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ANNUAL REPORT 2024

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ICAR

ICAR - CIAE, BHOPAL

ICAR - Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road, Bhopal-462038
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No. CIAE/AR/2024/44

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PREFACE

The ICAR-Central Institute of Agricultural Engineering (CIAE) in Bhopal, India, has been a cornerstone of agricultural mechanization in the country for the past 50 years. CIAE will be celebrating the Year 2025 as the Year of Golden Jubilee. Established in 1976, CIAE has diligently pursued research and development in various facets of agricultural engineering, encompassing areas like tillage, sowing, harvesting, post-harvest technologies, irrigation and drainage engineering and the integration of renewable energy sources. This has led to the development of innovative and efficient machinery, such as improved ploughs, seed drills, harvesters, threshers, food processing machinery, processes, products, gadgets of energy etc. significantly enhancing agricultural productivity and reducing labour-intensive tasks for farmers in the country.

Furthermore, CIAE has played a important role in disseminating these advancements through a multifaceted approach. This includes conducting extensive training programs for farmers, farm machinery operators, and entrepreneurs, establishing demonstration farms to showcase the benefits of mechanization, and providing vital extension services through Krishi Vigyan Kendras. These initiatives have empowered farmers with the knowledge and skills to effectively utilize modern agricultural machinery, leading to increased adoption and improved farm incomes.

CIAE Bhopal is at the forefront of agricultural innovation, leveraging AI, ML, and drone technologies to transform Indian farming. Through research, development, and capacity building, the institute is creating solutions for automated farming, precision agriculture, and efficient resource management. By developing precision machines for various agricultural tasks, designing AI/ML powered systems for crop monitoring and management, and promoting these technologies among farmers, CIAE Bhopal is significantly contributing to increased agricultural productivity, reduced costs, and sustainable farming practices.

While ICAR-CIAE primarily focuses on mechanization in agriculture, its research and development efforts indirectly contribute to natural farming. By developing energy-efficient machinery, promoting renewable energy solutions, and focusing on post-harvest technologies, the institute supports sustainable agricultural practices. Additionally, through training programs and knowledge dissemination, ICAR-CIAE empowers farmers to adopt eco-friendly methods and reduce their reliance on chemical inputs.

Beyond research and technology transfer, CIAE has actively engaged in policy advocacy, influencing government decisions on agricultural mechanization. This includes advocating for subsidies and incentives to encourage the purchase of agricultural machinery, promoting the establishment of custom hiring centers to make machinery accessible to small and marginal farmers, and fostering skill development programs for farm machinery operators and technicians. By collaborating closely with the agricultural machinery industry, CIAE has also played a pivotal role in improving the quality of farm machinery, promoting the development of new technologies, and ensuring their smooth commercialization.

Significant achievements were made by the scientists of the Institute in commercializing technologies, publishing papers and being awarded from very prestigious institutions. ICAR-CIAE, Bhopal is also emerging as a major study centre as well, the Institute has also been identified as the

ICAR-IARI Study Hub Centre for undergraduate and postgraduate programmes. The Institute has already started M.Tech. programme.

Compilation of this report would not have been possible without the able guidance of Hon'ble Secretary, DARE and Director General, ICAR, Dr Himanshu Pathak; support of Dr. Shyam Narayan Jha, Deputy Director General (Agricultural Engineering), ICAR; motivation from Dr. Krishna Pratap Singh, Assistant Director General (Farm Engineering) and Dr Kairam Narsaiah, Assistant Director General (Process Engineering), ICAR. Execution of all the research and development work presented in this report can be credited to the constant administrative and financial support received from the ICAR Headquarters and Institute. Salutations are also due for the staff of this Institute of prominence for being dedicated and persistent with their efforts in the pursuit of the agricultural mechanization of our great nation. The editorial team has done a commendable job in compiling all the work done by the Institute into a form that is easy to comprehend by all the stakeholders. I sincerely hope that this report excels in its purpose for which it is deemed to be so.

CR Mehta
Director

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कार्यकारी सारांश

अनुसंधान एवं विकास

- अंगूर के बागों में दानेदार उर्वरक के अनुप्रयोग के लिए एक ट्रैक्टर संचालित मशीन विकसित की गई है, जिसकी कार्य क्षमता और क्षेत्र दक्षता क्रमशः 0.72 हेक्टेयर/घंटा और 77.6 प्रतिशत है।
- 2 मीटर ऊंचे बाग के छतरियों के लिए एक समान स्प्रे कवरेज सुनिश्चित करने के लिए एक ट्रैक्टर संचालित वायु-सहायता प्राप्त रीसाइक्लिंग सुरंग स्प्रेयर विकसित किया गया। इसमें एक एयर-ब्लोइंग यूनिट, एक पीटीओ-संचालित रासायनिक छिड़काव प्रणाली और एक तरल संग्रह और पुनर्चक्रण तंत्र के साथ एक खुलने और बंद हो सकने योग्य सुरंग शामिल है। सुरंग की चौड़ाई अलग-अलग छतरियों की संरचनाओं के लिए समायोज्य (1-2 मीटर) है। अनुकूलित नोजल प्लेसमेंट (350 मिमी स्पेसिंग, 43° कोण) और 1100 मिमी सुरंग खोलने से स्प्रे जमाव में 74.55 प्रतिशत सुधार हुआ और स्प्रे उपयोग में 7.56 प्रतिशत की कमी आई। यह0.45 हेक्टेयर/घंटा की कार्य क्षमता और 78.63 प्रतिशत दक्षता के साथ, रासायनिक अपशिष्ट और पर्यावरण प्रदूषण को भी न्यूनतम करता है।
- छवि आधारित परिवर्तनीय दर नाइट्रोजन एप्लीकेटर को तरल और दानेदार रूप में एक क्षेत्र में पोषक तत्व की अनुकूलित डिलीवरी के साथ विकसित किया गया है, जिससे साइट विशिष्ट फसल आवश्यकताओं के आधार पर सटीक नाइट्रोजन अनुप्रयोग किया जा सकता है।
- कपास की कटाई के लिए एक मशीनीकृत समाधान प्रदान करने के लिए ब्रश प्रकार के कपास स्ट्रिपर हार्वेस्टर का विकास किया गया है। दो काउंटर रोटेटिंग पिकर दक्षता के साथ ब्रश और रबर बैट-प्रकार के कपास स्ट्रिपर की 93.15 प्रतिशत है और मशीन का शुद्ध बीज कपास उत्पादन 150 से 217 किलोग्राम/घंटा है।
- स्वदेशी चाय बागान के अंदर चाय की पत्ती तोड़ने और छंटाई के संचालन के लिए मानव रहित रोबोटिक प्लेटफॉर्म विकसित किया गया है जिसमें 1.4 मीटर की (ग्राउंड क्लीयरेंस) और एक ट्रैक की चौड़ाई है जिसे 1.4 और 2.0 मीटर के बीच समायोजित किया जा सकता है।
- माइक्रोकंट्रोलर सिस्टम के साथ डीप लर्निंग-आधारित कंप्यूटर विज़न को एकीकृत करते हुए, स्वचालित फ़ीड डिस्पेंसर (एएफडी) को भारतीय कृषि श्रमिकों के डेटा का उपयोग करके एर्गोनॉमिक रूप से डिज़ाइन किया गया था। इसमें सटीक फ़ीड डिलीवरी के लिए हॉपर, ऑगर-टाइप वॉल्यूमेट्रिक डिस्पेंसर, स्टेपर मोटर और पीएलसी की सुविधा है। सिस्टम ने ५ के अंशांकन कारक पर १०० प्रतिशत से अधिक वितरण सटीकता हासिल की, जिसमें फ़ीड मात्रा २४६.९ ग्राम (सप्ताह १) से २५३८.४ ग्राम (सप्ताह ९) तक थी। यह एएफडीदक्षता में सुधार करता है, मानवीय भागीदारी को कम करता है, और पोल्ट्री संचालन में रोग संचरण के जोखिम को कम करता है।
- नैनो यूरिया अनुप्रयोग के लिए ड्रोन छिड़काव की दक्षता का मूल्यांकन करने के लिए कपास की फसल पर एक क्षेत्र अध्ययन किया गया। तीन नाइट्रोजन उपचारों का परीक्षण किया गया: प्रिल यूरिया प्रसारण (११० किग्रा/हेक्टेयर), नैनो यूरिया नैपसेक स्प्रेयर के माध्यम से (५ लीटर/हेक्टेयर स्प्रे दर पर १.२५ लीटर/हेक्टेयर), और ड्रोन के माध्यम से (२५ लीटर/हेक्टेयर स्प्रे दर पर १.२५ लीटर/हेक्टेयर)। NDVI और SPAD मान आवेदन से एक दिन पहले और आठ दिन बाद दर्ज किए गए। परिणामों ने सभी उपचारों में NDVI और SPAD मानों में मामूली बदलाव प्रदर्शित किए। कोई महत्वपूर्ण अंतर नहीं देखा गया, यह दर्शाता है कि कपास में नैनो यूरिया प्रयोग के लिए ड्रोन छिड़काव पारंपरिक तरीकों जितना ही प्रभावी है।
- एक स्वचालित एआई सक्षम पर्ण प्रयोग प्रणाली विकसित की गई है जो टमाटर की फसलों में वास्तविक समय में नाइट्रोजन सांद्रता का अनुमान लगाती है, आवश्यक नाइट्रोजन मात्र की गणना करती है और स्प्रेयर N को वास्तविक समय में मापती है।
- एक दूर से नियंत्रित रोबोट वीडर विकसित किया गया, जिसमें चार पहिया ड्राइव वाहन, एक इलेक्ट्रॉनिक नियंत्रण इकाई और एक स्वीप-प्रकार की निराई प्रणाली शामिल है। दो स्वीप टाइन से सुसज्जित यह निराई इकाई अपनी गहराई और चौड़ाई (३५० मिमी तक) को समायोजित कर सकती है और इसे दूर से संचालित किया जा सकता है। ४५० मिमी पंक्ति अंतराल वाले मक्का में फील्ड परीक्षणों से पता चला कि उभरी हुई क्यारियों में निराई की दक्षता ८१.६ प्रतिशत और पौधों को ४.२ प्रतिशत नुकसान पहुंचा, और समतल क्यारियों में १४.६ प्रतिशत नुकसान के साथ ७४.९ प्रतिशत दक्षता मिली।
- एक हल्के वजन का बहु-फसल बोने वाला यंत्र जो अदला-बदली करने योग्य बीज प्लेटों से सुसज्जित है, यह विभिन्न फसलों के लिए उपयुक्त है, इसे भा.कृ.अ.प.-के.कृ.अ.स. स्व-चालित प्याज वीडर के लिए एक अटैचमेंट के रूप में विकसित किया गया। प्याज, सोयाबीन, चना और काले चने के लिए काली कपास मिट्टी में किए गए फील्ड परीक्षणों ने ८२ प्रतिशत से अधिक दक्षता के साथ ०.०३१५ से ०.०३८७ हेक्टेयर/घंटा तक की क्षमता प्रदर्शित की। रोपण की गहराई २०-७० मिमी और अंतराल ९३.५-१११.१६ मिमी तक था। बुवाई यंत्र ने एक समान बीज प्लेसमेंट और संतोषजनक प्रदर्शन सुनिश्चित किया।

- गेहूं और मक्का में सटीक यूरिया अनुप्रयोग के लिए एक ट्रैक्टर-चालित तरल उर्वरक एप्लीकेटर विकसित किया गया था, जिसका उद्देश्य नाइट्रोजन उपयोग दक्षता (एनयूई) में सुधार करना और पर्यावरणीय प्रभाव को कम करना था। इस प्रणाली में एक कल्टर-आधारित छह-पंक्ति इंजेक्शन तंत्र है जो तरल यूरिया को जड़ क्षेत्र में ५०-१०० मिमी गहराई तक रखता है, जिससे NUE ६७ प्रतिशत तक बढ़ जाता है और उपज से समझौता किए बिना यूरिया का उपयोग ३३-४४ प्रतिशत कम हो जाता है। फील्ड परीक्षणों ने इसकी प्रभावशीलता की पुष्टि की, नाइट्रोजन उर्वरक अनुप्रयोग के लिए पारंपरिक प्रसारण विधियों के लिए एक किफायती, कुशल और टिकाऊ विकल्प की पेशकश की।
- कृषि श्रमिकों में मांसपेशियों की गतिविधि और मस्कुलोस्केलेटल विकार (MSD) जोखिमों का आकलन करने के लिए अधिकतम स्वैच्छिक संकुचन (MVC) को मापने के लिए एक प्रयोगात्मक सेटअप विकसित किया गया था। भारतीय कृषि कार्यकर्ता मानवशास्त्रीय डेटा का उपयोग करके एर्गोनॉमिक रूप से डिज़ाइन किए गए, सेटअप में खड़े होकर किये जाने वाले कार्यों के लिए समायोज्य ऊर्ध्वाधर पोल और बैठे कार्यों के लिए स्टूल शामिल हैं।
- एल्युमिना-चूरा चार-समर्थित Ni उत्प्रेरक मीथेन पायरोलिसिस से हाइड्रोजन के कुशल और टिकाऊ उत्पादन के लिए एक अच्छी सामग्री के रूप में कार्य करता है। उत्प्रेरक ने १५ मिनट की अवधि के लिए ९८ प्रतिशत तक मीथेन रूपांतरण प्रदर्शित किया और उसके बाद १२० मिनट तक ८० प्रतिशत के रूपांतरण के साथ कायम रहा।
- 1 प्रतिशत एसिड उपचारित धान के भूसे और 600 डिग्री सेल्सियस पर तैयार बायोचार की प्रक्रिया की स्थिति में प्राप्त धान के भूसे से हाइड्रोजन गैस की अधिकतम प्राप्ति 2.47 लीटर प्रति किलोग्राम थी। इससे ज्ञात हुआ कि हाइड्रोजन उत्पादन को बढ़ाने के लिए बायोचार का अधिक सतह क्षेत्र सूक्ष्मजीव समुदाय के विकास के लिए अनुकूल है।
- नैनोपोरस कार्बन-आधारित इलेक्ट्रोड ने 1.0 A/g की वर्तमान घनत्व, 48 Wh/kg की ऊर्जा घनत्व और 495 W/kg की शक्ति घनत्व के साथ-साथ उत्कृष्ट साइक्लिंग स्थिरता के साथ 343.29 F/g की विशिष्ट धारिता प्रदर्शित की। निष्कर्ष बताते हैं कि चने के डंठल से प्राप्त नैनोपोरस कार्बन उच्च प्रदर्शन वाले सुपर कैपेसिटर और ऊर्जा भंडारण उपकरणों के लिए एक आशाजनक जैव-सामग्री है।
- चने की फसल के अवशेषों के प्लाज्मा उपचार से इसका महत्वपूर्ण घनत्व प्राप्त हुआ, जैसा कि सतह क्षेत्र में 0.85918 m^2/g (कच्चा) से 0.045257 m^2/g (15 मिनट) तक की प्रारंभिक गिरावट से स्पष्ट है। प्लाज्मा उपचार के निष्कर्ष बायोमास छिद्रण और पहुंच को संशोधित करने में इसकी गतिशील प्रकृति को रेखांकित करते हैं, जिसका जैव रूपांतरण और सामग्री इंजीनियरिंग अनुप्रयोगों के लिए दूरगामी प्रभाव हो सकता है।
- सौर पीवी पोर्टेबल ग्रीनहाउस में उगाई गई फसल नियंत्रण की तुलना में प्रति पौधे अधिक संख्या में पत्तियां और पौधे की जड़ की लंबाई देती है। यह पाया गया कि सौर और नियंत्रण ग्रीनहाउस के बीच विकिरण में अंतर 38 प्रतिशत था।
- चने की बुवाई बहुउपयोगी ई-वाहन का उपयोग करके की गई थी, प्रभावी कार्य क्षमता 0.29 हेक्टेयर/घंटा थी, जिसमें 75.98 प्रतिशत दक्षता और ₹874.60/हेक्टेयर की लागत थी। बुवाई के दौरान अनुमानित बिजली की खपत 0.664 किलोवाट (19 ए करंट) थी, जो कुल 1518 एमजे/हेक्टेयर थी।
- संयुक्त एसिड और एंजाइमेटिक प्रीट्रीटमेंट प्रक्रिया धान के भूसे और मकई के भुट्टे को प्रभावी रूप से किण्वनीय शर्करा में परिवर्तित कर सकती है, जो जैव ईंधन उत्पादन के लिए एक टिकाऊ और कुशल मार्ग प्रदान करती है।
- बड़ी मिलों (8 टीपीएच और 12 टीपीएच) ने अधिकांश प्रक्रियाओं में बेहतर दक्षता दिखाई, सफेदी और पॉलिशिंग जैसे कुछ चरण प्रमुख ऊर्जा उपभोक्ता बने रहे, 4 टीपीएच मिल में कुल ऊर्जा और उत्सर्जन में 50 प्रतिशत से अधिक का योगदान दिया, और 8 टीपीएच और 12 टीपीएच मिलों में 45 प्रतिशत-50 प्रतिशत का योगदान दिया।
- सोयाबीन के खेत में सौर ऊर्जा से चलने वाले नैपसेक स्प्रेयर के इस्तेमाल से ऊर्जा की खपत में उल्लेखनीय कमी आई। हर्बिसाइड के इस्तेमाल के लिए, सौर स्प्रेयर के साथ ऊर्जा इनपुट १५०.३५ MJ/ha था, जबकि पारंपरिक पावर नैपसेक स्प्रेयर के साथ यह १७४.३५ MJ/ha था, जिसके परिणामस्वरूप १३.७७ प्रतिशत ऊर्जा की बचत हुई।
- कॉर्नकोब बायोमास में उच्च क्रिस्टलीय सेल्यूलोज के स्रोत के रूप में बहुत संभावनाएं हैं, जिसका उपयोग बायोकंपोजिट की तैयारी में किया जाता है। कॉर्नकोब का क्रिस्टलीयता सूचकांक, जो २९.६३ प्रतिशत था, निकाले गए सेल्यूलोज में बढ़कर ५३.९५ प्रतिशत हो गया।
- डिटॉक्सीफाइड धान के भूसे के हाइड्रोलाइज़ेट के डार्क किण्वन के परिणामस्वरूप किण्वन के ७२ घंटों में २२६.६७ mL/L का अधिकतम कुल गैस उत्पादन हुआ। हाइड्रोलाइज़ेट के पीएच ५.५ पर ४२६.६७ और १८३.४७ एमएल/एल का संचयी कुल गैस और हाइड्रोजन उत्पादन दर्ज किया गया। धान के भूसे के एसिड प्री-ट्रीटमेंट के बाद बचे अवशेषों से तैयार किए गए ब्रिकेट ९५.१८ प्रतिशत के शैटर इंडेक्स और १९.६३ एमजेकेजी-१ के कैलोरीफिक वैल्यू के साथ कॉम्पैक्ट पाए गए।

- ३० एल/मिनट की इष्टतम वायु प्रवाह दर और ३ के स्टीम-टू-बायोमास अनुपात पर, १.९५ एम३ किग्रा-१ सिनगैस में हाइड्रोजन सामग्री ६५ ± ०.९ प्रतिशत देखी गई।
- डार्क किण्वन प्रक्रिया में कपास हाइड्रोलाइज़ेट का उपयोग करके हेक्सोज के २.९ मोल/मोल तक अधिकतम H२ उत्पादन प्राप्त किया जाता है।
- LiPF६ का उपयोग करने वाले इलेक्ट्रोड १०० चक्रों के लिए परीक्षण किए गए अच्छे डिस्चार्ज स्थिरता को दर्शाते हैं और कार्बन ब्लैक और सक्रिय कार्बन-आधारित इलेक्ट्रोड के लिए ५०१ और ३८३mAh/g प्राप्त करते हैं। यह दर्शाता है कि कृषि बायोमास में लिथियम आयन (Li-ion) बैटरी एनोड के लिए कार्बन के उत्पादन की अच्छी क्षमता है।
- फसल अवशेषों से प्लास्टरिंग सामग्री तैयार करने के लिए, ३५० और ५५० डिग्री सेल्सियस के तापमान पर सोयाबीन के भूसे के थर्मल उपचार के साथ रेत के २५ प्रतिशत और ५० प्रतिशत प्रतिस्थापन से धान के भूसे की तुलना में बेहतर संपीड़न शक्ति मिलती है।
- सिंचाई शेड्यूलिंग के लिए, संदर्भ फसल वाष्पोत्सर्जन और फसल जल मांग के लिए मॉड्यूल को एकीकृत करके एक मशीन लर्निंग-आधारित निर्णय समर्थन प्रणाली विकसित की गई थी। इस प्रणाली को मध्य भारत में विभिन्न फसलों में मान्य किया गया था।
- गेहूं और चावल की उपज की भविष्यवाणी के लिए CNN-CBAM आर्किटेक्चर पर आधारित अत्याधुनिक डीप लर्निंग मॉडल बनाए गए, जो ग्राउंड ट्रुथ डेटा के साथ संयुक्त यूएवी-व्युत्पन्न मल्टीस्पेक्ट्रल इमेजरी का उपयोग करके ६५-८० प्रतिशत की सटीकता रेंज प्राप्त करते हैं। इसके अतिरिक्त, स्पेक्ट्रल वनस्पति सूचकांक (NDVI) के साथ संयोजन में मशीन लर्निंग मॉडल (सपोर्ट वेक्टर मशीन) का उपयोग करके उपज की भविष्यवाणी ने बेहतर प्रदर्शन किया, जो ९५ प्रतिशत सटीकता तक पहुंच गया।
- PANI (पॉलीएनिलिन) नैनोकणों का उपयोग करके सतह संशोधन के माध्यम से मृदा नमी सेंसर (MP ४०६) की गति, चयनात्मकता और संवेदनशीलता को बढ़ाया गया। संशोधित सेंसर ने वॉल्यूमेट्रिक मृदा नमी सामग्री के विभिन्न स्तरों में संवेदनशीलता में १२-२६ प्रतिशत की वृद्धि प्रदर्शित की।
- ०.४ हेक्टेयर क्षेत्र की सिंचाई के लिए रैखिक चाल सिंचाई प्रणाली का एक प्रोटोटाइप विकसित किया गया था। ८६ प्रतिशत एकरूपता के साथ २० मिमी की सिंचाई गहराई को लागू करने में लगभग १० घंटे लगते हैं।
- पचा हुआ घोल मछली के भोजन के रूप में उपयोग करने की बहुत संभावना है क्योंकि यह मत्स्याहर के लिए एक व्यवहार्य प्रोटीन स्रोत के रूप में काम कर सकता है। साथ ही, एफ़्लैटॉक्सिन और आर्सेनिक का स्तर विनियामक सीमाओं से नीचे पाया गया, जो दर्शाता है कि घोल मछली के भोजन में उपयोग के लिए सुरक्षित है।
- AI-चालित, स्वचालित वीडर खरपतवारों के कारण उपज की हानि को कम करता है और मैन्युअल वीडिंग की गहन-श्रम प्रक्रिया को कम करता है। वीडर खरपतवारों का पता लगा सकता है, निर्णय ले सकता है, नेविगेट कर सकता है, छिड़काव को नियंत्रित कर सकता है और मोटर कार्यों का सटीकता के साथ प्रबंधन कर सकता है।
- धान के भूसे को लिग्निन, सिलिका और सेल्यूलोज निष्कर्षण जैसे औद्योगिक रूप से मूल्यवान उत्पादों में बदलने की क्षमता। यह कृषि अवशेषों को प्रभावी रूप से मूल्यवान औद्योगिक उत्पादों में बदल देता है, अपशिष्ट प्रबंधन चुनौतियों का समाधान करता है और पर्यावरणीय स्थिरता को बढ़ावा देता है।
- निरंतर टॉरफिकेशन सिस्टम में चावल की भूसी के टॉरफिकेशन ने टॉरफिकेशन के बाद ईंधन गुणों में महत्वपूर्ण सुधार का संकेत दिया। HHV में लगभग २२-२३ प्रतिशत की उल्लेखनीय वृद्धि हुई।
- पाइन नीडल जैविक तेल से ग्रीस का उत्पादन विकसित ग्रीस रिएक्टर के माध्यम से निष्पादित किया गया। रिएक्टर में इम्पेलर का डिज़ाइन प्रभावी मिश्रण के माध्यम से सजातीय ग्रीस प्रदान करने में मदद करता है।
- छोटे किसानों के लिए हेड फीड टाइप अलसी थ्रेशर विकसित किया गया है, जो ०.५ एचपी इलेक्ट्रिक मोटर द्वारा संचालित है। इसकी थ्रेसिंग क्षमता १७८.६२ किलोग्राम प्रति घंटा है और इसकी दक्षता ९९.३१ प्रतिशत है। इसकी लागत ५०,००० रुपये है, तथा इसकी परिचालन लागत ८९.१७ रुपये प्रति घंटा है, जिससे १७.८ गुना अधिक उत्पादन और ५.६३ गुना अधिक लाभ प्राप्त होता है।
- ट्रैक्टर से चलने वाली हल्दी कंबाइन हार्वेस्टर को 28 किलोवाट बिजली की आवश्यकता और 0.16 हेक्टेयर/घंटा कार्य क्षमता के साथ विकसित किया गया है। इसमें 750 मिमी डी-टॉपिंग यूनिट, डिगर कम कन्वेयर और संग्रह टैंक शामिल हैं। इससे 97 प्रतिशत खुदाई, 94 प्रतिशत डी-टॉपिंग, 70 प्रतिशत सफाई दक्षता प्राप्त होती है और परिचालन लागत 1100 रुपये/घंटा है।

- विभिन्न अवशेष प्रबंधन विधियों का उपयोग करके गेहूं में ड्रोन-आधारित पूर्व और बाद के उद्भव शाकनाशी छिड़काव का मूल्यांकन किया गया है। 2.0-3.0 मीटर/सेकंड और 2-3 मीटर ऊंचाई पर संचालित ड्रोन ने 81-92 प्रतिशत फालारिस माइनर नियंत्रण और 70-86 प्रतिशत ब्रॉडलीफ खरपतवार नियंत्रण दिखाया, जो कि नैपसेक स्प्रेयर के बराबर है, जिसमें महीन बूंदें और बेहतर स्प्रे एकरूपता है।
- 5-DOF रोबोटिक आर्म की विशेषता वाले सब्ज़ी ट्रांसप्लांटर के लिए रोबोटिक मीटरिंग मैकेनिज्म, जिसमें सीडलिंग का चित्रण किया गया है, इसने 0.7 किमी/घंटा की फ़ॉरवर्ड स्पीड पर 99.68 प्रतिशत तुड़ाई दक्षता, 4.05 प्रतिशत सीडलिंग क्षति और 91 प्रतिशत रूट-मीडिया आसंजन हासिल किया। यह सिस्टम व्युत्क्रम किनेमेटिक्स का उपयोग करके सटीक सीडलिंग प्लेसमेंट सुनिश्चित करता है और इसका परीक्षण सिम्युलेटेड स्थितियों के तहत किया गया था।
- सटीक, सुरक्षित छिड़काव के लिए रेडियो फ़्रीक्वेंसी (RF)-नियंत्रित कीटनाशक एप्लीकेटर विकसित किया गया है। इसमें RF, स्प्रेयर, ड्राइवर और ट्रॉली मॉड्यूल शामिल हैं, जो 24V DC मोटर और 12-नोजल, 2.65मीटर बूम का उपयोग करते हैं। फ़ील्ड परीक्षणों ने 3 किमी/घंटा पर 65-70 प्रतिशत दक्षता के साथ 0.5ha/h कवरेज दिखाया, जिससे रासायनिक उपयोग और ऑपरेटर जोखिम कम हो गया।
- 77 प्रतिशत जैविक खाद और 23 प्रतिशत मिट्टी का उपयोग करके कई चावल बीज गोलियां विकसित की गईं, जिससे 0.971 गोलाकारता, 98.42N टूटने की ताकत और 98.92 प्रतिशत गोली बनाने की दक्षता प्राप्त हुई। फील्ड परीक्षणों ने क्यारियों के बीच बेहतर अंतर (174.2 मिमी), आबादी (3/क्यारी) और ड्रम सीडिंग की तुलना में 80.22 प्रतिशत एकरूपता दिखाई। यह विधि सटीकता, पौधे के खड़े होने और बीज बोने की स्थिरता को बढ़ाती है।
- 0.42ha/h कार्य क्षमता, 85 प्रतिशत कार्य दक्षता और 30 मिमी काटने की ऊंचाई पर 90 प्रतिशत कटाई दक्षता के साथ एक ट्रैक्टर संचालित लैथिरस हार्वेस्टर विकसित किया। यह नुकसान को 3.5 प्रतिशत तक कम करता है और हाथ से कटाई की तुलना में लागत में 75 प्रतिशत की बचत करता है, जिससे तेज़, श्रम-कुशल फसल संग्रह सुनिश्चित होता है।
- रिज एकरूपता और रोपण स्थिरता में सुधार करने के लिए एक पहिया-माउंटेड दो-पंक्ति बेल्ट कप प्रकार का आलू बोने की मशीन विकसित की गई थी। 710 मिमी पंक्ति अंतराल और 60-80 मिमी रोपण गहराई के साथ 3.8-4.0 किमी/घंटा की गति से संचालन करते हुए, इसने 0.4 हेक्टेयर/घंटा कार्य क्षमता हासिल की। प्लांटर बेहतर संघनन, एक समान कंद प्लेसमेंट सुनिश्चित करता है, और प्रति घंटे 5.5-6.3 लीटर डीजल की खपत करता है।
- ट्रैक्टर से संचालित गन्ना पत्ती डिट्रैशर सह श्रेडर को श्रम को कम करने और दक्षता में सुधार करने के लिए विकसित किया गया था। इसने 82.17 प्रतिशत दक्षता पर 0.31 हेक्टेयर/घंटा की कार्य क्षमता हासिल की। मशीन मैनुअल डिट्रैशिंग की तुलना में 9,290 रुपये/हेक्टेयर (83.70 प्रतिशत) बचाती है, जिससे श्रम की मांग और स्वास्थ्य जोखिम कम होते हैं।
- एक हल्के वजन और कम लागत वाले तथा लंबे समय तक चलने वाले श्वसन मॉनीटर को फ्लेक्स-टाइप सेंसर और Arduino-आधारित प्रणाली का उपयोग करके विकसित किया गया। यह नथुने की गिनती की तुलना में ९६.९६ प्रतिशत सटीकता के साथ मवेशियों के श्वसन को लगातार ट्रैक करता है।
- फोटोइलेक्ट्रिक प्रॉक्सिमिटी सेंसर का उपयोग करके सेंसर-आधारित मवेशी धुलाई प्रणाली विकसित की गई थी, ताकि पशु का पता लगने पर धुलाई शुरू हो सके। इस प्रणाली में २७ फ्लैट-फैन नोजल, एक टाइमर-नियंत्रित पंप, तथा समायोज्य पानी के दबाव और नोजल की ऊँचाई शामिल हैं। दूध दुहने से पहले गर्मियों में स्वच्छता में सुधार करने के लिए इसे डिज़ाइन किया गया |यह मानव श्रम को कम करते हुए धुलाई को स्वचालित करता है और सफाई दक्षता को बढ़ाता है।
- एक बैच-प्रकार के मवेशी वॉशर को सात खोखले-शंकु नोजल के साथ फिट किए गए मोटर चालित क्षैतिज बूम के साथ डिज़ाइन किया गया था। यह प्रणाली श्रम को ५० प्रतिशत तक कम करती है, पानी के उपयोग को ६७-७२ प्रतिशत तक कम करती है, और बाह्य परजीवी हटाने में ८८ प्रतिशत तक सुधार करती है।
- मवेशियों के लिए दो घूमने वाले ब्रश वाली एक ग्रूमिंग यूनिट विकसित की गई, जो इलेक्ट्रिक मोटर द्वारा संचालित होती है और एल-आकार में स्थित होती है। यह ऑपरेशन इन्फ्रारेड प्रॉक्सिमिटी सेंसर द्वारा प्रारंभ किया जाता है। इसने त्वचा संक्रमण को (३-४ प्रतिशत)कम किया, ड्राफ्टेबिलिटी (१५-१६ प्रतिशत) में सुधार किया, और कुल मिलाकर ३३ प्रतिशत से अधिक सकारात्मक प्रभाव डाला।
- तीन-पंक्ति वाले पशु-चालित डिबल सीडर को सटीक बीज प्लेसमेंट के लिए अन्तः परिवर्तनीय रोटर और स्पेसर के साथ विकसित किया गया था। चावल और भिंडी के लिए कार्य परीक्षणों ने क्रमशः ०.१७८ हेक्टेयर/घंटा और ०.२७ हेक्टेयर/घंटा की कार्य क्षमता दिखाई। २.८ किमी/घंटा की गति से संचालित होने के कारण, इसे न्यूनतम ड्राफ्ट बल की आवश्यकता होती है और यह धान के लिए ९७८ रुपये/हेक्टेयर और भिंडी के लिए ५८९ रुपये/हेक्टेयर की कम लागत वाली रोपण प्रदान करता है।

- एक साथ बीज बोने और निषेचन के लिए स्लरी एप्लीकेटर के साथ एकीकृत बैल-चालित प्लांटर विकसित किया गया था। २.२५ किमी/घंटा की गति और ०.२१४ हेक्टेयर/घंटा की क्षमता के साथ कार्य दक्षता ७९.७९ प्रतिशत तक पहुँच गई। यह प्रणाली समान रूप से घोल वितरित करती है, जिसमें बीज की दर ८-१० किलोग्राम/हेक्टेयर होती है तथा परिचालन लागत १३७५ रुपये/हेक्टेयर होती है, जिससे श्रम की लागत घटकर ४.७५ घंटे प्रति हेक्टेयर रह जाती है।
- बैल द्वारा खींचे जाने वाले बायोगैस स्लरी एप्लीकेटर को बेलनाकार टैंक और दो-पहिया चेसिस के साथ को खाद को दक्षतापूर्वक फैलाने के लिए विकसित किया गया था। विभिन्न वाल्व सिरों पर परीक्षण किए जाने पर, इसने ०.३२३ हेक्टेयर/घंटा की कार्य क्षमता और २/३ वाल्व स्थिति पर ८०.९९ प्रतिशत दक्षता हासिल की। खेतों में तरल खाद का एक समान वितरण सुनिश्चित करने के लिए पट्टी की चौड़ाई ११२५ मिमी से १३९५ मिमी तक थी।
- पेडल से संचालित नारियल का छिलका हटाने वाला यंत्र, बैठने के लिए संशोधित किया गया है, जिसमें आसान हैंडलिंग के लिए एक संग्रह ट्रे है। इसने ८८.७२ प्रतिशत छिलका हटाने की दक्षता हासिल की और संचालन के दौरान मध्यम हृदय गति के साथ ऑपरेटर के कार्यभार और असुविधा को कम किया।
- कई सेंसर (पीआईआर, एलडीआर, धूल, कंपन, डीएचटी) और एक सर्वो मोटर का उपयोग करके एक एआई-संचालित सुरक्षा प्रणाली, जो थ्रेशर च्यूट की बेस प्लेट को स्वचालित रूप से खोलती है, जिससे घूमते हुए ड्रम तक पहुंच को प्रतिबंधित करके हाथ की चोटों को रोका जा सकता है।
- एक AI-आधारित प्रणाली छवि प्रसंस्करण का उपयोग करके फीडिंग रोलर्स के पास मानव शरीर के अंगों का पता लगाती है और स्वचालित रूप से उलटने और अलार्म को ट्रिगर करती है, जिससे थ्रेसिंग के दौरान दुर्घटना के जोखिम में काफी कमी आती है।
- वास्तविक समय के कैमरा फीड के साथ VR-आधारित रिमोट-कंट्रोल सिस्टम धान ट्रांसप्लांटर को दूर से संचालित करने में सक्षम बनाता है। यह प्रभावी कार्य क्षमता और स्वीकार्य मिसिंग हिल दरों को बनाए रखते हुए ऑपरेटर की ऊर्जा व्यय और असुविधा को कम करता है।
- लिथियम-आयन बैटरी से चलने वाला मैनुअल ट्रांसप्लांटर रीढ़ की हड्डी के भार को कम करके एर्गोनोमिक आराम में सुधार करता है, क्षेत्र की क्षमता को २४ प्रतिशत तक बढ़ाता है, और बेहतर संतुलन और कम ऑपरेटर थकान के साथ कठोर श्रम को कम करता है।
- YOLO ऑब्जेक्ट डिटेक्शन और एक मैकेनिकल ब्रेकिंग एक्ट्यूएटर का उपयोग करने वाला एक AI सिस्टम स्वचालित रूप से बाधाओं का पता लगाता है और ब्रेक लगाता है, जिससे ब्लाइंड स्पॉट परिदृश्यों में ट्रैक्टर की सुरक्षा में सुधार होता है।
- दो एर्गोनोमिक उपकरण (बैटरी से चलने वाला ब्रश और रोलर फ्रेम) उच्च वर्षा वाले क्षेत्रों में किसानों के लिए शारीरिक प्रयास और चोट के जोखिम को कम करते हुए, संतरे के पेड़ों से शैवाल और लाइकेन को कुशलतापूर्वक हटाते हैं।
- ट्रैक्टर पर लगे हुए हिना हार्वेस्टर २ किमी/घंटा की गति से ९६.०८ प्रतिशत कटाई और ९७.०१ प्रतिशत संवहन क्षमता प्रदान करते हैं, जिसमें शारीरिक आकलन मध्यम कार्य तीव्रता का संकेत देते हैं, लेकिन कुल मिलाकर कटाई का प्रदर्शन बेहतर होता है।
- टेलिस्कोपिक स्प्रे लांस, एक कैनोपी हुड, और ESP३२ माइक्रोकंट्रोलर द्वारा नियंत्रित एम्बेडेड मौसम और कैनोपी सेंसर सहित एक रेट्रोफिट सिस्टम ऑपरेटर के रासायनिक जोखिम को कम करता है और छिड़काव में आराम और दक्षता में सुधार करता है।
- निचले शरीर का एक्सोस्केलेटन भार उठाने के दौरान मस्कुलोस्केलेटल जोखिम और शारीरिक परिश्रम को कम करता है, रीढ़ की हड्डी के संपीड़न बलों और हृदय गति में महत्वपूर्ण कमी के साथ, श्रमिक की सुरक्षा और दक्षता में सुधार करता है।
- ट्रैक्टर पर लगे स्पोर्ट्स कैमरा और मॉनिटर के साथ ड्राइवर मार्गदर्शन प्रणाली बार-बार पीछे की ओर मुड़ने से होने वाली असुविधा को कम करती है, ऑपरेटर के एर्गोनॉमिक्स को बढ़ाती है और शारीरिक तनाव को कम करती है।
- थ्रेशर के लिए एक संलग्न स्क्रीन अटैचमेंट कण पदार्थ को पकड़ता है, जो उच्च शेड स्क्रीन घनत्व के साथ धूल के संपर्क को काफी कम करता है (लगभग 72 प्रतिशत तक), जिससे कार्यकर्ता के स्वास्थ्य और सुरक्षा में सुधार होता है।
- एक अध्ययन में पॉलिशिंग सेक्शन की तुलना में चावल मिलों के फीडिंग सेक्शन में उच्च एंडोटॉक्सिन एक्सपोजर पाया गया, जिससे मिलिंग ऑपरेशन में वायुजनित एंडोटॉक्सिन जोखिमों को कम करने के लिए सुरक्षा की आवश्यकता पर जोर दिया गया।
- एक अध्ययन में घास काटने की मशीन के संचालन के दौरान उच्च शोर (87-95 डीबी (ए)) और हाथ-बांह कंपन का जोखिम दिखाया गया है, जिससे 1.7 वर्षों के भीतर उंगली के सफेद होने का खतरा उजागर हुआ है और स्वास्थ्य संबंधी खतरों को कम करने के लिए एर्गोनोमिक सुधार की आवश्यकता बताई गई है।

प्रौद्योगिकी प्रदर्शन और क्षेत्र में पहुंच

कृषि मशीनीकरण पर उप-मिशन (SMAM) के तहत, भा.कृ.अ.प.-के.कृ.अ.स.ने भोपाल जिले में ५५० हेक्टेयर में बड़े पैमाने पर ड्रोन छिड़काव प्रदर्शन आयोजित किए। कुल २३१ ड्रोन प्रदर्शन आयोजित किए गए, जिसमें ९१३ गांवों के ४,२४५ प्रतिभागियों ने भाग लिया। किसानों की प्रतिक्रिया में समान छिड़काव, पानी और इनपुट का कम उपयोग, न्यूनतम रासायनिक जोखिम और श्रम बचत जैसे लाभों पर प्रकाश डाला गया, हालांकि लागत, बैटरी बैकअप और कौशल आवश्यकताओं पर चिंताएँ व्यक्त की गईं।

डीबीटी किसान हब चरण-II के तहत, १० गाँवों (राजगढ़ और छतरपुर जिलों में ५-५) में प्रदर्शन भूखंड स्थापित किए गए, जिनमें सोयाबीन (var. RVSM ११३५) और उड़द (var. T-9) जैसी फसलें शामिल थीं, जिनमें क्रमशः ३० किलोग्राम और ६ किलोग्राम प्रति किसान बीज दिया गया। बुवाई के लिए मशीनरी सहायता भी बढ़ाई गई। गुना जिले में कस्टम हायरिंग सेंटर (सीएचसी) और तेल निकालने वाली इकाइयों को तकनीकी रूप से सहायता प्रदान की गई।

लाइसेंसिंग और पेटेंट

वर्ष २०२४ में, उद्योगों को तीन प्रौद्योगिकियों का लाइसेंस दिया गया, और कई नए कृषि उपकरण (जैसे लहसुन डिबलर, बंच फील्ड क्रॉप हार्वेस्टर, केला फाइबर एक्सट्रैक्टर) को भा.कृ.अ.प.द्वारा प्रमाणित किया गया। फलों के ग्रेडर और एलोवेरा जेल एक्सट्रैक्टर सहित पाँच पेटेंट दिए गए। भा.कृ.अ.प.-के.कृ.अ.स.लोगो को भी ट्रेडमार्क किया गया।

प्रशिक्षण एवं क्षमता निर्माण

व्यापक प्रशिक्षण कार्यक्रम आयोजित किए गए, जिसमें कस्टम हायरिंग (३०६ प्रतिभागी), ऑनलाइन किसान प्रशिक्षण और विश्वविद्यालय छात्र अनुलग्नक के लिए उद्यमिता पर ११ एक-सप्ताह के कार्यक्रम शामिल थे। मशीनरी के उपयोग और मूल्य संवर्धन को बढ़ावा देने के लिए विशेष प्रदर्शन दौरे और ग्रामीण युवा प्रशिक्षण भी आयोजित किए गए।

राष्ट्रीय और अंतर्राष्ट्रीय संबंध

बीज उत्पादन, कॉफी कटाई मशीनरी और बाजरा प्रसंस्करण के लिए क्रमशः IIPR, कॉफी बोर्ड, SKUAST-कश्मीर जैसी संस्थाओं के साथ समझौता ज्ञापन पर हस्ताक्षर किए गए। भा.कृ.अ.प.-के.कृ.अ.स.के वैज्ञानिकों ने मिस्र, चीन, वियतनाम, नेपाल और कनाडा में वैश्विक मंचों में भी भाग लिया।

प्रमुख कार्यक्रम और आउटरीच

भा.कृ.अ.प.-के.कृ.अ.स. भोपाल और क्षेत्रीय केंद्रों में वार्षिक प्रौद्योगिकी और मशीनरी प्रदर्शन मेले में १.७५ लाख से अधिक किसान शामिल हुए। भा.कृ.अ.प.-के.कृ.अ.स. ने एग्री इंटेक्स, किसान मेला और अंतर्राष्ट्रीय कृषि और बागवानी एक्सपो जैसी राष्ट्रीय प्रदर्शनियों में भी प्रौद्योगिकियों का प्रदर्शन किया।

परीक्षण और परामर्श

भा.कृ.अ.प.-के.कृ.अ.स. केंद्रों पर २७२ मशीनों का परीक्षण किया गया, जिससे ₹५.२९ करोड़ से अधिक राजस्व प्राप्त हुआ। इसमें जुताई से लेकर कटाई के बाद की मशीनरी तक की विस्तृत श्रृंखला शामिल थी।

उपलब्धियाँ और पुरस्कार

सीआईएई के वैज्ञानिकों को आईएसएई, एनएएएस और अन्य राष्ट्रीय मंचों पर कई पुरस्कार मिले। ड्रोन छिड़काव, आईओटी सिंचाई, सोयाबीन प्रसंस्करण और स्मार्ट सेंसर पर काम को मान्यता देते हुए कई सर्वश्रेष्ठ पेपर और मौखिक प्रस्तुति पुरस्कार प्राप्त किए गए।

मीडिया और प्रकाशन

सीआईएई के विशेषज्ञों ने आकाशवाणी, दूरदर्शन पर अपनी उपस्थिति दर्ज कराई और प्रतिष्ठित पत्रिकाओं में ३५ से अधिक शोध पत्र प्रकाशित किए, जिसमें सुनियोजित कृषि, स्मार्ट सिंचाई, यूएवी छिड़काव और खाद्य प्रसंस्करण में नवाचारों पर प्रकाश डाला गया।

EXECUTIVE SUMMARY

Research & Development

- A tractor operated machine has been developed for application of granular fertilizer in grape vineyards with precision having field capacity and field efficiency of 0.72 ha/h and 77.6%, respectively.
- A tractor-operated air-assisted recycling tunnel sprayer was developed to ensure uniform spray coverage for 2-meter-high orchard canopies. It includes an air-blowing unit, a PTO-powered chemical spraying system, and a collapsible tunnel with a liquid collection and recirculation mechanism. The tunnel width is adjustable (1–2 meters) for varying canopy structures. Optimized nozzle placement (350 mm spacing, 43° angle) and a 1100 mm tunnel opening improved spray deposition by 74.55% and reduced spray usage by 7.56%. With a field capacity of 0.45 ha/h and 78.63% efficiency, it also minimizes chemical waste and environmental contamination.
- Image based variable rate nitrogen applicator has been developed with an optimized delivery of nutrient over a field in liquid and granular form, allowing precise nitrogen application based on site specific crop requirements.
- Brush type cotton stripper harvester has been developed to provide a mechanized solution for cotton picking. The brush and rubber bat-type cotton stripper with two counter rotating picker efficiency is 93.15% and net seed cotton output of the machine ranged from 150 to 217 kg/h.
- Unmanned robotic platform has been developed for tea leaf plucking and pruning operation inside the indigenous tea plantation having 1.4 m of ground clearance and a track width that can be adjusted between 1.4 and 2.0 meters.
- Integrating deep learning-based computer vision with a microcontroller system, the Automatic Feed Dispenser (AFD) was ergonomically designed using data from Indian farm workers. It features a hopper, auger-type volumetric dispenser, stepper motor, and PLC for precise feed delivery. The system achieved over 100% dispensing accuracy at a calibration factor of 5, with feed quantities ranging from 246.9 g (week 1) to 2538.4 g (week 9). The AFD improves efficiency, reduces human involvement, and minimizes disease transmission risks in poultry operations.
- A field study was conducted on cotton crop to evaluate the efficiency of drone spraying for nano urea application. Three nitrogen treatments were tested: prill urea broadcasting (110 kg/ha), nano urea via knapsack sprayer (1.25 l/ha at 5 l/ha spray rate), and via drone (1.25 l/ha at 25 l/ha spray rate). NDVI and SPAD values were recorded one day before and eight days after application. Results showed minor changes in NDVI and SPAD values across all treatments. No significant differences were observed, indicating that drone spraying is as effective as traditional methods for nano urea application in cotton.
- An automatic AI enabled foliar application system has been developed that estimate real-time nitrogen concentration, calculated required nitrogen dose and sprayer N in real time in tomato crops.
- A remotely controlled robotic weeder was developed, featuring a four-wheel drive vehicle, an electronic control unit, and a sweep-type weeding mechanism. The weeding unit, equipped with two sweep tynes, can adjust its depth and width (up to 350 mm) and is operated remotely. Field tests in maize with 450 mm row spacing showed a weeding efficiency of 81.6% and 4.2% plant damage in raised beds, and 74.9% efficiency with 14.6% damage in flatbed conditions.
- A lightweight multi-crop planter equipped with interchangeable seed plates, it suits various cropswas developed as an attachment for the CIAE self-propelled onion weeder. Field tests in black cotton soil for onion, soybean, chickpea, and black gram showed field capacities ranging from 0.0315 to 0.0387 ha/h with over 82% efficiency. Planting depth ranged from 20–70 mm, and spacing from 93.5–111.16 mm. The planter ensured uniform seed placement and satisfactory performance.
- A tractor-drawn liquid fertilizer applicator was developed for precise urea application in wheat and maize, aiming to improve nitrogen use efficiency (NUE) and reduce environmental impact. The system features a

coulter-based six-row injection mechanism that places liquid urea 50–100 mm deep into the root zone, enhancing NUE by up to 67% and reducing urea use by 33–44% without compromising yield. Field trials confirmed its effectiveness, offering a cost-effective, efficient, and sustainable alternative to conventional broadcasting methods for nitrogen fertilizer application.

- An experimental setup was developed to measure Maximum Voluntary Contraction (MVC) for assessing muscle activity and musculoskeletal disorder (MSD) risks in agricultural workers. Designed ergonomically using Indian farm worker anthropometric data, the setup includes adjustable vertical poles for standing tasks and stools for seated operations. It enables MVC measurement of six major muscle groupsusing standardized exertion methods. Collected MVC data will be compared with EMG data from real farming tasks to evaluate muscle load, aiding in ergonomic tool design and safer, more efficient agricultural practices.
- The alumina-sawdust char-supported Ni catalyst acts as a promising material for the efficient and sustainable production of hydrogen from methane pyrolysis. The catalyst exhibited a methane conversion up to 98% for a period of 15 min and thereafter it sustained for 120 mins with a conversion of 80%.
- Maximum recovery of hydrogen gas was 2.47 L per kg of paddy straw obtained at a process condition of 1% acid treated paddy straw and biochar prepared at 600°C. It suggested that more surface area of biochar is favourable for microbial community growth to enhance the hydrogen production.
- The nanoporous carbon-based electrode exhibited a specific capacitance of 343.29 F/g at a current density of 1.0 A/g, an energy density of 48 Wh/kg, and a power density of 495 W/kg, along with excellent cycling stability. The findings indicate that chickpea stalk-derived nanoporous carbon is a promising bio-material for high-performance super capacitors and energy storage devices.
- Plasma treatment of chick pea crop residues led to its significant densification, as evidenced by an initial drop in surface area from 0.85918 m^2/g (raw) to 0.045257 m^2/g (15 min). The findings of plasma treatment underscore its dynamic nature in modifying biomass porosity and accessibility, which could have far-reaching implications for bioconversion and material engineering applications.
- Crop grown in solar PV portable greenhouse yields more number of leaves per plant and root length of plant as compared to control. It was found that difference in radiation between solar and control green house was 38%.
- The sowing of Chickpea was done using multi utility e-vehicle, the effective field capacity was 0.29 ha/h, with 75.98% efficiency and a cost of ₹874.60/ha. The power consumption during the sowing operation was estimated 0.664 kW (19A current), totaling 1518 MJ/ha.
- The combined acid and enzymatic pretreatment process can effectively convert paddy straw and corn cob into fermentable sugars, offering a sustainable and efficient pathway for biofuel production.
- The larger mills (8 TPH and 12 TPH) showed improved efficiency in most processes, certain stages like whitening and polishing remained major energy consumers, contributing over 50% of total energy and emissions in the 4 TPH mill, and 45%-50% in the 8 TPH and 12 TPH mills.
- The introduction of a solar-operated knapsack sprayer in a soybean field significantly reduced energy consumption. For herbicide application, energy input with solar sprayer was 150.35 MJ/ha, compared to 174.35 MJ/ha with a conventional power knapsack sprayer, resulting in the energy saving of 13.77%.
- Corncob biomass has a great potential as a source of high crystalline cellulose which finds its application in the preparation of biocomposites. The crystallinity index of corncob, which was 29.63%, increased to 53.95% in extracted cellulose.
- The dark fermentation of detoxified paddy straw hydrolysate resulted in maximum total gas production of 226.67 mL/L at 72h of fermentation. The cumulative total gas and hydrogen production of 426.67 and 183.47 mL/L was reported at pH 5.5 of the hydrolysate. The briquettes prepared from the residue left after acid pre-treatment of paddy straw were found to be compact with shatter index of 95.18% and calorific value of 19.63 MJKg-1 .

- At the optimal air flow rate of 30 L/min and steam-to-biomass ratio of 3, the hydrogen content was observed 65 ± 0.9 % in 1.95 m3 kg-1 syngas.
- The maximum H2 production is achieved by up to 2.9 mole/mole of hexose using cotton hydrolysate in dark fermentation process.
- The electrodes using the LiPF6 shows the good discharge stability tested for 100 cycles and achieved 501 and 383 mAh/g for carbon black and the activated carbon-based electrodes. It shows agricultural biomass has a good potential for the production of carbon for lithium ion (Li-ion) battery anodes.
- For preparation of plastering material from crop residues, 25% and 50% replacement of sand with thermally tratment of soybean straw at temperature of 350 and 550 ^{0}C gives better compressive strength as compared to paddy straw.
- For irrigation scheduling, a machine learning-based decision support system was developed by integrating modules for reference crop evapotranspiration and crop water demand. This system was validated across various crops in Central India.
- State-of-the-art deep learning models, based on CNN-CBAM architecture, were created for yield prediction of wheat and rice, achieving an accuracy range of 65–80% using UAV-derived multispectral imagery combined with ground truth data. Additionally, yield prediction using a machine learning model (support vector machine) in conjunction with spectral vegetation indices (NDVI) demonstrated superior performance, reaching up to 95% accuracy.
- The speed, selectivity, and sensitivity of soil moisture sensors (MP 406) were enhanced through surface modification using PANI (polyaniline) nanoparticles. The modified sensors exhibited a 12–26% increase in sensitivity across varying levels of volumetric soil moisture content.
- A prototype of the linear move irrigation system was developed to irrigate an area of 0.4 hectares. It takes approximately 10 hours to apply an irrigation depth of 20 mm with 86% uniformity.
- The digested slurry has a great potential to be used as fish feed as it can serve as a viable protein source for fish feed. Also the levels of aflatoxin and arsenic were found to be below regulatory limits, indicating that the slurry is safe for use in fish feed.
- Developed AI-driven, self-driving automated weeder minimizes yield loss due to weeds and reduces the labor-intensive process of manual weeding. The weeder can detect weeds, make decisions, navigate, control spraying, and manage motor functions with precision.
- The potential of valorization of paddy straw into industrially valuable products such as of lignin, silica, and cellulose extraction. It effectively transforms agricultural residues into valuable industrial products, addressing waste management challenges and promoting environmental sustainability.
- The torrefaction of rice husk in a continuous torrefaction system indicated significant improvements in the fuel properties after the torrefaction. The HHV increased remarkably by approximately 22–23%.
- The production of grease from pine needle bio-oil executed through developed grease reactor.The impeller's design in the reactor helps provide homogeneous grease through effective mixing.
- Head feed type linseed thresher was developed for small farmers, powered by a 0.5 hp electric motor. It has a threshing capacity of 178.62 kg/h with 99.31% efficiency. Costing Rs. 50,000, its operating cost is Rs. 89.17/h, yielding 17.8 times more output and 5.63 times higher profit.
- Tractor-operated turmeric combine harvester has been developed with 28 kW power requirement and 0.16 ha/h field capacity. It includes a 750 mm de-topping unit, digger cum conveyor, and collection tank. Achieving 97% digging, 94% de-topping, 70% cleaning efficiency and operating cost is 1100Rs./h.
- Drone-based pre- and post-emergence herbicide spraying has been evaluated in wheat using various residue management methods. The drone, operating at 2.0–3.0 m/s and 2–3 m height, showed 81–92%

Phalaris minor control and 70–86% broadleaf weed control, comparable to knapsack sprayers, with finer droplets and better spray uniformity.

- Robotic metering mechanism for vegetable transplanters using portray seedlings, featuring a 5-DOF robotic arm, it achieved 99.68% picking efficiency, 4.05% seedling damage, and 91% root-media adhesion at 0.7 km/h forward speed. The system ensures precise seedling placement using inverse kinematics and was tested under simulated conditions.
- Radio frequency (RF)-controlled pesticide applicator has been developed for precise, safe spraying. It includes RF, sprayer, driver, and trolley modules, using 24V DC motors and a 12-nozzle, 2.65 m boom. Field tests showed 0.5 ha/h coverage at 3 km/h with 65–70% efficiency, reducing chemical use and operator exposure.
- Multiple rice seed pellets developed using 77% organic manure and 23% clay, achieving 0.971 sphericity, 98.42 N breaking strength, and 98.92% pelleting efficiency. Field trials showed improved hill spacing (174.2 mm), population (3/hill), and 80.22% uniformity over drum seeding. This method enhances precision, plant stand, and seeding consistency.
- Developed a tractor-operated Lathyrus harvester with 0.42 ha/h field capacity, 85% field efficiency, and 90% harvesting efficiency at 30 mm cutting height. It reduces losses to 3.5% and saves 75% in costs compared to manual harvesting, ensuring faster, labor-efficient crop collection.
- A wheel-mounted two-row belt cup type potato planter was developed to improve ridge uniformity and planting consistency. Operating at 3.8–4.0 km/h with 710 mm row spacing and 60–80 mm planting depth, it achieved 0.4 ha/h field capacity. The planter ensures better compaction, uniform tuber placement, and consumes 5.5–6.3 litres diesel per hour.
- Tractor-operated sugarcane leaf detrasher cum shredder was developed to reduce labor and improve efficiency. It achieved a field capacity of 0.31 ha/h at 82.17% efficiency. The machine saves Rs. 9,290/ha (83.70%) compared to manual detrashing, reducing labor demand and health risks.
- A light weight and low-cost and lon-invasive respiration monitor was developed using a flex-type sensor and Arduino-based system. It continuously tracks cattle respiration with 96.96% accuracy compared to nostril counting.
- Sensor-based cattle washing system was developed using photoelectric proximity sensors to trigger washing upon animal detection. The system features 27 flat-fan nozzles, a timer-controlled pump, and adjustable water pressures and nozzle heights. Designed to improve summer hygiene before milking, it automates washing while reducing manual labour and enhancing cleaning efficiency.
- A batch-type cattle washer was designed with a motorized horizontal boom fitted with seven hollow-cone nozzles. The system reduces labour by 50%, cuts water use by 67–72%, and improves ectoparasite removal by up to 88%.
- A grooming unit with two rotating brushes, powered by electric motors and positioned in an L-shape, was developed for cattle. The operation is triggered by infrared proximity sensors. It reduced skin infections (3–4%), improved draftability (15–16%), and an overall positive impact exceeding 33%.
- Three-row animal-drawn dibble seeder was developed with interchangeable rotors and spacers for precise seed placement. Field tests for rice and okra showed field capacities of 0.178 ha/h and 0.27 ha/h, respectively. Operating at 2.8 km/h, it requires minimal draft force and offers low-cost planting at Rs. 978/ha for paddy and Rs. 589/ha for okra.
- Bullock-drawn planter integrated with a slurry applicator was developed for simultaneous seed sowing and fertilization. Field efficiency reached 79.79% with a speed of 2.25 km/h and capacity of 0.214 ha/h. The system distributes slurry uniformly, with a seed rate of 8–10 kg/ha and operational cost of Rs. 1375/ha, reducing labour to 4.75 hours per hectare.

- Bullock-drawn biogas slurry applicator with a cylindrical tank and two-wheel chassis was developed for efficient manure spreading. Tested at various valve openings, it achieved a field capacity of 0.323 ha/h and 80.99% efficiency at 2/3 valve position. Swath width ranged from 1125 mm to 1395 mm, ensuring uniform distribution of liquid manure across fields.
- A pedal-operated coconut dehusker modified for sitting use, with a collection tray for easier handling. It achieved 88.72% dehusking efficiency and reduced operator workload and discomfort, with moderate heart rate levels during operation.
- An AI-driven safety system using multiple sensors (PIR, LDR, dust, vibration, DHT) and a servo motor to automatically open the thresher chute's base plate, preventing hand injuries by restricting access to the rotating drum.
- An AI-based system detects human body parts near feeding rollers using image processing and triggers automatic reversal and alarms, significantly reducing accident risks during threshing.
- VR-based remote-control system with real-time camera feeds enables operating paddy transplanters remotely. It lowers operator energy expenditure and discomfort, while maintaining effective field capacity and acceptable missing hill rates.
- A lithium-ion battery-powered manual transplanter improves ergonomic comfort by reducing spinal loads, increases field capacity by 24%, and lowers drudgery with enhanced balance and reduced operator fatigue.
- An AI system using YOLO object detection and a mechanical braking actuator automatically detects obstacles and applies brakes, improving tractor safety in blind spot scenarios.
- Two ergonomic tools (battery-operated brush and roller frame) remove algae and lichen from orange trees efficiently, reducing physical effort and injury risks for farmers in high rainfall regions.
- Tractor-mounted henna harvester offers 96.08% harvesting and 97.01% conveying efficiencies at 2 km/h, with physiological assessments indicating moderate work intensity but overall enhanced harvesting performance.
- A retrofit system including telescopic spray lances, a canopy hood, and embedded weather and canopy sensors controlled by ESP32 microcontroller reduces operator chemical exposure and improves spraying comfort and efficiency.
- A lower body exoskeleton reduces musculoskeletal risks and physical exertion during load carrying, with significant reductions in spinal compressive forces and heart rates, improving worker safety and efficiency.
- A driver guidance system with a tractor-mounted sports camera and a monitor reduces discomfort caused by frequent backward turning, enhancing operator ergonomics and reducing physical strain.
- An enclosed screen attachment for threshers captures particulate matter, significantly reducing dust exposure (up to ~72%) with higher shade screen densities, thus improving worker health and safety.
- A study found higher endotoxin exposure in feeding sections of rice mills compared to polishing sections, emphasizing the need for safety interventions to reduce airborne endotoxin risks in milling operations.
- A study showed high noise (87-95 dB(A)) and hand-arm vibration exposure during mower operation, highlighting the risk of finger blanching within 1.7 years and calling for ergonomic improvements to reduce health hazards.

Technology Demonstrations & Field Outreach

- ·Under the Sub-Mission on Agricultural Mechanization (SMAM), ICAR-CIAE organized large-scale drone spraying demonstrations 550 hectares in Bhopal district. A total of 231 drone demonstrations were conducted engaging 4,245 participants from 913 villages. Farmer feedback highlighted benefits like uniform spraying, reduced water and input use, minimal chemical exposure and labour savings, though concerns on cost, battery backup, and skill requirements were noted.

- Under DBT Kisan Hub Phase-II, demonstration plots were established in 10 villages (5 each in Rajgarh & Chhatarpur districts), covering crops like soybean (var. RVSM 1135) and black gram (var. T-9), with seed support of 30 kg and 6 kg per farmer, respectively. Machinery support for sowing was also extended. Custom Hiring Centres (CHC) and oil expeller units were technically assisted in Guna district.

Licensing & Patents

- In 2024, three technologies were licensed to industries, and several new farm implements (like garlic dibbler, bunch field crop harvester, banana fiber extractor) were certified by ICAR. Five patents were granted, including on a fruit grader and aloe vera gel extractor. The ICAR-CIAE logo was also trademarked.

Training & Capacity Building

- Extensive training programs were conducted, including 11 one-week programs on entrepreneurship for custom hiring (306 participants), online farmer trainings, and university student attachments. Specialized exposure visits and rural youth trainings were also held, promoting machinery use and value addition.

National & International Linkages

- MoUs were signed with institutions like IIPR, Coffee Board, SKUAST-Kashmir for seed production, coffee harvesting machinery, and millet processing respectively. CIAE scientists also participated in global forums in Egypt, China, Vietnam, Nepal, and Canada.

Major Events & Outreach

- The annual Technology and Machinery Demonstration Mela at CIAE Bhopal & regional centers attracted over 1.75 lakh farmers. CIAE also showcased technologies at national exhibitions like Agri Intex, Kisan Melas, and the International Agri & Horti Expo.

Testing & Consultancy

- 272 machines were tested at CIAE centers, generating over ₹5.29 crore revenue. This included a wide range from tillage to post-harvest machinery.

Achievements & Awards

- CIAE scientists received numerous awards at ISAE, NAAS, and other national platforms. Multiple best paper & oral presentation awards were secured, recognizing work on drone spraying, IoT irrigation, soybean processing, and smart sensors.

Media & Publications

- CIAE experts featured on AIR, Doordarshan, and published over 35 research papers in reputed journals, highlighting innovations in precision agriculture, smart irrigation, UAV spraying, and food processing.

ABOUT THE INSTITUTE

ICAR-Central Institute of Agricultural Engineering (CIAE), Bhopal, is the premier institute for agricultural engineering in Indiawhich is devoted to the promotion of agricultural mechanization with the aim of enhancing agricultural productivity, reducing drudgery in agricultural sectors, generation and management of energy in agricultural systems, resource conservation, minimization of post-harvest losses, value addition of agricultural produce, by-product utilization, human resource development and creation of employment opportunities in the rural sector.

Established on 15th February 1976, the Institute has completed more than 49 years of its glorious journey. The institutional activities are organized through five divisions (Agricultural Mechanization, Agro Produce Processing, Agricultural Energy and Power, Irrigation and Drainage Engineering and Technology Transfer), four AICRPs coordinating centres (Farm Implements & Machinery, Mechanization of Animal Husbandry, Energy in Agriculture and Agro-based Industries and Ergonomics and Safety in Agriculture), two centres (Centre of Excellence on Soybean Processing and Utilization and Krishi Vigyan Kendra-KVK) and a Regional Centre, Coimbatore. The Regional Centre at Coimbatore addresses the engineering intervention needs of the southern states of the country. While, pan-India needs are catered to through different AICRPs and CRPs, linked with ICAR-CIAE, Bhopal. The Centre of Excellence on Soybean Processing and Utilization promotes soybean utilization through its research, development, and training activities. The institute's KVK serves to demonstrate the technologies for broader adoption by the farmers in general and of the Bhopal district in particular. The institute is also involved in postgraduate teaching and research activities to train the young minds for the development of scientific knowledge in the area of agricultural engineering.

The mandates of the Institute are

- Research and development on agricultural mechanization, post-harvest food processing, irrigation and drainage engineering and energy management in agriculture.
- Human resource development through academic programs 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 of land used for research, office and residential purposes. The major water sources are six open wells, eight tube wells, and five farm ponds. All the water sources are connected through an underground irrigation grid to irrigate 21 ha of cropped area and 15 ha of orchards. The Institute also has a meteorological observatory, well-furnished hostel and guest house facilities for 80 guests. The Research Workshop provides the facilities for fabrication of research prototypes and the Prototype Production Centre for multiplication; the Computer Aided Design cell develops computer-aided models and drawings of research prototypes; Agricultural Knowledge Management Unit assists in database creation and conducting online examinations; Instrumentation Cell supports instrumentation in various research projects. The institute library is equipped with a computerized cataloguing facility, with around 25000 books and bound journals and an extensive collection of CD-ROMs (full form) on journals in agricultural engineering and related disciplines. The library provides e-subscription (through J-gate) of important & pertinent journals. 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 major activities in the programmes like UN-ESCAP CSAM, AARDO, SAARC, etc. In addition to the regular research and developmental activities, the Institute caters to the need for testing and certification of agricultural production and processing machinery manufactured by industries through its Bhopal and Coimbatore centres.

Over the years, the Institute has developed many successful technologies. Training and skill enrichment programs for different types of stalk holders, viz., farmers, manufacturers, upcoming entrepreneurs, extension functionaries, teachers, students, etc., of either gender have been continuing for a long time. Display and demonstrations of technologies on appropriate platforms are also persisting. To augment the technology dissemination, production, and supply of successful prototypes has become a successful model. The continuous efforts made by this Institute for society have brought accolades to the Institute through the conferment of the prestigious Sardar Patel Outstanding ICAR Institution Award for the year 2020. The details of personal and finance during the year 2024 is shown below.

Staff position as on 31-12-2024

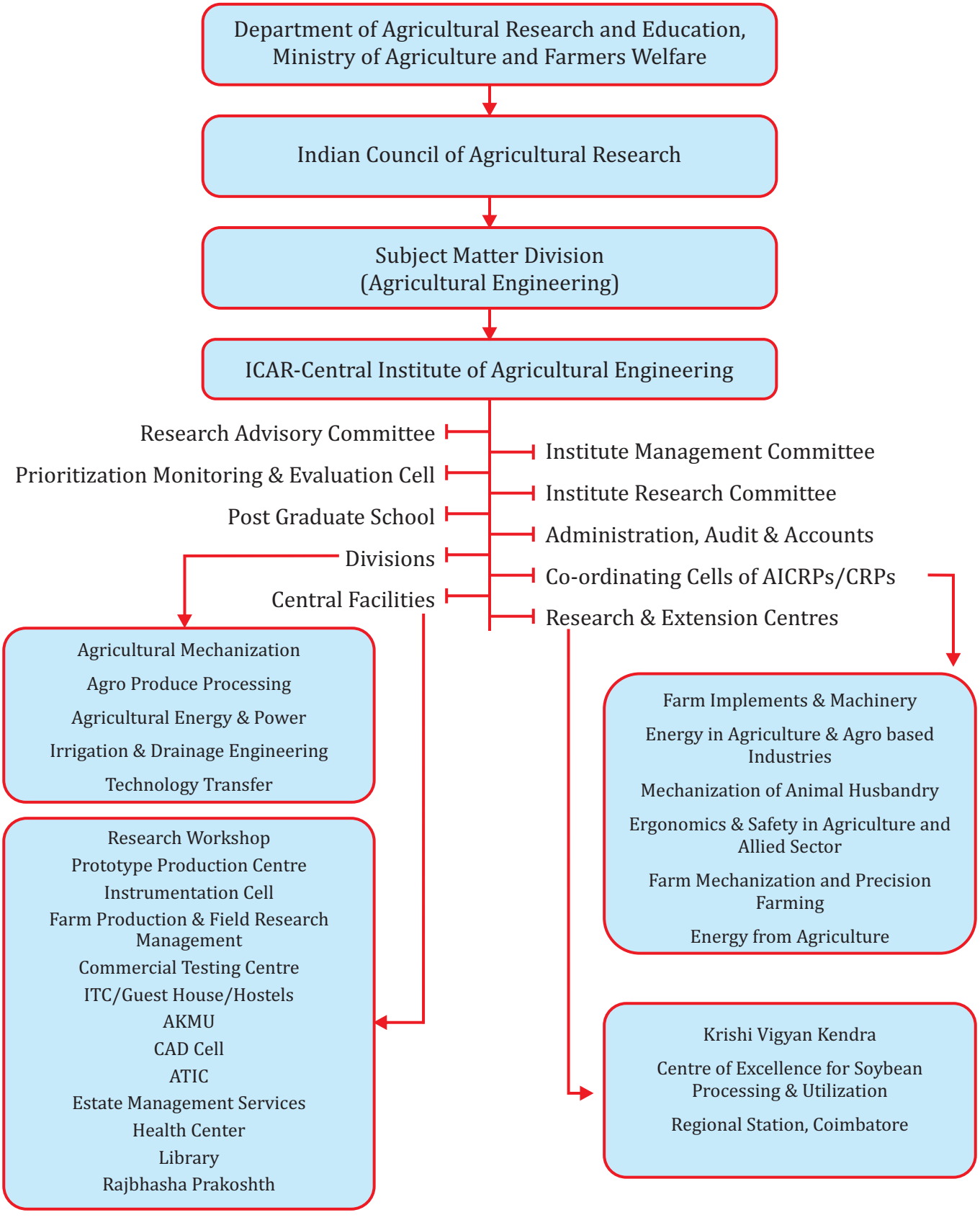
Post	Sanctioned	In-Position	Vacant
RMP	1	1	0
Head KVK	1	0	1
Scientist	89	67	22
Technical	133	66	67
Administrative	66	40	26
Skilled Support Staff	42	09	33
Total	**332**	**183**	**149**

Budget (2024-25)

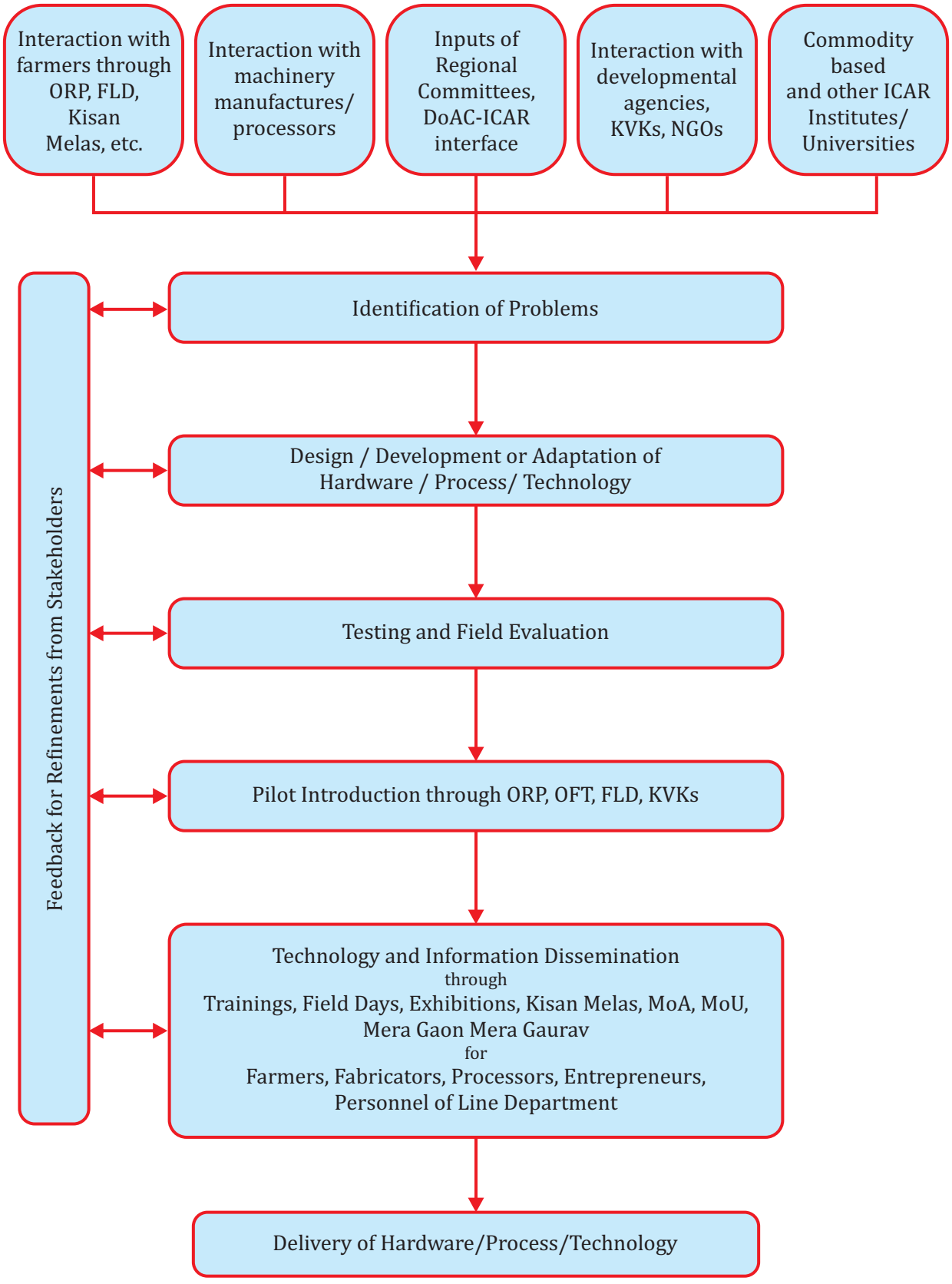
	Allocation (Rs. In Lakh)	Expenditure (Rs. In Lakh)
CIAE	7676.66	7676.66
AICRP on FIM	1756.28	1756.28
AICRP on EAAI	1512.10	1512.10
AICRP on UAE	592.00	592.00
AICRP on ESA	617.20	617.20
CRP on FMPF & MIS	219.79	219.79
CRP on EA	137.46	137.46

*Expenditure till 31-03-2025

ORGANOGRAM


Department of Agricultural Research and Education, Ministry of Agriculture and Farmers Welfare
Indian Council of Agricultural Research
Subject Matter Division (Agricultural Engineering)
ICAR-Central Institute of Agricultural Engineering
Research Advisory Committee
Prioritization Monitoring & Evaluation Cell
Post Graduate School
Divisions
Central Facilities
Institute Management Committee
Institute Research Committee
Administration, Audit & Accounts
Co-ordinating Cells of AICRPs/CRPs
Research & Extension Centres
Agricultural Mechanization
Agro Produce Processing
Agricultural Energy & Power
Irrigation & Drainage Engineering
Technology Transfer
Research Workshop
Prototype Production Centre
Instrumentation Cell
Farm Production & Field Research Management
Commercial Testing Centre
ITC/Guest House/Hostels
AKMU
CAD Cell
ATIC
Estate Management Services
Health Center
Library
Rajbhasha Prakoshth
Farm Implements & Machinery
Energy in Agriculture & Agro based Industries
Mechanization of Animal Husbandry
Ergonomics & Safety in Agriculture and Allied Sector
Farm Mechanization and Precision Farming
Energy from Agriculture
Krishi Vigyan Kendra
Centre of Excellence for Soybean Processing & Utilization
Regional Station, Coimbatore

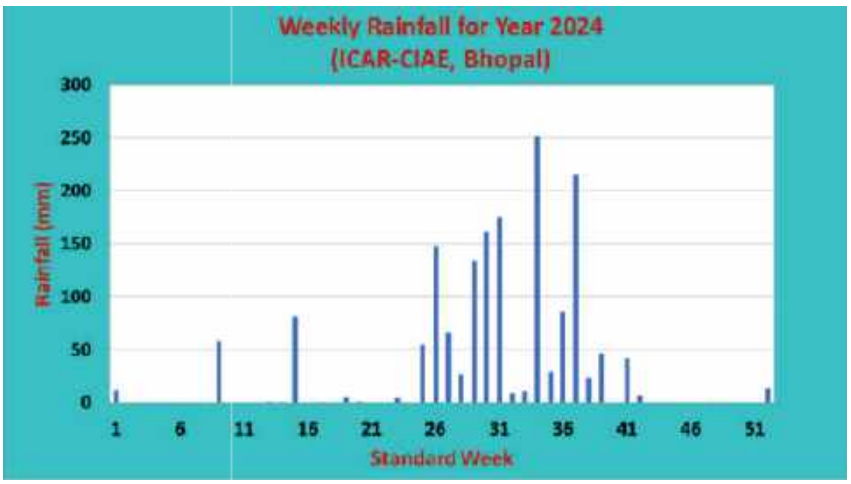
TECHNOLOGY DEVELOPMENT PROCESS OF ICAR-CIAE

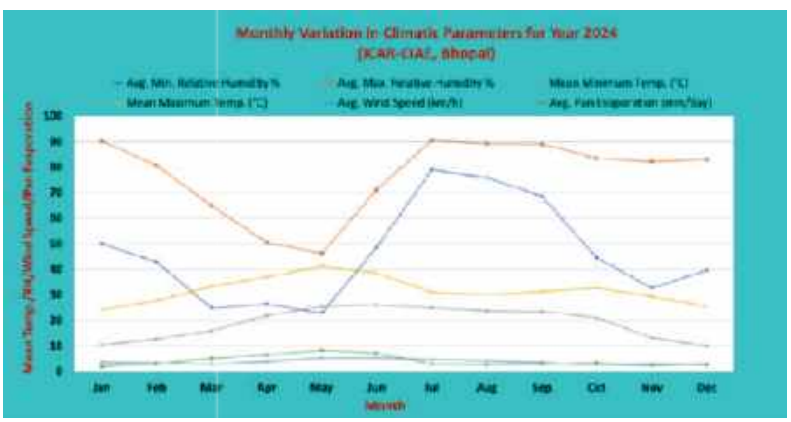


METEOROLOGICAL OBSERVATIONS

Agro-meteorological observatory of the institute is located at 77o25' E longitude and 23o16' N latitude at an elevation of 498.7 m above mean sea level. Rainfall, minimum and maximum temperature, relative humidity, pan evaporation and wind velocity were recorded on regular basis. Salient meteorological observations for year 2024 are:

- Monsoon started in Bhopal on June 19, 2024 and withdrawal began around September 23, 2024. The maximum rainfall for the season (129.0 mm) was recorded on August 25, 2024. The annual rainfall of 1650 mm occurred in 72 rainy days during the year 2024.
- The maximum temperature (45.0oC) of the year was recorded on May 27, 2024 while minimum temperature (3.3oC) was recorded on December 16, 2024. Humidity in the morning (7.20 AM) varied from 15 to 98 percent while in afternoon (2.20 PM) it varied from 12 to 97 percent.
- The mean maximum wind speed (24h) of 10.1 km/h was recorded on June 04, 2024 while the lowest of 0.7 km/h was recorded on November 15, 2024.
- The maximum pan evaporation of 12.5 mm was recorded on May 25 and May 27, 2024 while the minimum was 0.4 mm on July 27, 2024.





AGRICULTURAL MECHANIZATION DIVISION

Use of robotics/sensors/drone in agriculture

Efficacy of nano urea spraying with drone in wheat, maize and cotton crop

Field experiments were conducted to evaluate the efficiency of a drone spraying system for nano urea (nan urea plus, 20% N w/v concentration, IFFCO, New Delhi, India) application in a wheat, maize and cotton crops. The study involved three nitrogen fertilizer application treatments: (i) prilled urea broadcasting at a rate of 110 kg/ha, (ii) nano urea application using a gun or knapsack sprayer at a rate of 1.25 L/ha with a spray volume of 500 L/ha, and (iii) nano urea application using a drone sprayer at the same rate of 1.25 L/ha but with a significantly lower spray volume of 25 L/ha. The experimental plots were monitored using vegetation indices to assess the physiological response of the crop to the nitrogen treatments. NDVI (Normalized Difference Vegetation Index) was measured using a Green Seeker sensor, and chlorophyll content was estimated using a SPAD meter. Both parameters were recorded one day before and eight days after a nitrogen fertilizer application.

In wheat crop, prior to nitrogen application, the NDVI and SPAD values were 0.82 ± 0.03 (mean ± SD) and 44 ± 3, respectively, in prilled urea-treated plots; 0.81 ± 0.03 and 42 ± 5 in gun sprayer-treated plots; and 0.83 ± 0.03 and 45 ± 2 in drone-sprayed plots. Eight days after the application, these values increased to 0.86 ± 0.02 and 47 ± 1 for prilled urea, 0.85 ± 0.02 and 47 ± 1 for the gun sprayer, and 0.87 ± 0.01 and 47 ± 2 for the drone sprayer. The biomass yields were recorded as 14.72 t/ha, 14.35 t/ha, and 14.54 t/ha for prilled urea, gun, and drone treatments, respectively. Corresponding grain yields were 6.59 t/ha, 6.44 t/ha, and 6.75 t/ha.





In maize crop, initial NDVI and SPAD values were similar across treatments, ranging from 0.73 to 0.74 and 38 to 40, respectively. Post-application measurements showed slight improvements, with NDVI values reaching 0.76–0.77 and SPAD values ranging from 39 to 41. Biomass yields were 41.53 t/ha (prilled urea), 49.74 t/ha (gun sprayer), and 45.01 t/ha (drone sprayer), while grain yields were 9.18 t/ha, 10.97 t/ha, and 9.47 t/ha, respectively.




In cotton crop, the NDVI and SPAD values for prill urea-treated plots were 0.75 ± 0.05, 40 ± 3 one day before and 0.70 ± 0.04, 42 ± 3 eight days of after nitrogen fertilizer application. For knapsack-treated plots, the values were 0.73 ± 0.03, 41 ± 3 before and 0.72 ± 0.03, 42 ± 3 after application. In drone-sprayed plots, the values were 0.75 ± 0.03, 40 ± 3 before and 0.73 ± 0.04, 41 ± 3 after nitrogen fertilizer application. The cotton yield was 2070, 2160 and 2230 kg/ha for prill urea, knapsack and drone sprayer treatment, respectively.

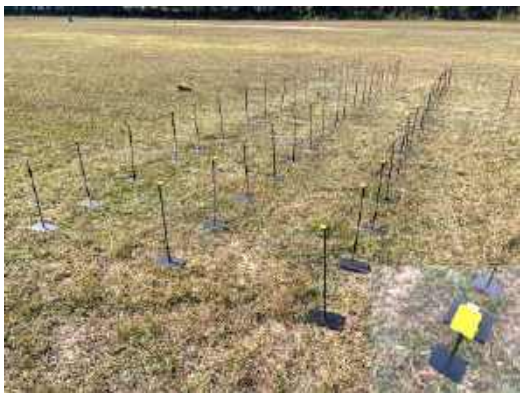


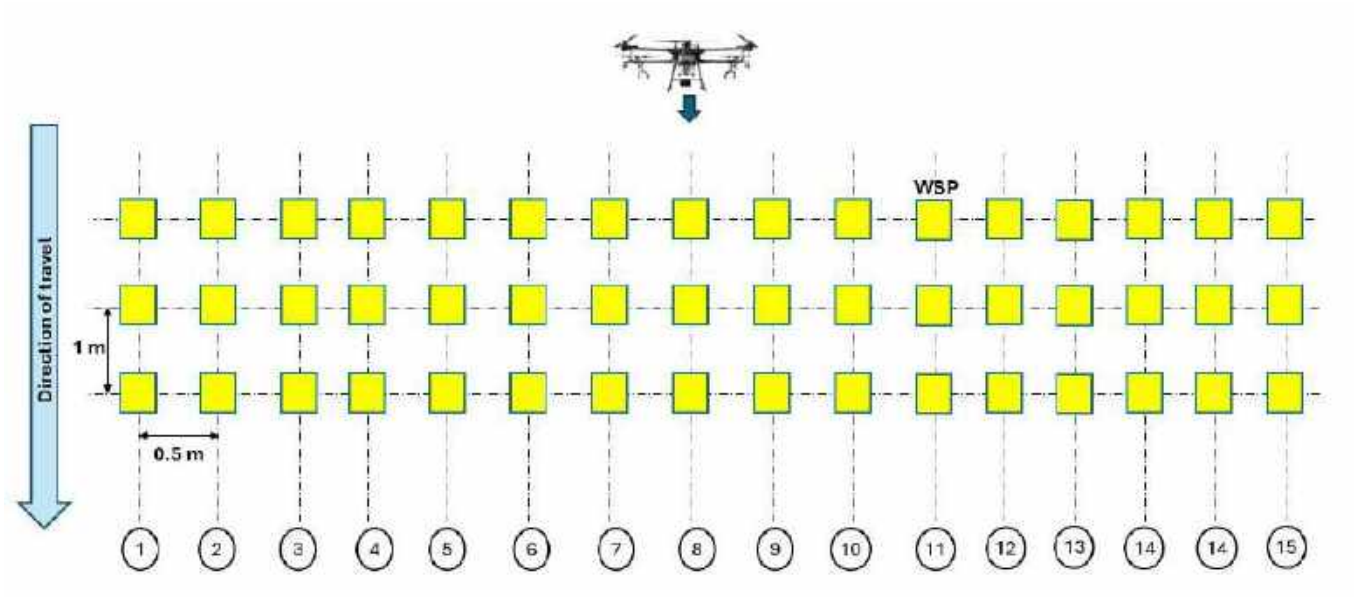


Based on the data, it was observed that overall, there were no significant differences in the effectiveness of traditional prill urea application, gun or knapsack sprayer based nano urea application, and drone-sprayed nano-urea application on vegetation indices, biomass and yields. These findings suggest that nano urea application through a drone spraying system is equally effective as traditional methods, while potentially offering advantages in terms of reduced spray volume and improved operational efficiency.

Swath measurement of drone spraying system

Swath measurement refers to the width covered by a drone sprayer in a single pass and is vital for precise application of pesticides or fertilizers, minimizing overlap and untreated areas. This study evaluated the effective swath of a drone sprayer under varying heights (1, 2, 3 m), speeds (2, 3, 4 m/s), and flow rates (1.5, 2, 2.5 L/min), resulting in 27 trial combinations. Water Sensitive Papers (WSP) were placed on 0.5 m high stands, arranged in three rows (1 m apart) with 15 stands per row at 0.5 m intervals to prevent ground contamination. WSPs were collected 15 minutes post-spray, scanned at 1200 dpi, labelled, and analyzed using DepositScan (ImageJ) to determine droplet coverage (%). Effective swath was defined as the width with a coefficient of variation (CV) ≤ 25%. Swath widths ranged from 1.31 to 2.7 m. Lower heights resulted in narrower but denser coverage, while higher heights gave broader swaths with reduced droplet concentration at the center. The widest effective swath (2.7 m) was recorded at 3 m height, 2 m/s speed, and 2.5 L/min flow rate, while the narrowest (1.31 m) occurred at 1 m height, 2 m/s speed, and 2.5 L/min flow rate.





Drone spray patternator

A drone spray patternator was developed to study the effects of downwash airflow and operational parameters on spray distribution from drone sprayers. The setup, measuring 5 m by 3 m, consists of 192 V-channels designed to prevent spillover and ensure accurate water collection. Each V-channel is 25 mm wide, 28 mm deep, and 1.6 mm thick, supported by 10 mm high vertical sheets, inclined at 30°. Channels are spaced 26 mm apart. Water collected from 180 effective channels is directed into 200 ml borosilicate glass tubes (25 mm diameter, 560 mm length) marked at 10 ml intervals. Tubes are arranged in a zigzag pattern within a 5050 mm long aluminum frame, aligned with V-channels above. A flip mechanism controls water flow into each tube, and a handle assembly allows for easy emptying post-experiment. The patternator is mobile, equipped with six wheels for easy movement. To protect the system from environmental factors, a 6.5 m × 4.5 m × 3 m shed, enclosed on three sides and topped with white polycarbonate sheets, was constructed. This setup enables precise evaluation of spray uniformity under varying drone heights and discharge rates, helping optimize drone spraying performance.

Sensor based spot fertilizer applicator for grape vineyard

The machine has been developed for application of granular fertilizer in grape vineyards with precision. The applicator is structured into four primary sub-units viz. fertilizer metering system, furrow openers, sensing unit, and fertilizer dispensing unit. It can deliver 84 g SSP per plant for an application dose of 1500 kg SSP per hectare. Field testing had been done in grape vineyard planted at 2.70 × 1.80 m spacing and area covered during testing was 0.5 ha. The effective field capacity of applicator is 0.72 ha/h with 77.6% field efficiency. The prototype applicator costs around ₹60,000 and has an operating cost of ₹2600/ha.

Unmanned robotic platform for tea plantation

An indigenous, self-propelled, hydraulically actuated high clearance vehicle was developed to carry out tea leaf plucking and pruning operations. Its components include a hydraulically driven transmission, cooling, differential, and a disc-type negative brake system. It features 1.4 m of ground clearance and an adjustable track width between 1.4 and 2.0 meters. The highest designed on-road speed of operation was 20 km/h and the turning radius was 4 m. The performance of the vehicle alone was found satisfactory at tea garden of TTRI, Jorhat.

Robotic transplanter for plug-type vegetable seedlings

A multi-gripper type robotic transplanter is being developed for plug-type vegetable seedlings. The developed system consisted of conveying system for nursery portrays, multi-gripper type seedling extractor and planting unit. The portray conveying system operates with stepper motor. The seedling extractor operates with linear actuators and servomotors. Row shifting can be achieved with a stepper motor which moves the complete extractor to and fro. The extractor and grasp release 4 seedling in one go. The gripper/end-effector attached on extractor unit is a spring loaded flat plate type, and the gripping & releasing of seedling was done by rotating the servomotor by 180^0. The spring loaded gripper holds the seedling by compressing and releases it during

extension. The developed robotic transplanter can extract about 8 seedlings/min and transplanting cycle is about 30 s for each stroke. The study is in progress.

Automatic vegetable transplanter for plastic mulch laid raised beds

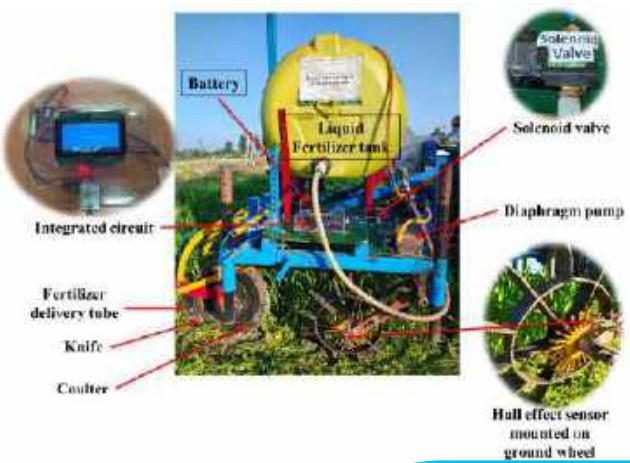
A tractor-operated integrated unit is being developed to perform raised bed formation, drip lateral laying, plastic mulch laying, and automatic seedling transplanting in a single pass. The machine features components including a variable-width raised bed former, drip dispensing unit, mulch roll holder, soil covering mechanism, seedling indexing unit, and a finger-type pick-and-drop transplanting system. Powered by the tractor's hydraulics and a Geneva mechanism, seedlings are accurately placed through a synchronized punching unit that ensures precise vertical placement. Currently, the mechanical transmission system is being upgraded with geared stepper motors to enhance accuracy. The integrated system can transplant 70–80 seedlings per minute and is expected to save approximately ₹7,000 per hectare and 29 man-days/ha compared to existing manual or semi-mechanized methods, offering a cost-effective, labour-saving solution for precision horticulture. Field trials for crops like chilli, brinjal, cabbage, and tomato are underway.

Light weight self-propelled multi-crop planter

Multi-crop planter is an attachment developed for the CIAE-self-propelled onion weeder. A four-row inclined plate planter consists of a hopper partitioned into four sections, inverted-T type furrow openers and power transmission system comprising of chain and sprockets. Four sets of seed plates with different cell sizes are provided to make it suitable for different seeds. The performance of lightweight self-propelled multi-crop planter has been evaluated for onion, chickpea, soybean, and black gram in black cotton soil at a forward speed of 1.5 km/h. The actual field capacity of planter is 0.034, 0.0315, 0.0387 and 0.0315 ha/h, at a field efficiency of 82.3, 84, 83.22 and 82.9%, in onion, Soybean, chickpea and black gram, respectively. Whereas, average planting depth is 22-30, 20-30, 50-70 and 30-40 mm at an average plant spacing of 93.5, 95.16, 111.16 and 110.23 mm in onion, soybean, chickpea and black gram, respectively. The performance of light weight planter is found to be satisfactory showing seed placement at uniform spacing and depth.

Fertilizer Application

Tractor-drawn coulter-based six-row liquid fertilizer applicator with speed-synchronized delivery system



To overcome nitrogen loss and uneven distribution in conventional urea broadcasting, a tractor-drawn coulter-based six-row liquid fertilizer applicator was developed. It places liquid urea 50–100 mm below the surface, directly into the root zone, enhancing nitrogen use efficiency by up to 67% and reducing total urea use by 33–44% without affecting crop yield. Field trials in wheat and maize confirmed its efficiency and sustainability. To improve precision, a speed-synchronized liquid fertilizer delivery system was integrated using an Arduino Mega 2560 microcontroller. It automatically adjusts discharge based on the tractor's speed using a Hall Effect sensor, solenoid valve, LCD

display, data logger and PWM. As a result, farmers can achieve comparable or even higher crop yields using up to 33–44% less nitrogen fertilizer, directly lowering input costs. Overall this innovation offers a cost-effective, efficient, and environmentally friendly solution for precision fertilizer application in modern agriculture.

Air assisted recycling tunnel sprayer for horticultural crops

A tractor operated field prototype of an air-assisted recycling tunnel sprayer was developed to achieve uniform spray coverage for 2-meter-high orchard canopies. The prototype comprised three main systems: an air-blowing unit, a chemical spraying system powered by the tractor's PTO, and a collapsible tunnel equipped with a liquid collection and recirculation system. The tunnel's adjustable width, ranging from one to two meters, allowed it to accommodate varying young orchard canopy structures. The spraying mechanism, optimized with a nozzle spacing of 350 mm, a nozzle angle of 43 degrees, a tunnel opening of 1100 mm, and a fin pitch of 41 mm, reduced spray liquid usage by 7.56% and improved spray deposition by 74.55%. The liquid collection system used a DC-powered pump to return excess spray to the storage tank, minimizing the chemical wastage and reducing environmental contamination. The field prototype demonstrated a working width and height of 1.5 meters and 2 meters, respectively, with a field capacity of 0.45 ha/h and a field efficiency of 78.63%.

Real-time nitrogen estimation and foliar spraying system

Precision agriculture technology is crucial for reducing fertilizer waste and improving input use efficiency. In this context, developing a variable rate application system is essential for sustainable crop production. A real-time nitrogen estimation and foliar spraying system has been designed for tomato cultivation in a polyhouse environment. The system features a constant-pressure vertical spraying boom equipped with a nozzle assembly consisting of a hollow cone nozzle, solenoid valve, and auxiliary nozzle, ensuring uniform spray pressure during operation. The system integrates an Arduino Mega and Raspberry Pi with ultrasonic and proximity sensors, DC motors, a touch display, DC pump, encoder, power bank, and an 8-channel relay module. The machine operates autonomously on fixed railing system, detecting each plant and capturing leaf images in real time. Nitrogen concentration in the leaves is estimated using deep learning models, including Vision Transformer, AlexNet, and EfficientNet. Leaf detection is performed with over 95% accuracy using the YOLO model. The nitrogen estimation models were trained on a dataset of 2500 tomato leaf images collected across three growing seasons, achieving a R^2 of 0.86 and an error range between 1.5% and 12.3%. Once a plant is detected, the Raspberry Pi processes the captured leaf images to determine the nitrogen concentration of each leaf and computes an average value for the entire plant. This data is then sent to the Arduino, which calculates the precise spraying duration required to deliver the appropriate amount of nitrogenous foliar spray. The Arduino controls the solenoid valves for accurate application, while the auxiliary nozzles maintain stable pressure throughout. Spraying is adjusted dynamically based on plant height, ensuring targeted and efficient nutrient delivery. The system advances sequentially from plant to plant, enabling real-time, site-specific foliar application tailored to individual crop needs. The complete process of nitrogen estimation and foliar spraying for a single plant takes approximately 12 to 15 seconds, and the system can cover a 500 m^2 polyhouse area in about 3.0 to 3.25 hours.

Interculture

Thinning device for establishing optimum plant population for a row crop

Thinning, a crop management practice to reduce plant competition is traditionally done by hand in a bent posture, causing musculoskeletal disorders in workers. To address this problem, an ergonomically designed e-powered manually guided thinning device has been developed. The device includes two DC motors powered by a 12 V battery, a limit switch, and a rotary cutting element mounted on a mild steel frame with rubber wheels. It features a long handle with controls for easy operation in a standing posture. The operator guides the device to the target plant, and the cutting element removes the extra plants. The equipment has been tested in maize crop. It was operated at a depth of 20-35 mm. Thinning capacity of the device was 3-5 plants per minute. The device significantly reduced postural risks, achieving a low REBA score of 3, as compared to 8 in traditional method.

Battery-powered pruner for pomegranate orchard

A battery-powered long-handled pruning device was developed, designed ergonomically for selective pruning in pomegranate orchards. Conventional tools like secateurs and loppers are less effective due to limited reach and high effort requirements. The device features a 24V DC geared motor-driven cutting blade mounted on a 2000 mm aluminium pipe. It includes a control unit, actuating switch on the handle, and directional blade control via two limit switches. The pruner can cut stems up to 12 mm in diameter at heights of 2–2.5 meters, achieving 12–15 cuts per minute. Field tests showed an average working heart rate of 126 beats/min, indicating moderate workload. A REBA score of 6 and discomfort rating of 4 categorized the posture risk and physical strain as moderate.

Harvesting and yield mapping

Tractor operated cotton harvester

The low-cost indigenous brush and rubber bat-type cotton stripper was designed and developed to strip the cotton from open cotton bolls. It consisted of a pair of counter-rotating rollers with three brush strips and three rubber bats. A centrifugal blower (10 hp) is used for conveying the seed cotton from the delivery ends of both screw augers to a storage tank through an air duct. The effective field capacity of the machine is 0.1 ha/h at a field efficiency of 80% at a forward speed of 1.35 km/h. Maximum picker efficiency is 93.15% at minimum harvesting loss of 6.8%, trash content of 22.95%, respectively. The net seed cotton output with the machine ranged from 150 to 217 kg/h.

Yield prediction using multi-temporal data from UAV-based multispectral imagery

An experiment was conducted at the ICAR-CIAE research farm, Bhopal, to evaluate a UAV-based multispectral (MS) imaging system for maize yield estimation (variety: J-1006). The crop was sown over 0.5 ha with 0.50 × 0.40 m spacing. A UAV hexacopter equipped with an MS sensor captured five spectral bands—Blue, Green, Red, Red Edge, and Near-Infrared—alongside a high-resolution panchromatic band. The sensor provided pan-sharpened output at 2 cm resolution (at 60 m altitude)

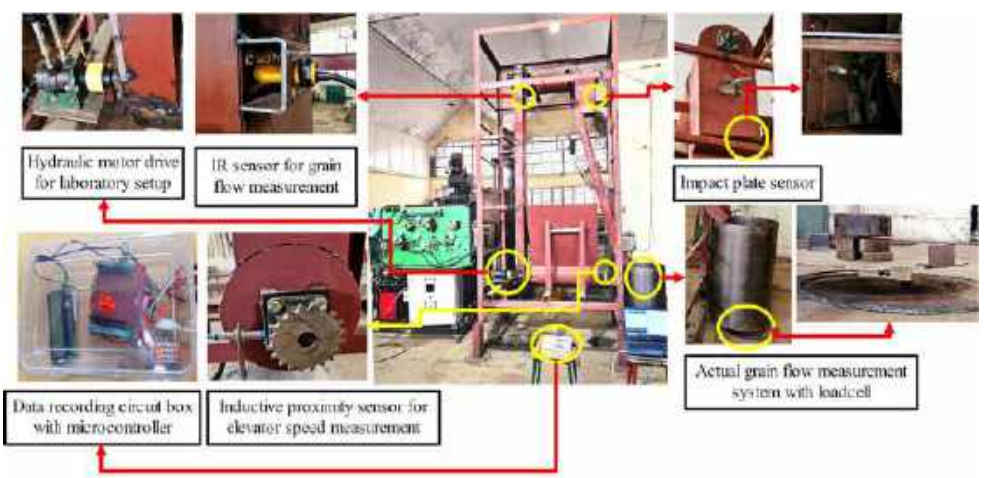
and 1.6 MP resolution for each spectral band. Flying at a consistent 10 m altitude and 5 m/s speed, the drone captured 70% overlapping images during key growth stages: knee height, flag leaf emergence, flowering, silking, and maturity. Images were processed using Pix4D Mapper (Ag Multispectral template) and ArcGIS Pro. An orthomosaic map with a 20×16 m grid was generated. NDVI values varied from 0.29 (±0.16) at knee height, 0.75 (±0.20) at flag leaf emergence, and 0.86 (±0.07) at silking. Data analysis is ongoing.

Yield monitoring system for grain combine harvester

The yield monitoring system comprises a grain flow sensor, moisture sensor, GPS, speed sensor, cut width sensor, data logger, and microcontroller. Two grain flow sensor concepts—optical (IR) and impact type—were selected and tested using a fabricated laboratory setup. This setup includes an elevator paddle, clean grain elevator, electric motor, orientation jack, inlet hopper, screw conveyors, and a collection tank. The IR sensor was mounted on top of the clean grain elevator to measure volume-based flow, while the impact sensor (a cantilever-type load cell with HX711 amplifier and ADC converter) was placed at the end of the screw conveyor to detect grain impact. An inductive proximity sensor measured elevator speed. All sensors interfaced with an Arduino Uno, and data were recorded using an SD card module.

The installed sensors were calibrated in laboratory against the actual grain flow rate. The R2 values for IR sensor and Impact sensor-based grain flow measurement is 0.83 and 0.80, respectively. The IR sensor and Impact sensor were calibrated in controlled conditions by analyzing the effects of pitch, roll, and elevator speed on grain flow measurements. The experiment followed a Full Factorial Completely Randomized Design (CRD) with three independent parameters: pitch and roll at five levels each (-10°, -5°, 0°, 5°, 10°), and elevator speed at three levels (1.18, 1.42, 1.66 m/s). For each parameter combination, three replications were conducted. The dependent parameters measured were the actual grain flow rate, grain flow rate using an IR sensor, and grain flow rate using an impact plate sensor. The results indicates that the model is highly significant across Actual grain flow rate, Grain flow rate by IR sensor & Grain flow rate by Impact plate sensor, with p-values at the 1% level. Among the factors, pitch (A) shows a significant effect (1%) on the actual grain flow rate, grain flow rate using an IR sensor, and grain flow rate using an impact plate sensor, while elevator speed (C) and its quadratic term (C^2) exhibit significance at the 5% level in actual grain flow rate and grain flow rate by impact plate sensor. The interaction terms (AB, AC, BC) and roll (B) are largely non-significant, except for roll (B) in the grain flow rate measurement by impact plate sensor, where it shows a strong effect (1%). These results suggest that pitch (A) and elevator speed (C) are the primary influencing factors in grain flow rate measurements.

The results obtained from IR sensor and impact plate sensor-based grain flow measurement were compared with the actual grain flow rate using paired t-test in SPSS software. The mean difference between Actual grain flow and IR grain flow is 199.12 g/min, with a standard deviation of 1.65 and a standard error of the mean (SEM) of 2.97. This indicates that the IR sensor tends to slightly underestimate grain flow, but with high variability and error, reflecting less consistent measurements. In contrast, the mean difference between Actual grain flow and Impact grain flow is only 3.92 g/min, with a standard deviation of 0.84 and a standard error of the mean of 1.67. This very small mean difference and lower variability suggest that the impact plate sensor provides much closer and more consistent estimates of actual grain flow. There is no significant difference in the grain flow rate measurement at 5% level of significance. But difference in mean is minimum in case of impact plate sensor. Therefore, it can be adopted for grain flow measurement in combine.



Ergonomics

Study on work fatigue analysis of agricultural workers to improve working efficiency

A detailed study was conducted to evaluate the physical strain faced by agricultural workers, especially women, during paddy transplanting. Discomfort and fatigue were assessed using the Body Part Discomfort Score (BPDS), Overall Discomfort Rating (ODR), and Nordic Musculoskeletal Questionnaire (NMQ). Results revealed a high prevalence of musculoskeletal disorders (MSDs): 100% reported lower back pain, 96.6% knee pain, and 91.6% shoulder pain within a day. Chronic lower back pain lasting over seven days affected 93% of women workers. Chi-square analysis showed significant links between MSDs and age, experience, and BMI, with new and underweight workers at higher risk. Ergonomic risks were evaluated using RULA and REBA scores, averaging 7 and 9, indicating urgent need for intervention. Physiological and EMG analyses on 12 workers showed high muscle loads, particularly in the erector spinae, latissimus dorsi, and trapezius muscles. The average heart rate was 115 bpm and energy expenditure was 18.16 kJ/min, classifying the task as moderately heavy. BPDS and ODR scores averaged 55 ± 7 and 8 ± 1. A revised work schedule of 35 minutes work followed by 5 minutes rest and a 1–2 PM lunch break was recommended to reduce fatigue, lower MSD risk, and improve productivity in paddy fields.

Animal Husbandry

Automatic poultry feed dispenser

An automatic Feed Dispenser (AFD) for poultry that integrates deep learning-based computer vision with a microcontroller system was developed considering the ergonomics database of Indian agricultural farm workers, ensuring suitability for local conditions. The AFD comprises a hopper, a volumetric auger-type feed dispenser, a stepper motor, and a programmable logic controller (PLC). The feed dispensing mechanism operates using a stepper motor, ensuring precise volumetric delivery. The system demonstrated high accuracy in feed dispensing—reaching to near 100% accuracy—when the calibration factor was set to 5, in alignment with the recommended feed dosage. Dispensing quantities ranged from 246.9 g in the first week (days 1–7) to 2538.4 g in the ninth week (days 57–63), enabling precise adjustments based on bird age and population.By significantly reducing physical strain, labour costs, and time requirements while also lowering the risk of disease transmission due to reduced human interaction the developed AFD represents a transformative advancement in modern poultry farming.

AGRICULTURAL ENERGY AND POWER DIVISION

Solar energy gadgets and their applications

Solar PV integrated portable greenhouse for horticulture production

A prototype of semi-transparent solar PV integrated green house was fabricated and south roof of the green house was covered with semi-transparent panels (48V,72W with 10%transparency). Total 06 panels were installed at green house. Leafy vegetables like spinach was grown inside the solar PV integrated green house. Foggers (02 nos) for spraying water and maintaining humidity and DC fan(24V) (01 no.) were installed inside the green house. A 12V,100Ah battery was connected with panels through MPPT solar charge controller (VOC-145V). All the installed accessories of solar greenhouse are operated with solar energy generated through panels. Performance parameters like solar radiation (ambient and inside the green house), temperature as well as RH (ambient and inside the green house) were measured and recorded. Photo synthetically active radiations (PAR) were also measured for the spinach inside the solar green house and compared with control. The performance of green house was compared with control green house. The south wall was also partially covered with solar panels.

It was found that difference in radiation between solar and control green house was 38%. The average temperature and RH(%) for solar green house was found as 27^{0}C and 40% respectively. Yield of spinach was found as 2.8 kg/m2 inside the solar green house. Number of leaves per plant and root length of plant and were found more as compared to control. The average PAR value for spinach was 150 µmol/m2s which is within the range of plant requirement. The sizing of panels would be optimized in terms of electricity generation, cost and the plant yield. The study is in progress.

Multi-utility electric vehicle

A multi-utility electric vehicle has been developed which is powered by a 6kWh LiFePO4 battery (60V, 100Ah) and a 60V BLDC motor with a controller for light agricultural tasks. The chassis was analyzed using Ansys 18.1 to design for strength and stability. The MUEV, with a 530 kg payload (excluding the driver), was equipped with reaper and planter attachments, a 12V DC power pack, and a hydraulic cylinder with a 10L tank. It has a 2.5m turning radius and was suited for tasks like sowing, harvesting, and transportation. Field evaluation for paddy harvesting observed an effective field capacity of 0.203 ha/h, 80.55% efficiency, with a power consumption of 2.42 kW (38A current). The operating cost and energy consumption were estimated as Rs 1125/ha and 179.11MJ/ha respectively. For chickpea sowing, the effective field capacity was 0.29 ha/h, with 75.98% efficiency and a cost of ₹874.60/ha. The power consumption during the sowing operation was estimated 0.664 kW (19A current), totaling 1518 MJ/ha. Battery tests performed at ICAR-CIAE and it was lasted for 4-5 h without load and 2-3 h under field conditions.

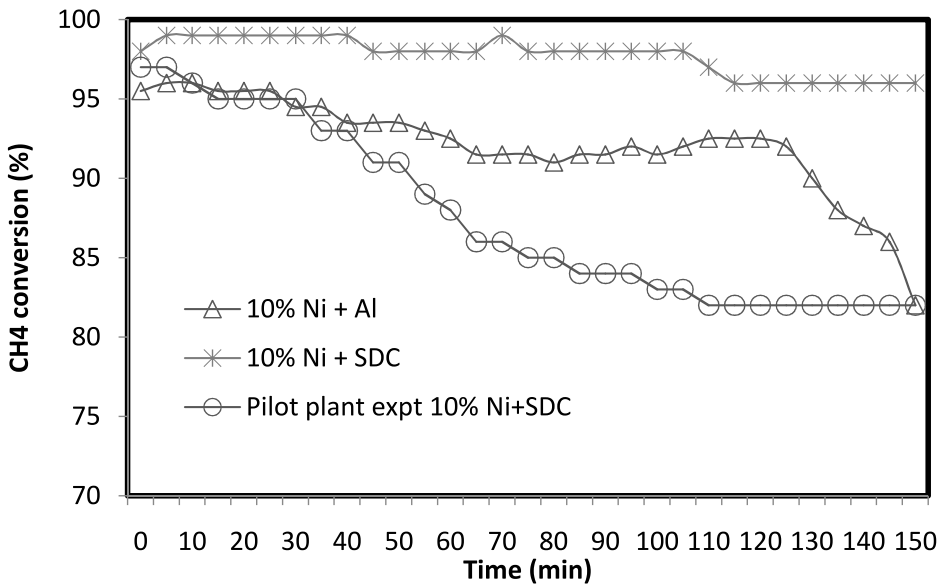
Solar power pack for pruning and variable rate spraying

A solar power pack, consisting an MPPT charge controller, a 40V 100Ah Li-ion battery, and 900W flexible solar panels is under development. Real time monitoring and logging of battery charging percentage, voltage, temperature, and load were implemented in the design. For the smart variable-rate spraying system, a Python algorithm was developed to control spraying based on data from an RPlidarLiDAR sensor rotating at 8000 Hz. A circuit diagram was designed for the variable-rate spraying system. An integrated embedded system with a microprocessor and sensor has been developed. Calibration of the system for varying canopy densities and flow rates is currently under progress.

Bio-hydrogen generation

Bio-hydrogen generation from methane through catalytic reforming

This research investigates the hydrogen production through methane pyrolysis. By impregnating nickel (Ni) onto saw dust char and alumina balls (Al), the catalytic activity was enhanced, leading to improved hydrogen yields. to systematically study the effects of various parameters, including temperature, gas flow rate, and catalyst loading, on the hydrogen production process. The results of this study provide valuable insights into the optimization of hydrogen production from methane pyrolysis using sustainable catalysts. The char derived from sawdust and alumina balls of 2-3 mm size served as the catalyst supports. Nickel impregnation, at 5, 10 and 15% concentrations, was employed to enhance the catalytic activity. Preliminary experiments were conducted to evaluate the performance of the prepared catalysts. The catalyst exhibited a methane conversion up to 98% for a period of 15 min and thereafter it sustained for 120 mins with a conversion of 80%. The high catalytic activity and stability of the catalyst can be attributed to several factors, including strong metal-support interaction between Ni nanoparticles and the alumina-sawdust char support. The porous structure of the support provides a large surface area for the adsorption and activation of methane molecules. Multi-walled carbon nano tubes (MWCNT) were found to be formed during the methane conversion. The diameter and wall thickness of these nanotubes was determined by SEM and TEM analysis and found to be 13 and 11 nm, respectively. This research demonstrates the potential of the alumina-sawdust char-supported Ni catalyst as a promising material for the efficient and sustainable production of hydrogen from methane pyrolysis.



Methane conversion rate (%) using methane pyrolysis reactor

Development of process protocol for the production of hydrogen with porous C-induced dark fermentation using paddy straw

Bio-hydrogen generation though biochemical conversion pathway was initiated using paddy straw. Paddy straw as lignocellulosic biomass is an attractive resource as it is renewable, cheap and available in large quantities. It has high carbohydrate content that can be converted into bio-hydrogen through dark fermentation process. The paddy straw was treated with 0.5% and 1 % Sulfuric acid and hydrolysate obtained was used for experiment. The solid fraction was washed and dried at 65°C. Biochar was produced from solid fraction at a temperature of 400, 500 and 600°C for 1h. The biochar sample was analyzed for surface area and proximate analysis. Experiments were conducted using hydrolysate with addition of biochar at a rate of 10 g per liter. The surface area of material was analyzed using BET surface area. It was observed that with the increasing pyrolysis temperature the surface area of biochar was increased. It was 18.49, 29.62 and 204.77 m2 per g at a pyrolysis temperature of 400, 500 and 600°C respectively for 0.5 % treated sample. Similarly for 1 % acid treated sample it was 36.33, 66.67 and 234.27 m2 per g at a pyrolysis temperature of 400, 500 and 600°C respectively. Maximum recovery of hydrogen gas was 2.47 L per kg of paddy straw obtained at a process condition of 1% treated material and biochar prepared at 600°C. It suggested that more surface area of biochar is favourable for microbial community growth to enhance the hydrogen production.

Generation of high grade nanoporous carbon from biomass

Generation of supercapacitor grade carbon from crop residues

The synthesis of nanoporous carbon from chickpea stalk through chemical and thermal activation using potassium hydroxide (KOH) was studied. The synthesized nanoporous carbon was thoroughly characterized and applied in for energy storage. Activation of the chickpea stalk was performed under an inert nitrogen atmosphere at varying activation times (30, 60, and 90 minutes) and temperatures (750, 800, and 850 °C). The chemically activated nanoporous carbon was successfully tested as a supercapacitor electrode material for the first time, demonstrating its potential in energy storage applications. Comprehensive characterization of the raw chickpea stalk and the prepared nanoporous carbon was conducted using Thermogravimetric analysis (TGA), proximate analysis, adsorption analysis, BET surface area analysis, SEM, XRD, and FTIR spectroscopy. Thermogravimetric analysis revealed that the chickpea stalk undergoes mass loss in three stages, with major volatile degradation occurring between 143–374 °C. Adsorption analyses revealed that the nanoporous carbon exhibited high microporosity and mesoporosity.

The BET surface area analysis showed that all the prepared nanoporous carbon samples possessed micro and mesopores. The highest surface area (1239 m^2/g) and pore volume (0.60 cm^3/g) were recorded for sample CT-9(temperature 850°C, holding time 90 min, and heating rate 10°C/min). SEM imaging revealed interconnected micro and mesopores in the prepared nanoporous carbon. FTIR analysis indicated functional groups such as alcohol group (O–H), ester group (C–O), carbon dioxide (O=C=O), and carboxylic acid (O–H) significantly improved the interaction between the material and electrolyte ions. Electrochemical performance was

evaluated using a three-electrode setup with 1M KOH as the electrolyte. Cyclic Voltammetry (CV), Galvanostatic Charge-Discharge (GCD), and Electrochemical Impedance Spectroscopy (EIS) were employed to analyze the nanoporous carbon as an electrode material. The results showed that the nanoporous carbon-based electrode exhibited a specific capacitance of 343.29 F/g at a current density of 1.0 A/g, an energy density of 48 Wh/kg, and a power density of 495 W/kg, along with excellent cycling stability. The equivalent series resistance was measured at 1.06 Ω. These findings indicate that chickpea stalk-derived nanoporous carbon is a promising bio-material for high-performance super capacitors and energy storage devices.

Plasma treatment of crop residues for improved characteristics

Plasma-based treatment of lignocellulosic biomass is an emerging, innovative, and eco-friendly approach to modifying structural and physicochemical properties of crop biomass. This study explores the effects of non-thermal plasma treatment on chickpea crop residue, focusing on structural and surface modifications using X-ray Diffraction (XRD) and Brunauer-Emmett-Teller (BET) analyses. Chickpea stalk biomass, collected and prepared into fine powder, underwent cold plasma exposure for varying durations (15, 30, 45, and 60 minutes) under controlled low-pressure conditions. The plasma environment, generated by high-voltage electrical discharge, facilitated extensive surface and molecular alterations, driven by reactive ionized species. The interaction between plasma-generated radicals and lignocellulose components induced profound changes in crystallinity, porosity, and molecular organization. XRD analysis revealed a distinct evolution in crystallinity with plasma exposure. A progressive shift in peak positions and variations in intensity suggested molecular rearrangement, where 15 and 60 minute treatments promoted enhanced crystallinity, while the 30 minute exposure exhibited broader peaks indicative of partial amorphization. These structural modifications reflect the intricate interaction of plasma with hydrogen bonding networks, potentially unlocking new avenues for biomass valorisation. BET surface area analysis further confirmed substantial morphological transformations. Plasma treatment led to significant densification, as evidenced by an initial drop in surface area from 0.85918 m^2/g (raw) to 0.045257 m^2/g (15 min). However, a sharp increase in pore diameter and volume after 30 minutes suggested an expansion of microporous structures, likely due to plasma-induced etching effects.

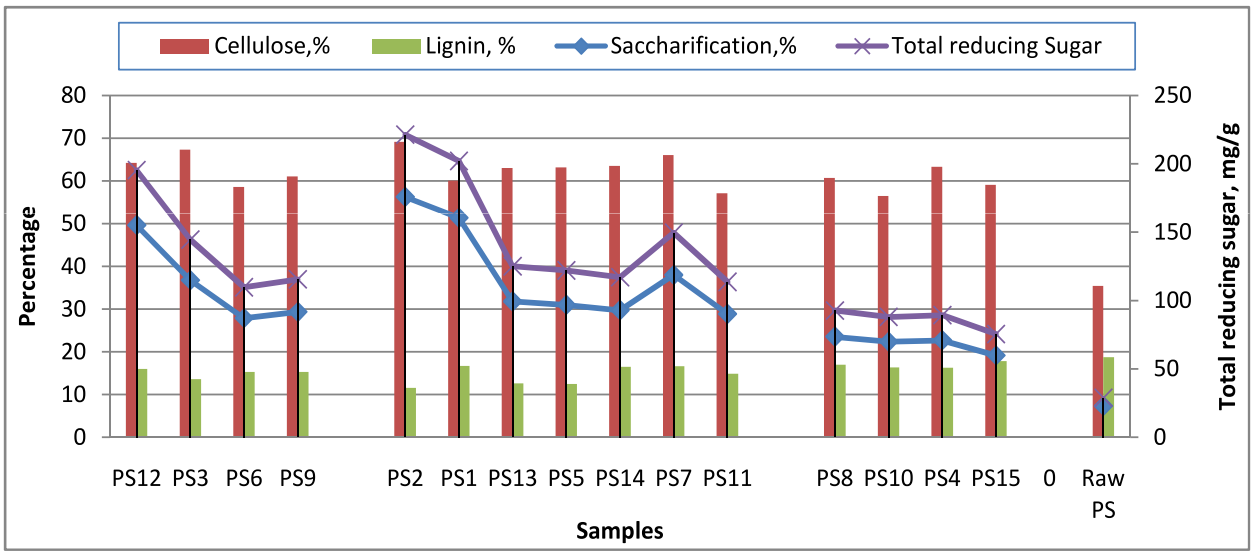
Value added products from biomass

Process optimization for maximizing the fermentable sugar yieldsfrom paddy straw and corn cobs

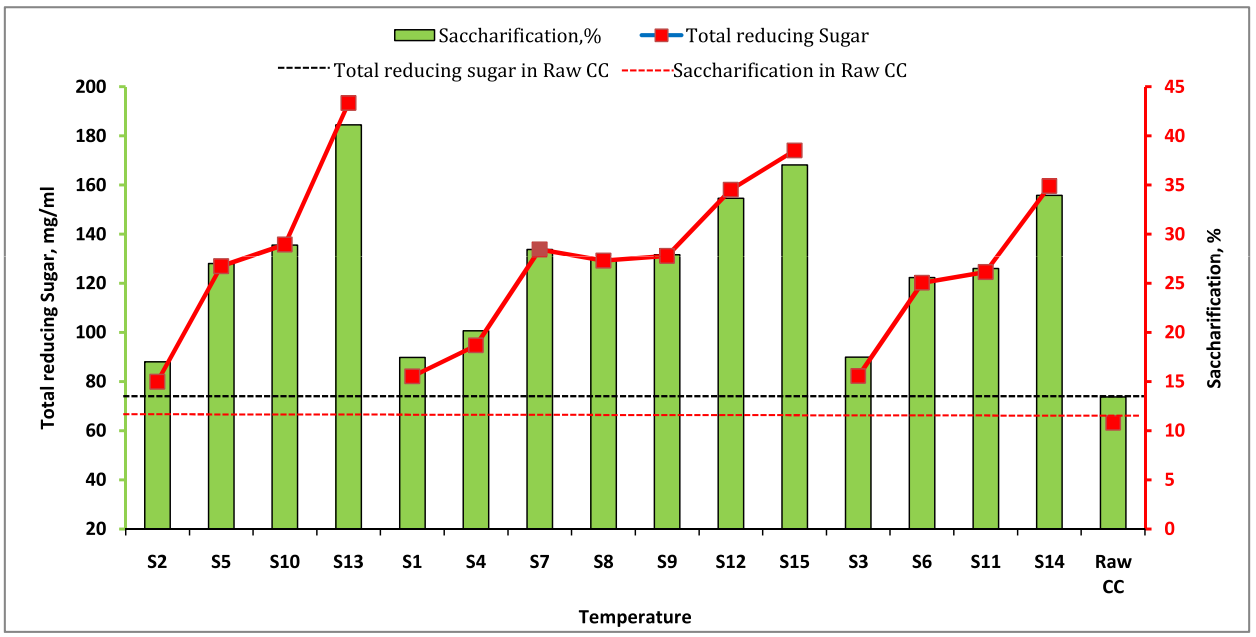
This study focuses on maximizing the fermentable sugar yields from paddy straw and corn cobs through an integrated acid and enzymatic pretreatment process. Two-step pretreatment process: dilute sulfuric acid pretreatment followed by enzymatic hydrolysis was experimented. A response surface methodology (RSM) with a Box-Behnken design was employed to optimize key process parameters such as acid concentration, temperature, and residence time for the pretreatment.

For paddy straw, the optimal conditions were found to be 1% H2SO4, 80°C, and 20 minutes, which resulted in effective cellulose enrichment (95.4%) and lignin reduction (38.2%), promoting efficient enzymatic hydrolysis. Using cellulase from Trichoderma reesei, enzymatic hydrolysis yielded high glucose concentrations of 225.2 mg glucose/ml per gram of paddy straw. Surface modifications of pretreated paddy straw were validated using Brunauer-Emmett-Teller (BET) analysis and morphological studies, revealing a 58.6% decrease in surface area, a 25% decrease in pore volume, and an 87.9% increase in mean pore diameter under optimized conditions. These changes indicate improved accessibility of cellulose for hydrolysis and suggest a more efficient conversion of paddy straw into biofuel.

Similarly, for corn cob, the optimal pretreatment conditions involved a 0.5% sulfuric acid concentration, 120°C reaction temperature, and 40-minute duration. Under these conditions, the cellulose content of the pretreated corn cob increased to 66.10%, while the hemicellulose content decreased significantly. Enzymatic hydrolysis of the pretreated corn cob resulted in a maximum saccharification yield of 41.1%, corresponding to a glucose yield of 185 mg/g of corn cob. The fermentation experiments using Acetone-Butanol-Ethanol (ABE) are currently under progress to assess the potential for converting the fermentable sugars obtained from the pretreated biomass into biofuels



Effects of acid pretreatment, time and temperature on total reducing sugar yield and saccharification efficiency of paddy straw.



Effects of acid pretreatment, time and temperature on total reducing sugar yield and saccharification efficiency of corn cob.

Extraction of cellulose from corncob residues

Process technology for extraction of cellulose from corncob residues valorization of corncob residues was done through synthesis of high crystalline cellulose using chemical treatments, which involved alkaline pre-treatment and bleaching. The cellulose content was notably increased in the extracted cellulose (88.13%) as compared to corncob biomass (42.30%). The morphological, chemical, and thermal properties of the resulting cellulose were thoroughly examined through various analytical techniques. The fiber diameter of extracted cellulose was reduced compared to corncob biomass. The chemical structure of the cellulose was analysed using the FTIR, confirming the effectiveness of the treatments. The XRD pattern of extracted cellulose exhibits sharp peaks at 2θ of 16 ◦ , 22 ◦ , 34 ◦ and 45 ◦ , respectively. The appearance of sharp peaks attributes the typical crystalline nature of the cellulose. The XRD results showed that crystallinity index of corncob, which was 29.63%, increased to 53.95% in extracted cellulose. Furthermore, thermogravimetric analysis demonstrated that the lower degradation temperature of extracted cellulose would be beneficial for degradation of bio based materials.

Development of pellets using digested biogas slurry and soybean stalks

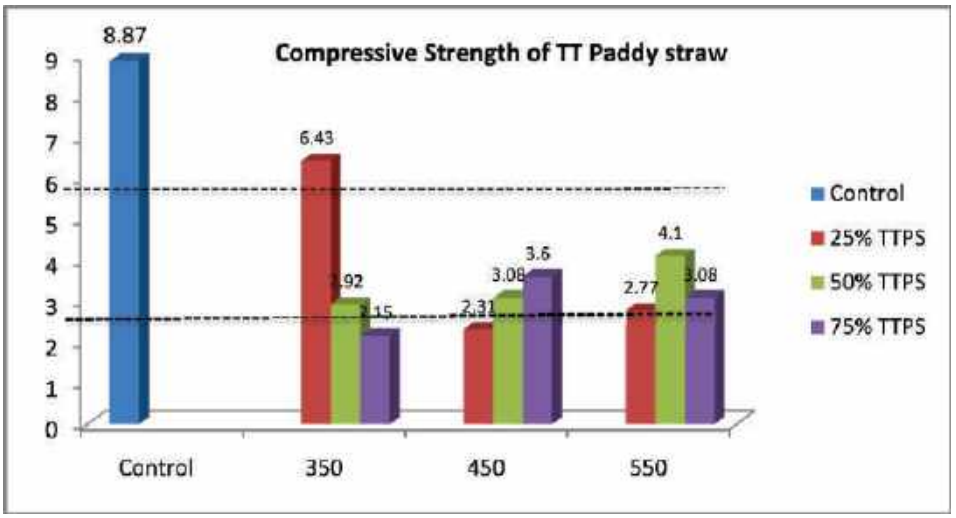
This study investigates the utilization of digested biogas slurry (DBS), a byproduct of anaerobic digestion, in combination with soybean stalks to form biomass pellets as an alternative energy source. The research systematically assesses the physicochemical properties of both substrates and evaluates optimally blending ratios (1:1, 2:1, and 3:1) and moisture content (10,15 and 20%) for pellet production. Results indicate that blending (1:1, MC 15%) of soybean stalks with DBS yields pellets which has superior calorific values (17 MJ/kg). Maximum mechanical strength was achieved as 17.28MPa with bending ratio of 1:1, and significant bulk density of 1962 kg/m3was observed with bending ratio of 1:1 (MC 20%). As compared to conventional fuels, developed DBS pellets have reduced emissions and maximum 79.9% water resistance index (3:1). These findings offer a promising approach to managing agricultural waste while promoting circular bioeconomy practices and sustainable energy systems.

Development of plastering material using paddy/ soybean straw for small dwellings

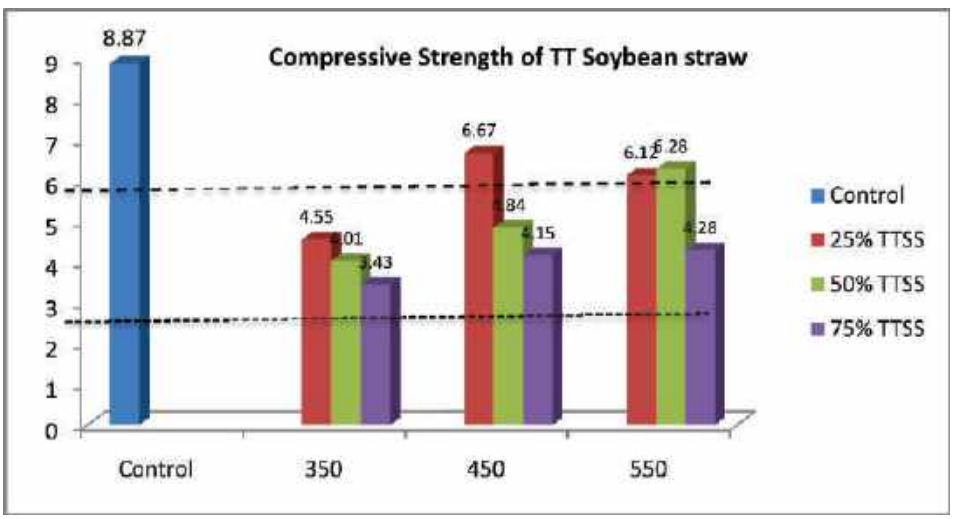
Thermally treated straw (paddy and soybean) based mortar cubes (50 x 50 x 50) mm and prismatic samples (40 x 40 x 160) mm were prepared and mixed with cement: sand ratio of 1:3 in different combinations by the replacement of sand with thermally treated straw i.e. 1:2:1, 1:1:2 and 1:0:3. Soybean and paddy straw was selected for thermal treatment at three temperatures i.e. 350,450 and 550^{0}C. The thermally treated paddy and soybean straw was mixed in different proportion with sand at constant proportion of cement. The cement to sand ratio for mortar preparation was kept as 1:3 (volume basis). The water to cement ratio of a 0.6 (weight basis) was used as it is suitable to produce conventional mortar. The sand was replaced by the raw biomass and thermally treated biomass (25%, 50% & 75%) for mortar preparation while the portion of cement was kept same (25%). Similarly for flexural strength test the prismatic bars of 160 x 40 x 40 were prepared for different combinations (25, 50 and 75%) of cement sand and thermally treated biomass. Samples for compressive and flexural strength testing were prepared in molds and cured in water for 28 days.

T=350^0 T=450^0 T=550^{0}C

Mortar cubes prepared by mixing of thermally treated biomass at different temperature



Compressive strength of Thermally treated paddy straw after 28 days of curing



Compressive strength of Thermally treated soybean straw after 28 days of curing

It was observed that replacement of sand with thermally treated soybean straw found better in terms of compressive strength as compared to thermally traeted paddy straw. Replacment of sand to the tune of 25% and 50% with thermlly treated soybean straw (treatment imparted at temperature of 350 and 550^{0}C) gives better and stable results as compared to paddy straw.

Energy auditing

Analysis of energy and carbon footprint in rice milling

The study collected data from three rice milling plants in Bramhapuri, Maharashtra, with capacities of 4 TPH, 8 TPH, and 12 TPH. The energy consumption and carbon emissions were analyzed across various stages of rice milling, including cleaning, hulling, whitening, polishing, and others. The process flow for each milling stage was mapped, and energy usage and CO_2 emissions for each stage were recorded. A breakdown of energy input (in MJ per tonne of rice) and CO_2 emissions (in kg CO_2 equivalent per tonne) was calculated for each mill capacity, providing insight into the energy demands and environmental impacts of each operation. The study revealed varying trends in energy consumption and CO_2 emissions across different milling capacities. While larger mills (8 TPH and 12 TPH) showed improved efficiency in most processes, certain stages like whitening and polishing remained major energy consumers, contributing over 50% of total energy and emissions in the 4 TPH mill, and 45%-50% in the 8 TPH and 12 TPH mills.

Process-wise energy input and carbon dioxide emissions of rice mills

S.No.	Process	Energy input, MJ.T^{-1}			Carbon-di-oxide emission, kg CO_2eq. T^{-1}		
		4 TPH	8 TPH	12 TPH	4 TPH	8 TPH	12 TPH
1	Cleaning	59.65	42.01	37.66	4.41	3.11	2.80
2	Hulling	59.29	61.54	59.66	4.42	4.58	4.44
3	Paddy separation	14.17	10.41	6.94	1.04	0.77	0.51
4	Thick grading	5.79	2.31	6.07	0.43	0.17	0.45
5	Whitening	278.40	213.24	177.03	20.74	15.89	13.19
6	Tip separation	8.31	11.44	8.54	0.61	0.85	0.63
7	Polishing	278.80	172.75	157.47	20.78	12.88	11.74
8	Colour sorting	23.98	24.84	27.90	1.78	1.84	2.07
9	Length grading	30.74	29.56	37.83	2.28	2.19	2.81
10	Dust cyclone section	42.33	24.50	23.01	3.16	1.83	1.72
11	Bran cyclone section	98.08	118.10	117.30	7.31	8.81	8.75
12	Bran & Tip separation	53.53	42.39	38.60	3.99	3.16	2.88
13	Packaging	25.29	11.52	10.30	3.16	1.71	1.42
	Total	978.37	764.61	708.31	74.09	57.79	53.41

Energy inflow outflow assessment of soybean wheat cropping system of selected villages of MP

The survey and data collection from the farmers was carried out in the 30 selected villages of Madhya Pradesh and a total 600 farmer's data were collected and analyzed. To evaluate efficiency, Data Envelopment Analysis (DEA), a non-parametric statistical method, was employed to identify efficient and inefficient farmers and to calculate the projected energy saving.

The introduction of a solar-operated knapsack sprayer in a soybean field significantly reduced energy consumption. For herbicide application, energy input with solar sprayer was 150.35 MJ/ha, compared to 174.35 MJ/ha with a conventional power knapsack sprayer, resulting in the energy saving of 13.77%. In case of insecticide application, the energy consumption with the solar-operated knapsack sprayer was observed 51 MJ/ha. In Madhya Pradesh energy consumption for insecticide application with the manual knapsack sprayer was 59 MJ/ha, whereas with the power knapsack sprayer it was 116 MJ/ha, resulting in a 14% and 56% energy saving respectively with the solar-operated sprayer, showcasing its efficiency and sustainability.

Intervention of technologies like laser land leveler (LLL), seed cum fertilizer drill and solar-operated knapsack sprayer were carried out in the farmer's field. It was observed that, energy saving of 5.59% is possible with the use of LLL. A seed cum fertilizer drill was introduced for sowing soybean (variety RVS 1135) with a seed rate of 85 kg/ha, reducing total energy consumption to 1932 MJ/ha compared to the regional average of 2615 MJ/ha. This intervention achieved around 26.10% energy saving.

IRRIGATION AND DRAINAGE ENGINEERING DIVISION

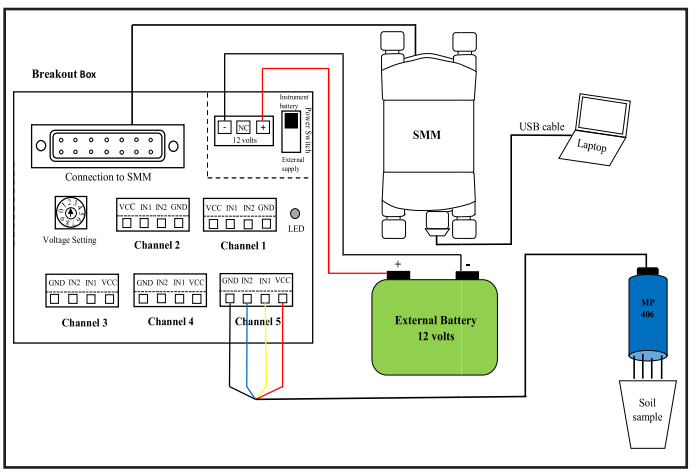
Linear move irrigation system for small farm

An indigenous irrigation system tailored for small farms has been developed for better adoption of morden irrigation systems. A linear move irrigation system using a guiding arrangement was developed and evaluated for irrigating 0.4 ha area, suitable for crop heights up to 1.5 m. The developed system can operate using an electric gear motor drive; using timer controllers and a single- and three-phase electric circuit, system moves at forward a speed of 0.2 km/h and operates semi-automatically to apply the designed depth of irrigation on a stop-and-go basis. The cost of the developed system is approximately Rs. 1,00,000/- and the expected life of the system is 10 years. The developed system with five sprinklers achieved a distribution uniformity of 78.5% and a coefficient of uniformity of 86.2%. The developed unit can save the labour cost of operation by about 25% compared to a portable sprinkler system and will not cause hindrance to mechanized intercultural operations.

Estimation of evapotranspiration and carbon fluxes using eddy covariance for wheat crops in vertisols

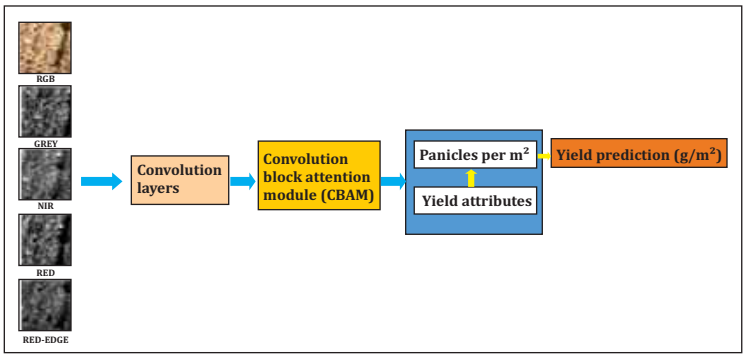
Quantification of evapotranspiration and carbon fluxes in wheat and soybean crop fields was done using the eddy covariance technique, which provides a direct and continuous measurement of the net ecosystem exchange of CO2 between the land surface and the atmosphere. The net ecosystem exchange, gross primary production, and ecosystem respiration in the winter wheat field were -512.05, 937.79, and 425.74 g C m-2 for the year 2021-22 and -546.80, 972.15 and 425.30 g C m-2 in the year of 2022-23. Evapotranspiration for wheat was quantified as 326.1 and 305.2 mm for the crop season 2021-22 and 2022-23.

Nano sensor and its application through cloud-based network for real time irrigation to soil and plant



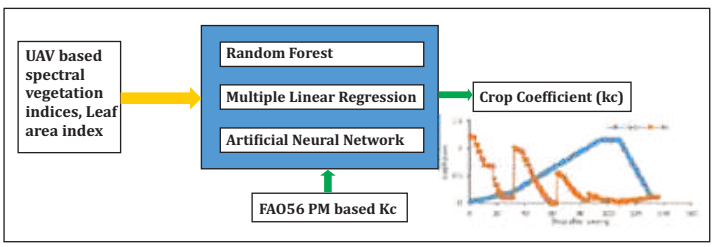
Doping of PANI with strong acids increases its electrical conductivity but makes it unstable at higher humidity or moist conditions. The CSA-doped PANI was prepared for deposition on the stainless steel needle surface of the soil moisture sensor. A set-up was developed for surface modification of MP 406 soil moisture sensor using nanoparticles of PANI material. The findings revealed notable improvements in the sensor's performance. Sensitivity in the 35-45% VSW range increased from 6.77 to 8.31 mV/% soil moisture. The enhancement in sensitivity after PANI deposition rose to 26.2% at 100% VSW from 12.1% at 10% VSW.

Yield prediction using data driven techniques and UAV imagery



Yield estimation using UAV imagery enables timely, accurate crop assessment, supporting precision farming, resource optimization, and informed decision-making. State-of-the-art CNN-CBAM-based deep learning models were developed for yield prediction for wheat and rice using UAV RGB and multispectral imagery. The ground truth data on the number of panicles, panicle length and yield per m^2 were collected and verified. A new approach of convolution block attention module (CBAM) was added to CNN layers for improving feature selection and prediction. The performance of developed models was evaluated by statistical parameters such as MAE representing panicles per m^2. The minimum MAE (Panicles per m^2) in the testing dataset for CBAM-AgriV1, CBAM-AgriV2 were 2 and 7, respectively. Wheat yield prediction using CBAM-AgriV1 and CBAM-AgriV2 models had R^2 = 0.77 and R^2 = 0.70, respectively. Similarly, for rice yield prediction, the R^2 of 0.63 and 0.57 were observed for corresponding models, respectively.

Estimation of crop coefficient using machine learning and UAV imagery



This study aimed to explore the potential of leaf area index (LAI) and multispectral vegetation indices (VIs) obtained by an unmanned aerial vehicle (UAV) for estimating the Kc value for a wheat crop on a field scale. Hence, the performance of the estimation model for daily wheat Kc derived by two machine learning algorithms (random forest (RF), multiple linear regression (MLR), and artificial neural network (ANN) based on the ground-based LAI and UAV-based multispectral VIs (NDVI, SAVI, GNDVI, TCARI, RTVI) was evaluated under multiple irrigation conditions during the entire cropping cycle. Maize RFR with VIs-LAI-based ET was compared to FAO-56-based ET. The Random Forest model with vegetation indices and ground truth (LAI) as input was better (R^2 = 0.81, RMSE = 0.124) than other models for wheat crop coefficient estimation.

ML based decision support system for micro-irrigation scheduling

ML based DSS for micro-irrigation scheduling has been developed with three modules. In Module 1, the web application for Machine learning (ML) based reference evapotranspiration (ETo) prediction was developed using python and HTML. The random forest (RF) model was selected to predict ETo as it outperformed the support vector regression and artificial neural network model. For a weather input combination of maximum temperature (Tmax), minimum temperature (Tmin), relative humidity and wind speed, the RF algorithm predicted the ETo with highest R2 (0.98) and lowest RMSE (0.46 mm/day). The real time forecasted weather dataset was integrated with a web-based application using the flask API to predict 5 days' lead time ETo. The database of weather, crop and soil information for DSS was prepared and integrated with the DSS module. Based on weather and crop information, predict crop water demand was predicted in Module 2. An irrigation scheduler was developed for guiding when to irrigate and how much to irrigate for crops grown in module 3.

Automatic irrigation control valves for gravity-fed canal systems

A prototype of automatic irrigation control valve for gravity-fed canal systems has been developed to reduce the labour intensiveness of surface irrigation. It was evaluated for real-time controlling the surface irrigation. The developed control valve operates using an electric gear motor drive. This valve can automatically open and close with the help of sensors and controller commands. The system has been integrated with automation system using soil moisture sensors and cut-off ratio conditions to enhance the water application efficiency.

Root zone climate control structure for mushroom and hydroponic leafy green cultivation

Direct exposure to sunlight and elevated ambient temperatures can significantly increase the temperature of the nutrient solution in hydroponic systems, negatively affecting the root zone environment and hindering the growth of leafy vegetables. To overcome this challenge, a root zone climate control structure equipped with a fan-pad cooling system has been developed. This system uses PVC pipes installed within a closed, insulated structure to limit heat gain from solar radiation and the surrounding air. It effectively maintains optimal root zone temperatures for hydroponics while also creating a suitable microclimate for mushroom cultivation. The fan-pad system has demonstrated a reduction in internal temperature by 8–15°C and an increase in humidity by 20–25% compared to external conditions. This innovative structure enables the concurrent cultivation of leafy vegetables and mushrooms in a controlled environment, significantly enhancing resource efficiency. The system can reduce water usage by up to 80–90% and boost crop yields. Additionally, this technology holds substantial promise for urban agriculture by lowering transportation costs, enhancing food security, and enabling year-round cultivation of fresh produce in limited spaces.

AGRO PRODUCE PROCESSING DIVISION

Tender jackfruit peeling machine

A motorized peeling machine was developed for removal of spikey peel of tender jackfruit. Jackfruit holding assembly and peeling arm with blade are the key functional components of the machine. A spring-loaded peeling arm carrying a peeling blade was fixed on the surface of the rotating jackfruit. During the rotation of jackfruit, the peeling arm moves linearly from top to bottom simultaneously peeling the jackfruit. Rotational speed of jackfruit, linear speed of peeling arm and location of peeling blade are the key operating parameters of the machine. The peeling efficiency was reported to be 96.57 % with a peel loss of about 2.8 % at a rotational speed of 80 rpm, linear peeling rpm speed of 5 m/s and location of peeling blade of 85 mm. The machine is operated by an electric motor (1.47 kW) and its output capacity is about 120 kg/h.

Cutting cum anti-browning system for peeled tender jackfruit

A cutting cum anti-browning treatment system has been developed. The cutting assembly consists of set of blades (6 Nos.) operated vertically in reciprocating motion. The cutting blade is operated with pneumatic system comprising of a pneumatic cylinder (bore 75 mm, stroke 400 mm), at maximum pressure of 0.98 N/mm^2. A stainless steel container contains the anti-browning solution (ascorbic acid, 1.5 % conc.) fitted at cutting platform to avoid the browning of cut pieces of peeled jackfruit. During operation, the peeled jackfruit has to be kept in the container containing the anti-browning solution where it is cut and simultaneously treated with an anti-browning solution. The effective time to cut one peeled jackfruit is 5 seconds after touching the blades on surface of fruit. However, the output capacity of the cutting system including the time of loading and removal is about 250-270 kg/h of cut tender jackfruit.

Shredding machine for tender jackfruit

A shredding machine has been developed for shredding of peeled and cut tender jackfruit. The machine consists of a shredding disc designed for effective shredding of the peeled cut jackfruit. A collection disc is placed below the shredding disc which throws out the shredded jackfruit to the outlet. In operation the sliced/cut jackfruit has to be fed from the feeding chute above the top of the machine and has to be pressed slightly for shredding. The machine is operated by 1 hp single phase electric motor and has an output capacity of 100 kg/h.

Grain handling, surface disinfestation treatment cum bagging system

The mechanized self-propelled, walk behind type grain handling cum bagging system was developed. The developed mechanized system consists of two opposite direction-rotated screw conveyors fitted at front rotated at the speed of 250 rpm for gathering the spread grains at center, the specially designed inclined bucket elevator picks the grains from flour and conveyed it up to overhead hopper. The hopper of the machine with surge capacity of 10 kg of grains metered and discharges grains from its bottom to the reciprocating conveying deck keeping in view of single layer maintained on deck. The machine has been tested for wheat grains. The conveying deck contains about 4.5 kg of grains (wheat) at a time and conveyed towards discharge chute through its reciprocating movements. The conveying deck also equipped with overhead array of 05 nos. of infrared heaters (1000 W each) to give in-situ surface treatment for early stage disinfestation of the conveying grains. The treatment time of 45-60 s can be maintained as per the requirement through adjusting the reciprocating movement of deck. The grains were further collected in the attached bag at the discharge end of the deck. The whole system is running by 3 Hp three phase electric motor. The machine has a capacity of 0.6 tonne/h bagging of free flowing grains. The system operated at 0.7 km/h and 6.36 % of deck slope effectively treated the grains with 100 % of insect mortality and 0 no. of egg hatchability. The cost of operation in developed system is Rs. 210/ t of grains.

Cleaner cum grader for millets

Small and variable size of millets and its lighter weight makes a challenge for its cleaning with commercial mechanical cleaner cum grader machine. A cleaner cum grader machine has been developed for millets. It consists of a hopper for controlled feeding, a set of different-sized sieves (screens) to separate millets based on their size, and a blower to remove dust and light impurities. The machine is operated by a 0.25 hp electric motor (single phase). The machine was tested for cleaning cum grading of sorghum. The cleaning efficiency of sorghum was recorded to be 90-92 % at an operating speed of 400 rpm and stroke length of 10 mm. Two number of screens were used for testing of machine for sorghum. The aperture size of top and bottom screen was 4.30 and 3.20 mm, respectively whereas the percentage open area was 67% and 37 %, respectively. The capacity of developed cleaner cum grader is 70-80 kg/h

Multi millet de-husker

Dehulling of minor millets like kodo, kutki etc. is a great challenge due to its small size and strong adherence of hull to the kernel. A multi-millet de-hulling machine, consisting of a pair of rubber rollers rotating at differential speeds in opposite directions for providing the shearing and crushing action for de-husking of millets, has been developed. The machine is operated with a 2 hp electric motor (single phase). The developed dehuller was tested for dehulling of kodo millet. The dehulling efficiency of kodo was recorded to be 70-75 % in single pass, at an operating speed of 400 rpm. The capacity of developed dehuller is 70-80 kg/h.

Potato storage with controlled aeration and humidification through floor ducting system

A sensor-enabled on-farm storage structure for potatoes, equipped with aeration and humidification arrangement through a floor ducting system was developed. The system facilitates monitoring the key storage parameters such as temperature and humidity using sensors and provision for aeration and humidification arrangements during storage. Experimental findings revealed that the developed structure maintained a temperature of 22-26°C compared to the ambient condition of 34-39°C, and relative humidity also increased to more than 50% compared with dry summer condition RH of 17-38%. The system was able to achieve a cooling efficiency of 89.89%. Experimental trials demonstrated significant improvements in potato quality retention with reduced weight loss (system- 3.95%, control- 8.14%), rotting (system-8%, control- 38%), and greening incidence (system - 16%, control- 42%) at the end of 6 weeks of storage in comparison to ambient stored samples. Reducing sugar content in the stored sample showed a slightly increasing trend with a maximum value of 58.11±0.69 mg/100 g of FW, which is lower than the values reported for the cold stored sample, which is beneficial while processing

Infrared assisted drying and quality evaluation of tomatoes with comparative analysis of drying methods

A process has been optimized to make powder of tomato. The process involves slicing of tomato, infrared assisted hot air drying and grinding. Tomatoes at Stage 5 ripening result in lower slicing losses (2.68%) and higher slicing efficiency (94.21%). Slice thickness also plays a vital role in product quality, slicing efficiency and drying characteristics. A thickness of 6 mm was found optimal, with better slicing performance, reduced moisture content, higher drying rates, and minimal shrinkage in the final product. The effects of IR intensity and source-to-sample distance on drying performance were investigated. It was observed that a lower IR intensity of 1000 W/m^2 resulted in higher moisture content (15.59%), lower drying rates (5.45 × 10-2 Kg water/Kg DM-min), and prolonged drying times (5.5 hours). Conversely, a higher IR intensity of 2000 W/m^2 led to reduced drying time (3.5 hours) and moisture content (10.30%) but caused slight burning in samples placed directly below the heater. A moderate IR intensity of 1500 W/m^2, with a source-to-sample distance of 100 mm, was found to be optimal, ensuring efficient drying with acceptable quality attributes. A comparative study between IR-assisted drying, hot air drying, freeze drying, biomass-based drying, and commercially available sun-dried samples revealed that freeze-dried products exhibited superior in terms of color attributes, better moisture retention, reduced shrinkage, and higher rehydration ratio.

Development of tomato ketchup, puree and powder

The value-added products from the mature, ripen tomatoes like ketchup, puree and powder has been developed. The various steps for the preparation of ketchup includes washing, cleaning, hot water blanching (100°C for 6 minutes) followed by peeling, crushing/grinding, straining and cooking. The various specialized spices are added as ingredient in the pre-cooked paste and allowed for final cooking to reach at desired thickness. The desired thickness is judged based on TSS 26-28 °Brix for ketchup. Similar method is followed for the preparation of tomato puree up to cooking. However, there is no addition of any spices after cooking while the paste is concentrated up to 30 minutes, and stirred continuously until the TSS reaches at 80 °Brix. Further, with the addition of recommended preservatives, puree was allowed for bottling and cooling. The tomato powder was developed from the dried slices of the tomatoes. The tomato slices of about 6 mm thickness were dried in hot air drying at 60°C for 72 hours and then these dehydrated tomato slices were grinded in hammer mill or in grinder to get fine powder. The dehydrated tomato powder packed in airtight containers.

Tomato Ketchup

Tomato Puree

Tomato Powder

Technology for production of fresh gluten, gluten flour and gluten free flour

The fresh gluten, gluten flour and gluten free flour were developed using gluten extractor. About 30 kg of wheat flour was fed to the gluten extractor, and operated at a 50 rpm with mixing time of 22 minutes. About 17 liters of water (57%) was added initially for dough making. Once the dough was formed, excess water was further added to wash the dough by running a helical screw at 40 rpm. Further, adding the water (40 liter), the gluten extractor kept stationery without running for half an hour for better soaking of the dough. The machine was then run to separate the gluten from dough. Water that turn starchy was discarded in an interval and freshwater was added and run the screw until the water remains close to transparent. Finally, water was discarded and the gluten was collected in a mesh bowl through the exit gate conveyed by rotating screw. Total 8 kg of wet gluten was collected during this stage. After that, this wet gluten was dried in the tray dryer at 60°C for 30 h and grounded to make powder. Total 3.250 kg (10.6%) gluten powder obtained. The discarded starchy water from the outlet was collected separately, dried in tray dryer at 60°C for 30h, and then grounded to obtain gluten free flour. The process obtained about 83.33% (25 kg) of gluten free flour.

Gluten Extractor

Wet gluten

Fresh Gluten

Gluten powder

Millet based value added products

Millet based nutri-protein mixture

The ingredients used in the product includes millet grains, pulses (green gram, chickpeas, and peas), nuts and seeds, dried fruits, cocoa powder/vanilla powder, and soy milk powder. The ingradients then exposed to selected unit operations and process conditions. Its per 100 g nutritional value includes 18.5 g of protein, 60 g of carbohydrates, 14 g of fat, 149 mg of calcium, and 5.0 mg of iron.

Millet based biscuit

Millet jaggery-based biscuits have been developed to leverage the nutritional benefits of millets. The biscuits are developed with ingredients such as whole-wheat flour, millets, jiggery, skim milk powder and ghee. The thickness of the biscuits is kept at 5 mm during the sheeting of dough. The proximate composition of biscuit includes moisture content of 3.98±0.12%; protein content of 10.21±0.34%; fat content of 20.56 ±1.32%; total ash of 1.65±0.11%, carbohydrate of 64±1.57% and hardness of 50.97 ± 8.16 N. The cost of production of developed millet-based biscuit is Rs. 210/kg.

Millet nutri-dalia

The millet-based nutria dalia was developed using sorghum flour, spice mix made from dry vegetables such as capsicum, tomato, green coriander, and spices like cumin, turmeric powder, salt, and herbal mixtures. The ingredients are fermented which enhances protein digestibility, B-vitamin content, and reduces anti-nutrients and improves mineral bioavailability. The per 100 g nutritional profile of the product includes 340 kcal of energy value, 70-75 g of carbohydrates, 8-10 g of protein, 2-4 g of fat and 40 mg of calcium content with shelf-life of 40 days in metallic packaging.

Millets based nutri bar

A millet-based nutri bar was developed using a blend of nutritious ingredients, including millets as primary ingradient, dry fruits, soymilk powder, choco powder, honey, butter, and

natural flavoring agents. This snack food is rich in protein, fiber, and essential nutrients, making it as an excellent choice for health-conscious consumers. Honey serves as a natural sweetener and binding agent, while butter enriches the texture. The per 100 g bar contains about 350-400 kcal of energy, 50-55 g of carbohydrates, 8-10 g of proteins, and 12-14 g of fats. The shelf life of the product was 5 to 6 months in a laminated pouch.

Roasted bajra, roasted kodo, bajra ladoo and kodo ladoo

The products are prepared through dry-roasting of bajra and kodo millets in a mechanical roaster or in open pan at 120–125°C for 15 minutes. After roasting, the grains were cooled up to room temperature under ambient conditions. It may consume as its whole form or may ground into flour or flavored with seasonings for snacks applications.The 100 g of roasted kodo millet grains contains 8–9 g of proteins, 2–3 g of fat, 65–70 g of carbohydrates and 2.5 g of ash while roasted bajra contains 11-12% of protein and 5-6% of fats.

The millets were soaked in for 18 h in 80°C hot water and then dry-roasted. These roasted bajra and kodo was then mixed with jaggery and ghee to make ladoo. The per 100 g Bajra-Jaggery Ladoo, contains 685 kcal of energy, 11.7 g of protein, 18.5 g of fat and 118 g of carbohydrates while Kodo ladoo contains 9.7 g of protein, 18 of fat and 118 g of carbohydrates.

Roasted Bajra

Roasted Kodo

Bajra Ladoo

Kodo Ladoo

CENTRE OF EXCELLENCE FOR SOYBEAN PROCESSING AND UTILIZATION

Process protocol for enhancing cooking quality of soybean splits

A process protocol was developed using novel pre-treatment techniques: ultrasonication (US) and microwave (MW) treatments for enhancing the cooking quality. The conditions for each method were optimized to achieve the best cooking properties, resulting in significantly reduced cooking time and energy consumption. For ultrasonication treatment, the optimal parameters were determined to be a power level of 500W, an ultrasonication time of 20 minutes, and a soaking time of 36 minutes. Under these conditions, the cooking time for soybean dal was reduced to 32 minutes, with a hardness value of 27.35 N. For microwave treatment, the optimal parameters were a power level of 745W, a microwave treatment time of 10 minutes, and a soaking time of 29 minutes. This treatment reduced the cooking time to 36 minutes, with a hardness value of 26.45 N. The sensory evaluation confirmed the effectiveness of these treatments, with the treated samples achieving an overall acceptability score of 7.4 and 7.8 for US and MW treatments, respectively, as compared to 6.4 for the control samples.

Continuous edible film making machine

A continuous edible film making machine has been developed for the efficient and scalable production of edible films suitable for food packaging applications. Designed to work with a wide range of biopolymers such as CMC, starch, pectin, gelatin, and others used in the casting method. The developed machine enables consistent and uniform film formation on a moving conveyor system. The machine produces films up to 0.60 m wide with a production capacity of 3 meters per hour. When tested with carboxymethyl cellulose (CMC) film-forming solution, the machine produced films with excellent mechanical and barrier properties: Tensile Strength of 21.78 MPa, Elongation of 23.45%, and Water Vapor Permeability of 1.49×10^{-10} g/m·Pa·s. These values are comparable to lab-scale results. The developed films have been successfully evaluated for food packaging, especially for retaining texture and moisture in muffins, confirming the machine's suitability for semi-commercial applications and sustainable packaging research. The study confirmed good texture and moisture retention, indicating that mechanically cast films are well-suited for various food packaging applications.

Pectin fortified tofu

A tofu with improved texture was formulated by fortifying with pectin. Soymilk was mixed with 1% (w/v) and 3% (w/v) pectin solutions, and then coagulated with 1% (w/v) citric acid. Tofu fortified with pectin exhibited enhanced texture, measuring a hardness value of 563 ± 9.3 g and 179 ± 8.7 g for 1% and 3% pectin solutions, respectively, as compared to the control sample's hardness value of 864 ± 5.9 g. Additionally, pectin fortification increased tofu yield by 10% and boosted protein content to 20%, as compared to 14% in traditional tofu after 14 days of storage. The improved texture in pectin-fortified tofu is attributed to the entrapment of water molecules within the protein–pectin network.

Pectin-fortified tofu

Xylose-rich soybean hull hydrolysate and its bioconversion by aspergillus niger ITCC 8304

A fermentation medium rich in xylose was developed from soybean hulls, referred to as soybean hull hydrolysate (SHH), with an initial xylose content of 8,869.20 mg and a pH of 5.5. To support the growth of Aspergillus niger ITCC 8304, the SHH was detoxified using activated charcoal. Over the 120-hour fermentation period, the xylose concentration significantly decreased to 1,402.45 mg, accompanied by a drop in pH to 3.25, and visible fungal growth, indicating efficient xylose utilization by A. niger. Concurrently, the genomic DNA of A. niger ITCC 8304 was successfully isolated using the CTAB method and validated through PCR amplification using β-tubulin, ITS, and 18S primers, each yielding distinct and specific amplicon sizes, thereby confirming the integrity and authenticity of the fungal strain used in the study.

Growth of the *A. niger* during the SHH fermentation

REGIONAL STATION, COIMBATORE

Small tractor operated sugarcane sett cutter planter

The sugarcane sett cutter planter is suitable for single row planting. It was fabricated out of MS square tube 60 × 5 mm. The main frame had a major dimension of 1191 mm length, 1505 mm width and 1091 mm height. A standard three-point hitch arrangement was provided for hitching the frame to the tractor, PTO power transmission system, cutting mechanism, operator's seat, ridger, soil closure, press roller, fertilizer hopper and pesticide tank were mounted on the main frame with necessary supports. The capacity of fertilizer hopper, pesticide tank and sugarcane hopper was 25 kg and 60 lit and 100 kg, respectively. Whole canes are fed into the depth of furrow bottom manually and sett cutting mechanism cut the sett and the setts are dropped into the furrow opened by the deep furrow opener. The cutting length of the sugarcane sett was 300 mm. Simultaneously fertilizer is dropped into the furrow and also insecticide is sprayed into the above sett and then soil is covered by press roller. The unit was evaluated at R&D farm of ICAR-Sugarcane Breeding Institute, Coimbatore. The actual field capacity and field efficiency of the machine are 0.2 ha/h and 70%, respectively.

Detection-based pesticide sprayer system as an attachment to unmanned multi-purpose track- type vehicle

A detection-based pesticide sprayer system was developed as an attachment to an unmanned track- type vehicle. The system consists of a pesticide tank (200 litre), two 12 VDC water pumps, two ultrasonic sensors, an electronic control unit (ECU) and two sets of lances with spray nozzles, each on both side of vehicle. The developed system was evaluated at field condition, at operating speed of 2 kmh-1, the system accurately detects tree canopies and achieves a droplet size (VMD) within the recommended range of 140-200 µm, with a spray coverage of 30-40%. The developed system was evaluated at field condition, at operating speed of 2 kmh-1, the system accurately detects tree canopies and achieves a droplet size (VMD) within the recommended range of 140-200 µm, with a spray coverage of 30-40%.

Continuous feed banana fiber extractor

Continuous feed banana fiber extractor was designed and developed for high capacity extraction of fibre from banana pseudostem. The continuous feed banana fiber extractor has an input capacity of 175-200 kg/h pseudostem outer sheath and output capacity of 500-600 g/h dried fiber (existing equipment @150g/h). The dried fibre recovery is 2.5-3.5 %.

Cashew nut separator, pulp extractor and fibrous material separating machine

The equipment was developed in collaboration with ICAR Directorate of Cashew Research, Puttur, Karnataka. It has three main assemblies' viz., Cashew nut separator, Pulp separator and Fibrous material separator. Equipment processes all nut types and apple conditions. It has high cashew nut separation efficiency [250-300kg/h (RCN)] with high separation efficiency > 99 % and minimal nut damage of less than 1.0 %. Saving in cost of operation and time is 82.50 % and 96 %, respectively

AICRP on FARM IMPLEMENTS AND MACHINERY

Use of robotics/sensors/drone in agriculture

Pre and post emergence herbicide application with drone

A study was conducted at the Ludhiana centre to evaluate a drone-based spraying system for the application of pre- and post-emergence herbicides on wheat crops sown using various paddy residue management techniques, including incorporation, happy seeder, super seeder, and smart seeder. The objective was to compare the performance of the drone sprayer with traditional ground-based systems, particularly knapsack sprayers. Pre-emergence herbicide Stomp (Pendimethalin 30%) was applied at a rate of 2.5 L/ha within 0–2 days after sowing, and the post-emergence herbicide Total (Sulfosulfuron 75% + Metsulfuron Methyl 5% W.G.) was sprayed 30–35 days after sowing. The drone operated at a forward speed of 2.0–3.0 m/s and maintained a spraying height of 2.0–3.0 meters above the crop canopy. The droplet size (VMD) for the drone sprayer equipped with a flat fan anti-drift nozzle ranged from 425–600 µm, compared to 700–1500 µm for the knapsack sprayer. When an adjuvant (0.1% of the water volume) was added, the VMD increased to 550–725 µm for the drone and 1700–2200 µm for the knapsack sprayer. The number median diameter (NMD) for the drone was approximately 200 µm, while it was 600–1000 µm for the knapsack sprayer. Droplet density ranged from 12–32 drops/cm^2 for drone spraying and 13–39 drops/cm^2 for the knapsack, depending on adjuvant use. Weed control effectiveness at 60 days after sowing showed that phalaris minor was reduced by 81–92% with drone spraying, compared to 71–91% using a knapsack sprayer. Broadleaf weeds were controlled by 70–86% with the drone and 83–94% with the knapsack sprayer.

Robotic metering mechanism for vegetable transplanter using portray seedlings

The CAU, Gangtok centre developed a robotic metering mechanism for vegetable transplanter using portray seedlings. The developed system comprises a robotic arm with 5 degrees of freedom (DOF), including the actuator, microcontroller, servo motor driver, rotary encoder, and battery. A graphical solution was determined for the inverse kinematics of the robotic arm movement concerning the seedling position coordinates in the protray. This solution enabled accurate movement of the robotic arm for picking and placing seedlings. The performance of the developed robotic metering system was evaluated in the laboratory under simulated conditions. The machine's forward speed was simulated using the RPM of the rotary encoder, assuming the transplanter's ground wheel has a diameter of 300 mm. The test was conducted on a specially developed test bench. The robotic metering system achieved a maximum forward speed of 1 km/h for a plant-to-plant spacing of 40 cm. The performance of the robotic arm was assessed based on picking efficiency, seedling damage, and root-media adhesion under laboratory conditions. Optimum performance was observed at a machine forward speed of 0.7 km/h and a seedling age of 6 weeks, resulting in a picking efficiency of 99.68%, seedling damage of 4.05%, and root-media adhesion of 91%.

Seeding/ planting

Multiple rice seed pellet for direct seedling

This study was carried out at CAU, Gangtok to develop multiple rice seed pellets for precision direct seeding. Organic manure was used as the filler material and bentonite clay as the binding agent. A lab-scale pelletizer

was employed to prepare the pellets, with mixture compositions varying from 10–30% clay and 70–90% organic manure, following a randomized D-optimal mixture design. Optimization of the pellet composition was performed using regression modelling and numerical analysis, based on parameters such as sphericity, specific gravity, breaking strength, germination percentage, mean germination time, pelleting time, and pelleting efficiency. The optimal pellet formulation was found to be 23% clay and 77% organic manure, resulting in pellets with sphericity of 0.971, specific gravity of 1.45, breaking strength of 98.42 N, mean germination time of 12 days, pelleting time of 3.55 minutes per batch, and pelleting efficiency of 98.92%. Field trials using a manual planter in puddled soil showed average hill spacing of 17.42 cm, hill population of 3, and hill spacing uniformity of 80.22%, compared to 9.81 cm, 6.1 plants, and 63.63% uniformity with drum seeding.

Wheel-mounted two-row belt cup type potato planter

A tractor operated two row belt cup type potato planter has been modified and developed to overcome the issues of low forward speed, non-uniform height of ridge and uneven germination. This modified machine has the provision of ground wheel for maintaining the forward speed and uniform height of ridge along with compaction discs for solving issue of ridge compaction. The machine consists of two vertical rubber belts fitted with plastic cups in paired rows for picking potato tubers, seed tubes, furrow openers, three-bottom ridger to form two ridges followed by discs for better compaction of soil, a fertilizer metering system and a frame along with two ground wheels. Initial trials of the machine have been conducted at farmer's field of Village Jainpur, Ludhiana. The average speed of operation has been varied between 3.8 to 4.0 km/h with row to row spacing of 710 mm. Depth of planting with the developed machine varied between 60 to 80 mm. The plant to plant spacing of varied between 230 to 480 mm as the potato tubers after dropping forming a single row. The average field capacity of the modified planter is 0.4 ha/h with the average fuel consumption of 5.5 to 6.3 l/h.

Pesticide application

Radio frequency-controlled pesticide applicator

TNAU Coimbatore developed an RF-controlled pesticide applicator designed for precise and efficient spraying. The system includes four key modules: the RF Module, which uses a transmitter and receiver for remote control; the Sprayer Module, featuring a 19 lpm pump, a 2.65-meter boom with 12 nozzles, and motors to move the boom; the Driver Module, with a battery, steering and pump motors, and control circuits; and the Trolley Module, which supports all other parts on wheels. Powered by 24V DC motors, the applicator responds to RF signals, enabling remote operation and reducing direct exposure to chemicals. The RF communication allows long-range, reliable control. Field tests showed the machine can cover 0.5 ha/h at 3 km/h with 65–70% efficiency. Though uneven terrain slightly affects performance, the system significantly improves precision, reduces chemical usage, and promotes safer pesticide application in agriculture.

Harvesting/ Detrashing/ Threshing

Tractor operated sugarcane leaf detrasher cum shredder

In order to mechanize sugarcane leaf detrashing cum shredding operation, tractor operated sugarcane leaf detrasher cum shredder has been developed at MPKV, Rahuri centre. The developed equipment was evaluated at Karveer, Dist. Kolhapur over 13.09 ha area for 42 hours. The effective field capacity of the machine was observed to be 0.31 ha h-1 and field efficiency 82.17%. The net saving by using this machine was worked out to be Rs. 9,290 per ha (i.e. 83.70%) over conventional method.

Tractor operated turmeric combine

Tamil Nadu Agricultural University Coimbatore centre has developed a tractor operated combine harvester for turmeric. It consists of a de-topping unit, a digger cum conveyor unit, and a collection tank. The de-topping system, with a width of operation of 750 mm, is designed for cutting and cleaning turmeric stalks and mounted just below the two lower hitch points between tractor's rear wheels and the digging unit. The digger cum collector consists of a three-point hitch, a main frame, a digging blade, a conveyor system, a collector tank with a tail wheel, a press wheel, and a power transmission system. The digging width is 750 mm, and the rhizome-conveying speed is set at 250 rpm. The collection unit is attached behind the conveying system, where the dugout turmeric bunches are conveyed through an oscillating conveying system. The total power requirement for operation equipment is 28 kW hence a tractor having 35 – 40 kW is sufficient to operate. The field capacity was observed as 0.16 ha/h with 97% digging efficiency, 94% de-topping efficiency and 70% cleaning efficiency at forward speed of 2.5 km/h. The cost of operation was Rs. 1100/h.

Tractor operated lathyrus harvester

IGKV, Raipur centre developed a tractor operated lathyrus harvester. The developed harvester consists of a cutting unit, reel unit, gathering unit, crop cleaner mechanism, and driving system. Key performance results of the harvester include a field capacity of 0.42 ha/h, field efficiency of 85%, harvesting efficiency of 90%, and 3.50% losses (including cutter bar,

conveying, and shattering losses) at a 30 mm cutting height, 250 rpm cutter bar speed, and 12.5 rpm reel speed. The machine costs Rs. 1,45,000, with Rs. 789 per hour or Rs. 1878 per ha operational cost. The harvester provides a 75% cost savings over traditional methods, while also saving time and reducing worker fatigue.

Head feed type linseed thresher

A head feed type linseed thresher has been developed at AICRP on FIM, IGKV Raipur centre. The developed prototype consists of threshing drum, concave unit and reciprocating sieve unit. The principle of working of thresher is to remove the capsule from the plant, then separate the seeds from the capsule, and then clean the seed from the remaining capsule. This prototype operating as a "hold on" type was designed to not only separate linseeds but also preserve the stalks for potential fibre extraction. This thresher is operated with 0.5 hp electric motor so that it is useful for small farmers. The threshing capacity of the prototype was observed as 178.62 kg/h with 99.31% efficiency. The cost of machine is Rs. 50,000/- and the operating cost was 89.17 Rs./h. The developed machine has output of 17.8 times more than the traditional method with profit of more than 5.63 times.

AICRP on MECHANIZATION OF ANIMAL HUSBANDRY

Animal drawn multi-crop precision dibble seeder

The animal-drawn three-row dibble seeder was developed by the IGKV Raipur centre. The developed dibble seeder consists of main frame, dibble seeder rotor, lifting mechanism, hitch, handle and transport wheel. Dibble seeder has different rotors and spacers which are used for particular seeds and tooth through which seeds are placed precisely in the soil at desired depth. The developed animal-drawn three-row dibble seeder was evaluated under actual field conditions for planting rice and okra during the Kharif 2024-25 and Rabi 2024-25 seasons, respectively. The dibble seeder was operated at a speed of 2.8 km/h at planting depth of 31.25 mm. The draft requirement to pull the dibble seeder was 245 N and 197 N for paddy and okra seeds in the Kharif and Rabi seasons, respectively. The actual field capacity was 0.178 ha/h for dibbling paddy and it was 0.27 ha/h for dibbling okra seeds. The results indicated that the developed seeder would require 5.8 hours to plant paddy seeds while it took 3.7 hours to plant okra seeds in one hectare. The operational cost for planting was Rs 978 per hectare and Rs 589 per hectare for paddy and okra, respectively.

Cattle washing unit

The batch type cattle washing unit has been developed by VNMKV, Parbhani centre. The development of the cattle washing unit involved creating a portable, low-cost structure made from MS steel pipes. A cattle washing unit structure is fitted on an RCC platform measuring 4.25 x 1.25 x 0.15 meters. The rectangular boom moving and scrolling at top and fitted with seven hollow cone nozzles, one from top side of animal, two each from upper side, middle and lower side of animal respectively. The boom is moving horizontally on main frame by chain (12.7mm) and sprocket (72 teeth) arrangement with the help of small 300 watt electric motor which is fixed at top of the main frame. The drain is kept for drain out the water falling on the concrete ramp. The two gates are provided in frame for enter and exit the animal comfortably. The HTPE pump of 2.24 kW capacities is used for water supply. Animals require 50% less labor, 76-88% less time, and 2.15 times (50%) more effective in ectoparasite removal as compared to traditional practices during washing with the developed system. Additionally, water usage is reduced by 67-72%.

Cattle grooming unit

The batch type grooming unit has been developed by VNMKV, Parbhani centre. The grooming unit has two brushes, each 375 mm in diameter and 600 mm in length, powered by a 1.4kW electric motor. The brushes are positioned in a horizontal and vertical (making L-shape) direction to groom the animal's dorsal and lateral sides. The brush height can be adjusted to match the animal's size, allowing the bristles, which are 2 mm thick, to effectively groom the animal's body. The grooming unit is powered by a 0.75kW electric motor connected to a 20:1 gear ratio gearbox. Two infrared proximity sensors, with a range of 1-3 meters, are placed near the brushes and are controlled by a panel. It was also observed that after the grooming operation, skin infections decreased by 3-4%, draftability improved by 15-16%, and the overall impact increased by more than 33%.

Non-invasive respiration rate monitor for cattle

The sensor-based non-invasive respiration rate monitor developed by IGKV Raipur enables accurate, continuous monitoring of cattle respiration. The device consists of a flex-type sensor, amplifier, microcontroller, and TM1637 4-digit 7-segment display, powered by an Arduino. It is secured using a 3m nylon belt with a buckle. The flex sensor is made of plastic and carbon, where bending alters resistance, allowing it to function as a bend sensor or goniometer. The monitor's specifications include a RISC 8-bit AVR CPU, 32 KB program memory, 8 ADC channels, and 6 PWM pins, operating at 3.3–5V DC with a 400 g weight. The development cost is Rs.7500/-. The device was validated against reference methods (flank movement and nostril breathing). Results showed high correlation (96.96%) between sensor-based monitoring and nostril-based counting, with a t-test indicating no significant difference ($P<0.01$). The sensor-based method recorded a mean respiration rate of 39.5 bpm, closely matching nostril-based values (38.15 bpm), proving its reliability.

Sensor based mechanized washing system for cattle

A prototype of a sensor-based mechanized washing system for cattle has been developed by GBPUAT, Pantnagar centre to facilitate the washing and cleaning of cattle before milking in summer. The primary components of the system include the main frame, reflective-type photoelectric proximity sensor, controller box, nozzles, pipes and fittings, pressure regulator and gauge, and water pump. The sensor detects an animal when it reaches the washing station's sensing area and sends an output signal to turn on the control box, which is the next component of the system and includes an SMPS, timer, relay, and contactor. The timer relay is triggered upon receiving the sensor's output signal. A 2.24 kW electric motor receives electricity from the contactor, which is activated by the relay. After that, the electric motor powers the two-stage plunger pump. Water is delivered by the pump to the washing station via 12.5 cm GI pipes. It has twenty-seven flat-fan-style nozzles. These nozzles atomize the water into fine droplets and distribute evenly over the cattle's body. After the set duration on the timer, the pump's power supply is automatically cut off. The developed sensor-based washing system for cattle is currently being calibrated in the laboratory under four water pressure levels (1.5, 2.0, 2.5, and 3 kg/ cm^2) and five showerhead height levels (0, 0.25, 0.75, 1.25, and 1.5 m).

AICRP on ERGONOMICS AND SAFETY IN AGRICULTURE AND ALLIED SECTOR

Seeding/planting/trasplanting

Remote-controlled sensor based direct rice seeder

A remote-controlled self-propelled battery-powered rice seeder has been developed by CAEPHT, Gangtok centre to overcome the operational difficulties in direct seeding with manual drum seeder in terraced and valley lands. The developed seeder can be remotely controlled through an android based mobile application using Wi-Fi connectivity. The seeder consists of micro-controller, stepper motor, DC geared motor, motor drivers, battery, wheels and frame. It has been evaluated in laboratory condition at forward speed varying from 0.5 to 3.0 km/h and hopper fill level varying from 25 to 75%. The forward speed of 0.7 km/hand 75% hopper fill level have been found optimum with corresponding seed rate of 20.2 kg/ha, missing hill index of 0%, hill spacing uniformity of 93.7%, coefficient of variance of number of seeds per hill of 0.25 and hill span of 94 mm. The developed seeder was evaluated in the field in puddled soil conditions in Sajong village of East Sikkim. The field capacity and field efficiency of the seeder are found to be 0.017 ha/hand 62%, respectively. The remote-controlled seeder could reduce drudgery of the operator by 64% over manual drum seeder. In addition to that the operator could remotely operate the seeder comfortably from outside the field.

Immersive VR system for remote operation of 2-wheel paddy transplanter

A virtual reality-based remote-control system integrating robotic mechanisms, an electronic control unit (ECU), and lever actuation with gear motors was developed at PAU, Ludhiana. The system includes front and rear cameras that provide real-time field views on computer and mobile screens, enabling efficient remote operation. Operators manipulate the machine using a hand-held remote controller while observing live camera feeds and path navigation trajectories. Results highlight the influence of forward speed on effective field capacity (EFC) and field efficiency (FE), with EFC increasing linearly from 0.158 to 0.204 ha/h and FE declining from 75.11% to 68.13% as forward speed rises from 1.75 km/h to 2.50 km/h. The incidence of missing hills was significantly influenced by forward speed, linearly increasing from 0.43% to 1.78% as speed increased from 1.75 km/h to 2.50 km/h. Remarkably, missing hills within the range of 1.5-2.0% are generally deemed acceptable in such operations. Energy expenditure rates are lower for remote-controlled operators (7.56 to 9.72 kJ/min) compared to walk-behind operators (8.20 to 27.67 kJ/min). Significant advantages were observed for the remotely controlled system, including 70.04 to 78.95% lower Rapid Entire Body Assessment (REBA) scores, 45.77 to 89.33% lesser Overall discomfort rating (ODR), 33.43 to 35.15% lesser EER, 32.36 to 36.3 lesser sound pressure lever (SPL), and 75.0 to 81.93% lesser hand arm vibrations (HAV) as compared to walk-behind type paddy transplanter. Further testing and validation of the VR system's time lag are ongoing to ensure seamless functionality.

Battery powered transplanting mechanism for two row root wash type manual transplanter

The development of a battery-powered two-row paddy transplanter for root-washed seedlings has addressed the unique challenges of Konkan's small, terraced, and uneven fields. This manually operated transplanter is designed for use in puddled fields and is powered by a lithium-ion battery that drives a DC motor-based transplanting mechanism. Power is transmitted to the seedling pickers-cum-holders and the seedling shifter-cum-erectors through a speed reduction-cum-transmission unit. The pickers extract seedlings from the

bottom of a tray containing root-washed seedlings, while the shifter-cum-erectors accurately place them in two rows. A novel cam-based holding and releasing mechanism has been developed, and an aerodynamically curved wooden float ensures smooth operation. Field evaluation revealed an average battery discharge time of 4 hours 30 minutes and an operational cost of ₹3,992 per hectare. Ergonomic comparisons between the developed electric transplanter and the conventional hand-cranking type showed significant improvements. The horizontal and vertical forces acting on the L4/L5 spinal segment were reduced by 73% and 17.7%, respectively, with a 31.6% reduction in spinal moment. Field capacity increased by 24% (0.036 ha/h), while the Body Part Discomfort Score (BPDS) dropped by 18%. Additionally, drudgery reduction in terms of cardiac cost was recorded at 16.5%. The transplanter's sinkage decreased by 29±9%, and the deviation in the centre of gravity was reduced by 10.4% vertically and 96% horizontally, demonstrating improved balance and operator comfort.

Modified pedal operated coconut dehusker

Pedal operated coconut dehusker has been modified and adjusted to have sitting position. The coconut collection tray has been developed for easy handling of coconut. The dehusking efficiency of modified dehusker was 88.72%. The mean resting heart rate of the operator was 72.6±0.94 bpm. During continuous operation (from 6th to 20th minute), the average working heart rate was 185.6±2.50 bpm with the corresponding oxygen consumption rate 1.87±0.048 l/min. The relative cost of workload during dusking was recorded as 32.96±5.60 %. The overall discomfort rating was relatively low 4.4 ±0.41.

Spraying

Knapsack sprayer retrofit for enhanced safety and efficiency

To retrofit a knapsack sprayer, two metallic support structures were installed on either side of the spray tank, providing a foundation for vertically attaching telescopic spray lances and supporting the transmission system. This system enabled a to-and-fro movement of the spray lance with a 1:2 transmission ratio, allowing full canopy coverage. The motion was manually controlled via a handlebar, which transmitted movement to the spray lance during field operations. The study evaluated dermal exposure during spraying using a battery-operated knapsack sprayer. Field trials were conducted at ICAR-IARI, New Delhi, in maize crops at varying heights under controlled conditions: 29–32 °C temperature, 54–72% relative humidity, and 2.7–3.0 km/h wind velocity. Results showed the highest chemical exposure on the right-hand glove (536.029 µg), followed by the mask (344.303 µg) and right arm (569.420 µg), with notable exposure also detected on the chest and back. To reduce operator exposure and enhance comfort, a canopy hood was developed using light-colored tarpaulin, offering sun protection and featuring a 30 cm clearance for movement. Additionally, an embedded system was integrated into the setup, incorporating weather sensors (temperature, humidity, light, wind velocity) and crop canopy distance sensors. Controlled by an ESP32 microcontroller, the system provided real-time data via Wi-Fi and included a buzzer to alert the operator to unsuitable spraying conditions. Following successful lab testing, the complete system—sprayer, canopy hood, and embedded sensors—was field-integrated, significantly enhancing operator safety, comfort, and spraying efficiency.

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Personnel protective equipment kit for spraying with power sprayer

Pesticides deposition on the body has an adverse effect on human health during pesticides spraying. Dr BSKKV, Dapoli centre has evaluated six different types of fabrics for their suitability of adoption for preparation of dosimeters to reduce pesticide exposure to operators. The set-up consists of 80×80mm test fabric (middle layer) and two 80×80mm one sided absorbent papers of known weight. An emulsifiable concentrate 0.2 mL of the Prowl® 3.3 EC was applied at the centre of fabric layer from a height of 25 mm. The experiment shows that the materials for protective clothing classified as Level C1 (relatively low potential risk) with the upper limit for percent penetration as 40% was fulfilled by fabric-2 (GSM-215) having penetration of 37%. Similarly, fabric classified as Level C2 (highly repellent fabric) with the upper limit for percent penetration less than 5% is fulfilled by fabric-6 (GSM-200) with penetration of 0.72%. A study of physiological parameters of workers during working with power sprayer in mango plantation wearing six different types of PPE kits with eye protectors and masks show that ΔHR was less than limit of continuous performance for all six types of PPE kits and it is 21.2 beats/min for safety kit having C2 level fabric apron. Similarly, VO2max was less than 35% i.e. acceptable work load for all six types of PPE kits; and for safety kit having C2 level fabric apron VO2max was 22.3%. Study of wearing comfort on the basis of modified Corlett and Bishop (1976) rating scale, shows that for 6 PPE kits the rating varies from 3.6 to 7.6. The wearing comfort for safety kit with C2 level fabric was 7.6 indicating very comfortable rating. The increase in temperature inside PPE kits ranged from 3.9 to 11oC and it was 4.6oC for safety kit with C2 level fabric. The cost of PPE kit manufactured with C2 level fabric was Rs. 610/-.

Harvesting

Tractor front mounted Henna harvester

The MPUAT, Udaipur centre developed a tractor front-mounted henna harvester to address the limitations of existing self-propelled units by improving cutting and conveying efficiencies through optimized cutting parameters, thereby offering an affordable and efficient solution for henna harvesting. The developed machine has a harvesting efficiency of 96.08% and conveying efficiency of 97.01% (shattering losses 3.25%) at a forward speed of 2 km/h, a reel speed of 32 rpm and a cutting blade speed of 1500 rpm. The field capacity and field efficiency of the system were 0.3715 ha/h and 84.41%, respectively. The physiological impact of operating the harvester was assessed by measuring the workers' heart rates. The average working heart rate was 128 beats per minute, classifying the task as moderately heavy work based on the work-to-rest heart rate ratio.

Ergonomic intervention of powered cylindrical lawn mower to enhance operator comfort

Ergonomic interventions for powered cylindrical lawn mowers were undertaken to enhance operator comfort by assessing noise and vibration exposure during operation, with the study conducted at the ICAR-IARI centre, New Delhi. Noise levels were measured at the operator's ear across three engine speeds and two modes of operation, revealing a range from 87.40 to 95.47 dB(A). Noise levels increased with mower speed and were consistently higher during running conditions than idle. The critical frequency range with maximum amplitude was identified between 1000 and 6000 Hz, showing consistent trends across all operational

scenarios. Health risk assessments were carried out using OSHA and ACGIH standards, determining safe exposure durations ranging from 3.75 to 11.47 hours under OSHA guidelines and 0.71 to 4.59 hours under the more stringent ACGIH criteria. Corresponding exposure dosages ranged from 47.94 to 146.69% (OSHA) and 119.70 to 771.85% (ACGIH). Hand-arm vibration levels measured during all operational conditions ranged between 10.81 and 23.03 m/s^2, also increasing with engine speed and higher during running than idle. Frequency analysis revealed dominant vibration amplitudes within the 25 to 50 Hz range at the one-third octave band. The calculated 8-hour equivalent vibration exposure varied from 7.64 to 16.28 m/s^2. Based on these findings, the minimum number of safe exposure years before a 10% prevalence of finger blanching was estimated to be just 1.7 years. These results highlight the significant ergonomic challenges posed by powered cylindrical lawn mowers and emphasize the need for targeted ergonomic interventions to mitigate health risks and improve long-term operator comfort.

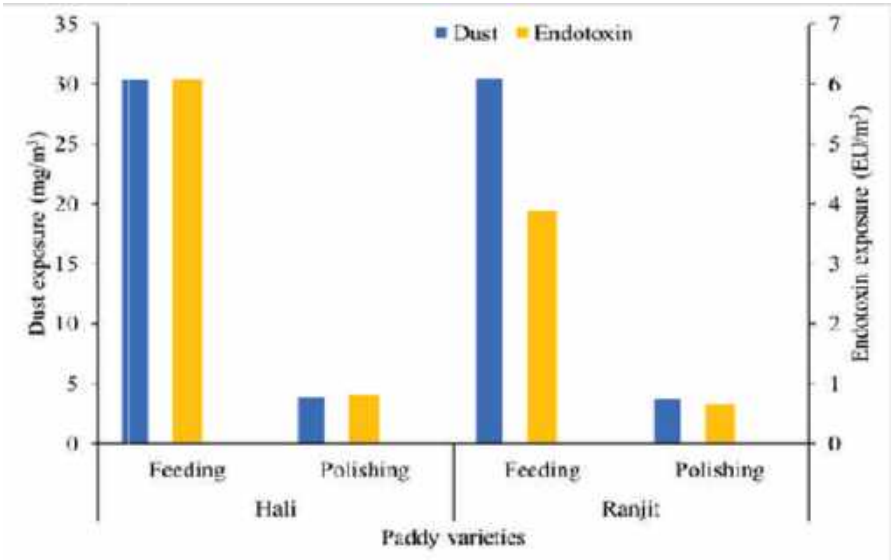
Dust abatement system for thresher

The study conducted at MPUAT, Udaipur, focused on developing and evaluating a Dust Abatement System (DAS) for threshers to reduce farm workers' exposure to harmful dust particles generated during crop threshing operations. The primary goal was to protect workers from dust-related health hazards without compromising threshing productivity. The DAS was designed by incorporating an enclosed screen attachment at the blower outlet of the thresher. This screen, made of material impermeable to particulate matter of various sizes (PM1, PM2.5, PM4, PM10, and Total Suspended Particles), effectively captured and contained dust emissions. During threshing, dust-laden air was directed toward the screen, where particles settled at the bottom, preventing their release into the surrounding environment. The study evaluated particulate matter levels (PM5 and PM10) with and without the DAS under three shade screen densities: 30%, 50%, and 75%. Results showed that higher shade screen density led to greater reductions in dust concentration. At 30% shade density, PM5 and PM10 were reduced by 33.87% and 35.61% at Level 1 (L1), and by 33.33% and 31.28% at Level 2 (L2). With 50% shade density, reductions reached 55.10% and 58.09% at L1, and 52.87% and 50.30% at L2. The highest reduction occurred with a 75% shade screen, where PM5 and PM10 were reduced by 72.24% and 72.95% at L1, and by 70.11% and 68.71% at L2. These findings demonstrate that the DAS, particularly when combined with higher-density shade screens, significantly mitigates dust exposure during threshing operations, enhancing worker safety.

Industrial environmental pollution

Assessment of endotoxin exposure among rice mill workers

A study conducted at NERIST, Nirjuli, Arunachal Pradesh, investigated endotoxin exposure among rice mill workers by analyzing PM10 dust samples from different sections of rice mills during the milling of two paddy varieties. The results revealed that endotoxin exposure was significantly higher in the feeding section compared to the polishing section during the milling of both paddy varieties. For the Hali variety, the geometric mean (GM) endotoxin exposure in the feeding section was 3.67 EU/m^3, while it was 3.89 EU/m^3 in the polishing section. In contrast, for the Ranjit variety, the GM endotoxin exposure in the feeding section was 0.82 EU/m^3, and in the polishing section, it was 0.66 EU/m^3. The analysis showed that the PM10 dust and endotoxin exposure were consistently higher in the feeding section regardless of the paddy variety being milled. These findings highlight the occupational exposure risks associated with rice milling operations and emphasize the need for appropriate safety measures to mitigate the exposure of workers to airborne endotoxins.



AICRP on ENERGY IN AGRICULTURE AND AGRO-BASED INDUSTRIES

Solar energy

Solar dryer with thermal storage

PAU, Ludhiana Centre, developed a solar dryer with latent heat storage for operation beyond sunshine hours and evaluated its performance by drying bitter gourd and ginger slices at the Department of Renewable Energy Engineering, PAU, Ludhiana. The dryer has a loading capacity of 30 kg of agricultural produce and features an evacuated tube solar collector with an aperture area of 3.0 m^2. It was equipped with six trays, each measuring 51 cm × 67 cm, for drying products. To assess its field performance, a new solar dryer with thermal storage was fabricated and installed at the farm of S. Rajwinder Singh Dhaliwal in Lohara, District Moga, approximately 85 km from PAU. The farmer, engaged in diversified farming activities such as crop cultivation, livestock rearing, and food processing (including turmeric processing, jaggery making, and drying of aonla, moringa leaves, and giloy), used the solar dryer for drying of different products. Aonla, showing a significant reduction in drying time and superior product appearance compared to open sun drying. Due to low solar radiation during peak winter months, the farmer plans to expand its post-winter use for drying other food materials.

Solar powered AI based self-driving automated weeder

TNAU, Coimbatore centre, designed an AI-driven, self-driving automated weederto minimize yield loss due to weeds and reduce the labor-intensive process of manual weeding. The weeder consists of a solar panel, battery, charge controller, navigation system, GPU, pump, spraying assembly, and maneuvering mechanism for real-time autonomous weed control. It was evaluated for 5 hours at a speed of2 km/h, with a30 kg herbicide storage capacity, a100 kg payload, a300 W solar panel, and a 50 Ah/24 V battery. To ensure precise herbicide application, the system processes weed images in real field conditions. Black gram was chosen for testing, and the YOLO model was used to train the system for real-time weed detection with high accuracy. Images were split into training (70%), validation (20%), and testing (10%) datasets, with preprocessing and data augmentation techniques applied to improve model performance. The weeder can detect weeds, make decisions, navigate, control spraying, and manage motor functions with precision. The NVIDIA Jetson Orin Nano serves as the ideal development platform for these operations.

Pilot scale solar assisted biomass pyrolysis reactor

TNAU, Coimbatore centre, designed and developed a solar assisted pyrolysis system for biochar production. The system consists of a parabolic solar collector, temperature controller, receiver, pyrolytic reactor and accessories. The collector frame was fabricated with mild steel sheet and reflector was fabricated with acrylic sheet silver glass mirror (1.8 mm) to absorb the solar radiation. The aperture area of parabolic solar collector was 7 m2 with diameter of 3 m. The focal length was found to be 1.82 m and the depth of parabolic collector was 0.3 m as per the design. The arc length of parabolic collector was 1.57 m. The concentration ratio was calculated to be 630, which is sufficient to reach temperatures of 250 - 400°C. The system was designed and fabricated with a manual tracking system to track the sun path on dual axis. The parabolic shape ensures that all incoming parallel rays (sunlight) are reflected to a single focal point, maximizing efficiency in applications. The larger

diameter increases the aperture, allowing more rays to be captured and focused, which is particularly beneficial for applications requiring high precision and heat energy collection. The capacity of the reactor used for the pyrolytic reactor for pyrolysis process was 5 kg per batch.

Value added products from biomass

Pots and fish feed from digested slurry

GBPUAT, Pantnagar centre, evaluated the potential use of digested slurry as a sustainable source of fish feed. The study involved comprehensive analyses, including proximate composition, phytochemical properties, heavy metal content, and overall nutritional profile. The digested slurry used in this investigation was sourced from the biogas plant at Pantnagar Dairy Farm. Following collection, the samples underwent meticulous preparation to facilitate the required analytical procedures. The nutritional composition, assessed through proximate analysis, along with evaluations of heavy metals and the overall composition of the fish feed samples, has been analyzed and summarized. The nutritional composition analysis was comprehensive, assessing parameters such as moisture content, crude protein, crude fat, crude fiber, ash content, and carbohydrate levels. Additionally, the heavy metal and composition analysis involved a detailed examination of elements such as sulphur, carbon, arsenic, and total aflatoxin. These analyses are crucial in determining the safety and nutritional viability of digested slurry as an alternative fish feed source. The findings suggest that digested cow dung slurry can serve as a viable protein source for fish feed, particularly due to its nutrient density. The proximate analysis revealed a protein content of 20.14%, supporting its feasibility for various fish species. Furthermore, the levels of aflatoxin and arsenic were found to be below regulatory limits, indicating that the slurry is safe for use in fish feed with respect to these toxins. However, caution should be exercised regarding the sulfur content, which, although moderate, requires careful monitoring to prevent toxicity.

Analysis of digest slurry

S. No.	Parameter	Test Result
1	Total Protein, % by wt.	20.14
2	Total Fat, % by wt.	0.22
3	Ash Content, % by wt	26.46
4	Fibre, % by wt	12.33
5	Moisture content%	5.34
5	Total Aflatoxins, µg/kg	BLQ, [LOQ-1*]
7	Carbohydrates, % by wt	44.84
8	Carbon, %	37.63
9	Sulphur, %	1.41
10	Arsenic, mg/kg	BLQ,[LOQ-0.3]

Pilot scale torrefaction unit

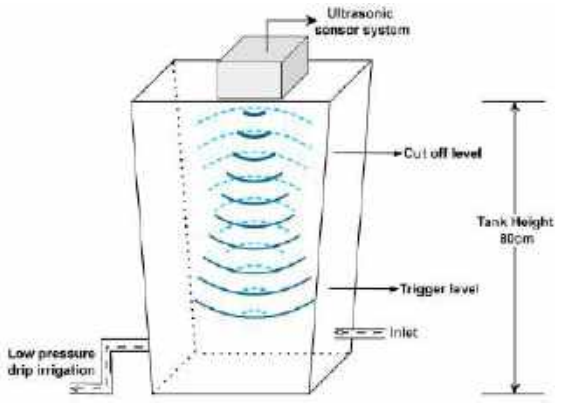
MPUAT, Udaipur centre, developed a continuous torrefaction system, for clean energy production using agricultural crop residues. The system addresses challenges associated with conventional torrefaction reactors, including inefficient management of volatiles and environmental pollution. With a biomass handling capacity of 1 to 30 kg per hour, the system incorporates the reuse of volatile compounds released during the torrefaction process, redirecting them as a heat source to enhance energy efficiency and sustainability. The system was operated at temperatures of 250°C, 275°C and 300°C, with a total residence time of 12 minutes and an effective residence time of 8 minutes. Performance evaluations of the system were conducted using key metrics, including mass yield, proximate and ultimate analysis, higher heating value (HHV), and the hydrophobicity of the torrefied biomass. The results indicated significant improvements in the fuel properties of rice husk after torrefaction. Notably, there was an increase in fixed carbon, carbon content, and higher heating value (HHV), along with a reduction in moisture content, demonstrating the hydrophobic nature of the torrefied biomass. The HHV increased remarkably by approximately 22–23%. Furthermore, the economic analysis confirmed the feasibility of the system, reporting a Net Present Worth (NPW) of Rs. 2,009,262.52, a Benefit-Cost Ratio (BCR) of 1.54, a payback period of 18 months, and an Internal Rate of Return (IRR) of 48%.

Pilot plant development for biokerosene and biodiesel production from the used cooking oil

TNAU, Coimbatore centre, used cooking oil samples were collected from restaurants and were filtered to remove food residues left in them after cooking. Physicochemical analysis of the oil samples was determined by measuring their specific gravity, density, carbon residue content, viscosity, calorific value and acid value and it was found to be 0.95, 976.7 kg/m3, 0.37%, 129.26 cSt. 9867 KJ/kg and 2.589 mg KOH/g, respectively. GC-MS analysis of the oil sample was carried out to find out the fatty acid composition. The conversion of triglycerides present in the used cooking oil into free fatty acids was carried out by hydrolysis process using sulphuric acid as a catalyst and by heating the sample up to 120°C followed by stirring with hot water for 2 hours. The cooking oil and sulphuric acid are mixed in various ratios and 10:1 ratio was optimized. Separation of top fatty acid layer and bottom glycerol and aqueous layer was performed using separating funnel. The acid value of the fatty acid fraction is determined as 7.768 mg KOH/g which showed the increase in free fatty acid content after hydrolysis of the oil sample. The hydrolyzed sample is analyzed for fatty composition by using GC-MS. The fatty acid fraction is further subjected to electrolysis process using copper electrodes and acetic acid electrolyte in different concentrations to convert the free fatty acids in hydrocarbons. The GC-MS analysis of the product obtained by the electrolysis process and furthers the conversion of hydrocarbons into biokerosene by electromagnetic induction using methanol is in progress.

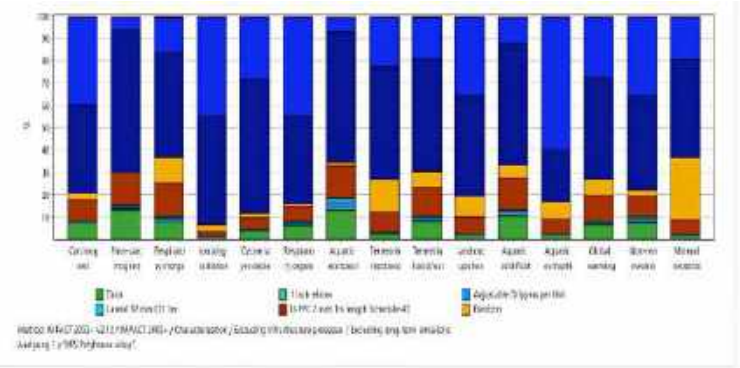
CRP on MICRO IRRIGATION SYSTEM

Automation in filling of tank for low pressure/low flow drip irrigation



The most common way of knowing when the tank is filled is by observing when it overflows the brim. This can be prevented if the tank is regulated automatically. In this experiment, automation system was developed by mounting ultrasonic sensor on the top of the tank. The sensor transmits an ultrasonic pulse down into the tank. This pulse travels at the speed of sound and is reflected back to the transmitter from the liquid surface. The time delay measurement between transmitted and received signals enables the device to calculate the distance to the surface. The microcontroller is programmed to automatically determine the liquid level and actuate the pumping machine accordingly.The developed ultrasonic based embedded system with IoT for tank water level measurement was tested with low pressure low flow water tank (200 litres capacity). The length, width and height of water tank were 50 cm× 50 cm × 80 cm. The sensor's range is from 25 cm so the cut off value was kept as 28 cm and trigger level as 50 cm. The system continuously checks the water level and actuate after given time interval if the condition is met. The system has Wi-Fi connectivity which helps in remote access of real time water level values. The data was recorded on the AWS cloud that can be downloaded in form of csv file. The developed system in real time monitors the level of water in a tank and then the pump operation ON or OFF made to avoid overflow and wasting of the water and thus saving both inadequate consumption of electricity and water.

Life cycle assessment calculator for gravity fed drip irrigation under protected and open field condition



A comparative gate-to-gate lifecycle assessment (LCA) was conducted to examine different irrigation practices for hilly terrain. In the project all the data related to crop production and resources invested, all alternative resources used for crop production (analytical), all possible resource variations adaptable for crop production (analytical), water utilization and cropping pattern, irrigation system data including laterals and piping arrangement, energy investment for various pressurized irrigation resources and components data, greenhouse components and open field data has been collected. The life cycle assessment of MIS system for polyhouse has been determined. The LCA results for gravity DIS for Polyhouse structure reveals that overall emissions of Carcinogens of 4.229570118 kg C2H3Cl eq and Non-carcinogens 16.5641717 kg C2H3Cl eq; Global warming of 244.7318599 kg CO2 eq and Non-renewable energy i.e., primary energy of 6549.75 MJ. The maximum impacts were from polyhouse structure, despite bamboo is being harvested locally energy equivalent for labours and using cutting equipment making impactful emissions. The protected cultivation systems require more materials (plastic sheets, metal structures) but result in longer system lifespan and lower operational impacts compared to open-field systems which have lower initial embodied energy, but higher maintenance over the time. Protected systems have 20-25% lower carbon emissions over the lifecycle due to better water management and reduced pumping requirements.

Electronic tensiometer for IoT based micro irrigation system in hilly region

The operating range of analog tensiometer to know the status of soil moisture tension in the plant root zone for irrigation scheduling is 0-100 kPa. However, the setensiometer cannot be connected/integrate with IoT based smart irrigation system. Therefore, IoT based tensiometer was assembled with porous ceramic cups and transparent PVC pipes of suitable diameter and length. The low cost electronic tensiometer operates by utilizing an MPX5100DP (0-100 kPa) pressure sensor to measure soil water tension, which is then processed by an Arduino Uno. The sensor output is converted into a readable signal and transmitted via an NRF24L01 Wi-Fi module for remote monitoring. Power is supplied by a 12V battery, which is charged through a solar panel and regulated using a voltage converter to provide necessary voltages for the components. Data logging is handled by an RTC module for timestamping and an SD card module for storage. Additionally, an LTE module facilitates real-time data transmission to cloud servers or mobile applications. A 3-inch TFT display provides an on-site visual representation of the measured soil moisture tension, ensuring efficient water management in agricultural applications. The MPX5100DP sensor readings are closely matches with TD values, proving accuracy whereas lower error values at higher pressures indicate better accuracy. However, potential errors arise due to sensor calibration, power fluctuations from the solar panel, or connectivity issues. The system ensures continuous data collection and remote transmission, enhancing agricultural water management.

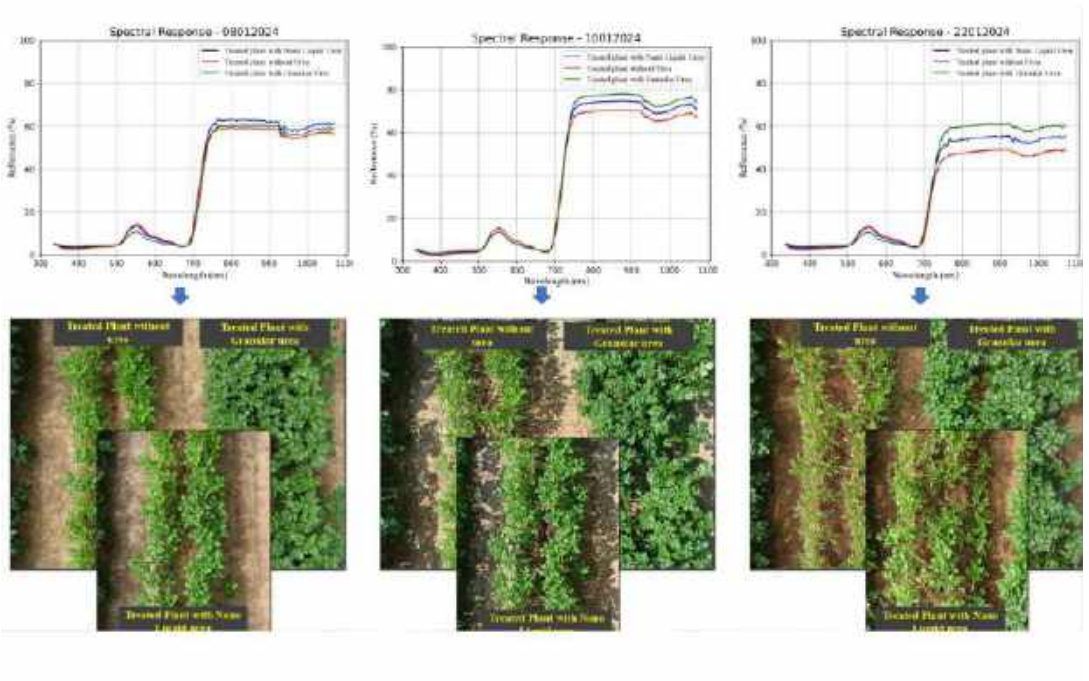
Evaluation of the different dripper types in wastewater Irrigation for cotton cultivation

Optimization of drip irrigation systems for wastewater reuse by evaluating the uniformity coefficient (UC %) and discharge rate consistency of various dripper types is critical for higher application efficiency. In this study, seven types of 4 lph drippers (Adjustable, Online Pressure Compensating (PC), Online Non-Pressure Compensating, J-Loc, Micro Tube, Inline Surface, and Inline Subsurface) were installed and monitored in cotton (var. CO 17) for irrigation, using treated sewage wastewater (W) and groundwater (G) within a controlled irrigation setup. For ten weeks, weekly discharge rate data were collected from fifteen fixed points per dripper to analyze flow rate variations, the uniformity coefficient (UC %), and tendencies for clogging. The inline surface dripper showed good hydraulic characteristics, maintaining an 83.8% uniformity coefficient after 10 weeks with a 12.2% discharge reduction. Adjustable and Online PC Drippers exhibited significant performance deterioration, with discharge reductions of 46.5% and 32.7%, respectively. Statistical analysis confirmed significant variations in dripper performance, with critical discharge variability in pressure-compensating variants. Cotton growth parameters showed a direct correlation with dripper performance metrics, with the Inline Subsurface and surface dripper system yielding optimal results. Inline surface and subsurface drippers had a good crop growth response and the least amount of clogging in wastewater irrigation.

Spectral response-based phenotyping of the potato crop under drip irrigation

Monitoring abiotic stress in potato crops under a drip irrigation system using spectral response analysis and phenotyping variables can aid in developing a precision monitoring framework. The integration of soil moisture monitoring, imaging, and spectroradiometer enable real-time stress detection. The experimental design employed a Randomized Complete Block Design to investigate the effects of nitrogen and water stress on potato plants grown in lateritic sandy soil. The treatment without Nitrogen (F2) consistently had higher absorption (lower reflectance 60-62% in NIR as compared to 70-75% in nitrogen treatment) in the red region (~680 nm), indicative of reduced chlorophyll content and poorer health. Distinct Red-Edge Shift (680–750 nm) is observed between granular Nitrogen (60%) and no-nitrogen treatment (45-50%). F1 and F3 treatments consistently showed higher reflectance in the NIR region, indicating greater biomass and healthier canopy. F2 (untreated with urea) exhibited lower reflectance throughout, suggesting stress or poor vegetative vigor. The granular urea enhances reflectance over the time. While initially showing a weaker spectral response, plants treated with granular urea exhibit significantly higher reflectance in later growth stages compared to those treated with liquid urea or without any urea application. No significant distinction was observed in the visible

spectrum among different nitrogen treatments, but the NIR band showed pronounced variations. This highlights the superiority of NIR imaging in assessing plant health, structure, and water content in potato crops. NIR imaging's capability to identify plant stress should be leveraged for early detection of nutrient deficiencies and water stress.



CRP on ENERGY FROM AGRICULTURE

Biohydrogen from crop residues

Bio-hydrogen production from paddy straw

The PAU, Ludhiana centre studied dark fermentation of paddy straw waste with mixed bacterial inoculum. The study was carried out on hydrogen production from the hydrolysate of acid pre-treated paddy straw by using facultative bacteria Enterobacter aerogenes. The maximum reducing sugar content of 16.94 g was observed in the pre-hydrolysate after pre-treatment of paddy straw (100gm) under optimized reaction conditions involving 1.90 percent sulphuric acid, 51.85 min pre-treatment time and a solid: liquid ratio of 1:17.51. The dark fermentation of detoxified paddy straw hydrolysate resulted in maximum total gas production of 226.67 mL/L at 72h of fermentation. During fermentation, volatile fatty acid content of the hydrolysate increased by 28- fold along with 19- and 24-fold decline in total and reducing sugar content. The cumulative total gas and hydrogen production of 426.67 and 183.47 ml/L was reported at pH 5.5 of the hydrolysate. The briquettes prepared from the residue left after acid pre-treatment of paddy straw were found to be compact with shatter index of 95.18% and calorific value of 19.63 MJKg-1.

Hybrid process for bio-hydrogen production from rice-straw: a circular economy approach

SPRERI, VV Nagar, attempted two different routes, i.e., biochemical and thermo-chemical conversion routes, were selected to explore bio-hydrogen generation potential from the selected crop residues.

Bio-chemical conversion route

Production of hydrogen from lingnocellulosic biomass is mainly carried out through two different routes, i.e., photo-fermentation and dark-fermentation. Among these two, a dark fermentation route was selected for rice straw to initiate lab-scale feasibility studies.

Under this study, anaerobic hydrogen-producing strains were isolated and identified from sources like sewage sludge, biogas slurry, and cow dung. Strain identification was performed using 16s RNA gene sequencing and nomenclated as Enterobacter cloaceae SPA1, Staphylococcus epidermis SPS3 and Shigella flexneri SPD1. From the isolated strains, the dark-fermentative hydrogen (H2) production potential of SPD1 from various pure (glucose, fructose, sucrose, lactose, and galactose) and crop residues (coconut coir, cotton fiber, groundnut shells, rice straw, and wheat straw) derived sugars was studied. Among pure sugars, SPD1 exhibited the highest H2 production of up to 3.2 mole/mole of hexose using glucose (5.0 g/l). In the same line, pre-treatment of various selected crop residues, i.e., rice straw, wheat straw, cotton fibers and coconut coir, was carried out using green solvents, i.e., choline chloride and lactic acid mixture. The enzymatic hydrolysis of such crop residues resulted in up to 36.0 g/l of sugars. The maximum H2 production is achieved by up to 2.9 mole/mole of hexose using cotton hydrolysate.

Thermo-chemical conversion route

Under this part, with the objective to convert CO and CH4 of the producer gas into H2, a water gas shift reactor (WGSR) setup having the potential to produce 1 kg/day of hydrogen was designed and developed. Using the fluidized bed gasification system for groundnut shell as a feedstock at 750°C with equivalence ratios in the range of 0.25-0.30 and inlet air-pressure of 2 bar. At such parameters, a hydrogen concentration of 6 vol.% was achieved in the produced gas with a gas yield of 2.2-2.5 Nm3/kg.

The developed set-up features a two-step reactor system comprising a high temperature reactor (HTR) and a low-temperature reactor (LTR) connected in series. Different catalysts, i.e., iron-based catalysts for the HTR and copper-based catalysts for the LTR were developed and used depending on the reaction temperatures. Both the mentioned catalysts were synthesized in-house using the wet impregnation method. Initially, the system temperature profile was tried to achieve and maintain using dummy catalysts.

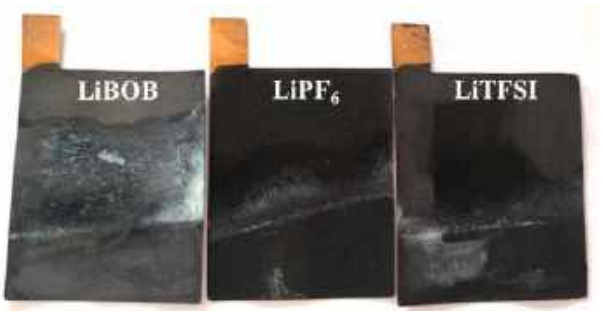
After achieving the temperature stability, trials were carried out using actual catalysts and pure CO as a gas stream. The system's efficiency was first evaluated using pure CO with varying steam-to-CO ratios at a lower CO flow rate of 0.5 LPM with an equivalent steam ratio. At such flow rate and optimized LTR and HTR temperatures, i.e., 250 °C and 450 °C, respectively, the hydrogen concentration reached 80.01 vol.%.

Value added carbon from biomass

Design and development of anode for li-ion batteries using carbon derived from agricultural residues and its experimental investigation

MPUAT, Udaipur centre has processed agricultural biomass for the purpose of creating carbon for lithium ion (Li-ion) battery anodes. The carbon was produced using the vacuum pyrolyzer and then activated using the chemical activation (wet and dry) method. The activated carbon was analysed for physical morphology using the SEM, BET, XRD and the best sample was selected for the development of anodes. The developed electrodes were evaluated using the electrochemical workstation for CV, GCD and EIS studies. The main findings are:

- The carbon yield of wheat straw (WS) biomass was obtained 30.5, 28, and 25% at a temperature of 500, 600 and 700°C respectively. In the same way, the sugarcane bagasse (SB) biomass shows highest recovery of 36% at 500°C followed by 31.5 and 28% at 600 and 700°C respectively. Finally, the corn cob (CC) biomass was shown the carbon production of 34.5% at 500°C followed by 32.5 and 30% at 600 and 700°C respectively.
- The BET results reveal that the dry activated carbon samples provide 1031.16 m2/g for wheat straw, 1165.32 m2/g sugarcane bagasse and 1093.76 m2/g for corn cob. Compared to wet activated carbon with high micropore area which is suitable for electrochemical energy storage devices.



- The cyclic voltammetry reveals that the LiPF6 electrolyte forms the porous globules surface film of varied sizes on the carbon electrodes with carbonate solvents. This SEI morphology prevents the li ions consumption and reduces electrical path into carbon particles and maintains the total interfacial resistance.

- The electrodes using the LiPF6 shows the good discharge stability tested for 100 cycles and achieved 501 and 383 mAh/g for carbon black and the activated carbon-based electrodes. This beaten the theoretical capacity of graphite 372 mAh/g which is mentioned by the previous research work.
- The conventional carbon black exhibits the specific capacity of 251 mAh/g and the activated carbon-based electrodes with the specific capacity of 122 mAh/g with a coulombic efficiency of 88 and 87% in the negative potential window of -1.0 – 0.0V (Li/Li+).
- The activated carbon shows the depressed semicircles at the high frequency region indicated that there is low charge transfer resistance occurs for the activated carbon electrodes in Lithium electrolytes, Lithium Hexafluorophosphate (LiPF6) followed by Lithium Bis (trifluoromethane sulfonyl) imide (LiTFSI) and Lithium Bis (oxalate) borate (LiBOB).

Continuous microwave pyrolyser for bio char production from cotton stalk

The JAU, Junagadh centre developed a microwave pyrolyser of 20 kg capacity for biochar production. The shredded cotton stalk was selected for production of biochar using developed microwave pyrolyser. The bulk density of shredded cotton stalk was found to be 151.32 kg/m3 and the bulk density of grounded (2 to 5mm particle size) cotton stalk biomass was found to be 161.92 kg/m3. Proximate analysis of cotton stalk was carried out and the moisture content was found as 12.11% on dry basis and the fixed carbon, volatile matter, ash content, ratio of volatile matter to fixed carbon and calorific value were found as 15.99% db, 79% db, 5.01% db and 4358.0 Cal/ g respectively. Chemical analysis of shredded cotton stalk was performed and the pH, EC and OC values were measured at 5.58, 0.03 dS/m and 56.09 % respectively. The values of available N, available P2O5, available K2O and available S of shredded cotton were found as 0.78, 0.11, 0.40 and 0.12 % respectively.

PG RESEARCH

Development of computer vision-based disease management system for tomato crop

Name of Student: Er Abhishek Upadhyay (Roll No: 11962)

Name of Research Guide: Dr NS Chandel

This study presents a novel hybrid Vision Transformer (ViT) model optimized for real-time disease classification in tomato crops and a computer vision (CV)-based precision sprayer for targeted pesticide application. The ViT model achieved 91.53% classification accuracy by optimizing hyper-parameters - epochs, batch size, and learning rate, using response surface methodology (RSM) on a dataset of 1,690 images of healthy and diseased tomato leaves. To address pesticide application challenges, spray characterization was performed using three nozzle types (flat fan, hollow cone, and flower (8-hole)) at varying pressures (196, 294, and 392 kPa). Droplet properties, including size distribution, specific surface area (SSA), and spray deposition, were analyzed. Results showed smaller droplet sizes and increased SSA with higher pressures, improving pesticide coverage. A CV-based precision sprayer was developed and evaluated in a polyhouse environment. It demonstrated high detection efficiency for diseased plants, achieving 95.83% at 0.34 km/h, with optimized sensor-to-nozzle distances ensuring precise spray alignment. The precision system reduced pesticide application rates for late blight and powdery mildew to 355.66 L/ha and 257.72 L/ha, respectively, compared to 902.04 L/ha with conventional methods. Controlled experiments highlighted significant influences of spraying height and pesticide type on droplet characteristics, coverage, and deposition. Metalaxyl 8% + Mancozeb 64% WP achieved maximum droplet density (30.93 droplets/cm^2) and coverage (26.54%) at lower spraying heights. Economic analysis confirmed feasibility with an operational cost of ₹82.60 per hour and a break-even point of 25.5 hectares per year. The system's high detection accuracy, reduced agrochemical usage, and environmental benefits establish it as a viable solution for sustainable agriculture.

Development of canopy volume based variable rate spraying system for pomegranate orchard

Name of Student: Er Deepak Thorat (Roll No: 11400)

Name of Research Guide: Dr CR Mehta

Pomegranate crops are highly prone to pests and diseases, leading growers to rely on intensive spraying, often exceeding 45 sprays per season. Traditional air-blast sprayers waste 30–50% of chemicals through drift, runoff, and residue, applying chemicals uniformly without considering canopy variations, resulting in inefficient pest control. A variable rate spraying system was developed to optimize spray volume based on canopy volume. Laboratory tests was conducted with experimental variable rate spraying system at sensor spacing (0.30, 0.48 and 0.66 m), object depth (0.75, 1, 1.25 m), and forward speed (0.57, 0.7 and

0.83 m s- 1) with two types of objects (i.e. flat surface object and plant). MAPE in spray volume delivery was observed from 5.99 to 6.87% for flat surface object and 11.03 to 12.44% for plant, demonstrating the acceptable accuracy for field application. The developed system was further tested in field-controlled conditions across three pomegranate orchards (2, 4 and 8 year-old) to optimize specific spray volume based on

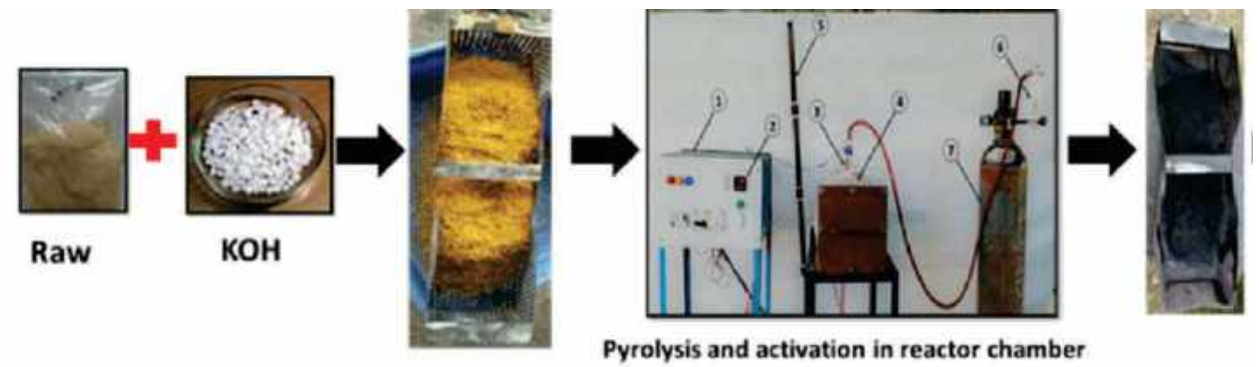
the canopy size, varying nozzle flow rate (1.6, 2.1, and 2.6 L min- 1) and forward speed (0.43, 0.71, and 0.95 m s-1). Spray deposit analysis showed a negative correlation with forward speed and a positive correlation with nozzle flow rate, while droplet size (VMD) remained consistent. Forward speed significantly influenced all responses than the nozzle flow rate, with inner canopies receiving lower deposits than outer zones. Using Response Surface Methodology, optimal specific spray volumes of 0.093, 0.084, and 0.077 L m-3 were identified for selected orchards, meeting the criteria for effective pesticide application. Field tests at 0.085 L m-3 achieved VMD of 261.21 - 320.78 µm, spray coverage of 20.17 - 41.0%, droplet density of 44.39 - 85.40 droplets cm-^{2}, and deposits of 1.42 - 2.40 µl cm-^{2}, with 46.81% chemical savings compared to conventional sprayers.

Investigations on nano-micro surface modification of biomass-based carbon for Supercapacitor electrode

Name of Student: Mr Ravi Kumar Sahu (Roll No: 11965)

Name of Research Guide: Dr Sandip Gangil

This study focused on the synthesis of nanoporous carbon from chickpea stalk through chemical activation using potassium hydroxide (KOH). The synthesized nanoporous carbon was thoroughly characterized and applied in the field of energy storage. Activation of the chickpea stalk was performed under an inert nitrogen atmosphere at varying activation times (30, 60, and 90 minutes) and temperatures (750, 800, and 850 °C). Comprehensive characterization of the raw chickpea stalk and the prepared nanoporous carbon was conducted using TGA, kinetic analysis, proximate analysis, adsorption analysis, BET surface area analysis, SEM, XRD, and FTIR spectroscopy. Adsorption analyses revealed that the nanoporous carbon exhibited high microporosity and mesoporosity. Furthermore, the BET surface area analysis, confirmed by Type IV isotherm curves, showed that all the prepared nanoporous carbon samples possessed micro- and mesopores. The highest surface area (1239 m^2/g) and pore volume (0.60 cm^3/g) were recorded for sample CT-9. SEM imaging revealed interconnected micro- and mesopores in the prepared nanoporous carbon. FTIR analysis indicated functional groups such as alcohol group (O–H), ester group (C–O), carbon dioxide (O=C=O), and carboxylic acid (O–H) significantly improved the interaction between the material and electrolyte ions. Electrochemical performance was evaluated using a three-electrode setup with 1M KOH as the electrolyte. Cyclic Voltammetry (CV), Galvanostatic Charge-Discharge (GCD), and Electrochemical Impedance Spectroscopy (EIS) were employed to analyze the nanoporous carbon as an electrode material. The results showed that the nanoporous carbon-based electrode exhibited a specific capacitance of 343.29 F/g at a current density of 1.0 A/g, an energy density of 48 Wh/kg, and a power density of 495 W/kg, along with excellent cycling stability. The equivalent series resistance was measured at 1.06 Ω. These findings indicate that chickpea stalk-derived nanoporous carbon is a promising bio-material for high-performance supercapacitors and energy storage devices.



Infrared pretreatment for milling quality improvement of Kodo millet

Name of Student: Ms Edde Mounika (Roll No: 11677)

Name of Research Guide: Dr Debabandya Mohapatra

Kodo millet (Paspalum scrobiculatum), a nutrient-dense grain native to India, thrives in arid conditions and offers high levels of protein, vitamins, minerals, dietary fiber, and bioactive compounds. However, its small size, unique shape, and anti-nutritional factors like tannins and phytates hinder nutrient bioavailability and dehusking efficiency. Conventional hydrothermal treatments are labor-intensive and may cause off-flavors and reduced shelf life, prompting the exploration of infrared (IR) radiation as an energy-efficient alternative. This study evaluated IR treatment as a pretreatment for dehusking Kodo millet, focusing on dehusking efficiency, nutritional enhancement, and reduction of anti-nutritional factors. A laboratory IR setup was used, with variables including voltage (200–260 V), duration (30–210 s), and grain moisture content (10–16% w.b.). Optimal conditions were identified as 220 V, 90 s, and 12% w.b. Machine learning models predicted critical responses, with XGBoost outperforming others. A Discrete Element Modeling (DEM) study optimized screw geometry and rotational speed for efficient grain transport and exposure to IR heating. An IR applicator was fabricated with a capacity of 200 kg/h achieved a dehusking efficiency of 72.08%, head rice yield of 71.71%, and reduced operating costs (Rs 0.28/kg). IR-treated millet showed significant nutritional improvements, including increased protein (6.75% d.b.), fiber (0.95% d.b.), and ash content (1.06% d.b.). Tannins and phytates decreased by 86.76% and 25.47%, respectively, while antioxidant potential, phenolics (188.72 mg GAE/100 g DW), and flavonoids (1712.21 mg QE/100 g DW) significantly increased. Structural analyses confirmed enhanced dehusking efficiency due to surface roughening and micro-cracks. Compared to conventional treatments, IR-treated millet exhibited superior bioactive compound retention, lighter color, reduced cooking time (12.58 min), and better storage stability, particularly in HDPE packaging at 15°C. IR treatment enhances dehusking, nutritional quality, and storage stability, offering a sustainable solution to increase Kodo millet's commercial value.

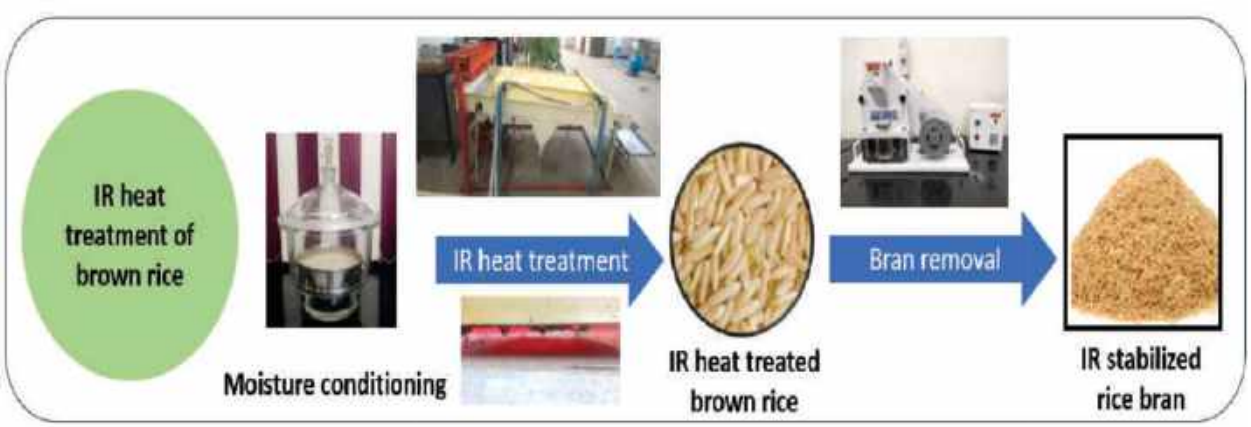
In-situ stabilization of rice bran with infrared heating of brown rice

Name of Student: Ms Bogala Pravallika (Roll No: 11391)

Name of Research Guide: Dr SK Giri

A continuous infrared (IR) heat treatment system of 100 kg/h capacity for brown rice was developed. The IR heat treatment experiments were conducted by considering three independent variables including initial moisture content (MC) (10 %, 12 % and 14 %), distance of heater from brown rice surface (D) (40 mm, 60 mm and 80 mm) and heating time (HT) (30 s, 60 s and 90 s). The IR heat treated brown rice was further allowed to achieve room temperature followed by polishing for 20 s by Satake polisher. The optimum values of IR heat treatment variables viz. MC, D and HT were 12 %, 60 mm and 60 s, respectively. The values of dependent variables viz. surface temperature, moisture loss, free fatty acids (FFA), peroxide value (PV), head rice yield, degree of polishing, broken rice percentage, total phenol content, total flavonoid content, and DPPH antioxidant activity were 67.5 °C, 0.33 %, 2.36 %, 1.60 mEq/kg, 91.54 %, 6.92 %, 2.16 %, 734.68 mg GAE/100 g, 572.63 mg QE/ 100 g and 95.13 %, respectively at the optimized processing condition. The amylose content of IR heat treated milled rice was in range of 12.18±0.22 to 14.43±0.07 %. The cooking time, solid loss and water absorption ratio of the IR treated milled rice were in range of 20.27±0.03 and 22.28±0.01 min, 3.01±0.03 to

4.52±0.12 % and 3.11±0.03 to 3.98±0.12 %, respectively. Storage study of raw and IR stabilized rice bran at storage conditions (ambient and refrigerated) and packaging materials (low density polyethylene, polypropylene and laminated aluminium pouches) revealed that under refrigerated condition, the FFA and PV of IR stabilized rice bran packed in laminated aluminium pouches were far below the accepted limit at the 7th week and at ambient condition, the FFA and PV were below the accepted limit for 7 weeks. Thus, the rice bran can be stabilized in-situ with infrared heat treatment of brown rice with storability of 7 weeks.



Effect of hydrogel placement depths on crop and water productivity in vertisols

Name of Student: Mr Umashankar (Roll No: 11974)

Name of Research Guide: Dr KVR Rao

Water scarcity poses a critical challenge in agriculture, particularly in arid and semiarid regions. Superabsorbent polymers (SAPs), such as hydrogels, have emerged as promising solutions for enhancing soil moisture retention and improving crop yield and water productivity in these environments. A comprehensive study, i.e. a one-year grow bag experiment and a two-year field trial conducted to evaluate the effects of hydrogel type and application depth on soil water distribution, water productivity, and crop growth. Two hydrogel types—polymer-based (Hydrogel-1) and small organic molecule-based (Hydrogel-2)—were applied at four depths: surface, 5, 10, and 15 cm. The grow bag study was implemented using a randomized block design, while the field study employed a split-plot design. The findings indicated that the water absorption capacity of polymer-based was negatively impacted by water salinity, whereas molecules-based hydrogel maintained consistent performance under saline conditions. Soil moisture retention improved with deeper hydrogel applications, with polymer-based hydrogel at 10 cm significantly extending irrigation intervals by 2–4 days as compared to the control. Hydrogel applications at 10 cm depth significantly enhanced spinach growth parameters, including plant height, leaf count, leaf area, root length, SPAD value, and shoot and root fresh and dry weight and yield. The highest yield (35.2 t/ha) and water productivity (20.3 kg/m^3) were achieved with Hydrogel-1 applied at 10 cm depth. Additionally, a 10-row seed-cum-hydrogel applicator was developed and tested for optimized application depth in spinach cultivation. The applicator demonstrated an effective field capacity of 0.37 ha/h, operating at 77% efficiency with a forward speed of 2.5 km/h. Economic analysis revealed the highest benefit-cost ratio (2.42) in the treatment combination H1D3 (Hydrogel-1 at 10 cm depth), followed by H2D3 (Hydrogel-2 at 10 cm depth) with a ratio of 2.13. The study concludes that hydrogel application at a depth of 10 cm optimizes resource use efficiency and water productivity in spinach cultivation on vertisols, while water has become a precious resource.

Development of crop-water management strategies under changing climate in upper tapi sub catchment

Name of Student: Er Abhishek Patel (Roll No: 11405)

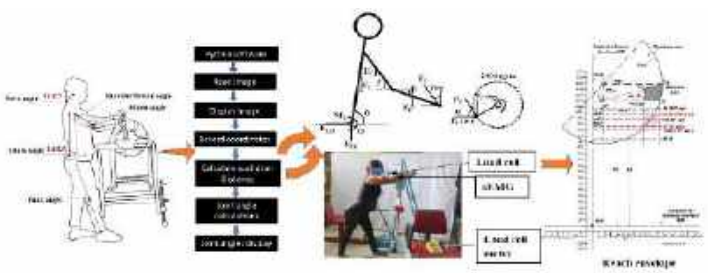
Name of Research Guide: Dr KVR Rao

Agriculture, the largest water consumer, must meet the demands of a growing population amidst changing climatic conditions. The IPCC projects a global temperature increase of 1.5–4°C by 2100, with significant impacts on precipitation and hydrological cycles. Land use/land cover (LU/LC) changes exacerbate these issues by altering water balance and rainfall distribution. This study integrates hydrological modeling, LU/LC dynamics, and climate projections to develop sustainable crop-water management strategies under changing climatic conditions. The SWAT model was employed to assess runoff potential, calibrated (1994–2001) and validated (2007–2009) at the Burhanpur gauging station using SUFI-2 in SWAT-CUP 2019. Sensitivity analysis identified CN2.mgt as the most influential parameter. Several performance metrics confirmed model accuracy, while uncertainty analysis demonstrated its reliability. GIS-based weighted overlay analysis revealed 25.43% of the watershed as medium to very high suitability for rainwater harvesting. LU/LC projections using a hybrid CA-Markov model predicted forest (4,934.05 km^2) and cropland (3,295.73 km^2) as dominant classes by 2035, with built-up land increasing moderately to 221.29 km^2. Climate projections using a multi-model ensemble of 13 GCMs under SSP245 and SSP585 scenarios for 2035–2050 and 2075–2090 indicated rising trends in rainfall and temperatures. SWAT simulations showed significant increases in pre- and post-monsoon streamflow, with mixed trends during monsoon months. Crop water requirements were estimated for major Kharif (565.98–694.64 mm) and Rabi (416.70–487.76 mm) crops, with volumetric water demand ranging from 3,229.45–4,013.11 MCM. Analysis between water availability and demand emphasize optimizing irrigation systems and implementing sustainable water management strategies. This study provides insights for policymakers to ensure water sustainability and food security in the Upper Tapi Sub-catchment.

Ergonomic studies on hand cranking operation for women workers

Name of student: Manisha Hanumant Jagadale (Roll No: 10951)

Name of Research Guide: Dr KN Agrawal



Human energy is a significant source of power in agriculture sector in India. Agriculture, in spite of being largest employer with about 55% workforce, their availability is decreasing day by day. The participation of women workers in agriculture is increasing due to growing demand of male workers in other sectors. Therefore, various factors affecting cranking performance were identified and optimized based on female workers' physiological, postural, biomechanical, and muscle activity studies. To optimize cranking parameters based on physiological work load, postural interaction, and muscle fatigue study, the cranking length, cranking height, and power were selected in the range of 180-300 mm, 800-1100 mm and 30-70 W, respectively. The physiological workload was measured in terms of heart rate, cardiovascular stress index, oxygen consumption during work, energy expenditure rate, overall discomfort rate, and cranking efficiency, and was analyzed using the response surface methodology for optimization. Based on physiological parameters the optimized cranking height of 910.8 mm, cranking length of 249.3 mm, and 38.10 W power. The muscular fatigue for flexor digitorum superficials, biceps, and deltoid muscles were 7.51%, 17.34%, 14.95%, and 11.92%, respectively. The average compressive force was the same, i.e., 379.70 N for lower, higher, and optimized levels of cranking parameters. For lower, higher, and optimized levels of cranking parameters, the average shear force was 24.13 N, 33.79 N, and 22.12 N, respectively. A reach envelope in the sagittal plane for both hand cranking in standing posture by female agricultural workers had been developed. The perusal of the reach envelope indicated that worker should position the cranking shaft not closer than 437 mm and not farther than 571 mm forward of the worker's body centreline.

NETWORK PROJECT ON PRECISION AGRICULTURE (NePPA)

The programme is designed to develop precision AG-Techs for sustained enhanced input use and production system with safe environment and quality produce to make agriculture a profit-making enterprise. ICAR-CIAE is one of the partner Institutes with projects running under the umbrella title of "Development of sensor-based technologies for precise farm input application and quality control in post-harvest processing", the three sub-projects under this area are as listed below.

Image based variable-rate nitrogen applicator for paddy crop

This equipment was developed to address site-specific nitrogen requirements in crops. The unit uses a digital imaging system and a camera to assess crop nitrogen stress non-destructively, which is then processed by an AlexNet deep learning model. This model is developed in a Raspberry Pi microcontroller, which controls a proportional flow control valve to adjust fertilizer rates (Low, Medium, and High) based on stress levels. The system was operated at 2.0 km/h in paddy fields with four hollow cone nozzles to spray fertilizer uniformly. NDVI values were recorded before and after urea applications, showing significant improvements: a 72.4% increase after the second application and a 94.2% increase after the third. This embedded system offers a promising solution for precision nitrogen application in field crops.

AI/IoT based intelligent irrigation system for field crops

Application of the right amount of water at the right time to fulfil the water requirement of the crop is critical for improved input use efficiency. For achieving this condition, an intelligent irrigation system comprising a soil moisture sensor and a temperature sensor was installed at the effective root zone of a specific crop in soil. An AI-based irrigation system with sensors placed throughout crop field utilizes IoT protocol (MQTT) to collect real-time data on soil moisture levels, weather prediction from weather website. By integrating AI algorithms with IoT devices, users can optimize water usage to increase crop water productivity and reduce costs. The moisture sensor sends the signal to the Wi-Fi configured module of ESP 32, which triggers the water pump and irrigates the field using the smartphone or computer application if the moisture level falls below the pre-defined value and prediction of occurrence of rainfall is low. Specifically, written algorithm can process data on weather forecasts on rain, and sensor readings to generate precise irrigation schedules suitable to the specific needs of crop and field. The developed system was tested in sweetcorn field under different soil moisture content levels. During the growing season of the sweet corn crop, the water depths applied (mm) in IoT-based and ETC based drip irrigation was compared. Compared to 100% ETC drip irrigation, IoT-based drip irrigation 100% FC and 80% FC used 12.7 and 24.5% less irrigation water, respectively. The developed system could avoid irrigation at the inexact time of day, reduce runoff from overwatering saturated soils, save labour and time and precise application of irrigation water to the field.

Sensor based multi pass cleaner for chickpea

Cleaning of the agricultural produce is a very important postharvest operation. It not only increases the value of the product, but also enables a safe storage and efficient secondary processing operations. The developed machine has specifications that will suit the small farmers at an affordable price.Chickpea grains were cleaned from the fields was carried out by a sieving mechanism in the sorting machine. Secondary cleaning of the straw material occurred with the help of an aspirator, which efficiently separated lighter foreign particles such as small straw, dust, and other unwanted materials. Further cleaning was carried out by a blower, which blew away foreign materials, ensuring that only clean and high-quality chickpeas moved forward in the sorting process. The blower (primary cleaning that the feed undergoes while it falls down from the feed hopper before the it goes for final cleaning) could achieve a cleaning efficiency of 67 per cent. Images of the grains with foreign materials were captured with an image resolution of 640 × 640 pixels in the light tight housing. The objective of building the image based object detection model was to identify and locate good grains, infected grains, broken grains, immature grains, husk, stalks and stones. The dataset of 896 images containing 28,061 objects were used for building object detection model. YOLOv7 object detection model was used for object detection. The model detected the good grains with a precision, recall and accuracy of 0.889, 0.933 and 0.93 respectively. The final model was exported from the development environment and tested on real working environment. YOLOv7 model with tuned hyper parameters yielding an accuracy of 85% has been finalized. Actuating device has been switched to motorized linear actuator in place of solenoid. Pre-cleaning efficiency of the aspiration unit is 67%. The overall capacity of the machine is 100 kg/h with 82% clean grain. However, the efficiency of the machine can be increased by passing the first output as an input, and repeating this operation up to two times to get more than 95% clean grains.

TECHNOLOGY TRANSFER

Agri drone technology demonstration

Under the Sub-Mission on Agricultural Mechanization (SMAM) scheme, a large-scale demonstration of the drone spraying system was conducted during 2022 to 2025 across 550 hectares (1360 acres) of farmland in different villages of Bhopal district. This initiative aimed to introduce farmers to modern agricultural practices, emphasizing the benefits of drone spraying technology for efficient nutrient and pest management. The events showcased the advantages of drone technology, such as uniform nutrient application, reduced water and chemical wastage, lower labor dependency, minimal environmental impact and available subsidy scheme for different stake holders. As per consent of farmers and available farming land for spraying with farmers, the area was decided and drone spraying was conducted. The demonstrations were strategically planned across multiple locations of villages of Bhopal district to ensure farmers from diverse agricultural backgrounds could observe and understand the cost-effectiveness and efficiency of drones in field operations. The drone demonstration was conducted using nano urea as nutrient and sprayed in wheat crop field. A total of 231 demonstrations were conducted 157 on farmers' fields and 74 at the CIAE research farm with 4,245 participants, including farmers, agricultural officers, and other stakeholders. Additionally, drone demonstrations were held during training programs at CIAE Bhopal, engaging participants from 913 villages. In total, 36 villages in the Bhopal district were covered, including Khamkheda, Rasalkhedi, Mandkansiya, Jaitpura, Shahpur, Sagoniya, Devpur, Barodi, Lambakheda, Dewalkhedi, Pipliya Jahir Pir, BarkhediHajjama, Kachi Barkheda, RasuliaBhanpur, Shahpur, Hinouti (Pardi), Fatehpur, Dabra, Rasalakhedi, Shekhpura, Rondiya, Bandikhedi, Dhamkheda, Bardi, Kanchbawli, Bhairopura, Kanera, Barodi, Patan, Sonkachh, Amjhara, Shahpur, Bhainskheda, Lamba Kheda, Sukliya, parwaliysadak, Narwar Jhala, etc.

Establishment of demonstration plots under DBT Kisan Hub Phase-II project

Under the DBT Kisan Hub Phase-II project, CIAE established ten one-acre demonstration plots five each in Rajgarh and Chhatarpur districts across selected villages, where farmers were provided with high-yielding seed varieties along with machinery support for sowing of the crops. Digital content on conservation agriculture and resource conservation machinery was also developed and disseminated through a YouTube channel to benefit farmers and stakeholders. Technical assistance was extended for the successful establishment of a Custom Hiring Centre (CHC) in Tumankhedi village and an oil expeller unit in Aaron village of Guna district. Additionally, four online training programs were organized for 180 farmers on topics such as conservation agriculture, crop residue management, and entrepreneurship development for CHC establishment. An exposure visit to ICAR-CIAE was conducted for 20 farmers from Khandwa district. Interaction meetings were held in aspirational districts to promote value addition and post-harvest technologies for local crops. Furthermore, the existing package of practices for 13 selected crops was surveyed across eight districts of Madhya Pradesh, and improved machinery packages were finalized. Technical literature including leaflets and bulletins was also developed and distributed to increase awareness and adoption.

Licensing of Technologies

The technologies developed by the institute are being promoted by involving farm and processing machinery manufacturing and food processing industries through licensing. During the year 2024 the institute has marketed licenses to three industries to manufacture, sell and promote the technologies.

S. No	Name of License/firm	Name of Technology Licensed
1.	M/s G T Bioscience Private Limited, Nagpur	ICAR-CIAE SPAD Meter 2.0
2.	M/s Greenfield Equipment India Private Limited, Coimbatore.	ICAR-CIAE - SBI Small tractor operated EPN applicator for sugarcane white grub management
3.	M/s Kriti Nutrients, Dewas	ICAR-CIAE Process technology for Dietary Fibre extraction

Newly Certified/released Technologies

S. No	Name of the Technology	Inventors
1.	Tractor drawn garlic dibbler for raised beds	Dr. Dilip Jat Dr. Syed Imran S.
2.	Bunch field crop harvester	Dr. Manoj Kumar Er. Sweeti Kumari
3.	ICAR-CIAE NRCB multiple feed banana fibre extraction equipment	Dr. Ravindra Naik Dr. P. Suresh Kumar
4.	ICAR-CIAE SBI Small tractor operated EPN applicatorfor sugarcane white grub management	Dr. T. Senthikumar Dr. Syed Imran Dr. T. Arumuganathan Dr. C. Sankaranarayanan
5.	Abiotic stress detection device	Dr. NS Chandel Dr. Subir Kumar Chakraborty Dr. Y.A. Rajwade Dr. Dilip Jat
6.	Hand held device for soybean disease identification	Dr. Manoj Kumar Dr. NS Chandel Dr. LS Rajput
7.	Automatic fruit grader	Dr. Subir Kumar Chakraborty Dr. Subeesh A.
8.	Equipment and chemical free process technology for production of grape raisin	Dr. DA Pawar Dr. SK Giri Dr. AK Sharma

Intellectual Property and Consultancy

Patents Granted			
S. No.	**Title**	**Patent No. and date of grant**	**Inventor(s)**
1.	Fruit and vegetable grader for spherical commodities	Patent No. 500483 17.01.2024	Dr. Nachiket Kotwaliwale Dr. BD Shukla Dr. SD Deshpande Dr. Sunita Singh
2.	Singulation and pickup mechanism for bare root seedlings of onion, cuttings and the like	Patent No 514390 23.02.2024	Dr. AP Magar Dr. BB Gaikwad
3.	Multi millet thresher-cum-dehuller	Patent No.525306 14/03/2024.	Dr. KP Singh Dr. RRPotdar
4.	Automatic washer cum singulating system for spherical fruits	Patent No. 527269 15.03.2024	Dr. Subir Kumar Chakraborty Dr. Nachiket Kotwaliwale Dr. Karan Singh
5.	Continuous feed aloevera whole gel extraction equipment	Patent No. 539121 24.05.2024	Dr. Ravindra Naik Dr. SJK Annamalai

Trademark Granted

Trademark granted to ICAR-CIAE logo under class 42 vide Certificate No.3785968 dated 8th November, 2024.

Memorandum of Understanding (MoUs) signed

Sl. No.	MoU signed with	Purpose	Date
1.	Directorate of Tribal Welfare, Government of Tamil Nadu	Tribal Livelihood Project on 'Empowerment of Tribal Farmers Societies through Smart Agri Mechanization Packages in Tribal Areas of Tamil Nadu' at Namakkal, Tamil Nadu.	6 March, 2024
2.	M/s Watershed Support Services and Activities Network (WASSAN), an NGO based at Hyderabad	Demonstrations of agricultural engineering technologies using the network of WASSAN.	20 March, 2024
3.	Mechanization and Technology Division, Department of Agriculture & Farmer's Welfare, Govt. of India, New Delhi	Assessment of status of a firm mechanization and custom hiring in India	5 July, 2024
4.	ICAR-IIPR Regional Centre, Bhopal	Breeder seed production of IIPR pulse varieties	5 August, 2024
5.	MelseemaiPazhangudiyinar Farmer Producer Company Ltd., Hasanur, Erode district, Tamil Nadu	Establishment of Millet Processing Centre under the Tribal Sub -Plan (TSP) for a period of three years at Hasanur, Erode District, Tamil Nadu	14 August, 2024

Sl. No.	MoU signed with	Purpose	Date
6.	National Institute of Food Technology, Entrepreneurship and Management, Thanjavur (NIFTEM -T) Tamil Nadu	Cooperation on Agricultural processing/ food sector and concerning personal exchange.	12 September, 2024
7.	Central Coffee Research Institute (CCRI), Coffee Board (Government of India), Chikkamagaluru, Karnataka	development of a mechanical coffee harvester	5 November, 2024

On Farm Testing (OFT) and Frontline Demonstration (FLD) by KVK

Sl. No.	Crop/ Technology	Villages	No. of farmers	Area (ha)
On Farm Testing				
1.	Assessment of different sowing techniques in potato cultivation	Muriya Kheda	1	0.2
2.	Assessment of wheat variety HI 1633 (Pusa Vani)	Raipur	5	2
3.	Assessment of intake of bio-fortified variety of wheat: HI 1633 (Pusa Vani) on nutritional status of farm family	Raipur	5	2
4.	Assessment of post emergence weedicide in wheat	Gondarmau, Agariya Chapar, Bhairopura	5	2
5.	Assessment of plant growth regulator (GA3) in tomato	Raipur, Gondarmau, Kacchi Barkheda	5	0.5
6.	Assessment of bio fertilizers for growth and yield in wheat crop	Ratatal Khajuri	1	0.5
7.	Assessment of residue management machinery for wheat sowing	Ratatal Khajuri	2	1.0
8.	Assessment of calcium on growth and yield of tomato	Raipur, Gondarmau, Kacchi Barkheda	5	0.5

Frontline Demonstration

Sl. No.	Crop/ Technology	Villages	No. of farmers	Area (ha)
1.	Excel decomposer technology for residue management	Gondarmau	2	1.0
2.	Demonstration of tomato hybrid Arka Rakshak	Raipur, Gondarmau, Bhairopura, Golkhedi	10	1.0
3.	Demonstration of high yielding Mustard variety HI-1165-40 &HI-150-35	MungaliyaHaat, Parwa Kheda, Kalyanpura, Gondarmau, Khajuri Kalan	5	2
4.	Demonstration of *Poshan Vatika* for production of vegetables at household level	Raipur, Gondarmau, KacchiBarkheda	5	0.1

Machine demonstration in farmer's field (KVK)

S.N.	Crop/ Technology	Place	Date	Details (q)
1.	Spiral grader demonstration for grading of soybean seed	Village- Chandpur	06.05.2024	15
2.	Groundnut decorticator	Village-Parwaliyasadak		2.5
3.	Power opera ted grain (wheat) cleaner machine	Village- Lambakheda	17.05.2024	2.0
4.	Groundnut Decorticator Machine in different villages	Villages- Ratatal, Agaria Parewakheda, Chanpur, Khajuri Ratatal, Entkhedi, Parwaliyasadak, and Barkhedi Hajjam	15.05.2024 29.05.2024 03.06.2024 05.06.2024 10.06.2024 11.06.2024	12.3

Training programmes organized by KVK

Sl. No.	Training Title	Date	No of participants
1.	Poshan vatika	23-24 January, 2024	89
2.	Sustainable farming	5 March, 2024	22
3.	Production technology of kharif crops	12 May, 2024	22
4.	Weed Management in Major Kharif crops	11 July, 2024	14
5.	Post-harvest management and value addition of kharif crop: soybean	23-25 July, 2024	69
6.	Integrated farming systems and nutrient management	29 August, 2024	95
7.	Uses and importance of agricultural equipment	10-14 September, 2024	20
8.	Maintenance and repair of agricultural equipment	23-27 September, 2024	25
9.	Healthy dietary guidelines & importance of *poshanvatika*	15 October, 2024	25
10.	Scientific production technology in wheat crop	11 November, 2024	11
11.	Scientific cultivation of vegetable nursery	27 November, 2024	28
12.	Food Preservation andStorage	28 November, 2024	36
13.	Soil testing and its Importance	5 December, 2024	54
14.	*Poshan vatika* for household food & nutritional security	30-31 December, 2024	63
15.	Rural agriculture work experience (B.Sc. Agriculture final year students)	140 days	114

Media Activities

Speaker	Topic	Media	Date
MP Singh	Irrigation practices in rabi crops	AIR, Bhopal	18.02.2024
MP Singh	• Production of nutri-cereals • Flower cultivation	Makhanlal Chaturvedi National University of Journalism and Communication, Bhopal	01.03.2024
Dilip Jat	Agricultural equipment useful for stubble management	AIR, Bhopal	08.04.2024
MP Singh	• Balanced diet of milking cattle • Importance of intercropping	Makhanlal Chaturvedi National University of Journalism and Communication, Bhopal	27.04.2024
RK Singh	• Importance of drip irrigation • Water conversation in agriculture	Makhanlal Chaturvedi National University of Journalism and Communication, Bhopal	30.04.2024

Speaker	Topic	Media	Date
MP Singh	Contemporary agriculture & Krishi Choupal	Doordarshan Kendra, Bhopal	21.05.2024
Dipika Agrahar Murugkar	Processing in agriculture	Doordarshan Kendra, Bhopal	24.05.2024
Dipika Agrahar Murugkar	Choupal – Samayik charcha	Doordarshan Kendra, Bhopal	02.06.2024
MP Singh	Contemporary agricultural practices and techniques related to Kharif crops	Doordarshan Kendra, Bhopal	08.08.2024
UR Badegaonkar	Kharif faslon ki katai evam gahai hetu krishi yantra	AIR, Bhopal	17.08.2024
Dilip Jat	Avanced agricultural equipment for harvesting and threshing of crops	AIR, Bhopal	25.09.2024
CR Mehta	Pradhan Mantri Drone Didi Yojana and application of drone technology in agriculture sector	AIR, Bhopal	06.10.2024
Dipika Agrahar Murugkar	Fruit and vegetable processing system	AIR, Bhopal	10.10.2024
MP Singh	Food security and storage	Doordarshan Kendra, Bhopal	10.10.2024
PP Ambalkar	Opportunities in agricultural enterprise for rural youth	AIR, Bhopal	16.10.2024
MP Singh	Advanced sowing techniques in rabi crops	AIR, Bhopal	17.11.2024
CR Mehta	Use of modern agricultural machinery	Doordarshan Kendra, Bhopal	30.12.2024
Satya Prakash Kumar	Application of drone in agriculture and CIAE drone research work	DD Kisan, Doordharshan Delhi	06.01.2025
UR Badegaonkar	Use of drones in agriculture	AIR, Bhopal	10.01.2025

Participation in Exhibitions

Sl. No.	Exhibition	Date	Place
1.	Technology and machinery demonstration mela	13 February, 2024	RS, ICAR-CIAE
2.	Agri Intex	11-15 July, 2024	CODDISIA, Coimbatore
3.	Kisan Mela	21 August, 2024	ICAR NRC Banana, Trichy
4.	TNAU State level Mega Farmer's Day	26-29 September, 2024	TNAU Coimbatore
5.	ICAR-CIPHET Industry Interface Fair (IIFA-2024) and 36th Foundation Day	3-5 October, 2024	ICAR-CIPHET, Ludhiana
6.	National Consultation and Exhibition on Food System for Sustainability and Profitability of Millets	5-6 October, 2024	RLBCAU Jhansi
7.	Agri Expo on the occasion of National Tribal Day	15 November, 2024	Kallakurichi District, Tamil Nadu
8.	Kisan Mela	9 December, 2024	Kuppuchipalayam, Coimbatore District, Tamil Nadu
9.	International Agri and Horti Technology Expo	20-23 December, 2024	ICAR-CIAE, Bhopal
10.	11thVigyan Mela	27-30 December, 2024	Bhopal

Technology and Machinery Demonstration Mela

The Technology and Machinery Demonstration Mela is a large event held at the Central Institute of Agricultural Engineering (CIAE) in Bhopal, and the centres of AICRP schemes operated from the institute every year in the month of February. The event showcases the latest agricultural machinery and technologies from all over India. Farmers visit the mela to learn about new agricultural engineering products and technologies and see them in action. They can also talk to experts about how to use these new technologies to improve their farms. The mela is a great opportunity for farmers to network with other farmers and learn from each other.

Melas were also jointly organized by AICRPs on Farm Implements and Machinery, Ergonomics and Safety in Agriculture, and Post-Harvest Technology, and Agricultural Machinery Manufacturers. More than 1.75 lakh farmers participated at different centers during the month of Feb., 2024. Over 1.75 lakh farmers witnessed display and demonstration of more than 40 different types of farm and processing machinery. This year institute celebrated this event on 14th Feb., 2024 with much enthusiasm and showcased the latest machines and equipment developed at the institute. About 900 farmers from different parts of the Madhya Pradesh participated in the event. CIAE Regional Station at Coimbatore also organized the Mela in association with TNAU and centres of AICRP schemes on 13 February, 2024 and participated by about 600 farmers from different districts of Tamil Nadu.

Commercial Testing

ICAR-CIAE, Bhopal has a mandate to test, evaluate and issue report on existing farm equipment and postharvest machinery through commercial testing and assist manufactures in developing new machinery through confidential testing. During the year 2024, the farm machinery and post-harvest machinery from various industries were tested at the Farm Machinery Testing Centre (FMTC) and Post-Harvest Equipment and Machinery Testing Centre (PHEMTC) at ICAR-CIAE Bhopal and ICAR-CIAE Regional Centre, Coimbatore. Across the centres 272 machines were tested generating an overall revenue of Rs. 52963525/-.

Farm Machinery Testing Centre		
Category wise machinery tested	ICAR -CIAE, Bhopal	ICAR-CIAE RS, Coimbatore
Land development, tillage & seedbed preparation equipment	38	15
Sowing and planting equipment	11	02
Inter-cultivation equipment	0	03
Plant protection equipment	24	00
Harvesting and threshing equipment	11	00
Equipment for residue management	11	11
Hand tools	01	01
Total	**96**	**32**

Post Harvest Equipment/Machinery Testing Centre		
Category Of Machines Tested	ICAR-CIAE Bhopal	ICAR-CIAE RS, Coimbatore
Cleaning and Grading	07	07
Dehulling and Milling	13	57
Oilseed processing	01	18
Polishing and boiling	0	04
Shelling and decortications	00	09
Drying	00	03
Other	06	03
Total	**27**	**117**

TRAINING AND CAPACITY BUILDING

International

Sl. No.	Winter School	Duration	No. of Participants
1.	AARDO (Agricultural Engineering Technologies for Enhancing Productivity & Profitability in Agricultural Sector)	16 to 23 October, 2024	10

ICAR Sponsored CAFT training programmes

Sl. No.	CAFT	Duration
1	Power Rich Bio-functional Foods: Sustainable Technologies for Utilization, Processing and Marketing	31 January to 9 February, 2024
2	Entrepreneurship Development through Mechanized Production, Processing and Value Addition of Millets and their By-Products	22 February to 2 March 2024

Other training programmes

Sl. No.	Training	Date	No. of Participants
1.	Fruits and Vegetable Processing (Organized in collaboration with the Tamil Nadu Food Processing and Agri Export Promotion Corporation (TNAPEx), Government of Tamil Nadu)	4 January, 2024	40
2.	Hands-on training and demonstration of women-friendly improved agricultural tools and implements	17-19 January 2024	40
3.	Entrepreneurship Development in Agro-processing (SCSP scheme)	17-23 January 2024	25
4.	farm machinery with major focus on conservation agriculture and resource conservation machinery (DBT Kisan Hub Phase-II project)	6 February, 2024	20
5.	Precision Farming Machinery for Crop Production	4 batches	212
6.	Automobile maintenance, road safety and behavioural skills (Sponsored training programme for Drivers of Agriculture University, Kota)	27-31 May, 2024	17
7.	Training cum demonstration of CIAE RS technologies to the Chief Engineer & Officials of AED and farmers	15 July, 2024	20
8.	Hands on training on Soymilk and Tofu under ABI-NAIF	22 July, 2024	10
9.	Testing and development of agricultural machinery and operation and maintenance of tractors and agricultural implements and machineries (4-weeks training of DOFWAC Officials)	22 July to 16 August 2024	01
10.	Entrepreneurship Development on setting up of centres for Custom Hiring of agricultural machinery as an enterprise	11 batches	306
11.	Entrepreneurship Development Programme on SoyMilk, Tofu & Soy-based Confectionary Products	3 batches	17
12.	One Month Practical Training of B. Tech (AE) Students	1-30 June 2024	32
13.	One Month Practical Training of B. Tech (AE)Students	1-30 July 2024	33
14.	Entrepreneurship Development among Rural Youths for Establishment of Custom Hiring Centre (CHC) of Agricultural Machineries (DBT Kisan Hub Phase-II project)	13 August, 2024	31
15.	Rural Agricultural Work Experience and Industrial Attachment (Sponsored Rural Agricultural Work Experience (RAWE) training programme for RNTU, Raisen)	21 August, 2024 to 13 January, 2025	48
16.	Refresher training program on Farm Mechanization & Custom Hiring for Agripreneurs	9-13 September, 2024	17
17.	Rural Agricultural Work Experience and Industrial Attachment (Sponsored Rural Agricultural Work Experience (RAWE) training programme for LNCT, Bhopal)	17 September, 2024 to 14 January, 2025	51
18.	Maintenance and Repair of Agricultural Equipment (Sponsored training - ATMA, Begusarai)	23-27 September, 2024	25



AWARDS AND RECOGNITIONS

Director, CIAE in various Committees

- Chairperson, Agricultural Machinery and Equipment Sectional Committee, FAD 11, BIS
- Technical Expert, Inception Workshop of the Integrated Straw Management Project of CSAM at Dharan, Nepal (12-13 Dec., 2024)
- Member Secretary, Working Group to look into issues of mechanization of cotton harvesting by ICAR, New Delhi
- Member, Research Advisory Committee [Engineering], National Innovation Foundation, Gandhinagar, India
- Member, Research Advisory Committee, ICAR-Central Institute of Agricultural Engineering, Bhopal
- Member, Academic Council, ICAR-Indian Agricultural Research Institute
- Member Secretary, ICAR Regional Committee No. VII (Maharashtra, Madhya Pradesh, Chattisgarh& Goa)
- Mentor, Software Technology Parks of India (STPI) for "Center of Excellence for IoT in Agriculture at Dr. PDKV, Akola
- Chairman, Committee for examination and verification, sequent of tests to be carried out and time-line of individual tests related to farm implements and machinery to be added in the master list of farm machinery available on "Central Farm Machinery Performance Testing Portal" of DoAC&FW (M&T)
- Member, Management and monitoring committee for 'Women in Agriculture' of DoA&FW, MoA&FW
- Member Secretary, Committee to explore the possibilities of funding from state Government of Madhya Pradesh of ICAR (2024)

Awards received at 58th Annual Convention of ISAE held at VNMKV, Parbhani (12-14 November, 2024)

S.No.	Scientist	Award
1	Sandip Mandal	ISAE Commendation Medal 2024
2	NS Chandel	Distinguish Service Award 2024
3	RR Potdar	
4	Bikram Jyoti	
5	Ramesh Kumar Sahni	Best Reviewer Award (JAE) 2024
	Ramesh Kumar Sahni	Associate Editor in 'Farm Machinery and Power (FMP) Division
6	AK Raul & VS Vala	Best paper award for the paper'Development of a self-propelledhigh clearance vehicle: A way forwardfor mechanized tea leaf harvesting'
7	Dilip Jat, Satya Prakash Kumar & Yogesh Rajwade	Best Oral Presentation Award for the paper 'Development of an automatic spraying system for polyhouse'
8	Manish Kumar & HS Pandey	Best Oral Presentation Award for the paper 'Development and Performance Evaluation of a Coulter-Based Six-Row Tractor Operated Liquid Urea Injection System for Wheat Cultivation'

S.No.	Scientist	Award
9	Sandip Mandal & Niranjan Kumar	Best Oral Presentation Award for the paper 'Conversion of methane to hydrogen through catalytic pyrolysis'
10	Sadvatha RH, Srimitha S, MuhammadMishal M & Saraswati Eshwaren	Best Oral Presentation Award for thepaper 'Devlopment of multi flavouredSorghum Milk'
11	Syed Imran S, T Senthilkumar & G Manikandan	Best Oral Presentation Award for the paper 'Development and evaluation of remotely controlled track-type vehicle for small farm'
12	Ravindra D Randhe, Murtaza Hasan, DK Singh, NK Soora, Pramod Kumar, Wasi Alam & Indra Mani	Second prize in oral presentation for the paper 'Development of weightsensing system for fertigation scheduling in soil less grow bag cultivation'

Other Awards

Name	Details of award/honour received for	Awarding Society/Institute
Dr. Adinath Kate	Young Scientist Award for outstanding contribution in the field of "Agricultural Engineering and Technology"	National Academy of Agricultural Sciences (NAAS), New Delhi
Dr. Manoj Kumar, Senior Scientist	Best scientist award in the field of Agricultural Statistics	Society of Krishi Vigyan at Fourth SKV National Conference held at Jabalpur during 1-3 March 2024.
Dr. Manish Kumar, Senior Scientist	Young scientist award in the field of Agricultural Engineering	Society of Krishi Vigyan at Fourth SKV National Conference held at Jabalpur during 1-3 March 2024.
Dr. Manoj Kumar, (FMP) Senior Scientist	Best oral presentation award	National Conference on "Plant Health for Food Security: Threats and Promises" organized by Indian Phytopathological Society, held at ICAR-IISR, Lucknow during 1-3 February, 2024.
Dr. Harsha Wakudkar	Best poster award at National Conference on Innovative Technologies and Entrepreneurship Development in Agriculture held during March 07-08, 2024	CAET, Dr. PDKV, Akola
Dr. Dilip Jat	Best technology certificate during 96th ICAR Foundation day at New Delhi.	ICAR, New Delhi

Name	Details of award/honour received for	Awarding Society/Institute
Dr. Adinath Kate	Working Committee member of NAAS-YUVA, a new initiative of National Academy of Agricultural Science for "Youth United for Visionary Agriculture"	NAAS, New Delhi
Dr Mukesh Kumar	Best oral presentation award in an International Conference on "Agrovoltaics and Sustainability in Farming" organized by Tamil Nadu Agricultural University, Coimbatore on 19 September, 2024 for paper titled "Solar-powered IoT-enabled floating pump for small farms"	TNAU, Coimbatore
Dr Syed Imran and team	Best oral award in International Conference impact of climate change on biodiversity a global perspective at TANUVAS, Chennai, organized by TANUVAS, Chennai TANUVAS, Chennai and CIFOR- World Agroforestry (ICRAF) during 11-13 July, 2024	TANUVAS, Chennai
ICAR CIAE Regional Station Coimbatore	Technical Excellence Award"– for the year 2024. The award was presented during Annual Convention of The Deccan Sugar Technologist's Association (India), Pune, India held at Pune, Maharashtra on 24th August 2024	The Deccan Sugar Technologist's Association (India), Pune, India.
Malathi, Ravindra Naik et al.	Best Technical Paper Award for the paper entitled 'Mechanized priming of Sugarcane planting material – An efficient and economical way of delivering agro inputs for healthy Nursery and Main field crops'. The award was Presented during SISSTA 53rd Annual Convention held at Bengaluru during 19-20 August, 2024	The South Indian Sugarcane and Sugar Technologist Association

Name	Details of award/honour received for	Awarding Society/Institute
AP Magar, BB Gaikwad, AP Pandirwar	Best Oral Paper Presentation award for the paper 'Tractor drawn eight row transplanter for onion seedlings'	3rd International Conference on "Climate-Smart Nutri Sensitive Integrated Farming System for Gender-equitable Sustainable Agriculture: Prospects and Challenges (ICNSFS- 2024)" at ICARCIWA, Bhubaneswar, India during 6-8 November, 2024
A. Khadatkar, PB Sujit, R Agrawal, K Viswanath, CP Sawant & Ajit Magar	Best Oral Paper Presentation award for the paper 'Development and evaluation of remote controlled robotic weeder for row crops'	
Mukesh Kumar, Ajita Gupta	Best Oral Paper Presentation award for paper 'Solar Powered IoT-enabled Digital Flume for Open Channel Flow Measurement'	
Muzaffar Hasan	Second prize on oral presentation 'Innovative Soybean Processing: From Dietary Fiber to Fortified Fermented Products'	
Muzaffar Hasan	Young Scientist Award 2024 for Outstanding contribution in the field of 'Biochemistry of soybean processing'	
Mukesh Kumar & CD Singh	Best Oral Presentation Award for Solarpowered IoT-enabled floating pump for small farms	International Conference on Agrovoltaics and Sustainability in Farming" organized by Tamil Nadu Agricultural University, Coimbatore, held on 19 September, 2024
Vinod Kumar S., Chandra Deep Singh, KV Ramana Rao, Mukesh Kumar and Yogesh Anand Rajwade	Best paper award 2024 for the Paper 'Development of a smart IoT based drip irrigation system for precision farming', during 75th International Executive Council meeting held on 3 September 2024 in Australia.	Irrigation and Drainage Journal of M/S John Wiley & Sons Ltd, UK.

Name	Details of award/honour received for	Awarding Society/Institute
Dr Syed Imran S	First prize in oral presentation at International Conference on Sustainable Food - Water - Energy - Mechanization - Nexus and Whole Grain" during Jan 27-28, 2025	International by AEC&RI, TNAU; NIFTEM-T & University of Guelpa, Canada
Dr. Manojit Choudhury (SMS, Farm Machinery & Power)	Krishan Nath Synghal Memorial Gold Medal for overall outstanding performance in Ph.D. degree programme in the discipline of Agricultural Engineering	63rd Convocation, ICAR-IARI, New Delhi, held on 22.03.2025
M.S. Raghuwanshi, Hritick Biswas, Ravindra Naitam, Nirmal Kumar, Abhay Shirale, Pravesh Moharana and Ranjay Kumar Singh	Best Poster presentation Award	Indian Society of Soil Science
CP Sawant	Best oral presentation award on "Tractor chalit plastic mulch layer-cum-planter ka design evamvikas" in "Rashtriya Hindi Vigyan Sammelan-2024" on "Amritkal main rashtriyavaigyanikchetana ka unnayan", held on 30-31 July, 2024 at CSIR-AMRPI, Bhopal	CSIR-AMRPI, Bhopal
ICAR-CIAE Regional Centre, Coimbatore	Technical Excellence Award for the year 2024	The Deccan Sugar Technologist's Association (India), Pune, India

HUMAN RESOURCE DEVELOPMENT

Name and Designation	Course Title	Duration	Organizer
Dr. Adinath Kate, Scientist	Pedagogy development Program	29 January to 2 February, 2024	IARI, New Delhi
Dr. Abhijit Khadatkar, Senior Scientist Dr. Deepak Thorat, Scientist	Refresher course on Robotics	19 February, 2024 to 2 March, 2024	UGC – MMTTC JNTU, Hyderabad
Dr. RK Singh, Principal Scientist	Introduction to Remote Sensing & Geographic Information System using QGIS	19-23 February, 2024	National Water Academy (Central Water Commission), Pune (online mode)
Dr Muzaffar Hasan, Scientist	Decoding Genomics & Proteomics Data using Machine Learning Approach	21-27 February, 2024	ICAR-IASRI, New Delhi *(Virtual Mode)*
Dr. Sweeti Kumari, Scientist	ICAR-sponsored CAFT training on "Entrepreneurship Development through Mechanized Production, Processing, and Value Addition of Millets and Their By-Products"	22 February, 2024 to 2 March, 2024	ICAR-CIAE, Bhopal
Dr. Abhijit Khadatkar, Senior Scientist Dr. Ajit Magar, Senior Scientist	Data Visualization using R	4-8 March, 2024	NAARM, Hyderabad
Dr. Dilip Pawar, Scientist Dr. Sandip Mandal, Senior Scientist	Pedagogy development Program	4-8 March, 2024	IARI, New Delhi
Dr Muzaffar Hasan, Scientist	Application of molecular and genomic tools for bio fortification in crops	5-7 March, 2024	ICAR- IARI, New Delhi.
Gopal Carpenter, Scientist Dr. Mukesh Kumar, Scientist Dr. Ravindra Randhe, Scientist	IP Awareness/Training program under National Intellectual Property Awareness Mission organized by Intellectual Property Office, India	24 April, 2024	Online
Dr. Sandip Mandal, Senior Scientist Dr. Prabhat K Guru, Scientist Dr Ramesh Kumar Sahni, Scientist	Enhancing Pedagogical Competencies for Agricultural Education	1-5 April, 2024	National Academy of Agricultural Sciences, NASC Complex, New Delhi
Dr Subir Kumar Chakraborty, PS	MDP on Leadership	3-4 June, 2024	ICAR-NAARM, Hyderabad
Dr. Shashi Rawat, Principal Scientist	Training on Prevention of sexual harassment of women at workplace by ISTM (online)	29 July, 2024	Online (organized by DoPT)

Name and Designation	Course Title	Duration	Organizer
Dr. Sweeti Kumari, Scientist	Faculty Development Programme (online)	10-30 September, 2024	National Agricultural Development Cooperative Ltd. (NADCL), Baramulla & ICAR-ATARI (Zone-VIII), Pune
Dr. KVR Rao	Skill upgradation organized for sectional committee members	22 July, 2024	BIS, New Delhi
Dr Muzaffar Hasan	1st International Workshop-cum-Webinar on "CRISPR Genome Editing,"	22-26 July, 2024	virtual mode
Dr. Ravindra Randhe	Mushroom cultivation training program	23-28 September, 2024	ICAR-DMR, Solan
Dr. Harsha Wakudkar, Scientist	Material characterization and data analysis	2-22 September, 2024	SIAS research center, Kohinoor, Kerala (Virtual mode)
Dr Muzaffar Hasan	Genome editing technologies in crops	14-23 October, 2024	ICAR-IIRR Hyderabad

Foreign Deputations

Sl. No.	Name of Employee	Foreign Deputation Purpose	Place of Visit & Period
1	Dr. CR Mehta	Sixth Session of the Technical Programme Committee (TPC) of African-Asian Rural Development Organization (AARDO)	Egypt (4-8 February, 2024)
2	Dr. VK Bhargav	Regional Workshops on Integrated straw Management in Asia and the Pacific Mechanization Solution for Sustainable and climate smart Agriculture	China (19-20 June, 2024)
3	Dr Samlesh Kumari	Training as a Researcher at University of Guelph, Canada	Guelph, Canada (11 July to 25 August, 2024)
4	Dr KN Agrawal	8 IAPSIT International Sugar Conference and Sugarcon 2024	Quy Nhon, Vietnam (16-19 September, 2024)
5	Dr SP Singh	8 IAPSIT International Sugar Conference and Sugarcon 2024	Quy Nhon, Vietnam (16-19 September, 2024)
6	Dr CR Mehta	Eleventh Annual Meeting of the Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM)	Nepal (3-13 December, 2024)
7	Dr Abhijit Khadatkar	7th Regional Training of Trainers of the Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM)	Nepal (6-11 December, 2024)
8	Dr Manish Kumar	7th Regional Training of Trainers of the Asian and Pacific Network for Testing of Agricultural Machinery (ANTAM)	Nepal (6-11 December, 2024)

Ph. D Awarded

Er HS Pandey, Scientist was awarded Ph.D. for his thesis titled 'Development and Performance Evaluation of a Battery-Powered Weeder'. He did his Ph.D. from College of Technology and Engineering, Maharana Pratap University of Agriculture & Technology, Udaipur under the guidance of Dr. GS Tiwari, Retired Professor, CTE, MPUAT, Udaipur.

Er. Manojit Chowdhury, Subject Matter Specialist, was awarded Ph.D. for thesis entitled “Design and development of crop canopy reflectance based real-time variable rate fertilizer application system” by ICAR-IARI, New Delhi on 31 December, 2024. He completed his Ph.D. under the guidance of Dr. Tapan Kumar Khura, Principal Scientist, Division of Agricultural Engineering, ICAR-IARI, New Delhi.

Professional Attachment Training

Ms. Nisha Sulakhe, Scientist, ICAR-CISH, Lucknow underwent Professional Attachment Training on 'Packaging of fresh produce' during 4 December, 2023 to 2 March, 2024.

IMPORTANT COMMITTEES

Research Advisory Committee

1.	Dr. DC Joshi, Former Vice Chancellor, Agriculture University, Kota	Chairman
2.	Prof. Madan Kumar Jha, Professor (HAG), Groundwater Hydrology & IWRM and Head, Agricultural and Food Engineering Department, Indian Institute of Technology Kharagpur	Member
3.	Dr. V. Siva Reddy, Director (Tech), National Institute of Solar Energy Ministry of New and Renewable Energy (MNRE), Gurugram	Member
4.	Dr. D. Manohar Jesudas, Retired Professor (Farm Machinery), TNAU, Coimbatore	Member
5.	Dr Tanweer Alam, Additional Director, Indian Institute of Packaging, Lucknow	Member
6.	Dr. KP Singh, ADG (FE), ICAR	Member
9.	Director, ICAR-CIAE, Bhopal	Member
10.	Dr Subir Kumar Chakraborty, PS & I/c. PME Cell, ICAR-CIAE	Member Secretary

Institute Management Committee

1.	Dr CR Mehta, Director, ICAR-CIAE	Chairman
3.	Dr KP Singh, ADG (FE), ICAR, New Delhi	Member
4.	Director, Directorate of Agricultural Engineering, Govt of Madhya Pradesh	Member
5.	Director (Agriculture), Directorate of Agriculture, Govt of Madhya Pradesh	Member
6.	Shri Chanderkant Gour, Harda	Member
7.	Shri Manoj Kumar Sharma, Korba	Member
8.	Dr PK Sahoo, Principal Scientist, ICAR-IARI, New Delhi	Member
9.	Dr Gautam Majumdar, Principal Scientist, ICAR-CICR, Nagpur	Member
10.	Dr CS Sahay, Principal Scientist, ICAR-CIAE, Bhopal	Member
11.	Dr AK Singh, Head, Agricultural Engineering Division, ICAR-IISR, Lucknow	Member
12.	Finance & Accounts Officer, ICAR-CARI, Jhansi	Member
13.	Chief Administrative Officer, ICAR-CIAE	Member Secretary

Institute Research Committee

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4.	Head of Divisions and all Scientists	Member
5.	Dr Shashi Rawat, Principal Scientist	Member Secretary

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1	Dr CR Mehta Director	Chairman
2.	Dr. VP Chaudhary, Head AMD	Member
3.	Dr. KN Agrawal, PC, AICRP on FIM	Member
4.	Dr. UR Badegaonkar, Head TTD	Member
5.	Dr. Sanjay Shrivastava, PS, ICAR-IISS, Bhopal.	Member
6.	Dr Shashi Rawat, PS &Member Secretary IRC	Member
7.	Dr Subir Kumar Chakraborty, PS &I/c PME Cell	Member
8.	Dr V. Bhushan Babu, Senior Scientist & I/c. ITMU	Member Secretary

Zonal Technology Management Committee

1.	Dr CR Mehta, Director, ICAR-CIAE	Chairman
2.	Dr Nachiket Kotwaliwale, Director, ICAR-CIPHET, Ludhiana or his nominee	Co-Chairman
3.	Director, ICAR-CIRCOT, Mumbai or his nominee	Member
4.	FAO, ICAR-CIAE, Bhopal	Member
5.	Dr KN Roy, I/c. ITMU, ICAR-NINFET, Kolkata	Member
6.	Dr SK Pandey, I/c. ITMU, ICAR-IINRG, Ranchi	Member
7.	ADG (IPTM), ICAR or his nominee	Member
8.	Er Rajeev Choudhary, Director, Directorate of Agricultural Engineering, Govt of Madhya Pradesh	Member
9	Mr Jiten Jadhav, Deputy Manager, Eicher Tractor, Bhopal	Member
10.	Dr UR Badegaonkar, Head, TTD and PI, ZTMC	Member Secretary

PME Cell

1.	Dr Subir Kumar Chakraborty, Principal Scientist	In charge
2.	Dr Shashi Rawat, Principal Scientist	Secretary, IRC
3.	Dr NS Chandel, Senior Scientist	Nodal Officer, HRD
4.	Dr Adinath Kate, Scientist	Co-Nodal Officer, HRD
5.	Dr Satya Prakash Kumar, Scientist	Nodal Officer (MPR) and Secretary, Institute Seminar
6.	Dr AP Pandirwar, Scientist	Nodal Officer, Database on Institute Publications
7.	Dr V Bhushana Babu, Senior Scientist	Secretary, ITMU/ Consultancy Processing Cell/ Contract Research

Consultancy Processing Cell

1.	Dr. Dipika A. Murugkar, Principal Scientist,CESPU	Chairman
2.	Dr. CS Sahay, Principal Scientist, AMD	Member
3.	Dr. Sandip Mandal, Senior Scientist, AEP	Member
4.	Dr. V. Bhushana Babu, Senior Scientist, TTD	Member

Board of Studies

1.	Dr CR Mehta, Director	Chairperson
2.	Dr Karan Singh, Principal Scientist	Member
3.	Dr Subir Kumar Chakraborty, Principal Scientist	Member
4.	Dr Sweeti Kumari, Scientist	Member
5.	Dr SP Datta, Director, ICAR-IISS	Member
6.	Dr AK Biswas, Principal Scientist, ICAR-IISS	Member
7.	Dr Shashi Rawat, Principal Scientist	Member

Swachchh Bharat Mision Committee

1.	Dr Ranjay Kumar Singh, Principal Scientist	Chairman
2.	Dr Sandip Mandal, Senior Scientist	Member
3.	Incharge, Estate Management Section	Member
4.	Incharge, Farm Section	Member
5.	Shri Mustafa Kamal, AAO (Central Store)	Member Secretary

Institute Joint Staff Council

1.	Dr CR Mehta, Director	Chairman
Official Side		
2.	Dr Karan Singh, Principal Scientist	Member
3.	Finance & Account Officer	Member
4.	Chief Administrative Officer	Member Secretary
Staff Side		
1.	Shri AK Pathak, Technical Officer	Secretary
2.	Shri Abhishek Meena, Technical Assistant	Member
3.	Shri PV Sahare, LDC	Member
5.	Shri AK Kumre, SSS	Member

Official Language Implementation Committee

1.	Dr CR Mehta, Director	Chairman
2.	Dr KN Agrawal, PC, AICRP on FM	Member
3.	Dr MK Tripathi, Principal Scientist	Member
4.	Dr Karan Singh, Principal Scientist	Member
5.	Dr KVR Rao, Principal Scientist	Member
6.	Shri Abhishek Yadav, CAO	Member
7.	Shri Rajesh Tiwari, ACTO	Member
8.	Shri Rajesh Dubey, F&AO	Member
9.	Administrative Officer or Assiststant Administrative Officer	Invitee member
10.	Shri Rakesh Kumar, Deputy Director (OL)	Member Secretary

Women Cell

1	Dr Nita Khandekar, Principal Scientist	Chairperson
2	Dr Harsha Wakudkar, Scientist	Member
3	Dr Deepika Shende Channe, Assistant Chief Technical Officer	Member
4	Ms Sarita, Senior Technical Officer	Member
5	Ms Priya Borkar, Technical Officer	Member
6	Shri Ashish Sahu, AAO (Admin.)	Member Secretary

Committee for Prevention of Sexual Harassment of Women at Workplace

1.	Dr Nita Khandekar, Principal Scientist	Chairperson
2.	Dr V. Bhushana Babu, Senior Scientist	Member
3.	Dr K. Bharti, Principal Scientist, ICAR-IISS	Member
4.	Dr Ramesh Kumar Sahni, Scientist	Member
5.	Ms. Rachna Dhingra, Bhopal Group of Information and Action (NGO)	Member
6.	Dr AK Roul, Senior Scientist	Member Secretary

Standing Sports Promotion Committee

1.	Dr. Shashi Rawat, Principal Scientist	Chairperson
2.	Dr. Ashutosh Pandirwar, Scientist	Co-Chairperson
3.	Shri Ravindra Kumar Hedau,AAO(Purchase)	Member
4.	Smt. Jolly John,T-6	Member
5.	Secretary IJSC or member nominated by IJSC committee	Member
6.	Shri Medni Pratap Singh, ACTO	Secretary

RESEARCH PUBLICATIONS

> 8 NAAS Rating

1. Bhalekar, D.G., Sahni, R.K., Schrader, M.J. and Khot, L.R., 2024. Pneumatic spray delivery-based fixed spray system configuration optimization for efficient agrochemical application in modern vineyards. Pest Management Science, 80(8),4044-4054.
2. Chandel, N.S., Chakraborty, S.K., Chandel, A.K., Dubey, K., Jat, D. and Rajwade, Y.A., 2024. State-of-the-art AI-enabled mobile device for real-time water stress detection of field crops. Engineering Applications of Artificial Intelligence, 131,107863.
3. Chavan, S.M., Khadatkar, A., Hasan, M., Ahmad, D., Kumar, V. and Jain, N.K., 2024. Quinoa (Chenopodium quinoa Willd.): paving the way towards nutraceuticals and value-added products for sustainable development and nutritional security. Applied Food Research, p.100673.
4. Chaudhary, V.P., Sawant, C.P., Chaudhary, R., Gautam, R. and Wakchaure, G.C., 2024. Conservation Tillage Enhances Energy Efficiency and Mitigates Carbon Footprint and Greenhouse Gas Emissions in Long-Term Wheat Production Trials in the Western Indo-Gangetic Plain of India. International Journal of Plant Production, 1-18.
5. Durga, M.L. and Gangil, S., 2024. Comparative biopolymeric assessment of paddy straw during thermal degradation process. Journal of Analytical and Applied Pyrolysis, 180,106556.
6. Gatkal, N.R., Sachin, M.N., Girishkumar, B.B., Ramesh, K.S., Avdhoot, A.W., Pravin, B.K. and Ali, M., 2025. Review of UAVs for efficient agrochemical spray application. International Journal of Agricultural and Biological Engineering, 18(1),1-9.
7. Gatkal, N.R., Nalawade, S.M., Shelke, M.S., Sahni, R.K., Walunj, A.A., Kadam, P.B. and Ali, M., 2025. Review of cutting-edge weed management strategy in agricultural systems. International Journal of Agricultural and Biological Engineering, 18(1), 25-42.
8. Gatkal, N.R., Nalawade, S.M., Sahni, R.K., Bhanage, G.B., Walunj, A.A., Kadam, P.B. and Ali, M., 2024. Review of IoT and electronics enabled smart agriculture. International Journal of Agricultural and Biological Engineering, 17(5),1-14.
9. Gatkal, N.R., Nalawade, S.M., Sahni, R.K., Walunj, A.A., Kadam, P.B., Bhanage, G.B. and Datta, R., 2024. Present trends, sustainable strategies and energy potentials of crop residue management in India: A review. Heliyon, 10 (21), e39815.
10. Gautam, P.V., Agrawal, K.N., Roul, A.K., Mansuri, S.M. and Subeesh, A., 2024. Predictive modelling of sweep's specific draft using machine learning regression approaches. Soil Use and Management, 40(1), e12996.
11. Guru, P.K., Shrivastava, A.K., Khandai, S., Yahaya, R., Singh, S., Kumar, V., Tiwari, P. and Kumar, M., 2025. Development and Performance Evaluation of a Precision Seeder for Sustainable Rice Cultivation. Results in Engineering,104059.
12. Guru, P.K., Gupta, M., Sahu, P., Rani, A., Gangil, S., Diwan, P. and Panwar, G., 2025. Valorization of Corncob through Integrated Acid and Enzymatic Pre-Treatment for Maximization Yield of Fermentable Sugar. Waste and Biomass Valorization, 1-14.
13. Hamad, R., Chakraborty, S.K., Kate, A. and Mansuri, S.M., 2024. Understanding the changes in millable oil content and fatty acid composition of infrared radiation treated mustard (Brassica juncea) seeds using Vis-NIR-SWIR hyperspectral imaging. Infrared Physics & Technology, 137, 105128.
14. Hamad, R. and Chakraborty, S.K., 2024. A chemometric approach to assess the oil composition and content of microwave-treated mustard (Brassica juncea) seeds using Vis–NIR–SWIR hyperspectral imaging. Scientific Reports, 14(1), 15643.

15. Hamad, R., Chakraborty, S.K. and Kumar, V.A., 2024. Estimating the changes in mechanically expressible oil in terms of content and quality from ohmic heat treated mustard (Brassica juncea) seeds by Vis–NIR–SWIR hyperspectral imaging. Journal of Food Measurement and Characterization, 18(11), 9156-9169.

16. Hasan, M., Tripathi, K., Harun, M., Krishnan, V., Kaushik, R., Chawla, G., Shakil, N.A., Verma, M.K., Dahuja, A., Sachdev, A. and Lorezo, J.M., 2024. Unravelling the effect of extraction on anthocyanin functionality and prebiotic potential. Heliyon, 10(11).

17. Idapuganti, R.G., Das, A., Sungoh, H., Layek, J., Mandal, S., Verma, B.C., Lal, R., Rangappa, K., Babu, S. and Hazarika, S., 2024. Can biochar conserve soil moisture and improve soil properties for sustainable intensification of acid soils in the Eastern Indian Himalayas?. Land Degradation & Development, 35(3),1192-1208.

18. Jagadale, M., Gangil, S., Jadhav, M., Bhargav, V.K., Shrivastava, P., Nageshkumar, T. and Kumar, N., 2024. Valorization of Jute sticks (Corchorus olitorius) by torrefaction process: optimization and characterization of torrefied biomass as upgraded fuel. Biomass Conversion and Biorefinery, 14(15), 17313-17327.

19. Jagadale, M., Gangil, S., Jadhav, M., Sahu, P., Durga, L., Ghodke, P.K. and Basak, S., 2024. Biopolymeric degradation of jute sticks under pyrolytic thermal stresses. Process Safety and Environmental Protection, 189, 517-529.

20. Jiang, L., Jiang, H., Jing, X., Dang, H., Li, R., Chen, J., Majeed, Y., Sahni, R. and Fu, L., 2024. UAV-based field watermelon detection and counting using YOLOv8s with image panorama stitching and overlap partitioning. Artificial Intelligence in Agriculture, 13,117-127.

21. Kumar, S.P., Jat, D., Sahni, R.K., Jyoti, B., Kumar, M., Subeesh, A., Parmar, B.S. and Mehta, C.R., 2024. Measurement of droplets characteristics of UAV based spraying system using imaging techniques and prediction by GWO-ANN model. Measurement, 234, 114759.

22. Kumar, M., Sahni, R.K., Waghaye, A.M., Kumar, M. and Randhe, R.D., 2024. Electronic Sensor-Based Automated Irrigation System for Rice Cultivated Under Alternate Wetting and Drying Technique. AgriEngineering, 6(4), 4720-4738.

23. Kumar, M., Kumar, M., Singh, R.K., Waghaye, A.M., Babu, V.B. and Randhe, R.D., 2025. Trend detection and prediction of rainfall using logistic machine learning and deep learning models in Bhopal region of Central India. Journal of Water and Climate Change, 16(3), 1055-1072.

24. Kumari, K., Chakraborty, S.K., Kishore, A. and Chitranayak, 2024. Development of a parallel plate capacitive sensor-based system for assessing the quality of Paneer (Indian cottage cheese). Journal of Food Process Engineering, 47(1), e14515.

25. Lalita, Giri, S.K., Mohapatra, D., Tripathi, M.K., Kate, A. and Wahid, A., 2024. Optimization of process parameters of refractance window drying for aonla slices and comparison with other drying techniques. Journal of the Science of Food and Agriculture, 104(13), 7854-7863.

26. Lamo, C., Bargale, P.C., Gangil, S., Chakraborty, S., Tripathi, M.K., Kotwaliwale, N. and Modhera, B., 2024. High crystalline cellulose extracted from chickpea husk using alkali treatment. Biomass Conversion and Biorefinery, 14(1), 751-759.

27. Magar, A.P., Nalawade, S.M., Walunj, A.A., Gaikwad, B.B., Shelke, G.N., Khadatkar, A., Sawant, C.P. and Modi, R.U., 2025. Development and optimization of an automatic transplanting device for plug tray vegetable seedlings using embedded system. Scientific Reports, 15(1), 22483.

28. Mahanti, N.K., Chakraborty, S.K. and Pathare, P.B., 2024. Effect of Excess Application of Nitrogenous Fertilizer on Postharvest Quality of Spinach during Storage. Journal of Food Quality, 2024(1), 5521957.

29. Mahapatra, J., Tiwari, P.S., Singh, K.P., Nandede, B.M., Sahni, R.K., Pagare, V., Singh, J., Shrinivasa, D.J. and Mandal, S., 2024. An Adjustable Pneumatic Planter with Reduced Source Vibration for Better Precision in Field Seeding. Sensors, 24(11),3399.

30. Mahapatra, J., Tiwari, P.S., Singh, K.P., Nandede, B.M., Singh, J. and Sahni, R.K., 2024. Flexible orifice seed metering plate to address variability in seed shape, size and orientation enhances field performance of a pneumatic planter. Discover Applied Sciences, 6(11), 609.

31. Mallesham, P., Parveen, S., Rajkumar, P., Gurumeenakshi, G. and Naik, R., 2025. Enhancing Structural Stability of 3D Printed Cake with Xanthan Gum: A Rheological and Post-Process Analysis. Food Biophysics, 20(1), 46.

32. Mallesham, P., Parveen, S. and Naik, R., 2025. Nano-Bubbles: The Next Potential Drive to Advance Technologies in Food Industry—A Review. ACS Food Science & Technology.

33. Manjunatha, K., Savadi, S., Naik, R., Balasubramanian, D., Adiga, J.D., Muralidhara, B.M., Chethan, C.R. and Anilkumar, C., 2024. Investigation on torsional forces and angles at the nut and pedicel junction (NPJ) revealed varying cashew apple (hypocarp) and nut separation efficiency at different developmental stages in cashew. Industrial Crops and Products, 222, 119951.

34. Mandal, S., Jena, P.C., Gangil, S., Pal, S., Haydary, J., Sharma, R.K. and Verma, A., 2025. Ni-supported pigeon pea stalk biochar as a catalyst for ex situ tar cracking in biomass gasification. Biomass Conversion and Biorefinery, 15(2), 2525-2535.

35. Mao, W., He, L., Xia, M., Jiang, H., Li, R., Sahni, R., Majeed, Y., Zhu, Z. and Fu, L., 2024. A novel method to detect stem and fruit dynamically for apricot posture estimation and adjustment. Information Processing in Agriculture.

36. Mohanaselvan, T., Singh, S.P., Kumar, A., Kushwaha, H.L., Sarkar, S.K. and Joshi, P., 2024. Mechanization Level and Occupational Health Hazards in Sugarcane Cultivation in India. Sugar Tech, 26(2), 432-445.

37. Mohapatra, D., Nickhil, C., Kar, A., Sharma, Y., Deshpande, S.S., Tripathi, M.K. and Haromuchadi, S.R., 2024. Impact of LAB fermentation on the nutrient content, amino Acid Profile, and estimated glycemic index of Sorghum, Pearl Millet, and Kodo Millet. Frontiers in Bioscience-Elite, 16(2), 18.

38. Nagori, A., Jadhav, S.K., Guru, P.K., Gajendra, S., Gangil, S. and Rawat, M., 2024. Development and performance evaluation of paddy straw based insulating block composite for low temperature storage application. Energy and Buildings, 317,114379.

39. Pal, L., Giri, S.K., Mohapatra, D., Tripathi, M.K. and Kate, A., 2024. Mass transfer parameters and quality characteristics of aonla slices under refractance window drying. Drying Technology, 42(3), 492-505.

40. Pandiselvam, R., Hegde, V., Sujithra, M., Prathibha, P.S., Prathibha, V.H. and Hebbar, K.B., 2024. Evaluation of unmanned aerial vehicle for effective spraying application in coconut plantations. Heliyon, 10(19), 1-10.

41. Patil, H., Naik, R. and Paramasivam, S.K., 2024. Utilization of banana crop ligno-cellulosic waste for sustainable development of biomaterials and nanocomposites. International Journal of Biological Macromolecules, 137065.

42. Pravitha, M., Dipika Agrahar, M. and Ajesh Kumar, V., 2024. Recent developments in tomato drying techniques: A comprehensive review. Journal of Food Process Engineering, 47(2), e14550.

43. Puramshetti, L., Giri, S.K., Mohapatra, D., Tripathi, M.K., Kate, A., Kumar, M., Lalita and Mishra, A., 2025. Impact of ultrasonic-assisted extraction on the release of bioactive compounds from Carica papaya Linn. leaves using probe and bath sonication. Biomass Conversion and Biorefinery, 1-13.

44. Rajwade, Y.A., Chandel, N.S., Chandel, A.K., Singh, S.K., Dubey, K., Subeesh, A., Chaudhary, V.P., Ramanna Rao, K.V. and Manjhi, M., 2024. Thermal–RGB Imagery and Computer Vision for Water Stress Identification of Okra (Abelmoschus esculentus L.). Applied Sciences, 14(13), 5623.

45. Saha, K.P., Singh, D., Senthilkumar, T., Singh, S.P., Jain, R., Kumar, M. and Bhushanababu, V., 2025. The Impact Assessment of Mechanized Transplanting of Sugarcane Settlings Using Economic Surplus Approach. Sugar Tech, 27(4),1269-1278.

46. Sahni, R.K., Schrader, M.J., Rathnayake, A.P., Khot, L.R., Hoheisel, G.A. and Zhu, H., 2024. Evaluation of Suitable Base Spray Rate Estimation Methods for Precision Chemical Applications in Vineyards with Different Training Systems. American Journal of Enology and Viticulture, 75(1), 0750009.

47. Sahu, R.K. and Gangil, S., 2025. Nanoarchitectonics with thermochemical activation for high adsorbent nanoporous carbon derived from chickpea stalk. Biomass and Bioenergy, 197, 107767.

48. Sahu, R.K. and Gangil, S., 2025. Insights into biopolymeric transitions during thermal degradation and kinetic parameters for Chickpea stalk (Cicer arietinum). Process Safety and Environmental Protection, 195,106766.

49. Sahu, P. and Gangil, S., 2024. ANN approach for the prediction of pyrolytic behaviour of pigeon pea stalk and insight into thermo-kinetics of pseudo components using RSM. Journal of Cleaner Production, 449, 141816.

50. Selvan, S.S., Mohapatra, D., Mahore, A., Patel, A., Kate, A., Singh, K., Roy, H. and Modhera, B., 2025. Evolution of a novel sensing system for monitoring the quality deterioration in pearl millet (Pennisetum glaucum L.) grains coupled with rancidity indicators and GC-MS analysis: A potential cardinal approach. Journal of Stored Products Research, 112, 102642.

51. Siddiqui, S.A., Elsheikh, W., Ucak, İ., Hasan, M., Perlita, Z.C. and Yudhistira, B., 2024. Replacement of soy by mealworms for livestock feed-A comparative review between soy and mealworms considering environmental aspects. Environment, Development and Sustainability, 1-44.

52. Siddiqui, S.A., Gadge, A.S., Hasan, M., Rahayu, T., Povetkin, S.N., Fernando, I. and Castro-Muñoz, R., 2024. Future opportunities for products derived from black soldier fly (BSF) treatment as animal feed and fertilizer-A systematic review. Environment, Development and Sustainability, 1-82.

53. Singh, R., Nisha, R., Naik, R., Upendar, K., Nickhil, C. and Deka, S.C., 2024. Sensor fusion techniques in deep learning for multimodal fruit and vegetable quality assessment: A comprehensive review. Journal of Food Measurement and Characterization, 18(9), 8088-8109.

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EVENTS ORGANIZED

Foundation Day Celebration

Institute celebrated its 49th Foundation Day on 15 February, 2024. On this occasion, Dr SN Jha, DDG (Agricultural Engineering) was the Chief Guest. The chief guest Dr SN Jha, DDG (Agricultural Engineering), acknowledged the efforts of the institute and also motivated the staff to work hard for better prospects. He emphasized the importance of assessing the progress achieved by the institute and setting the future targets for the benefit of stakeholders. Dr CR Mehta, Director spoke about the contribution made by the Institute including the project achievements, publications, copyrights, awards, etc including upcoming challenges and opportunities. Dr Mehta extended his heartfelt congratulations to all the dedicated staff who have played a pivotal role in building the institute's legacy. Dr KP Singh, ADG (Farm Engineering) and Dr. K. Narasimha, ADG (Process Engineering) also joined online and extended their best wishes. Director, ICAR-IISS, Bhopal and Deputy Director, Directorate of Agricultural Engineering, Madhya Pradesh graced the occasion as guests of honour. Dr. Tarun Kumar Bhattacharya, Distinguished Scientist, Govind Ballabh Pant University delivered Prof. A.C. Pandya Memorial Lecture on 'Bioethanol and biogas policy and their possibilities in the Indian context'. Three progressive farmers were honoured for their significant contribution to agriculture. Institute's staff who have completed 25 years of service were felicitated for their contributions. The scientists and the students of the institute were honoured for their excellent scientific research papers. Winners of the ICAR Central Zone Sports meet were also honoured.

IMC Meeting

The 54th meeting of the Institute Management Committee was held on 13 February, 2024. The meeting was also attended by the QRT chairman and members to present major recommendations to the Committee. Dr. CR. Mehta, Director chaired the meeting and was attended by Dr. KP Singh, ADG (Farm Engg.), ICAR; Er.Rajiv Choudhary, Director, Directorate of Agricultural Engineering, Govt. of Madhya Pradesh, , Er. AK Upadhyay, Director, CFMTTI Budni, Dr. PK Sahoo, Principal Scientist, ICAR-IARI, New Delhi, Dr. CS Sahay, Principal Scientist, ICAR-CIAE, ShriChanderkantGour, Harda, MP and Shri Ravi Bhadra, SFAO, ICAR-IGFRI, Jhansi and Project Coordinators and Head of Divisions from the institute. ShriAbhishekYadav, Chief Administrative Officer and Member Secretary briefed the members about the significant activities of the Institute and presented the agenda to the committee. The members appreciated the work and revenue generating activities being conducted in the Institute. The committee agreed to the agenda placed before the committee.

RAC Meeting

The 29th Research Advisory Committee meeting was held during 18-19July, 2024 under the chairmanship of Dr DC Joshi, Former Vice Chancellor, KotaAgricultura University. Other members present during the meeting included Dr R. ManoharJesudas, Retd. Professor and Head, AMRC, TNAU, Coimbatore; DrMadan Kumar Jha, Professor and Head, AGFE, IIT Kharagpur; Dr Siva Reddy V (online, 19th July), Director (Tech.), National Institute of Solar Energy, Gurugram, Haryana; DrTanweerAlam, Director, Indian Institute of Packaging, New Delhi; Dr Krishna Pratap Singh, ADG (Farm Engineering), ICAR; Dr CR Mehta Director, ICAR-CIAE and

DrSubir Kumar Chakraborty, Member Secretary and PS, ICAR-CIAE. In the two-day meeting, the current research works being conducted in the institute were reviewed by the committee and the future direction was also suggested.

IRC Meeting

The 110th IRC meeting was held on 28 - 29 May, 2024 and 62 members of IRC participated. There were 103 projects (25 RPF-I, 21 RPF III, 34 RPF II and 23 Extension Proposals) discussed and critically reviewed during the IRC meeting. Chairman IRC emphasized the importance of proper planning for projects, aligning them with the ICAR and national priorities and RAC recommendations. He urged scientists to adhere to the timelines set by the IRC for project completion, while emphasizing the need for divisional project reviews by HODs at regular intervals.

Annual Workshop of AICRP on EAAI

The XXVII workshop of ICAR-All India Coordinated Research Project on Energy in Agriculture & Agro-based Industries (EAAI) was organized during 28-30 January, 2024 at Punjab Agricultural University, Ludhiana. The inaugural session of the workshop was held on January 29, 2024 under the Chairmanship of Dr. SN Jha, DDG (Agricultural Engineering), ICAR and Chief Guest was Dr. Satbir Singh Gosal, Vice Chancellor, PAU, Ludhiana. On 28th January, a technical session to discuss new research program for year 2024-25 was organized under the Chairmanship of Dr KP Singh ADG (FE), ICAR. An interaction session with the different stakeholders of renewable energy gadgets/equipment was also organized. DDG (AgrilEngg.) suggested to all Research Engineers that national priority in the field of Bio Energy must be considered while preparing the new projects. There should be focus for commercialization of developed equipment. During the inaugural session, the publications of ICAR-CIAE Bhopal, CCSHAU Hisar, TNAU Coimbatore and SPRERI VV Nagar centres were released. Dr. VK Bhargav, Project Coordinator, AICRP on EAAI presented the Project Coordinator's report on the progress of work done by sixteen centres of the scheme and action taken report of last workshop, budget details significant quantified achievements, output, outcome and impact of the scheme.

Annual Workshop of AICRP on ESA

XV Annual Workshop of AICRP on 'Ergonomics and Safety in Agriculture (ESA) was organized during 20-21 March, 2024 in online mode. The workshop was chaired by Dr. S. N. Jha, DDG (Engg.) and Co-chaired by Dr. K. P. Singh, ADG (FE) and Dr. C. R. Mehta, Director, ICAR-CIAE. Dr. P. K. Nag, Former Director, NIOH, Ahmedabad and Dr. L. P. Gite, former Project Coordinator, AICRP on ESA, ICAR-CIAE, Bhopal were experts to review the progress of the centers. Dr. Sukhbir Singh, Project Coordinator (AICRP on ESA) presented the report of the scheme. PIs of respective centre presented their annual progress. About 42 participants participated in this workshop, which included the senior level scientists from ICAR-CIAE, senior officials and REs/PIs and associated scientists from 12 centers of AICRP on ESA. Chairman, Co-chairman and experts provided their keen observations, inputs and suggestions for improvement in research work of the cooperating centres.

Meeting of centres of AICRP on UAE

A virtual meeting for the approval of new research project proposals to be undertaken by centres of AICRP on Increased Utilization of Animal Energy with Enhanced System Efficiency was organized on 1 March, 2024. Dr. K. P. Singh, ADG (FE), ICAR presided over the meeting as chairman with Dr. CR Mehta, Director, ICAR-CIAE as co-chairman. Dr. KN Agrawal, Project Coordinator, AICRP on FIM, ICAR-CIAE participated in the meeting as a special invitee. Valuable comments were provided to improve the projects outcomes and deliverables. Chairman suggested the PIs to bring uniqueness to their projects. He appreciated the efforts in the new projects focusing on precision and AI-based initiatives related to Animal Husbandry mechanization. Twenty new research project proposals were presented by the respective Principal Investigators (PIs)/Co-Principal Investigators of cooperating centres.

World Intellectual Property Day

A Seminar on 24 April, 2024 was organized by NAIF-ZTMC & ABI, ICAR-CIAE, Bhopal to mark the Celebration of World Intellectual Property Day - 2024 with the theme: Intellectual Property Management: Transition from Agriculture to Agribusiness. A presentation on topic "Online-E Filing of IP applications" was delivered by Ms. AparnaPandharkar, Indian Patent Agent.

Review meeting of Network Programme on Precision Agriculture (NePPA)

A review meeting of Network Programme on Precision Agriculture (NePPA) under the broad area, "Development of sensor based technologies for precise farm input application and quality control in post-harvest processing", was held at ICAR-CIAE, Bhopal on 18 April, 2024. The meeting was attended by DrAmitabhaBandopadhyay, Chairman, TAC, NePPA; Dr Anil Rai, ADG (ICT), ICAR; Dr C.R. Mehta, Director, ICAR-CIAE, Bhopal; Dr Rabi Narayan Sahoo, Programme Leader, NePPA; DrSubhash N Pillai, Head, Agril Physics, ICAR-IARI, New Delhi; and the NePPA team of ICAR-CIAE, Bhopal. The meeting started with on-site field visits followed by a detailed review presentation of ATR's till date and documented progress of the research projects.

Review Meeting DBT Kisan Hub Project

A Review Meeting with Manthan (Hub coordinator) and other partners under DBT Kisan Hub Project in eight aspirational districts of Madhya Pradesh was organized on 9 July, 2024. During the meeting, the agenda was briefed by the Hub coordinator and reviewed the progress of the current kharif season of all the partners. Each partner presented activities carried out in the last rabi and summer seasons, including the activities under progress for the current Kharif season. Also, an action plan for future activities for the ongoing kharif season was discussed by the partners.

Launching Workshop cum Training of State Coordinators of project on "Assessment of Farm Mechanization Status and Prospects of Custom Hiring in India"

The Launching Workshop was held at NAAS Complex, New Delhi on August 20, 2024. Dr. HimanshuPathak, Secretary (DARE) & DG (ICAR) Chaired the session alongside Smt. S. Rukmani, Joint Secretary, Ministry of Agriculture & Farmers Welfare as a guest of honor, Dr. S. N. Jha, DDG (Engineering), ICAR, New Delhi as a co-chairman, Dr. K.P. Singh, ADG (FE), ICAR, New Delhi, Dr. C. R. Mehta, Director, ICAR-Central Institute of Agricultural Engineering (CIAE) Bhopal. Dr. K. Narsaiah, ADG (Process Engg), ICAR, New Delhi and Project coordinators of different AICRP schemes along with SMD officials and Official of M&T, Department of Agriculture and Farmer's Welfare were also present.

The DG (ICAR) highlighted the need to conduct such study in systematic manner and leverage digital technologies for efficient data collection and analysis. Dr. S. N. Jha underscored the importance of proper statistical considerations in the data collection process and recommended that State Coordinators directly gather 20% of the data to ensure accuracy. Smt. Rukmani, Joint Secretary (MA&FW) emphasized the significance of the study in shaping farm machinery schemes to enhance mechanization and improve farm power availability in under-mechanized regions. Dr. C. R. Mehta provided an overview of the project, detailing its historical background and strategic goals.

Scientist-Agro Machinery Industry Meet

Scientists – Agro-machinery Industry Meet was organized on 23 August 2024. In this event 50 participants including agricultural machinery manufacturers of Madhya Pradesh and 04 manufacturers from Punjab and Scientists / Officers from ICAR-CIAE, Bhopal participated.

Academia-Industrial Interaction Meet

Interaction Meet on Agricultural Mechanization was organized at Rajkot (Gujarat) on 24 September, 2024. Agricultural machinery manufacturers from Gujarat, as well as scientists and researchers participated in the meet. This meet aimed to strengthen licensing partnerships between academia and industry to advance agricultural and horticultural mechanization. Shri Parshottam Rupala, MP, Rajkot, inaugurated the event, emphasizing that mechanization boosts productivity and alleviates labor challenges. Shri Rajiv Chaudhary, Director of Agricultural Engineering in Madhya Pradesh, discussed plans to include agricultural machinery in subsidy programs to benefit farmers. Dr. CR Mehta, Director, ICAR-CIAE highlighted the increasing mechanization in India, stressing the need for quality standards. CIAE technologies ready for commercialization were presented, followed by discussions on machinery standards and testing.

Awareness workshop on Soy for Food Uses and its Role in Entrepreneurship Development

An awareness program on "Soy for Food Uses and its Role in Entrepreneurship Development" was organized on 5 September 2024 in association with AFSTI-Bhopal Chapter. The event was attended by 30 undergraduate/ postgraduate students and faculty members from the Food Technology and Nutrition Department of

Government Geetanjali College and SantHirdaram College, Bhopal. The primary aim of the programme was to create awareness about soybeans' potential in food applications and fostering entrepreneurship in agribusiness. It specifically encouraged the development of agribusiness ventures, helping students transform their innovative ideas into successful commercial enterprises. Followed by the lectures, participants were given a practical demonstration of the soybean processing techniques at the pilot plant level.

National Level Awareness Campaign on Accidents due to tractor trailers and other farm machinery

A national level awareness campaign was conducted by Coordination Cell of AICRP on Ergonomics and Safety in Agriculture and Allied Sector on prevention of accidents caused by tractor-trailer and agricultural machinery during 14-16 October 2024. The campaign aimed to raise awareness among farmers, machinery operators and rural communities about the risks associated with tractor-trailers and other agricultural machinery. During this campaign, the participants were taught about safe machine operation, maintenance tips and accident prevention measures through interactive sessions, exhibitions and expert talks. Farmers were made aware of the hazards caused by alcohol consumption, fatigue, poor training and experience, loose clothing, and incorrect posture while operating machines. The program was organised at 12 cooperating centres of AICRP on ESAAS in their respective states. During the campaign more than 1200 farmers participated and more than 300 slow moving vehicle (SMV) emblems were distributed among the tractor-trailer owners.

World Food Day

The Institute along with Bhopal chapter of the Association of Food Scientists and Technologists India (AFSTI) celebrated World Food Day on 16 October 2024 by organizing a live demonstration on cottage-level production of soymilk, tofu, and related products at Government Gitanjali Girls College. The programme was attended by 200 students and faculty members. A live demonstration of soymilk production, techniques for making tofu, and preparation of soy-based snacks was arranged. An interactive session was organized to address queries of students on health benefits and culinary uses of soy products, such as freshly prepared soymilk and tofu. The event successfully raised awareness about soy's health benefits and fostered engagement in sustainable food practices.

Workshop on Soybean Processing for Food, Health, and Income Generation

A workshop on “Soybean Processing for Food, Health, and Income Generation” was held on 19-20 November 2024. The event brought together a wide range of stakeholders, including soybean industry professionals, health experts, academic researchers, students, and entrepreneurs, to explore the immense potential of soy products in promoting health, food security, and economic growth. Over two days, the workshop highlighted the critical role of soybean processing in addressing public health challenges and fostering sustainable economic opportunities through value-added soy-based products. Sessions included expert talks, hands-on demonstrations, and panel discussions focused on the nutritional benefits of soy, innovative processing techniques, and entrepreneurship opportunities in soybean value chains. The event was organized in association with All India Soy Family Association (AFSTI), Bhopal chapter.

World Yoga Day

International Yoga Day was celebrated at the institute on 21 June 2024. The theme of the event was “Yoga for Self and Society,” was marked by great enthusiasm and active participation from the institute's staff and guests. Experts from the Sahaj Yoga Foundation, Bhopal, including Dr. PurnimaNayak, Mr. Pratik Shrivastava, Smt. Neerja Pare, Smt. SushmaChoure, Smt. Hemlata Sharma and Smt. Suparna Kumar conducted the yoga session. The session included general yoga practices, meditation, various asanas (postures), pranayama (breathing exercises), and relaxation techniques. Dr. CR Mehta, Director, addressed the participants and urged all staff members to practice yoga regularly to maintain physical and mental health.

Vigilance Awareness Week

Vigilance Awareness Week 2024 was organized during 28 October to 3 November 2024 under the theme "Culture of Integrity for Nation's Prosperity". Dr CR Mehta, Director, ICAR-CIAE emphasized the critical importance of vigilance for ethical conduct and accountability within the institution and beyond. The week began with an inauguration and pledge ceremony, coordinated by Vigilance Officer Dr. K.N. Agarwal, where institute staff committed to ethical standards in their professional roles. Alongside, an outreach poster presentation was organized at Oxford Senior Secondary School, Karond, directed by Dr. MK Tripathi, Chairman of Vigilance Awareness Week. This event included over 100 students and 30 teachers, aimed to instil integrity and vigilance awareness among young students. On October 29, an outreach program with 60 farmers was held in a nearby village. The week's activities continued with a quiz program on vigilance and anti-corruption practices on October 30 and participated by more than 40 officers. A debate competition on "Corruption can be controlled by Integrity only," was held on November 1, On November 2, an online extempore session, was conducted to share views on vigilance topics on ethical issues. On November 3, a slogan display activity was organized. The Vigilance Awareness Week 2024 was concluded on 5 November, and the event featured prize distributions to various awardees, recognizing their participation and contributions throughout the week.

Awareness Workshop on POSH

The Women Cell of the Institute organized sensitization/ awareness workshop on Prevention of Sexual Harassment (POSH) of Women at Workplace on 9 December, 2024. Dr. Neeta Khandekar, Chairperson of the Women Cell, told that to prevent sexual harassment, the Government of India has enacted the Sexual Harassment Prevention, Prohibition and Redressal Act (POSH) 2013. The Institute encouraged all the employees to take training on “Prevention of Sexual Harassment of Women at Workplace” available on the Karmayogi Bharat Website, accessible through the iGOTKarmayogi platform. On this occasion, POSH Consultant and Advocate MsBhavanaTripathi gave detailed information about POSH. She gave detailed information about the preventing sexual harassment in the workplace, including relevant laws, reporting procedures, and creating a respectful work environment.

BIS ManakManthanprogrammme

Regional Station, Coimbatore organized a "ManakManthan" programmme for Technical Discussion on "IS 19040:2023 Millet Dehusker - Specification and Test code" in collaboration with BIS, Coimbatore chapter on 22 February 2024.

Mahila Kisan Diwas celebration

On the occasion of MahilaKisanDiwas, a field day was organized at ParvaliaSadak village, Bhopal. Over 180 farmers, including 147 women, participated. Dr. Sukhbir Singh, Project Coordinator of AICRP on ESAAS, inaugurated the event. The program included live demonstrations of women-friendly agricultural technologies, covering safety practices for handling farm tools and machinery. Participants were introduced to small equipment like manual groundnut decorticators, coconut dehuskers, vegetable transplanters, dibblers, maize shellers, and protective safety gadgets for spraying. A session was also dedicated to promoting a nutritious, balanced diet for farm women's health and the establishment of kitchen gardens to encourage self-sustenance.

हिन्दी पखवाड़ा

संस्थान में दिनांक 14 से 28 सितंबर 2024 तक हिन्दी पखवाड़ा का आयोजन कियागया। हिन्दी दिवस के अवसर पर संस्थान के निदेशक डा .सी .आर .मेहता की अध्यक्षता में हिन्दी पखवाड़ा उद्घाटन कार्यक्रम का आयोजन किया गया। हिन्दी पखवाड़े के दौरान संस्थान के वैज्ञानिकों, प्रशासन एवं वित्त से जुड़े अधिकारियों एवं कर्मचारियों, तकनीकी श्रेणी के अधिकारियों एवं कर्मचारियों, प्रोजेक्ट कर्मियों, संविदा कर्मियों एवं विद्यार्थियों के लिए 8 प्रतियोगिताओं-हिन्दी रंगोली प्रतियोगिता, हिन्दी प्रश्न मंच प्रतियोगिता, हिन्दी पोस्टर प्रतियोगिता, हिन्दी गीत अन्ताक्षरी प्रतियोगिता, हिन्दी क्विज प्रतियोगिता, हिन्दी वाद विवाद प्रतियोगिता, हिन्दी तकनीकी लिखित प्रतियोगिता एवं हिन्दी दमशराज प्रतियोगिता का आयोजन किया गया। हिन्दी पखवाड़ा आयोजन समिति की अध्यक्षा डा .नीता खांडेकर की अगुवाई में समिति के सदस्यों डा . बिक्रम ज्योति, डा .हर्षा वाकुडकर, श्री राजेश तिवारी, सहायक मुख्य तकनीकी अधिकारी, श्रीमती दीपिका शेन्डे, सहायक मुख्य तकनीकी अधिकारी तथा सदस्य सचिव श्री राकेश कुमार, उपनिदेशक ने हिन्दी पखवाड़ा की विभिन्न गतिविधियों तथा प्रतियोगिताओं का सफलतापूर्वक आयोजन कराने में महत्वपूर्ण भूमिका का निर्वहन किया।

संस्थान के निदेशक डा .सी .आर .मेहता की अध्यक्षता तथा प्रोफेसर सी.सी .त्रिपाठी निदेशक, एनआईटीटीटीआर, भोपाल के मुख्य आतिथ्य में दिनांक 03.10.2024 को संस्थान के रजत जयंती सभागार में राजभाषा पुरस्कार वितरण समारोह आयोजन किया गया जिसमें पखवाड़े के दौरान आयोजित की गई प्रतियोगिताओं के विजेताओं को प्रमाणपत्र से सम्मानित कर सरकारी कामकाज में हिन्दी के प्रयोग, प्रचार, प्रसार एवं कार्यान्वयन के लिए प्रोत्साहित किया गया।

Swachchta Pakhwada

Swacchata Hi Sewa campaign was observed during 17 September to 2 October, 2024. The theme of this year 'Swachhata Hi Sewa' was SwabhavSwachhata and SanskarSwachhata. To begin with, banner on Swachhta Hi Sewa was displayed at three prominent places of the institute and Swachhata pledge was taken online under the Chairmanship of the Director General, ICAR New Delhi Dr. HimanshuPathak online at 10:00 AM. Almost all categories of staff including KVK participated in the event.Various activities including EkPedMaaKeNaam plantation drives, cyclathons, Swachhata Quizzes at Schools, street plays, decorative murals, human chain, cleanliness drives, identification of black spots, preventive health check-ups, distribution of PPE Kits, safaimitrasamman etc. were conducted during the fortnight.

Another Swatchhtapakhwada was organized during 16–31December, 2024. During this fortnight several events related to cleanliness and awareness were conducted. Activities like waste to wealth, cleaning sewerage and water lines, recycling waste water, review and weeding out of old records, tree plantation drive, reducing plastic waste, community engagement in cleanliness drives, celebration of Kisandiwas by KVK, drawing competition, signature campaign, cleaning of public places, utilization of organic waste, Swachhta Run campaign and organizing press conference were conducted. All categories of staff members took part in various activities in the fortnight with great enthusiasm.

International Women's day Celebration and Educational Tour

The CIAE Women's cell organized an educational trip to the CGIAR institute ICARDA located in Sehore district and to a women FPO in commensuration with the International Women's day celebration. The staffs of the institute were briefed about the activities of both the organization as an initiative to broaden the horizon of the women staff as well as students. On 5th March 2024 several programmes were organized. Dr Nita Khandekar, Chairperson, Women Cell, ICAR-CIAE, Bhopal, in her welcome address spoke about how the progress of women in our society can be accelerated. Mrs. Anita Mehta was the chief guest of the programme. Dr. C. R. Mehta in his presidential address focused on the importance of women in day to day life and also motivated everyone to achieve higher goals in our life. He acquainted the audience with the theme of the year "Invest in women: Accelerate progress". Dr Mehta further in his address told that this global occasion, dedicated to celebrating the social, economic, cultural, and political achievements of women, is symbolised by three distinct colours: Purple, Green, and White. These colours trace their origins back to the Women's Social and Political Union (WSPU) in the United Kingdom in 1908. The Purple signifies justice and dignity, while Green embodies hope, and White represents purity. In line with the theme "Inspire-Inclusion" a talk was delivered by MsMuskanAhiwar, a young women, who inspires the slum girl children to read. She has been running the library "kitabimasti" at the Durganagar Colony, Bhopal since she was 9 years old. She has been a recipient to several awards from NITI Aayog as well as state government. The women staff, students, and family members of ICAR-CIAE attended the event. Earlier in the forenoon a rangoli competition was also organized for all the participants. A cultural programme was organized by the staff and their families in the afternoon session. The programme was co-ordinated by Dr. Harsha Wakudkar and Ms Dipika Shinde. MsSarita and Ms Priya Borkar.

International Rural Women's Day

The Women Cell of the Institute in collaboration with Solidaridad (NGO) organized two-day program (15-16 October 2024) to mark "International Rural Women's Day." On 15 October, the event was held at Gandharvpuri village, Dewas district, with the participation of around 1,000 women farmers. The program focused on regenerative agriculture, emphasizing waste-to-wealth technologies, conservation agriculture, and natural farming. The importance of women farmers' participation in sustainable agriculture was also highlighted. A policy meeting was held on 16 October at Hotel JehanNuma Palace, Bhopal, discussing women's roles in rural development and regenerative agriculture. Panels addressed topics such as gender inclusion in agriculture, women-friendly technologies, and food security. Experts, including Dr. SandipMandal and Mr. Medni Prasad Singh, stressed developing women-centric agricultural machinery. Representatives from

ICAR, the Department of Agriculture, women entrepreneurs, sarpanch's, and journalists participated in the discussions. The program was coordinated by Dr. HarshaWakudkar and Dr. DeepikaShendeChanne under the guidance of Dr. Nita Khandekar, Chairperson.

Independence Day Celebration

Independence Day was celebrated at the Institute on August 15, 2024. Dr CR Mehta, Director addressed the staff and emphasized the significance of independence, reflecting on the sacrifices made by freedom fighters. He highlighted the role of agricultural engineering in nation-building and the contributions of CIAE in this regard. The celebration continued with cultural performances and patriotic songs, fostering a sense of national pride and unity among the CIAE community.

Visit of Secretary, DoA & FW

Shri Manoj Ahuja, Secretary, Department of Agriculture and Farmers Welfare, Government of India visited Regional Station, Coimbatore on 9th March, 2024. He was accompanied by Mr. Samuel Praveen Kumar, Jt. Secretary, DAC & FW, GoI, New Delhi and Mr. T. R Kesavan, Group president, TAFE India. During the visit, equipment and technology developed by the Regional Station were demonstrated/displayed.

Visit of ADG (FE)

Dr. K.P. Singh, ADG, Farm Engineering, ICAR, New Delhi visited CIAE on 29 April 2024 to review progress of CIAE scientists for the year 2023-24, with a focus on the contributions and advancements made by each scientist according to the directive of 'One Scientist, One Technology in a Year'.

Visit of SVPUAT, Meerut

Dr. K.K Singh, Vice Chancellor, SardarVallabhBhai Patel University of Agriculture & Technology, Meerut (Former Director, ICAR-CIAE, Bhopal) visited CIAE on 12th June, 2024 to interact with scientists of the institute and to have a friendly discussion on advanced scientific works being conducted in the institute.

Secretary, DARE & DG ICAR visits Regional station Coimbatore

Dr. HimanshuPathak, Secretary, DARE & Director General, ICAR visited Regional Station, Coimbatore on 11 July, 2024. He was accompanied by Dr G. Hemaprabha, Director, ICAR Sugarcane Breeding Institute, Coimbatore and Dr Dinesh Singh, Project Coordinator AICRP on Sugarcane.

During the visit, equipment and technology developed by CIAE Regional Station (in collaboration with other ICAR Institutes) like package of equipment for sugarcane cultivation, banana cultivation, minimal processing of banana central core, rope making from banana pseudo-stem, cassava cultivation, primary processing of Cashew apple and onion cultivation were displayed and demonstrated.

ON-GOING RESEARCH PROJECTS

Agricultural Mechanization Division

S. No.	Project No.	Title	Investigators
1	959	Yield prediction using multi -temporal data from UAV -based multispectral imagery	S P Kumar Ramesh K Sahni R Sanodiya
2	960	Plant disease detection using UAV multispectral imagery	Ramesh K Sahni S P Kumar Saxena, RVSKVV, Sehore
3	961	Development of small tractor-mounted hydraulically powered multi -purpose tool carrier for intercultural and canopy management in orchard	A K Roul Bikram Jyoti
4	962	Mechanization package for ginger cultivation	H S Pandey Manish Kumar
5	963	IOT-Based monitoring and early infe ction detection in dairy cattle using Infrared thermography	Vijay Kumar AbhijitKhadatkar
6	964	Development of portable cattle bed for dairy cows to ensure comfort and hygiene	U C Dubey
7	965	Design and development of manual-operated poultry litter mixture equipment	U C Dubey
8	966	Development of tractor operated pearl millet harvester	C S Sahay A K Roul Ganapti, IIMR Sanjana, IIMR
9	Ext-29	Assessment of status of farm mechanization and custom hiring in India (Funded by M&T Division, DAC&FW, New Delhi)	K N Agrawal S P Singh Sukhbir Singh V P Chaudhary V. Bhushana Babu Karan Singh N S Chandel A P Pandirwar DilipJat Syed Imran S Abhishek Waghaye
10	928	Monitoring, mapping & development of agricultural farms using GIS at ICAR -CIAE	Shashi Rawat Karan Singh H S Pandey Khushboo Rani (ICAR-IISS)
11	895	Impact assessment of selected agricultural machinery and post-harvest technologies	K P Saha Dushyant Singh T. Senthilkumar
12	EXT-18	Awareness and extension services on best farm practices for cotton farmers to improve yield, quality and sustainability	A P Pandirwar
13	944	Promotion of conservation agriculture machinery for major crops in vertisols	Dushyant Singh Manish Kumar A K Viswkarma, IISS Bhopal A K Biswas, IISS Bhopal
14	937	Dissemination of climate resilient agricultural mechanization technologies in selected villages of MP	Manoj Kumar C S Sahay

S. No.	Project No.	Title	Investigators
15	936	Development of computer vision based human posture analysis system for ergonomic assessment	R R Potdar R Sanodiya
16	941	Ergonomic interventions to mechanize selected operations in pomegranate cultivation	R Potdar D S Thorat
17	EXT-17	TULIP: Tea harvesting unmanned robotic platform for northeast indian tea plantation	A K Roul
18	906	Robotic transplanter for plug-type vegetable seedlings	Abhijit Khadatkar C P Sawant
19	925	Development of lab based robotic harvester for tomato	A P Magar Abhijit Khadatkar Shashi Rawat
20	942	Development of gypsum applicator for reclamation of sodic soil (Inter-institutional Collaborative Project)	A P Magar Abhijit Khadatkar Ashim Datta (ICAR-CSSRI, Karnal)
21	927	Development of automatic vegetable transplanter for plastic mulch laid raised beds	C P Sawant A P Magar KVR Rao
22	946	Development of mechanized CA model farm for rice based cropping systems in vertisol	C P Sawant A K Vishwakarma, IISS
23	EXT-16	Expansion of activities of biotech kisan hub in eight aspirational districts in Madhya Pradesh-phase II	D S Thorat Dushyant Singh
24	945	Work fatigue analysis of agricultural workers to improve working efficiency	SweetiKumari Vijay Kumar
25	939	Investigation on efficacy of drone spraying system for nano urea application in wheat and maize crops	Ramesh K Sahani S P Kumar
26	938	Standardization and Promotion of drone spraying in selected villages of Madhya Pradesh	S P Kumar Ramesh K Sahani D S Thorat
27	943	Development of plant nitrogen monitoring and management system for polyhouse	DilipJat Y A Rajwade N S Chandel Abhijit Sarkar (ICAR –IISS Bhopal)
28	940	Mechanization of selected operations in Marigold cultivation	Vijay Kumar Sweeti Kumari
29	907	Development of image based variable-rate nitrogen applicator	N S Chandel DilipJat
30	935	Development of tractor operated liquid-fertilizer injection system	Manish Kumar H S Pandey
31	893	Development of brush type cotton harvester	A P Pandirwar A K Roul Ramakrishna G Idapuganti, CICR VG Arude, CIRCOT
32	EXT-12	Design and development of an air assisted recycling tunnel sprayer for horticultural crops	Bikram Jyoti A K Roul Manoj Kumar (Stat.)
33	903	Development of yield monitoring system for grain combine harvester	R Sanodiya K N Agrawal
34	902	Development of portable in-situ soil gas flux measurement system	H S Pandey Manoj Kumar
35	894	Development of remote operated weeder for wide spaced field crops	Abhijit Khadatkar
36	926	Development of a controller based feed dispensing system for poultry	U C Dubey

Agro Produce Processing Division

S No.	Project No.	Title	Investigators
1	EXT-21	Study on determining storage losses of pulses stored in warehouses and to recommend norms for loss/gain during long term storage	S Mangaraj DilipPawar Ajay Yadav Adinath Kate
2	EXT-22	Development of on farm storage structure with hybrid evaporative cooling system for fresh horticultural produce (MPCST funded)	Adinath Kate S Mangaraj DilipPawar
3	898	Technology outreach and agricultural engineering interventions for improving the rural livelihoods of SC BPL beneficiary of selected villages of Madhya Pradesh and Tamil Nadu	S Mangaraj R. Senthil Kumar R Potdar Dilip Pawar Sweeti Kumari
4	929	Development of IoT enabled mini silo storage system for chickpea	Adinath Kate Karan Singh
5	948	Value chain on processing of millets for functional foods and nutraceuticals	M K Tripathi Ajay Yadav Pravitha, M
6	947	Development of pH based intelligent indicator for high value fresh produce	M K Tripathi Ajay Yadav Pravitha, M
7	930	Development of active edible coating for the shelf life extension of fresh produce	Ajay Yadav Ajesh Kumar Samlesh Kumari
8	885	Development of grain handling system with IR-UV based in-situ surface disinfestation	Adinath Kate Dilip Pawar
9	908	Technology package for minimal processing and powder production from tender jackfruit	Dilip Pawar

Central for Excellence in Soybean Processing and Utilization

S. No.	Project No.	Title	Investigators
1	967	Development of an index for identifying varieties suitable for good quality soymilk and tofu	D Agrahar Murugkar Ajesh Kumar Samlesh Kumari Muzaffar Hasan
2	968	Xylitol production from soyhull by Aspergillusniger through CRISPR/Cas9 based metabolic engineering	Muzaffar Hasan M K Tripathi Ajesh Kumar
3	913	Studies on the effect of soybean seed varieties and storage conditions on yield and quality of soymilk and tofu	Samlesh Kumari Nita Khandekar Mrinal Kanti Kuchlan
4	912	Enhancing soy splits cooking quality using novel processing techniques	Ajesh Kumar V Muzaffar Hasan
5	949	Development of proc ess technologies for soy based dairy alternatives using functional starter culture	Samlesh Kumari Muzaffar Hasan
6	874	Design and development of a continuous edible film making machine	Ajesh Kumar V

Agricultural Energy and Power Division

S. No.	Project No.	Title	Investigators
1	969	Development of solar PV integrated greenhouse for horticulture production	Ankur Nagori P K Guru
2	970	Analysis of energy and carbon footprint in rice milling	P K Guru Gopal Carpenter
3	971	Design and development of solar power pack for pruning and variable rate spraying in orchards	Gopal Carpenter Ankur Nagori
4	915	Crop residue availability assessment in the state of MP	V K Bhargav Sandip Gangil
5	952	Development of process and protocol for material based bio hydrogen storage	V K Bhargav S Gangil
6	951	Synthesis of drop -in fuel and bio-pitch from paddy straw bio-oil	S Mandal
7	950	Process optimization for production of biobutanol using lignocellulosic biomass	P K Guru
8	914	Energy inflow and outflow assessment of soybean and wheat cropping system in selected village of MP	H Wakudkar
9	897	Development of multi-utility e-vehicle for agricultural operations	Ankur Nagori V K Bhargav
10	919	Bio-hydrogen generation from biogas through catalytic methane reforming	S Mandal H Wakudkar

Irrigation and Drainage Engineering Division

S. No.	Project No.	Title	Investigators
1	EXT-23	Development and promotion of precision horticulture technologies (externally funded)	Y A Rajwade KVR Rao
2	920	Development of automatic valve control system for surface irrigation	R D Randhe C K Saxena
3	923	Development of AI/IoT Based intelligent irrigation system for field crops	C D Singh Mukesh Kumar Y A Rajwade
4	EXT-15	Development of nano sensor and its application through cloud based network for real time irrigation to soil and plant (NASF project)	C D Singh N S Chandel
5	953	Development of solar powered hydroponic system for smart urban farming	R D Randhe A M Waghaye
6	954	Machine learning based decision support system for micro-irrigation management	A M Waghaye Karan Singh
7	955	Engineering interventions in the input controls for improvement in energy efficiency of small scale indoor deep water culture hydroponics	C K Saxena A M Waghaye
8	EXT-19	Estimation of evapotranspiration and carbon fluxes using eddy covariance and satellite data for irrigation water management of soybean and wheat crops in Vertisols (Externally funded project with ISRO-NRSC, Hyderabad under National Hydrology Project)	R K Singh Mukesh Kumar Chandrasekar K, NRSC Anurag Mishra, NRSC
9	921	Unmanned aerial vehicle based multispectral imagery and data driven techniques for irrigation scheduling and water productivity in field crops	Y A Rajwade N S Chandel KVR Rao P Sujith (IISER)

Technology Transfer Division

S. No.	Project No.	Title	Investigators
1	972	Sustainable business opportunities with agricultural engineering technologies for upcoming entrepreneurs	KVR Rao S K Chakravarthy V. BhushanaBabu
2	EXT-24	Training Centre for Processing of Cereals, Pulses, Millets and Oilseeds at ICAR-CIAE, Bhopal (Externally Funded Project under RKVY)	S K Chakraborty U R Badegaonkar
3	EXT-25	Intellectual Property Management and Transfer/Commercialization of CIAE Technologies (National Agriculture Innovation Fund)	U R Badegaonkar V. Bhushana Babu
4	855	Integrating tillage, traffic, crop residue and crop rotation management practices in prevailing cropping system for facilitating conservation agriculture mechanization in vertisols	U R Badegaonkar Mukesh Kumar Manish Kumar Manoj Kumar (Stat)
5	911	Development of sensor based multi-pass cleaner for pulses	S K Chakraborty Adinath Kate

Regional Station, Coimbatore

S. No.	Project No.	Title	Investigators
1	973	Promotion of millet-based enterprises through technological interventions for inclusive women empowerment	R Senthil Kumar S K Aleksha Kudos
2	EXT-26	Empowerment of tribal farmers societies throu gh smart agri mechanization packages in tribal areas of Tamil Nadu (Funded by Tribal Welfare department, Govt of Tamil Nadu)	R Senthil Kumar M Muthamil Selvan Ravindra Naik Sadvatha RH
3	974	Development and evaluation of aerial pollinator system for cotton crop	Syed Imran S T Senthilkumar Baghyalakshmi K, ICAR CICR RS
4	EXT-27	Part of NASF funded project : Development of smart foods, bio -composites, green packaging and bio-energy from Agro-residues (Lead Institute ICAR NRC Banana ; Partners -ICAR CIAE RS Coimbatore and 6 other institutes)	Ravindra Naik Dawn C. P Ambrose
5	EXT-28	Part of the project “Development of Agripreneruship and Agri-business models for Grassroots Innovations (GRIs)” Under Rural Technology Action group project (RuTAG 2.0) (Funded by Office of Principal Scientific Advisor, Govt of India (lead Institute, ICAR NAARM , Hyderabad; ICAR-CIAE RS Coimbatore and IIPM, Bangalore)	Ravindra Naik
6	EXT-20	Development of robotic harvester for grape bunches (NASF Funded)	Syed Imran S T Senthilkumar N A Deshmukh (NRC Grapes) A K Sharma (NRC Grapes)

S. No.	Project No.	Title	Investigators
7	958	Development of in-situ shredder incorporator for major crop residues	M. MuthamilSelvan
8	899	Development and evaluation of FCV tobacco leaves stringing machine	Sadvatha RH SK Aleksha Kudos T. Kiran Kumar (CTRI)
9	900	Development of pulsed UV light system for fresh fruits and vegetables	Sadvatha RH
10	901	Development of self-propelled track type vehicle for small farms	Syed Imran S T. Senthilkumar
11	924	Development of raw banana peeler and papad making machine	SK Aleksha Kudos Ravindra Naik
12	931	Development of jackfruit bulb remover and deseeder	Dawn C.P. Ambrose
13	933	Development of process and machine for wet shelling of sweet corn	S.K. Aleksha Kudos Sadvatha RH

INSTITUTE STAFF

SCIENTIFIC STAFF

Director, ICAR-CIAE

- Dr. CR Mehta

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- Dr. KNAgrawal, Project Coordinator, AICRP on FIM
- Dr. SP Singh, Project Coordinator, AICRP on MAH
- Dr. VK Bhargava, Project Coordinator, AICRP on EAAI
- Dr. Sukhbir Singh, Project Coordinator, AICRP on ESAAS

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- Dr. Sandip Gangil, Head, AEP
- Dr KVR Rao, Head, IDED
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- Joshi Nidhi
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- Katare Abhishek
- Khan Furqan
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- Maurya Shivam
- Meena Manoharsh
- Modi Shubham
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- Patel Akhilesh
- Rangesh Kumar
- Ranjan Ravi
- Rathour SS
- ShuklaRP
- Singh RMP
- Sonkar Pravesh
- Yadav Kunal

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Dubey Rajesh

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Joseph Thomas

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- Sahu Ashish
- Singh Swati
- Shinde Deepa

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- Prasad Bindu
- Shankar K
- Soni Lokendra

Assistants

- Abhishek
- Ashutosh Kumar
- Awasthi Ashutosh
- Lohani Manju
- Mandol AK
- Meena AK
- Meena Parikshit
- Panthi Nikhil
- Sachin
- Sharma Deepak
- Shreya Nayak
- Tiwari Sachin
- Verma Premlata
- Waghmare Ashalata

Upper Division Clerks

- Choudhary Santosh
- Parewa Sheelesh Kumar
- Sahare PV
- Singh Kalyan
- Umredkar Madhuri

Lower Division Clerks

- Chouksey Rahul
- Maskole Radheshyam
- Patwa Prashant
- Rokade Mahesh
- Soni GK

SKILLED SUPPORT STAFF

- Bilendar
- Jatav Sumit
- Kamlesh
- Kumre AK
- Mittal Ramkali
- Rajput Jaya
- Sanjay
- Sharma Rishi
- Verma Basant

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

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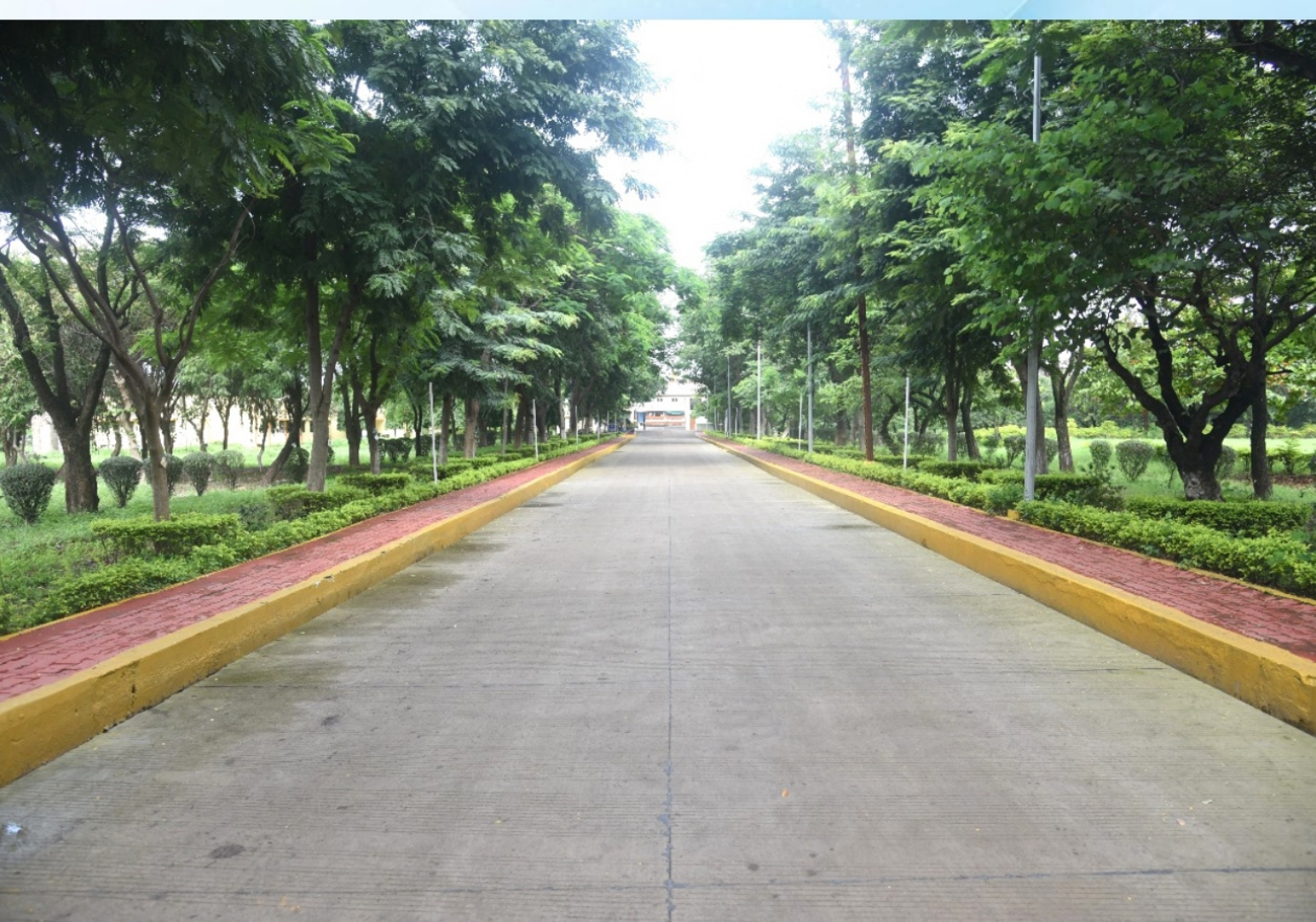

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