया गया। अपने सम्बोधन में उन्होंने कहा कि कृषि अभियांत्रिकी के क्षेत्र में अधिकाधिक पठन सामग्री हिन्दी में उपलब्ध करवाई जानी चाहिए ताकि अधिक से अधिक

प्रयोगकर्ताओं व हितधारकों को इसका लाभ प्राप्त हो सके। उद्घाटन के साथ ही प्रश्नमंच कार्यक्रम का आयोजन किया गया। (इस अत्यंत रोचक व ज्ञानवर्धक प्रतियोगिता में सभी वर्गों

के कार्मिकों ने उत्साहपूर्वक हिस्सा लिया।) विजेताओं को स्थल पर ही पुरस्कार वितरित किए गए। कार्यक्रम में अन्य दिनों में सामान्य हिन्दी ज्ञान प्रतियोगिता, वाद–विवाद प्रतियोगिता, अहिन्दी भाषी कार्मिकों के लिए प्रतियोगिता, तकनीकी, अधिकारियों व कर्मचारियों के लिए प्रतियोगिता, तात्कालिक भाषण, शोध पत्र लेखन व पोस्टर प्रदर्शन प्रतियोगिता एवं महिलाओं के लिए हिन्दी प्रतियोगिता आदि विभिन्न प्रतियोगिताओं का आयोजन किया गया।दिनांक 01.10.2019 को समापन व पुरस्कार वितरण समारोह में मुख्यातिथि द्वारा एक भव्य कार्यक्रम में विजेताओं व उपविजेताओं को पुरस्कार व प्रमाण पत्र प्रदान किए गए।

गाजर घास जागरूकता सप्ताह कार्यक्रम

"गाजरघास जागरूकता सप्ताह" कार्यक्रम पर कृषि विज्ञान केन्द्र, सी.आई.ए.ई, भोपाल एवं पी.डी. आत्मा के अधिकारियों साथ ग्राम इस्लामनगर एवं अरवलिया में 16 अगस्त 2019 को कृषक संगोष्ठी का आयोजन किया गया। इस कार्यक्रम में कुल 60 कृषकों ने भाग लिया। इसी कार्यक्रम के अन्तर्गत 20 अगस्त 2019 को ग्राम सागोनिया एवं काँछीबरखेडा में कृषक संगोष्ठि का आयोजन किया गया। इस कार्यक्रम में कुल 67 (44 पुरूषों व 23 महिलायें) कृषकों ने भाग लिया। जिसमें से ग्राम सागोनिया सें 40 कृषक (29 पुरूषों व 11 महिलायें) व ग्राम काँछीबरखेड़ा से 27 कृषक (15 पुरूषों व 12 महिलायें) उपस्थित हुये। दिनांक – 21 अगस्त 2019। इस कार्यक्रम में कुल 74 (62 पुरूषों व 12 महिलायें) ने भाग लिया। जिसमें से ग्राम सुकलिया से 45 कृषक (35 पुरूषों व 10 महिलायें) व ग्राम रायपुर से 29 कृषक (27 पुरूषों व 02 महिलायें) उपस्थित हुये तथा दिनांक– 22 अगस्त 2019, को संस्थान में अधिकारियों द्वारा कृषकों को गाजर घास से होने वाले नुकसान व नियंत्रण संबंधित जानकारी दी गई। इस कार्यक्रम प्रभारी डॉ. के.पी. साहा, इंजी. डी.के द्विवेदी, श्री रवीन्द्र सिंह, श्रीमती एस.के.भारती, श्री ए.एल.शर्मा, श्री आर.बालामुरूगन और अन्य कृषि विज्ञान केन्द्र के स्टाफ उपस्थित रहे।

Swacchata Hi Sewa

Swacchata Hi Sewa 2019 programme was organized at ICAR-CIAE Bhopal during 11 September to 2 Oct, 2019 with great fervor and enthusiasm. On the opening day, Dr M Din, Director administered Oath of Cleanliness to

all the staff of the Institute. On 12 Sep, staff visited the Institute Colony and motivated the residents not to use plastic bags in their day to day routine. They were also advised to carry bags made of cloth or jute while going to the market. On 13 Sep, an awareness cum training programme was organized on 'management of plastic waste' and two video clips were projected on this topic. A cleanliness programme was carried out in the office premises on 16 Sep. Similarly, on 17 Sep, an awareness programme to prevent single use plastic was organized. On 18 Sep, a seminar to the topic 'minimization of use of plastic in daily life was organized. On 19 Sep, staff visited Nabi Bagh village located near the Institute and carried out cleanliness drive in the village. On 20 Sep, posters were displayed outside the main gate of the Institute to make the common public aware regarding health issue and minimal use of plastic. A 'shramdaan' programme was organized in Institute campus on 21 Sep and a poster competition on 23 Sep. On 24 Sep, a debate on the topic 'plastic waste management' was organized in which many orators were of the view that immediate and complete ban on use of plastics may be impractical in daily life. On 25 Sep, weeding out of very old office records and cleaning of workplaces was organized. On 26 Sep, a tree plantation programme was carried out in the Institute campus. On 27 Sep, Dr KK Singh, ADG (FE), ICAR planted a tree and emphasized on the importance of cleanliness in our surroundings. On 28 Sep, office personnel formed group and collected plastic waste in office premises. On 30 Sep, staff visited village Chanderi of Bhopal district and motivated the villagers to maintain cleanliness in daily life. On 1 Oct, a rally was carried out along with children of Red Rose School, Bhopal to create awareness for banning the use of plastics. The valedictory function was organized on 2 Oct. The Chief Guest on the occasion was Smt Navita Singh, Chairperson, Railway Recruitment Board, Bhopal. Dr Nawab Ali, former DDG (Engg) was the special guest. A vote of thanks was proposed by Dr Punit Chandra, Convenor of the Swachhta Committee.

150th Birth Anniversary of Mahatma Gandhi

ICAR-CIAE organized several events to mark the 150th Birth Anniversary of Mahatma Gandhi during 26 Sep to 2 Oct, 2019.

On 26 Sept, 4 short films based on the life of Gandhiji was screened and a presentation on the theme 'Bapu Jee- Ek Jeewan Parichay' was made.

On 27 Sep, debate competition on the philosophy of Mahatma Gandhiji was organized. On 28 Sep, quiz competition on the life of Mahatma Gandhi was organized. Institute staff actively participated in these two competitions.

On 30 Sep and 10 Oct, school children were sensitized about the importance of health and hygiene, single use plastic and its management. Essay and Poster making competitions on the topic 'Life and Principles of Mahatma Gandhi' and 'Bapu Ki Swashakti Grameen Arthvyawasthha', respectively were conducted at Red Rose School, Lambakheda, Bhopal. More than 110

students participated. The winners of these competitions were awarded on 2 Oct, at Institute Campus (ICAR-CIAE Bhopal).

The Chief Guest for the programme on 2 Oct was Smt Navita Singh, Chairperson, Railway Recruitment Board, Bhopal. Dr Nawab Ali, former DDG (Engg) was invited as special guest. Dr. KN Agarwal, Project Coordinator, AICRP on ESA and Dr S Mangaraj, Principal Scientist delivered lectures on single use plastic and its future management. This was followed by prize distribution to the winners of the various

competitions organized during Swacchta Hi Sewa Campaign and 150th Birth Anniversary of Mahatma Gandhiji. Speaking on the occasion, Smt, Navita Singh, Chairperson, Railway Recruitment Board, Bhopal highlighted the importance of plastic use in everyday life. Dr Nawab Ali, former DDG (Engg), ICAR deliberated on the role of pollution in good health and also highlighted the life style of Gandhiji. He stated that food plays an important role in success of the healthy life. Dr M Din, Director ICAR-CIAE highlighted the role of Mahatma Gandhiji in nation's building. The events were coordinated by Dr Punit Chandra, Convenor, Swachhta Committee and Dr. MK Tripathi, Convenor for the 150th Birth Anniversary Celebrations of Mahatma Gandhiji. Dr. LK Sinha, Chairperson, Swachhta Mission presented vote of thanks.

Meeting of Research Engineers of AICRP on ESA

Meeting to finalize modalities for agricultural accident survey was organized on 4 Sep, 2019, attended by 16 participants including PIs from various Centres of

AICRP on ESA and CIAE, Bhopal. In the deliberations held during the meeting, problems associated with the accident data collection and availability of resources were discussed. Dr. L. P. Gite, Ex-Project Coordinator AICRP on ESA, Chief Guest of the meeting, highlighted about the importance of agricultural accidents survey to make the agricultural operations and profession safer.

World Food Day

On 16 Oct, World Food Day-2019 celebration programme was organized by AFST (India)- Bhopal chapter and co-hosted by women cell at ICAR-CIAE, Bhopal. The programme was chaired by Dr. S.S. Deshpande, Vice President while Dr. Punit Chandra, Secretary of AFSTI Bhopal Chapter and Dr. Debabandya Mohapatra, member women cell helped conduct of the celebrations. The Chief Guest of the programme was Dr. Jyoti Khare, a gynaecologist from Bhopal. Dr. Punit Chandra delivered a speech on the world food day 2019 theme “For A Zero Hunger World”.

He mentioned that disease and food are attached to each other like faces of two coins, if you are ill means there is some problem in the food you are eating and if proper food is taken in diet means, you can be free from diseases. He also mentioned the quote of Hippocrates "Let food be thy medicine and medicine be thy food". Dr. SS Deshpande delivered talk about the study written in the book "Wheat Belly" authored by William Davis Milwaukee-based American cardiologist and author of health books. She recommended to move towards our ancient traditional foods and millets which are easily available in market and awareness related the importance of millets is growing in the society. Dr. Jyoti Khare stressed importance of diet in the changing lifestyle and in the present world; the time spent in physical activities is decreasing due to work pressure, competition, urbanization, life style etc. Dr. Khare mentioned that to stay healthy in a present scenario we need to change our food habits and in case of PCOD somewhere diet is also responsible. Finally, she concluded the speech by reminding us the importance of water and black salt along with balance diet.

Awareness Programme and Interaction Meeting for Rural Students on Renewable Energy Sources

An awareness program and interaction meeting for rural students on renewable energy sources was

organized by Agricultural Energy and Power Division (AEP) of ICAR-CIAE, Bhopal on 20 Dec 2019. Total 116 rural students and 14 teachers from Government Higher Secondary School, Padariya Kachhi, Raisen road, Bhopal participated in this program.

Meeting of the Institute Bodies

RAC Meeting

The 24th meeting of the ICAR-CIAE Research Advisory Committee was held during 7-8 March, 2019. Dr. VM Mayande, Chairman RAC, stressed on need to plan and prioritize the R&D programmes to address challenges of Indian agriculture sector through effective engineering interventions so as to make Indian agriculture sustainable, profitable and climate friendly. Prof Mayande, also made a presentation highlighting the areas in which ICAR-CIAE may focus in coming years. Dr. Kanchan K Singh, ADG (FE), ICAR stated that formulation of next plan has been initiated at Council and the ICAR-CIAE should formulate the new flagship programmes with focus on development of technologies for precision agriculture through application of electronic, instrumentation, artificial intelligence, robotics, IOT for agricultural mechanization. ICAR-CIAE may submit a proposal for creation of new Division to address these emerging areas of R&D. The other expert members of RAC who attended and provided valuable advice to CIAE

scientists included Dr. Divaker Durairaj, Former Dean, College of Agricultural Engg., TNAU, Coimbatore, Dr. VVN Kishore, Former Head, Department of Energy & Environment, TATA Energy Research Institute University, Delhi, Dr. Debraj Behera, Prof & Head, Deptt of Farm Machinery & Power, Odisha University of Agriculture & Technology, (OUAT), Bhubaneswar also provided valuable advice to ICAR-CIAE scientists for undertaking their R&D programmes. The RAC members also saw demonstration of several new technologies developed by institute recently. Dr PC Bargale, Principal Scientist & Head TTD and Member Secretary proposed vote of thanks to the members.

IRC Meetings

102nd IRC meeting was organized during 1-4 May 2019. In 102nd IRC, 21 new research project proposals, 21 RPF-III and 48 RPF-II were presented and discussed.

103rd IRC meeting was held during 25-26 Sep and 1 Oct, 2019. In 103rd IRC, 19 new research project proposals (RPF I), and 09 RPF-III were presented and discussed.

IMC Meeting

The 52nd meeting of Institute Management Committee was held on 8 March, 2019 under the chairmanship of Dr. KK Singh, Director. Other members present in the meeting include Dr. Kanchan Kumar Singh, ADG (FE), ICAR; Dr HS Oberoi, Head, Division of Post-Harvest Technology & Agril. Engg., IIHR, Bengaluru; Dr. AK Singh, PS (Farm Machinery & Power), IISR, Lucknow; Dr. CR Mehta, Project Coordinator, AICRP on FIM, ICAR-CIAE, Bhopal; Dr. JJR Narware, Director, CFMTTI, Budni; Shri Rajiv Choudhary, Director, Directorate of Agricultural Engineering, Govt. of Madhya Pradesh, Bhopal; Dr. S Patel, Prof. & Head, Department of Agricultural Processing & Food Engineering, IGKVV, Raipur; Shri Padam Singh, progressive farmer, P.O. Kotra Chopra, Berasia and Shri Ravi Kumar, CAO and Member Secretary. Dr. KVR Rao, Principal Scientist made a presentation on Agri-Business Incubation (ABI) at ICAR–CIAE, Bhopal.

Brain Storming Sessions

Mechanization of Cotton Harvesting

A Brain stroming session cum interaction meet on Mechanization of Cotton Harvesting was organized at the institute on 27 Sep, 2019.

More than 100 praticipants from ICAR institutes, BIS, SAU; private organizations such as John Deere, Bajaj Steels, Maharastra Cotton Seeds, Ankur Seeds, etc. particiapted in this meet. Dr. Kanchan K. Singh, Assistant Director General (Farm Engg), ICAR, New

Delhi chaired the meet. In the opening remarks, he stressed the need to mechnize cotton harvesting because delay in harvesting results in about 15% losses and In India, cotton picking is done almost 100% manually. Cotton picking involves almost 30-40% of the total production cost for the crop. Five lead papers were presented during various sessions followed by open discussion forum. During the discussion a number of issues in mechanization of cotton harvesting such as Non-synchronous ball opening, absence of appropriate defoliates and growth inhibitors, longer plant heights, high intial cost of picker and percentage of trash content, ginners not ready to procure mechanically picked cotton, etc were discussed in detail. The limitations of existing cotton harvesters developed or imported and demonstrated at farmer's field were also discussed. ICAR-CICR has worked on high density cotton planting with lesser height and synchrous ball opening plant varieties. A low cost pre-cleaner is required in order to promote the mechanical harvesting of cotton. A team was constituted comprising of ICAR-CIAE, Bhopal,CICR Nagpur and CIRCOT Mumbai, IARI, New Delhi, PI, AICRP on Cotton and private institutions such as M/S John Deer, M/S Bajaj steels, M/S Maharastra cotton seed, M/S Ankur seeds, M/S SIMA, M/S New Holland, M/S DCM, Hisar to identify the problem and give the solution in given time frame. Dr. PS Tiwari, Head, AMD coordinated the interaction meet.

Establishment of High Density Mango orchards

Brainstorming session on feasibility of establishing ultra high density mango orchards of Totapuri variety was held on 13 Sep, 2019. The event was organized in collaboration with state horticulture department. During the session, Scientists, Subject Matter specialists of KVK, Progressive farmers, Consultants and horticulture officials interacted and raised their

opinion on the subject of the session. A total of 70 participants attended the session. Dr. S. Rajan, Director, ICAR-CISH was the Chief Guest of the event and Dr. M. Din, Director (Actg.), ICAR-CIAE addressed the participants about the mechanization aspects of ultra-high density orchards. Dr. Kalai Dorai, Commissioner, Horticulture Department, MP State Coordinated the event.

Vigilance Awareness Week

Vigilance Awareness Week was observed during 28 October to 2 Nov, 2019 with great enthusiasm and active participation. The week began with the administering of the Integrity Pledge to all officers and staff of CIAE by Dr. PS Tiwari, Director (Acting). The objective of Vigilance Awareness Week was to bring about alertness among the people and government employees through participative and pro-active vigilance management, to bring down corruption to zero. Different programme within the institute and outside the institute like quiz, speech, debate, essay writing and Nukkad Natak in college were also organized. Concluding prograame of Vigilance Awareness Week 2019 was organized on 2 November, 2019. Shri A. Jayadevan (IPS), Suprintendent of Police & Head of Branch, CBI (ACB), Bhopal was the Chief Guest on the occasion.

SAC Meeting of KVK

SAC Meeting of KVK, ICAE-CIAE was held on 2 Nov, 2019 and was chaired by Dr. KN Agrawal, I/c Director. About 46 honorary members of the committee constituting of district officials of line departments, representatives of NGOs, print and electronic media and progressive farmers from different villages of Bhopal district participated in this meeting. Dr. KP Saha, I/c KVK presented action plan of KVK Bhopal for the year 2019-20. Dr. RKS Tomar, Joint Director Extension Services, RVSKVV, Gwalior was the chief guest in this programme.

Swachhata Pakhwada

Under Swachhata Pakhwada (16-31December, 2019), the Institute organized various day to day activities involving farmers, villagers students, staff, entrepreneurs, doctors, progressive farmers, village level extension workers, local people and officials from Nagar Nigam Parshads. Swachhta Pakhwada was launched by Swachhta pledge by CIAE staff under the leadership of Dr. PS Tiwari, Director (Acting) followed by plantation of trees. During this pakhwada, programmes included awareness to farmers, villagers, students, youth and local people for cleanliness and complete sanitation, hygienic conditions in villages, composting of biomass, stopping open defecation, utilization of waste water, management of plastic waste and biodegradable waste, discouraging use of plastics. The various activities also included cleanliness drive in CIAE campus, at school premises, nearby colonies, Karond square and at farmers field and also in nearby villages. CIAE organized Quiz completion for students, Extempore Debate competition for staff and many training programmes for farmers/entrepreneurs, doctors, progressive farmers, village level extension workers, govt. and private officials for creation of wealth from waste by utilizing cow dung, crop residue and other bio-degradable waste through application of Institute developed technologies. The Institute also contributed immensely in Swachhta awareness through "Mera Gaon Mera Gaurav" in various villages. A press conference was held on 30 Dec, 2019 in which Dr. PS Tiwari, Director (Acting) explained various programmes arranged during Swachhta Pakhwada-2019. Progressive farmers and doctors were also awarded prizes for their efforts in encouraging and motivating the farmers and persons living in their areas. The briefing was covered by about 15 print media and published in their newspapers. The Swachhta Pakhwada-2019 concluded on 31 Dec, 2019.

DISTINGUISHED VISITORS

Dr. B S Bisht, Former Director, CIPHET and Former Vice Chancellor, GBPUA&T, Pantnagar visited CIAE RC, Coimbatore on 14 Mar, 2019 to witness the new technologies developed at the center.

Dr. Thawar Chand Gehlot, Hon'ble Minister of Social Justice & Empowerment, Government of India visited CIAE Bhopal on 24 Feb, 2019 as the cheif guest during live telecast of the launch of prestigious scheme of Govt of India "Prime Minister's Kisan Samman Nidhi Yojna [PM-KISAN].

Dr. R. Murugesan, Chief Engineer. Agricultural Engineering Department, Coimbatore visited CIAE RC, Coimbatore on 13 Mar, 2019 for a discussion regarding equipment for state programme.

Dr. K. Alagusundaram, DDG (Engineering) visited the institute on 20 July, 2019 and 02 Nov, 2019. During his visit, he interacted and reviewed the progress of scientists of the Institute.

Dr. P.P Rao, Director, SRFMT&T Institute, Ananthapur and Dr. P. K. Chopra, Additional Commissioner (M&T), DEoAc, New Delhi visited CIAE RC, Coimbatore on 29.01.2019 for Establishment of "Post-Harvest Technology Machine and Equipment Testing Centre".

Dr. Kanchan K Singh, ADG (FE) visited this institute on 27 Sep, 2019 and Chaired the Brain storming session on Mechanization of Cotton Harvesting and interacted with participants of International training programme on Mechanization Technologies for Sustainable and Profitable Agriculture in African-Asian Region.

Dr. KK Singh, Member ASRB and former Director, CIAE Bhopal visited the Institute on 30 Sept, 2019. He interacted with scientists of the institute. Krishi Yantra Mitra App developed by CIAE was released by Dr. Singh.

Sh. Parusram Ex. Chief Secretary, Govt. of MP and DG, AIGGPA and Sh. MM Upadhyay, Ex. APC & Director AIGGPA visited on 6 Aug, 2019 to have collaboration between institute and Atal Bihari Vajpayee Institute of Good Governance in Public Administration.

Distinguished visitors at ICAR- CIAE Bhopal and RC Coimbatore

Name	Designation	Date	Purpose of visit
Dr. TP Ojha	Former DDG (Engg.) and Director, CIAE	27 Apr, 2019	MP Vision 2025
Shri Sandeep	Senior Officer, The Maharashtra Agro - Industries Development Corporation Limited (MAIDC), Goregaon, Mumbai	6-7 May, 2019	Modalities for taking license of CIAE technologies specially the CIAE developed software for custom hiring business model
A team from New Holland	New Holland, India	24 Apr, 2019	For Maldives proposal to ITMU
A team from Aga Khan Foundation , NGO	Aga Khan Foundation , NGO	17 May, 2019	For collaborative project exploration
Mr. Manoj Kumar	BM, PWC, Himachal Pradesh Horticulture Development Board, HP	3 June, 2019	To partner with CIAE as technology provider
Mr. Anant Chaturvedi	Startup Vikalp	4 June, 2019	Exploratory visit

Name	Designation	Date	Purpose of visit
Dr. K N Mishra	AP Paper Mills, Telangana	14 Aug, 2019	For development of tools and implements for forestry mechanization
Dr. A S Dabir	HOD-Establishment Dept., Udyojak Deptt., Maharashtra Centre for Enterpreneurship Development	01 Nov, 2019	Collaboration for commercialization of technologies
Dr. Anil Kumar	Head Biotech, CAU, Jhansi	5 Feb, 2019	Discussion on collaborative project
Dr. RGS Rao	Dean, NMIMS, Shirpur, Maharashtra	21-22 June, 2019	For exploring knowledge and technologies of agricultural engineering of students

ICAR-CIAE-RC, Coimbatore			
Dr. N Kumar Dr.K Alagusundaram Dr. B Shridar	Vice chancellor, Tamil Nadu Agricultural University, Coimbatore DDG (Engg.), ICAR, New Delhi Dean, AEC& RI, Tamil Nadu Agricultural University, Coimbatore	16 Oct, 2019	Foundation stone laying ceremony for farm machinery and post harvest equipment & machinery testing centre
Dr. A Dakshinamurthy	Former Director, Paddy Processing Research Centre, Thanjavur	6 Nov, 2019	Chief guest of valedictory session of training programme on "Processing, Value addition and marketing of Nutricereals"
Dr. P Muthuraman	Head, TTD, ICAR-IIRR, Hyderabad	14 Nov, 2019	Exploratory visit for post harvest rice mechanization
Sh. R Amalorpavanathan	Former Deputy Managing Director, NABARD	12 Dec, 2019	Chief Guest for inauguration of ICAR Short course
Dr. KP Sudheer	ADR, KAU, Thrissur, Kerala	13 Dec, 2019	Interaction with participants of ICAR Short course
Dr. A Arunachalam	Pr. Scientific Officer to Secretary (DARE) & DG (ICAR), New Delhi	21 Dec, 2019	Interaction with Scientists of ICAR CIAE RC, Coimbatore
Dr. S Manian	Former Vice Chancellor of Annamalai University, Chidambaram, Tamil Nadu	21 Dec, 2019	Chief Guest for valedictory ceremony of ICAR Short course

ONGOING RESEARCH PROJECTS

Agricultural Mechanization Division

Project No.	Project Title	Investigators
765	Development of transplanter for onion seedlings	AP Magar
776c	Development of integrated system for harvesting and conveying of bunch crops	Manoj Kumar Sweeti Kumari
778	Smart sprayers for pomegranate young orchards	CP Sawant Bikram Jyoti
782	Development of drip lateral and plastic mulch layer -cum-planter.	N Gaikwad CP Sawant A Khadatkar
791	Package of machinery for orchard crops suitable for mini tractors	SP Kumar BM Nandede AK Roul
798	Design and development of tools and gadgets for floriculture (Collaborative project with ICAR-Directorate of Floricultural Research, Pune)	RS Yadav Vijay Kumar TN Saha GB Kadam
799	Characterization and substitution of existing materials for selected machinery	Dushyant Singh NS Chandel RK Sahni CP Sawant
811	Development of mechanized CA model farm for major cropping systems in vertisol of Central India	KP Singh RS Singh BL Lakaria
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	BM Nandede Dilip Jat
815	Mechanization package for garlic cultivation on raised beds	Dilip Jat S Imran
816a	Development of side trencher-cum-FYM applicator for grapes orchard	A Khadatkar CP Sawant
816b	Design and development of induction based air assisted electrostatic sprayer	Bikram Jyoti AP Pandirwar
816c	Development of tractor operated fertilizer applicator for grape vineyard	DS Thorat AP Magar
822	Development of manual tools for chemical swabbing, tying, suckering and bark removing operations in grape cultivation	RR Potdar Imran Syed
823	Development of tractor drawn five row weeder for onion	AP Pandirwar RR Potdar
824	Determination of water stress indices using spectral reflectance and thermal imaging in field crops.	NS Chandel YA Rajwade

Project No.	Project Title	Investigators
836	Development of lab based robotic transplanter for plug-type vegetable seedlings	A Khadatkar AP Pandirwar
838	Mechanization of selected operations in Litchi cultivation	RK Sahni Sweeti Kumari Manish Kumar A Kumar
839	Development and promotion of CA machinery	Dushyant Singh NS Chandel AK Viswakarma
854	Participatory promotion of climate resilient agriculture machinery in selected village cluster of MP	Manoj Kumar (Stat) KP Singh Ramadhar Singh
855	Integrating tillage, traffic, crop residue and crop rotation management practices in prevailing cropping system for facilitating conservation agriculture mechanization in vertisols	Uday R Badegaonkar S Imran Manoj Kumar (Stat) KP Singh Mukesh Kumar
856	Deep learning based frame work for identification of crop parameters	NS Chandel SK Chakraborty YA Rajwade Dilip Jat
857	Development of image based hand held device for diseases identification in soy bean	Manoj Kumar NS Chandel Sanjeev Kumar
858	Model farm machinery package for major horticulture crops of India	R S Singh Karan Singh BM Nandede Bikram Jyoti
EXT-3	Development of automated soil nutrient sensing system (NASF Project)	PS Tiwari RK Sahni Vijay Kumar
EXT-7	Technology forecasting and projecting market trends for Agricultural machinery manufacturing sector in India (Funded by DSIR)	Dushyant Singh V. Bhusana Babu Manoj Kumar
EXT-8	Engineering input in establishment of biotech kisan hub (Funded by DBT)	Dushyant Singh BM Nandede

Agro Produce Processing Division and Centre of Excellence on Soybean Processing and Utilization

Project No	Title	Investigators
801	Technology package for the production of quality grape raisins with NRC, Grapes	Dilip Pawar SK Giri
802	Development of Infrared pre-treatment system for pulse milling	AK Sharma A Kate SK Giri
794	Enhancement of awareness of food uses of soybean for nutrition purpose	SS Deshpande
804	Development and characterization of edible films for food packaging application	Ajesh Kumar S Mangraj
819	Development of process and pilot plant for extraction of dietary fibre from soybean and chickpea hull	M Hassan Ajesh Kumar S Mangaraj
842	Development of process technology for soymilk based synbiotic chocolate	Muzaffar Hasan Samlesh Kumari
859	Development of soy-based nano-composite biofunctional edible packaging film	Samlesh Kumari Ajesh Kumar
860	Process technology for production of plant byproducts based solid nutrient culture media(s) for food applications	MK Tripathi SK Giri Rahul M Srivastava (MANIT, Bhopal)
861	Development of kit for identification of soy protein in paneer and milk (lateral flow kit)	Punit Chandra
862	Development of pilot plant for preparation of protein hydrolysates from defatted soyflour using enzymatic process	LK Sinha
863	Development of user friendly image based embedded system for automated packing line	SK Chakraborty
EXT-1	Development of soy multigrain nutritionally rich functional foods for children (National Fellow project)	D A Murugkar
EXT- 4	Post-harvest management of medicinal root crops	D Mohapatra Dilip Pawar
EXT-9	Development of a sensing system for safe management of potato, onion and tomato instorage	D Mohapatra Adinath Kate MK Tripathi

Agriculture Energy and Power Division

Project No	Title	Investigators
805	Solar powered prime mover for spraying and weeding operations	PC Jena A Nagori
826	Development of torrefaction system with 200 kg biomass capacity	S Gangil VK Bhargav

Project No	Title	Investigators
843	System for production of enriched biochar from crop residues	Sandip Mandal Chirag Maheswari AK Shukla (IISS, Bhopal)
844	Development of portable gasifier with inbuilt tar cracking system	Sandip Mandal PC Jena
845	Development of crop residue hydrolysate based micro algae production and byproduct utilization	Swapnaja K Jadhav Samlesh Kumari Chirag Maheswari
846	Development of process and technology for value added products from segregated biocrude	S Gangil VK Bhargava Sandip Mandal R Suresh (MANIT, Bhopal)
847	Energy assessment and crop residues management for fuel supply chain of power plants	VK Bhargava S Gangil
864	Development of process for Bio-CNG generation from baled paddy straw	Swapnaja K Jadhav PC Jena Chirag Maheswari
865	Development of CNG fueled Tractor for agricultural and haulage operations	PC Jena VK Bharava AK Roul
EXT-10	Studies on thermal degradation of crop residues for kinetics, bio polymeric transitions and value added products (Funded by NASF)	S Gangil VK Bhargava

Irrigation and Drainage Engineering Division

Project No	Title	Investigators
620a	Establishment of PFDC and its operations in MP State	KVR Rao
747b	Feasibility study on use of broad bed and furrow (BBF) and mole drainage system for crop sensitive to water logging in vertisols	Ramadhar Singh KVR 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 drainage trencher for laying sub-surface pipes	RD Randhe AM Waghaye BM Nandede
806	Design of horizontal subsurface flow filter for agricultural runoff / waste water for irrigation	YA Rajwade CK Saxena MV Coumar (ICAR-IISS, Bhopal)
827	Development of real time automatic plot irrigator	RD Randhe YA Rajwade AM Waghaye
828	Development and testing of surface and subsurface drip lateral retrieval systems	CK Saxena KVR Rao

Project No	Title	Investigators
849	Development and evaluation of IoT based smart irrigation system for field crops in vertisols	CD Singh Mukesh Kumar AM Waghaye
850	Development of automatic self cleaning filter for micro irrigation system	Mukesh Kumar CK Saxena
866	Design and development of floating axial flow pump for small farms	Mukesh Kumar CD Singh
Ext.5	Pilot project on solar powered micro irrigation system	KVR Rao PC Jena

Technology Transfer Division and Krishi Vigyan Kendra

Project No	Title	Investigators
819	Assessment of draught animal power availability for selection of suitable package of animal drawn implements in M P	UC Dubey M Kumar
820	Development of bullock drawn planter for sowing of soybean and chickpea cropping system on raised beds	UC Dubey MB Tamhankar
867	Technology dissemination and agricultural mechanization in selected villages of Madhya Pradesh for increased productivity and income generation	UC Dubey (upto Aug 2019 S Mangaraj (Sep 2019 onwards) Ramadhar Singh KP Saha Manoj Kumar (stat) Rahul Potdar PC Jena Mukesh Kumar Dilip A Pawar Sweeti Kumari MK Tripathi R Senthil Kumar SK Aleksha Kudos
EXT-11	Impact assessment of custom hiring centres & high tech machinery hubs established in Madhya Pradesh (Funded by DAE, Govt of MP)	MB Tamhankar KP Saha

ICAR-CIAE-RC, Coimbatore

Project No.	Title	Investigators
786	Development of pelletizing techniques on small-seeds for mechanized sowing	MM Selvan RavindraNaik P Masalamani
807	Development of banana sucker paring equipment, pseudo stem injector, bunch harvester and pseudostem outer sheath plate making equipment	Ravindra Naik T Senthil Kumar Dawn CP Ambrose V Kumar (ICAR-NRC Banana)
808	Development of Power operated carrot harvester cum detopper for hilly region -	T Senthil Kumar
809	Development of farm machinery mobile app for major crops of Tamil Nadu	R Senthil Kumar MM Selvan

Project No.	Project No./ Title	Investigators
810	Technology commercialization and entrepreneurship development of selected CIAE technologies in Tamil Nadu	R Senthil Kumar
830	development of pigeon Pea transplanter	MM Selvan
821	Design and development of mechanized slicer for cashew apples (In collaboration with ICAR DCR, Puttur)	Ravindra Naik
832	Development of tractor operated whole cane harvester for small farmers (Collaborative project with ICAR-SBI, Coimbatore)	T Senthilkumar T Arumuganathan (ICAR SBI,Coimbatore) AK Singh (IISR, Lucknow) MK Singh (IISR, Lucknow)
833	Chitosan coated bags for storage of food grains	RH Sadvatha SK Aleksha Kudos
834	Development of transplanter, stringing machine and hybrid energy curing barn for tobacco leaves	Sadvatha RH SK Aleksha Kudos T Senthilkumar M Anuradha (CTRI Rajahmundry) T Kiran Kumar (CTRI) J Poorna Bindu (CTRI)
829	Development of mechanization package for baby corn processing	SK Aleksha Kudos RH Sadvatha
852	Establishing Value chain for chilli processing	Dawn CP Ambrose RavindraNaik
853	Development of Millet popping machine	S Balasubramanian Dawn CP Ambrose
EXT-6	Main streaming gender and empowerment through women friendly farm mechanization package in tribal areas of Tamil Nadu (Funded by DST, New Delhi)	R Senthilkumar MM Selvan S Balasubramanian

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ACRONYMS

Acronym	Description
AAO	Assistant Adminstrative Officer
AARDO	Afro Asian Rural Development Organization
AICRP	All India Coordinated Research Project
AKMU	Agricultural Knowledge Management Unit
CAD	Computer Aided Design
CAFT	Centre for Advanced Faculty Training
CIAE	Central Institute of Agricultural Engineering
CRP	Consortia Research Platform
CSAM	Centre for Sustainable Agricultural Mechanization
CJSC	Central Joint Staff Council
DFSF	Defatted soy flour
DoAC&FW	Department of Agriculture Cooperation and Farmer's Welfare
DST	Departmetn of Science and Technology
EA	Energy from Agriculture
EAAI	Energy in Agriculture and Agro-based Industry
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
IARI	Indian Agricultural Research Institute
IR	Infra red
IRC	Institute Research Committee
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 Agriculture Research System
NICRA	National Initiative on Climate Resilient Agriculture
NIR	Near Infrared
NRC	National Research Centre
OFT	On-Farm Trial
PFDC	Precision Farming Development Centre
PFT	Prototype Feasibility Testing
PME	Prioritization, Monitoring and Evaluation
PPC	Prototype Production Center
PPP	Public Private Partnership
R&D	Research and Development
RAC	Research Advisory Committee
RMP	Research Management Position
SAARC	South Asian Association for Regional Cooperation
SAU	State Agriculture University
SCSP	Schedule Caste Special Programme
SHG	Self Help Group
SMS	Subject Matter Specialists
UAE	Utilization of Animal Energy
WCD	Women and Child Development