Annual Report 2020

ICAR- Central Institute of Agricultural Engineering

Nabi bagh, Berasia Road, Bhopal-462038

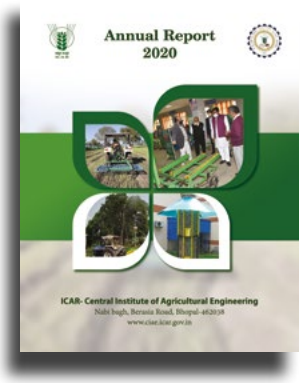
www.ciae.icar.gov.in

ICAR - CIAE

Annual Report 2020

ICAR- Central Institute of Agricultural Engineering
Nabi bagh, Berasia Road, Bhopal-462038
www.ciae.icar.gov.in

ICAR-CIAE Annual Report
No. CIAE/2021/40



ICAR- Central Institute of Agricultural Engineering
Nabi bagh, Berasia Road, Bhopal-462038. India
Tel. No. : +91-755-2737191, 2521000, 2521001
Fax No. : +91-755-2734016
E-mail : director.ciae@icar.gov.in
Website : www.ciae.icar.gov.in

Published by
Director, ICAR-CIAE, Bhopal

Chief Editor
K.V.R.Rao

Editors
M.B.Tamhankar
Ashutosh Pandirwar
Dilip Jat
Dilip Pawar
Swapnaja Jadhav
Yogesh A Rajwade
Ajesh Kumar
Syed Imran

Photography
SK Bagde
Kalyan Singh

Printed at
M/s Semaphore Technologies Pvt. Ltd.
3, Gokul Baral Street, Kolkata

July, 2021

Correct citation
Anonymous. Annual Report 2020. ICAR-Central Institute of Agricultural Engineering, Bhopal. Report No. CIAE/2021/40

KISAN call centre 1800-180-1551

PREFACE

During the challenging time of COVID-19 pandemic, the institute staff remained committed to address the mechanization needs of the country. Paucity of agricultural labourers due to migration during the pandemic gave an opportunity to the scientists of the institute to come out with greater engineering interventions in developing high capacity, precision, reliable and energy efficient farm equipment and machinery. Precision farming equipment such as smart tractors, unmanned aerial vehicles, robots for harvesting, agri-bot for covered cultivation, wireless technology etc., are under development to address the shortage of manpower. The post harvest management of agricultural produce is one more important area where the institute is striving hard to develop process protocols and machinery to add value to the farm produce for higher commercial returns, leading to doubling of farmer's income.

Some of the important research contributions of the institute during 2020 includes Tractor drawn pneumatic planter for pigeon pea, Tractor operated garlic weeder, Liquid urea spraying system retrofitted on straw baler, High pressure spraying system for locust control, Smart sprayer for young pomegranate orchards, Banana sucker paring equipment, Banana pseudostem injector, Tractor operated banana bunch harvester etc. On farm water management aspects such as varying irrigation methods, utilization of waste water and crop management under waterlogged conditions were also studied during the year. In energy from agriculture, micro-algae production from paddy straw, energy assessement of crop residues, and non-thermal plasma pyrolysis reactor were some of the contributions. To address the post harvest losses and to add value to agro-produce, the scientists have developed modular units for onion storage, quinoa pearler, debunching tool for medicinal root crops etc. Apart from these, the institute has come out with automatic and pedal operated hand sanitization systems not only for the benefit of institute staff but also for the citizens of the country. These units are licensed to industry and are presently available in open market.

Four All India Coordinated Research Projects and three Consortia Research Projects operated across the country have come out with location and crop specific solutions. The technologies/equipment developed by them are being tested under prototype feasibility testing and front line demonstrations across the country.

The lockdown and restrictions due to COVID-19 pandemic have opened the doors for organizing virtual meetings in the form of webinars. The institute during the year has organized 52 training programmes/workshops/seminars/interaction meets/review meetings. Majority of the internal meetings of the institute were conducted through virtual mode. During the year, 6267 prototypes were supplied and carried out testing of 184 commercial units manufactured by industries. The staff of the institute received awards and recognitions from professional bodies for their contribution to the profession.

I am indebted to Hon'ble Secretary, DARE and Director General, ICAR Dr. Trilochan Mohapatra for his constant guidance. My sincere thanks are due to Dr. K. Alagusundaram, Deputy Director General (Agril. Engg.), ICAR; Dr. Kanchan K. Singh, Assistant Director General (FE), ICAR and Dr. S.N. Jha, Assistant Director General (PE), ICAR for their untiring support to the institute in executing R&D and other activities presented in this Annual Report. The administrative and financial support received from ICAR Headquarter is thankfully acknowledged. The dedication of institute staff during hard time needs special mention, as none of the institute activities were affected despite the pandemic. The achievements and activities reported in the Annual Report may provide useful information to different stake holders. Finally, I express my sincere thanks to the Annual Report editorial team for their commitment in bringing out this report on time.

July, 2021

(C.R. Mehta)

Contents

कार्यकारी सारांश

संस्थान ने इस वर्ष कृषि एवं प्रसंस्करण मशीनीकरण के क्षेत्र में विभिन्न अनुसंधान एवं तकनीकी हस्तांतरण किये। संस्थान की समग्र गतिविधियों को हितधारकों के लाभ के लिए संक्षित रूप में प्रस्तुत किया गया है।

नए उपकरण / मशीनरी / प्रौद्योगिकी

- वाक बिहाइंड राइस ट्रांसप्लांटर के लिए सेंसर आधारित डीप प्लेसमेंट फर्टि_लाइजर एप्लीकेटर विकसित किया गया। मशीन की कार्य क्षमता, कार्य दक्षता और उर्वरक अनुप्रयोग दक्षता क्रमशः 0.16 हेक्टेयर/घंटा, 72% और 94% है।
- टिड्डियों को नियंत्रित करने के लिए एक ट्रैक्टर चलित उच्च दबाव छिड़काव प्रणाली विकसित की गई। इस मशीन से 2.50 किमी/घंटा की अग्र गति पर 18 मीटर की ऊंचाई तक छिड़काव किया जा सकता हैं। स्प्रेयर की कार्य क्षमता और कार्य दक्षता क्रमशः 80-115 पौधे/घंटा और 80% है।
- अनार के बगीचे में कीटों को नियंत्रित करने के लिए ट्रेक्टर चलित स्प्रेयर पर स्मार्ट छिड़काव प्रणाली को अनुलग्नक किया गया। इस स्प्रेयर की कार्य क्षमता एवं कार्य दक्षता क्रमशः 0.84 हेक्टेयर/घंटा और 60% है।
- अरहर की बुवाई के लिए दो-पंक्ति ड्रम टाइप न्यूमैटिक प्लांटर सह उर्वरक ड्रिल विकसित की गई। मशीन की कार्य क्षमता एवं कार्य दक्षता क्रमशः 0.18 हेक्टेयर / घंटा और 71% है।
- ट्रैक्टर चलित 19 पंक्ति लहसुन वीडर विकसित किया गया। जिसकी कार्य क्षमता, कार्य दक्षता, निराई दक्षता और पौधों की क्षति क्रमशः 0.29 हेक्टेयर/घंटा, 81.2%, 69.6% और 0.1% है।
- केले के पौधे के लिए दो घूर्णन ग्रेटिंग ब्लेड्स आधारित सकर परिंग उपकरण विकसित किया गया। इसकी कार्य क्षमता 200-250 चूसक/घंटा है। ट्रिमिंग और ग्रेटिंग तंत्र के संयोजन में मशीन की क्षमता लगभग 100 चूसक/घंटा है।
- केले के छद्म स्टेम में रसायन डालने के लिए इंजेक्टर विकसित किया गया है। इस इंजेक्टर के द्वारा 2-4 मिली प्रति पेड़ रसायन की मात्रा डाली जाती है। इसकी कार्य क्षमता 140-150 पेड़/घंटा है।
- ट्रैक्टर चलित केले का बंच हारवेस्टर विकसित किया गया। हार्वेस्टर की अधिक-तम पहुंच लगभग 2.7 मीटर है और 25 किलो वजनी गुच्छों को संभाल सकता है। विकसित बंच हारवेस्टर की कार्य क्षमता 45-50 पेड़/घंटा है।
- पुआल के उपचार के लिए बेलर आधारित यूरिया छिड़काव प्रणाली विकसित की गई। मशीन की कार्य क्षमता 8.3 टन/हेक्टेयर के पुआल लोड पर 109 बेल/घंटा है।
- सोयाबीन, काले चने, हरे चने इत्यादि की गुच्छी फसलों की कटाई के लिए ट्रैक्टर चलित इंटीग्रेटेड हार्वेस्टिंग-कम-कन्वेयिंग मशीन विकसित की गई। इस मशीन की कार्य क्षमता और कार्य दक्षता क्रमशः 0.19 हेक्टेयर/घंटा और 78% है।
- संस्थान के दत्तक गाँव में क्लाइमेट स्मार्ट मशीनरी जैसे कि रोटो टिल ड्रिल, ब्रॉड बेड फरो , लेजर लैंड लेवलर, रिज और फ़रो और मोल ड्रेनेज तकनीक का प्रद-र्शन किया गया। गेहूं की फसल की बुवाई के लिए रोटो टिल ड्रिल और सोयाबीन की फसल के लिए ब्रॉड बेड फरो सिस्टम अनुशंसित किये गए।
- विभिन्न सिंचाई विधियों (पारंपरिक और माइक्रो स्प्रिंकलर) और सिंचाई के स्तरों के तहत गेहूं की फसल की उपज और जल उत्पादकता पर जल तनाव के प्रभाव का आकलन किया गया। गेहूं में इष्टतम उत्पादन और जल उत्पादकता को प्राप्त करने के लिए 75% फसल वाष्पीकरण पर सूक्ष्म फवारा द्वारा सिंचाई को अनुशंसित किया गया।
- अपशिष्ट जल के उपचार के लिए एक क्षैतिज उप-सतही प्रवाह फिल्टर बेड बेड विकसित किया और उपचारित जल का परिक्षण सिंचाई के लिए किया गया। पानी के विभिन्न भौतिक-रासायनिक गुणों के लिए प्रदूषक हटाने की क्षमता 70% और अलग-अलग भारी धातुओं के लिए 40-80% तक पाई गई।
- जलभराव के प्रति संवेदनशील फसलों की उत्पादकता पर ब्रॉड बेड फ़रो (बीबीएफ) युग्मित मोल ड्रेनेज के उपयोग का अध्ययन किया गया। सोयाबीन की खेती की तकनीकी-आर्थिक व्यवहार्यता के लिए ब्रॉड बेड फ़रो के साथ 4 मीटर की दूरी पर मोल ड्रेनेज को अपनाने की अनुसंशा की गई।

मूल्य वर्धित उत्पाद, प्रक्रियाएं और सॉफ्टवेयर्स

- मिलिंग की लागत और समय को कम करने के लिए 200 किग्रा/घंटा क्षमता की एक नियंत्रित अवरक्त विकिरण आधारित पूर्व उपचार प्रणाली विकसित की गई है। इस प्रणाली के साथ पूर्व-उपचार की गई अरहर में 78%दाल की रिकवरी, 97.2% डीहलिंग दक्षता, 2.0% ब्रोकन और 17.4% अपशिष्ट प्राप्त हुआ।
- प्याज भण्डारण के लिए एक टन क्षमता का रूफ टॉप नेचुरल एयर वेंटिलेटर संचालित संरचना विकसित की गयी। इस संरचना में भण्डारण के दौरान प्याज के वजन में कमी, सड़न और अंकुरण क्षति क्रमशः 18, 5.5 और 0.2% थे।
- फसल अवशेषों के तापीय क्षरण का अध्ययन करने के लिए नॉन-थर्मल प्लाज्मा रिएक्टर विकसित किया गया। इस प्रणाली का महत्वपूर्ण कार्य निर्वात के विभिन्न स्तरों के तहत प्लाज्मा में मुक्त और आवेशित रेडिकल्स का सृजन करना है।
- धान पुआल के हाइड्रोलाइज़ेट से ग्रोथ मीडिया तैयार करके 1.4 ग्रा./ली. सूक्ष्म शैवाल बायोमास का उत्पादन किया गया। जो कि वाणिज्यिक ग्रोथ मीडिया की तुलना में लगभग 40% अधिक है।
- दो चरण सक्रियण में अरहर के डंठल का उपयोग करके एक उच्च छिद्रपूर्ण कार्बन तैयार किया गया। सक्रिय अरहर के डंठल की औसत सक्रियण ऊर्जा 84 किलो जल/मोल थी। इस छिद्रपूर्ण कार्बन की गुणवत्ता मानक सक्रिय चारकोल के समान पाई गई।
- इन-सीटू टार क्रैकिंग के लिए चार आधारित निकेल इन्फ्यूज्ड उत्प्रेरक को संश्ले_षित करने के लिए अध्ययन किया गया। निकल की लोडिंग 0.2 और 300 मिमी बेड की गहराई पर टार क्रैकिंग दक्षता 81-86% प्राप्त हुई। प्रोड्यूसर गैस में टार की मात्रा 32-236 मि.ग्रा./मी3 प्राप्त हुई।
- धान के पुआल संग्रह के लिए प्रत्यक्ष और अप्रत्यक्ष ऊर्जा की खपत को वर्गा_कर और गोल बेलर के लिए आकलित किया गया। खेत से धान के पुआल संग्रहण, बिजली संयंत्र तक परिवहन और संयंत्र में स्टैकिंग की कुल लागत लगभग ₹ 4500-6000 प्राप्त हुई।
- सफ़ेद मूसली के लिए मेन्युअली संचालित डी-बंचिंग टूल विकसित किया गया। इस टूल की डी-बंचिंग क्षमता लगभग 10.30 किग्रा/घंटा थी। जबकि चाकू के बिना मैनुअल सेपरेशन के लिए 5.10 किग्रा/घंटा और चाकू का उपयोग करके 7.50 किग्रा/घंटा थी।

प्रौद्योगिकी हस्तांतरण, प्रशिक्षण और क्षमता विकास

- लाइसेंसिंग और समझौते के ज्ञापन के माध्यम से आठ विभिन्न निर्माताओं को कुल बारह तकनीकों का व्यवसायीकरण किया गया।
- प्रो ट्रे में उगाई गई गन्ना बड चिप के लिए दो पंक्ति ट्रैक्टर चलित प्लांटर का व्यवसायीकरण किया गया। इस मशीन को तमिलनाडु सरकार द्वारा मशीनीकरण कार्यक्रम में सब्सिडी के लिए शामिल किया जा रहा है।
- किसानों के खेतों पर 77 फ्रंटलाइन प्रदर्शन किए गए, जिससे कि उपयोगकर्ता लाभान्वित हो सके।
- संस्थान द्वारा विकसित प्रौद्योगिकियों को बढ़ावा देने के लिए बारह प्रदर्शनियां और बारह मीडिया कार्यक्रमों (दूरदर्शन / ईटीवी) में भाग लिया गया।
- विभिन्न हितधारकों को मशीनों / उपकरणों / उपकरणों के प्रोटोटाइप की कुल 6267 इकाइयों की आपूर्ति की गई।
- विभिन्न कृषि मशीनरी उद्योगों द्वारा निर्मित मशीनों / उपकरणों की एक सौ चौहत्तर इकाइयों का परीक्षण किया गया।
- संस्थान ने इस वर्ष 52 प्रशिक्षण कार्यक्रमों / कार्यशालाओं / सेमिनारों / सहभागिता मीट / समीक्षा बैठकों आदि का आयोजन किया।
- छह नए पेटेंट आवेदन, पहले प्रस्तुत किए गए तीन पेटेंट आवेदनों के जवाब और एक कॉपीराइट के आवेदन दायर किये गए।
- मानव संसाधन विकास के तहत, संस्थान के कर्मचारियों ने विभिन्न संगठनों द्वारा आयोजित 32 प्रशिक्षण कार्यक्रमों में भाग लिया।

पुरस्कार तथा सम्मान

- संस्थान के एक वैज्ञानिक NAAS एसोसिएट के सदस्य बनाये गए, चार वैज्ञानिक व्यावसायिक सोसायटी के फैलो बने, एक वैज्ञानिक को बेस्ट बुक अवार्ड मिला, एक वैज्ञानिक को यंग साइंटिस्ट अवार्ड मिला और एक वैज्ञानिक को उत्तराखंड गवर्नर का रिसर्च अवार्ड मिला। एक वैज्ञानिक और एक पीएच.डी. छात्र को बेस्ट पोस्टर प्रेजेंटेशन अवार्ड मिला।
- संस्थान के एक वैज्ञानिक को एफएसएसएआई के वैज्ञानिक पैनल में नामित किया गया। एक वैज्ञानिक के शोध पत्र को सर्वश्रेष्ठ पेपर, एक पीएच.डी. छात्र को सीएसआईआर-सीनियर रिसर्च फेलोशिप मिली, दो वैज्ञानिकों को व्यावसायिक पत्रिकाओं के संपादक के रूप में नामित किया गया।
- इस वर्ष के दौरान 74 शोध पत्र, 9 पुस्तकें और पुस्तक अध्याय, 15 तकनीकी बुलेटिन और 72 लोकप्रिय लेख और पत्रक भी प्रकाशित किए गए।।

आयोजन

वर्ष के दौरान वैश्विक भारतीय वैज्ञानिक (VAIBHAV) शिखर सम्मेलन कार्यक्रम, उत्पादन मशीनीकरण पर COVID-19 महामारी द्वारा उत्पन्न चुनौतियां और कोविड-19 अवधियों के दौरान और बाद के रास्ते पर वेबशॉप, भारत में कृषि मशीनरी विनिर्माण क्षेत्र पर कोविड-19 का प्रभाव: वर्तमान चुनौतियाँ और भविष्य की रणनीतियाँ पर वेबशॉप, दक्षिण भारत में जीरो-टिल मशीनरी को अपनाने पर विचार मंथन, कटाई पश्चात प्रसंस्करण प्रौद्योगिकी पर व्यावसायिक बैठक, अकादमिया-उद्योग-सहभागिता बैठक, अरुणाचल प्रदेश राज्य में वेल्थ फ्रॉम वेस्ट प्रौद्योगिकी को अपनाने की संभावना पर बैठक, बाजरा प्रसंस्करण कार्यशाला, स्वच्छता अभियान और महात्मा गांधी की 150 वीं जयंती इत्यादि उत्सव आयोजित किये गए।

कोविड-19 के दौरान सलाह

किसानो को महामारी के दौरान फसल उत्पादन एवं प्रसंस्करण के लिए आवश्यक मशीनों के सुरक्षित संचालन के लिए एसएमएस, व्हाट्सएप संदेश और ई-मेल के माध्यम से निम्नलिखित सलाह प्रदान की गई थी:

- समय पर हस्तक्षेप के लिए कृषि मशीनरी
- सुरक्षित अनाज हैंडलिंग और भंडारण
- अंगूर की कटाई के बाद का प्रबंधन
- फल और सब्जी हैंडलिंग

Executive Summary

The institute has executed various research and transfer of technology activities towards mechanization of preand post production agriculture during this year. The overall activities of the institute have been presented as a summary for the benefit of the stakeholders.

New Equipment/Machinery/Technologies developed

- Sensor based fertilizer applicator for deep placement of fertilizers, as an attachment to walk-behind rice transplanter. The field capacity, field efficiency and fertilizer application efficiency of the developed unit were 0.16 ha/h, 72% and 94%, respectively.
- Locust control by a tractor operated high pressure spraying system.The effective field capacity and field efficiency of the sprayer are 80-115 plants/h and 80%, respectively at a forward speed of 2.50 km/h.
- Smart spraying attachment for plant canopy detection and spraying in young pomegranate orchard. This sprayer has effective field capacity and field efficiency of 0.84 ha/h and 60%, respectively.
- Mechanized seeding of pigeon pea using tractor drawn two row drum type pneumatic planter having effective field capacity and field efficiency of 0.18 ha/h and 71%, respectively.
- Timely weeding operation in garlic crop through a tractor operated 19 row weeder with weeding efficiency of about 70% with effective field capacity and field efficiency of 0.29 ha/h and 81%, respectively.
- Insect control in banana pseudo stem through an injector that can inject the chemicals at the rate of 2-4 ml per tree and can cover 140-150 trees/h.
- Drudgery reductionduring banana harvesting using a tractor operated banana bunch harvester that can harvest banana bunches at height upto2.7 m and can handle bunches weighing up to 25 kg.
- Shelf life enhancement and more adaptability of straw by animals through urea solution spraying system for straw baler to pre-treat paddy straw during baling operation. Capacity of the straw baler with urea spraying system is 109 bales/h for paddy at a straw load of 8.3 t/ha.
- Ease in harvesting of bunch crops (soybean, black gram, green gram etc.,) using tractor operated integrated harvesting-cum-conveying machine. The developed machine has effective field capacity and field efficiency of 0.19 ha/h and 78%, respectively.
- Promotion of climate smart machineries such as roto-till drill, broad bed and furrow (BBF) seeder, laser land leveller, ridge and furrow seeder and mole drainage technology in adopted village.The study recommends roto-till drill for sowing of wheat crop and adoption of broad bed and furrow system for soybean crop.
- Optimization of irrigation system for wheat crop for enhanced water use efficiency.The study recommends for irrigating wheat crop with micro sprinklers at 75% of crop evapotranspiration to achieve optimal yield and water productivity
- Use of wastewater for agriculture through horizontal sub-surface flow filter bed. The pollutant removal efficiency for different physico-chemical properties of water was up to 70% and 40-80% for different heavy metals.
- Enhancing soybean productivity in waterlogged vertisols through broad bed furrow (BBF) coupled with mole drainage systems. The study recommends for adoption of BBF coupled with mole drains spaced at 4 m for techno-economic viability of cultivating soybean crop in waterlogged vertisols.

Value Added products and processes

- A controlled infrared radiation based pre-treatment system of 200 kg/h capacity has been developed to reduce time of milling and cost.Pre-treated pigeonpea with IR system resulted indehulling efficiency of 97%, dal recovery of 78% with 2.0% broken and 17.4% mealy waste.
- A roof top natural air driven ventilator based onion storage structure of 1 tonne capacity has been developed. The results of storage study indicated 18% physiological weight loss, 5.5% rotting and 0.2% sprouting losses of stored onions.
- Thermal degradation of crop residues using a non-thermal plasma reactor. Generation of free and charged radicals in plasma under different levels of vacuum is one of the important functions of the system.
- Micro-algae production using the prepared growth media from paddy straw hydrolysate could generate micro algal biomass of 1.4 g/l, which is about 40% higher than commercial growth media.

- A high porous carbon was prepared using pigeon peastalk in two stage activation. The quality of prepared porous carbon was found at par with standard activated charcoal. The average activation energy of activated pigeonpea stalk was estimated at 84 kJ/mol.
- Study was conducted to synthesize char based Ni infused catalyst for *in situ* tar cracking. Tar cracking efficiency achieved is in the range of 81-86% at optimum loading of 0.2 'Ni' at a bed depth of 300 mm.The final tar content in producer gas varied from 32 to 236 mg N/m3.
- Energy consumption for paddy straw collection was accounted in the direct and indirect formof energy for square and round balers.The overall cost of paddy straw collection from field, transportation to power plant and stacking at plant ranged from ₹ 4500/- to 6000/-.
- A manually operated de-bunching tool for Safed *Muslihas* been developed. The de-bunching capacity of the tool wasabout 10.30 kg/h as compared to 5.10 kg/h for manual separation without knife and 7.50 kg/h using knife.

Technology Transfer, training and capacity building

- A total of twelve technologies were commercialized to eight different manufacturers through licensing and memorandum of agreement.
- Tworow tractor drawn planter for sugarcane bud chip settlings raised in protrays has been commercialized and is being included for subsidy by Government of Tamil Nadu in their Mechanization programme.
- Seventy Seven frontline demonstrations of improved farm tools and machinery were conducted in farmers' fields for the benefit of end users.
- Participated in twelve exhibitions and twelve mediaprogrammes (Doordarshan/ETV) events to promote the technologies developed by the institute .
- A total of 6267 units of research prototypes of machines/ implements/tools were supplied to different stakeholders.
- 184 units of machines/implements manufactured by different agricultural machinery industries were tested.
- The institute organized 52 training programmes/ workshops/seminars/interaction meets/review meetings etc.during the year
- Six new patents applications and replies to three patents applications submitted earlier were filed. One copyright application also filed during the year.
- Under human resources development,the staff of the institute participated in 32 training programmes organized by various organizations.

Awards and Recognitions

- The Scientific accolades includes NAAS Associate Member (1 no.), Fellow of Professional Societies (4 no.), Best Book Award (1 no.), Young Scientist Award (1 no.), Uttarakhand Governor's Research Award (1 no.).
- One Scientist has been nominated in scientific panel of FSSAI, One scientist's research paper was adjudged as the Best Paper, one Ph.D. student got CSIR-Senior Research Fellowship, two scientists were nominated as Editors of Professional Journals.
- During the year, 74 research papers were published in journals, 19 books & book chapters, 15 technical bulletins and 72 popular articles & leaflets were also published.

Events

- Some of the events organized during the year includes VAIBHAV *(Vaishwik Bharatiya Vaigyanik)* Summit 2020Webshop on Challenges Posed by COVID-19 Pandemic on Production Mechanization and Way Forward during and post COVID-19 Periods, Webshop on Impact of COVID-19 on Agricultural Machinery Manufacturing Sector in India: Present Challenges and Future Strategies, Brainstorming Seminar on Adoption of Zero-till Machinery in South India, Business Meet on Post-harvest Processing Technologies, Academia-Industry-Interaction meet, Interaction Meet on Possibility of Adoption of Wealth from Waste Technology in Arunachal Pradesh State, Millet Processing Workshop, *Swachhata Abhiyan*, Celebration of 150th Birth Anniversary of Mahatma Gandhi, etc.

Advisories during COVID-19

The following advisories were provided to stakeholders through SMS, WhatsApp messages and e-mails for safe handling of pre and post production mechanization during the Pandemic:

- Agricultural machinery for timely interventions
- Safe grain handling and storage
- Post harvest management of grapes
- Fruits and vegetable handling

Introduction

ICAR-Central Institute of Agricultural Engineering (CIAE), Bhopal, a premier agricultural engineering institute in India, is devoted to promote agricultural mechanization leading to enhancing agricultural productivity; reducing drudgery of agricultural workers; 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, Harnessing Animal Energy Systems, Energy in Agriculture & Agro Industries and Ergonomics & Safety in Agriculture), two centers (Center of Excellence on Soybean Processing and Utilization and KrishiVigyan 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) and CRPs. 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 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. 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. 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-ESCAPCSAM, 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 2020 are shown below.

Staff Position (as on 31.12.2020)

Posts	Sanctioned	In position	Vacant
RMP	01	01	00
Scientific	89	75	14
Technical	144	75	69
Administrative	73	46	27
Skilled Support Staff	42	26	16
Total	349	223	126

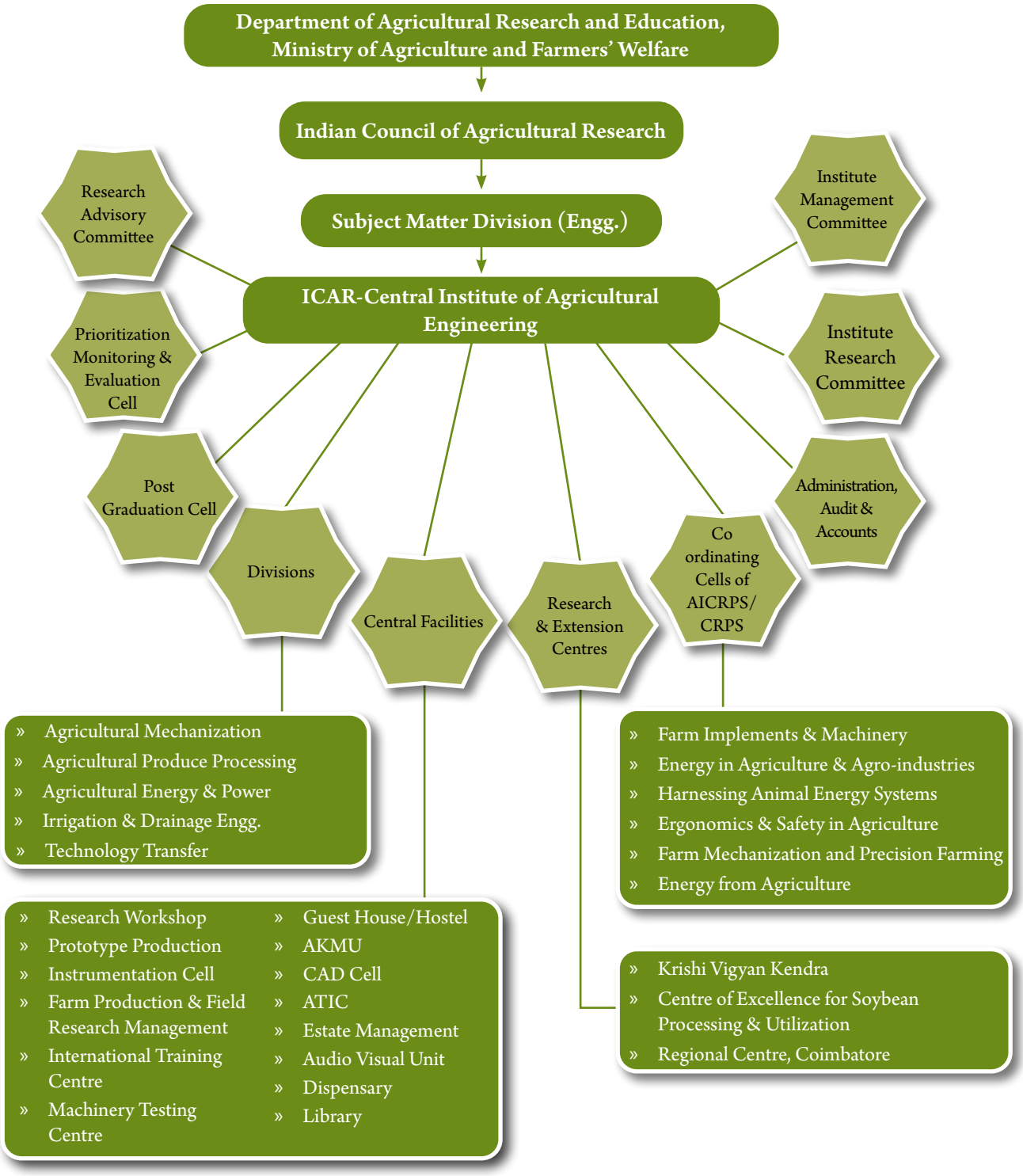
As per council letter no F. No. 14-2/2017/E-I(R&P) dated 17thJune, 2019

Budget 2020 (₹ in lakh)

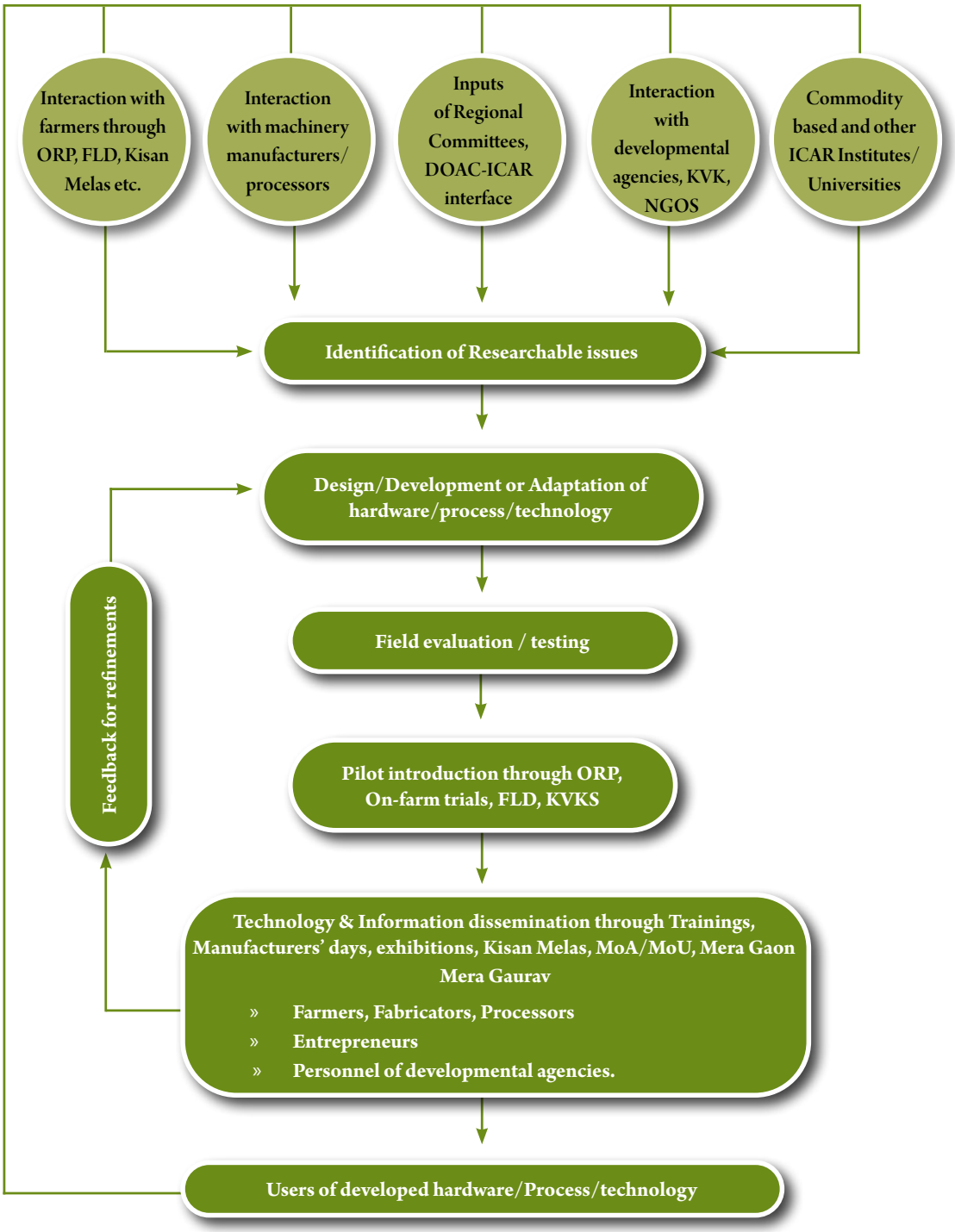
Scheme	Sanctioned	Expenditure*
ICAR-CIAE	6317.32	4628.35
AICRP on FIM	1505.92	1071.61
AICRP on EAAI	1287.09	858.14
AICRP on HAES	641.77	424.17
AICRP on ESA	546.76	361.84
CRP on FMPF & MIS	197.50	91.40
CRP on EA	126.25	56.93

* Expenditure till 31.12.2020

Organogram


Department of Agricultural Research and Education, Ministry of Agriculture and Farmers' Welfare
Indian Council of Agricultural Research
Subject Matter Division (Engg.)
ICAR-Central Institute of Agricultural Engineering
Research Advisory Committee
Institute Management Committee
Prioritization Monitoring & Evaluation Cell
Institute Research Committee
Post Graduation Cell
Administration, Audit & Accounts
Divisions
Central Facilities
Research & Extension Centres
Co ordinating Cells of AICRPS/ CRPS
» Agricultural Mechanization
» Agricultural Produce Processing
» Agricultural Energy & Power
» Irrigation & Drainage Engg.
» Technology Transfer
» Research Workshop
» Prototype Production
» Instrumentation Cell
» Farm Production & Field Research Management
» International Training Centre
» Machinery Testing Centre
» Guest House/Hostel
» AKMU
» CAD Cell
» ATIC
» Estate Management
» Audio Visual Unit
» Dispensary
» Library
» Krishi Vigyan Kendra
» Centre of Excellence for Soybean Processing & Utilization
» Regional Centre, Coimbatore
» Farm Implements & Machinery
» Energy in Agriculture & Agro-industries
» Harnessing Animal Energy Systems
» Ergonomics & Safety in Agriculture
» Farm Mechanization and Precision Farming
» Energy from Agriculture

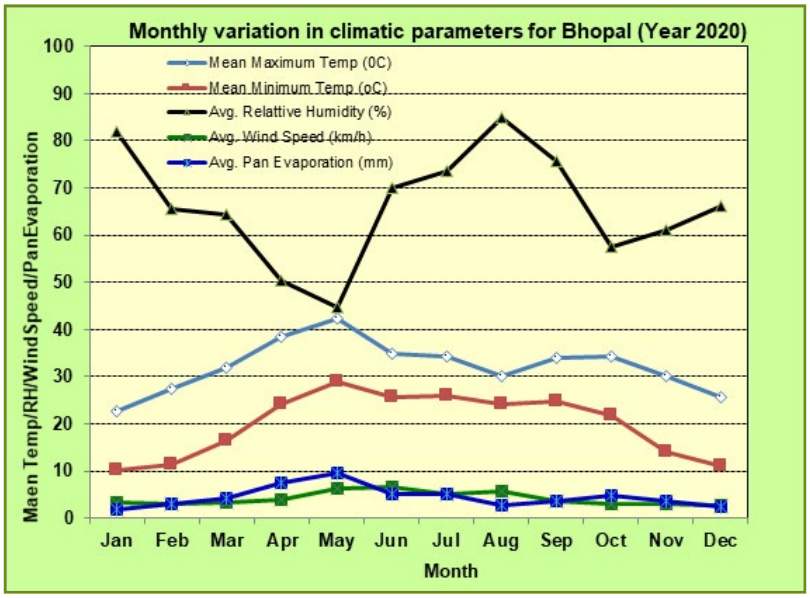
Technology Development Process of ICAR-CIAE

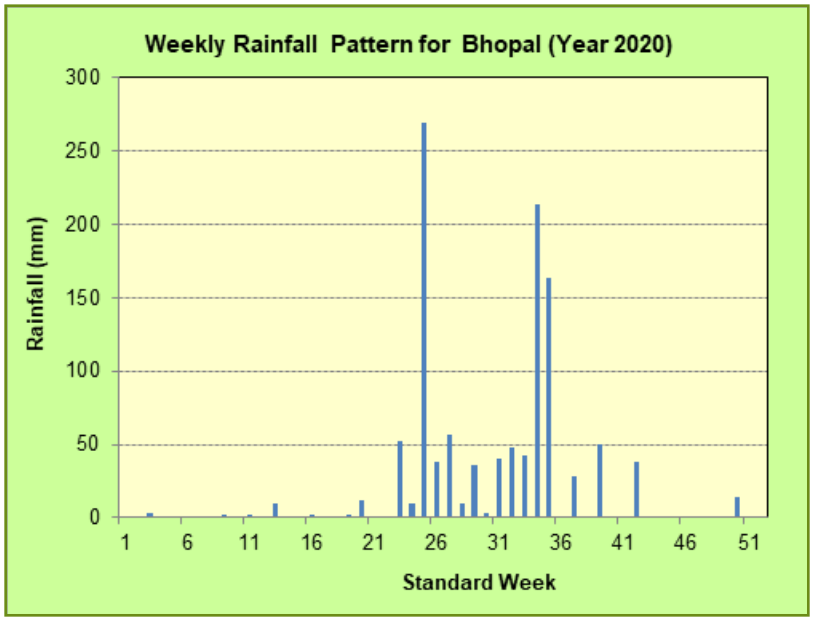


Meteorological Observations

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 were recorded on regular basis. Salient meteorological observations for 2020 are:

- Monsoon started on June 17, 2020 and withdrew on October 24, 2020. The highest rainfall of the season (147.6 mm) was recorded on August 22, 2020. Annual rainfall of 1150.9 mm occurred in 48 rainy days during the year 2020.
- The maximum temperature of the year (45.4°C) was recorded on May 25, 2020 while minimum temperature (3.5°C) was recorded on January 11, 2020. Humidity in the morning (7.20 AM) varied from 36 to 98 per cent while in afternoon (2.20 PM) it varied from 14 to 97 per cent.
- The highest average wind velocity of 11.1 km/h was recorded on May 27, 2020, while the lowest was 1 km/h on December 5, 2020.
- The highest pan evaporation of 15.7 mm/day was recorded on May 27, 2020 while the lowest was 0.8 mm/day on January 18, 2020.





Research and Development

AGRICUTLURAL MECHANIZATION

Tractor drawn pneumatic planter for pigeon pea

Uniform spacing between seeds is important in sowing operation for better germination, plant stand and root growth for higher yields. Pneumatic planters perform this operation preciously. Seed viability for sowing in single seed, higher cost the pneumatic planters directs the alternative technology solution for the bottlenecks. Therefore, an attempt has been made to develop a low cost, single or multi seed hill drop planter. Tractor drawn two row drum type pneumatic planter with fertilizer drill has been developed for sowing of single and multi-seeds on hills. It consists of an aspirator operated by petrol engine, cylindrical drum type metering

device, seed ejector, seed delivery tube, shoe type furrow opener, a pair of ground wheels and chain sprocket type power transmission system. Metering device consists of PVC pipe of 90 mm diameter. Ten orifices of 4 mm diameter are drilled at a desired spacing, which is operated at a pressure of 2 kPa. The planter can be adjusted for planting seeds on beds at 750, 900, 1200 mm row-to-row and adjustable plant-to-plant spacing. Fertilizer metering device is having vertical plate with 10 slots of 15x15 mm size. Metering units of both seed as well as fertilizer have been powered by a ground wheel. The effective field capacity and field efficiency of the pneumatic planter are 0.18 ha/h and 71%, respectively. Machine and cost of operation for sowing of pigeon pea on beds are ₹ 60,000/- and ₹ 546/h, respectively.

Tractor operated garlic weeder

One-fourth of the cost of garlic cultivation is accounted for weeding operation alone. Hand weeding generally requires about 50-60 man-days/ha. Presently, no mechanical weeder is available for weeding in garlic crop. Therefore, a tractor operated 19 row garlic weeder has been developed for weeding. It consists of main frame, tyne frame, depth control wheels, link chain, spring tyne and three point hitching system. Tyne frame is connected to the main frame with the help of link

chains. The link chain provides the lateral movement and maintains uniform depth to the spring tynes during operation. Depth control wheels are provided for adjustment of depth of weeding. The garlic weeder has been evaluated in the garlic crop sown at 100 × 100 mm spacing and at working depth of 45-60 mm. Effective field capacity and field efficiency of the weeder are 0.29 ha/h and 81.2%, respectively at 2 km/h forward speed of operation. Average weeding efficiency and plant damage by garlic weeder are 69.6% and 0.1%, respectively.

Deep placement fertilizer applicator as an attachment to walk-behind rice transplanter

Sensor based deep placement fertilizer applicator as an attachment to walk-behind rice transplanter has been developed. The unit consists of hopper, electronic control metering system, soil float with furrow opener. Electronic metering mechanism system consists of auger-metering mechanism, proximity sensor, digital hour meter counter, solenoid actuator for fertilizer placement and air blower. Auger-

metering mechanism is operated by optimized speed using 12V motor to meter required amount of fertilizer. Proximity sensor with relay is used to actuate the linear solenoid attached opener. A single proximity sensor is attached near to the planting unit to detect planting arm. When the planting arm detected by the sensor, it sends signal to the digital hour meter counter which inturn actuates linear solenoid attached opener to drop the fertilizer in between row so that it ensures adequate nutrient supply. Battery is provided to power the electronic control system. Two air blowers are attached to fertilizer unit to avoid the blockage in the delivery tube end. The developed deep placement fertilizer applicator was evaluated in puddled rice field. Field capacity, field efficiency and fertilizer application efficiency of deep placement fertilizer applicator as an attachment to walk-behind rice transplanter was 0.16 ha/h, 72% and 94%, respectively. The approximate cost of the developed system is ₹ 18,000/-. Saving in cost of operation is about 62 per cent.

High pressure spraying system for locust control

Locust swarms are famous for voraciously feeding on agricultural crops, trees, and other plants and can devastate crops and grasses grown for people and livestock. Presently, there are no indigenous mechanized high pressure spraying systems to control locusts in the country. A prototype of high pressure and variable height sprayer has been developed to

control hopper and adult locusts. It consists of a spray gun (15 m range), UV stabilized HDPE PVC tank (1 m^3 capacity), diaphragm type pump, pressure regulator, automated spraying unit with braided flexible pipe, automated spraying unit developed from DC motor, speed controller driver, battery and regulator to control the direction of spray gun. The automated spraying unit is mounted on a telescopic frame 5 m in height. The DC motor and spray gun are fitted on the MS plate and their linkage converts the rotational output of the DC motor into back-and-forth motion of the spray gun at an angle of 120°. The unit can be retrofitted on any tractor operated sprayer. The high pressure sprayer was tested at the rated engine speed of 1500 rpm and operating pressure of 2942-3923 kPa. Spray droplets of 200 - 500 µm size can reach up to 18 m height. Large size of droplets ensures minimum drift and high volume spraying suitable for hopper and adult locust resting on a tree. Field capacity and field efficiency of the sprayer are 80-115 plants/h and 80%, respectively at a forward speed of 2.50 km/h. The approximate cost of the retrofitted spraying system is ₹ 18,000/-.

Smart sprayer for young pomegranate orchards

In young pomegranate orchards, the losses of agrochemicals are more due to its thin canopy. A smart sprayer embedded with sonar system that can identify the presence of plants may provide efficient utilization and significant reduction in losses of the agro-chemicals. Therefore, a smart spraying attachment for plant canopy detection and spraying in young pomegranate orchard has been developed to control pests. The

sprayer is capable to cover two rows of plants from both sides in single pass of operation and gives effective field capacity and field efficiency of 0.84 ha/h and 60%, respectively at a forward speed of 5 km/h (1.39 m/s). Total costs of tractor mounted smart sprayer is ₹ 1.2 lakhs and cost of operation of tractor mounted smart sprayer is estimated to be ₹ 795/- per h and ₹ 946/- per hectare. The BEP and payback period of the sprayer are ₹ 231 h/year and 9 years, respectively. The developed system can be retrofitted on any tractor based spraying system.

Banana sucker paring equipment

Rotating grating blade mechanism

The equipment developed by ICAR-CIAE in collaboration with NRCB consisting of the two grating blade rotating on a vertical plane. The blade is operated by a 0.75 kW motor. The banana sucker to be trimmed is held against the rotating grating blade (300 mm) and adjusted as per the area and the

depth of the banana sucker to be trimmed. The speed of operation of the blades is 2400 rpm. The capacity of the equipment is 200-250 suckers/h. Control panel box is provided to control the speed of the two rotating blades. The overall size of the equipment is 1570 × 840 × 1800 mm. Saving in cost of operation is about 82 per cent

Combination of trimming mechanism and rotating grating blade mechanism

The equipment consisting of the provision for trimming the bigger size banana suckers using the trimming knife mechanism and two rotating grating blade rotating on a vertical plane for trimming of small banana sucker. Based on the suckers to be paired, the power can be used from a single power source by using suitable power transmission mechanism. The trimming knife mechanism consisting of the holder on which the banana sucker to be trimmed 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 trimming knife is placed at the required position so that the 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 capacity is about 100 suckers per h. Smaller banana sucker can be trimmed by holding against the rotating grating blade and adjusted as per the area and the depth of the banana sucker to be trimmed. The capacity of rotating grating double blade mechanism is about 200 suckers per h. The saving in cost of operation is about 75 per cent.

Banana pseudostem injector

Banana pseudo stem injector has been developed for injecting chemicals in banana pseudo stem. The unit injects the determined quantity of chemical precisely to the stem at required places. It consists of chemical tank, peristaltic pump, control unit with non-return valve and injector. The

injector is made of S.S material and the chemical tank is made of plastic with storing capacity of 16 l. The peristaltic pump is attached to pump the liquid from chemical tank to injection system. The control unit is attached with electronic embedded system to control chemical quantity and depth of injection by 8 mm I/P & O/P screw variable valve. A non-return valve is attached with control unit to restrict the chemical back flow to the injector after injection. Quantity of liquid injected is 2-4 ml per tree, coverage 140-150 trees/h, spillage percentage and injector efficiency is recorded as 2% and 95% respectively. About seventy per cent in cost is saved over traditional method.

Tractor operated banana bunch harvester

Bunch harvesting is done manually and requires more labour and is tedious operation. To eliminate the human drudgery, a tractor operated banana bunch harvester has been developed.

The unit consists of main frame, harvesting boom, bunch holding and bunch cutting system, hydraulic system and power transmission system. The main frame is designed to attach in front of the mini tractor chassis. Bunch harvesting boom is made to hinge the harvesting boom with mainframe and hydraulic cylinder, which is used to lift and lower the harvesting boom. A hydraulic cylinder is provided for operating harvesting boom and bunch holding and cutting assembly. Maximum height of reach of the harvester is about 2.7 m and can handle bunches weighing up to 25 kg. Power from tractor PTO is transmitted through step up gearbox to the gear pump to operate the hydraulic cylinders through two double acting spring center directional control valves. Bunch harvester has a capacity of harvesting 45-50 trees/h. About 23 per cent of cost can be saved when compared with manual harvesting.

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. The urea treated straw is liked by cattle and helps to increase the milk production and body weight of animals. Conventionally, the straw is mixed manually with urea solution. Urea solution spraying system for straw baler (rectangular type) has been developed by the institute in collaboration with ICAR-NIANP, Bengaluru to pre-treat paddy straw during baling operation. The system consists of a plastic tank, spray boom with flat fan nozzles, HTTP pump, hose pipe, strainer, pressure relief valve and pressure gauge. The urea solution having

concentration of 8% has been used with the system for on the go spraying of urea solution on loose straw during conveying to compression chamber of baler. The capacity of straw baler with urea spraying system is 109 bales/h for paddy at straw load of 8.3 t/ha. The cost of retrofitted urea solution spraying system is ₹ 30000/- and cost of urea treatment is ₹ 0.50 per kg of straw. The weight and moisture content of bales increased in the range of 50-70% after application of urea solution. The 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 analyzed for crude protein (CP) content of the feed. Due to treatment of urea solution, the CP content increased in all the treatments and ranging from 9.14 to 13.41% for wheat and 8.93 to 12.28%, for paddy straw. 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 straw baler with the system.

Integrated system for harvesting and conveying of bunch crops

The harvesting of bunch crops such as soybean, black gram, green gram etc. is still being carried out manually to reduce the harvesting losses to a minimum which requires 18-25 man-days/ha. However, these crops are susceptible to higher losses when harvested using conventional reapers due to higher interaction between machine and plants. On the other hand, the use of combine harvesters has limitations of its timely availability and small fields. The shattering losses also increase exponentially at late harvesting. Therefore, a tractor operated integrated harvesting-cum-conveying machine with 2120 mm cutter bar width has been developed at ICAR-CIAE, Bhopal. It is a modified vertical conveyor reaper with

an integrated conveying system for conveying cut crop to a collection box/trailer. The developed machine has been evaluated for the harvesting of soybean, black gram and green gram. The average cut height, effective field capacity and field efficiency of the machine are 66-80 mm, 0.19 ha/h and 78%, respectively at 1.5 km/h forward speed. The harvesting losses are 1.5-2.9% for soybean, black gram and green gram. The approximate cost of the machine is ₹ 1 Lakh while unit cost of operation is ₹ 711/h. Break-even point (BEP) and payback period of the machine are 84 h/year and 2.5 years, respectively. Integrated harvesting-cum-conveying system can give economic benefit and time saving of 49.4% and 60.4% respectively, in comparison to manual harvesting of bunch crop by sickle.

Climate smart agriculture machinery promotion in selected village clusters of Madhya Pradesh

In recent decades, adverse effects of climate change have been observed in agricultural production system, therefore, there is a need to promote climate smart agricultural machineries to overcome these adverse effects. Demonstration of climate resilient agricultural machinery has been done to promote among the farmers. Climate smart machineries identified are roto-till drill, broad bed and furrow planter, laser land leveller, ridge and furrow and mole drainage technology. The energy use efficiency (4.02) is higher for roto-till drill demonstrated in wheat field in comparison to conventional field (3.64). The specific energy for roto-till drill and conventional farming are 5.46 and 6.08 MJ/kg of production, respectively. The total input energy in wheat production after adopting roto-till drill (21.14 GJ/ha) is about 39% less in comparison to conventional practices (34.87 GJ/ha). The carbon emission in case of roto-till drill is 1670 kg of equivalent C/ha which is 9% less in comparison to conventional practice (1834 kg of equivalent C/ha). Based on this study, roto-till drill is recommended for sowing of wheat crop which is energy efficient, eco-friendly and leads to sustainable agriculture. The broad bed and furrow system is recommended for sowing of soybean crop to conserve soil moisture as well as to drain excess water during heavy rainfall.

Technology Forecasting and Projecting Market Trends for Agricultural Machinery Manufacturing Sector in India

The investigations have been conducted in three states viz., Punjab, Tamil Nadu and Odisha for assessing the market trends in agricultural machinery manufacturing sector. Primary data were collected from 110 manufactures covering 18 manufacturing hubs. Demand forecasting of agricultural machinery is being done using structural time series modelling technique. The forecast of the market trendupto year 2030 in these selected hubs of four states for different machinery requirement is presented in table.

State and name of the machinery	Number of units required
Tamil Nadu	
Chaff cutter	16424
Multicrop thresher	678
Cultivator	6942
Conoweeder	8244
Rotavator	10152
Punjab	
Paddy threshers	5015
Chaff cutter	3349
Self-propelled combine	733
Odisha	
Power thresher	15364
Rotavator	6359
Pedal thresher	5462
Mandawaweeder	26825
Conoweeder	1264
Hand winnower	1338
Cycle hoe	1913
Seed treatment drum	65

The forecasting of agricultural machinery in these states indicating high demand of the above mentioned machinery.

Technologies under development

Tractor mounted trencher for grape orchards

The FYM application in grapes is done manually by digging a continuous trench near the plant, which is drudgery prone operation in grapes cultivation. Trench making close to the vineyard rows is an important operation which requires precision. An effort has been taken to develop a tractor

mounted side trencher to dig a trench up to a depth of 300 mm. The trencher has provision for adjusting width as well as depth. The width of trencher can be varied from 2.0-2.6 m to match the plant geometry of 2.4, 2.7 and 3.0 m row spacings. Two mould board plough bottoms are used at different depths to make the trench by attaching them on both sides inward on the main frame. The trencher can dig up to a depth of 300 mm at 1.44 km/h forward speed. During the functional testing the actual field capacity and field efficiency of the equipment is about 0.28 ha/h and 85%, when operated at 2.3 m width. Rigorous testing will be carried out in grape orchards in next season.

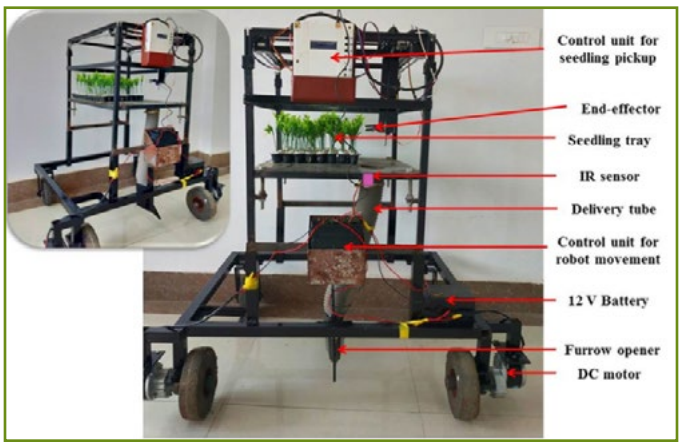
Farm Yard Manure (FYM) applicator for grape orchards

FYM application in grapes is most drudgery prone operation in grapes cultivation which is done manually by digging a continuous trench near the plant. A FYM applicator with 1 tonne capacity has been developed for placing FYM near the plant on each side continuously. It consists of mixing chamber, a pair of augurs for dispensing FYM, hydraulic motor, and conveyor-type dispensing unit. The developed FYM applicator have provision to increase the width of conveying system by extending the slide tray attached to the lower part of conveyor. The applicator can dispense FYM from 2.3 to 2.6 m width to match the plant geometry having row to row spacing from 2.5 to 3.0 m. The equipment can deliver 7.8 kg/min FYM at 1000 rpm of the tractor engine from each outlet, as per recommended dose. The effective field capacity of the

developed equipment is 0.44 ha/h with field efficiency of 80%. The functional testing of the machine has been completed; however rigorous testing in grape orchards will be carried out in next season.

Robotic transplanter for plug seedlings

Manual transplanting of vegetable seedling in field is time consuming as well as labour intensive operation. Lack of manpower during transplanting operation and to ensure timeliness in operation, a seedling pick-up mechanism using robotic arm is under development 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 servomotor. The seedling picking mechanism is integrated with the manipulator with computer programming using Microchip. The end-effector grasps the seedling, pick-up and moves to the XY (0, 0) co-ordinate, and release the seedling. As soon as the seedling is delivered to the delivery tube, the IR sensor placed in delivery tube gives the signal to the robot and robot moves forward to the next dropping point. The developed robot can pick and place 3 seedlings/min.



Small tractor operated three-row garlic dibbler

For planting of garlic cloves manually about 65-85 man-days/ha are required. Considering the economic importance of the garlic production, a tractor-drawn three row garlic dibbler has been developed for sowing garlic cloves at recommended spacing with high accuracy. It can maintain the seed spacing of 100 mm and row spacing of 150 mm. Main function of the dibbling unit is to receive the garlic cloves from the metering unit cups and dibble them into the soil at proper depth. Dibbling cup is conical in shape and made from two spring actuated jaws. A cam and follower system is used for the opening and closing of the dibbling cups. Levelling roller is attached in front of the dibbling unit to level the soil. The chain and cup type metering mechanism is used. A close-fitting housing is attached from the periphery of top sprocket to the release point of cloves. Initial testing of the machine for dibbling of garlic seeds has been completed.

Tractor operated semi-automatic seedling transplanter for tobacco

The equipment consists of main frame which can be attached to standard three-point hitch arrangement of the tractor, the metering mechanism, operator's seat, furrow openers, seedling planting mechanism, system for spot application of water and soil compaction wheel. The nursery grown in the protrays can be dropped through the metering mechanism by two operators who are seated behind the equipment. A shoe type soil opener opens up the soil. The seedlings, which is dropped down from the seedling placement mechanism is placed in the opened up soil. The soil compaction wheels which follows the soil opener closes the soil thereby giving stability to the seedlings plants. The plant to plant spacing can be easily changed from 50, 60 and 75 cm. The row to row spacing can be changed to 70 and 100 cm to suit the different region demand. The field capacity of the equipment is 0.2 to 0.3 ha/h and the missing percentage is to the tune of 2-3 per cent at a working speed of 1.5 km/h. The quantity of water applied per plant is 200-250 ml. The savings in cost is 65 per cent. Saving in labour is 85 per cent.

Self-propelled onion weeder

Manual weeding in onion crop is a very tedious, costly and time consuming operation due to its closed spacing. Therefore, four row engine powered push type onion weeder consisting of four verticle rotory type weeding units has been developed. A soil working element in each weeding unit is a spring tyne used in reel of the combine harvester. Each tyne with outer diameter of 100 mm fixed on hub of 100 mm diameter. All four units are arranged on main frame at the spacing of 0.15 m and powered by means 1.5 hp petrol engine. Weeding units are operated by means of chain sprockets and worm gear box with reduction ratio of 1:20. The theoretical field capacity of machine is 0.09 ha/h at the speed of 1.5 km/h. Weeding efficiency and plant damage with the push type weeder are 91.21% and 6.81%, respectively. Push type onion weeder has been upgraded to self-propelled weeder by giving power from same 1.12 kw petrol engine to the wheels. Performance of weeder is found satisfactory during ongoing field trials. However, line transplanting of onion seedlings may be recommended for the best performance of weeder.

Girdling tool for litchi tree

Girdling is a selective wounding process that removes strips of bark in litchi tree. It increases fruit size and yield in litchi. Traditionally, girdling is done with the help of simple serrated

knife or girdling knife which takes around 15 minutes to girdle a branch and girdling depth is also not uniform. Sometimes two to three branches of a litchi tree need to be girdled, which require more time per tree. In order to mechanize this laborious process, a motorized girdling tool has been developed by the institute. It mainly consists of a circular blade to cut the wood bark from the tree, safety cover to protect the operator from rotating blade, handle and a 12 V battery-operated motor. The tool has been tested on litchi tree at ICAR-National Research Centre on Litchi, Muzaffarpur, Bihar. The girdling depth and width are 2-3 mm and 3-4 mm, respectively, which satisfy the girdling requirement of the litchi tree. The time taken to complete one girdling operation is 2-4 minutes compared to 15 min when done with traditional knife or girdling knife. Long duration testing of the tool is yet to be carried out.

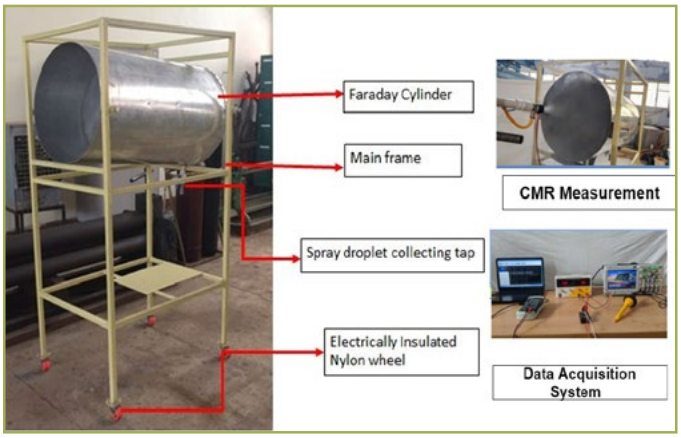
Small tractor operated EPN applicator for sugarcane

The equipment consists of main frame which can be attached to standard three-point hitch arrangement of the tractor, solution tank, solution tank holding frame, furrow opener, water pump, agitator assembly, flow and speed control unit. The main frame rear side provided to telescopic arrangement for row spacing adjustment. The EPN (Entomopathogenic nematodes) powder is diluted in water tank with help of agitator. The agitator is powered by 12 V torque DC motor at maximum speed of 150 rpm. A shoe type furrow opener with wings is fitted to the main frame in rear side of unit. The

diluted EPN solution is pumped by using battery operated diaphragm pump with the output capacity of 4 l/min. The solution outlet is taken from the bottom side of the tank through pump to behind of the furrow opener. The capacity of the tank is 75 l. The field capacity of the equipment is 0.16 ha/h at an operating speed of 2 km/h. The savings in cost of operation is 70%. Saving in labour is 85 per cent.

Instrumentation set up for direct acquisition of charged spray droplets

A faraday cylinder test setup is being developed for direct acquisition of charged spray droplets dispensing from induction based air assisted electrostatic sprayer. The system consists of a high voltage electrostatic probe, micro ampere meter with data logger, faraday cylinder and DC power supply. The system can be used to calculate the spray cloud current



of charged spray droplets. The charge to mass ratio (CMR) of an electrostatic system is determination of charge sustained in the droplet per unit mass density. It has been observed that, the individual effect voltage, flow rate and electrode type (Copper, Aluminium and Brass) have significant effect on charge to mass ratio (CMR) at 5% level of significance, while, interaction of flow rate and distance is insignificant ($p<0.05$). CMR showed a constant curve after a voltage of 4.0 kV. An optimized value of voltage (4.0 kV), flow rate (120 ml/min) and distance of an electrode from orifice value is selected for copper electrode using response surface methodology.

Induction based air assisted electro-static sprayer

An electrostatic spraying reduces pesticide use by 50% and enhances deposition efficiency as high as seven times compared to conventional methods of spraying in row crops. It can even attack the pests present on abaxial surface of leaf thus gives better pests control in the field. Therefore, an induction based air assisted electrostatic nozzle has been developed with a flow rate of 120 l/s and high voltage DC charging system to charge an electrode up to 10 kV. The air pressure of the nozzle

is regulated at 300 kPa. The electrostatic system consists of base frame, petrol engine, air compressor, spray tank, air filter, air moisture separator and spray gun with electrostatic nozzle. Spray lance can operate up to a distance of 10 m. Bio efficacy of an electrostatic sprayer is 85% for LN90 dosages of 0.15 ml/l on cotton aphids and 92% for LN90 dosage of 0.2 ml/l on jassids. The percent coverage, VMD, spray deposits per square meter and volumetric spray deposition are 15.35%, 159, 670 deposits/m^2 and 0.486 µl /cm^2, respectively.

Deep learning based frame work for abiotic stress phenotyping in field crops

The identification of water stress is a major challenge for timely and effective irrigation. Several direct and indirect methods exist for identification of crop water stress but, they are time consuming, tedious and require highly sophisticated sensors or equipment. Image processing is one of those techniques which can help in the assessment of water stress directly. Machine learning techniques combined with image processing can aid in identifying water stress beyond the limitations of traditional image processing. Deep learning (DL) techniques have gained momentum recently for image classification and the convolution neural network based on DL is being applied widely. In present study, comparative assessment of three DL models, AlexNet, GoogLeNet and Inception V3 are applied for identification of water stress in maize, and wheat crops. A total of 1200 digital images have been acquired for each crop to form the input dataset for the deep learning models. Among the three models, performance of GoogLeNet is superior with an accuracy of 98.3 and 68.8% for maize, and wheat, respectively. The onset of convergence in GoogLeNet models commenced after 8 epochs with 22 (maize), and 15 (wheat) iterations per epoch with error rate of less than 7.5%.

Tractor operated garlic harvester for raised beds

Garlic Harvesting is one of the most laborious and time-consuming operation. The garlic bulbs are difficult to harvest manually under black cotton soil conditions. To overcome the problem, a tractor operated garlic harvester has been developed for harvesting of garlic crop sown on raised beds. The machine can harvest garlic crop sown on broad beds. The cutting discs are provided to cut the furrow slice vertically. The triangular point blade having 10 knives is attached in front of conveying unit for loosening black cotton soil and easy penetration. The machine has chain type conveying mechanism rotating by means of belts and pulleys driven by tractor PTO and gear box. The developed garlic harvester has been operated in testing plot (without garlic crop) for its functional testing at forward speed of 2.2 km/h. The machine will be tested in next season for harvesting the garlic crop.

IRRIGATION AND DRAINAGE ENGINEERING

Wheat crop under varying irrigation methods for enhanced water productivity

To assess the effect of water stress on yield and water productivity of wheat crop under different irrigation methods and levels, a field experiment on wheat crop (Var. HI 1544) was laid in strip plot design with two irrigation methods (conventional and micro sprinkler) and four irrigation levels (25, 50, 75 and 100% of crop evapotranspiration) with three replications. Under sprinkler irrigation, higher yield (5.71 t/ha) was recorded over conventional irrigation (4.89 t/ha). Similarly, water productivity was higher by 93-118% in sprinkler irrigation over conventional irrigation. Maximum wheat yield of 6.22 t/ha was recorded at irrigation application of 100% of crop evapotranspiration by sprinkler irrigation method, followed by irrigation at 75% evapotranspiration. The results show similar yield can be achieved under sprinkler irrigation with 25% less water application. Thus, farmers may irrigate wheat crop using micro sprinklers at 75% of crop evapotranspiration to achieve optimal yield and water productivity.

Gravity drip irrigation system for small landholder

Gravity based drip irrigation is very simple, affordable and low pressure technique with ease in installation, operation and maintenance. Evaluation of gravity drip irrigation was carried out under constant and falling head conditions of water level. The water storage tank of 1000 l capacity was installed at 1.5 m height above ground for gravity drip irrigation. Tape and point source laterals were laid over 500 m^2 area each with emitters spaced at 0.3 m. Under falling head condition, coefficient of uniformity was 83 and 87% in round and tape lateral, respectively. The uniformity coefficient of 94 and 96% in round and tape lateral, respectively, indicated that maintaining the constant head in the water storage tank is helpful to achieve higher irrigation efficiency in gravity drip irrigation system.

Manually operated top opening system for small greenhouse

Greenhouses are used to grow crops under partial or fully controlled environmental conditions to get optimum growth and productivity during the off-season. During the summer, opening and closing the top of greenhouse for maintaining the optimum temperature inside the greenhouse is needed to flush out the accumulated hot air inside the structure. For this purpose, a manually operated single point top opening system was developed and installed in a greenhouse. It consists of a

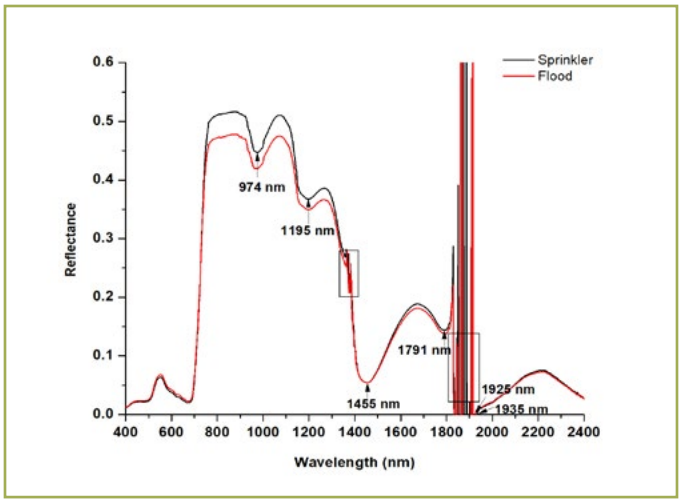
winch machine with rope, pulley, movable unit, and fixed stand. The fixed stand is mounted on the stable platform inside greenhouse. The movable unit is moves up and down on the fixed stand by using the winch machine and pulley. Other parts of the movable unit are attached to the top of greenhouse. The developed mechanism is a manually operated low cost and low maintenance system which is suitable for lifting the top of the greenhouse upto 200 m^2 area.

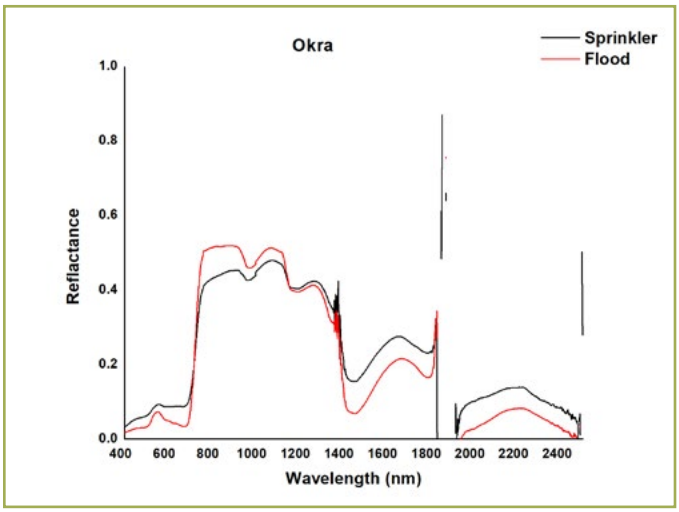
Horizontal sub-surface flow filter beds for waste water treatment

With upcoming challenges such as rise in population thereby demand for higher food production and competitive uses of water from other uses such as industry, domestic and other resources, there is need to recycle wastewater for making it suitable for irrigation. Thus, reuse of water using robust, low cost and less maintenance decentralized technologies which can be adopted at village level are of vital importance. A hortizontal subsurface flow filter beds for wastewater treatment has been designed and installed in the institute farm. The filter beds were made of reinforced cement concrete with inlet section, treatment section and an outlet. The filter media consisted of layers of gravel, grit and sand filled to a total depth of 60 cm. After the number of lab experiments, 2 days of retention period of wastewater in the filterbed is recommended for optimal removal of the pollutants. The system can be installed on-line on local wastewater drains considering daily flow rate. The pollutant removal efficiency for different physico-chemical properties of water was up to 70% and for different heavy metals it was 40-80%.

Identification of critical wavelengths for water stress assessment in wheat and okra crops

In NIR and SWIR region of the spectrum, the depth of trough feature plays an important role for the detection of water stress. This study has demonstrated the possibility of detecting the plant water status from wavelengths of NIR and





SWIR regions. Wheat and okra were cultivated under flood and sprinkler irrigation methods with different levels of water stress. In wheat, six infrared troughs at 974, 1195, 1455, 1791, 1925 and 1935 nm, were identified, showing more trough depth and In Okra, four trough features at 976, 1174, 1453 and 1790 nm were identified for the irrigation methods. In wheat, the spectral bands at 974 and 1195 nm showed 36 and 18% difference in the percentage of reflectance, respectively between sprinkler and flood methods. Thus, to detect the moisture stress on crop, wavelengths 974 nm and 1195 nm could be selected as the optimum wavelengths for spectral signatures NIR region. Overall, spectral signatures under flood irrigation has shown a low reflectance signature with decreasing water absorption trough features in NIR-SWIR region compared to the sprinkler method in wheat and vice-versa in Okra, as can be verified by variation in soil moisture content.

Broad Bed and Furrow coupled with mole drainage system

Study has been carried out to investigate the effect of broad bed furrow (BBF) coupled with mole drainage on

productivity of crops sensitive to waterlogging. The field experiments have been carried out with BBF and mole drainage consisting eight treatments with three replications using randomised block design and standard recommended cultivation practices for soybean crop (Variety: JS-2034) during 2016-2020. Adoption of surface drainage (broad bed and furrow-BBF of triangular shape having 200 mm depth, 400 mm top width and 1.5 m spacing) technology in the semi-arid region (rainfall < 750 mm) resulted in the increase in soybean grain yields over the conventional practice of cultivation (control) from 27.0 to 30.0% in temporary waterlogged vertisols. However, in high rainfall regions, adoption of BBF of 200 mm depth coupled with Mole drainage system enhanced soybean grain yields by 67.0 to 70.0 per cent over control. Economic analysis indicated the benefit-cost (B/C) ratios of 1.65 and 2.03 for BBF, and BBFs coupled with mole drainage system respectively with payback period of less than 2 years.

AGRICUTLURAL ENERGY AND POWER

Non-thermal plasma pyrolysis reactor

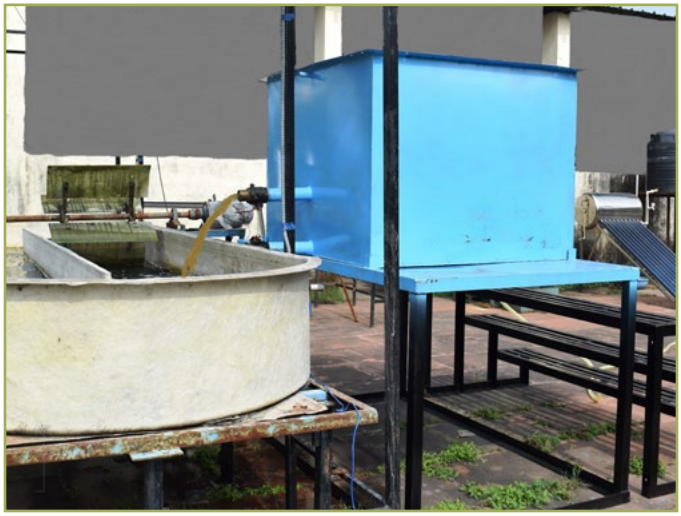
A non thermal plasma reactor has been designed and developed to study the thermal degradation of crop residues. The system consists of stain-less steel (SS) main reactor equipped with viewing glass, needle valve for allowing carrier gas in the reactor, passage for high vacuum system and plasma gun. The plasma gun has been designed for generation of plasma arc inside the reactor using molybdenum plate as the cathode and SS sample holder as anode. High vacuum system has been attached with the reactor to generate different levels of vacuum. It consists of the rotary pump, diffusion pump, penning and pirani gauge for vacuum pressure measurement, integrated three ways to control the vacuum inside the reactor. It can generate the vacuum as high as 10-8 bars. The thermal degradation behaviors of crop residues can be studied under different levels of vacuum and plasma intensity in different environment. Generation of free and charged radicals in plasma under different levels of vacuum is one of the important functionalities of the system.

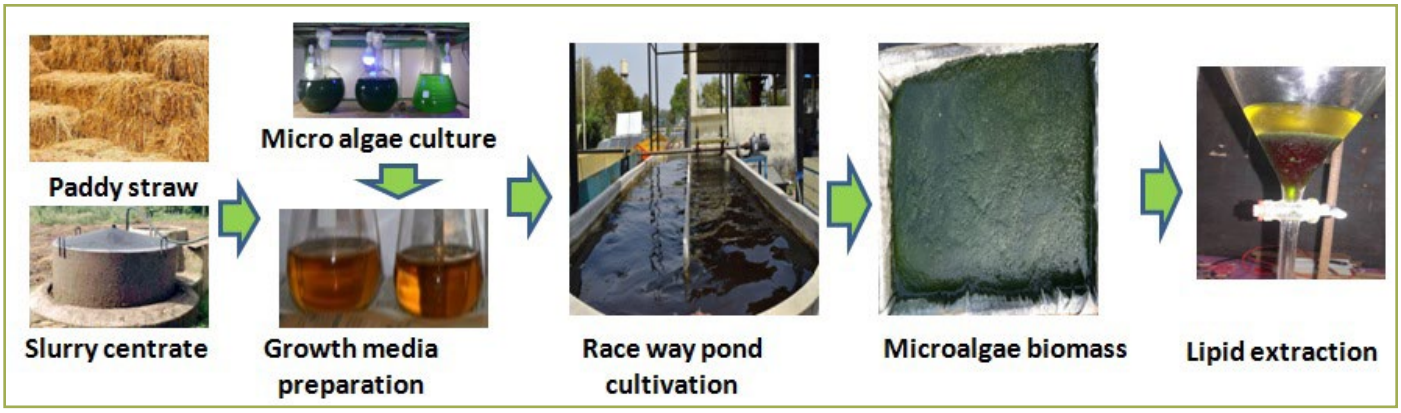
Ergonomic Design of Solar Powered Prime Mover Operators' Workstation

The operators' workstation has been designed by considering 5th and 95th percentile of workers' body dimensions along with their capabilities and limitations. Driver seat has been provided with adjustment of 100 mm. The mock up has been developed considering the reach and clearance of small and larger operator. Subjective evaluation on the mock up for ingress, egress and accessibility to controls has been conducted with 15 subjects having age, weight and height range of 19-61 year, 49-102 kg and 1600-1766 mm, respectively. Different postural angles viz. trunk, elbow, hip, knee and ankle angle have been measured and compared with the comfort angle range. The overall dimensions of the solar powered prime mover (Lenth-1060mm, width-950 mm and height-1300 mm) and the range of trunk, elbow, hip, knee and ankle angle and overall dimension of workstation has been made to suit most of the drivers. All the prime mover controls viz. steering, brake, accelerator, etc. are suitably placed within operator reach envelope.

Paddy straw hydrolysate cum slurry centrate production unit for microalgae production

Nutrient media is a crucial part in microalgae production, therefore a unit for paddy straw hydrolysate cum slurry centrate production of 1.5 m^3 capacity is developed by ICAR-CIAE, Bhopal. Centrate is the homogeneous liquid extract of slurry produced by washing, filtration and sedimentation. This unit has been designed to have two concentric rectangular containers. Paddy straw will be placed in inner perforated container for 12 to 16 hours. Upper lid has uniform water distribution facility from where water is sprayed on paddy straw. The unit has two outlets and is placed at the designated height so that the hydrolysate or centrate directly can be empty in to race way pond for microalgae production. Upper



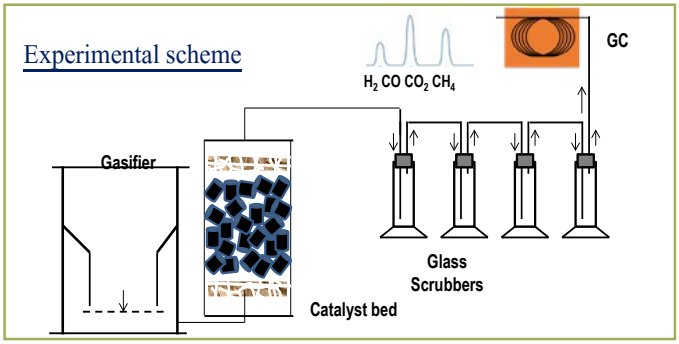


outlet is for slurry centrate so that the sediment will not be disturbed and fine centrate will be available. The growth media produced utilizing Paddy straw hydrolysate mixed with biogas slurry centrate at 50:50 ratio and Paddy straw – cow dung co-digested slurry centrate diluted with water at 1:7 ratio, could generate microalgae of 1.2 g/l and 1.4 g/l, respectively in the ponds that are 20 and 40% than commercial fertilized based media. Lipid extracted from the produced microalgae biomass is in the range of 17 to 21%.

Production of high porous carbon from pigeonpea

A high porous carbon was prepared using pigeonpea stalk in two stage activation. In first step, the pigeonpea stalk was carbonized at 300 to 450°C temperature in annular core biochar reactor. The volatile vapours were allowed to escape outside the reactor to enhance the porosity. The carbonized pigeonpea was then activated in second step under carbon dioxide environment at different temperatures of 800 to 900°C. The maximum iodine value and methylene blue value were found to be 720 and 160 mg/g, respectively. The methylene blue of produced activated carbon was almost similar with the methylene blue value of standard activated charcoal (179 mg/g). The total carbon in the produced activated carbon was found to be 85%. The average activation energy of activated pigeonpea stalk was estimated at 84 kJ/mol.

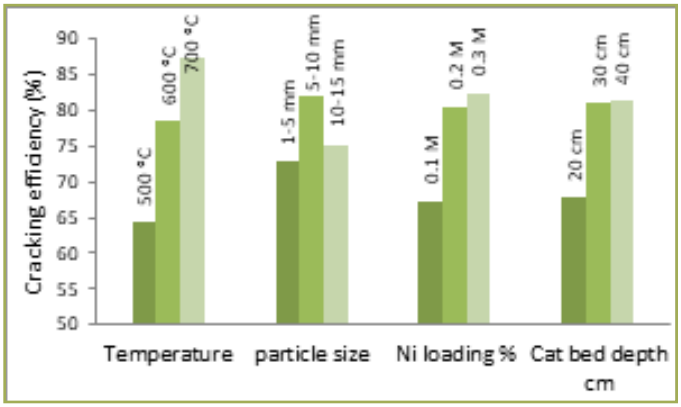
Tar cracking in producer gas using Ni-loaded char catalyst



Tar in producer gas creates substantial economic and efficiency loss in gasifier based power plants. Study was conducted to synthesize char based Ni infused catalyst for *in situ* tar cracking. A Taguchi orthogonal L_9 array has been adopted for the optimization study using chickpea straw pellets. The temperature of catalysts bed was varied from 500 to 700 °C, particle size of char catalysts from 1 mm to 15 mm and bed depth from 200 to 400 mm. The experimental setup consisted of a mini gasifier, an electrically heated tubular reactor, temperature sensors, tar collecting scrubbers and gas analyzer. Producer gas was passed through the hot catalyst bed at various conditions. The samples were passed through two scrubbing bottles filled with isopropanol at 30°C followed by tar-isopropanol separation by distillation at 70°C. Tar cracking efficiency increased with increasing temperature and Ni-loading and observed to achieve in the range of 81to 86% at optimum loading and bed depth of 0.2 Ni and 300 mm respectively. The final tar content in producer gas varied between 32 to 236 mg N/m^3.

Energy assessment and crop residues management for fuel supply chain of power plants

The energy consumption for the paddy straw collection was accounted in the direct and indirect form of energy. Direct energy included fuel and human energy consumption, and indirect energy included the machinery and farm implement energy consumption. The round baler and square baler



collection systems were investigated in this study. The square baler was found to consume higher energy as compared to round baler due to high field capacity and large bale size. The chopping and raking were consumed equal energy in all cases. The indirect energy consumption was almost same in both the cases. The economics of paddy straw collection and transportation to power plant using both the system was also estimated. The cost of loading was found to be ₹ 140 per tonne in case of square baler. Transportation of bales is done by tractor-trailers and the average cost of transportation was estimated as ₹ 450 per tonne for 30 km of distance. The overall cost of paddy collection from field, transportation to power plant and stacking at plant comes out to be in the range of ₹ 4500/- to 6000/-

Technologies under development

Torrefaction system for 200 kg biomass capacity

A pilot scale torrefaction system having 200 kg biomass capacity has been developed. The unit is equipped with six electric heaters of 9 kW capacity and has provision for removal of torrefied biomaterial by tilting the reactor. In torrefaction, the moisture and hemicellulosic segment of biomaterial devolatizes and the remaining material becomes rich in cellulosic and lignin fractions. The biomaterial becomes dry and brittle due to this process. Torrefaction experiments were carried out on paddy straw to investigate the biopolymeric changes in crop residue when the biomaterial is heated until temperatures of 200–300°C and residence times of 60-180 minutes. The raw paddy straw was placed in the reactor and the reactor was sealed from all openings. Samples are under characterization such as moisture content, bulk density, proximate analysis, TC, TOC, TGA, etc. The size of raw material and compaction level of raw material inside the torrefaction reactor is also influencing the recovery. The recovery was found to vary from 90-98%.

System for production of enriched bio-char from crop residues

A continuous energy efficient biochar production unit has been developed with an anticipated biomass feeding capacity

of 100 kg/h. Reactor heating is done by producer gas for reducing electrical energy requirement. Enriched bio char granules were formulated using clay, soil and cow dung at different proportions. Among those, biochar granules having 30% kaolinite and 10% soil has been found to be effective as binding agent with good strength. Both bulk density and crushing strength have been found higher in this ratio. Zinc (Zn) adsorption capacity of biochar prepared at 500 °C was tested at IISS, Bhopal, by keeping biochar in $ZnSO_4$ bathing solution containing 0, 25, 50, 100, 200, 400, 600, 1200, 2400, 4800, 7200, 10800, 16200, 24300 and 36450 mg Zn/L for 6, 12, 24, 48 and 72 hour with intermittent shaking. Zn concentration in filtrate was determined using an AAS instrument. Maximum adsorption of 74280 ppm was attained with 16,200 mg Zn/L (with 324000 ppm concentration) bathing solution for 24 hour. Further studies are going on to understand the Zn release pattern from Zn adsorbed-bio-char.

Synthesis of bio-crude and its fractionation

A bio-crude production unit has been developed to accommodate about one kilogram powdered biomass. The novelty of condenser is that it uses the principle of tube-cell heat exchanger. Water is used as a condensing medium which is allowed to flow in the outer jacket of the condenser unit by a centrifugal pump. The cleaning of the tubes can be done easily by opening the condenser system. The bio crude vapour is immediately passed through the heat exchanger to condense the bio crude from gas. The institute has also developed a process and technology for value added products from segregated bio-crude. For that a bio-crude segregation unit is developed which has annular core concept. The output of the main reactor was connected with segregated collection system for collection of segmental condensate in five different chambers to segregate the biocrude in different segments having different carbon chains. Unit has been tested for dry run. The on-load runs are under progress.

Conversion of tractor diesel engine to 100% compressed natural gas engine

To substitute fully or partially the gasoline or diesel fuel with Compressed Natural Gas (CNG) and bio-CNG an attempt has been made to develop a CNG based system to retrofit in the tractor engine by modification of engine components. A three cylinder tractor engine has been selected for the study. Frame for mounting CNG cylinder (60 l water capacity) has been fabricated, assembled and installed in front of the tractor. The CNG kit is fitted with CNG cylinder. The reduction in compression ratio of tractor engine from 17:1 to 10.33:1 has been done by using 5.2 mm thick spacer and placed below the engine head. The fuel pump has been replace with spark

distributor and fitted/aligned in the timing gear mechanism of the tractor with modified flange. An inlet air manifold has been fabricated and carburettor has been suitably fitted to regulate the air-CNG mixture. All the arrangements with air cleaner have been made to connect carburettor and air cleaner. Further arrangements are in progress to operate the tractor engine with 100% CNG.

AGRO PRODUCE PROCESSING

Infrared pre-treatment system for pulse milling

Proper pre-treatment is required for loosening of complex biological bonds prior to milling of pulses. Conventional practices of pre-treatment used for pigeonpea are time and energy consuming, expensive and have some other quality and safety issues. Therefore, a controlled infrared radiation based pre-treatment system has been developed to reduce time of milling and cost by addressing safety and quality issues. The infrared (IR) treatment system consists of infrared heating module fastened beneath the mirror polish concave reflector to maintain the appropriate flux. The material conveying deck is driven by vibrating motor fixed at bottom of the deck. The exposure time of grains under infrared is controlled by controlling vibration of conveying deck via vibration motor. The power density can be maintained by adjusting the distance between grain layer and IR heating module. The system has an output capacity of 200 kg/h. The treatment parameters have been optimized for milling of pigeon pea pre-treated with IR system for maximum dehulling efficiency and dal recovery. The treatment has been given to the pre-scratched pigeon pea grains in double pass. This treatment yields dehulling efficiency of 97.20%, dal recovery of 78.0 % with 2.0% broken and 17.40 % mealy waste.

Natural ventilator based modular onion storage system

A roof top natural air driven ventilator based onion storage structure of 1 tonne capacity made of FPR material has been developed. A UV resistive polycarbonate sheet based roof with sufficient overhang is provided to the structure which protects the filled onion from rain and direct sunlight. During operation, ventilator takes the air inside the stored onions and pushes it out via through the outer peripheral blades. The exit air removes respiratory heat generated by the stored onions. Removal of air creates pressure gradient inside the storage structure. Due to this pressure difference, fresh air enters into the storage structure from the sides and bottom and fills the space of air exhausted by ventilator. This process continues till the ventilator keeps rotating. A UV resistive polyethylene film cover is provided to protect the stored onion from high humidity and rain water. To maintain the ventilated condition, sufficient space between the cover and outer surface of the storage structure has been ensured during covering of structure. The results of storage study indicated 18 % physiological weight loss, 5.5 % rotting and 0.2 % sprouting losses of stored onions.

De-bunching tool for medicinal root crops

The roots of medicinal crops like *safed musli and shatavari* are in the form of bunch with its apex end attached together. Separation of these roots is foremost operation in its post-harvest handling and processing. In existing practices, the roots are separated by manual cutting with a knife. However, considerable amount of useful part of roots gets lost due to cutting by straight knife. Further, the manual cutting with knife is tedious and risky. Therefore, a manually operated de-bunching tool has been developed. It consists of a platform and a cutting blade operated by handle provided with a hinge

and spring arrangement. The curved C-type cutting blade has been designed to minimize the loss of useful parts of roots. The tool has been tested for *safed musli* and the de-bunching capacity was found to be 10.30 kg/h, which was 5.10 kg/h for manual separation without knife and 7.50 kg/h using knife. The percentages of separated roots and material loss were recorded as 83.70% and 16.30%, respectively for de-bunching of *safed musli* roots using developed tool. Increased de-bunching capacity of 2.80 kg/h and reduced material loss of 3.96% were observed using de-bunching tool compared to manual knife cutting operation.

Technologies under development

Peeling machine for medicinal root crops

A peeling machine has been developed for medicinal root crops. The principle components of machine are peeling drum having its inside surface abrasive and the central shaft mounted with array of nylon brushes. The brush assembly rotates against the abrasive surface hence carrying out peeling of roots crops between bristles and the inner surface of drum by means of abrasion and shearing action. There is also provision of water spray for washing of roots before and during peeling of material. The developed machine has been tested for Safed musli roots. The peeling efficiency for *safed musli* was observed to be 92 % in double pass. Washing of roots takes place simultaneously with peeling to remove out the peeled off material. The capacity of machine for *safed musli* peeling is 15-20 kg/h. The machine has potential to mechanize peeling operation of medicinal root crops and to reduce drudgery, labour cost and time.

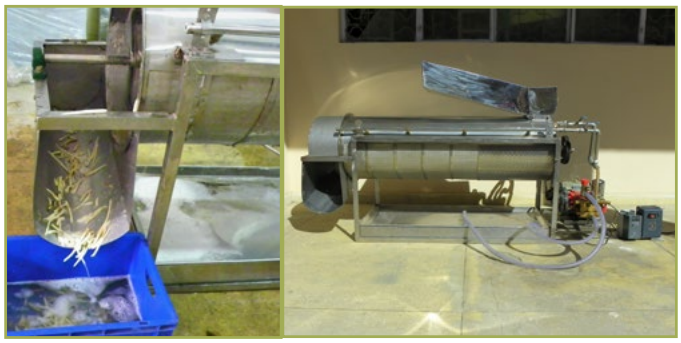
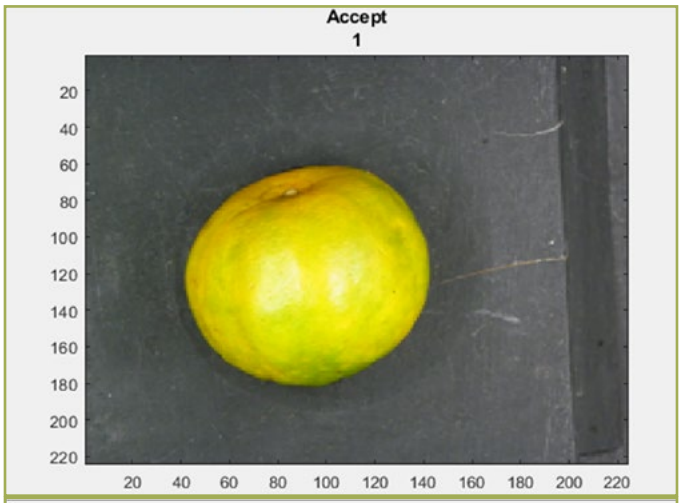
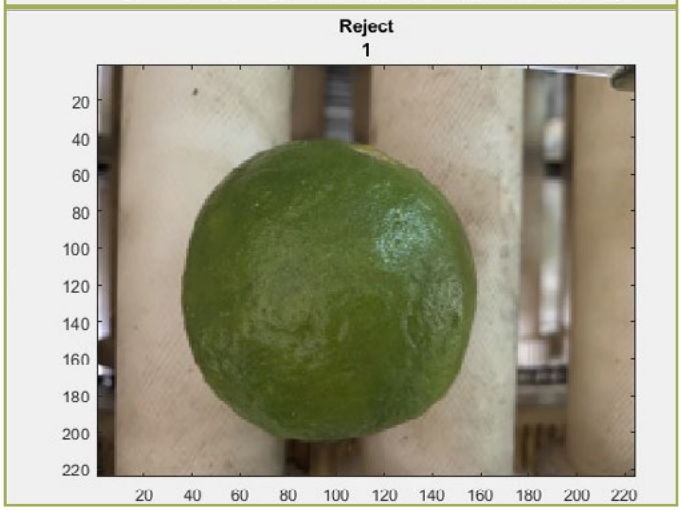


Image based automated packing line for horticultural fruits

Machine vision and image processing techniques have been found increasingly useful in the fruit industry, especially for applications in quality inspection and defect sorting applications. The machine under development aims to install





an image based spherical horticultural produce quality assessment mechanism and a touch-screen type interface for ease of operation of an automated fruit classification line. The mechanisms and structure of the machine has been completed along with weight based grading with the load cell with an overall error of ±1.0 g. Testing of deep learning model with more than 1000 images of oranges has been conducted. Deep learning algorithm for identification of oranges on the basis of colour was run using MATLAB. There was 100 per cent success in separation of green oranges from the yellow ones by GoogLeNet model in the MATLAB platform.

Production of plant by-products based solid nutrient culture media

Soybean by-product based hydrolysate was prepared for development of culture media. Milled okara powder and tofu whey (10 to 20% w/v) was mixed in sulphuric acid (0.25% to 0.50%) and pre-treated at 90°C and in autoclave conditions (120°C for 30 min). Pre-treated hydrolysate was filtered; its pH was adjusted and dried in a tray dryer. The growth efficiency of the microbe in the hydrolysate formulated medium was compared with the rich medium (de Man Rogosa Sharpe/MRS). The hydrolysate mixed with MRS culture in different ratios. The optical density at 600 nm (growth rate), dry weight and viable cell number of the formulated medium were observed at 24 to 48 hours cultivation. The MRS mixed with the hydrolysate in the ratio of 25:75 v/v gave the maximum specific growth rate, which was comparable to the specific media. The formulated media based hydrolysate have potential in reduction of production cost and is free from all animal derived ingradiients.

Encapsulation of flax seed oil and probiotics in chocolate millet bar

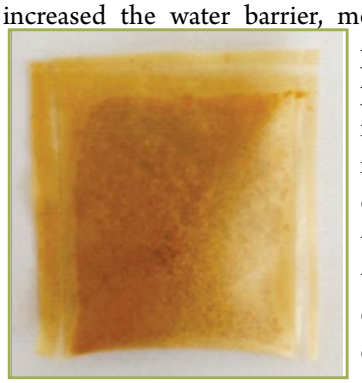
The study is aimed to boost the viability of probiotic bacteria strain acidophilus by encapsulation and spray-drying with a combination of gum arabic and soy protein isolate. Water-in-oil emulsion was prepared by sonication, containing 6% flaxseed oil dispersed in aqueous solutions including 20% total wall material. The emulsion was sonicated at 24 kHz for 120 s. The emulsion was then spray dried and nano-capsules were incorporated into the millet bar. The encapsulated microorganism cells maintained higher viability throughout the dried condition and subsequent storage for 3 months at 4°C. The sample containing flaxseed oil nano-encapsulated with gum arabic and soy protein wall material yielded the greatest probiotic bacterial count (Log CFU/mL) and the lowest peroxide value (mEq/kg). Moreover, this sample had the highest eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA) contents. Amaranth and jaggery bars were prepared and coated with chocolate containing encapsulated flax seed oil and probiotic mixture. Tests revealed that the omega 3 levels were high (11.97%) and the probiotics were viable for a period of 3 months.

Nano-encapsulated flax seed oil based eggless chocolate cake

The functional chocolate cakes enriched with omega-3 fatty acids using nano-encapsulated flaxseed oil has been developed. For nano-encapsulation a combination of gum arabic and soy protein isolate were used as wall materials whereas lecithin was applied as the emulsifier for the formation of nano-sized complexes with flaxseed oil that was converted to a powder of nanoparticles by spray drying. They were characterized for morphology, size and density of particles, bulk density, free oil content and encapsulation efficiency, wettability and dispersibility in water. The optimized particles were then incorporated into chocolate cake formulation to investigate their effects on its quality characteristics. Results have showed that the omega-3 (% of fat content) levels of nano-encapsulated flaxseed oil was higher (9.91) as compared to flax seed powder (7.84). Sensory analysis of cakes reported an acceptability of 7.5 on the 9 point Hedonic scale. The storage quality of cake prepared using nano-encapsulated flaxseed oil was also higher as compared to that of flax seed powder based cake showing that nano-encapsulation is a successful method for improving the omega 3 fatty acids into the diet with a longer shelf-life.

Soybean based composite edible film

A soybean based composite edible film has been developed and its applications in food products has been explored. Soybean aqueous extract was used as the main ingredient for the development of an edible film with different additives which increased the water barrier, mechanical and anti-bacterial properties. The water barrier property of the film ranged from 5.3 to 9.2 x 10^{-10} g/ms Pa. The tensile strength of the film varied from 5.1 to 8.2 MPa, which is higher than similar composite edible films. The elongation of the film ranged from 70 to 88%. The edible film was used as a packaging material for the instant masalas of ready to cook noodles. Sensory evaluation of the film showed overall acceptability score of 7.80 out of 10. The film was also tested as a cheese slice separator in cheese packaging. The application of edible film to the cheese slice reflects its suitability for separating ingredients in sandwiches and burgers and to wrap the similar food products.



Quinoa Pearler

A pearler has been developed for processing of quinoa. The power operated continuous feed machine consists of feed hopper, pearling chamber, pearled grain outlet and husk aspirator. The pearling chamber consists of a cylindrical enclosure, which houses the main shaft, half of that is overlaid with pegs arranged longitudinally in four rows to give impact force/ pounding action on the quinoa grains and the rest is coated with emery to provide polishing effect. The pearled grains with husk fall onto the deflecting plate where the husk is removed by the husk aspirator. It is then safely collected through the cyclone separator. The pearled grain is collected through the pearled grain outlet located at the opposite side. The optimum airflow and bran removal is obtained by adjusting the air inlet. Unlike millet grains, quinoa grains have flat surface like tiny tablets. The pericarp is removed by combined impact and abrasion force. The pearled grains with husk are then passed through the deflector plate. Air aspirator then separates the husk through suction. The pearled quinoa is collected through the pearled grain outlet and husk is collected through the husk outlet on the other side. The developed unit operated by electric motor (1.49 kW, single phase) has a capacity of 35-40 kh/h with the recovery of 91%. The machine cost is approximately ₹ 70,000/- with motor.

Pilot plant for dietary fibre extraction

Dietary fibre is the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human body. Agricultural byproducts like soybean hull and chickpea hull are some good sources of these dietary fibres. A pilot plant for extraction of dietary fibre from soybean and chickpea hull has been developed. Dietary fibre is extracted by the method of acid-alkali hydrolysis. A digestion cum washing unit is developed to carry out the unit operations such as acid digestion, alkali digestion with intermediate washing of the sample. The unit is equipped with constant temperature control required for the dietary fibre extraction process. The pilot plant unit is capable of extracting dietary fibre from both soybean hull as well as chickpea hull with a capacity of 10 kg per batch and extraction efficiency of 80%. The biochemical analysis shows the total dietary fibre content of extracted dietary fibre from soybean hull and chickpea hull as 80% and 76%, respectively. The total cost for the establishment of dietary fibre extraction pilot plant is worked out as ₹ 2,96,400/- and the Cost of production of one kg of dietary fibre is ₹ 194.

Technology under Development

Power operated grader for multiplier onion

Grading of agricultural produce adds value to the product and economic gain to the farmer while marketing. A power operated grader for multiplier onion has been developed. The grader consists of feeding inlet, perforated grading drums, feed outlets, variable speed drive and frame etc. The grading assembly is provided with three perforated metal drums rotating at desired speed by variable speed drive. The size of the drum hole is 25, 40 & 55 mm respectively, according to size of multiplier onion. The multiplier onion fed into the feed inlet passes to the rotating grading drums and the graded onion get collected at the respective outlets provided below the grading drums. The capacity of grader is 580 kg/h and is operated by 0.75 kW single phase electric motor.

SUCCESS STORIES

Fruit-cum-vegetable grader

Grading of fruits and vegetables is one of the most important post harvest operation. It adds value to the product and gives better economic return to the producer. Manual grading is an expensive and time consuming process due to non-availability of labours during peak season. Shri Madan Mohan Patidar, proprietor of M/s Sanwaria Herbal and Musli Farm, Misrod, Bhopal produces about 250 tonne of onion from 15 acres of land. Manually, 500 man-days will be required for grading 250 tonne of onion (@ 500 kg/ day/ person) at total labour cost of ₹ 2.0 lakhs (₹ 400/man-days). Under the Mera Gaon Mera Gaurav (MGMG) programme, fruit-cum-vegetable grader of 2 t/h capacity developed by ICAR-CIAE, Bhopal was demonstrated to Shri Patidar for grading of onion, sweet lemon and guava etc. The grader was installed at M/s Sanwaria Herbal and Musli Farm, Misrod, and run for grading of 250 tonne of onions in the farm. The grader could grade 250 tonne of onion in 16 days considering 8 h of operation per day. This helped in saving time, labour and cost of grading. The cost of operation of the grader was ₹ 300/t and total cost was ₹ 75000/- for grading of 250 tonne of onion. Hence, Shri Patidar saved ₹ 1,25,000/- (63%) by using the grader. He was highly satisfied and impressed with the performance of grader. The cost of onion without grading was ₹ 4000/t. Moreover, the price obtained for graded onion was ₹ 7000/t. Shri Patidar gained a net profit of ₹ 7,50,000/- from 250 tonne of graded onion. The graded uniform size onions fetched more prices in the market and earned benefit. Thus, the overall benefit from marketing of graded onion using the ICAR-CIAE Fruit-cum-Vegetable Grader for the farmer was ₹ 7,50,000/-.

Establishment of Minimal processing of banana central core

After completing ITI in Air conditioning, Shri Arumugam went to Dubai to make his livelihood. After serving for a short time, he returned to India with an aim to make own livelihood and provide employment to others in his very remote village in Tutucorin district. He started his career by supplying the minimally processed banana central core to nearby hotels at Toothukudi, Tamil Nadu. Although there was a huge demand for the product, he could not cater to the demand as minimally processing by hand was very tedious. He underwent a training at ICAR CIAE Regional Centre Coimbatore and enrolled as Entrepreneur under BPD services of CIAE. A couple of visits by the scientists from CIAE RC, Coimbatore also helped him to mcechanize the processing of banana central core. Now he has mechanised the minimally processing activities of banana central core. He supplies his product to Madurai, Chennai, Coimbatore, Trivandrum, Bangalore etc. Everyday he is processing about 800- 1000 kg of banana central core and making a net profit of about ₹ 50-60 thousand per month apart from giving employment to 10-15 rural women/ youths.

Establishment of Juice concentration from garcinia

Mr Rathu Belliappa of Hakathur village, Madikeri, Karnataka was producing juice concentrate from Garcinia combogia by traditional method at his remote village. He has completed his XII and completed his Diploma in Horticulture. Traditional method for juice concentration is very unhygienic, labourious and consumed a lot of fuel. He adopted the post harvest

mechanization package for juice concentration developed by the CIAE Regional centre, Coimbatore. He enrolled himself as an entrepreneur under BPD services of CIAE RC. The package of equipment was established at the remote village, which is a catchment area for garcinia combogia. Now he has been able to produce the juice concentrate and sell to the local market for last two seasons. He made an initial investment of about 4 lakh rupees for equipment and shed. The part loan was obtained from the bank. During the crop season he is able to produce about 10 l of juice per day, and sold at ₹ 1000 per litre. He is able to make a profit of about ₹ 30,000 per month during the cropping season. Scientists of regional centre, Coimbatore have helped in establishment of the unit and also linked to ICAR IIHR station at Chetalli and Forestery college, Ponnampet under UAS Shimoga, Karnataka for marketing of the end product.

Two row tractor drawn mechanical planter for sugarcane bud chip settlings raised in portrays

ICAR-CIAE in collaboration iwth ICAR-SBI has developed a two row tractor drawn mechanical planter for sugarcane bud chip settlings raised in portrays. The planter has been licensed to three manufacturers for commercial manufacturing. So far the licensed manufacturers have sold about 40 units across the country. Government of Tamil Nadu has included this planter for promotion under their Agricultural Mechanizaiton programme through custom hiring centres.

INIATIVES TO TACKLE THE COVID-19 PANDEMIC

Sensor based touch-free hand wash system (Automatic system)

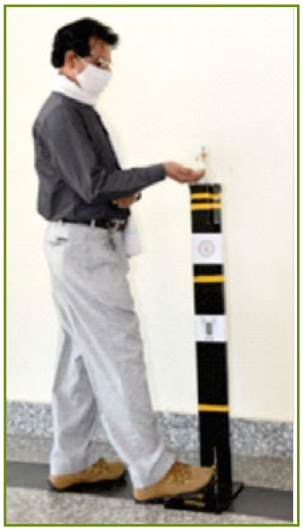
The touch-free hand wash system consists of water tank (100 l), Infrared sensor, water pump, DC speed regulator, Battery, relay board, touch-free sanitizer dispensing unit and water disposing plastic hose. When the hand reaches near the infrared sensor it produces output pulse to relay, which triggers (act as a switch) the pump to turned it on. Pump in turn ensures the flow of liquid soap/water from tank to liquid soap / water outlet. A single relay triggers up to 5 ml of hand wash from touch-free dispenser unit and 100 ml of water from water tank. The discharge rate of liquid soap and water could be regulated based on necessity by using DC regulator switch. The unit has a capacity of 120 persons or hand wash/h. The system can be powered by AC current and provision is also given to use in DC battery for portable use. It can also be charged by battery and operated by solar panel. Developed system useful for regular hand washing to prevent spread of COVID-19 pandemic in agriculture market, hospitals, offices, malls, crowded market, railway station, industries. The technology has been licensed to Ishaan enterprises, New Delhi and they have sold 28 units.

Sensor based portable touch-free hand sanitizer unit (Automatic system)

The touch-free soap hand sanitizer is a standalone wall mounted or placed on the table to dispense the sanitizer without touching the unit. In this unit, infrared sensor is located near the outlet in order to detect the user hands. As soon as the hand is detected below the santizer tank, relay (act as switch) trigger the AC/DC pump to operate and up to 5 ml of sanitizer will be dispense at delivery end. It has a capacity of sanitizing 180 hands in an hour. The provision is given to use 12 VDC water pump with 12V DC Battery. It is suitable for regular hand washing to prevent spread of COVID-19 pandemic in agriculture market, hospitals, offices, malls, crowded market, railway station, industries. The technology has been licensed to Ishaan enterprises, New Delhi and they have sold 680 units.

Touch-free pedal operated sanitizer dispensing unit

The touch-free pedal operated sanitizer dispensing unit has been developed for hand sanitization without touching any surface with hand. The unit is very simple in construction and operation, and is designed in such a way that required quantity of sanitizer or liquid soap can be dispensed by pressing the foot pedal. Total height of the unit is 1100 mm. It is portable and can be placed at entrance of lobbies, corridors, farms, meeting rooms, outside the shops etc. The cost of this unit is about ₹ 1000/. This developed unit is being used for hand sanitization at different premises of the institute.



Apart from the technological interventions, the institute has issued many advisories to farmers through mass media to cope up with the prevailing COVID-19 situation.

AICRP ON FARM IMPLEMENTS AND MACHINERY

Major activities of the scheme are to develop agro-climatic, zone specific farm impements and machinery, protocol, multi-locational trials of technology, prototype production, technology demonstration and aid in skill development in the area of farn mechanization. The project operates pan India with 25 centers. Some of the recent R and D developments by the scheme are

Tractor operated seeder for mat type paddy nursery

A tractor operated seeder for mat type paddy nursery which lays polythene sheet on the field, prepares 1m width soil bed with simultaneous uniform seed placement has been developed by PAU, Ludhiana center. For placing soil over the polythene sheet, two soil cutting and conveying units are attached on both sides of the machine. A screw conveyor is placed at the rear end of soil conveyors for conveying the soil over a sieving system, which is provided for removal of soil clods/foreign matter. The soil metering unit is attached below the sieving system which consists of a fluted roller.

A seed metering box is fitted at the rear side of the machine to place seed over the soil mat. The power to rotating drives of the machine is provided from tractor PTO. The selected parameters for field evaluation of the machine were 80 mm depth and 398 sieve oscillations/min. The overall adequate seed spread is found to be 92.0% and overall adequate soil mat thickness of 89.0% is obtained at a forward speed of 1.7 km/h. The fuel consumption rate of the machine is 4.45-4.85 l/h. The effective field capacity of the machine for nursery sowing is 0.11 ha/h. Damage to plastic sheet during machine operation is negligible (0.19%). The performance of the machine is encouraging in the field however manual correction of seed is required as after in sowing.

Tractor operated turbo bund former for mulched fields

A tractor operated bund former for mulched fields has been developed and evaluated by PAU, Ludhiana, Punjab. It performs three operations viz., straw removing (up to 1.25 m width) followed by soil pulverization and trapezoidal shaped soil bund forming simultaneously in one pass. It consists of mulcher, rotavator and bund former unit operating simultaneously. Mulcher has flat flail type blades (without serrations) which act on standing stubble with impact action to pick up the straw and throw out with centrifugal force. The cut stubble and loose straw is thrown out of the chute opening which falls ahead of the bund plates on the ground. It removes the straw from front of 1.25 m wide rotavator. Second working

unit rotavator having C type blades (total 30 blades) arranged in pairs on each side of the flange alternately in staggered manner. Bund forming unit is placed at rear, consists of main frame, holding plates and a pair of rectangular plates on both sides. The effective field capacity of developed tractor operated bund former is found to be 1.17 ha/h at forward speed of 1.5 km/h. The operational cost of machine is ₹ 1922/ha while cost of forming bund per meter length is ₹ 1.45/m. There is 78.0 % saving in labour over the conventional bund forming method.

Tractor drawn pneumatic planter for planting chilli's on ridges

Tractor drawn pneumatic planter has been developed at PJTSAU, Hyderabad for sowing chilli seeds on the ridges so as to avoid nursery raising which also reduces the human drudgery and cost of planting. The seed metering mechanism consists of two nylon discs (one is stationary and another

is rotating) each with thickness of 30 mm and 150 mm in diameter. The seed sucks into the seed metering chamber by means of an aspirator while the rotating discs drop the seed into the furrow due to cutoff. The seed metering mechanism is driven by the drive wheel by means of chain and sprocket. The seed hopper is located at the top of the seed metering mechanism. An inverted T-type furrow opener is used in place of boot type furrow opener to open up a narrow furrow of 20-30 mm depth. The field capacity of the planter is 0.26 ha/h at a seed rate of 1.3-1.5 kg/ha. The field efficiency, missing index and germination percentage of planter are 76.5%, 3%, and 82%, respectively.

Tractor operated strip-till seeder

A tractor operated mounted type strip-till seeder for direct sowing of wheat in combine harvested paddy field has been developed at PAU Ludhiana center. The machine consists of a straw managing rotor having nine flanges each with 6 blades for tilling a strip of furrow, seed & fertilizer box, disc type furrow openers and a furrow covering roller. The rotor is powered by tractor PTO through a gear box. Seeding unit consist of a seed & fertilizer box having fluted roller type seed metering

unit and paired disc type furrow openers for each row. Seed and fertilizer tubes are opened in the paired discs. Seed and fertilizer is placed in a strip of field tilled by rotor blades. A furrow covering roller is fitted behind the furrow opener discs to cover the open furrows. The machine can incorporate a part of straw into the soil while remaining part of straw is left on the surface as residue mulch thus preventing burning of paddy straw. The effective field capacity of the strip-till seeder is 0.30 ha/h and fuel consumption is 6.0 l/h.

Rotary till-drill with disc type furrow openers for direct sowing of wheat in combine harvested paddy field

The mechanical harvesting of rice and wheat is done by combine harvesters with the introduction of mechanization into Indian agriculture. Due to small period of 2-3 weeks between rice harvest and wheat sowing, the burning of rice straw has become a common practice to clear the fields for sowing next crop. However, *in situ* incorporation of paddy straw has positive effect on soil organic carbon, infiltration rate, water holding capacity and also enhances soil microbial

biomass enzyme activity. Incorporation of paddy straw with traditional implements like rotavator, disc harrow, cultivator etc. takes 6-8 operations. Therefore, a rotary till-drill with disc type furrow openers has been developed at PAU, Ludhiana for direct sowing of wheat in combine harvested paddy field. The machine consists of a disc type straw managing rotor for incorporation of paddy straw and a seeding unit for sowing wheat directly after combine harvesting. The straw managing rotor with 12 toothed discs fitted at an angle of 25.34 degree with vertical plane. These rotary discs cut and mix the paddy residue into soil. Power to the straw managing rotor is provided from tractor PTO through gear box. Seeding unit consists of a seed & fertilizer box, seed tubes, disc type furrow openers and furrow covering roller. The furrow opener discs are powered by a ground wheel. The field capacity and fuel consumption of

the machine is 0.26-0.30 ha/h and 7.0-7.25 l/h, respectively. Prototype feasibility testing of the machine has also been carried out at 5 locations covering an area of 19.6 ha.

Power operated 2- row rice transplanter

A DC motor operated 2-row pull type rice transplanter has been developed by BAU, Ranchi for transplanting of root washed type seedlings using four bar linkage mechanism. It consist of picking mechanism, transplanting mechanism, power transmission system, float assembly, seedling tray, handle and ground wheel. Two D.C. motors powered by a set of two dry lead acid batteries (12 V 7Ah) are used to operate both seedling picking as well as transplanting mechanism and ground wheel for easy movement of the machine in the puddled field. The effective field capacity of transplanter is found to be 0.03 ha/h at an average operating speed of 0.93 km/h with average field efficiency of about 58%. Average visible damage, floating hills and missing hills is 9, 14 and 12 respectively. Total estimated cost of the developed battery operated rice transplanter is ₹ 15,000/-. The machine can be

operated with less fatigue by an operator while the movement of the transplanting finger can be controlled with the help of switch provided on the handle.

Multi-purpose tool carrier for homestead agriculture

Homestead cultivation, a prominent system in Kerala is the cultivation around the immediate surroundings of the house. An affordable and versatile powered multipurpose tool carrier (MPTC) can improve the efficiency of human power furthermore it avoid the requirement of different implements and power sources for different operations. Hence, a multipurpose implement system powered by back-pack engine of a brush cutter has been developed by the KAU Tavanur centre of AICRP on FIM. Apart from the use for a brush cutter,

the developed system can be used for 5 different operations viz. wet land paddy weeding, row crop vegetable weeding, shallow tillage, digging small diameter pits and basin clearing for coconut tree. Paddy weeding attachment has also been developed for the multipurpose tool carrier which is powered by the 1.5 kW brush cutter engine. It has been found that, the earth auger has a fuel consumption of 1.7 l/h for digging pits in the soil with moisture content in the range of 7-10%. The cost of operation of wet land weeder is ₹ 2300/- ha while the cost of operation of earth auger is ₹ 50/100 pits.

Tractor operated sensor based inter and intra row weeder for wider row crops

Manual weeding in wide spaced crops is arduous and consumes high labour especially in cotton, sugarcane and vegetable crops. Inefficient management of weeds can reduce the production by 15-20%. Therefore, a tractor operated sensor based inter cum intra row weeder has been developed at IIT, Kharagpur. The system consists of 3 rotary hoes working independently for inter-row weeding and 3 independent rotary hoes for intra-row weeding. The intra-row weeding is based on sensing to discriminate main crop and weeds while weeding. The rotary hoe for intra-row weeding works on the principle of ultrasonic sensing which provides information of presence of main crop. This information is utilized by the automatic embedded control system to control the rotary hoe movement within the intra-row region so as to effect weeding. The developed machine has been tested at IIT Kharagur in

chili and tomato crops. The effective field capacity and field efficiency of sensor based inter and intra row weeder is 0.43 ha/h and 75% for wider row crop. The weeding efficiency of the machine is 90% in chili and 89% in tomato. The labour cost in weeding is reduced which ultimately reduces total cost of cultivation by 10-15%. Timely precise weeding in rows and between plants in chili crops increases yield and also saves soil nutrients consumed by unwanted weeds.

Tractor drawn groundnut picker combine

Harvesting of groundnut is very tedious, time consuming and labour intensive task. Hence, tractor operated picker combine harvester has been developed at TNAU, Coimbatore to reduce the labour requirement and drudgery in digging and collection of harvested groundnut. The combine can pick groundnut vines from dried windrows and remove the pods by combing action using hanging fingers fixed on the cylinders. It consists of crop pickup realer, threshing cylinder, crop transferring plates, chaff beaters, oscillating cleaning sieve, chaffer, blower, power transmission system, hydraulic motor, three point hitch and draw bar. A gear box of 3:1 ratio is used for the picker combine and the power transmission system. Two separate drives are taken from the gear box to power pickup realer and

threshing system. The threshing and conveying efficiency of the picker combine is found to be 99% whereas the maximum stripping efficiency is 95% at 4 days after harvesting. It has been observed that, the entire plant mass is picked up by the header and conveyed into the threshing cylinder without any damage to kernals and pods.

Tractor operated grass seed harvester

The grass seed harvesting machine has been developed by ICAR-IGFRI, Jhansi and ICAR-CIAE, Bhopal in collaboration. The machine has been designed on the basis of relevant morphological properties of different grasses

needed for efficient grass seed harvesting. It consists of the spiral bruising element on a rotary cylinder head which act as a grass seed collection mechanism. The machine has been tested in Dinanath Grass field at ICAR-IGFRI, Jhansi and its seed collection capacity found to be 5.5-6.0 kg/h, and the time required to fill the seed collection chamber is 40-45 min. The effective field capacity of the grass seed harvester is 0.1 ha/h at an average operating speed of 3.24 km/h for Dinanath grass.

Tractor operated dust separation system for wheat straw combine

Wheat straw harvested by commercial straw combines contain undesirable materials like soil and other foreign material which may lower feed intake, disrupt digestion and may have adverse impact on animal health. Farmers usually go for an extra cleaning operation to separate dirt from the bruised straw obtained from commercial wheat straw combine. The dust separation system for wheat straw combine developed by PAU, Ludhiana aims to reduce the soil entrainment into the bruising unit and eventually in the bruised straw. A perforated

sheet is provided at a distance of 130 mm behind the cutter bar and under the straw conveying unit to remove the soil. A clod trapper hinged vertically is provided at the point where cut straw enters the bruising unit to remove soil clods come along with the straw. The bruising drum consists of serrated tooth M type blades (204 blades) for bruising the wheat straw. A counter cutter is provided adjacent to the concave and below the bruising drum for effective size reduction of straw. A cleaning sieve is placed below it. A centrifugal blower is used for blowing the bruised wheat straw. The bruised straw is blown into the wire meshed trailer, hooked behind the machine, by means of an adjustable duct. The straw size of bruised wheat straw obtained in the range of 16.85 to 17.97 mm and 18.20 to 18.29 mm at forward speed of 2.5 and 2 km/h respectively. The percent ash content, percent acid insoluble ash and percent dust concentration in developed wheat straw combine are 9.0%, 5.90% and 6.78%, respectively at forward speed of 2.5 km/h.

AICRP ON HARNESSING ANIMAL ENERGY SYSTEMS

The scheme is devoted to animal based agricultural mechanization through the development of machines, gadgets, tools to harness animal energy with or without aid of conventional energy sources for different unit operations. The project through its nine centers developes equipment of appropriate size that can be used with different kinds of location specific animals and their breeds.

Bullock drawn equipment for direct seeded rice (DSR)

A bullock drawn 3-row zero till for sowing of paddy with aim to save the water and to reduce the cost of cultivation under direct seeded rice (DSR) has been tested by UAS Raichur center in Hosur village, Raichur district. Row spacing and seed rate were kept at 225 mm and 25 kg/ha, respectively. Depth of sowing was maintained at 30 mm. Post emergent herbicide – Bispyribac sodium 10% SC @ 100 ml in 200 litres of water was used for weed control. Effective field capacity of till drill is 0.095 ha/h with field efficiency of 68%. Direct seeded rice (DSR) resulted in water saving of 30 % as compared to transplanted rice. The DSR crop yield is 20.0% more as compared to transplanted rice.

Animal drawn seed cum manure drill for organic farming

Animal drawn seed cum manure drill developed by MPUAT, Udaipur center consists of a rectangular shaped main frame, screw jacks to vary the height of frame from the ground, two pneumatic wheels and a hitch beam. Furrow openers are clamped on the frame using quick fixing type 'U' clamps. Two MS sheet boxes with variable orifice metering mechanism having diamond shaped orifices are provided for seed and manure. The quantity of seed and manure can be regulated by the sliding MS sheets with diamond shape orifice is provided just below the base of seed box. Pneumatic transport wheels drive the agitator shaft provided in seed and manure boxes to avoid the bridging of material over the orifice. The developed seed cum manure drill has been calibrated and the maximum manure application rate obtained is 1000kg/ha. Recommended rate of manure application is 3000 to 5000 kg/ha

OUAT animal drawn sorghum thresher cum cleaner

OUAT sorghum thresher cum cleaner has been developed for simultaneous threshing as well as cleaning of harvested and dried sorghum crop. It is operated by a pair of bullocks in rotary mode. It consists of a hopper, threshing cylinder and a concave. The threshing cylinder shaft gets drive from the bullock operated rotary system by belt and pulley system, while the blower and aspirator is mounted on the cylinder shaft. The

sieves are attached to the threshing cylinder shaft by a cross belt and pulley drive and operated by an eccentric mechanism. The thresher cum cleaner has an average output capacity of 122.7 kg/h at feed rate of 166.5 kg/h. The threshing and cleaning efficiency of thresher are 95.2% and 94.5%, respectively. The rotational speed of main shaft and blower shaft were 562 rpm and 598 rpm, respectively while the speed of bullocks was 1.86 km/h. Draft and power requirement of the sorghum thresher cum cleaner is 464 N and 0.24 kW respectively. The overall fatigue score of bullocks is 14 after 1 h of continuous operation indicating that the equipment could be operated comfortably by the animals. Cost of operation by sorghum thresher cum cleaner is ₹ 0.25/kg as compared to ₹ 3.85/kg by conventional method.

Improved animal housing structure for draught and milch animals

UAS, Raichur has developed an improved animal housing structure equipped with the renewable energy gadgets, water fogging system with automatic time controlled switch and protection mesh. The animal standing floor surface area (21.0 x 8.0 m) has been improved by providing 3.0% slope on ground surface with a provision to collect urine through channel. The feeding manger of size 9.0 x 1.10 x 0.60 m is provided inside the animal housing structure. The surrounding of the animal housing structure is covered with metallic wire mesh to prevent the entry of mosquito/insects. The lighting in the structure is provided by solar lighting system. Multidirectional fogger assembly of 5 units at a distance of 0.9 m apart created cooled atmosphere inside the animal housing structure during summer days. Thirty minutes off and one minute on position of fogger assembly improved the cooling effect. The inside air temperature of animal housing structure was less by 5-8^{0}C compared to outside temperature at relative humidity of 61.3% ensuring comfortable environment for animals in improved structure.

Total Mixed Ration (TMR) mixing machine for draught and milch animals

Total mix ration machine developed by MPUAT, Udaipur consists of a large conical hopper with a single vertical tapered spiral type flight centered in the hopper. As the spiral type flight rotates, the feed mixture in the hopper is churned and mixed uniformly. The tapered flight moves feed toward the top of the mixer, and it bubbles to the top toward the sides and back down to the flight. The feed eventually moves towards the discharge door provided at the bottom of the hopper and is unloaded when the door is opened. For preparing TMR mixture 60% wheat straw and 40% concentrates were taken. The concentrate comprised of mineral mixture, de-oiled rice bran, wheat/barley, gram churi, groundnut cake and salt. All these ingredients were fed to the mixture and mixture was operated for 10, 15 and 20 minutes. Uniformity of the mix has been determined using sieving technique. TMR performance has been evaluated using four sieves 9, 11, 13 and 24 mesh to separate ingredients into five fractions based on proportions. The capacity of the TMR machine is 25 kg. Mixing time of 10 minutes is found to be the best for obtaining uniform TMR mixture. It is clear from the analysis that, the quantity of ingredients in TMR mixture varied from 1.5 to 4.46% and variation in nutritive value of TMR mixture within the batch is less than 6% which indicates that the ingredients are mixed uniformly.

Animal drawn sub-surface manure applicator

Animal drawn subsurface manure applicator developed by GBPUAT, Pantnagar consists of screw type of metering mechanism. The theoretical manure rate, actual manure rate and efficiency of screw conveyer are 11.62 kg/h, 7.0 kg/h and 60.32%, respectively. The machine can deliver 0.14 kg of organic manure per meter length as per agronomical recommendations of 10 t/ha application rate of manure. The organic manure can be applied at the depth of 50-200 mm to minimize nitrogen emission as per requirement.

AICRP ON ENERGY IN AGRICULTURE AND AGRO-BASED INDUSTRIES

The mandate of the All India Coordinated Research Project on Energy in Agriculture & Agro-based Industries is development of technologies and processes for enhanced use efficiency of renewable and non-renewable energy sources in production agriculture and agro-processing. The objective of the Project is to develop and demonstrate renewable energy technologies and practices for enhancing utilization efficiency of conventional energy based systems and augmenting use of renewable energy in agricultural sector. The AICRP on EAAI implemented its program through approved sixteen cooperating centers of the Project.

Bio-methanation system for food processing industry

Food processing industry waste is potential substrate for bio methanation. The TNAU, Coimbatore centre selected four processing industries generating grape waste, vegetable and fruit wastes, tapioca, banana, potato and gluten waste to study bio methanation process. Two Anaerobic Fixed Film Packed Bed Reactors (AFFPBR) (20 l) with 0.2 and 0.3 D/H ratio were developed. These wastes were mixed with cow dung at various proportions. Grape waste was digested using substrate at the proportion of 100:0 and could generate 5 l/kg and cow dung could generate up to 15.73 l/kg of biogas. The biogas production using tapioca, banana, potato waste and mixed waste with cow dung measured as 16.2 (50:50), 27.3 (75:25), 22.5 (75:25) and 34.5 (75:25) l/ kg respectively, whereas gluten waste resulted a maximum biogas of 25.9 (75:25) l/ kg with a retention time of 47 days. Among the developed reactors, AFFPBR (0.3 D/H) found to be efficient to treat grape industry wastewater with biogas yield of 5 l/ kg (53.9% CH_4) with 78.4, 74.24 and 61.38 % TS, BOD and COD destruction efficiency in 12 h HRT.

Small capacity solar dryers for Amla (Indian Gooseberry)

The PAU, Ludhiana centre designed and developed a forced circulation solar dryer of 100 kg *Amla* (*Phyllanthus emblica*) loading capacity. It has solar air heater of evacuated tube type of aperture area 1.50 m^2 polyhouse of floor area 9 m^2. There were tray racks inside the polyhouse for loading the drying product. The dryer was installed at the village forest committee of Habit Pindi, Pathankot, Dunera, Nungal, Kakrui and at the premises of M/s Shiv Shakti Self Group, village Harra Teeka. The farmers have dried amla (*Phyllanthus emblica*), bahera (*Terminalia bellirica*), jamun (*Syzygium cumini*), etc. The farmers are quite satisfied with the performance of the dryer.

Lignocellulolytic enzyme production system (500 l capacity)

Lignocellulolytic enzymes plays important role in utilization of biomass for bio fuel generation. The PAU, Ludhiana centre designed, fabricated a field fermentor of 500 l capacity and installed at demonstration area of the Department of Renewable Energy Engineering. The various trials for production of lignocellulolytic and silicolytic enzymes were conducted in the field fermentor using various fungal and bacterial cultures. Partially purified enzyme extract from biodigested slurry using *P.chrysosporium* was compared with all the available commercial lignocellulases from different fungal sources, which was at par with commercial enzymes. More quantity of lignocellulolytic enzymes

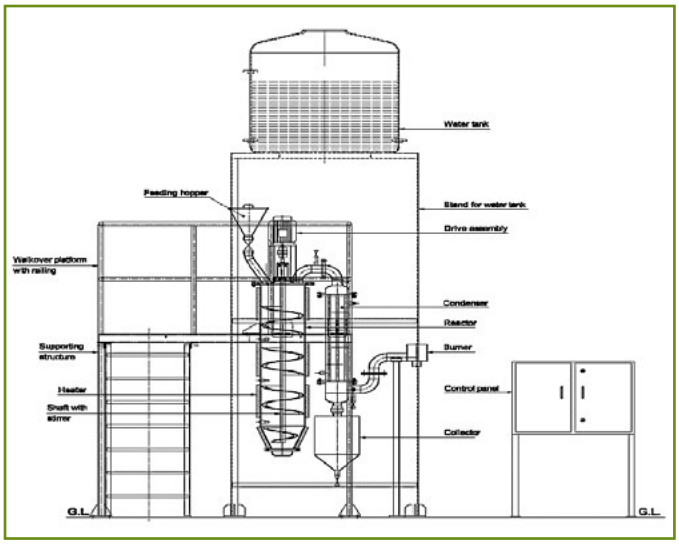
were produced using BDS as compared to the standard medium, which saves about ₹ 5800-13000/batch of 200 l. The crude enzymes can also be used to increase paddy straw digestibility and biogas production which produced 257.97 l biogas/kg paddy straw as compared to 219 l of control indicating 17.3% increase.

Solar PV module based cold storage system

The SPRERI, VV Nagar centre installed an experimental set-up which includes cold storage room, vapor compression machine (VCM, 2 TR), 10 kWp PV panel. The cold room has volume of 29 m^3 with 25 mm of insulation. Experiments were conducted without load for on-grid and off-grid. With grid, minimum temperature can reach up to -10°C and with solar PV module up to -5°C during the day time in December month. It was found that VCM can operate at radiation as low as 300 W/m^2.

Production of activated carbon from agro-industrial wastes

The up-scaled reactor of 5 kg capacity was designed and fabricated at SPRERI VV Nagar centre. Production of activated carbon was done by chemical activation method because chemical activation was found more economical and effective than the physical activation. Experiments were carried out with 250 g char of groundnut shell (GNS), sawdust (SD), and cotton stalk (CS) separately, using $ZnCl_2$, H_3PO_4 and KOH as an activating agent having (1:1 impregnation ratio) at 550°C temperature and 100 ml/min of nitrogen flow. The yield (wt.%) observed is in the range of 85-90 % for all the selected feed-stalks. Methylene blue number (MB_n) observed for the



samples are GNS_$ZnCl_2$ (198.8 mg/g), GNS_H_3PO_4 (195.0 mg/g), GNS_KOH (193.4 mg/g), SD_$ZnCl_2$ (196.2 mg/g) and CS_ $ZnCl_2$ (197.8 mg/g).

Jacketed pressure cooker retrofitted with evacuated tube collector

Solar cookers are being used for years now, However, to enhance the efficiency and versatility of cooking a 5 litre capacity jacketed pressure cooker was designed, fabricated and retrofitted with the solar ETC heap pipe system at SPRERI VV Nagar. Stagnation test was conducted with no water inside the cooker and the maximum temperature was observed as 144°C. Water boiling test was conducted with 3.0 l water and allowed to get heated up to 95°C, before being replaced by a fresh load. This system is 2 times efficient than system with jacketed SS pot with cover. The first lot took 1 h and 40 min due to pre-heating of circulating oil. Later the water was getting heated to 95°C in 18 to 22 min. Overall system efficiency is found to be 19.0% for water boiling.

AICRP ON ERGONOMICS AND SAFETY IN AGRICULTURE

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

Ergonomic interventions in semi-automatic vegetable transplanter

The present design of semi-automatic vegetable transplanters requires ergonomic modifications to make it comfortable for workers. Two types of semi-automatic vegetable transplanters have been ergonomically evaluated by TNAU center. Based on the evaluation, modifications have been done in the finger type vegetable transplanter. Work station is designed considering the anthropometric data and reach envelope of agricultural workers of Tamilnadu. The transplanter is provided with a comfortable seat, picking and placing of seedlings within the primary working zone of the operator. Seedlings tray is made as sliding unit so that the operator can have easy access to the seedlings. Trials are conducted with chilli seedlings planted at spacing of 0.45 m and forward speed of 1.3 km/h. The rate of picking and dropping has been found to be 45 to 50 seedlings per minute. The easier access to the seedlings has reduced the time of picking and release of the seedlings, however, continuous working induces faster fatigue to the worker.

Self-propelled adjustable platform for working at different heights

Pruning and harvesting of crops grown inside a greenhouse is done at overhead height. The existing practices results in greater muscle load, increased levels of discomfort, difficulty in moving the system forward and backward, reduced performance due to restrictions on posture and no height adjustment resulting in injuries. ICAR-IARI center of AICRP on ESA has developed a self-propelled adjustable platform suitable for pruning and harvesting operations at different working heights. The system is powered with rechargeable battery power pack for forward movement and adjustment of the platform height using hydraulic system. Force required to move the platform is 6 kg at gear ratio of 1:9 in 10 s of time. However, the energy required to move 1.5 m is 600 Nm at forward speed of 0.54 km/h where lifting per stroke is 15 mm and total lift is 1200 mm. The energy required to lift the platform for change of stage (0.4 m) is 400 Nm. The use of developed platform enhances the reach of worker, reduces drudgery of pushing and pulling with ease of steering.

Occupational health issues interventions in chilly processing industry

Chilly processing industry involves various operations at milling section (grinding mill discharge), cleaning section (unloading the chilli, chili stem breaking), polishing section (chili oil polishing machine), maintenance and facility section. Workers are usually exposed to chilli dust which causes irritation of eyes, nose and leads to many occupational health problems. In this study, the dust particle concentration has been measured from the chili processing industry situated in Udaipur region. The respirable dust concentration and total suspended particles varied from 0.095-5.32 mg/m^3 and 0.14-18.14 mg/m^3, respectively, at various locations of the unit. The average respirable dust concentration values are above standard exposure limit of 4 mg/m^3 and 10 mg/m^3 as per ACGIH and OSHA, respectively in certain units of the plant. Therefore, dust masks (six types) were evaluated on 10 workers in terms of breathing resistance, air leakage from sides, feeling of tightness on face, rate of sweating, any communication problem and spoil & smudge of skin during the use of dust protectors. The operators were advised to wear the mask for at least 60 minutes during the tests. Cotton matty dust mask (with 1 mm foam) had maximum acceptability (with maximum acceptability score of 28) during working in chili processing.

Study on health hazards of workers in rice/flour mills

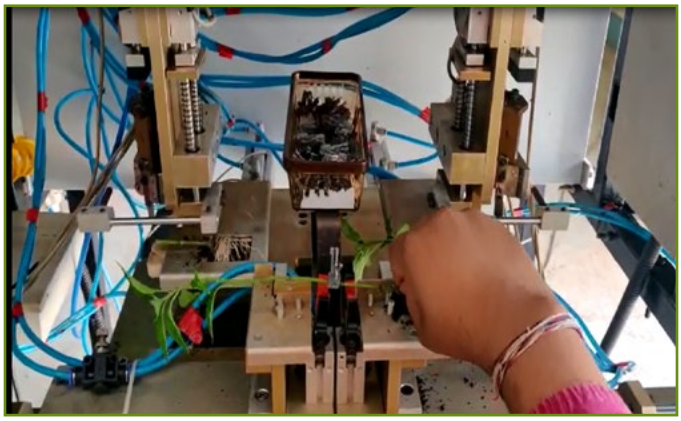
Dust and noise are two major problems associated with rice hullers. OUAT, Bhubaneswar center has surveyed twenty four rice huller machines in Puri district, out of which twenty (82 %) are electrical operated and rest by diesel engines. The workers are mostly exposed to generated dust causing pulmonary diseases, eye irritation, nose conjunction, choking of throats, etc. Average experience of workers exposed to dust is 15 years. Total dust concentration inside huller room at feeding site, at distance of 1, 2 and 3 m from the feeding site is observed as 359, 335, 316, 298 mg/m^3 for PM2.5 and 528, 494, 472, 446 mg/m^3 for PM10, respectively. A dust arresting chamber has been fixed in one of the rice hulling unit to arrest and collect the dust. Value of PM2.5 and PM10 recorded after intervention at feeding site, 1 , 2 and 3 m distance from feeding site are observed to be 226, 212, 201, 193 mg/m^3 and 332, 301, 290, 282 mg/m^3 respectively. The average inhalable, thoracic and respirable dust concentration measured using respicon dust sampler was 24.2, 39.6 and 64.5 mg/m^3, respectively during the operation. Average respirable dust concentration is 42.5 % less with an attachment of a dust arresting chamber. The workers are therefore advised to use personal protective equipment such as dust mask and eye goggles to reduce the health risk.

CRP ON FARM MECHANIZATION & PRECISION FARMING

This Consortia Research Platform (CRP) is mandated to "Engineering interventions for precise application of agricultural inputs for sustainable agricultural production system under open and protected cultivation". Development of precision farm equipment and technologies is the major area of research besides promotion and transfer of successful technologies in different parts of the country through linkages with different stakeholders and hands on training programmes for farmers. The project operates with seven centers for precision farming activities. A new programme on micro irrigation has been included under this CRP from 2018-19 with five centers for providing indigenous engineering solutions for automation of micro-irrigation and fertigation systems through development/adoption of appropriate equipment.

Vegetable grafting machine

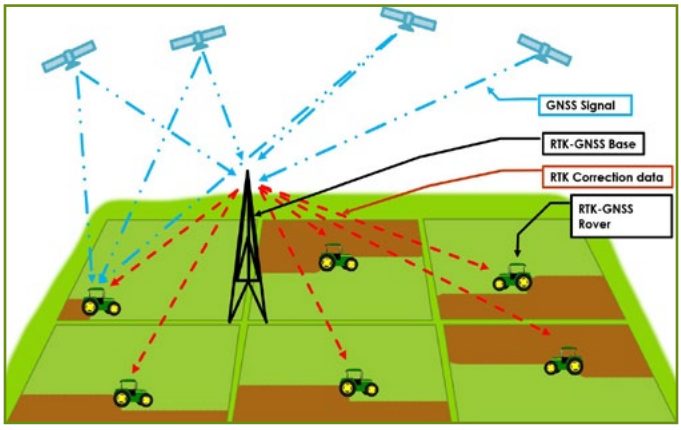
Manual grafting of vegetable seedlings is a labour intensive and time consuming process. In order to mechanize the process of grafting, a grafting machine has been developed by ICAR-IIHR, Bangalore center. It is designed to have 450 angled slant cut to the stem of root stock and scion. This system is provided for root stock and scion separately. The grippers, movement of seedlings and cutting mechanisms are operated using pneumatic cylinders and pneumatic fittings. The entire operating cycle of the grafting machine is controlled by a PLC (Programmable Logic Controller). It has manual step by step control for individual operation and automatic control for continuous operations. Air compressor is used to operate pneumatic cylinders at 5 bar pressure with the help of solenoid valves. Clip or tape for covering and holding the cut joint is placed manually. Capacity of the machine is 150 – 180 grafts per hour.



Technologies under development

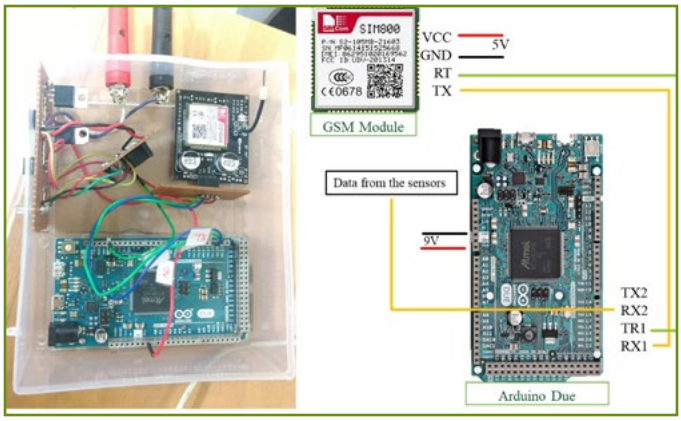
Precise navigation aid system for agricultural autonomous system

The objective of the research work is to develop a low-cost precise navigation aid system for agricultural autonomous system i.e. autonomous tractor, autonomous drones. The navigation system comprised of a high precision RTK-GNSS (Real-Time Kinematic Global Navigation Satellite System) receiver and a MARG (Magnetic, Angular Rate, and Gravity) sensor. An Android-based application "Tractor Path" has been developed to evaluate the performance of the system. The application can show the real-time tracking of the tractor on the Google map thus it can be used as a mobile-based guidance system. Optimum fieldwork pattern and turning model has been analyzed and included into the App. As the overall productivity is significantly dependent upon the time required for any operation the App helps to find the optimum fieldwork plan for a given width of machine and field size. The developed app is a multilingual to make it farmer friendly. Currently it can work on English, Hindi and Bangla. The average accuracy during preliminary testing is 0.35 m with the minimum and maximum accuracies of 0.12 m and 0.60 m, respectively.



Real-time data monitoring system for an autonomous tractor

The purpose of an autonomous tractor or unmanned tractor is to reduce human effort and provide efficient operation in the field. The real-time data monitoring system can be a building block for an autonomous tractor. Two-way real-time data monitoring system can play an important role for proper functioning of an autonomous tractor. In the absence of a monitoring system, an operator or a supervisor cannot



take appropriate action in case of a malfunctioning of the system thus can cause the halt of the operation. This will lead to a reduction in overall productivity. Also, there are problems associated with the autonomous tractors without a real-time monitoring system such as numerous performance parameters of the tractor during agricultural operations are inaccessible for accurate utilization, and unauthorized human intervention cannot be detected. Thus, in this research work, a web application and a GSM network-based communication system for the real-time data monitoring system has been developed using GSM module with 2 sec latency.

Establishment/ strengthening of Custom Hiring Centre (CHC)

A Custom Hiring Centre (CHCs) has been established at Krishi Vigyan Kendra by ICAR-RC ER, Patna center of CRP-FMPF to provide services to the farmers. The important farm machinery and implements like power tiller with attachments, paddy thresher, motorized crop cutter, pedal operated paddy thresher, knapsack sprayer, animal drawn lugged wheel puddler and a set of weeding tools viz., cono weeder, dry land weeder, grubber, cycle wheel hoe, twin wheel hoe etc. are available at the center on hiring basis.

CRP ON ENERGY FROM AGRICULTURE

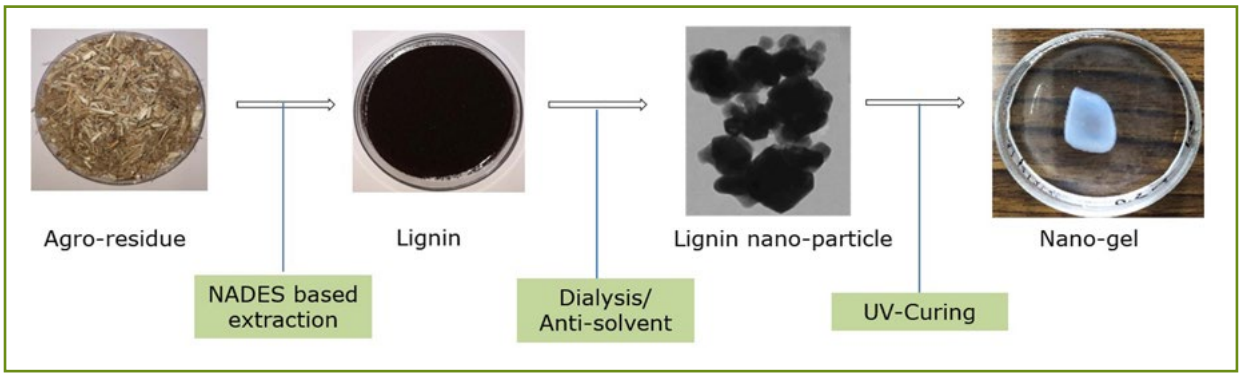
The major aim of this consortia research platform is to facilitate basic and strategic research for development of process and technology for generation of liquid bio fuel from biomass like crop residues, algae, etc. and establishing facility for advance bio energy research and conduct of demonstration of energy efficient agricultural operation with a view to enhance the share of renewable energy use in Indian agriculture. Activities are carried out through six research centers in different parts of the country.

Optimization of biomass-to-liquid fuel production process

Research is carried out by TNAU, Coimbatore Centre for development of efficient process of fuel generation using biomass. A continuous fixed bed Fischer-Tropsch reactor was developed to study the activity and selectivity of the synthesized catalysts for liquid fuel production from biomass. In this reactor, FT synthesis occurs at 200 to 250°C in the pressure range of 10 to 30 bar. The syngas reacts with the monometallic or bimetallic catalyst bed inside the reactor forming gas and liquid products. Both the catalysts were observed to have two stages of weight loss signifying moisture removal and metal oxide formation through thermo gravimetric analysis. Activation energy increased with increase in cobalt addition (9.98 to 10.86 kJ/mol) in bimetallic catalysts implying difficulty in formation of cobalt oxide in the presence of iron.

Development of UV curing cabinet for synthesis of NADES extracted lignin for the synthesis of nano composites

SPRERI, VV Nagar extracted the lignin present in the agro-residue was extracted using Natural Deep Eutectic Solvents (NADES). Further, the lignin extracted was subjected to dialysis and anti-solvent method for nano-particle synthesis. Nano-particles obtained were in range of 70-100 nm. The nano-particles synthesized were incorporated into polymer for nano-gel synthesis. Nano-gel was synthesized through UV-curing method. An UV curing cabinet was designed and developed at SPRERI. Nano-gel was synthesized using acrylamide-bis-acrylamide as polymer matrix and irgacure as UV-initiator. FTIR analysis was performed for lignin nanoparticles for confirming the functional groups, chemical bonds and its band pattern of the nanoparticles synthesised from the lignin.



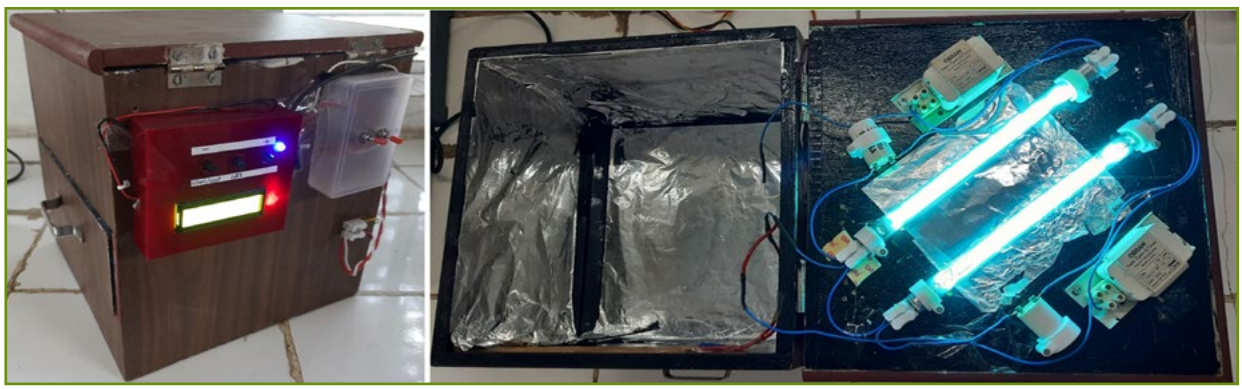


Photo bio-reactor for micro-algae cultivation

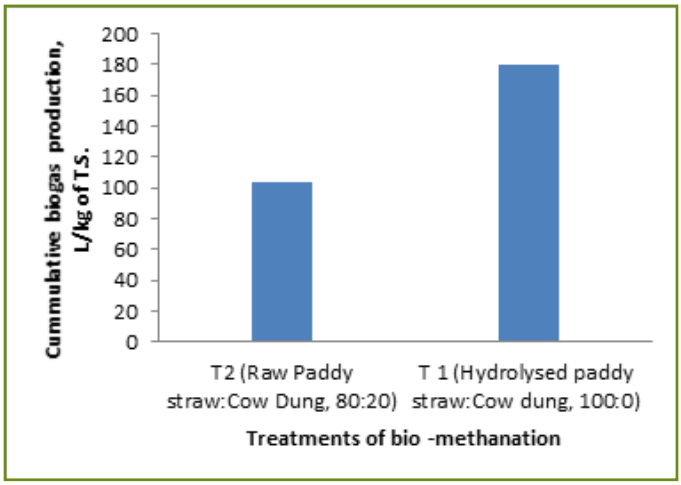
Micro-algae biomass production can be enhanced using closed type system called photo bio reactor under controlled conditions. A photo bio-reactor was designed and fabricated by TNAU centre. This photo bioreactor has 3" diameter and of 24" length borosilicate glass tube and CO_2 and air mixing station with mini air compressor with 20 l air filter; LED 24" bright white; agitator with disk impeller; DC gear head motor; CO_2 sparger and mixing vessel; sensor Probes for pH and temperature. The reactor is installed and commissioned and the parameter optimization is under progress. Lipid profiling of algae and the isolation of bacteria are in progress.

Evaluation of dry fermentation paddy straw based biogas plants in PPP mode

PAU, Ludhiana centre installed five (05) modified family size (4m^3 per day capacity) paddy straw based biogas plants made up of M.S. Sheet in P-P-P mode above the ground – One at KVK, Patiala, KVK, Bahowal, one at Village – Kotli, District – Hoshiarpur, one at Village – Shahbajpura, Block – Raikot, District – Ludhiana and one at Mela Route of PAU, Ludhiana in the PAU Campus and are working well.

Utilization of hydrolysed paddy stratw for bio-methanation

CIAE-Bhopal centre developed the process of growth media preparation using paddy straw hydrolysate for micro-algae. The remaining residue from hydrolysis was studied for bio methanation as this residue is partially treated and its biomethanation was compared with raw paddy straw. The experiment is conducted by preparing substrate as i) residue of paddy straw hydrolysate in combination with cow dung and ii) raw paddy straw in combination with cow dung in different proportions on weight basis (T1. 40:60,T2. 60:40, T3. 80:20 and T4. 100:0) using 0.25 and 0.225 kg total solids for experiment, respectively. Bio gas slurry (10% of substrate on wt. basis) is added as an inoculum to the prepared substrates. Measured amount of water is added to bring down dry matter content of substrate to 10%. An outlet is provided at the bottom of the digestion contained for sampling. Water displacement method is used for measurement of the bio gas production. Biogas production from hydrolysed paddy straw residues T1 treatment within 110 days of retention produced higher biogas with cumulative production of 180 l per kg of total solids while T2 treatment of raw paddy straw produced biogas of 103.1 l per kg of total solids that is 1.74 times higher than that of later treatment.



KVK, Patiala

KVK, Shahbajpura

Ludhiana

Kotli

Hoshiyarpur

Performance of crops under the Agri-voltaic System

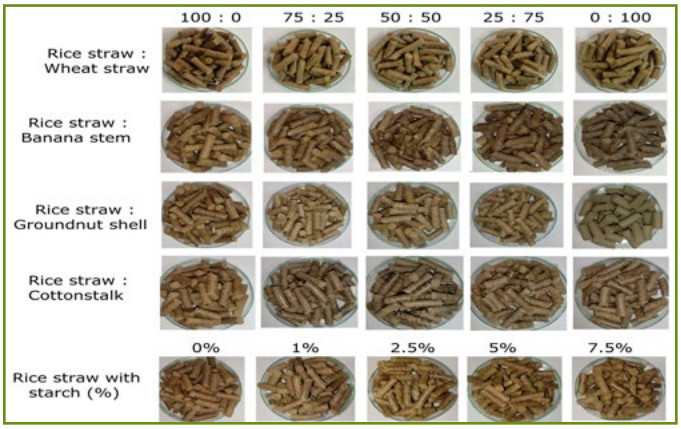
The JAU, Junagadh conducted Performance of field crops and shade resistance vegetable crops under the agri-voltaic system, Groundnut was harvested and result showed that there was no loss of yield under the Agrivoltaic system as compared to open field. Micro climate data under the agri-voltaic system as well in open field was recorded. The temperature under agri-voltaic system is found 1-2°C less than the open field throughout the season. Relative humidity was found higher under the agri-voltaic system. Solar radiation was found 15-22 % lower under the agrivoltaic system throughout the season. Power generation of agri-voltaic system was found as 2005 kWh and 3773 kWh during groundnut and cotton crop growing seasons respectively.

Carbon molecular sieves from lignocellulosic biomass using chemical vapour deposition (CVD)

The TNAU, Coimbatore centre developed process to prepare low cost carbon molecular sieves using lignocellulosic biomass especially using lignocellulosic feedstocks like coconut shell and cotton stalk. Physical (steam) and chemical (KOH, $ZnCl_2$ and H_3PO_4) activation of produced biochar were carried out at different impregnation ratios, activation temperatures and time. In CVD process, the benzene will be vaporized and allowed to deposit on the surface of activated carbon which reduces the pore entrance to match the desired adsorbate size. The carbon molecular sieve production system (5 kg capacity) was developed. It comprises of an inert gas feeding system (N_2), a dosing pump, benzene preheater and reaction chamber (0.01375 m^3). Carbon molecular sieve adsorption column of volume 250 cm^3 was designed. Preliminary study was conducted to assess the effect of 1-step and 2-step activation process. During 1-step, biomass was impregnated with chemical activation agents (KOH, $ZnCl_2$ and H_3PO_4) with 1:1 ratio and oven dried at 110°C. The dried mixture was activated for 1 h at 600°C with 10°C/min heating rate under nitrogen flow. In the 2-step activation process, the biomass was carbonized at 600° C under nitrogen flow for 1 h, and then chemically activated with agents.

Refinement of properties of fuel pellets from different biomass

The SPRERI, VV Nagar centre refined the properties of fuel pellets from different biomass using blends and binders. Pellets from different biomass blends viz. rice straw mixed with cotton stalk, wheat straw, groundnut shell, banana stem in 3 different proportions (100; 75:25; 50:50; 25:75) were produced using 8 mm die. 75:25 ratio was found to be best in terms of CV, bulk density and durability. Pellets of 8 mm die were also produced from rice straw mixed with starch, glycerol, cooked potato waste, vegetable market waste, water hyacinth and cattle dung etc. CV of the produced pellets was in the range of 13 to 17 MJ/kg. Durability of produced pellets was found to be in the range of 95-99%. The cost of the pellets ranged from ₹ 8.0 to 9.0 per kg of pellets.



Energy efficient briquetting system for chopped paddy straw

Biomass briquetting plant has been installed and commissioned in Department of Renewable Energy Engineering, PAU, Ludhiana. Production of binderless briquettes from chopped paddy straw has been started. Ultimate analysis and proximate analysis was conducted. Physical parameters like density, water resistance, shatter index and durability have been determined which is 860 kg/m^3, 89.05%, 97.90% and 97% respectively. Calorific value achieved was 15.27 MJ/kg. The performance of imbert type gasifier was investigated using paddy straw briquettes as fuel by studying the influence of airflow rate on fuel consumption rate and temperature profile inside the combustion zone. The total cost involved in producing briquettes is ₹ 4.75/kg (loose) and ₹ 5/kg (packed in bags).

TECHNOLOGY TRANSFER

Commercialization of Technologies

The institute developed technologies are being promoted by involving agricultural machinery manufacturing industries through license agreements. During the year 2020 the institute had signed license agreement with nine industries to promote thirteen technologies developed by the institute.

Technologies Licensed

Sl. No.	Technology	Licensed to
1	CIAE Millet Mill and CIAE Dal Mill	M/s KPMC Limited, Indore
2	Tractor Operated Cassava Stake Cutter Planter	M/s Bhansali Agro Tech, Dhantara, Ahmednagar, Maharashtra
3	ICAR-CIAE Hand Held Vegetable Transplanter (Single Row) ICAR-CIAE Hand Held Vegetable Transplanter (Two Row) ICAR-CIAE Manually Operated Portray Type Nursery Seeder ICAR-CIAE Manually Operated Pull Type Three Row Planter for Millets- Multi-Crops (Model I-Inclined Plate Type) ICAR-CIAE Manually Operated Pull Type Three Row Planter for Millets- Multi-Crops	M/s Manak Industries, Bhopal M/s Shree Ganesh Engineering Works, Maharashtra M/s Vainketesh Laxmi Krishi Yantra Udyog, Bhopal, MP
4	Nutri Bar	M/s DiTriRu, (Disabled, Tribal and Rural Manufacturer), Thane, Maharashtra
5	Two Row Tractor Drawn Mechanical Planter for Sugarcane Bud Chip Settlings Raised in Portrays	M/s. Uttam Sugar Mills Limited, Tehsil Roorkee, District Haridwar, Uttarkhand
6	Portable Touch-Free Hand Sanitizer Unit (Automatic System) Touch-Free Hand Wash System (Automatic System)	Ishaan enterprises, New Delhi

On Farm Trials/Demonstrations in Farmers' Field

Sl. No.	Name of the Equipment/ Technology	No. of demonstrations / feasibility trials conducted	Area covered in ha	No. of farmers/ users familiarized/ benefitted
1.	OFT – Soybean (JS 2029)	10	4.0	10
2.	OFT - Broad Bed Seed Drill for sowing of soybean	09	3.6	09
3.	OFT- Strip till drill machine for sowing wheat variety(HI 1544)	11	4.4	11

Frontline Demonstrations

S. No.	Name of the Equipment/ Technology	No. of demonstrations conducted	Area covered in ha or hours of use	No. of farmers/ users familiarized
1	CIAE Inclined Plate Planter	17	5.3 ha	48
2	Power Weeder	06	8.5 h	40
3	Power Sprayer	06	7.0 h	55
4	Cono Weeder	02	10.0 h	45
5	Ridge & Furrow Seed Drill	02	-	02
6	Post Hole Digger	01	1.0 h	01
7	Raised Bed Planter	06	1.0 h	06
8	Semi-Automatic Potato Planter	06	5.0 h	06
9	Broad Bed Planter	01	1.0 h	01

Participation in Exhibitions

ICAR-CIAE participated in following Agri-fairs / Exhibitions for promotion and creation of awareness on CIAE technologies among stakeholders.

- Krishi Mela, KVK, Murshidabad, West Bengal (10-13 Jan, 2020)
- Kisan Mela, ICAR-IIPR,Kanpur Regional Centre, Phanda, Madhya Pradesh (10 Feb, 2020)
- Kisan Mela 2020, Junagadh Agriculture University, Junagadh (19 Feb, 2020)
- Banana Expo/ Hort Expo, Kalaiarangam, Tiruchirapalli, Tamil Nadu (22-23 Feb, 2020)
- Krishi Mela, Namakkal, Tamil Nadu (23-24 Feb, 2020)
- Rashtriya Krishi Mela, IGKV, Raipur, Chhattisgarh (23-25 Feb,2020)
- 29th Swadeshi Science Congress Cum Rural Conclave, ICAR-CPCRI, Kasaragod (27-28 Feb, 2020)
- Krishi Vigyan Mela, ICAR-IARI, Pusa, New Delhi (1-3 March, 2020)

Media Activities

Date	Topic	Name of the media	Name of the Presenter
02.01.2020	निराई–गुड़ाई और पौध संरक्षण के लिए बेहतर कृषि उपकरण	DD Madhya Pradesh	Dr. Dilip Jat
08.01.2020	सिंचाई की उन्नत विधियॉं	DD Madhya Pradesh	Dr. CK Saxena
14.01.2020	कृषि विज्ञान केन्द्र की उपयोगिताए वं महत्व	DD Madhya Pradesh	Er. DK Dwivedi
20.01.2020	Foods to be consumed during pregnancy	AIR, Bhopal	Dr. Dipika Agrahar Murugkar
20.01.2020	सोयाबीन प्रसंस्करण एवं लघु उद्योग की स्थापना	DD Madhya Pradesh	Dr LK Sinha
04.02.2020	कृषि यंत्रों में सुविधा एवं सावधानी	DD Madhya Pradesh	Dr RR Potdar
12.05.2020	Touch free hand wash system	Suriyan FM	Dr. T.Senthilkumar
12.05.2020	Automatic sanitizer dispenser unit	Suriyan FM	Dr. Syed Imran
01.05.2020	Touch free hand wash system and Automatic sanitizer dispenser unit	News 18 Tamil Nadu	Dr. T.Senthilkumar and Dr. Syed Imran
02.05.2020	Touch free hand wash system and Automatic sanitizer dispenser unit	Pudhiya Thalaimurai TV	Dr. Syed Imran and Dr. T. Senthilkumar
21.10.2020	Sanrakshan kheti main gehu ki buwai ke liye unnat krishi yantra	DD Kisan	Dr. CP Sawant
30.10.2020	Recording on rotary slasher and potato planter	ETV	Er. DK Dwivedi

Prototypes Supplied

Sl.	Power Source	Quantity (nos)
1.	Manual	6161
2.	Bullock Drawn	20
3.	Tractor Operated	19
4.	Electric Power Operated	67
	Total	6267

TRAINING AND CAPACITY BULDING

CAFT Training

ICAR sponsored Advanced Faculty Training programme on "Rapid Detection Techniques for Quality Evaluation and Safety of Foods" was organized during 13-22nd January, 2020. Eight participants from the National Agricultural Research System attended the programme. The aim of the training was to give an overview of recent progress in rapid detection methods and several nondestructive techniques involved in safety and quality evaluation of food products. Some of the topics covered during the training includes: Electrophoretic technique in food quality, Hyperspectral imaging in quality assessment, Chromatography techniques in food analysis, Role of biosensors, Dye detection tests for food spoilage, Smart packaging and HACCP & FSSAI regulation. Awareness visits were organized to Indian Institute of Soil Science, Indian Institute of Science Education and Research, Bhopal Memorial Hospital Research and Center (BMHRC) and Sanchi Milk Plant, Bhopal.

HRD Programme on Repair and Maintenance of Office/Residential Buildings including Guest Houses

ICAR sponsored HRD programme on "Repair and Maintenance of Office/ Residential Building including Guest houses" was organized during 21-23rd January, 2020 for Technical/ Adminis-trative staff members of ICAR institutes/ HQ associated with works/ estate management. A total of 29 staff members from 27 different ICAR institutes participated in the training. The major topics covered in the training were administrative procedures for works proposals; introduction and process for work proposals, preparation of estimate, selection of agency, monitoring of ongoing works; annual repair maintenance of operations - electrical and substation etc.; green building concept and design; development, commissioning and maintenance of roof top solar system and planning and design of building including safety measures.

Orientation Training for Assistant Directors (Agril. Engg.) of Govt. of Bihar

ICAR-CIAE organized orientation training cum capacity building programme for Assistant Directors (Agril. Engg.), Department of Agriculture, Govt. of Bihar during 15th January–4th February, 2020. Fifty one Assistant Directors (Agril. Engg.) participated in the training. The training program was designed to enrich the knowledge of participants in farm machinery, irrigation and drainage, agricultural processing and energy in agriculture. The lectures were supplemented by field visits and on-farm demonstrations. Demonstrations were arranged on implements required for seed bed preparation, sowing/ planting/ transplanting, spraying, interculture, harvesting and threshing operations. Women friendly tools/ implements, conservation agriculture machinery and bullock drawn machinery were also demonstrated. The participants were also briefed about renewable energy technologies, greenhouse cultivation and soybean processing.

Training on Protected Cultivation

A training program on ''Entrepreneurship and leadership development program on protected cultivation (vegetable)" was organized during 10-15th February, 2020. This was a self-sponsored training programme for nine progressive farmers

interested in Protected Cultivation Techniques and to avail subsidy from the National Horticulture Board. The training schedule included class room lectures and practical classes on selection of protected cultivation practices, micro-irrigation systems in protected structures, crop management practices, quality nursery raising techniques, post harvest management of horticultural crops and Government Schemes in protected cultivation technology. Field visits to a few farmers' fields were also arranged where such techniques are in operation.

Refresher Training Programme for Established Agripreneurs

Refresher training programme on farm mechanization for established agripreneurs under AC & ABC scheme of MANAGE, Hyderabad was organized during 17-20th February, 2020. A total of 28 agripreneurs from Madhya Pradesh and Maharashtra participated in the training. Training programme formulated to impart the knowledge in the areas of farm machinery, irrigation and drainage, agricultural processing and energy in agriculture. CIAE Regional Centre, Coimbatore also organized this training during 21-24th February, 2020 and participated by 21 established agripreneurs. The training pro-gramme included 16 lecture modules and mainly covered topics viz. the status of agril. mechanization, machinery for rice, banana, sugarcane, horticulture, millets and other field crops, agro-processing and value addition, demonstration of CIAE-RC marketable technologies, industry visits, protocols and cost economics and business promotion of custom hiring operations.

Entrepreneurship and Leadership Development Programme

The Entrepreneurship and Leadership Development Programme of National Horticulture Board made it mandatory for farmers, entrepreneurs and applicants desirous of availing benefit under its schemes to undergo 6-days training programme at designated institutions. The training titled "Entrepreneurship and Leadership Development Programme on PHM-Cold Room, Cold storage, Ripening Chamber and Reefer-van for Horticulture Entrepreneurs (NHB Schemes)" was organized during 17-22nd February, 2020. Total 12 participants participated in the training from states of Maharashtra, Rajasthan and Jharkhand. The training programme included theory classes and demonstration/ practical on cold storage, cold room, ripening chamber, reefer van and other processing aspects of horticultural commodities. Different schemes, guidelines of NHB and marketing aspects were also covered in the training programme.

Hands-on Training for Farmers

Six hands-on training on Improved Agricultural Implements and Machinery were organized for farmers under CRP on FM & PF. About 384 farmers from different parts of the counry namely Maharashtra, Madhya Pradesh and Tamil Nadu participated in the training. Participants were briefed on updates of technologies on farm mechanization and agro processing. The hands-on trainings and demonstrations of improved agricultural technologies were conducted. Visits to different laboratories were also arranged to get an exposure of different available agricultural technologies. Demonstration of implements for seed bed preparation, sowing/planting/ transplanting, spraying, interculture, harvesting and threshing operations were arranged.

Title	Duration	Number of Participants
Hands-on Trainings for farmers on improved agricultural implements and machinery	06-08, January 2020	68
	14-16, January 2020	62
	23-25, January 2020	51
	13-15, February 2020	37
	18-20, February 2020	109
	02-04, March 2020	57

Entrepreneurship Development Programme on Custom Hiring

Three Entrepreneurship Development Pro-grammes on 'Custom hiring of agricultural machinery as a business enterprise', sponsored by Govt. of MP were organized during 1-7th January, 2-8th February and 1-7th March, 2020. A total of 91 participants including 14 women participants participated in this training programme. Of these, 71 custom hiring centres have been established in different districts of Madhya Pradesh.

Winter School on Precision Agriculture

ICAR sponsored winter school on "Application of Sensors, Instrumentation, Artificial Intelligence and Machine Learning in Precision Agriculture" was organized during 14th February–5th March, 2020. A total of 25 participants of 10 disciplines from 12 states attended the winter school. The trainees were

exposed to sensors, advanced instrumentation system and different deep learning and machine learning algorithms used in agricultural production systems. The hands-on training sessions were also given on chip or embedded system boards like Arduino and Raspberry Pi. The applications of image based techniques and hyperspectral remote sensing technologies were also demonstrated in various field operations like seed bed preparation, sowing/planting/transplanting, weeding, spraying, harvesting and threshing. The trainees also visited the Eicher tractors for industrial exposure.

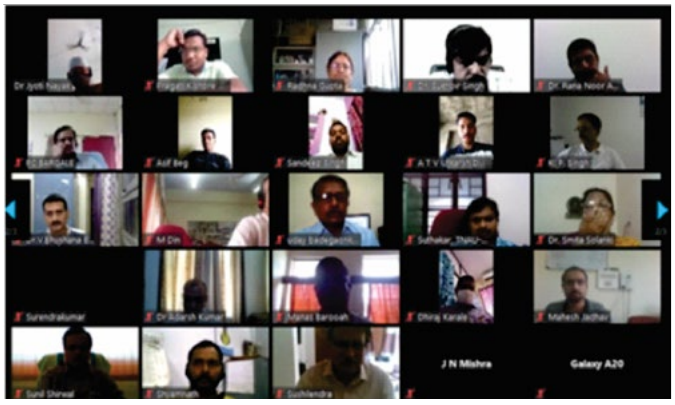
KVK Training Programmes

A total of 19 training programmes were organized by KVK, ICAR-CIAE Bhopal that includes 6 off-campus and 13 on-campus covering the following subject/targeted area.

S.No.	Subject/Targeted area	Number of participants
1	Integrated Pest & Nutrient Management	118
2	Health Management	125
3	Nursery Raising Techniques	29
4	SDP on Harvester Machine Operators	20
5	SDP on Greenhouse Operators	20
6	Horticulture Crop Management	20
7	Sowing Techniques	12
8	Role of Women In Farm Operations	59
9	Training of Trainers	201
10	Training of CEOs and FPOs	13

Training on Ergonomical Design Guidelines

An online training programme on Ergonomical Design Guidelines for agricultural tool, equipment and work places was organized during 29th June-3rd July, 2020. Total 40 participants including 22 from SAUs, 8 from ICAR institutes, 8 from national institutes and 2 from industry participated in the training programme. The training programme was inaugurated by Dr. K. Alagusundaram, Dy. Director General (Agril. Engg), ICAR, New Delhi. In his inaugural address, he highlighted the need of application of ergonomic principles in design of agricultural machinery and agro-based processing machinery to reduce drudgery and improve worker's efficiency. Dr. Kanchan K. Singh, Asst. Director General (Farm Engg.,), ICAR in his address emphasized on improving the life style of agricultural workers by developing agricultural technologies through ergonomic interventions. While welcoming delegates, Dr. C.R. Mehta, Director, ICAR-CIAE, Bhopal informed about the role of ergonomics in farm equipment design especially for development of gender friendly agricultural tools and equipment to empower women workers. The training comprised exposure to holistic approach of designing agricultural implements and workplaces of tractors and self-propelled implements. The special emphasis was given on applications of ergonomical considerations during the design process with due incorporation of limits with respect to anthropometric and strength data of Indian workers and environmental aspects such as vibration, noise, dust, chemical and ambient conditions. The participants were provided first-hand experience through examples of design of machinery or workplace using ergonomic principles through participatory learning.



Soy-Food Training Programme for Upcoming Entrepreneurs

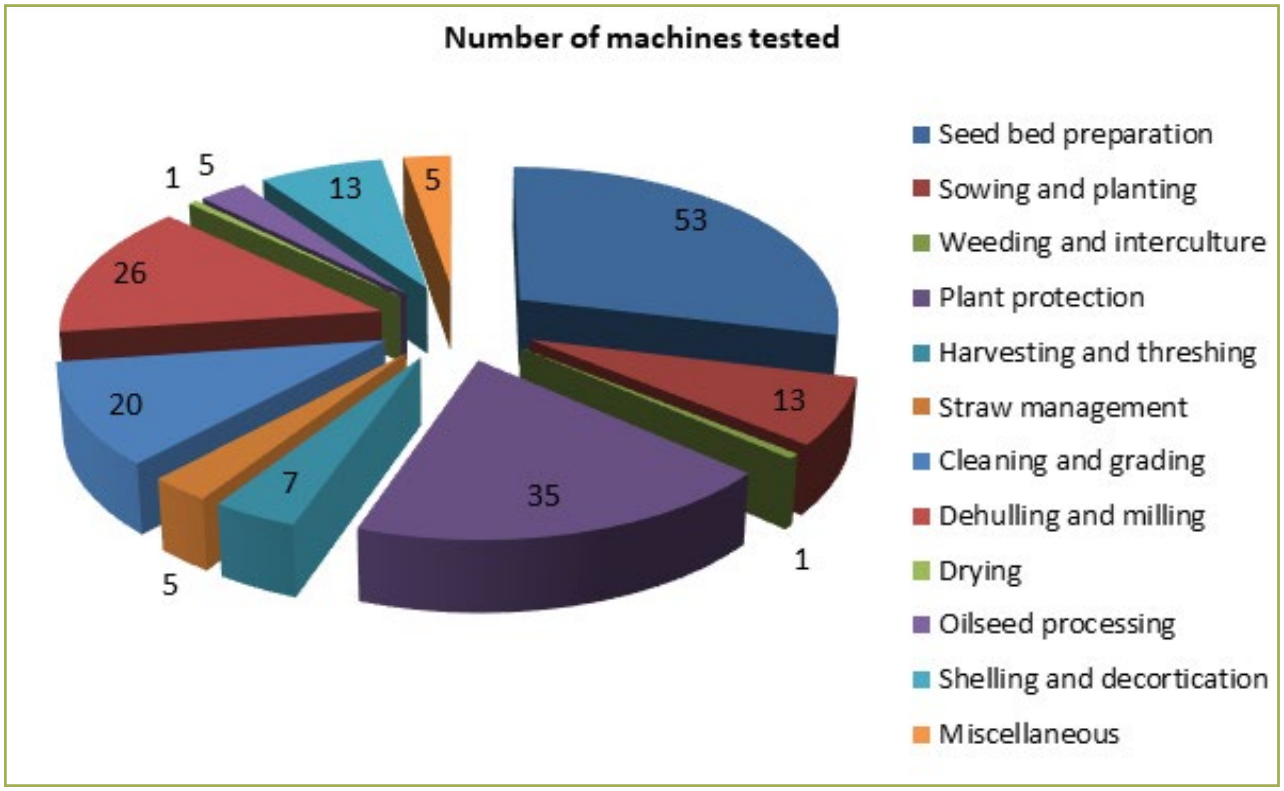
A webinar on "Awareness Programme on Entrepreneurship Development in Soybean Processing with special reference to Soy milk and Tofu" was organized on 30-31st July, 2020, 25–26th August, 2020 and 23–24th September, 2020 with the aim of creating awareness about soybean use in which various aspects of soybean processing were discussed and participated by 103 persons. The participants included farmers, engineers, government servants and students. A 6-day soy food training programme for upcoming entrepreneurs was conducted in the month of November and December 2020. Total 27 persons took training in November and December 2020. The training covered various aspects of soybean processing that included information of different soy based food products, preparation of soy milk and tofu, introduction to soy processing equipment, project planning, storage and packaging, marketing aspects of soy products and health benefits of soybean.

LINKAGES AND COLLABORATION

Sl. No.	Organization	Collaboration
1	ICAR Consortia Research Platforms	Research
2	ICAR- CTRI, Rajamundry	Research
3	ICAR-SBI, Coimbatore	Research
4	ICAR-DCR, Puttur	Research
5	ICAR-NRC Banana, Tiruchirapalli	Research
6	ICAR-IISR, Lucknow	Research
7	TNAU, Coimbatore	Research
8	State Line Departments, TN, AP, Karnataka, MP, Kerala	Extension
9	Krishi Vigyan Kendra	Extension
10	Non-Government Organisations	Extension
11	Department of Science and Technology	Research
12	Science & Engineering Research Board	Research
13	Oklahoma State University	Research
14	Washington State University	Research
15	Maavan Drone Academy, Chennai	Research
16	Apex UAV, New Delhi	Research
17	Int. Center for Agril.Res. in Dry Areas, Lebanon	Research

Commercial Testing of Farm Machinery & Post Harvest Equipment

Farm machinery and post harvest machinery manufactured by different industries are being tested at main campus as well and at regional centre at Coimbatore. During the year, the institute has tested 184 agricultural machineries under different categories and generated a revenue of ₹ 178.68 lakhs.



Intellectual Property and Consultancy

S. No.	Date of filing app./ Reply date	Application no. allotted by the Patent Office	Title	Inventors (s)
Patent e-filed: 06 Nos.				
1.	24.11.2020	202021051085	Plant detection based automatic fertilizer dispensing mechanism for spot fertilizer application suitable for widely spaced crops	Deepak S. Thorat Manoj Kumar AR Raju
2.	02.11.2020	202021047715	Straw Cutting and Handling Mechanism for Sowing/ Planting under Combine Harvested Crop Residue Conditions	UR Badegaonkar Manish Kumar
3.	25.09.2020	202021041614	Counter rotating cotton stalk puller cum chain conveyor with drum clearance adjustment mechanism	Ashutosh P Pandirwar Himanshu S Pandey
4.	04.06.2020	202021023413	Chemical-free pre-treatment process and equipment for production of raisins	Dilip A Pawar SK Giri N Kotwaliwale Ajay K Sharma
5.	13.03.2020	20007978	A High speed planting mechanism for soybean and like	Manoj Kumar Ramesh K Sahni
6	07.01.2020	201621001885	Process Technology for Production of Pro-Biotic Soya Cheese Spread	MK Tripathi SK Giri
Patent FER Reply e-filed: 03 Nos.				
1.	06.01.2020	117/MUM/2012	Pneumatically Operated sugarcane Bud Chipping Machine	SJK Annamalai R. Naik NV Nair NR Prasad
2.	31.08.2020	2357/MUM/2014 E-91/7941/2020/MUM	Multi millet thresher-cum-dehuller	KP Singh RR Potdar
3.	24.11.2020	1711/MUM/2013	Process Technology for Utilization of digested biogas slurry	Urmila Gupta

Copyrights filed

S. No.	Application Number	Date of filing	Title	Innovators
1.	16643/2020-CO/SW Dated: 23.10.2020	23.10.2020	Software for Water Balance Simulation Model for Roof Water Harvesting	Abhishek M. Waghaye Mukesh Kumar Ravindra D. Randhe Karan Singh Ranu Gupta

Consultancy/ Contract Projects with Brief Details

Under the contract research project with M/s Burgeon Agri. Pvt., Nashik, Maharashtra a "Modular backyard poultry cage has been developed". Modular structure with rust free material is the salient feature of the developed technology.

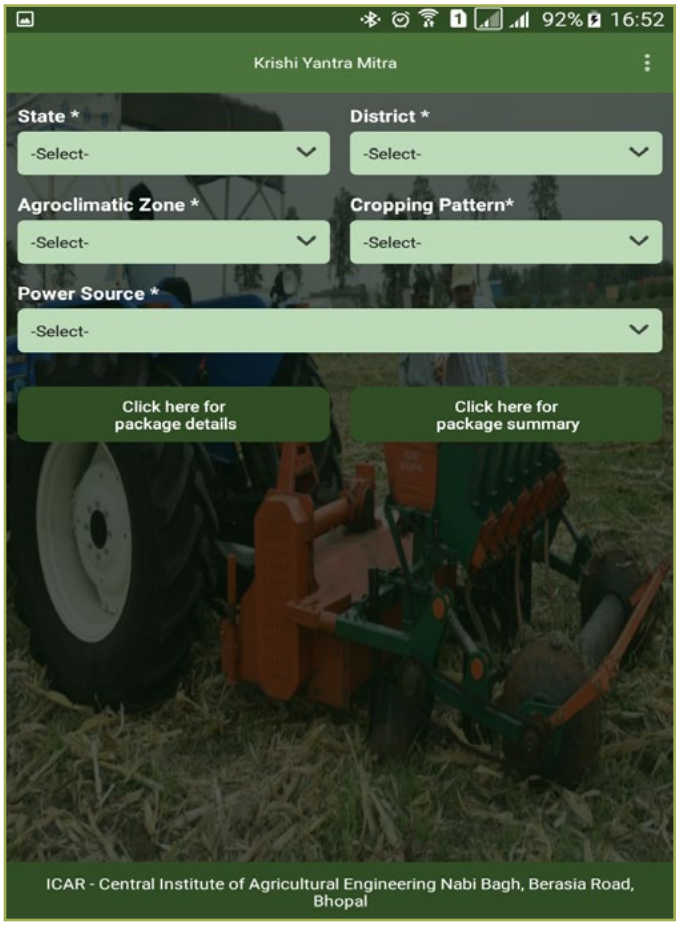
Agri-Business Incubation Unit

The Institute extended Institute's technology incubation facility to following three upcoming entrepreneurs:

Technologies	Incubatee/ Firm	From
Post harvest mechanization package for Banana central core	M/s Ponmani Agro Services, Coimbatore	31 Jan, 2020
Modern dal mill for nursery raising	Mr. S Khandelwal, Bhopal	10 Feb, 2020
Covered cultivation technology	Mr. Rahul Singh, Bhopal	27 Feb, 2020

Mobile App on Farm Machinery Package for Different Agro-climatic Zones

The institute has developed a mobile app on "Model Farm Machinery Package for Different Districts/Agro-climatic Zones of India". App is able to provide state wise, district wise/ agro-climatic zone wise, cropping pattern wise and power source wise farm machinery package. The app also helps the end users to understand the economic parameters such as machine cost, operating cost, hiring rate, annual cost, annual return, break-even analysis and payback period. For the ease of decision making by the end users, specifications of the machine with photographs and manufacturers details were also included in the app. This app is available at google play store with the name Krishi Yantra Mitra.



Human Resource Development

Name and Designation	Training Title	Duration	Organizer
Ajesh Kumar V Ajita Gupta	CAFT Training Programme on "Rapid detection techniques for Quality Evaluation and safety of foods"	13-22 Jan, 2020	ICAR-CIAE, Bhopal
SP Singh DK Jain	Repair and Maintenance of Office, Residential Building including Guest Houses	21-23 Jan, 2020	ICAR-CIAE, Bhopal
PV Sahare	Capacity Building Training Programme for CJSC Members	27-31 Jan, 2020	NAARM, Hyderabad
Mustafa Kamal Sanjay Kumar Singh Swati Singh Kumar Gaurav CP Mishra	Administrative and Financial Management	05-11 Feb, 2020	ICAR-CIFT, Kochi
Jessy Joy Kaveri Mondal K Shankar	Enhancing Efficiency and Behavioural Skills	24-29 Feb, 2020	ICAR-NAARM, Hyderabad

Name and Designation	Training Title	Duration	Organizer
Ajita Gupta	Crop Simulation Modelling and Impact Of Climate Change on Agricultural Production Systems: A Training Programme on Multi-Model Simulation	16-21 Mar, 2020	ICAR-IISS, Bhopal
A Khadatkar	Protected Cultivation Technologies for Climate Smart Agriculture	21-26 Apr, 2020	MPKV, Rahuri
Adinath Kate	Smart Handling and Processing Systems of Horticultural Produce	09-14 May, 2020	MPKV, Rahuri
Ajita Gupta	Carbon Sequestration in Climate Smart Agriculture	11-13 May, 2020	MPKV, Rahuri
Pravitha M	Science Communication for Smart Scholars	12-25 May 2020	ICAR-CIFE, Mumbai
Manoj Kumar AP Pandirwar	Basic Practices of ANSYS 2020 R1 for agricultural researchers	12-29 May, 2020	VNMKV, Parbhani
Pravitha M	Professional Attachment Training	09 Jun to 08 Sep, 2020	ICAR-CPCRI Kerala
Mukesh Kumar Ajita Gupta	Remote Sensing & GIS Technology and Applications for University Teachers & Government Officials	13 Jun - 01 Jul, 2020	IIRS, Dehradun
Abhijit Khadatkar	Introduction to Machine Learning using Python	11-20 Jul, 2020	Soft Computing Research Society, New Delhi
Abhijit Khadatkar SP Kumar Manoj Kumar	Automation and Robotics in Agriculture	22-31 Jul, 2020	PAU, Ludhiana
Manoj Kumar AP Pandirwar	Analysis of Experimental Data using R	05-13 Aug, 2020	ICAR-NAARM, Hyderabad
Adinath Kate	Two Week National e-Training on Indian Agricultural Education System and Entrepreneurship Scope in 21st Century	05-14 Aug, 2020	PDKV, Akola
AP Pandirwar Abhijit Khadatkar Manoj Kumar Bikram Jyoti and SP Kumar	EDEM to Simulate the Various Operations (Grain Handling, Soil- Tool Interaction, etc.) Involved in Agricultural Engineering	01- 24 Aug, 2020	CAEZEN Technologies, Bengaluru
SK Giri NS Chandel	COVID-19 and its Impact on Small and Medium on farm and Off Farm Agro-Based and cottage enterprises	17-28 Aug, 2020	Rural Development Academy, Bangladesh
Satya Prakash Kumar	ABC of Scientific Writing	18 Aug-02 Sep, 2020	ICAR-CIAE, Bhopal
Satya Prakash Kumar	Machine Learning & Applications	24-28 Aug, 2020	ICAR-CIAE, Bhopal
Ravindra Naik	IP Valuation and Technology Management	01-05 Sep, 2020	ICAR-NAARM, Hyderabad
Satya Prakash Kumar	Drone Remote Sensing in Agriculture"	09-10 Sep, 2020	CIAE, Bhopal
PC Bargale Dipika A. Murugkar V. Bhushana Babu BM Nandede	Workshop cum training on "Intellectual Property Rights in Agricultural Research & Education in INDIA"	12-18 Sep, 2020	NAHEP-IPTM Unit, ICAR
Swapnaja K Jadhav	DST training on Climate Change: Challenges and Response (CCCR)	05-09 Oct, 2020	LBSNAA, Mussoorie
Adinath Kate	Green Perspectives in Food Processing Sectors (virtual)	5-21 Oct, 2020	NIFTEM, Sonipat
SK Giri	MDP on "Priority Setting, Monitoring and Evaluation (PME) of Agricultural Research Projects"	12-17 Oct, 2020	ICAR-NAARM, Hyderabad
PC Bargale	IP Valuation & Technology Management	15-19 Oct, 2020	NAARM, Hyderabad
Subeesh A	FDP training on Artificial Intelligence	23-27 Nov, 2020	AICTE Training and Learning Academy

Name and Designation	Training Title	Duration	Organizer
Ramadhar Singh RK Singh	International Workshop on Application of Remote Sensing and GIS	01-03 Dec, 2020	Bhopal
Ravindra Naik	Management Development Programme on Leadership Development	08-19 Dec, 2020	ICAR-NAARM, Hyderbad
Ajita Gupta and Debabandya Mahapatra	DST training programme on Internet of Things (IoT) for Women Scientists and Technologists	14-18 Dec, 2020	ESCI, Hyderabad
UR Badegaonkar	Climate Change: Challenges and Response	14-18 Dec, 2020	LBSNAA, Mussoorie

PG School Students Activities

During the session 2020-21, five students are enrolled for doing their Doctoral programmes. Out of these five, two students joined in Farm Machinery and Power, two in Agricultural Processing and Structures and one in Soil and Water Conservation Engineering disciplines. Due to prevailing pandemic, the classes for the first semester of the students is being conducted online. During the year two students were awarded PhD degree and two students submitted their PhD thesis. PhD scholars participated in various activities other than academics such as attended national and international conferences and seminars, training programmes and webinars. Some students participated in various events also won the awards and honours.

AWARDS & RECOGNITIONS

Awards Received by the Scientists

Name	Name of the Award
Dr.Nachiket Kotwaliwale	ISAE Fellow-2019
Dr.KVR Rao	ISAE Fellow-2019
Dr.CK Saxena	Fellow-2020, Institution of Engineers
Dr.RK Singh	Fellow-2020, Indian Water Resources Society
Dr.KN Agrawal	ISAE Commendation Medal-2019
Dr.S Mangaraj	ISAE Best Book Award-2019
Dr.PC Jena	ISAE-Distinguished Service Certificate-2019
Dr.NS Chandel	JAE Best Paper Award 2019
Dr.T Senthilkumar	Best Poster Presentation , ISAE Convention-2020
Dr.T Senthilkumar	Soil Conservation Society of India Leadership Award-2019
Dr.R Senthil Kumar	Reviewer Excellence Award, ASCC
Dr.Sandip Mandal	NAAS Associate Member-2020
Dr.Adinath Kate	Governors Research Award-2019, Uttarakhand
Er.Swapnaja K Jadhav	Young Scientist Award, MP Young Scientist Congress-2019
Er.Prabhakar Shukla	Best Poster presentation in International Conference on Food, Health Agriculture Innovation-2020

Recognitions

Dr. Nachiket Kotwaliwale has been nominated as member of Scientific Panel on Labelling & Claims/ Advertisement by the FSSAI.

Dr. PC Jena has been honoured with Quarterly Franklin Membership (Membership ID#IE67957) by London Journals Press for the paper entitled "Tar and Particulate Matters Removal from Producer Gas by Using Oily Organic Filter Media".

Dr. MK Tripathi has been nominated as Editor (Review-TPF Post Harvest Process & Food Engineering, Pantnagar Journal of Research, Formerly International Journal of Basic and Applied Agricultural Research) from Nov, 2020.

Dr MK Tripathi has been nominated as Editor, Clinical Medicine Research, Science Publishing Group, USA.

Dr MK Tripathi has been nominated as Member, FSSAI, NetSCoFAN (Network for Scientific Cooperation for Food Safety and Applied Nutrition), New Delhi.

CSIR – SRF Fellowship (2020) for the Ph.D. Student research project of Er. Mathangi Raja Sekhar entitled "Design and Development of Soy chap making machine" under the guidance of Dr. S. Mangaraj at ICAR-CIAE, Bhopal campus.

Dr. R.K. Singh was appointed as the Subject Editor of Soil & Water Conservation Engineering by the Editorial Board of Pantnagar Journal of Research.

Ph.D. Awarded

Sandip Mandal, Senior Scientist was awarded with Doctor of Philosophy by G B Pant University of Agriculture and Technology, Pantnagar Uttarakhand.

Rahul Rajaram Potdar, Scientist was awarded with Doctor of Philosphy by ICAR-Indian Agricultural Research Institute, New Delhi.

PUBLICATIONS

Research Papers Published in NAAS Rated Journals (> 6.0 rating)

Agrahar-Murugkar D. 2020. Food to food fortification of breads and biscuits with herbs, spices, millets and oilseeds on bio-accessibility of calcium, iron and zinc and impact of proteins, fat and phenolics. LWT-Food Science and Technology, 130:1-8. https://doi.org/10.1016/j.lwt.2020.109703.

Balasubramanian S, Deshpande SD and Bothe IR. 2020. Design, development and performance evaluation of CIAE millet mill. Agricultural Mechanization in Asia, Africa & Latin America, 52 (1): 42-48.

Banga KS, Kotwaliwale N, Mohapatra D, Babu VB, Giri SK and Bargale PC. 2020. Assessment of bruchids density through bioacoustic detection and artificial neural network (ANN) in bulk stored chickpea and green gram. Journal of Stored Products Research, 88, 101667. DOI: 10.1016/j.jspr.2020.101667.

Bembem K, and Agrahar-Murugkar D. 2020. Development of millet based ready-to-drink beverage for geriatric population. J. of Food Science and Technology 57: 3278–3283.

Chakraborty SK, Kotwaliwale N, Navale SA. 2020. Selection and incorporation of hydrocolloid for gluten-free leavened millet breads and optimization of the baking process thereof. LWT-Food Science and Technology. (accepted paper). https://doi.org/ 10.1016/j.lwt.2019.108878.

Chakraborty SK, Mahanti NK, Mansoori SM, Tripathi MK, Kotwaliwale N and Jayas DS. 2020. Non-destructive classification and prediction of aflatoxin-B1 concentration in maize kernels using Vis-NIR (400-1000 nm) hyperspectral imaging. Journal of Food Science and Technology, DOI: 10.1007/s13197-020-04552-w.

Chandel NS, Chakraborty SK, Rajwade YA, Dubey K, Tiwari MK and Jat D. 2020. Identifying crop water stress using deep learning models. Neural Computing and Applications, DOI:10.1007/s00521-020-05325-4.

Chandel NS, Rajwade YA, Golhani K, Tiwari PS, Dubey K, annd Jat, D. 2020. Canopy spectral reflectance for crop water stress assessment in wheat (Triticum aestivum, L.). Irrigation and Drainage. doi.org/10.1002/ird.2546

Chaturvedi, S, Singh, SV, Dhyani, VC, Govindaraju, K, Vinu, R. and Mandal, S. 2020. Characterization, bioenergy value, and thermal stability of biochars derived from diverse agriculture and forestry lignocellulosic wastes. Biomass Conversion and Biorefinery. 1-14.

Jat D, Chandel NS, Gurjar B and Jha A. 2020. Performance of pneumatic loader for loose straw handling on a farm yard. Range Management and Agroforestry, 41(1): 116-125.

Jyoti B, Mani I, Kumar A and Khura TK. 2020. Electrostatic induction spray charging system for pesticide application in agriculture. Indian Journal of Agricultural Sciences, 90 (7): 1245–1249.

Kate AE and Giri SK.2020. Mass transfer dynamics of simultaneous water gain and solid loss during soaking of pigeon pea grains. Journal of Food Science, 85(10): 3406-3414.

Kate AE, Singh A, Shahi NC, Pandey JP and Prakash O. 2020. Modelling and kinetics of microwave assisted leaching based oil extraction from *Bhat*. Journal of Food Process Engineering, 1-9. DOI: 10.1111/jfpe.13503.

Kate AE, Sutar PP. 2020. Effluent free infrared radiation assisted dry-peeling of ginger Rhizome: A feasibility and quality attributes. Journal of Food Science, 85(2), 432-441.

Khwairakpam B and Agrahar-Murugkar D. 2020. Development of millet based ready to drink beverage for geriatric population. Journal of Food Science and Technology, Doi.org/10.1007/s13197-020-04359-9.

Kumar M, Sarangi A, Singh DK, Sudhishri S and Rao A R. 2020. Development of production function of wheat cultivars under irrigated saline environment and foliar potassium fertigation. Current Science, 118 (12): 1939-1945.

Kumar S, Mohapatra D, Kotwaliwale N and Singh KK. 2020. Efficacy of sensor assisted vacuum hermetic storage against chemical fumigated wheat. Journal of Stored Products Research, DOI: 10.1016/j.jspr.2020.101640

Mahanti NK and Chakraborty SK. 2020. Application of chemometrics to identify artificial ripening in sapota (Manilkara zapota) using visible near infrared absorbance spectra. Computer and Electronics in Agriculture, DOI: 10.1016/j.compag.2020.105539.

Mahanti NK, Chakraborty SK, Kotwaliwale, N and Vishwakarma AK. 2020. Chemometric strategies for non-destructive and rapid assessment of nitrate content in harvested spinach using vis-NIR spectroscopy. Journal of Food Science, DOI:10.1111/1750-3841.15420.

Mandal S. 2020. Beehive charcoal briquettes: clean cooking fuel for rural areas. Current Science, 118 (11):1641-1642.

Mehta CR, Chandel NS and Rajwade YA. 2020. Smart Farm mechanization for sustainable Indian Agriculture. Agricultural Mechanization in Asia, Africa and Latin America. 50 (4): 99-104

Mohapatra D, Patel AS, Kar A, Deshpande SS and Tripathi MK. 2020. Effect of different processing conditions on essential minerals and heavy metal composition of sorghum grain. Journal of Food Processing and Preservation. https://doi.org/10.1111/jfpp.14909.

Moharana PC, Raghuvanshi MS, Bhatt RK, Goyal RK, Singh RK, Meena HM, Kumar Mahesh and Landol Stanzin. 2020. Frost heaves in cold arid Leh-Ladakh region: Observations on their morphological variability and patterns as indicators of pasture land degradation. Current Science, 119 (5): 799-807.

Muthamil Selvan M and Mani I. 2020. Development of power operated continuous-feed green-pea sheller. Indian Journal of Agricultural Sciences, 90(2), 396-400.

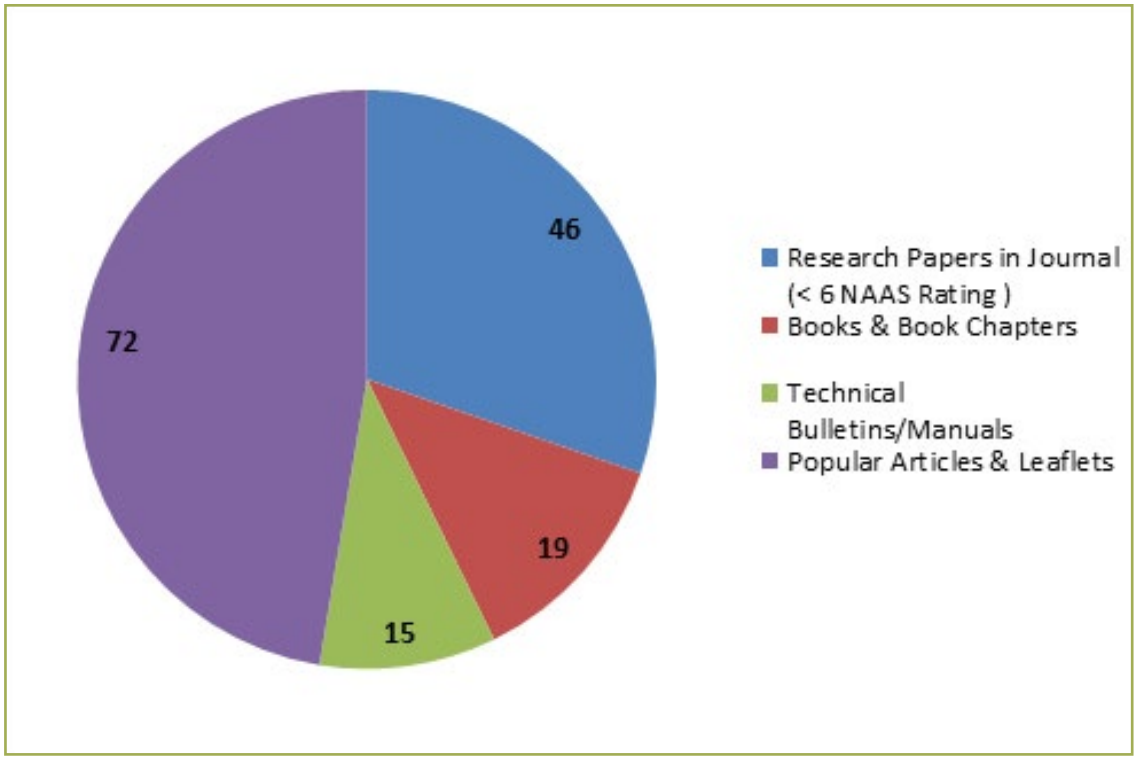
Nickhil C, Mohapatra, D, Kar A, Giri SK, Tripathi MK and Sharma Y. 2021. Gaseous ozone treatment of chickpea grains, part I: Effect on protein, amino acid, fatty acid, mineral content, and microstructure. Food Chemistry, 345: 128850.

Singh P, Tripathi MK, Yasir M, Khare R, Tripathi MK and Srivastava R. 2020. Potential inhibitors for SARS-CoV-2 and functional food components as nutritional supplement for COVID-19: A review. Plant Foods for Human Nutrition. DOI: 10.1007/s11130-020-00861.

Singh SP, Kumar A and Kushwaha HL. 2020. Sugarcane canopy spraying: A perspective solution with ergonomics and mechatronics approach. Sugar Tech. 22(2):203-207.

Tiwari S, Kate A, Mohapatra D, Tripathi MK, Ray H, Akuli A, Ghosh A and Modhera B. 2020. Volatile organic compounds (VOCs): Biomarkers for quality management of horticultural commodities during storage through e-sensing. Trends in Food Science & Technology. 106: 417-433. DOI: 10.1016/j.tifs.2020.10.039

Other Publications Details:



EVENTS ORGANIZED

Annual Workshop of CRPs

ICAR-CIAE, Bhopal and AEC&RI, TNAU, Coimbatore jointly organized the 5th Annual Workshop of CRPs (FMPF, MIS, EA, SA and NF) under Agricultural Engineering Division of ICAR during 28-30rd January, 2020 at Agricultural Engineering College and Research Institute, TNAU, Coimbatore. About 70 scientists from various participating centres of CRPs on Farm Mechanization and Precision Farming including Micro Irrigation Systems, Energy in Agriculture, Secondary Agriculture and Natural Fibers presented their annual progress reports and discussed the future programmes. Dr K Alagusundaram, DDG (Agril. Engg), ICAR was the Chairman and Dr Kanchan K Singh, ADG (FE) and Dr SN Jha, Co-chaired different technical sessions of the workshop. It was suggested that innovative and unique research proposals are expected from various centres of CRPs and a brainstorming session may be organized for deciding future programmes of various CRPs. The possibility of energy generation from agricultural residue may be explored under CRP on EA.

Krishi Sangoshti and Technology & Machinery Demonstration Mela

On 14th February, 2020 to commemorate the Foundation Day of the institute, Kisan Sanghoshti and Technology & Machinery Demonstration Mela was organized in association with Directorate of Agricultural Engineering, Govt. of MP at institute premises. Dr. RC Maheshwari, Ex Vice Chancellor, SDAU, Gujarat and Chief guest on the occasion emphasized on adoption of farm mechanization by small and marginal farmers to double the farmer's income. Shri Rajeev Choudhari, Director, DAE, Govt of Madhya Pradesh, Bhopal, briefed on custom hiring model for small and marginal farmers. Dr VP Singh, Director, ICAR-NIHSAD, Bhopal, Shri OP Chouksey, President, MP Farm Machinery Manufacturing Association were also present on the occasion. Field demonstrations of successful ICAR-CIAE developed technologies were conducted and farmers' interaction meet was also held. About

1500 farmers, 100 agricultural machinery manufacturers and officials of the line departments participated in the event. About 10 farmers and successful entrepreneurs were felicitated on this occasion for their significant achievements in adopting the ICAR-CIAE Agricultural Engineering Technologies as well as setting up of enterprises based on training and incubation provided by CIAE, Bhopal.

Technology and Machinery Demonstration Mela

ICAR-CIAE Regional Centre jointly organized a Technology and Machinery Demonstration Mela with TNAU AICRP schemes on 14th February, 2020 under CRP on Farm Machinery and Precision Farming (FM& PF) project. More than 1000 farmers from different districts Tamil Nadu participated in the Mela. Dr.N.Kumar, Vice Chancellor, TNAU Dr.Y.G.Prasad, Director, ICAR-Agricultural Technology Application Research Institute (ATATRI), Zone-X, CRIDA campus, Hyderabad and Mr. Balachandra Babu, Manging Director, Farm Implements India private ltd., Chennai, Dr R Shridar, Dean, AEC&RI, Dr K. S Subramanian, Director of Research, TNAU, other university officials and farmers witnessed the demonstration of Package of equipment for sugarcane

bud chip technology, Package of equipment for minimal processing of banana central core, package of equipment for cassava cultivation, Banana pseudostem shredder, Moringa leaf stripper, Multiplier onion peeler, Potting machine, Curry leaf stripper, Package of equipment for rope making from banana pseudeostem, Millet mill, Millet harvester, package of equipment for banana cultivation etc. On this occasion farmer's – scientist's interaction meet was also organized at TNAU Coimbatore.

Academia-Industry-Interaction meet

Academia-Industry-Interaction meet was organized in collaboration with Junagadh Agricultural University at Junagadh on 19th February, 2020. In this meet, over 200 participants mostly farm machinery manu-facturers from Rajkot, Ahmedabad, Vadodara and nearby vicinity of Junagadh participated. A presentation was made by Dr. PC Bargale, Head, TTD highlighting CIAE technologies suitable and relevant for commercialization in the state of Gujarat. Several manufacturers indicated their interest in CIAE technologies and enquired for possible joint collaboration for R&D projects.

Institute's Foundation Day Celebrations

The Institute celebrated its 45th foundation day on 15th February, 2020. On this occasion, institute initiated the tradition of organizing Prof. AC Pandya Memorial Lecture in the memory of its founder Director to recognize his contribution for laying the foundation of ICAR-CIAE as a pioneering agricultural engineering institute at national and international level. The scientists, officials and staff of the Institute participated in the celebration. Chief Guest of the function, Dr. RC Maheshwari, Former Vice-Chancellor, Sardarkrushinagar Dantiwada Agricultural University (SDAU), Gujarat delivered the first Prof AC Pandya memorial lecture. He stated that Prof. Pandya was a visionary and had great leadership skills, professional ethics and values. Dr Maheshwari also applauded

the Institute's accomplishments during its journey of 44 years and stated that the Institute has successfully developed many useful agricultural engineering technologies which have helped farming community in reducing drudgery, increasing productivity and enhancing income. Dr. AK Patra, Director, IISS, Bhopal & the Guest of Honour of the function appreciated the research accomplishments of the ICAR-CIAE and its efforts to reach the stakeholders. He also congratulated the entire team of CIAE on this occasion. Dr. P S Tiwari, Acting Director, ICAR-CIAE chaired the function and briefed about the achievements of the institute during last one year. As per the tradition, nine institute officials who completed 25 years of their glorious services to the institute were felicitated. The officials and staff members who brought laurels to the institute by winning national and international awards/recognitions for their contribution in research, teaching and sports during the year were also felicitated in the programme. The awards were also distributed to winners of best research paper, poster competition etc. organized on the occasion.

Workshop of AICRP on EAAI

XXIII annual workshop of AICRP on EAAI was organized during 18-20th February, 2020 at MPUA&T, Udaipur. Dr AK Mehta, Director Research, MPUA&T, Udaipur welcomed the Chief Guest, Dr. NS Rathore, Vice-Chancellor MPUA&T, Udaipur, the Guest of Honour Prof. BS Pathak, Ex-Director, SPRERI, Vallabh Vidyanagar and other dignitaries Dr. S. Kamaraj, Ex-Prof. & Head, CAE&RI, TNAU, Coimbatore, Dr. AK Dubey, Ex-LCPC- CRP on EA, ICAR-CIAE, Bh opal . Dr KC Pandey, PC, AICRP on EAAI presented the Project Coordinator's Report, highlighting achievements made by the

centres during 2019-20. PC Report cum highlights 2019-20, technical bulletins from MPUAT Udaipur, PAU Ludhiana and ICAR-CIAE Bhopal were released on the occasion. Various technical sessions were also organized.

RAC Meeting

The 25th meeting of the Research Advisory Committee (RAC) of ICAR-CIAE, Bhopal was held during 25-26th February, 2020. Dr. PS Tiwari, Director (Acting) welcomed the Chairman and the members of the Research Advisory Committee. In his welcome address, Dr. Tiwari highlighted some of the major achievements of the Institute during 2019-20. Dr. V M Mayande, Chairman RAC, in his opening remarks stated that ICAR-CIAE has made a significant impact on agricultural mechanization of the country. He also highlighted the areas requiring urgent CIAE interventions through focussed and time bound R&D programmes. Dr. KK Singh, ADG (FE), ICAR stated that CIAE may review progress and relevance of the ongoing projects and should prioritize ongoing R&D programmes vis-à-vis available resources. The other expert members of RAC who provided valuable advice to CIAE scientists included Dr Divaker Durairaj, Former Dean, College of Agricultural Engg., TNAU, Coimbatore; Dr Man Singh, Director, WTC, ICAR-IARI, New Delhi; Dr. Debraj Behera, Prof & Head, Deptt. of Farm Machinery & Power, Odisha University of Agriculture & Technology, (OUAT), Bhubaneswar; and Dr JIX Antony, Vice President, Olam, Bengaluru. The RAC members also witnessed demonstration of several new technologies developed by institute.

Demonstration of Mobile Food Processing Unit of IIFPT

Demonstration of "Mobile Food Processing Unit for Farmers" was organized on 2nd March, 2020 at village Khurchani, Ratibad, Bhopal in collaboration with Ind ian Institute of Food Processing Technology (MoFPI), Thanjavur (Tamil Nadu) and M/s. Solidaridad. More than 200 participants including farmers, entrepreneurs and undergraduate students of local agriculture college participated in the demonstration. The main objective of this event was to demonstrate onsite processing and value addition to locally grown fruits & vegetables such as tomato, onion, ginger, garlic etc. The processing of tomatoes for making tomato ketchup was demonstrated using the equipment installed on the mobile van costing about ₹ 40 lakhs. Such units are likely to provide more income to the farmers at their villages enabling them to get better price of their agro-produce.

Demonstration of Technology Package for Raisins Production

A package of technology developed at institute for the production of raisins without use of any chemical in the pre-treatment and entire process of raisin making has been tested and demonstrated at NRC on Grapes, Pune during 2-5th March, 2020 in the presence of Director, NRCG, scientists and other staff. The technology package consists of grape de-bunching machine and abrasive pre-treatment equipment. The demonstration included de-bunching of grapes, sorting and washing, abrasive pre-treatment to berries and drying of treated berries. The package of technology was also demonstrated to 16 farmers from Maharashtra and Karnataka states at NRCG, Pune.

Millet Processing Workshop

A one-day 'Workshop on millet processing' was organized at ICAR-Central Institute of Agricultural Engineering Regional Centre, Coimbatore on 04th March, 2020. In this interactive workshop about 20 participants of different stakeholder viz., Researchers, Academicians, Farmers, machinery

manufactures, processors, traders, FPOs, Entrepreneurs and NGOs were present. The major issues in millet production, its value addition in the production of niche foods, domestic and global market were discussed in detail. As outcome, suggestions including cultivation of millets in wastelands instead of diverting the farmers from their regular cultivation pattern, promotion of millets consumption among general public through various means, development of improved machineries for drying, cleaning, grading and destoning, development of improved effective storage technologies, bulk procurement by the Government, quality maintenance during storage, transportation, export, etc. were obtained.

International Women's Day

The Women's Cell of the Institute celebrated International Women's week during 5-6th March, 2020. On 5th March, talk on "I am Generation Equality: Realizing Women's Rights" was delivered by Dr Mona Purohit, Dean and Head, Faculty of Law, Barkatullah University, Bhopal. The talk was attended by all the women staff (including from ICAR-IISS and ICAR-NIHSAD, Bhopal), students, spouses of the staff residing in the campus. This was followed by a cultural programme by the Institute staff and students.

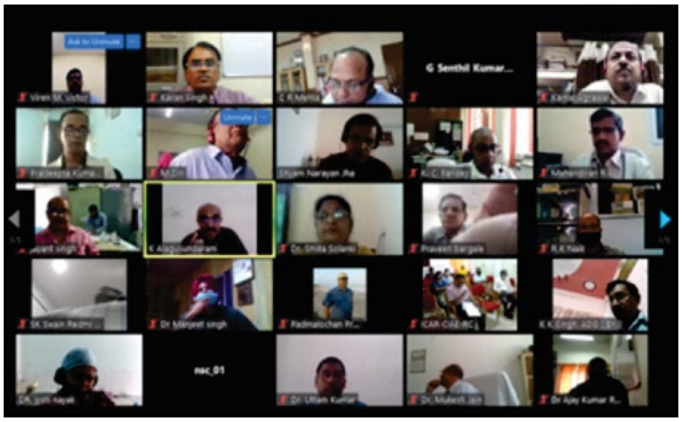
IRC Meetings

The 104th IRC was held in 24 sessions during May–June, 2020 and attended by 76 members of IRC. Total 86 projects (63 RPF II and 23 RPF III) were discussed and reviewed. Dr. C.R. Mehta, Director, CIAE & Chairman, IRC welcomed all the members of IRC and mentioned that the country is facing difficult time due to the COVID-19 pandemic and CIAE is striving hard towards achieving its goal. He told that scientists should formulate research projects based on national need, government policies and initiatives and recommendations of major committees.

The 104th Institute Research Council was held online during 2-3rd July, 2020 for consideration of new research projects. Total 23 new research projects were presented, discussed and reviewed, out of which, 15 research projects were approved.

Webshop on Challenges Posed by COVID-19 Pandemic on Production Mechanization and Way Forward during and post COVID-19 Periods

ICAR-CIAE, Bhopal organized a Web based Workshop (Webshop) on 'Challenges Posed by COVID-19 Pandemic on Production Mechanization and Way Forward during and post COVID-19 Periods' on 8th June, 2020. Dr. K. Alagusundaram, Dy. Director General (Agricultural Engineering), ICAR was Chairman and Dr. Kanchan K. Singh, Asst. Director General (FE) and Dr. S. N. Jha, Asst. Director General (PE) co-chaired the programme. The Webshop was attended by 135 participants from different SAU's, ICAR Institutes, IIT, NERIST etc. Dr. Alagusundaram, DDG (Agril. Engineering) in his address emphasized the need of mechanization and proper planning of activities for sustainable agricultural production in view of the COVID-19 situations. Seven presentations were made during the Webshop. Dr. C.R. Mehta, Director, CIAE presented the national perspective on the subject, while region wise presentations were made by Dr. Manjeet Singh, Head, Department of Farm Machinery and Power, PAU, Ludhiana (Northern region), Dr. B. Sridhar, Dean, AEC&RI, TNAU, Coimbatore (Southern region), Dr. Debraj Behera, Head, Farm Machinery Department, OUAT, Bhubaneswar (Eastern region), Dr. T.B. Bastewad, Principal Investigator, AICRP on FIM, MPKV, Rahuri (Western region), Dr. Atul Srivastava, Head, Department of Farm Machinery and Power, JNKVV, Jabalpur (Central region) and Dr. D.K. Vatsa, Director Research, CSK HPKVV, Palampur (Hilly regions). The region specific issues and strategies were discussed during these presentations and guidelines were formulated for national and region specific interventions.



International Yoga Day - 2020

Fifteen days online yoga training sessions were organized for officers and staff members of the institute during June 7-21st 2020. The regular yoga practice sessions for enhancing the health and immune system were conducted under the guidance of Mrs. Rita Chaudhary, Area Head, Bhartiya Yog Sansthan, Bhopal. Number of offi cers and staff members of institute practiced different yogasanas, pranayams and dhyan based on common yoga protocol for an hour everyday with their family members.

The training programme concluded with celebration of International Yoga Day (IYD) in online mode on the theme of Yoga at Home and Yoga with Family on 21st June, 2020.

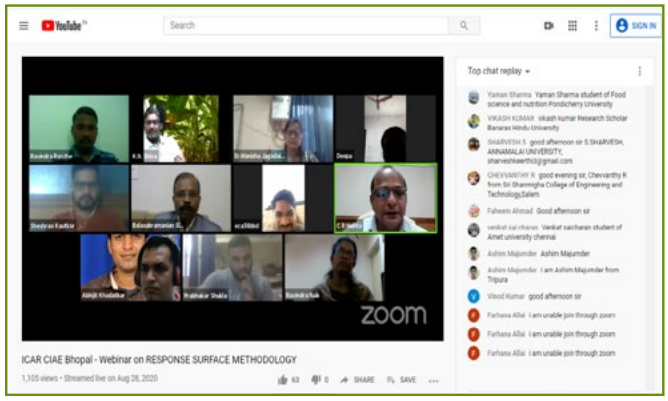
Webshop on Impact of COVID-19 on Agricultural Machinery Manufacturing Sector in India: Present Challenges and Future Strategies

Webshop on "Impact of COVID-19 on Agricultural Machinery Manufacturing Sector in India: Present Challenges and Future Strategies" wa s organized on 10th July, 2020 to discuss the present challenges faced by tractors and farm machinery manufacturing sector of the country due to COVID-19 pandemic and to formulate strategies to sustain the mechanization goals of the country. The online workshop was attended by more than 500 tractor and farm machinery manufacturers from different states, Scientists from Department of Scientific and Industrial Research (DSIR), Principal Investigators of AICRPs on FIM, UAE, ESA and Scientists (Farm Machinery Group) from ICAR-CIAE, Bhopal. Dr. K. Alagusundaram, Deputy Director General (Agricultural Engineering), ICAR was the Chairman, and Dr. Kanchan Kumar Singh, ADG (FE) and Dr. S.N. Jha, ADG (PE) co-chaired the programme of the workshop. Total 18 invited speakers (17 from national and state farm

manufacturers associations and one from DSIR) expressed their views through presentations in the workshop. The zone-specific issues due to COVID-19 and strategies were discussed during these presentations and outline of guidelines were finalized for national and region-specific interventions.

Webinar Series Organized by Regional Centre

Regional Centre, Coimbatore successfully organized the webinars on different topics related to mechanization and processing of food crops. This webinar series was inaugurated by Dr. C.R. Mehta, Director, ICAR-CIAE, Bhopal. The program was convened by Dr. S. Balasubramanian, Head, ICAR-CIAE RC, Coordinated by Dr. Dawn C.P. Ambrose, Principal Scientist and Dr. Syed Imran, Scientist of this Centre. The scientists of ICAR-CIAE Regional Centre delivered nine webinars during the period of August to October 2020, at weekly interval. About 4036 participants across the country participated this webinar lecture series. E-certificates were issued to the attendees.



Business Meet on Post-harvest Processing Technologies

An online business meet on the 'Post-harvest Processing Technologies' developed by ICAR-CIAE, Bhopal was held on 4th Aug, 2020. The meeting was convened to showcase recently developed technologies to the prospective stakeholders, viz. food processors, entrepreneurs, startups, machinery manufacturers, farmers and rural youth. The meeting was attended by about 100 stakeholders, besides around 500 playbacks were recorded on live video streaming on social media platform (https://youtu.be/l-ZpzNEb7AY). The meeting was inaugurated by Dr. K Alagusundaram, DDG (Agril. Engg.), ICAR. He emphasised the need of post-harvest technologies in general and product processing in particular, to help farmers as well as consumers. Dr. Kanchan K. Singh, ADG (FE), ICAR remarked that various government subsidy programmes are being targeted towards post-harvest processing and processing will play a vital role in doubling farmers' income by 2022. Dr.

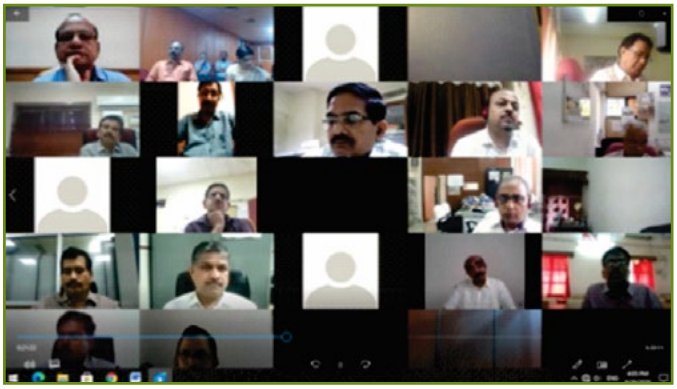
S.N. Jha, ADG (PE), ICAR lauded the efforts by ICAR-CIAE, Bhopal for conducting such business oriented meeting. He suggested that more such meetings may be held with selected small group of stakeholders wherein live demonstrations may be arranged. Dr. C.R. Mehta, Director, ICAR-CIAE informed that all the technologies being showcased in the business meet have been well tested and documented and sought partnership from stakeholders.

Independence Day Celebration

The 74th Independence Day of the nation was celebrated with pride and enthusiasm in which officers and employees of the Institute participated. After the flag hoisting, Dr. C.R. Mehta Director, ICAR-CIAE remembered the martyrs who sacrificed their lives for the freedom of the nation and called upon all to work sincerely to make the country of their dreams. Further, he highlighted the current issues and challenges before the country at present in context to Indian agriculture and effect of COVID-19 pandemic on agriculture, in particular. He also briefed about major achievements of the Institute and staff of the Institute during last one year. To mark the occasion, saplings were planted by the Director along with other officials in the Institute premises. All the SOPs related to COVID-19 were followed during the event.

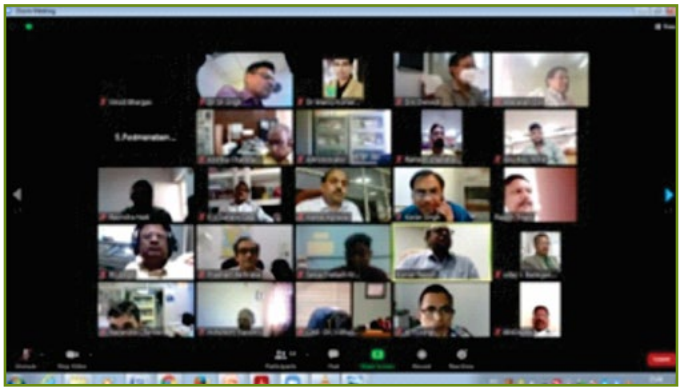
Brainstorming Seminar on Adoption of Zero-till Machinery in South India

ICAR-CIAE RC, Coimbatore organised a brainstorming seminar on 'Adoption of Zero-till machinery in South India' through online mode on 25th Aug, 2020. About 55 experts participated during the brainstorming meeting. The program was chaired by Dr. K. Alagusundaram, DDG (Engg), ICAR and Co-chaired by Dr. Kanchan. K. Singh, ADG (FE), ICAR and Dr. C.R. Mehta, Director, ICAR-CIAE Bhopal. Dr. K. Alagusundaram, DDG (Agril. Engg), ICAR addressed about the adoption of happy seeder, super seeder and informed that the adoption of zero tillage machinery will improve the pulse production in delta region of South India. Dr. Kanchan. K. Singh, ADG (FE) informed the group that the adoption of zero tillage machinery in Southern India is due for long time. Dr. C.R. Mehta, Director, ICAR-CIAE highlighted the advantages of adoption of zero tillage machinery in Indo-Gangetic zone. Dr. R. Murugesan, Chief Engineer, Agricultural Engineering Division, Govt. of Tamil Nadu shared his experiences of use of zero tillage and machinery and their mass scale adoption in the state. Eight presentations were made by identified experts in two technical sessions.



हिन्दी पखवाड़ा

केन्द्रीय कृषि अभियांत्रिकी संस्थान, भोपाल में हिन्दी पखवाड़ा 2020 कार्यक्रम 14 से 28 सितम्बर 2020 तक आयोजित किया गया। दिनांक 14.09.2020 को संस्थान के निदेशक डॉ. सी.आर. मेहता द्व ारा पखवाड़े का औपचारिक उद्घाटन किया गया। हिन्दी पखवाड़ा का समापन कार्यक्रम 01 अक्टूबर को सम्पन्न हुआ। श्री प्रशान्त पथरबे, सहायक महानिदेशक, पत्र सूचना ब्यूरो, भोपाल कार्यक्रम के मुख्य अतिथि थे। कार्यक्रम में हिन्दी पखवाड़े के दौरान आयोजित विभिन्न प्रतियोगिताओं जैसे– सामान्य हिन्दी प्रतियोगिता, हिन्दी कार्यक्रम (तकनीकी कर्मचारियों/अधिकारियों के लिए), महिलाओं के हिन्दी प्रतियोगिता (ऑनलाइन) वाद–विवाद प्रतियोगिता, निबंध लेखन प्रतियोगिता, वैज्ञानिक शोध पत्र व पोस्टर प्रदर्शन तथा अहिन्दी भाषी कर्मचारियों/अधिकारियों के लिए ऑनलाइन प्रतियोगिता) इत्यादि के विजेताओं को पुरस्कार एवं प्रमाण पत्र प्रदान किये गये। इस अवसर पर श्री प्रशान्त पथरबे ने हिन्दी को आगे बढ़ाने हेतु किये जा रहे प्रयासों पर प्रकाश डाला और भविष्य में लक्ष्य पूर्वक हिन्दी के विकास हेतु प्रयास करने का आह्वाहन किया। संस्थान के कार्यवाहक निदेशक डॉ. के. एन. अग्रवाल ने हिन्दी के प्रचार प्रसार हेतु किये जा रहे प्रयासों पर चर्चा की तथा संस्थान में राजभाषा के प्रसार हेतु कार्य रूपरेखा प्रस्तुत की। उन्होने लोगों से हिन्दी में अधिकाधिक कार्य करने का आह्वाहन किया तथा कहा कि वैज्ञानिक हिन्दी में बुलेटिन प्रकाशित करें तथा दूरदर्शन व समाचार पत्र के माध्यम से कृषि यंत्रों की जानकारी किसान भाइयों तक पहुचायें जिससे किसान लाभान्वित हों तथा कृषि का विकास हो सके।



Interaction Meet on Possibility of Adoption of Wealth from Waste Technology in Arunachal Pradesh State

CIAE-RC, Coimbatore organised a brainstorming interaction meet to explore possibility of adoption of technology of generation of wealth from banana pseudo-stem in Arunachal Pradesh state in collaboration with Arunachal Pradesh State Council for Science and Technology (APSCS&T), Itanagar through virtual mode on 25th Sept, 2020. About 35 officers from APSCS&T, Itanagar and scientists of CIAE-RC participated in the brainstorming meeting. The programme was chaired by Dr. C.R. Mehta, Director, ICAR-CIAE Bhopal. Shri C.D. Mungyak, Director cum Member Secretary, APSCS&T and Dr. Debajit Mahanta, Project Director, DBT-APSCS&T centre were the Co-Chairmen of the meet. Dr. S. Bala Subramanian, Head, ICAR-CIAE RC, Coimbatore,

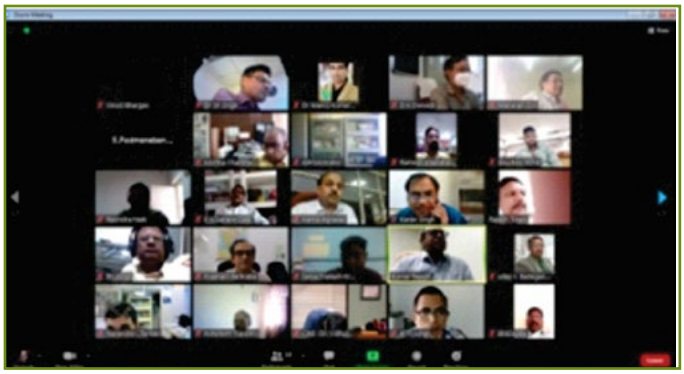
welcomed the participants. Dr. C.R. Mehta, Director narrated the role of ICAR-CIAE in agri-cultural mechanization, with special reference to North Eastern states. Dr. Ravindra Naik, Principal Scientist, ICAR-CIAE RC, Coimbatore delivered a detailed presentation on the role of post-harvest mech anization intervention in value addition and generation of wealth from banana pseudo-stem waste. This was followed by interaction/ discussion of possible adoption of related technologies in North Eastern states in general and Arunachal Pradesh in particular.

Midterm review of AICRPs

Mid-term review of four AICRPs coordinated from ICAR-CIAE, Bhopal was conducted under the Chairmanship of Dr. K. Alagusundaram, DDG (Agril. Engg), ICAR and co-chaired by Dr. Kanchan K. Singh, ADG (FE), ICAR during 4th, 8th, 15th & 22nd September and 29th October 2020. All the four project coordinators Dr. C. R. Mehta. PC, AICRP on FIM, M. Din, PC, AICRP on UAE, Dr. K. N. Agrawal, PC, AICRP on ESA and Dr. K. C. Pandey, PC, AICRP on EAAI coordinated review of respective AICRPs. Dr. K. Alagusundaram in his opening remarks highlighted the significance of the mid-term review meetings during COVID-19 period. Dr. Kanchan K. Singh remarked that more focus should be given on commercialization of developed equipment/technologies under the schemes. The discussions were held on the future programmes of the scheme and centre wise work plan for year 2020-21. Mid-course correction of the approved research projects with respect to various cooperating centres was also discussed. App on OUAT animal drawn implements was released in bilingual language e.g. English and Odia.

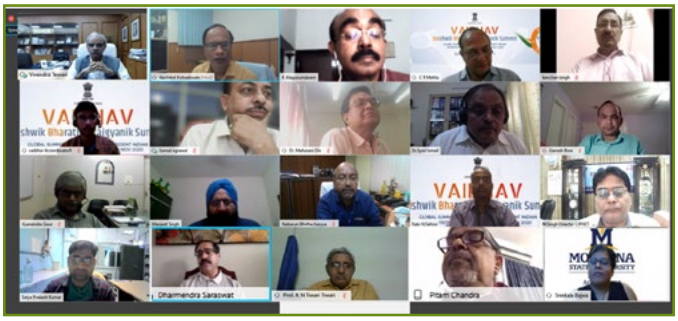
Celebration of 150th Birth Anniversary of Mahatma Gandhi

A week long programme was organized at ICAR-CIAE, Bhopal from 26th September to 2nd October, 2020 to celebrate 150th birth anniversary of our 'Father of Nation', Mahatma Gandhi. The week long celebrations were conceived to motivate and galvanise Indian citizens from all walks of life to achieve Mahatma Gandhi's dream of a clean India. During the week, number of activities were organized starting from short film based on Mahatma Gandhi, extempore, debate, and plantation in Institute campus. All above events were organized online except tree plantation. Dr Akhilesh Kumar Pandey, Honorable Vice-Chancellor, Vikram University, Ujjain, M.P delivered special lecture on Gandhi's philosophy on science and technology. The closing ceremony was organized on 2nd October, 2020. Dr. C.R. Mehta, Director CIAE highlighted the role of Mahatma Gandhi in society and nation building and his vision for Atma Nirbhar Bharat.



Vaibhav Summit on "Automation of Farming System"

VAIBHAV (Vaishwik Bharatiya Vaigyanik) Summit 2020 is a collaborative initiative by S&T and Academic Organisations of India to enable deliberations on thought process, practices and R&D culture to deals with the various multiple emerging global challenges. During the programme, academicians/ scientists of Indian origin and working overseas in the area of Farming System Automation and their Indian counterparts discussed about the global strength to solve specific Indian issues. Different possibilities of collaboration and cooperation were explored with an aim to develop an ecosystem of Knowledge and Innovation in the country leading to ATMANIRBHAR BHARAT in the area of Precision Agriculture. A session on "Automation of farming System" was organized under "Precision agriculture" on 06th Oct 2020. The session was chaired and co-chaired by Dr. K. Alagusundaram, DDG (Engg.), ICAR and Dr. Kanchan K Singh, ADG (FE), ICAR, respectively and was moderated by Dr. C.R. Mehta, Director ICAR-CIAE, Bhopal. The event was attended by various stakeholders from India and abroad with total participation being 856. Different deliberations of the panellists and the session officials led to identification of following areas for possible collaboration and exchange for research, training etc.: (1) AI and IoT applications for livestock management (breeding, milking, phenomics, comfort) (2) Drone in agriculture (development, application, regulations) (3) Precise input management through VRT (map-based and sensor based) (4) Artificial intelligence, big data management for affordable robotics application for small Indian farms (6)

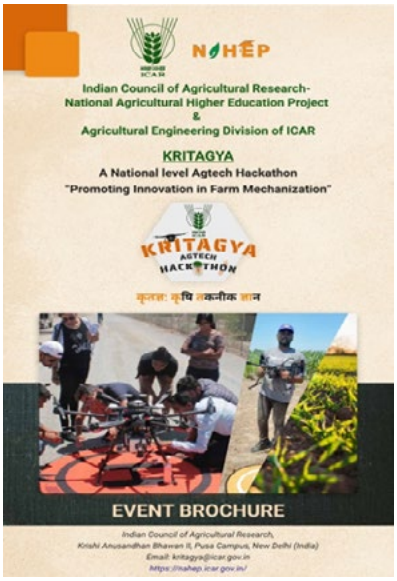


Automation in covered cultivation especially for high value crops (vertical farming, hydroponics, integrated systems).

Hackathon-Kritigya–2020 on Farm Mechanization "KRITAGYA"

Institute with the guidance of ICAR SMD (Engg) organized first ever Hackathon, *Kritigya–2020* on the advice of Hon'ble Prime Minster of India. The theme selected for this hackathon was "Promoting Innovations in Farm Mechanization". The aim of the hackathon was to explore the talent of young Indian students through their innovative ideas / concepts and out of box thinking for solving problems in farm mechanization by providing a national platform to share their novel ideas and converting them in to viable useful technologies. The event was in competitive mode and wieners were provided with cash awards and citation by ICAR. The DDG (Education) was the host and DDG (Engg) ICAR was the Co-host for the event. ICAR-CIAE, Bhopal was assigned the role of coordinator and Director CIAE was member of the *Kritagya* National Steering Committee as well as Co-Chairman of the Central Zone Organizing Committee, chaired by Hon'ble VC, JNKVV, Jabalpur. Dr PC Bargale, Head, Technology Transfer Division and Dr Yogesh Rajwade, Scientist were the Nodal officers for the Central zone which included states of Madhya Pradesh, Chhatisgarh, Telangana, Oddisha. In addition, Deans of Agricultural engineering colleges of the above mentioned states, representatives from national level agri business firm, national level agri business incubator, NGOs and venture capitalists/angel invester were the part of the central zone core committee.

ICAR-CIAE identified 13 major problem statements in the area of farm mechanization, the evaluation team and prepared the evaluation proforma for different ideas submitted by participating teams. The problems identified are: Women friendly equipment for small farm operations, Automatic transplanter/seeder for wetland paddy, On-the-go measurement of soil qualities and precision application of fertilizers, Solar/Hybrid powered tractors/prime movers for farm cultivation operations, Automatic weeders for row crops, Robotic harvesting of coconut/oil palm, Selective harvesting of physiologically matured tree fruits, Automatic vegetable transplanter, Harvesting of vegetable in multiple picking, Cotton picking for Indian conditions, Real time detection of plant diseases and simultaneous site-specific application of pesticides, Device for contact less determination of biotic stresses to crops, Yield determination without crop cutting or crop harvesting and Crop residue handling, storage and management



A total of 137 proposals were received and out of which, the evaluation committee recommended 17 proposals for online presentation of proposed solutions to the identified problems. The evaluation committee consisted of technical experts from IITs, NITs, ICAR and SAUs, representatives from NGO, agri business incubator, angel investors etc. Based on the presentations, the evaluation committee recommended five teams for National level competition from central zone.

Swachhata Abhiyan

Swachhata Pakhwada was successfully organized at ICAR-Central Institute of Agricultural Engineering main campus and also at Regional Centre, Coimbatore during 16th December to 31st December, 2020. All the scientific, technical, administrative and skilled helpers actively participated in all the activities organized to celebrate the event. During physical activity, all the precautions were followed as per the standard guidelines concerning COVID-19 (wearing mask, maintain physical distance, avoiding physical contact etc.). A programme was organized by main campus at village Kachhi Barkheda to create awareness on *swachhta abhiyan* in which villagers took part in large number. Activities were organized on organic waste management and green energy technology, proper garbage disposal, water conservation and its recycling at a residential colony, near CIAE campus. A poster competition was organized on the topic "Wealth from Waste". Similarly, a speech competition entitled "Effect of Swachh Bharat Mission" was organized in which employees of the Institute participated with great enthusiasm. "Kisan

Diwas" was organized on 23rd December, 2020 at the Institute in which officers from different organizations like IFFCO, NRLM Bhopal, Solidariaid (NGO) participated along with large number of farmers. A cleanliness campaign was held at market place near the Institute. Also, an online poster competition was organized for school children of Red Rose School, Lambakheda to create cleanliness awareness amongst them. A speech competition was organized on the topic "Rural cleanliness and green technologies".

Participatory Promotion of Climate Smart Agriculture Machinery

It is necessary to promote climate smart agricultural practices to overcome the adverse effects of prevalent cultivation practices that exploit the limited natural resources like fertile soil, water and minerals. Modern farm practices like tillage, interculture, irrigation, harvesting and threshing operations consume lot of energy and amongst them tillage consumes maximum quantum of energy. The efforts have been made to promote climate resilient agriculture using no-tillage or minimum tillage through demons-trations of machinery and technology like roto-till-drill, broad-bed-furrow planter, laser land leveller, ridge and furrow seeder and mole drainage technology on farmer's fields. Roto-till-drill was demonstrated in *rabi* season, 2019 and BBF planter in *kharif* season, 2020 for soybean crop. In addition, under SCSP component of NICRA-TDC, fertilizer has been distributed to 28 SC-BPL farmers of Kachhibarkheda and Sagoniya villages on 15th June, 2020.

Technology Dissemination (SCSP programme)

The distributed package of (agricultural implements/tools and other materials/items) under SCSP programme were monitored. The distributed items includes: irrigation pipes, water tank, mono block pump, battery sprayer, watering can, lawn mower, trowel, phawarh, belcha shovel, pick axe. solar study lamp, paint spray gun, dustbin, water purifier, mixer grinder, pressure cooker, stainless-steel storage tank etc. These items were distributed to trained beneficiaries of soya process and agricultural machinery for their livelihood support and agricultural activities.

Other SCSP Activities

Following programmes/activities were organized under SCSP programme:

Programme	Date	Place	Beneficiaries
Distribution of agricultural equipment (total 584 equipment)	2 - 4 Jan, 2020	Kurana and Barodi	154 farmers
Food processing and nutrition mela, demonstration of implements and distribution of agricultural equipment (hand operated/ pedal operated, total 162 equipment)	17 Jan, 2020	Balampur	100 farmers
Training programme on Sewing & Embroidery	20 Jan - 5 Feb, 2020	ICAR- CIAE	46 women from Sukaliya and Kurana villages
Beauty parlour training	10-20 Feb, 2020	ICAR- CIAE	36 women from different villages
Farmers' meet on processing techniques in millets and groundnut	20 Feb, 2020	RC, Coimbatore	50 farmers
Training on food processing and value addition for nutritional and food security	24-29 Feb, 2020	ICAR- CIAE	68 women from different villages

Programme	Date	Place	Beneficiaries
Sewing machine distribution (total 43 sewing machines)	9 March, 2020	ICAR- CIAE	43 women from different villages
Distribution of seeds-maize & vegetables, micronutrient mix, fertilizers, wheel hoe, irrigation kit, digging fork and fertilizers	23 May, 2020 21 Jul, 2020 29 Jul, 2020	Sirumugai, Karamadai block, Coimbatore District	49 male & 9 women farmers
Distribution of seeds-maize & vegetables, irrigation kit and digging fork	14 Aug, 2020	Palayam block, Erode District	21 male & 5 women farmers
Distribution of sickle (small), sickle (big) and hand hoe	20 Aug, 2020	Sirumugai, Karamadai block, Coimbatore District	36 male & 113 women farmers
Distribution of farm tools and input distribution	05 Sep, 2020	Palayam block, Erode District	14 male & 5 women farmers

A feedback survey was carried out among the SC-BPL beneficiaries in selected villages at Bhopal (Nipaniya Jat, Barodi, Sukaliya, Balampur, Kurana, Kachi Barkheda) and RC, Coimbatore (Irumporai).

As per the benchmark survey of SC-BPL beneficiaries, the tools, equipment and other materials namely irrigation pipe, water tank, battery sprayer, lawn mower, trowel, phawarh, belcha shovel, pick axe (Labour Kit), solar study lamp, mono block pump, watering can for plants, paint spray gun etc. were distributed under direct benefit transfer (DBT) to 386 SC-BPL beneficiaries of Kurana (130), Balampur (41), Barodi (60), Nipaniya Jat (65), Sukaliya (61) and Kacchi Barkheda (29) for their economic development and for increased productivity and income generation to support their livelihood. Farmers are using the distributed items for their agricultural activities and livelihood support. Increased yield of crops for which seeds and fertilizers distributed was observed during the feedback survey. The farmers produced about 4.5-5.25 t/ha of wheat which they were earlier producing about 2.5-3.0 t/ha. The beneficiary famers of regional centre, Coimbatore could get average increase in yield of brinjal and maize was 30 t/ha and 5 t/ha respectively. Thus there was substantial increase in the yield of crops of the farmers to whom the quality seed material was distributed.

Mera Gaon Mera Gaurav

Demonstrated bullock operated equipment and machinery to the MGMG farmers of Chanderi village of Bhopal district.

Three trainings were organized for the MGMG farmers in which 16 farmers were participated. 9 visits were carried out by the different groups in different

villages. 35 mobile advisory services on different related topics were provided to the 375 farmers.

Visit of State Horticulture Minister

Shri Bharat Singh Kushwah, Cabinet Minister for Horticulture & Food Processing, MP State visited institute on 29th December, 2020 with an objective to identify horticultural machinery and processing technologies that can be included in MP State subsidy schemes. The overall activities of the institute and AICRPs on machinery and technologies related to horticulture and processing were presented by Dr.CR Mehta, Director of the institute. After the interaction meeting, the honourable minister visited demonstration of horticulture machinery and processing technologies developed by the institute. Honourable Minister instructed the state horticulture officials who accompanied him to include Tractor operated garlic planter, onion transplanter, inclined plate planter, pneumatic planter, platform for orchard management, garlic stem & root cutter, onion detopper, onion storage structure, ripening chamber in State subsidy schemes for the benefit of Madhya Pradesh farmers. The Minister appreciated the technologies and processes developed by the institute and instructed the state officials for long term association with the institute.

IMPORTANT COMMITTEES

Research Advisory Committee		
1.	Dr. VM Mayande Former VC, PDKV, Akola	Chairman
2.	Dr. Debraj Behera Prof. & Head Deptt of Farm Machinery & Power , OUAT, Bhubaneswar	Member
3.	Dr. Divaker Durairaj Former Dean, College of Agricultural Engineering, TNAU, Coim.	Member
4.	Dr. Man Singh Project Director, WTC, ICAR-IARI, New Delhi	Member
5.	Dr. VVN Kishore Former Head, Department of Energy & Environment, TERI Energy Research institute University, New Delhi	Member
6.	Dr. Jix Antony New Health Platform Lead, NESTLE, Gurgaon	Member
7.	Director ICAR-Central Institute of Agricultural Engineering, Bhopal	Member
8.	Dr. Kanchan K Singh Assistant Director General (Farm Engineering), Indian Council of Agricultural Research, New Delhi	Member
9.	Dr. PC Bargale, Head, Technology Transfer Division, ICAR-Central Institute of Agricultural Engineering , Bhopal	Member Secretary

Institute Management Committee		
1.	Director, ICAR-CIAE, Bhopal	Chairman
2.	Dr. Kanchan Kumar Singh, ADG (Farm Engineering), Indian Council of Agricultural Research, New Delhi	Member
3.	Dr. HS Oberoi, Head, Division of Post Harvest Technology & Agricultural Engineering , ICAR-IIHR, Bengaluru	Member
4.	Dr. AK Singh, Principal Scientist, ICAR-IISR, Lucknow	Member
5.	Dr. PK Pathak, Principal Scientist & Head, Division of Farm Machinery & Post Harevest Technology, IGFRI, Jhansi	Member
6.	Dr. JJR Narware, Director, CFMTTI, Budni	Special Invitee
7.	Shri Mithilesh Kumar, SF&AO, IGFRI, Jhansi	Member
8.	Shri Rajiv Choudhary, Director, Directorate of Agricultural Engineering, Govt of Mdhya Pradesh, Bhopal	Member
9.	Shri Ravindra Kumar Verma, Additional Director (Engg), Department of Agriculture, Government of Bihar, Patna	Member
10.	Dr. S Patel, Prof & Head, Department of Agricultural Processing & Food engineering, IGKVV, Raipur	Member
11.	Shri Padam Singh, S/o. Shri Gorlal Thakur, Pipliya Junarder Village, Berasiya Tehsil.	Member
12.	Shri Suhas Manohar, Udaipur, Rajsthan	Member
13.	Chief Administrative Officer, ICAR-CIAE, Bhopal	Member Secretary

Institute Research Committee		
1.	Director, ICAR-CIAE, Bhopal	Chairman
2.	All Scientists and Head of Divisions, CIAE, Bhopal	Member
3.	Dr. Sandip Mandal, Scientist	Member Secretary

Institute Technology Management Committee		
1.	Director, ICAR-CIAE, Bhopal	Chairman
2.	HoDs (AMD/IDED/AEP/APPD/TTD)	Member
3.	Dr. KN Agrwal, PC AICRP on ESA	Member
4	Dr. Ramadhar Singh, Principal Scientist, IDED	Member
5.	I/c. PME Cell	Member
6.	Dr. Sanjay Shrivastava, Pr. Scientist, ICAR-IISS, Bhopal	External Member
7.	Member Secretary IRC	Member
8.	Dr. V Bhushan Babu, Sr. Scientist, AMD	Member Secretary & I/c. ITMC

Institute Joint Staff Council		
1.	Director, ICAR-CIAE, Bhopal	Chairman
Official Side		
2.	Dr.Nachiket Kotwaliwale	Member
3.	Dr. M Din, PC (UAE)	Member
4.	Dr.K.V.R.Rao	Member
5.	Dr. RK Tiwari, CTO	Member
6.	Shri MK Mulani, Finance & Account Officer	Member
7.	Chief Administrative Officer	Member Secretary (Official Side)
Staff Side		
1.	Shri AC Gupta, TO	Member
2.	Shri S Dilip Kumar, UDC	Member
4.	Shri AN Pawar, SSS	Member
5.	Smt Chandrakala Bai, SSS	Member
6.	Shri RC Maheshwari, Sr. Technician	Member Secretary, (Staff Side)

Women Cell		
1.	Dr. Dipika A. Murugkar, Principal Scientist	Chairperson
2.	Ms. Swapnaja Jadhav, Scientist	Member
3.	Ms. Jolly John, TO	Member
4.	Ms. Bindu Prasad, Stenographer III	Member
5.	Mrs. Suruchi Bhagchandani, Assistant	Member
6	Ms. Swati Singh, Assistant	Member
7.	Mrs. Kushal Suri, AAO (Rectt.), Ex. Officio	Member Secretary

PME Cell		
1.	Dr. SK Giri, Principal Scientist	In charge-PME Cell
2.	Dr.CK Saxena, Senior Scientist	Member
3.	Dr. Sandip Mandal, Scientist	Member
4.	Dr. CP Sawant, Scientist	Member

Committee for Prevention of Sexual Harassment of Women at Workplace		
1.	Dr. Dipika A. Murugkar, Principal Scientist	Chairperson
2.	Mrs. Samlesh Kumari, Scientist	Member
3.	Mrs. Deepika Shinde Channe, ACTO	Member
4.	Mrs. Manju Lohani, Assistant	Member
5.	Dr. K.Bharati, Principal Scientist	Member – ICAR-IISS
6.	Mrs. Kushal Suri, Assistant Administrative Officer	Member Secretary

Hindi Rajbasha Committee		
1.	Director	Chairman
2.	Dr. KP Singh, Principal Scientist	Member
3.	Dr. RS Singh, Principal Scientist	Member
4.	Dr. KN Agrawal, Project Coordinator, ESA	Member
5.	CAO	Member
6.	F&AO	Member
7.	Dr. SP Singh, CTO	Member Secretary

Board of Studies (PG School)		
1.	Director, ICAR-CIAE, Bhopal	Chairman and Professor
2.	Dr. Nachiket Kotwaliwale, Head APPD	Member
3.	Dr. M.Din, PC, AICRP on UAE	Member
4.	Dr. Karan Singh	PG School Coordinator
5.	Dr. SK Giri, Principal Scientist	Member
6.	Dr. KP Singh, Principal Scientist	Member
7.	Dr. RK Singh, Principal Scientist	Member
8.	Dr. Debabandya Mohapatra, Senior Scientist	Member
9.	Dr. AK Roul, Scientist	Member
10.	Mr. Aman Mahore, III year Student	Student Representative

Institute Technology Release Committee		
1.	Director, ICAR-CIAE, Bhopal	Chairman
2.	PCs of AICRPs (FIM, EAAI, HAES, ESA)	Member
3.	HoDs(AMD/AEP/APPD/IDED/TTD)	Member
4.	I/C PME Cell	Member
5.	PI & Co-PI of the Project or Technology	Member
6.	Member Secretary, IRC	Member Secretary

Scientific Staff and Senior Officers (as on 31st December 2020)

Director

PS Tiwari (Actg.) till 27th February, 2020

CR Mehta wef 28th February, 2020

Project Coordinator

CR Mehta, AICRP on FIM

KC Pandey, AICRP on EAAI

KN Agrawal, AICRP on ESA

M Din, AICRP on UAE

Head of Division

KC Pandey, I/C Head AEP (till 5th July, 2020)

Nachiket Kotwaliwale, APPD (till 9th October, 2020)

PC Bargale, TTD

PS Tiwari, AMD

Ramadhar Singh, IDED (wef 14th October, 2020)

Sandip Gangil, AEP (wef 6th July, 2020)

SK Giri, APPD (wef 12th October, 2020)

Principal Scientist

Badegaonkar UR, FMP

Balasubramanian S, ASPE

Bhargav VK, FMP

Chakraborty SK, ASPE

Chandra Punit, Bio. Chem.

Dawn CP Ambrose, ASPE

Debabandya Mohapatra, ASPE

Deshpande SS, Home Sc. Extn. (superannuated on 31st May, 2020)

Dipika A. Murugkar, Food and Nutrition

Dubey UC, FMP

Dushayant Singh, Mech. Engg.

Gangil S, FMP

Giri SK, ASPE

Mangraj S, ASPE

Muthamil Sevan, FMP

Naik Ravindra, ASPE

Ramana Rao KV, SWCE

Saha KP, Ag. Economics

Senthil Kumar T, FMP

Singh CD, EI

Singh Karan, Com. App.

Singh KP, FMP

Singh Ramadhar, SWCE

Singh RK, SWCE

Singh RS, Ag. Economics

Sinha LK, ASPE (superannuated on 31 October, 2020)

Tripathi MK, Bio. Chem.

Senior Scientist

Aleksha SK, ASPE

Mandal Sandip, FMP

Saxena CK, SWCE

Senthil Kumar R, Vet. Ext.

Scientist (SG)

Tamhankar MB, FMP

Scientist (SS)

Bhushana Babu V, Ag. Stat.

Scientist

Chandel NS, FMP

Gupta Ajita, LWME

Hasan Muzaffar, Plant Biochem (on study leave)

Imran Syed S., FMP

Jadhav Swapnaja K, FMP

Jat Dilip, FMP

Jena PC, FMP

Jyoti Bikram, FMP

Kate Adinath E, APE

Khadatkar Abhijit, FMP

Kumar Ajay V, APE

Kumar Manish, FMP

Kumar Manoj, Ag. Stat.

Kumar Manoj, FMP

Kumar Mukesh, LWME

Kumar SP, FMP

Kumar Vijay, FMP (on study leave)

Kumari Sweeti, FMP

Magar AP, FMP (on study leave)

Maheswari Chirag, Plant Biochem

Nagori Ankur, Mech. Engg. (on study leave)

Nandede BM, FMP

Pandey HS, FMP (on study leave)

Pandirwar AP, FMP

Pawar DA, APE

Potdar RR, FMP

Pravitha M, APE

Rajwade YA, LWME

Randhe RD, LWME (on study leave)

Roul AK, FMP

Sadvatha RH, ASPE

Sahni RK, FMP (on study leave)

Samlesh Kumari, Dairy Micro.

Sawant CP, FMP

Subeesh A, CS

Thorat DS, FMP (on study leave)

Waghaye AM, LWME (on study leave)

Wakudkar Harsha M, FMP (on study leave)

Yadav Ajay, Food Tech (on study leave)

Chief Administrative Officer

Kumar Rajesh

Administrative Officer

Dalal Ritu (till 28 August, 2020)

Senior Finance and Accounts Officer

Mulani MK

Assitant Administrative Officer

Roy Ashish

Raut MK

Tripathi RK

Kamal Mustafa

Rajak OP

Suri Kushal

Assistant Finance and Accounts Officer

Singh SK

Incharges

Shilarkar AP, Library

Singh CD, Instrumentation

Giri SK, PME Cell

Singh Dushyant, PPC

Singh KP, CAD cell

Singh Karan, AKMU

Raut MK, I/C Dispensery

Tiwari RK, VMS

Soni RD, Farm Section (till 31 July, 2020)

Singh Ravindra, Farm Section (wef 1 August, 2020)

Singh SP, EMS

Chakraborty SK, Guest House

Saha KP, KVK

Bhargav VK, Research Workshop (till 30 October, 2020)

Singh KP, Research Workshop (wef 31 October, 2020)

ACRONYMS

Acronyms	Description
AAO	Assistant Administrative Officer
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	Department 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
ICARDA	International Centre for Research in Dry Areas
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 Inovation in 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 Cente

Acronyms	Description
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
SERB	Science & Engineering Research Board
SHG	Self Help Group
SMS	Subject Matter Specialists
WCD	Women and Child Development

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

Agrisearch with a human touch

ICAR- Central Institute of Agricultural Engineering

Nabi bagh, Berasia Road, Bhopal-462038

Telephone : +91 755 2737191

Fax : +91 755 2734016

Email : director.ciae@icar.gov.in

Website : www.ciae.icar.gov.in