भाकृ अनुप
ICAR

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ICAR-CENTRAL INSTITUTE OF POST-HARVEST ENGINEERING & TECHNOLOGY, LUDHIANA (PUNJAB)

(An ISO 9001:2015 Certified Institute)

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ICAR

Annual Report 2016-17

Indian Council of Agricultural Research
Central Institute of Post-Harvest Engineering & Technology
P O: PAU, Ludhiana - 141 004 (Punjab), India

भाकृअनुप-केन्द्रीय कटाई-उपरांत अभियांत्रिकी एवं प्रौद्योगिकी संस्थान,
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PREFACE

Institute had a very active year addressing a wide range of pressing issues facing our needs and priority areas related to post-harvest sector. Changes put into effect by ICAR-CIPHET; Ludhiana in last 27 years will deliver benefits to the people for many years to come.

Our nation could turn out to be the food basket of the world in the course of time by suitable awareness about technical innovation and infrastructure for processing of agricultural produce. The institute has always been visionary towards the role of processing of agricultural commodities with appreciative research outcome this year, namely mechanization of *wadi* making system, buckwheat and oat dehulling etc. In the area of horticultural produce processing, Institute has developed a composite peeler cum juice extractor for sweet orange and *kinnow*, refractive window (RW) dryer system for guava pulp etc. To address the increasing demand of congenial environment for livestock produce, fish descaling machine and energy efficient solar based foldable tent dryer have been developed.Various value added/ health food products and process protocols including utilization of by-products for value addition, anthocyanin extraction from black rice, ecological method for the synthesis of silver nanoparticles have been standardized. Concerns about food safety and regulations have ensured the development of various techniques for detection of adulterant in food commodities. Our continuous effort in this direction has laid the development of molecular methods and spectroscopic techniques for detection of different food adulterants such as calendula in saffron, *safed zeera* in *black zeera* and sugar in honey.

The development of android based app reflected the delivery of the institute which was focused on online dissemination of post-harvest information to the farmers. All types of post-harvest related information on agricultural produce such as harvesting, on-farm storage, processing, packaging, transportation etc. and related machinery at any point of time and any number of times is available on finger tips of farmers through this app. The achievements of

AICRP on Post-Harvest Engineering & Technology (PHET) and AICRP on Plasticulture Engineering and Technology (PET), being coordinated at the institute are appreciable. Besides, carrying on its regular activities in 2016-17, the Institute continued to support the progressive farmers, entrepreneurs, agricultural officers through trainings, exhibitions/*melas*, entrepreneurship development programme, winter/summer schools in the area of post-harvest management, hands on training on various technologies held during this period. ICAR-CIPHET also got appreciation certificate for showing their technologies in *Krishi Unnati Mela*, New Delhi. Testing of all types of Post-Harvest Equipment and Machinery to ensure supply of quality post-harvest equipment & machinery by manufactures was continued. The research outcomes were disseminated in the form of technology licensing and commercialization to various end users and two patents were also filed during the period. We also joined hands with APEDA, New Delhi and CCSHAU, Hisar for collaborative research work in the area of post-harvest engineering and technology as well as food quality and safety.

Many distinguished personalities viz. Eng. Afonso Pedro Canga, Minister of Agriculture & Rural Development, Republic of Angola along with his team; Chairman ASRB; Deputy Director General (Agril. Engineering), ICAR, New Delhi; Deputy Director General (Education), ICAR, New Delhi; Assistant Director General (Process Engineering), ICAR, New Delhi; Assistant Director General (Farm Engineering), ICAR, New Delhi visited the institute. I take this opportunity to place on record my sincere thanks and gratitude to Hon'ble Director General, ICAR and Secretary, DARE; Chairman, ASRB; Additional Secretary, DARE; DDG (Agril Engg); ADG (PE) and ADG (Farm Engg) for their visionary leadership, continued guidance, encouragement and support for our institute. Meeting all of these objectives was, at times, difficult, but was achieved through the collaborative hard work, dedication, and leadership of the Scientific, technical, administrative and supporting staff of the institute.

R. K. Gupta
Director

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कार्यकारी सारांश

वर्ष 2016–17 में संस्थान ने कुछ महत्वपूर्ण उपलब्धियाँ प्राप्त कर कटाई–उपरान्त अभियांत्रिकी एंव प्रौद्योगिकी के क्षेत्र में अपने योगदान की निरन्तरता को बनाए रखा है। संस्थान में चल रही शोध परियोजनाओं में सब्ज़ी मिश्रित वड़ी बनाने की मशीन का विकास, कूटू/ओट डिहलर का विकास, स्वीट ऑरेंज और किन्नू का छिलका उतारने एवं रस निकालने की मशीन, बेर फलों के लिए बेहतर बीजकोष निकालने का साधन, अपवर्तक वातायन सुखाने की प्रक्रिया, खाद्यों में मिलावट की पहचान एवं उनका मात्रात्मक निर्धारण, मछली डीस्केलिंग, मूल्यवर्धित/ स्वास्थय खाद्य उत्पाद इत्यादि शामिल है। प्रत्येक वर्ष की भांति वर्ष 2016–17 में भी कटाई–उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी की अखिल भारतीय समन्वित अनुसंधान परियोजना में कई यंत्र, जैसे भण्डारण सरंचनाएं, प्रक्रिया प्रौद्योगिकी और मूल्य वर्धित उत्पाद विकसित किए गये। इसी प्रकार प्लास्टीकल्चर अभियांत्रिकी एवं प्रौद्योगिकी परियोजना के अंर्तगत संरक्षित खेती के लिए पालीहाउस संरचना की डिजाइन पर विभिन्न कार्य किये गए। संस्थान द्वारा वर्ष 2016–17 में अनुसंधान, प्रसार तथा अन्य सम्बन्धित क्षेत्रों में प्राप्त की गई उपलब्धियों का विवरण निम्नवत हैः

पूरी तरह से स्वतः सब्ज़ी मिश्रित वड़ी बनाने की मशीन बनाई गई है। इसका आकार 140X120X110 सेमी है। यह उपकरण खाद्य ग्रेड स्टील के प्रयोग से आउटसोर्सिंग के माध्यम से बनाई गई है। उपकरण की कुल विद्युत आवश्यकता 3.0 एचपी एवं क्षमता लगभग 150 किलोग्राम/घंटा है। इस उपकरण द्वारा लगभग 5 ग्राम वजनी वड़ी को विभिन्न (नौ) आकारों में डाई के प्रयोग से बनाया जा सकता है। कूटू/ओट की छिलका उतारने की मशीन को विकसित किया गया है। यह 1 एचपी डीसी मोटर द्वारा संचालित है। इस का कुल आयाम 1.20X0.94 X1.45 सेमी है। ओट अनाज के छिलके को हटाने के लिए ओट डेहलर को केन्द्रापसारक कार्रवाई के सिद्धांत पर विकसित किया गया है। मशीन की क्षमता 200 किलो/घंटा है। यह 1 एचपी डीसी मोटर द्वारा संचालित है। स्वीट ऑरेंज और किन्नू के लिए मिश्रित पीलर एवं रस निकालने की प्रणाली को विकसित करने के प्रयास किए गए। छीलने वाले ब्लेड (36 मिमी व्यास) के सुचारु कार्य करने के लिए एक शंकुधारी नल लगाया गया है। छीलने के बाद, फल (58%), छीलका (37%) और रस (5%) क्रमशः प्राप्त किया गया है। फलों का औसत छीलने का समय 6–14 फल/सैकेंड रहा। मानव कष्टप्रदता को कम करने के लिए एक बेहतर बीजकोष निकालने का उपकरण विकसित किया गया है जिससे कि बीजकोष निकालने के दौरान चालक के हाथ में चोट लगने की संभावना को कम किया जा सके। बीज कोष निकालने के साधन के संबंधित आयामः आधारः 15×15 सेमी, ऊंचाईः 30 सेमी, फल धारण कप की गहराईः 2.5 सेमी, उपकरण व्यासः 14 सेमी है। यह बीज कोष निकालने का साधन लगभल 14–16 बेर प्रति मिनट कोर कर सकता है। अपवर्तक वातायन सुखाने की प्रणाली को तैयार किया गया है। जिसमें एक साथ 60 लीटर पानी संगृह करने की क्षमता वाला थर्मास्टाट बाथ शामिल है। परिवेश की स्थिति (243 डिग्री सेल्सियस और 734 आरएच) में इस प्रणाली का उपयोग करके स्वीकार्य गुणवत्ता युक्त अमरूद बार बनाया जा सकता है।

कार्प (रोहू, कटाला, मृगल, सामान्य और बिगहेड कार्प) के उतारने के लिए एक प्रारूप मशीन का निर्माण और परीक्षण किया गया है। मशीन एक क्षैतिज पॉलीप्रोपाइलीन रोटर के साथ काम करती है जो मोटर–बेल्ट–चरली व्यवस्था के साथ संचालित होती है। मछली सफाई स्टेशन का मॉडल भी विकसित किया गया है जो कि पैरो की सहायता से बिजली द्वारा संचालित किया जा सकता है। इसमे ड्रेसिंग टेबल (100×48×120), राउंड कटर, 25.4 सेमी व्यास, जल छिड़काव प्रणाली, मोटर (1–10 एचपी, 9 400 आरपीएम) और पीवीसी चरखी (व्यास 20 सेमी), पैर रोटर और चरखी (व्यास 53 सेमी), तरल कचरा निपटान और निस्पंदन प्रणाली , ठोस अपशिष्ट निपटान प्रणाली शामिल है। यह मशीन मछली की दुकानों और प्रसंस्करण संयंत्रों में मछली को स्टीक काटने के लिए उपयोगी है। मशीन की क्षमता 2–3 किलोग्राम मछली प्रति मिनट है। मछली सुखाने के लिए सोलर आधारित तह ड्रायर का विकास किया गया है। यह चार ट्रे के साथ बनाया गया है आयाम ऊंचाई (खुले) 180 सेमी, नीचे की चौड़ाई 142 सेमी, लंबाई 180 सेमी है। यह प्रणाली मछली सुखाने के लिए उपयोगी है जो कीड़ो के प्रभाव से भी सुरक्षा करता है और इस तरह तेज दर से स्वच्छ मछली सूखाने का काम करता है।

मूंगफली की खली और परिष्कृत गेहूं के आटे से मफिन तैयार किया गया है। इस मफिन में 9.8% प्रोटीन, 1.6% कुल खनिज, 3.8 मिलीग्राम/100 ग्राम लौह और 135 मिलीग्राम/100 ग्राम कैल्शियम होता है। लोह मिश्रित गेहूं के दलिया का प्रीमिक्स छिड़काव तकनीक का इस्तेमाल करके तैयार किया गया है। केले युक्त विस्तारित स्नैक फूड एक्सट्रूजन प्रसंस्करण का उपयोग करके तैयार किया गया है। पके केले के उपयोग के पौष्टिक विस्तारित स्नैक तैयार करने के लिए अधिकतम शर्तें हैंः 8.0 ग्राम केला (100 ग्राम फीड सामग्री के लिए), 350 आरपीएम स्पीड और 14% फीड नमी। केले के साथ इस पौष्टिक विस्तारित स्नैक में वसा, कार्बोहाइड्रेट, क्रूड फाइबर, कुल खनिज, लोहा और कैल्शियम की मात्रा क्रमशः 3.8%, 73.8%, 2.3%, 2.1%, 4.5 एमजी/100

जी और 92 एमजी/100 जी है। इस केले युक्त विस्तारित स्नैक में प्रोटीन और कैलौरी की पौष्टिकता 15.5% और 391 किलोग्राम/100 ग्राम है, जो कि लगभग 50% प्रोटीन और 7–9 वर्षीय बच्चों की कैलोरी की 20% आवश्यकता को पूरा कर सकता है। फाइबर युक्त ऊर्जा बार तैयार किया गया है। अनुकूलित अनाज आधारित फाइबर युक्त ऊर्जा बार में 32% सोब्रिटोल, 18% प्रत्येक जई, जौ और मोती बाजरा, 10% अमरूद के फल का पाउडर, 2% पेक्टिन, 2% गम अरेबीक और 50 पीपीएम सूक्रोलोज मिला है।

काले चावल के पिसे हुए चोकर (मणिपुर विविधता) से एंथोसायनिन निकासी की प्रक्रिया को अनुकूलित किया गया है। थॉमसन बीज रहित अंगुर से उच्च मूल्य की हरी किशमिश तैयार की गई है। चांदी के नैनोकणों के संश्लेषण के लिए एक सरल पारिस्थितिकी पद्धति जिस में नीम के पत्तों और करी पत्तियों के हर्बल अर्क का उपयोग करके अनुकूलित किया गया है। ई. कोली की वृद्धि को रोकने में संश्लेषण नैनोकण प्रभावी पाए गए। तेल निकासी बढ़ाने के लिए एक्स–रे और अल्ट्रासाउंड प्री–ट्रिटमेंट का उपयोग अनुकूलित किया गया है। विभिन्न खाद्य व्युतपन्नों का पता लगाने के लिए आण्विक तरीकों और स्पेक्ट्रोस्कोपिक तकनीको जैसे केसर में कैलेंडुला, काले ज़िरे में सफेद जेरा और शहद में चीनी की मिलावट को अनुकूलित किया गया है।

भाकृअनुप–सीफेट ने एंड्राइड आधरित एप विकसित किया है ताकि किसानों को दूर स्थानों पर बैठकर भी कृषि–उपरांत प्रौद्योगिकी की जानकारी प्राप्त हो सकें। किसी भी समय कृषि, कृषि उत्पादन, खेती के भंडारण, प्रसंस्करण, पैकेजिंग,परिवहन आदि और संबंधित मशीनरी जैसे सभी प्रकार की फसल संबंधी जानकारी इस एप के माध्यम से किसानों को उपलब्ध किया जा सकता है। इसके अलावा, भाकृअनुप–सीफेट, अबोहर में फलों और सब्जियों के प्रसंस्करण के लिए एक पायलट प्लांट की स्थापना की गई है।

ए आई सी आर पी–पी एच ई टी द्वारा विकसित विभिन्न मशीनों, उत्पादों, और प्रकिया जैसे संशोधित पॉलीहाउस सौर ड्रायर, पोंगमिया डिकारटिकेटर, हल्दी धोने की मशीन, हल्दी राइजोम के लिए रोटरी ड्रायर, बांस शूट छीलने की मशीन, किन्नू के छिलके से पेक्टिन की निकासी के लिए पायलट सयंत्र, प्रोबायोटिक युक्त फलों से रस निकालने का सयंत्र, फलों के ओसमाटिक निर्जलीकरण के लिए पायलट संयंत्र, मछली वेंडिंग और प्रदर्शन इकाई, मल्टी मोड सौर सुखाने की मशीन, एप्पल बीज निकालने की मशीन, महिलाओं के अनुकूल ककड़ी और कददू के बीज निकालने की इकाई, लिंग अनुकूल सतत कोको पोड ब्रेकर, मांस युक्त जलेबी, थर्माप्लास्टिक कसावा स्टार्च कंपोजिट आधारित बायोडिग्रेडेबल उत्पाद आदि शामिल हैं। ए आई सी आर पी–पी.एच.ई.टी एवं पी ई टी की प्रौद्योगिकियों का प्रभाव आंकलन दो महत्वपूर्ण परियोजनाओं जैसे एफ सी आई और सी डब्ल्यू सी (गोदाम में अनाज के भंडारण के नुकसान पर अध्ययन और कुशल गोदाम प्रणाली में भंडारण नुकसान के लिए मानदंडों की सिफारिश) करने का कार्य प्रगति पर है। ए आई सी आर पी–पी ई टी की उपलब्धियों में पंजाब के ग्रीष्मकाल के दौरान मशरूम की खेती के लिए पाली–हाउस शामिल है, पृथ्वी ट्यूब हीट एक्सचेंजर के साथ गर्म और शुष्क क्षेत्रों के लिए ग्रीनहाउस डिजाइन, टमाटर की फसल पर रंगीन प्लास्टिक के प्रभाव, भाकृअनुप–सीफेट अबोहर में विकसित संशोधित सोखना शीतलन प्रणाली, सूक्ष्म सिंचाई के लिए पानी के अलवणीकरण के लिए फिल्टर, गीली घास बिछाने हेतु मशीन का विकास, स्वच्छ मछली विपणन के लिए मोबाइल मछली वेंडिंग ट्रॉली का निर्माण आदि।

शोध सम्बंधी क्रिया कलापों के अलावा संस्थान अन्य कई कार्यक्रमों जैसे कि किसानों, विद्यार्थियों, कृषि अधिकारियों और उद्यमियों को कटाई–उपरान्त प्रबन्धन से सम्बधित कई प्रशिक्षण कार्यक्रमों का भी आयोजन करता है। इस वर्ष संस्थान द्वारा 2 आईसीएआर प्रायोजित ग्रीष्म/शीत स्कूलों का आयोजन किया गया। इसके अलावा संस्थान द्वारा कृषि अधिकारियों के लिए एवं किसानों के लिए विभिन्न प्रशिक्षण कार्यक्रमों का आयोजन किया गया। विद्यार्थियों के लिए संवेदीकरण कार्यशालाएं एवं दिव्यांग बच्चों के लिए जागरूकता कार्यक्रम जैसे राष्ट्रीय विज्ञान दिवस का आयोजन किया गया।

प्रत्येक वर्ष की भांति इस वर्ष भी संस्थान ने विभिन्न कृषि प्रदर्शनियों में भाग लिया और संस्थान द्वारा विकसित प्रौद्योगिकियों एवं मशीनों का प्रदर्शन किया। प्रमुख प्रदर्शनियों में पंजाब कृषि विश्वविद्यालय, लुधियाना में आयोंजित किसान मेला, भारतीय कृषि अनुसंधान संस्थान, नई दिल्ली में आयोजित कृषि उन्नति मेला, सी आई आई एग्रोटेक का 12 वां सस्करण, चडीगढ़, क्षेत्रीय कृषि मेला, मुजफ्फरनगर इत्यादि शामिल हैं। भाकृअनुप–सीफेट ने कृषि उन्नति मेला में अपनी प्रौद्योगिकियों के प्रदर्शन के लिए प्रंशसा पत्र प्राप्त किया है। संस्थान की आधिकारिक वेबसाइट को भी उन्नत किया गया। कृषि उत्पादों के कटाई–उपरान्त प्रबंधन के बारे में जागरूकता पैदा करने के लिए रेडियो वार्ता युक्त कार्यक्रमों को आकाशवाणी जालंधर द्वारा प्रसारित किया गया है। संस्थान में साम्प्रदायिक सद्भावना सप्ताह, सतर्कता जागरूकता सप्ताह, जय किसान जय विज्ञान सप्ताह, का आयोजन किया गया। संस्थान का 27वां स्थापना दिवस पूरे हर्ष और उल्लास के साथ मनाया गया। इस वर्ष संस्थान में मेरा गॉव मेरा गौरव योजना को पूर्ण उत्साह के साथ किया गया।

खाद्य गुणवत्ता और सुरक्षा के साथ कटाई–उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी क्षेत्र में सहयोगात्मक अनुसंधान कार्य के लिए संस्थान ने एपेडा (APEDA) वं सी सी एस एच ए यू (CCSHAU) के साथ समझौता ज्ञापन पर हस्ताक्षर किए।

अनुसंधान के परिणामों को तकनीकों के रूप में वाणिज्यीकरण तथा लाईसेसिंग द्वारा प्रयोगकर्ताओं तक प्रसारित किया गया। प्रतिवेदित समयावधि के दौरान 4 तकनीकों के लाइसेंस देश के अलग–अलग क्षेत्रों के विभिन्न उद्यमियों को दिया गया, जिनमें प्रमुख है पोषक कार्यात्मक चपाती आटा, मखाना बीज के पापिंग और डिक्राटिकेशन के लिए यंत्रीकृत प्रणाली, कम वसा मांस पायसम बनाने की तकनीक, सूखे प्याज से पाउडर बनाने की प्रक्रिया शामिल है। इसके साथ ही 2 पेटेंट दाखिल किए गए है। इस वर्ष कई विशिष्ट हस्तियां जैसे कि कृषि वैज्ञानिक भर्ती बोर्ड के अध्यक्ष; अपर सचिव डेयर; उपमहानिदेशक (कृषि अभियांत्रिकी); भारतीय कृशि अनुसंधान परिषद, नई दिल्ली; सहायक महानिदेशक (प्रक्रिया अभियांत्रिकी), भारतीय कृषि अनुसंधान परिषद, नई दिल्ली; निदेशक, आदि ने संस्थान का दौरा किया है।

EXECUTIVE SUMMARY

ICAR-CIPHET is a pioneer organization mandated to undertake lead research in the area of post-harvest engineering and technology suitable to agricultural production catchment and agro-processing industries. During the reported period (2016-17), the institute has made significant progress in the area of post-harvest technology *i.e* post-harvest equipment and machinery, agricultural structures, process and products etc. Significant achievements and progress are summarized below.

Fully automatic *wadi* dropping system was fabricated with an overall dimension of 140x120x110 cm through out-sourcing with food grade stainless steel body. Total power requirement of the machine is 3.0 hp. The capacity of machine is approx 150kg/h (with each *wadi* dropping weighing about 5g). Nine different shapes of *wadi* can be made by changing the shape of the die.

Buckwheat dehuller (capacity 50 kg/h) is designed and developed. The machine consists of feed hopper (0.32 m x 0.32 m x 0.33 m), dehulling unit - emery coated roller (0.90 m length and 0.25 m diameter), seed and kernel separator (round opening screens of size 0.50 m x 0.30 m x 0.10 m) and husk aspirator. It is operated by 1 hp DC motor. The overall dimension of the dehulling machine is 1.20 m x 0.94 m x 1.45 m. The predicted values at the optimized conditions i.e. 750 rpm impeller speed, 25 kg/h feed rate and 7.10 % (w.b.) buckwheat seed moisture dehulling efficiency, brokens and husk were 67.5 %, 6.57 %, and 20.43 % respectively. Oat dehuller for dehulling of oat grain is developed on the principle of centrifugal action. The capacity of the machine is 200 kg/h. It consists of feed hopper (bottom area = 0.0036 m^2, top area = 0.16 m^2), dehulling unit – impact type with impeller (no. of vanes 5 forward curved), husk aspirator and impeller (diameter 360 mm and height 35 mm). It is operated by 1 hp DC motor. The overall dimension of the dehulling machine is 1.20 m x 0.94 m x 1.45 m. The predicted values at the optimized conditions i.e. 2500 rpm impeller speed, 75 kg/h feed rate and 6% (w.b.) oat seed moisture, were 70, 2.66, and 20.59 % dehulling efficiency, brokens and husk, respectively.

Efforts were made to develop composite peeler cum juice extractor for sweet orange and *kinnow*. A conical shaped support (34 mm diameter) is fitted for smooth functioning of peeling blade (36 mm dia). A conical hopper with flattened base and sigmoidal blade is fitted in order to facilitate the extraction of juice from peeled fruits. After peeling, the approximate weight of peeled fruit (58%), peel (37%) and juice (5%) respectively were obtained. The average peeling time/ fruit were in the range of 6-14s. An improved coring tool has been developed in order to reduce the human drudgery so that the chances of injury to the operator's hand while coring can be minimized. The respective dimensions of coring tool were: base: 15×15 cm, height: 30 cm, fruit holding cup diameter: 3.5 cm, fruit holding cup depth: 2.5 cm and coring tool diameter: 14 cm. The coring tool can core approximately 14-16 *ber* fruits/min (15-16 kg/h). A refractive window (RW) dryer system consisting a 60 litre stainless-steel

thermostatic bath filled with tap water for drying of guava pulp was designed and evaluated.The water surface is covered with a tray (400 × 370 mm) fitted with Mylar™ film (an infrared-transparent film of 80 μ thickness) for uniform spreading of pulp. The optimum condition for preparation of guava bar with acceptable quality using this RW drying system at ambient conditions (24 ± 3°C and 73 ± 4% RH) is water temperature (87°C), film thickness (2.5 mm) and guava pulp TSS (15°Brix) with a drying time of 22 min.

A prototype machine for descaling of carp (rohu, catla, mrigal, common carp, silver carp, and bighead carp) is fabricated and tested. The machine worked with a horizontal polypropylene rotor which is operated with motor-belt-pulley arrangement. The rotor contained steel spikes with zig-zag fashion. The cleaning efficiency was found to be around 70%. The second model of fish cleaning station is also developed which can be operated either manually by foot or mechanically by electricity. It consists of dressing table, round cutter, water spraying system, PVC pulley, foot rotor and pulley, liquid waste disposal, filtration system and solid waste disposal system. The machine is useful for steak cutting in fish retail shops and processing plants. The capacity of the machine is 2-3 kg fish (caps)/min. Solar based foldable tent dryer for fish drying is also developed. It is framed in MS pipe with four meshed trays. The dryer is useful for fish drying which protects insect infestation and thus hygienic drying with faster rate.

Dehulled de-skinned groundnut meal (DDGM) and refined wheat flour (RWF) based formulation for muffin was optimized with 72.5% level of RWF and 27.5% DDGM. The muffins contains 9.8% protein, 1.64% total minerals, 3.82 mg/100 g iron and 135 mg/100 g calcium with overall acceptability score as 7.8. Iron fortified wheat *dalia* premix was prepared using spraying technique for addition of fortificant namely ferrous sulphate to the wheat grits, followed by tempering and drying. Nutritious expanded snack food is developed utilizing food grains (maize, defatted soy flour, sesame seed) and banana pulp using extrusion processing. The optimum conditions for preparation of nutritious expanded snack utilizing ripe banana are: 8.0 g banana pulp (per 100 g feed material), 350 rpm screw speed and 14% feed moisture. The fat, carbohydrates, crude fibre, total minerals, iron and calcium content in this nutritious expanded snack was 3.9%, 73.8%, 2.29%, 2.1%, 4.48 mg/100 g and 92 mg/100 g, respectively. The protein and calories in this banana incorporated nutritious snack was 15.5% and 391kcal/ 100 g, which could fulfill about 50% of protein and 20% of calorie requirement of a 7-9 years old child. Fiber rich low energy bar have been prepared. The optimized cereal based fiber rich bar contained 32% sorbitol, 18% each of oats, barley and pearl millet, 10% guava fruit powder, 2% pectin, 2% gum Arabic and 50 ppm of sucralose. Final product was baked at 200 °C temperature for 20 min.

Process of extraction anthocyanin from bran of black rice was optimized (Manipur variety, Chakhao poireiton) (40 BSS, 0.420 mm) using 3 solvents *i.e.* methanol with 1% HCl, acetone with 1N HCl and methanol with 1N HCl and three different pre-treatments *viz.* ultrasonic (15, 45, 75 min), microwave (5, 15, 25 min) and shaking (15, 45, 75 min) at temperature of 40°C and 60°C. High value green raisins from Thompson seedless grapes were prepared by pre-treatment with 4% $CuSO_4$ for 4 min followed by air drying at 68°C. Encapsulation of oil-in-water emulsion of curcumin in alginate was carried out by air atomization technique with an in-house developed micro-encapsulator. The maximum release of curcumin was 69.8% after 2 h. Besides,

fortified bread with hybrid microcapsules (flaxseed oil, garlic oil, fish oil, flaxseed oil + garlic oil, and fish oil + garlic oil) have been prepared. Soy and ground nut protein isolate having protein content 90.9 % (d.b.) and 91.7 % (d.b.), respectively were prepared. Protein supplements utilizing groundnut protein isolate (protein 91.7 %, db) and soy protein isolates (protein 90.9%, db) were prepared. The other ingredients were sugar 8.5% and cocoa powder 1g/100g. The protein content in protein supplements is 78-80%.

A simple ecological method for the synthesis of silver nanoparticles was optimized using herbal extracts from neem leaves *(Azadirachta indica)* and curry *(Murraya koenigii)* leaves. The synthesized nanoparticles were found to be effective in retarding the growth of *E.coli.* Various pre-treatments for enhancing oil recovery viz. use of wheat bran fibers, x-ray pretreatments and ultrasound pre-treatment have been optimized. Molecular methods and spectroscopic techniques for detection of different food adulterants such as calendula in saffron, *safed zeera* in *kala zeera* and sugar in honey were also optimized.

The AICRP on Post-Harvest Engineering & Technology developed various machines, products and process protocols such as modified ANGRAU polyhouse solar dryer for chillies, pongamia decorticator, turmeric washer, rotary dryer for turmeric rhizomes, bamboo shoot peeling machine, pilot plant for extraction of pectin from kinnow peel, pilot plant for production of probiotic fruit juices, pilot plant for osmotic dehydration of fruits, refrigerated fish vending and display unit, multi-mode solar drier, apple seed extractor, multipurpose women friendly seed extractor for ash gourd, cucumber and pumpkin, gender friendly continuous cocoa pod breaker, continuous garlic clove peeler, fermented beverages from banana pseudo-stem, meat jalebi, thermoplastic cassava starch composites based biodegradable products etc. Two important projects like Impact Assessment of Technologies of ICAR-CIPHET, AICRP on PHET, PET and study on storage losses of food grains in FCI and CWC warehouse and to recommend norms for storage losses in efficient warehouse system is in progress. The achievements of AICRP on Plasticulture Engineering and Technology (PET) included poly-house for cultivation of mushroom during summers in Punjab, design and evaluation of earth tube heat exchanger (ETHE) coupled greenhouse for hot and arid region, performance evaluation of ETHE coupled greenhouse, development of semi-permanent shade net house to reduce the sun burn of pomegranate fruits in hot and arid region of Punjab, heating and cooling of polyhouse using ETHE, performance of asparagus cultivation within naturally ventilated polyhouse (NVP) as compared to open field condition, effect of coloured plastic mulches on tomato crop, modified adsorption cooling system developed at ICAR-CIPHET Abohar, filter for desalination of water for micro-irrigation, development of mulch laying machine, mobile fish vending trolley for hygienic fish marketing etc.

During 2016-17, ICAR-CIPHET organized training for farmers, officer's, entrepreneurs and students. Two ICAR sponsored summer/ winter schools i.e. "Engineering and Technology Innovations in Developing Health Foods" and "Approaches to Identification, Quantification and Reduction of Post-Harvest Losses in India"; two model training courses sponsored by Directorate of Extension (DOE), Ministry of Agriculture and Farmer Welfare i.e. "Processing, Value Addition and Entrepreneurship Development in Food Agri-Business" and "Post-Harvest Supply Chain/Cold

Chain Management of Vegetables"; four entrepreneurship development program (EDP); six farmers training; three officer's training were organized at the institute. A total of 144 students was also trained during this period. ICAR-CIPHET has also developed android based App to help farmers to get information by sitting at far places. All types of post-harvest related information on agricultural produce such as harvesting, on-farm storage, processing, packaging, transportation etc. and related machinery at any point in time, and any number of times is available on finger tips of farmers through this App. In addition, a pilot plant for processing of fruits and vegetables has been established at ICAR-CIPHET, Abohar.

The institute also participated in 9 different exhibitions/*melas* across the country such as "*Kisan Mela*" at PAU, Ludhiana; "12th edition of CII Agro Tech", Chandigarh;"*Krishi Kumbh*- Regional Agricultural Fair", Muzaffarnagar; "*Krishi Unati Mela*", IARI, New Delhi. Institute technologies were showcased and demonstrated to various stakeholders like farmers, entrepreneurs and researchers. ICAR-CIPHET also got appreciation certificate for showing their technologies in *Krishi Unati Mela*, New Delhi. Two industrial meet was also organized during this period at ICAR-CIPHET, Abohar and CCSHAU, Hisar.

The research outcomes were disseminated in the form of technology licensing and commercialization to various end users. A total of 4 technologies were licensed *viz.* nutritious functional *chapatti* flour, mechanized system for popping and decortications of *makhana* seeds, Low fat meat emulsion and process for making and dried onion flakes powder. Two patents were also filled during the period for grader for oblong and round fruits and vegetables and live fish carrier system and method of transportation of live fish therein. Memorandum of understanding was signed with APEDA, New Delhi and CCSHAU, Hisar.

Many distinguished personalities viz. Eng. Afonso Pedro Canga, Minister of Agriculture & Rural Development, Republic of Angola along with his team; Chairman, ASRB; Deputy Director General (Agril. Engineering), ICAR, New Delhi; Deputy Director General (Education), ICAR, New Delhi; Assistant Director General (Process Engineering), ICAR, New Delhi; Assistant Director General (Farm Engineering), ICAR, New Delhi visited the institute. A total of 1370 people visited ICAR-CIPHET during this period, which includes group of farmers, students and officials from different states across the country.

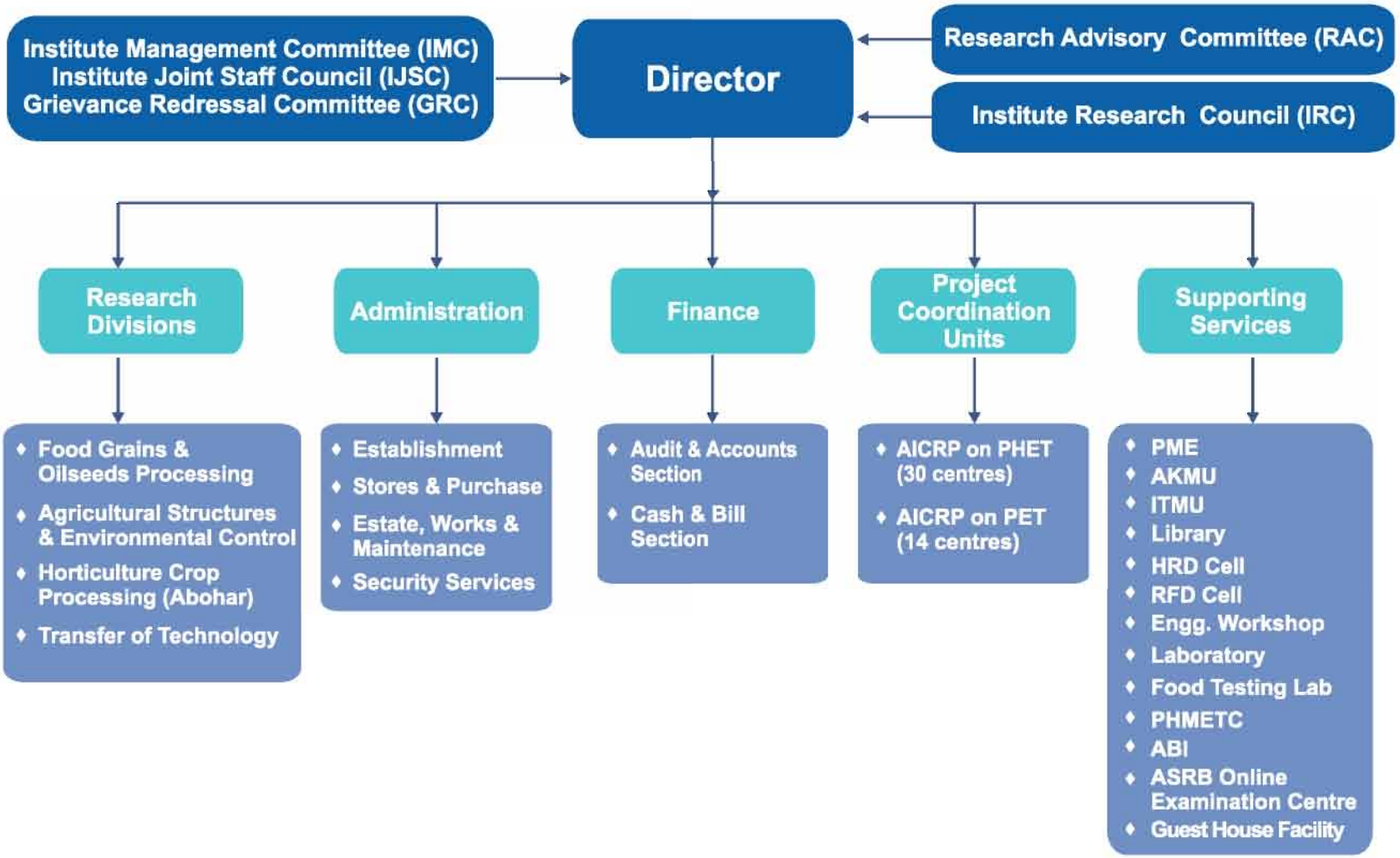
Vision

Higher profitability of agricultural production systems ensuring better income to farmers and increased employment opportunities in rural sector through efficient post-harvest engineering and technological interventions for loss reduction and value addition to agricultural produce and by-products resulting in high quality and safe food and feed at competitive prices for domestic and export markets.

Mandate

- Research for solving problems and identifying technologies related to post-harvest loss assessment and prevention, processing, value addition and storage of agricultural, horticultural, livestock, and aquaculture produce targeted to achieve food safety and quality assurance.
- Human resource and entrepreneurship development in post-harvest engineering and technology.

ORGANIZATIONAL STRUCTURE



OVERVIEW

The ICAR-Central Institute of Post-Harvest Engineering and Technology (ICAR-CIPHET) was established on 29th December 1989 at Ludhiana, Punjab (India); as a nodal institute to undertake lead researches in the area of post-harvest engineering and technology appropriate to agricultural production catchments and agro-industries. The institute's second campus was established on 19th March 1993 at Abohar, Punjab and is primarily responsible for conducting research and development activities on fruits and vegetables. ICAR-CIPHET is also headquarter to two All India Coordinated Research Projects (AICRPs) viz. AICRP on Post-Harvest Engineering and Technology (PHET) with 30 centres and AICRP on Plasticulture Engineering and Technology (PET) with 14 centres spread over the country.

Research Divisions

Ludhiana Campus

1. Agricultural Structures and Environment Control
2. Food Grains and Oilseeds Processing
3. Transfer of Technology

Abohar Campus

4. Horticultural Crops Processing

Consortium Research Platforms (CRPs)

1. CRP on Secondary Agriculture
2. CRP on Health Food

Infrastructure

Workshop

The workshop at ICAR-CIPHET, Ludhiana and Abohar manage fabrication and modification of post-harvest machinery, designed and developed under different research projects. Workshops also extend service support to repair and maintenance of institute facilities/ work etc. from time to time. Workshops have necessary facilities such as lathe machines, drilling machine, gas welding set, arc welding set, sheet bending machine etc. to deliver its services. Besides, various measuring instruments are also available in the workshops, which are used frequently for various research purposes.

Agro Processing Centre (APC)

The main objective of establishing agro-processing centres is to process the agricultural produce in production catchment with a view to enhance employment and augment income opportunities in rural areas. At ICAR-CIPHET, state-of-the-art agro-processing centre has been established for processing of bengal gram, green gram, pigeon pea, maize, black pepper, turmeric, coriander etc. The processed products are regularly being sold to the customers in and around Ludhiana.

Staff Position (2016-17)

Category	Sanctioned	Filled		Total Filled	Vacant
		Ludhiana	Abohar		
Scientific	76*	35	11	46	30
Administrative	21#	15	03	18	03
Technical	29	16	08	24	05
Supporting	05	03	01	04	01
Total	**131**	**69**	**23**	**92**	**39**

* Excluding Director # Including SAO

Discipline-wise distribution of scientific strength (2016-17)

Discipline	Pr. Scientist	Sr. Scientist	Scientist	Total
Agricultural Process Engineering	4*	1	13	18
Agricultural Structures & Environmental Management	-	-	3	3
Soil Water Conservation Engineering	1	-	-	1
Food & Nutrition	1	-	-	1
Food Technology	1	-	4	5
Agricultural Microbiology	1	-	2	3
Biotechnology (Plant Science)	-	1	-	1
Chemical Engineering	1	-	-	1
Biochemistry (Plant Science)	-	2	1	3
Electronics & Instrumentation	-	-	1	1
Horticulture	-	1	1	2
Home Science	-	-	1	1
Agricultural Economics	1	-	-	1
Agricultural Extension	-	-	1	1
Fish Processing Technology	-	1	1	2
Livestock Product Technology	-	-	2	2
			Total	**46**

*Excluding Director

During the reported period, the total revenue generated was Rs 1,19,835/- against the sale of processed products like *dal*, *besan*, ground spices etc. Besides, the APC facilities are also used for imparting hands-on-training to prospective small rural entrepreneurs.

Food Testing Laboratory

Food Testing Laboratory established at the Institute houses basic and some of the most advanced equipment for food analysis and evaluating the safety aspects of food products. This laboratory particularly caters to the food testing and quality analysis requirements of different stake holders, entrepreneurs in getting their samples tested. Testing protocols for certain parameters like water quality, fat, protein and fibre analysis, mineral contents etc. have been validated. This facility enable the institute to answer the need based test requirement of processers, entrepreneurs, small and medium enterprises and industry at affordable testing charges.

Post-Harvest Machinery & Equipment Testing Centre

The institute has been authorized for testing all types of Post-harvest machinery and equipment by Mechanization & Technology Division, Department of Agriculture & Co-operation, Ministry of Agriculture & Farmers Welfare, Govt. of India to ensure supply of quality post-harvest equipment and machinery by the manufacturers to the end users. This testing facility at ICAR-CIPHET is one of its kind in the country for testing of post-harvest machinery.

Agri-Business Incubation (ABI) Centre

Agri-Business Incubation (ABI) facility is also available at the institute. The centre is established with the financial help of ICAR, New Delhi under National Agricultural Innovation Fund (NAIF). The main objective of this centre is to encourage, nurture and support technologists, scientists and innovative agribusiness ideas to turn their innovations into sound commercial ventures. This helps in initiating technology-led and knowledge-driven enterprises. It is now well-proven that such mechanisms help not only in the growth of technology-based new enterprises but also in improving their survival rate substantially. The main objectives of the centre are

- Providing technology, skill up-gradation and incubation leading to promotion of viable enterprises and generation of employment opportunities to entrepreneurs
- To undertake last mile scale-up from pilot level of value chain in collaboration with stakeholders.
- To impart training and capacity building to prospective entrepreneurs in agribusiness ecosystem.

Library

ICAR-CIPHET library act as a rich repository of knowledge and information related to institute's mandate. It has good collection of books and journals in the area of post-harvest engineering, food processing, food engineering, food microbiology, food biochemistry, food bio-technology etc. During the reported year, the total number of books and standards in the library were 5085 followed by subscription of 9 Indian journals. The library as a member of Consortium for e-Resources in Agriculture (CeRA) is getting access to more than 2000 online full text journals and e-books. In addition of these, a number of national and international serial publications, annual reports, newsletters and research bulletins were received on gratis. Wi-Fi facility is available in the library for the users to access internet services. Current content service of journals and list of new arrivals is also being circulated among the ICAR-CIPHET staff.

Guest House

Both Ludhiana and Abohar campus has guest house facilities for providing accommodation to ICAR/SAUs/Government employees and farmers. One International Training Centre with 08 AC-rooms and dining hall with kitchen is also available at Ludhiana campus.

Units

Prioritization, Monitoring and Evaluation (PME) Cell

Prioritization, Monitoring and Evaluation concept is the key management tool in R&D system to enhance scientific productivity. It helps in setting a unified priority and monitoring of externally funded and in-house projects. PME cell of the institute conducts Institute Research Council meeting and maintains the record of research projects. The monthly, quarterly, half yearly performance review reports of individual scientist are collected and compiled into progress reports of the institute. It also acts as link between various regional committee meetings, directors' conferences etc. and the institute scientists. The exchange of information takes place through PME cell. The database of parliament questions and their answers, action taken reports and issues related to scientific activities of the institute are managed by PME cell. The research information related to ongoing and completed research projects is uploaded through Project Information and Management System (PIMS) and MIS-FMS to avoid duplication in research.

Institute Technology Management Unit (ITMU)

The Institute Technology Management Unit is responsible for Intellectual Property (IP) protection, management and transfer/commercialization of technologies developed by the institute. ITMU plays a crucial role in management of technologies. The role of ITMU is to encourage and accelerate the efforts towards development of technologies in the field of post-harvest management and to facilitate the transformation of ideas, inventions and technologies developed by the institute into commercial ventures to serve the society. ITMU since its inception has been involved in protection, management and commercialization of intellectual property generated by the institute. A total of 53 patent applications have been filed through ITMU out of which six patents have been granted. Rigorous efforts of ITMU have lead to the commercialization of 45 technologies developed by ICAR-CIPHET.

Agricultural Knowledge Management Unit (AKMU)

The institute has an Agricultural Knowledge Management Unit (AKMU) for the scientists and staff for data analysis and electronic communication. The unit has latest configuration desktop computers including three servers. More than 100 desktop computers of the institute are well connected through Local Area Network (LAN). Wi-Fi connectivity is available through 100 mbps line provided by National Knowledge Network (NKN). Internet is provided to different nodes through proxy server Nebero. The Nebero facility provides the information of internet bandwidth; user details, firewall security and stability on the network. Besides, AKMU houses a number of analysis and design software such as Design Expert Software, Creo Parametric, Corel draw graphics Suite, Adobe Professional, Network anti-virus, Unique code (Hindi Software) etc. The institute's website *www.ciphet.in* is also being maintained by AKMU.

Project Coordination Units

AICRP on Post-Harvest Engineering and Technology (PHET)

The All India Coordinated Research Project on Post-harvest Engineering and Technology was launched by the Indian Council of Agricultural Research in September 1972. The project is currently operating from 30 centres covering almost all states and agro-climatic zones of the country. The aim is to develop location and crop specific post-harvest technologies and equipment to minimize quantitative and qualitative post-harvest losses and to produce value added products from agricultural crops including livestock and their by-products. The major activities are: (i) Adoption/development of equipment/technologies for reduction in post-harvest losses in critical stages/operations, as well as crop/commodity-wise (ii) Development of need based agro-processing centres (APCs) in different production catchments for income augmentation and employment generation (iii) Value added products from agricultural crops/commodities (iv) Prototype production and process refinement with a view to develop appropriate complete packages for post-harvest utilization of crops/commodities and their by-products (v) Multi-location trails and demonstration of the post-harvest technologies.

AICRP on Plasticulture Engineering and Technology (PET)

AICRP on Plasticulture Engineering and Technology is operating with 14 cooperating centres in the country in different agro-climatic zones with coordinating unit at ICAR-CIPHET, Ludhiana. Sanctioned budget of the scheme for 2016-17 was 278.00 lakhs. Currently, total 43 projects are ongoing in which 22 were approved as new projects in the 12th annual workshop, 2016 of the scheme and 21 projects concluded. The role of PET has been instrumental in the development or modification of technologies related to Plasticulture in horticulture, irrigation, intensive fish culture and animal housing as per the mandated area of the centres.

Statement of Budget Estimates and Expenditure (2016-2017)

Plan

(Rs. in Lakhs)

Sr.No.	Account Head	Budget	Expenditure
1.	Institute	402.76	402.73
2.	AICRP on PHET	1881.67	1881.67
3.	AICRP on PET	278.00	278.00
4.	CRP on Secondary Agriculture	221.35	219.70
5.	CRP on Health Food	164.51	163.99
	Total	**2948.29**	**2946.09**

Non - Plan

(Rs. in Lakhs)

Sr.No.	Account Head	Budget	Expenditure
1.	Institute	851.00	837.96
2.	AICRP on PHET	19.00	18.52
3.	AICRP on PET	19.00	18.98
	Total	**889.00**	**875.46**

Revenue Generation

During the year 2016-17, the institute generated Rs. 26.29 lakhs revenue against target of Rs. 56.53 lakhs

RESEARCH ACHIEVEMENTS

Post-Harvest Equipment and Machinery

During the reported period significant progress was made in the area of post-harvest technology i.e post-harvest equipment and machinery, agricultural structures, process and products etc. Some of the technologies were fully developed and tested and some are under development. Overall significant achievements and progress are given below.

Vegetable Mixed *Wadi* Making System

Fully automatic *wadi* dropping system was designed and developed with overall dimension 140 x 120 x 110 cm made with food grade stainless steel body. The capacity of machine is approximately 150 kg / h (each *wadi* dropping weight about 5 g). Nine different shapes of *wadi* can be made by changing the die. The hand operated *wadi* dropping machine is also developed with the overall dimension of 540 x 260 x 340 mm, hopper 310 x70 x 129 mm. The hopper angle is kept at 25° for easy discharge of batter. The capacity of the machine has been estimated to be 15 to 18 kg of *wadi* per hour. The machine is mounted on a table top with dimensions (800 x 400 x 19 mm), base frame made up of cast iron. The idea is to operate hand operated system with foot while in sitting position to reduce drudgery.

Fully automatic *wadi* dropping system

Buckwheat Dehuller

Buckwheat dehuller of capacity 50 kg / h is designed and developed for dehulling of this gluten free and highly nutritive grain. The machine was fabricated in ICAR-CIPHET workshop. The machine consists of feed hopper (0.32 m x 0.32 m x 0.33 m), dehulling unit - emery coated roller (0.90 m length and 0.25 m diameter), seed and kernel separator (round opening screens of size 0.50 m x 0.30 m x 0.10 m) and husk aspirator. It is operated by 1 hp DC motor. The overall dimension of the dehulling machine is 1.20 m x 0.94 m x 1.45 m.

Performance evaluation of buckwheat dehuller has been carried out to optimize the machine/process parameters for efficient dehulling of buckwheat grains considering three levels of grain moisture (6, 7.5 and 9% w.b.), roller speed (500, 750 and 1000 rpm) and feed rate (25, 50 and 75 kg/h). Seventeen

Buckwheat dehuller

Oat dehuller

set of experiments were designed following Box-Benken Design of RSM using Design Expert software. Every set of experiment was performed using 2 kg sample size. Dehulling efficiency, broken and husk recovery in all the seventeen samples ranged from 53.13 - 68.56, 4.23 - 10.34 and 15.47 - 24.42 %, respectively. Optimum conditions for dehulling of buckwheat using the developed buckwheat dehuller were determined based upon maximum dehulling with minimum broken while keeping the independent parameters (grain moisture, roller speed and feed rate) in the range. The results of numerical optimization indicated that dehulling performance could be maximize if the developed buckwheat dehuller is operated at impeller speed of 750 rpm and feed rate of 25 kg/h using cleaned and graded oat seed having 7.10 % (w.b.) moisture. The predicted values at these optimized conditions were 67.5, 6.57, and 20.43% dehulling efficiency, brokens and husk, respectively.

Oat Dehuller

Oat dehuller for dehulling of oat grain is developed on the principle of centrifugal action. Centrifugal acceleration is used to separate the outer hull from the inner oat groats. The capacity of the machine is 200 kg / h. It consists of feed hopper (bottom area = 0.0036 m^2, top area = 0.16 m^2), dehulling unit – impact type with impeller (no. of vanes 5 forward curved), husk aspirator and impeller (diameter 360 mm and height 35 mm). It is operated by 1 hp DC motor. The overall dimension of the dehulling machine is 1.20 m x 0.94 m x 1.45 m.

Experiments *w.r.t.* to performance evaluation of oat dehuller were carried out to optimize the machine/process parameters for efficient dehulling of oat grains considering three levels of seed moisture (6, 9 and 12% w.b.), impeller speed (1900, 2200 and 2500 rpm) and feed rate (75, 150 and 225 kg/h). Seventeen set of experiments were planned following Box-Benken Design of response surface methodology using Design Expert software. Every set of experiment was carried out using 500 g sample size. Dehulling efficiency, broken and husk recovery in all the seventeen samples varied between 31.91 to 68.78, 1.15 to 5.56 and 17 to 24.8%, respectively. Optimum conditions for dehulling of oat using the developed dehuller were determined based upon maximum dehulling efficiency with minimum broken while keeping the independent parameters in the range. The results of numerical optimization

indicated that dehulling performance could be maximize if the dehuller is operated at impeller speed of 2500 rpm and feed rate of 75 kg/h using cleaned and graded oat seed having 6% (w.b.) moisture. The predicted values at these optimized conditions were 70.0, 2.66, and 20.59% dehulling efficiency, brokens and husk, respectively.

Improved Process and Machinery for Enhanced *dhal* recovery from Pigeon Pea

Pitting is the most important unit operation performed for every pulse prior to any pre-milling treatment for dehulling. However, dedicated machine for pitting was not developed so far. Further, there is a need to develop improved process and machines for pulse dehulling to reduce milling losses. Therefore the water absorption kinetics of pigeon pea (unpitted and pitted seeds) was studied. Behaviour of pigeon pea under uni-axial compressive load was studied. Hertz's theory of contact stresses was applied to predict the splitting and failure of cotyledons during uni-axial compressive loading between two rigid parallel plates. The apparent modulus of elasticity of pigeon pea decreased from 280.52 to 9.29 MPa when force was applied normal to the hilum joint (horizontal loading), whereas it decreased from 208.08 to 33.37 MPa when force was applied in the direction of the hilum joint (vertical loading) with an increase in moisture content from 5.3 to 34.6% (d.b.). At higher moisture contents (15.2% and above), the grains yielded after considerable deformation, thus showing a change in nature from brittle to ductile. Distribution of stresses below the point of contact were calculated and plotted to predict the location of the critical point, which was found at 0.45 to 0.75 mm and at 0.50 to 0.67 mm below the contact point in vertical and horizontal loading, respectively, depending on moisture content. The bio-yield of pigeon pea grains was due to breakage of the cotyledons in horizontal loading, whereas it was due to separation of the cotyledons in vertical loading. Separation of the cotyledons from each other was initiated before yielding of the cotyledons at lower moisture contents, and thus splitting of the seed took place.

A model of scratching machine based on abrasion and cutting was developed and evaluated initially. Based on findings, another pitting machine was developed to create cracks on the hull. A concave of 340 mm diameter was made using wire mesh screen made from tempered steel of 8 mm diameter. The concave was fitted with the scratching machine and evaluated. It was observed that the percentage of grains having cracks increased but the problem of split formation was observed. To overcome this problem, the cylinder was also made from the same wire mesh. Clearance between cylinder and concave was kept as 20 mm. Performance evaluation of the machine showed that the cracks in hull were created in more than 90% grains in medium-hard-to-mill pigeon pea after 60 s of pitting. In case of hard-to-mill pigeon pea samples, the cracks in hull were observed in more than 80% grains. Further, it was observed that in more than 50% grains, multiple cracks in the hull were formed. Preliminary trials indicated that the pitted grains can be dehulled in single pass after oil treatment.

Physical Properties of Paddy Variety (MTU-1010 & BB-11) Suitable for Flaking

The study of the physical properties of paddy variety (MTU-1010) suitable for flaking at five different moisture content (11.11%, 13.63%, 19.04%, 25%, 28.2% d.b.) was done. The values of the physical properties determined are given as: The length of paddy grain varied from 9.33 to 9.52 mm, the width varied from 2.27 to 2.45 mm whereas the thickness varied from 2.22 to 2.36 mm at different moisture content. The arithmetic mean diameter ranged from 4.61 to 4.77 mm whereas the geometric-mean diameter ranged between 3.609 and 3.80 mm. The sphericity was found in the range of 0.386 to 0.399. The surface area of paddy increased from 40.92 to 45.44 mm^2 when the moisture content was increased from 11.11% to 28.20% (d.b). The 1,000 seed mass increased linearly from 22.25 to 25.57 g with increase in moisture content. Bulk density of paddy decreased from 563.62 to 514.76 kg/m^3 with increase in moisture content. The static coefficient of friction increased significantly with moisture

content for all the surfaces. The static coefficient of friction ranged from 0.47 to 0.64, 0.62 to 0.78, and 0.43 to 0.63, respectively for plywood, mild steel, and galvanized iron surfaces in the experimental moisture content range. Further, the study of the physical properties of paddy variety (BB-11) suitable for flaking was also carried out at five different moisture content (11.90%, 16.63%, 20.22%, 24.20%, 27.86% d.b.). The values of the physical properties determined are given as: The length of paddy grain varied from 7.17 to 7.38 mm, the width varied from 2.63 to 2.68 mm whereas the thickness varied from 1.97 to 2.03mm at different moisture content. The arithmetic mean diameter ranged from 3.92 to 4.03 mm whereas the geometric-mean diameter ranged between 3.29 and 3.38 mm. The sphericity was found in the range of 0.448 to 0.458. The surface area of paddy increased from 33.98 to 35.87 mm^2 when the moisture content was increased from 11.90% to 27.86% (d.b). The 1,000 seed mass increased linearly from 20.00 to 23.57 g with increase in moisture content. Bulk density of paddy decreased from 632 to 605 kg/m^3 with increase in moisture content. The static coefficient of friction increased significantly with moisture content for all the surfaces. The static coefficient of friction ranged from 0.43 to 0.69, 0.58 to 0.79, and 0.39 to 0.68 respectively for plywood, mild steel, and galvanized iron surfaces in the experimental moisture content range.

Composite Peeler cum Juice Extractor for Sweet Orange and *Kinnow*

A conical shaped support (34 mm dia) is fitted for smooth functioning of peeling blade (36 mm dia). The position of machine components (cutting knives, shaft, gear etc.) was optimized for effective space utilization. A conical hopper (upper diameter: 6 inch, lower diameter: 4 inch, height: 4 inch) with flattened base is fitted in order to facilitate the extraction of juice from peeled fruits. The hopper of juicer is modified by fitting a sigmoidal blade in order to eliminate the use of plunger to automatize the juice extraction. After peeling, the approximate weight of peeled fruit (58%), peel (37%) and juice (5%), respectively were obtained. Experiments were carried out on peeling of sweet lime at 220, 256, 282,

Side view of the developed peeler cum juice extractor

308 and 362 rpm, respectively. The average thickness of peel was in the range of 2.50 ± 0.12 to 2.69 ± 0.22 mm. The juice loss was minimum (3.7%) at 220 rpm and maximum (15.7%) at 362 rpm, respectively. The average peeling time/ fruit was in the range of 6-14 s.

Improved Coring Tool for *Ber* Fruits

An improved coring tool has been developed in

Ber fruits coring tool

order to reduce the human drudgery so that the chances of injury to the operator's hand while coring can be minimized. The respective dimensions of coring tool were: base: 15×15 cm, height: 30 cm, fruit holding cup diameter: 3.5 cm, fruit holding cup depth: 2.5 cm, coring tool diameter: 14 cm. The coring tool can core approximately 14-16 *ber* fruits / min (15-16 kg/h).

Refractive Window (RW) Dryer System

The fabricated refractive window (RW) dryer system for guava pulp consisted of a 60 litre stainless-steel thermostatic bath filled with tap water. The water surface is covered with a tray (400 × 370 mm) fitted with Mylar™ film (an infrared-transparent film of 80μ thickness) for uniform spreading of pulp. The experiments were carried out in the laboratory at ambient conditions (24 ± 3°C and 73 ± 4% RH). A fan was placed close to the drier assembly to assist faster removal of water and keep the process controlled by internal moisture diffusion. Experiments were carried out using response surface methodology (Box-benken design) with the selected process variables as water temperature (87, 92, 97°C), film thickness (2, 3, 4 mm) and guava pulp total soluble solids (15, 20 and 25°Brix). Efficacy of the overall process was investigated using the responses as drying time (DT), ascorbic acid content (AA), titrable acidity (TA) and colour (L, a*, b*) of the final product (guava bar). The drying parameters were optimized using RSM. Drying of guava pulp was continued till the moisture content of the product reached to 15-20 % w.b. It was observed that increase in water temperature resulted in decrease of DT, whereas DT increased with increase in film thickness and pulp TSS. The optimum condition for preparation of guava bar with acceptable quality using this RW drying system was water temperature (87°C), film thickness (2.5 mm) and guava pulp TSS (15°Brix) with a drying time of 22 min. The AA, TA, L, a* and b* values were 236 mg/100, 1.91%, 70, 5 and 38, respectively. Experimental results suggested that the RW drying can be used effectively for preparation of quality guava bar.

Hybrid Cold Storage Structure for Onion and Tomato

Evaporative cooling followed by desiccation in conjunction with refrigeration system may prove as less energy intensive method for storage of perishables. Balls of 25-30 mm diameter prepared from wheat, paddy and guar straws were evaluated for their efficacy to adsorb water vapour. A desiccation system was also designed and optimized. Guar straw balls were found effective in adsorbing water vapours up to 6 h. Evaporative cooled room (EC room 2 T) coupled with guar straw based dehumidification system was evaluated for storage of onions and tomatos. The dehumidification system

Assembly of refractive window drying system for pulp drying

Guar straw ball based dehumidification system for evaporative cooled room

consists of three layers of desiccant material filled in 430×430×100 mm compartments, which are connected in series via venturi system. Desiccant balls of 25-30 mm diameter were prepared from guar straw and used in the system. Complete desiccation system is 2280 mm long. Both ends of the system open inside the EC room. One opening is of 430×430 mm fitted with exhaust fan whereas other opening is of 300×300 mm through which humid air enters into the system and passes through the desiccant material. Dried guar straw balls (6% moisture content) are filled into the compartments. The humid air (80-95% relative humidity) passes through the desiccant balls where the water vapour is adsorbed. The system maintains relative humidity of 65-70% during operation. The moisture content of guar straw balls reaches to about 28% in 6 h and thereafter regeneration of balls is required. The balls can be used repeatedly after regeneration for about 30 days. Regeneration of balls can be done by passing hot air of 60°C. An air conditioner is also fitted into the EC room to maintain the requisite temperature. This system was evaluated for bulk storage of onions and tomatoes. The study revealed that the onion can be stored safely in EC room with the operation of desiccation system for more than 45 days with maximum PLW of 2.5%. Tomato can be safely stored up to 30 days when AC was operated at 16°C with maximum PLW of about 5%. Depending upon the commodity to be stored, the requisite temperature and RH can be maintained in this system.

Continuous Primary Processing and Shrink Packaging Line for Cauliflower and Cabbage

Shrink packaging of fruits and vegetables is a common practice in developed world. It has the capability of not only increasing the shelf life but it protects the vegetables from minor mechanical injuries and dust also. The line includes stem cutting system, cleaning system, film wrapping and sealing machine and shrink packaging system. Study showed that the cauliflower harvested from field contains 62.6±5.9% by-product (stem and leaves) and remaining part is utilized for human consumption. However, the cauliflower which comes in market contains 35.4±6.6% by-product in the form of stem and petiole of leaves. Presence of leaves partially protects the PLW. Force deformation behavior of cauliflower under quasi static compressive loading for the two types of cauliflower samples i.e. cauliflower with petiole; and cauliflower curd were studied. The average force required for bio-yielding of cauliflower with petiole was 279.83±82.85 N at deformation of 15.93±3.09 mm whereas for cauliflower curd without petiole was 242.92±41.52 N, and 15.84±3.16 mm. It was observed that cauliflower with petioles were more susceptible to mechanical injuries. A system for wrapping polyethylene film on cauliflower was developed. It consists of film wrapping, and sealing the film at top and sides. The film wrapped cauliflower goes for shrink packaging machine. The complete line has capacity of 500 kg/h for cauliflower.

Onion Neck Folder

Designed and developed onion neck folder having drum and 4 wheels. It can be operated manually by pushing and also can be motor operated. Evaluated the performance of developed onion neck folder in onion field of ICAR-CIPHET farm. Refinement and modification is needed for betterment of operation with operator seat, cover and proper motor operation.

Onion neck folder

Onion root and neck remover

Onion Root and Neck Remover

Designed and developed onion foliage/ neck and root remover. Fabrication of onion foliage removal unit prototype is accomplished in ICAR-CIPHET workshop. Cutter components were fabricated using food grade stainless steel while other parts were made of mild steel. Developed unit was tested using bulbs with foliage.

Smart Device for Automatic Detection and Identification of Insect Infestation and Level of Infestation.

A table top device with shade free imaging chamber, slow moving conveyor assembly, linear vibrating feeding assembly with imaging device platform was designed. Conveyor assembly is fabricated with conveyor base frame of size 55x20x4cm with food grade PVC seamless belt (990x150x3 mm) in three colours *viz*. white, green and black. The power transmission assembly is made with 240V AC synchronous motor with suitable gear reduction. Linear vibrating slow feeding chute along with feed hopper is fabricated to hold 2.5-3 kg of wheat. The development and testing of the machine is under progress.

Prototype of smart device for automatic detection and identification of insects in stored grains

Fish Descaling Machine with Horizontal Rotor

A prototype machine for descaling of carp (rohu, catla, mrigal, common carp, silver carp, and bighead carp) is fabricated and tested. The machine works with a horizontal polypropylene rotor which is operated with motor-belt-pulley arrangement. The rotor contained steel spikes in zig-zag fashion. The cleaning efficiency was calculated and found about 70%. The second model of fish cleaning station is also developed which can be operated either manually by foot or mechanically by electricity. It consists of i) dressing table (100x48x120 cm) ii) round cutter, made of SS with diameter 25.4 cm iii) water spraying system iv) motor (1/10 HP, 9400 rpm) and PVC pulley (diameter 20 cm) v) foot rotor and pulley (diameter 53 cm) vi) liquid waste disposal and filtration system vii) solid waste disposal system. The machine is useful for steak cutting in fish retail shops and processing plants. The capacity of the machine is 2-3 kg fish /min.

Solar based Foldable Tent Dryer

Solar based foldable tent dryer for fish drying has been developed. It is framed in MS pipe with four meshed trays. The dimensions are height (open) = 180 cm, bottom width=142 cm, length=180 cm, Tray

Solar based foldable tent dryer

size: tray 1 (near bottom) = 116 x176 cm, tray 2= 94x176 cm, tray 3=68x176 cm, tray 4= 42x176 cm, mesh size=1.5x1.5 cm. This is covered with highly durable PVC coated rexine cloth (thickness 0.2 cm) jacket with black paint on inner side. One of the two longer sides is covered with transparent LDPE of 300 gsm. The bottom and two shorter sides are also covered with black rexine cloth. The dryer is useful for fish drying which protects insect infestation and enable hygienic drying at faster rate. The fisher folks in coastal states of India can effectively utilize this dryer for hygienic fish drying.

Establishment of modern Fruits and Vegetables Agro-Processing Centre at ICAR-CIPHET Abohar

Fruits and vegetable processing machinery were procured and pilot plant was established. The fruit processing plant consisted of washer, crusher, hydraulic juice extractor, baby boiler, steam jacketed kettle, juice pasteurizer, chilling unit, mixing tank, storage tank, vacuum filling unit and bottle crowning

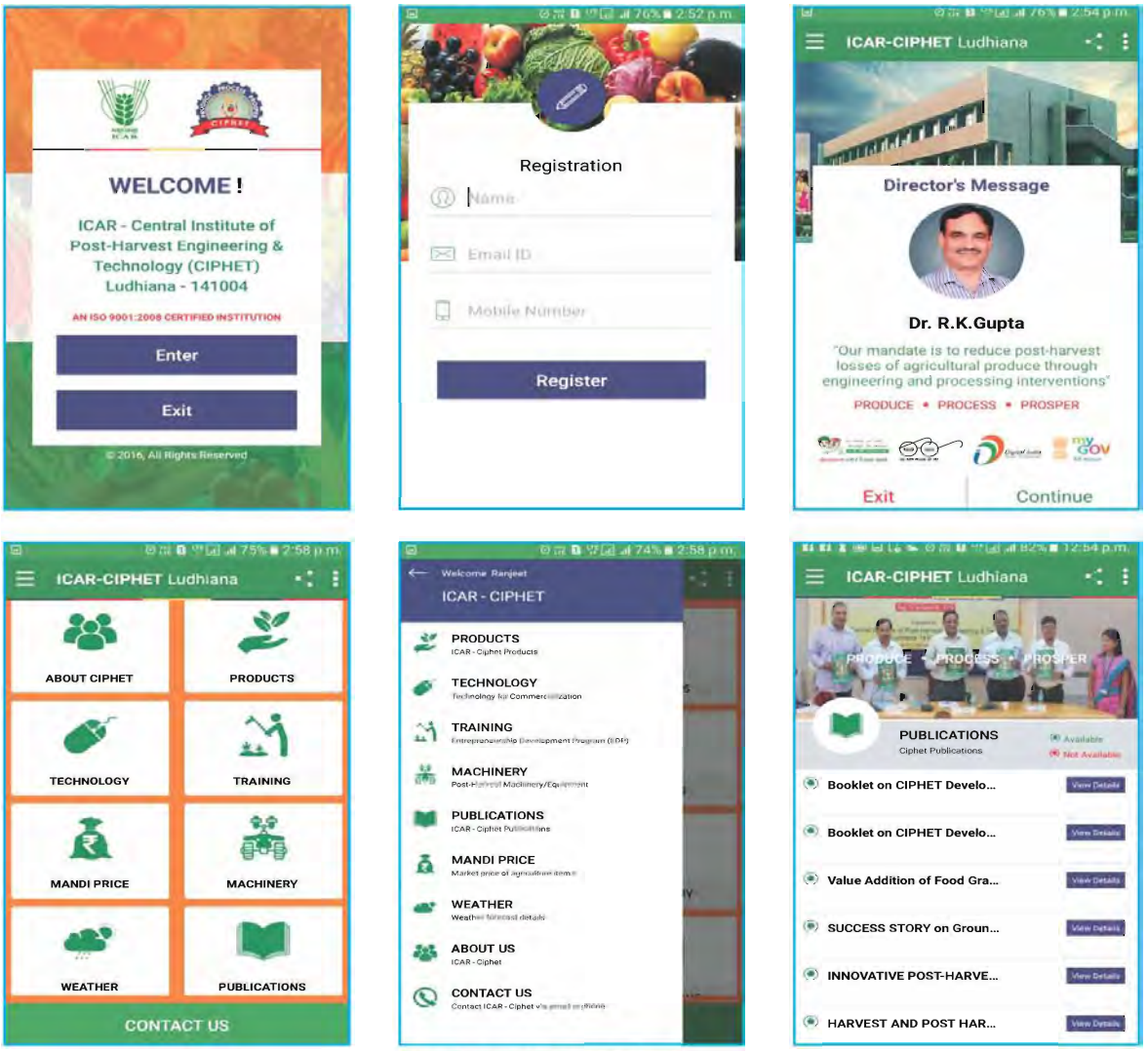
Fruit processing unit

Vegetable processing unit

machine. The vegetable processing plant consisted of vegetable washer, slicer, crusher, basket centrifuge, storage tank, dryer and vacuum packaging machine.

User Friendly Android Based Mobile Application (Mobile App)

ICAR-CIPHET has developed android based app to help farmers to get information by sitting at far off places. All types of post-harvest related information on agricultural produce such as harvesting, on-farm storage, processing, packaging, transportation etc. and related machinery at any point of time, and any number of times available on finger tips of farmers through this app. The information available is localized, thereby increasing the comfort and precision as required. This information is updated on regular basis and delivered via various means and modules of applications. The app is giving precise information regarding the developed post-harvest technologies with availability and cost. This app also provides information regarding *mandi* price and weather. Apart from this farmers are getting ready information regarding various seminars, training, exhibitions, visits and outreach activity on post-harvest technologies conducted by the institute time to time. Farmers can register with the institute for various activities and training programs and can get expert advice as per their need. The developed app will help the farmers as well as other section of the society to fulfil their demand with one touch.

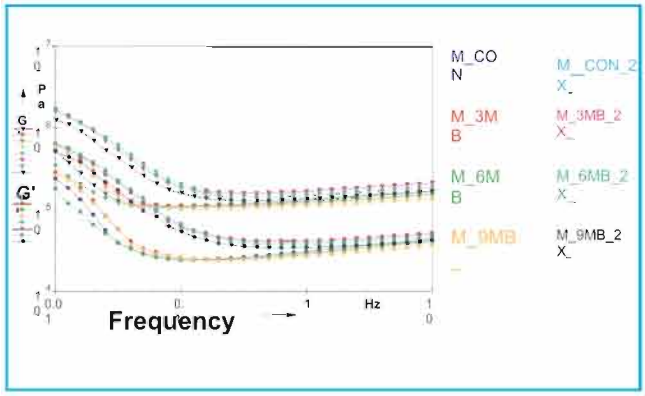


ICAR-CIPHET mobile App

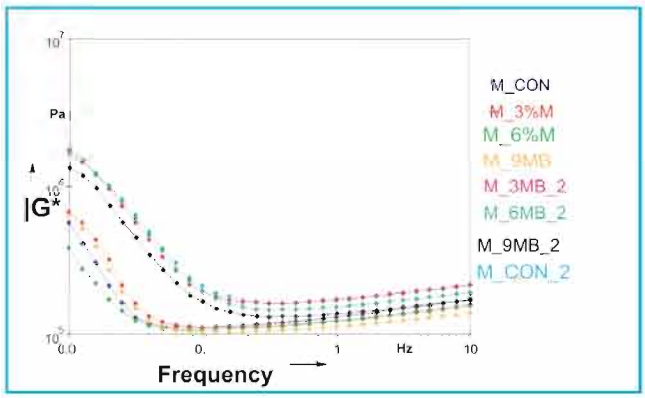
Moth Bean Flour and Xanthum Gum incorporated Maize Flour Chapatti

Effect of addition of moth bean flour (3- 9%, w/w) with and without xanthan gum (2%) was studied to improve the dough handling characteristics of maize flour. Addition of moth bean flour alone reduced the viscosity of maize flour blends, while addition of xanthan gum increased the viscosity in all the blends as compared to control. Maize flour blend having 3% moth bean flour and 2% xanthan gum showed the highest values for peak (3086.5cP) and final (3787cP) viscosities and minimum pasting temperature(75.45°C) among all studied flour blends.

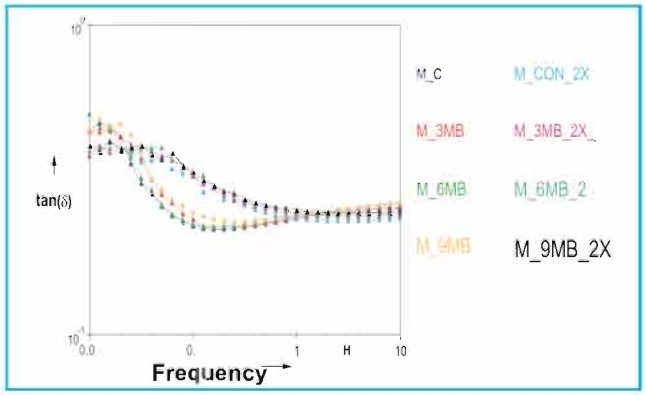
Mechanical spectra of all the tested samples showed that values for storage or elastic modulus (G') were higher than the values for loss or viscous modulus (G") at all the tested frequency range. The complex modulus (G*) gives information about the elasticity and the viscosity of the material; which in turn gives information on the strength of the samples. Highest G* values were obtained for dough supplemented with 3% moth bean flour and 2% gum. Addition of moth bean flour alone did not increase G* while addition of gum increased the G* value. At higher frequency, value of tan δ was lowest for maize with only xanthan gum and highest for maize with 6% moth bean flour but at lower frequencies reverse trend was observed. Maize dough characteristics *viz.* dough extensibility and rupture force increased with addition of moth bean flour and xanthan gum. Addition of gum caused significant variation in the extensibility and rupture force values. Dough with gum and 6% or 9% moth bean flour showed non-significant variation in extensibility and rupture force. In *chapaties* also, addition of moth bean and xanthan gum improved the extensibility, rupture force. Sensory evaluation revealed that addition of moth bean flour at 6% and 2% xanthan gum showed highest score (8.0) followed by 3% moth bean flour and 2% xanthan gum (7.9).



Frequency sweep analysis of dough from maize flour blends showing storage and loss modulus



Frequency sweep analysis of dough from maize flour blends showing values of G*



Frequency sweep analysis of dough from maize flour blends showing values of tan δ.

Protein Enriched Muffins Utilizing Dehulled De-Skinned Groundnut Meal

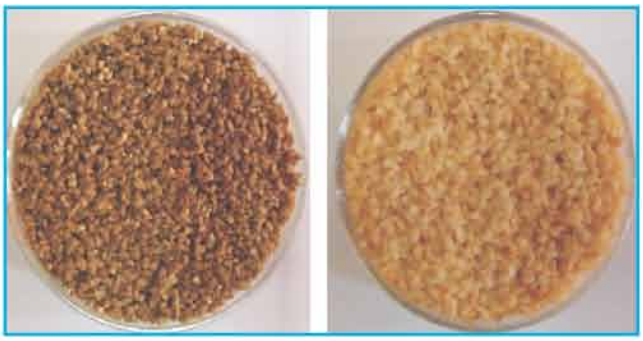
Dehulled de-skinned groundnut meal (DDGM) and refined wheat flour (RWF) based formulation for muffin was optimized following central composite design of response surface methodology using Design expert software. Muffin flour with different level of studied flour materials influenced the baking quality, colour of muffin crumb, textural as well as nutritional quality of muffins. Increasing level of DDGM in muffins flour increased the protein, total minerals, iron, calcium content and height of muffins after baking. Optimized level of RWF and DDGM in muffin formulation consisted of 72.5 and 27.5%, respectively with desirability as 0.831. The optimized level of food materials in muffin flour was further validated by analyzing the responses for muffins prepared using these levels of RWF and DDGM. The muffin sample showed to have 9.8 N hardness, 0.77 springiness, specific gravity 1.056, 10.1% weight loss, 38.6 mm height of muffin, 9.8% protein, 1.64% total minerals, 3.82 mg/100 g iron and 135 mg/100 g calcium content with overall acceptability score as 7.8. The study showed that DDGM based muffins may be safely stored even at ambient condition for 9 days with good sensory acceptability.

Process for Preparation of Iron Fortified Wheat *Dalia* using Biopolymer Coating

The study was carried out to standardize the process for development of iron fortified wheat *dalia* premix using recommended iron salt. Iron fortified wheat *dalia* premix was prepared using spraying technique for addition of fortificant namely ferrous sulphate to the wheat grits, followed by tempering and drying. In order to reduce the washing losses, if practiced before cooking as seen in some of the households, iron fortified *dalia* samples were coated with two selected biopolymers namely hydroxypropyl methyl cellulose (HPMC), methyl cellulose (MC) and combination of HPMC and MC. Iron fortified wheat *dalia* premix, prepared using standardized amount of iron in fortificant solution having 16.1mg iron per mL of solution indicated the desired iron content in the premix, hence this level of iron solution using ferrous sulphate was considered for further study to standardize the suitable coating material to reduce the leaching losses during washing, if practiced before cooking.

Premix samples for iron fortification of wheat *dalia* were evaluated for important quality parameters *viz.* colour quality, total minerals content, iron content, cooking and sensory characteristics. Iron fortification of wheat *dalia* reduced 'L', 'a' and 'b' values and thus resulted the premix with lower whiteness index and higher colour difference. Iron content in fortified wheat *dalia* (IFWD) premix increased with increasing level of iron content in the fortificant solution from 107.7 to 502mg /100 g *dalia* premix. Incorporation of iron salt significantly enhanced the level of total minerals (1.75% to 2.44%) and iron content in the premix as well in fortified wheat *dalia*. Iron fortified cooked wheat *dalia*, prepared using iron fortified *dalia* premix were of good sensory acceptability with mean sensory overall acceptability scores 7.5±0.52 to 7.8±0.61 comparable to 7.8±0.75 for control *i.e.* unfortified cooked wheat *dalia*. In view of desired iron content in the premix, addition of iron containing solution (iron content-16 mg/ mL), 30 min tempering time followed by drying may be considered for preparation of iron premix for preparation of iron fortified wheat *dalia*.

Biopolymers coating significantly reduced the washing losses of iron thus enhanced the retention of added iron in premix. Iron retention in fortified *dalia* premix samples, after single washing (with respect to



Cooked iron fortified wheat *dalia*

Iron fortified wheat *dalia* premix

iron content in unwashed iron fortified sample) ranged from 75.9 to 94.3% as compared to only 78.4% of iron retention in uncoated iron fortified *dalia* premix. In view of this, combination of HPMC and MC may be considered for coating of iron fortified wheat *dalia* premix.

Process for Preparation of Food Grains-Banana Pulp Nutritious Snacks

Nutritious expanded snack food is developed utilizing food grains (maize, defatted soy flour, sesame seed) and banana pulp following response surface methodology using extrusion processing. Response variables were expansion ratio, bulk density, colour quality ('L', 'a', 'b' value, colour difference (E), whiteness index (WI), yellowness index (YI)), water absorption index, water solubility, protein content, total minerals, iron content, calcium content and overall acceptability. Results were analyzed using a commercial statistical package, Design-Expert software version 8. Multiple regression analysis was used to fit the model,

Banana pulp incorporated snacks

represented by an equation, to the experimental data. The response surfaces for the models were plotted as a function of the two variables while keeping the other one at optimum level. Banana pulp had positive correlation with water solubility index, total minerals and iron content and negative with WI, protein and overall acceptability. Based upon multiple response analysis, the optimum conditions for preparation of nutritious expanded snack utilizing ripe banana are: 8.0 g banana pulp (per 100 g feed material), 350 rpm screw speed and 14% feed moisture. The fat, carbohydrates, crude fibre, total minerals, iron and calcium content in this nutritious expanded snack with banana was 3.86%, 73.83%, 2.29%, 2.1%, 4.48 mg/100 g and 92 mg/100 g, respectively. The protein and calories in this banana incorporated nutritious snack was 15.5% and 391kcal/ 100 g, which could fulfill about 50 percent of protein and 20% of calorie requirement of a 7-9 years old child. The high protein and significant amount of calories and mineral content in the developed snack food also had great potential in combating protein-calorie malnutrition.

Formulation of Low Energy Cereal based Fiber Rich Bar

To formulate fiber rich low energy bar, use of sugar as binding agent was avoided as it provides extra calories. In order to find out a low energy binder, maltodextrin was selected. The concentration of whole grains (barley, pearl millet and oats) was

Cereal based fiber rich bar

kept @ 25% each. Initially, maltodextrin was tried at 30, 40 and 50°B. The 40°B was found optimum. Pectin concentration 2% was found optimum when compared in range of 1-5%. Further, glycerol (a humectant) was found appropriate @ 4% (range 1-4%). Sucralose (a non-calorific sweetener) was found organoleptically appropriate at concentration of 200 mg/kg. During optimization, 40°B maltodextrin was compared with 70°B sorbitol (a

sugar alcohol) which does not contribute calories. The cereal bar with 70°B sorbitol was found to have even shape, more brightness and less crystallized spots which were visible at some places on bars having maltodextrin. Based on organoleptic score, bars with 10% fruit powder had desired liking, even texture and optimum binding property. The optimized cereal based fiber rich bar contained 32% sorbitol, 18% each of oats, barley and pearl millet, 10% guava fruit powder, 2% pectin, 2% gum arabic and 50 ppm of sucralose. Final product was baked at 200°C temperature for 20 min. The developed bar was tested for textural hardness and it was found that the crushing energy required for bar was 515.8 Ns while crushing force was 15.76 N. The developed bar is low in calorie and full of dietary fiber as no exogenous refined sugar has been added.

Value Added Product from Cored *Ber*

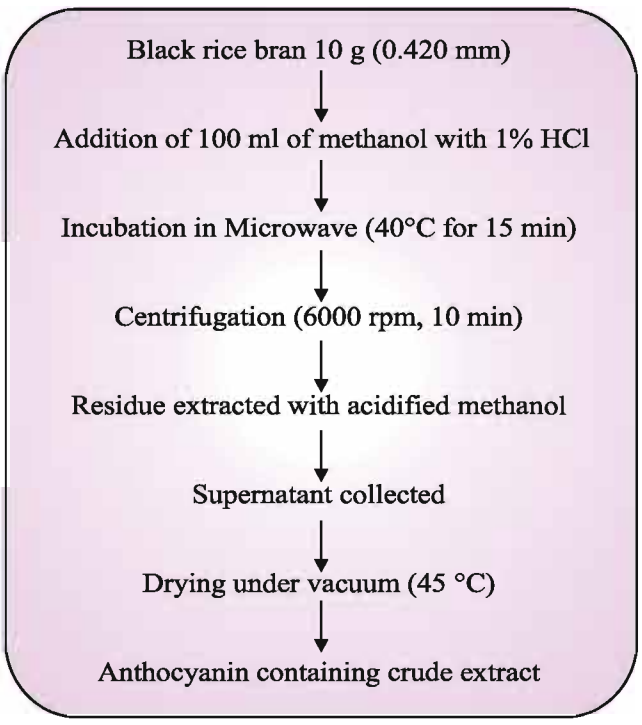
Value added product was prepared using osmo-dehydrated cored *ber* fruits (with and without peel) by stuffing it with sweetened milk *khoya*. *Ber fruit* was initially cored using the developed hand tool and the cored fruit was dipped in 50°Brix sugar solution for 6-7 h, further drained and dried at 50°C in tray dryer. Milk *khoya* sweetened with sugar (20 and 40 %) was used as stuffing.

Preparation and Preservation of Fruit Pulps for Manufacturing Fruit Bar

Pulp of *jamun*, guava and pear was prepared by mechanical extraction with a pulp recovery of 45, 69 and 54%, respectively. The pulp was preserved with or without blanching and 0.1% KMS at low (10°C) and freezing temperature (-20°C) in plastic jars. Guava bar was prepared from preserved pulp. The best quality was maintained in blanched pulps preserved with 0.1% KMS or frozen pulp. Non-enzymatic browning of guava pulp expressed in terms of OD at 440 nm indicated that browning was significantly less in blanched pulp treated with 0.1% KMS up to 90 days of storage. Un-blanched pulp (only KMS treated) had significantly higher browning (0.096) than blanched pulp (0.078). Frozen pulp was found to maintain the quality near to its fresh value. Guava pulp of good quality can be preserved by blanching and treating the pulp with 0.1% KMS and storing it in food grade plastic jars at low temperature (10°C) up to 3 months. However, guava bar prepared from frozen pulp rated highest for organoleptic quality among all other pulp preservation techniques.

Optimization of Process Parameters for Anthocyanin Extraction from Black Rice

Seven varieties of pigmented rice (red and black) were obtained from Kerala, Tripura and Manipur. These were used to prepare extracts using methanol with 1% HCl. Extracts thus obtained were used to measure anthocyanin content, total phenol, flavonoid content spectrophotometrically by pH differential method, Folin Ciocalteu method and taking absorbance at 374nm, respectively. DPPH, ABTS and FRAP activities were measured spectrophotometrically as per standard methods. Chakhao amuba and Poireiton varieties of Manipur black rice showed maximum anthocyanin content (1345-1433 mg cyanidin-3- glucoside equivalent/100 g bran). DPPH radical inhibition by



Process for Anthocyanin Extraction from Black Rice

59-67% was shown by different extract and maximum 67% was observed for the variety Chakhou poireiton. Phenolic content ranged from 1-2.5% and FRAP activity ranged from 16-36 mg ascorbic acid equivalent/g in different varieties.

Anthocyanin extraction process has been optimized from powdered bran of black rice (Manipur variety, *Chakhao poireiton*) (40 BSS, 0.420mm) using 3 solvents *i.e.* methanol with 1% HCl, acetone with 1N HCl and methanol with 1N HCl. Further three different pre-treatments *viz.* ultrasonic (15, 45, 75 min), microwave (5, 15, 25 min) and shaking (15, 45, 75 min) at temperature of 40°C and 60°C were given to get anthocyanin containing crude extract.

Process Protocol for Development of High Value Green Raisins

Ethyl oleate, K_2CO_3, $MgSO_4$, $MgCl_2$, $ZnCl_2$, $ZnSO_4$ and $CuSO_4$ with different concentrations, combinations and dipping times were used. Different pre-treatments showed significant ($p<0.05$) effect on moisture content and color attributes of samples in shade drying. Pre-treatments retained the green color as compared to untreated grapes. It was found that maximum green colour can be retained when Thompson seedless grapes pre-treated with 4% $CuSO_4$ for 4 min followed by air drying at 68°C. Vacuum impregnation treatment for higher impregnation of salts was also tried with flow rate of 1.5 CFM (cubic feet/min) (0.09 m/s) and ultimate vacuum of 150 micron (0.15 mm-Hg) was used.

Grapes (*var.* Thompson seedless with initial moisture content of 78.9%) were subjected to shade drying, cabinet drying at three different temperatures (60, 70 and 80°C) and polytunnel drying. Final moisture content of dried grapes was about 20±0.5% (*w.b.*). All the samples were pre-treated with ethyl oleate (1.6%) and potassium carbonate (2.0%) prior to drying. Results showed that raisins produced using cabinet dryer (at 60-80°C) were brownish in color. Polyhouse drying (above 60°C) was not successful in maintaining color of grapes and showed burned appearance within 48 h. However, raisins produced under shade drying were greenish (lower a^* value). Shade drying also resulted in decreased lightness (L^* value) and yellowness (b^* value). Thus study showed that shade drying with lower temperatures (35 to 40°C) is a good alternative than any other drying procedures including polyhouse drying, cabinet drying, sun drying etc.

Extraction of Fiber from Inedible Portion of Fruits and Vegetables

Experiments were carried out to extract dietary fiber (both soluble and insoluble) from fruit and vegetable inedible portions. Both variants of dietary fiber (soluble and insoluble) were extracted from *kinnow* and pomegranate peels and cauliflower stalk using acid-alkali digestion. The obtained soluble fiber was dried at 50°C for 4-6 h (in tray dryer) while insoluble fiber was dried at 130°C for 2 h (in oven). Insoluble fiber obtained from *kinnow* peel, cauliflower stalk and pomegranate peel was 10.0±1, 12.0±1 and 18.0±1% respectively, while the

$ZnCl_2$ treated | $MgCl_2$ treated | $MgSO_4$ treated | $CuSO_4$ treated

Cabinet dried sample with different chemical pre-treatments

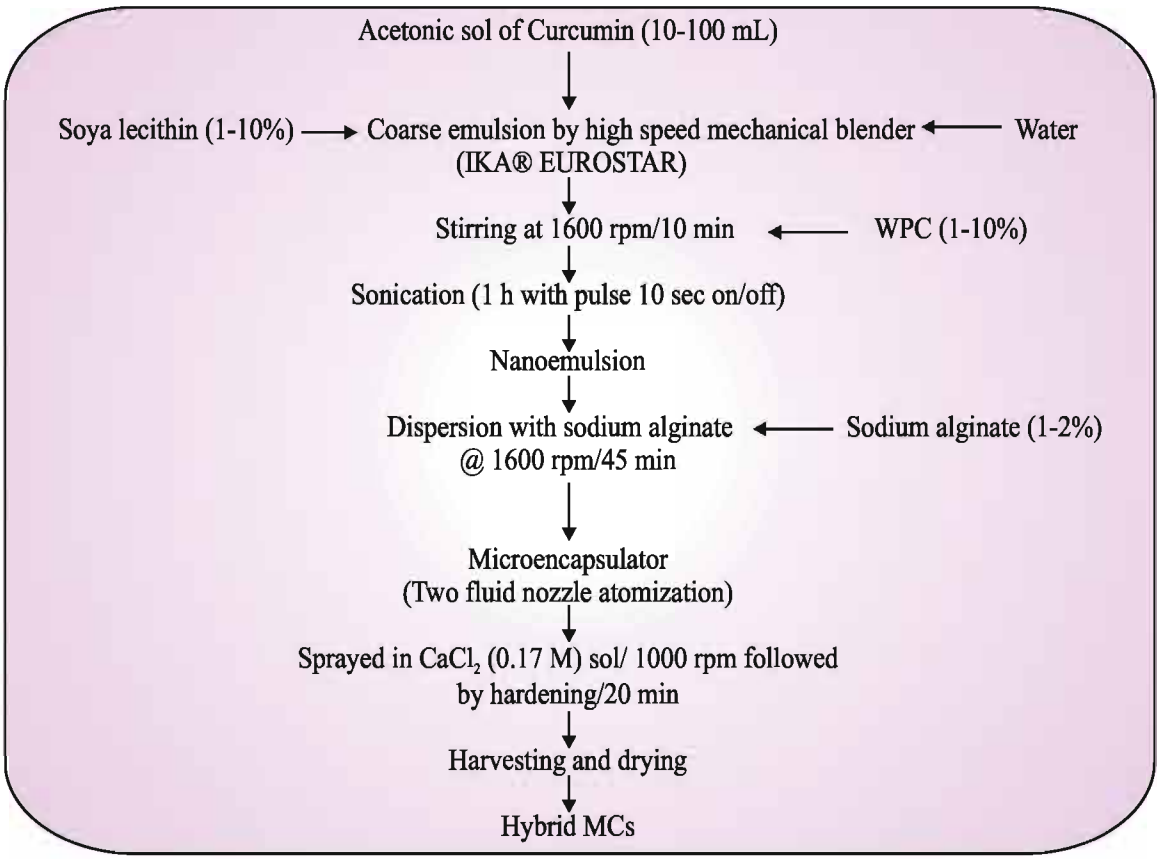
Dietary fiber yield from different sources of fruit by products

Raw material	Soluble dietary fiber (%)	Insoluble dietary fiber (%)
Kinnow peel powder	8.0±1	10.0±1
Cauliflower stalk powder	8.0±1	12.0±1
Pomegranate peel powder	8.0±1	18.0±1

corresponding values for soluble dietary fiber were 8.0±1% each.

Microencapsulation of Curcumin Air Atomization Technique

Coarse emulsions were prepared by adding curcumin (acetonic solution), soya lecithin in distilled water using high speed mechanical stirrer at 1600 rpm for 10 min. WPC was added to the nano-emulsions and stirred for 10 min using high speed mechanical stirrer (1600 rpm) at 60°C. In order to obtain narrow size distribution of particles, the nano-emulsion was subjected to sonication for 1 h. The emulsion was characterized further for the particle size and rheology. For the preparation of microcapsules, sodium alginate was added slowly to the emulsion and was stirred by using high speed mechanical stirrer. Encapsulation of oil-in-water emulsion of curcumin in alginate was carried out by air atomization technique with an in-house developed micro-encapsulator. Stirring was continued for 30 min after spray for hardening of



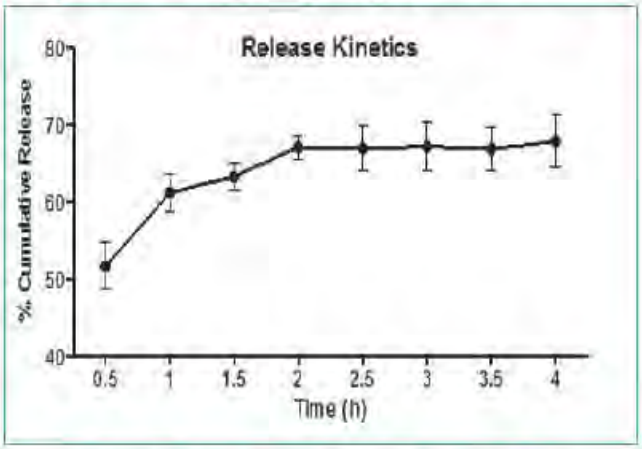
Preparation of curcumin hybrid microcapsules (MCs)

hybrid MCs. The hardened hybrid MCs were harvested and washed with deionized water. Capsules were dried at 37 °C and stored in nitrogen flushed pouches.

The curcumin hybrid microcapsules developed by the use of air atomization technique were found to be spherical in shape. The size of 10 randomly selected fresh microcapsules from different batches was found to be in the range of 1349.6 to 1834 µm whereas after 24 h of drying at room temperature, the hybrid microcapsules size was about 753.4 to 1120.3 µm. Increase in the drying time decreases the particle size. The average particle size of the prepared fresh and dried MCs was found to be 1293.6±175.44 µm and 889.7±191.19 µm, respectively.

The encapsulation efficiency of the prepared curcumin MCs was found 95.7 %. It showed that the lecithin and WPC in combination with calcium alginate stabilize the curcumin within the MCs.

Cumulative release (%) of curcumin was analyzed at biological pH (7.4) to estimate the



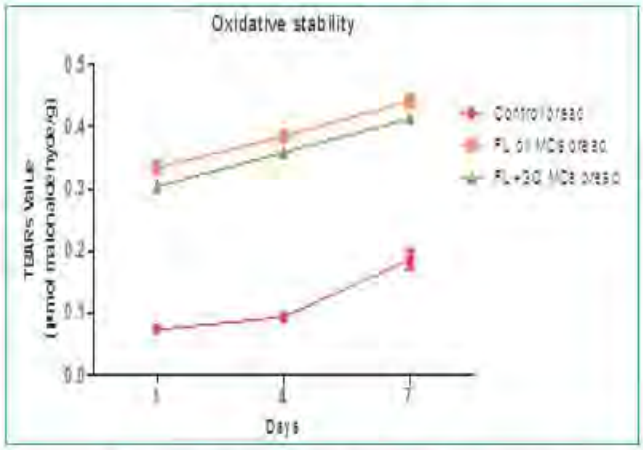
Cumulative release (%) of curcumin in phosphate buffer at biological pH (7.4)

bioavailability of curcumin its release with time, in the biological system. The graph showed the gradual increase in % release and the maximum release of curcumin was 69.82% after 2 h. After that the % cumulative release was found static/constant till 4 h in the biological conditions.

The average swelling index of five hybrid MCs of curcumin was found to be 10.21 to 37.92 from 2 to 12 h in PBS (pH 7.4). The curcumin MCs swelled 37.92 times from its initial size after 12 h in PBS (pH 7.4). The drastic increase in the size of curcumin MCs was observed from 0 to 6th hour.

Fortified Bread with Hybrid Microcapsules

Fortified bread with hybrid microcapsules (flaxseed oil, garlic oil, fish oil, flaxseed oil +garlic oil, and fish oil +garlic oil) have been prepared. The oxidative stability of functional bread fortified with hybrid MCs was monitored by measuring the formation of secondary oxidized products for a period of 7 days. The TBARS values of all bread samples were found to increase during storage. The functional bread showed increase in TBARS values which may be due to the effect of baking temperature FL and GO which are more susceptible to oxidation than saturated fat used in control bread. The rate of increase was similar in TBARS values in both control and fortified bread samples.



Oxidative stability of FL oil MCs and FL+GO MCs fortified bread

The color and textural properties of the developed functional bread have been analysed. ΔE values were found in the range of 2.63±1.12 to 12.04±0.77 for all the tested functional bread samples. ΔE value for the bread fortified with FL oil hybrid MCs was much higher (12.04±0.77) than the bread fortified with FL+GO hybrid MCs

(3.19±1.93). This may be due to the slight yellow color of FL oil as compared to the GO (clear transparent). GO may be affecting the color of the bread fortified with FL+GO hybrid MCs. The textural properties obtained from TPA of bread containing microencapsulated FL oil and GO indicated that hardness increased significantly ($p < 0.001$) whereas no change was observed in the cohesiveness and springiness in all the tested samples throughout the storage period. In sensory evaluation there was no significant difference ($p>0.001$) observed in appearance, colour, aroma and texture when compared to control bread with FL oil hybrid MCs on the 1st day of storage. These results are corroborated with the visual appearance and colour of bread. Both of the microcapsule-fortified samples scored above 6.0 throughout the storage period in the "like slightly" category, which is an acceptable score in 9-point hedonic scale.

Encapsulation of Flavonoids

Acetonic extracts of pomegranate and *kinnow* peels were analyzed for various antioxidant properties. Pomegranate peel extract was found superior in antioxidant profile compared to *kinnow* peel extract. Total phenol and flavonoid contents were exactly double in pomegranate peel extract compared to *kinnow* peel extract. The encapsulation of pomegranate peel flavonoids in alginate beads was carried out after dispersion of flavonoids in non-polar phase using micro-encapsulator. The alginate beads in single wash retained only 10% of the polyphenolics used for encapsulation. Therefore, spray drying was used for encapsulating polyphenolics in three different matrices viz. maltodextrin, cyclodextrin and alginate. Approximate yield of encapsulated material was 50%.

Preparation of Protein Supplements

Effect of different additives (maltodextrin, guar gum and lecithin @1.5% of total solids) on the

Protein supplements

Antioxidant profile of acetone extracts of pomegranate and *kinnow* peel

Parameter	*Pomegranate peel	*_Kinnow_ peel
Total phenolic content (µg/mg)	85.5	43.4
Flavonoid content (µg/mg)	60.0	30.0
Total antioxidant activity $AU_{0.5}$ (µg/ml)	593.0	353.0
Total reducing power $AU_{0.5}$ (µg/ml)	220.0	176.4
DPPH radical inhibition (%)	72.0	45.0
FRAP activity (FE) (µmoles)	2150.0	1716.0
Tannins (µg/g)	7720.0	720.0
Yield (%)	55.5	27.3

* Value are on dry weight basis

functional properties (water solubility index, water absorption index, oil binding capacity and foaming capacity) of soy protein isolate was evaluated. Water solubility index of control, malto-dextrin, guar gum and lecithin added soy protein samples were 49.2, 69.2, 60.7 and 63.8%, respectively. Water absorption index for these samples were 1.85, 2.35, 1.52 and 1.31 g/g protein, respectively. Oil binding capacity was 3, 2.5, 3, 3 ml / g protein and the foaming capacity was 1.60, 1.61, 1.63 and 1.47, respectively. The maltodextrin @1.5% can be added for smooth drying as well as to improve the solubility of soy protein isolate. The functional properties of prepared soy protein isolate were compared with commercially available soy protein isolate. Water holding capacity of prepared sample was 2.73 as compared to 2.43 g/g protein of commercial sample. Oil binding capacity for these samples were 2.49 and 1.89 ml/g protein, foaming capacity 1.13 and 1.05 ml/ml respectively. The functional properties of prepared soy protein isolate were slightly better than commercially available samples.

Soy and ground nut protein isolate were prepared pilot scale. The protein content was 90.9 % (d.b.) and 91.7 % (d.b.) in groundnut protein isolate and soy protein isolate, respectively. Protein supplements of groundnut protein isolate (protein 91.7 %, db) and soy protein isolates (protein 90.9%, db) where prepared with other ingredients (sugar 8.5% and cocoa powder 1 g / 100 g). The protein content in protein supplements is 78-80%.

Extraction of Protein from Mustard Cake

Mustard protein has potential to serve as an attractive source for the preparation of protein isolates for food purpose. Effect of temperature (ambient, 30°C, 50°C) with varying salts concentration (0.1N-1N NaCl; 0.1% Na_2SO_3) at pH 11 on extraction of protein was studied and found that on increasing temperature the recovery of protein increased. The strong alkaline condition extracts high amount of nitrogen and decrease the extractability of the phytic acid and leave most of it in the residual meal. So, alkali extraction and acid precipitation (pH 3-7) method was used for the study. The cake: water ratio was kept constant as 1:10. Higher extraction of protein was observed at 50°C. The protein was more soluble in NaCl as compared to Na_2SO_3 salt solutions. The optimized conditions for extraction of protein from mustard de-oiled cake was as: 0.1% NaCl aqueous solution, extraction temperature 50 °C, duration of extraction 2 h at constant pH 11, cake: water ratio of 1:10 followed by iso-electric precipitation at pH 6.3 and subsequently 4.5. Using above conditions, the extraction of protein was 81.3%. The yield of protein (purity 78%) from the extract of 30°C was 39% and from the extract of 50°C, it was 46%.

Extraction of Protein from Sunflower Cake

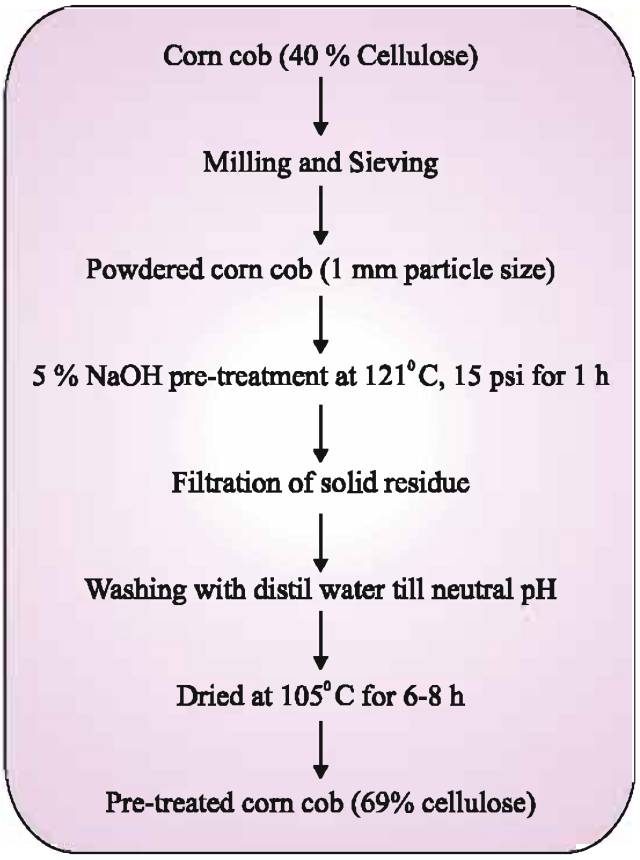
Effect of process parameters *i.e.* pH (6-12), extraction temperature (20-50°C), extraction duration (30-120 min) and salt (NaCl and Na_2SO_3) concentration (0.25-2.0%) on extraction and recovery of protein from sunflower de-oiled cake was studied. Alkali extraction and acid precipitation method was used for the study. The cake: water ratio was kept constant as 1:10 and extracted protein was precipitated at pH 4.5. The sunflower protein was found heat sensitive (lower water solubility at higher temperature) as the extraction was lower at 50 °C. The optimum extraction temperature was recorded at 30 °C. The protein was more soluble in Na_2SO_3 as compared to NaCl salt solutions. Extraction pH and duration had significant effect on solubility of sunflower protein in aqueous media. The optimized conditions for extraction of protein from sunflower de-oiled cake was as: 0.25% Na_2SO_3 aqueous solution, pH 12, extraction temperature 30 °C, duration of extraction 60 min at constant cake: water ratio of 1:10 followed by iso-electric precipitation at pH 4.5. Using above conditions 55% sunflower protein can be recovered from sunflower de-oiled cake in the form of protein isolate. Sunflower protein has potential to serve as an attractive source for the preparation of protein isolates for food purpose.

Optimization of Process Protocol to Enhance Cellulose Recovery of Corn Cob

Sieved sample (1 mm) was treated with different concentrations of sodium hydroxide (NaOH) ranging from 1-5% at solid-liquid ratio of 1:20 (w/v) which was heated to targeted pressure of 15 psi using steam at a temperature of 121°C for 1 h. The liquid fraction was discarded and the residual pretreated solid fraction was washed with hot distiled water to achieve neutral pH and kept in oven at 105°C for 6-8 h. The 5% sodium hydroxide (NaOH) pretreatment enhances the cellulose content in corn cob up to 30% in comparison to untreated corn cob (40%).

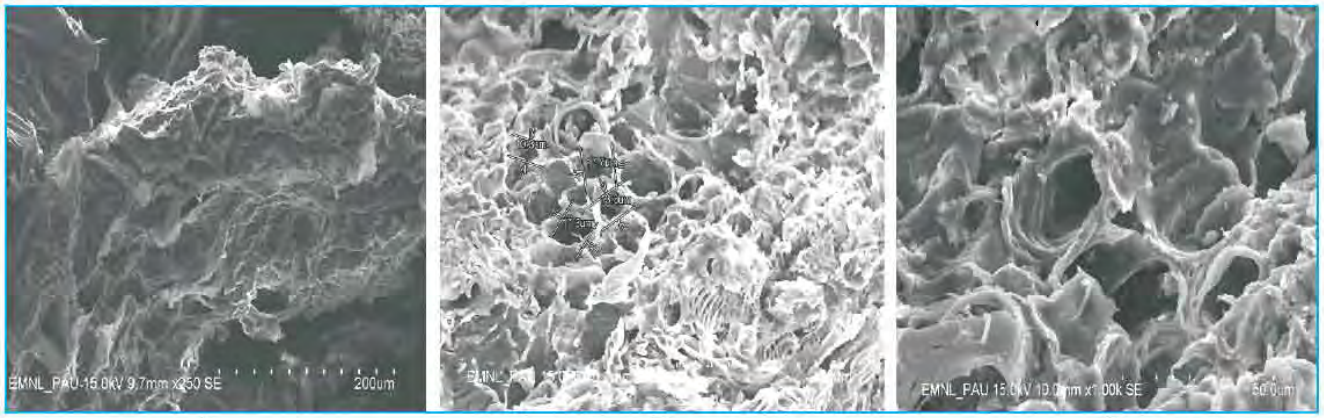
Raw corn cob Pretreated corn cob

The surface properties and microstructure of untreated and pre-treated corn cob samples were observed using scanning electron microscopy (SEM) at an accelerated voltage of 15 kV. The untreated corn cob had a rigid and ordered surface structure. However steam exploded 5% alkali pre-treated corn cob results in a rugged, rough, loose, and broken surface.



Process flow chart to enhance cellulose recovery of corn cob

Treatment with steam explosion and 5% alkali could remove most of hemicellulose and lignin in pre-treated corn cob as compared to untreated corn cob.



A B C

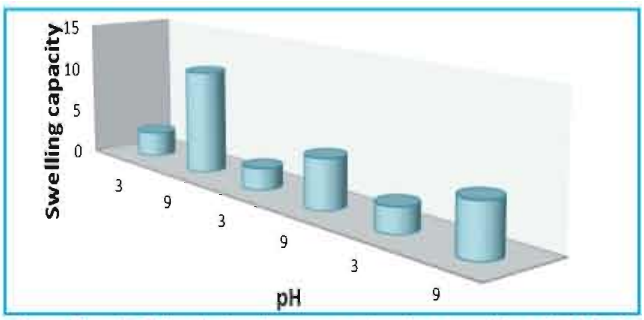
Scanning electron microscopic images of powdered corn cob (A) Untreated (B) & (C) after 5% NaOH treated

Optimization of pH based Swelling of Pectin Extracted from *Kinnow* Peel (Acrylic Acid: Pectin Hydrogels)

Dried and finely ground *kinnow* peel pectin powder (1%) was dissolved in distilled water. Acrylic acid: pectin solution (1%) based gels were prepared using methylene bis-acrylamide as cross linker. The acrylic acid: pectin solutions were prepared in the ratio of 5:1, 4:2, 3:3, 2:4 and 1:5, and respectively designated as A, B, C, D and E. Ammonium persulphate was used on catalyst/ initiator. The synthesized gels were allowed to polymerize by keeping them undisturbed for 6 h; immersed in distilled water for 24 h and dried for 72 h at room temperature. Known weights of dried gels were taken and immersed in buffers of pH 3.0, 5.0, 7.0, 9.0 and 11.0 for 24 h. The swelled gels were taken out, wiped and weighed to measure their swelled weight. There was an overall increase in swelling % and swelling coefficient with increasing pH. The lowest swelling % (242.1±6.17) was recorded with 'E' at pH 3.0 while highest swelling % (2115.7±12.16) was observed at pH 11.0 with 'D'. There was about 8 times increase in swelling % from pH shift of 3 to 11. Similarly, swelling coefficient augmented nearly 6 times from an initial value of 3.6±0.10 to 22.2±0.12. Since, combination 'D' at pH 11.0 showed highest swelling % and swelling coefficient, it was selected as the best combination for hydrogel preparation.

Reversible swelling-de-swelling behaviour of acrylic acid: pectin hydrogel

Pectin based hydrogels showed reversible swelling-de-swelling behaviour when the same gel subjected to solutions of different pH. This on-off behaviour of hydrogel having acrylic acid: pectin ratio (2:4; combination 'D') was tested in solutions with pH 3.0 and 9.0. At pH 9.0, the hydrogel swelled due to anion-anion repulsive electrostatic forces, while at pH 3.0, it shrunk within a few minutes due to protonation of the carboxylate anions. This swelling-de-swelling behaviour of hydrogels can make them as suitable candidate for designing targeted drug delivery systems



On-off switching behaviour as pulsative swelling (pH 9.0) and de-swelling (pH 3.0) of pectin based hydrogel

Assessing the salt based swelling of pectin hydrogel

Swelling capacity of pectin hydrogel in salt solutions is of prime importance for water release systems in food processing; hence its swelling capacity was established with four salt (NaCl, KCl, $CaCl_2$, $AlCl_3$) solutions of 0.05M each. The swelling ability of anionic hydrogels in various salt solutions is comparatively less compared to the swelling values in distilled water. However, within different salt solution, minimum swelling (1.80) was observed in $AlCl_3$ and maximum (5.39) in NaCl indicating a decrease in swelling capacity with increase in valency from univalent to multivalent ions of salt.

Evaluation of different citrus cultivars for their processing traits

Sixteen different cultivars of citrus for their processing traits and the physico-chemical composition of fruits were assessed. Largest fruit by weight was recorded for Washington orange (325g) followed by Late navel (311g). However, maximum juice content (> 50%) was found in *Kinnow*, valencia orange and daisy while minimum was observed in case of Washington orange and Mosambi. Among all cultivars, maximum peel content (47.2%) was found in Washington navel orange followed by pineapple orange (45.2%) and clementine orange (42.5). Pomace was found highest (35-37%) in Late navel, Mosambi, Michel and Clementine orange. *Kinnow* produced 28.1 % peel and 18.5 % pomace resulting in more than 45 % processing waste that can be utilized for extraction of pectin and dietary fiber by further processing.

Aqueous extraction of pectin from citrus peel waste

The peels of three citrus fruits viz. grapefruit, *kinnow* and orange were used for extraction of pectin by using aqueous extraction with organic (citric acid) and inorganic acid (H_2SO_4). The peels were also treated with 1000 units of cellulase and xylanase enzyme in order to facilitate the extraction process. The enzymes treated peel was incubated at 40°C for 2 h and aqueous extraction process was performed for 40-60 min. Use of organic acid favored better extraction of pectin over its inorganic acid. However, among different citrus peels; orange peel produced highest amount of purified pectin (13.8%) followed by *kinnow* peel (12.9%) while least was recorded in grapefruit peel (7.11%). Control treatment (H_2SO_4) resulted in recovery of 24 % crude pectin with a purified yield of about 7.0 %. Addition of either enzyme did not improve the pectin recovery and maximum yield of crude pectin (35.1 %) was obtained only with the addition of citric acid alone to a pH level of 2.0 indicating that citric acid was the most effective treatment for extracting pectin from citrus peel.

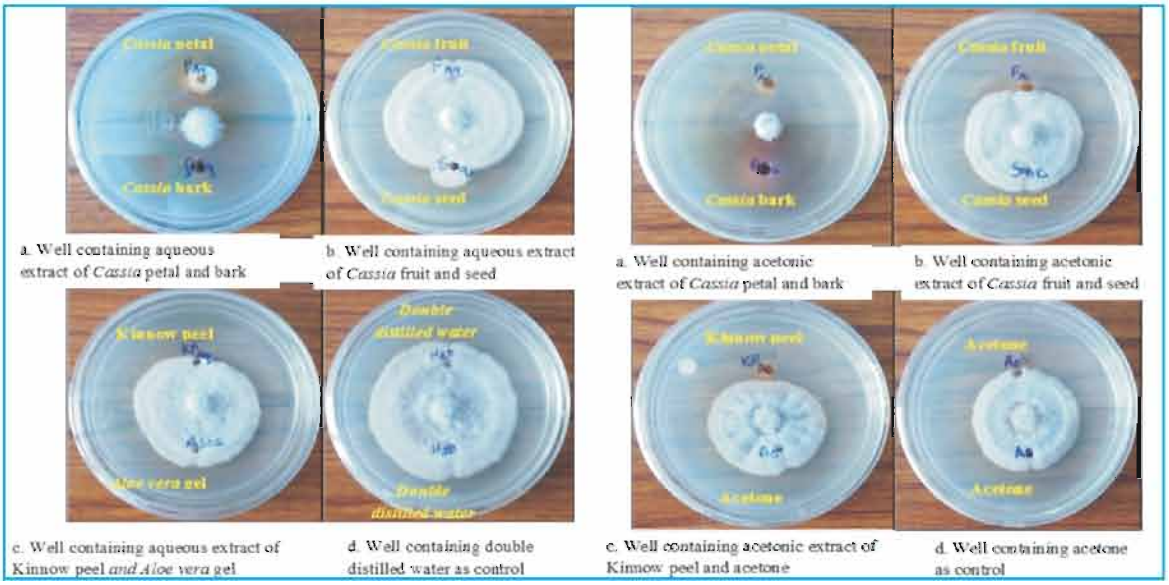
Utilization of Fruit Waste and Plant Extracts in Developing Antimicrobial Coatings for Extending Shelf-Life of Fruits

Preparation of extracts and estimation of antioxidant potential

Experiment were carried out to evaluate the antioxidant and antimicrobial potential of certain fruit residues and natural plant extracts in order to utilize them in developing antimicrobial coatings. Aqueous and acetone extracts were prepared from the petals, bark, fruit and seeds of *Cassia fistula* and fruit peel of *kinnow*. Total antioxidant activity (TAC) was estimated by DPPH method for all the extracts in terms of nmols of ascorbic acid equivalent/mg of dry weight. Higher total antioxidant activity was observed in the acetone extracts of *Cassia* bark, seed and *kinnow* peel as compared to their corresponding aqueous extracts. However, it was lower in the acetone extracts of *Cassia* petals and fruits when compared to their aqueous equivalents. The highest TAC (226.8 ±1.85) was found in *Cassia* petal and lowest (23.3 ± 0.21) in *kinnow* peel among aqueous extracts whereas among acetone extracts, the highest TAC (142.2 ± 3.79) was found in *Cassia* bark and lowest (26.20 ± 0.37) in *Cassia* seed. The values of ferric reducing antioxidant power (FRAP) for all extracts are presented in terms of nmols of ferrous sulphate equivalent/mg of dry weight. In both, aqueous as well as acetone extracts, maximum FRAP was found in *Cassia* bark *i.e.* 30.9±0.26 and 99.7±2.02, respectively. Among aqueous extracts, minimum FRAP (4.68±0.04) was found in *Cassia* seed whereas, in acetone extracts minimum FRAP (3.69 ± 0.06) was found in *kinnow* peel. Higher FRAP was found in aqueous extracts of *Cassia* fruit, *Cassia* seed and *kinnow* peel as compared to their corresponding acetone extracts while the remaining aqueous extracts had lower FRAP as compared to their acetone counterparts. Total phenolic content ranged from 0.83±0.02 to 54.55±0.93 µg of catechol equivalent/mg of dry weight. In both aqueous extracts as well as acetonic extracts, maximum total phenol was found in *Cassia* bark *i.e.*18.44±0.00 and 54.55±0.93 µg, respectively, while minimum in *Cassia* seed *i.e.*0.83±0.02 and 0.96±0.10 µg of catechol equivalent/mg of dry weight, respectively. It was also observed that the acetone extracts had higher total phenol content than the aqueous extracts, except aqueous extract from *kinnow* peel, though the difference was minor. The tannin content of all the extracts ranged from 0.11±0.01 to 18.57±0.02 µg of tannic acid/mg of dry weight. In general, the tannin content was found to be more in acetone extracts of *Cassia* as compared to their counter aqueous extracts except seed extract. In both aqueous as well as acetone extracts, maximum total tannin content was found in *Cassia* bark *i.e.* 0.49±0.01 and 1.10±0.04 µg of tannic acid/mg of dry weight, respectively and minimum in *Cassia* fruit *i.e.* 0.11±0.01 and 0.10±0.00 µg of tannic acid/mg of dry weight, respectively.

Estimation of antimicrobial potential

Aqueous and acetonic extracts of *Cassia* petal and bark exhibited antifungal activity against *Colletotrichum* spp. The aqueous and acetonic



a. Well containing aqueous extract of *Cassia* petal and bark

b. Well containing aqueous extract of *Cassia* fruit and seed

c. Well containing aqueous extract of Kinnow peel *and Aloe vera* gel

d. Well containing double distilled water as control

a. Well containing acetonic extract of *Cassia* petal and bark

b. Well containing acetonic extract of *Cassia* fruit and seed

c. Well containing acetonic extract of Kinnow peel and acetone

d. Well containing acetone as control

The growth pattern of *Colletotrichum* spp. (5 days incubation at 28°C) against different aqueous (left) and acetonic (right) extracts of *Cassia, kinnow* and aloe vera gel using well diffusion assay (Respective controls include double distilled water and acetone).

extracts of *Cassia* fruit, seed, *kinnow* peel and aloe vera gel were not effective against *Colletotrichum* spp. when compared to control. On the other hand, the highest antifungal activity was demonstrated in case of acetonic extracts of *Cassia* petal and bark based on growth pattern of *Colletotrichum* spp. when compared to control.

Synthesis of Silver Nano-particles

A simple ecological method for the synthesis of silver nanoparticles was developed using herbal extracts from neem leaves (*Azadirachta indica*) and curry (*Murraya koenigii*) leaves. Fresh leaves of neem and curry were thoroughly washed and dried in oven for overnight at 65°C. Dried leaves were used for methanol extraction and evaporated to dryness which was further used for the synthesis of silver nanoparticles. The silver nano-particles ($AgNO_3$) developed from the neem and curry leaf extracts were found to be spherical in shape. SEM analysis showed the size of nano-particles was in the range of 60-80 nm. Antioxidants properties are observed through FTIR analysis and UV-Vis spectra observed between 400-500 nm. Moreover, the synthesized nanoparticles were found to be effective in retarding the growth of *E.coli*. Applications of neem (4%) and/or curry leaf (2%) extract as a reducing agent for the development of nano-particles were found to be effective against *E. Coli*.

The average particle size for three different types of nano-particles emulsion was found to be less than 100 nm. Data showed that PDI ranges from 0.20 to 0.58, which indicates the equal particle size distribution with different concentration of reducing agents. Green silver synthesise of silver nanoparticles using neem plant extract were found to be less than <30 nm. Increasing the concentration of curry leaf extract results in reduction of molecule size. Size of curry leaf nano- particles was reported as 10-25nm. The compounds found in leaf broth for the synthesis of nano-particles are flavonone and terpenoid. The polyol components and the water soluble heterocyclic components are primarily liable for reduction of silver ions (Ag+) as well as stabilization of nanoparticles. Moreover, differences in morphology of synthesized nanoparticles, may be

due to variation in optical properties. It is also well known that silver nanoparticles exhibit brownish color in aqueous solution due to excitation of surface plasmon vibrations.

Pre-treatment for Quality Maintenance of Primary Processed Shrink Wrapped Cauliflower

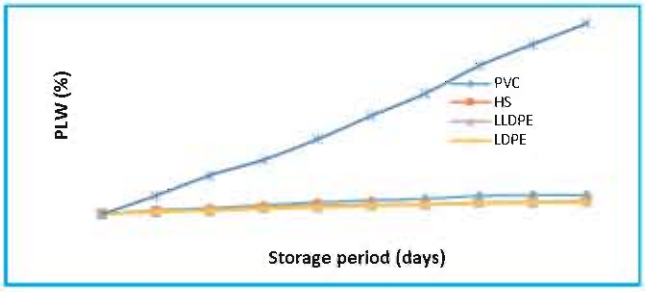
The study was undertaken to compare various pre-treatments to prevent browning of cauliflower head during its storage. Fresh cauliflowers were pre-cooled, cut back to remove the entire leaf and stem. Cauliflower head and butt were treated with 0.5 % KMS, 0.5% glutamic acid, 50% aloe vera gel and 0.01% chlorine wash before shrink wrapping in 15 micron polyolefin film. Though none of pre-treatment extended the shelf life of shrink wrapped cauliflower but most of the pre-treatments significantly reduced the degradation of colour and sensory quality during its storage. KMS was found most effective in preventing the curd browning and it was closely followed by the samples treated with aloe vera gel. However, aloe vera gel slightly reduced the sensory quality due to its bitter taste. Chlorine wash did not improve the colour but slightly reduced the spoilage. Glutamic acid was found least effective in all the aspects of quality parameters.

Effect of shrink wrap packaging on steady state gas composition of cauliflower

Effect of four different poly film during steady state of cold storage (2°C) was evaluated. Gas composition within the packages was found to be 15–17% O_2 and 1.21–3.46% CO_2. No significant differences in O_2 levels between different treatments were found. However, the lowest CO_2 content was found in packages made with PVC and the highest one in those wrapped in LDPE and heat shrinkable films. During shelf-life simulation, O_2 concentrations within wrapped cauliflower heads decreased sharply while CO_2 concentrations increased slightly due to increased temperature stimulating the respiration rate. This variation in behaviour between rates of decreasing O_2 and of increasing CO_2 with increasing temperature was probably due to the CO_2 /O_2 permeability properties of polymeric films used for wrapping the produce. The highest changes were observed in O_2 levels within PVC and LLDPE, the latter having the lowest O_2 concentrations (9.17%). However no significant differences in CO_2 concentrations (2–4%) around wrapped heads between different films used were detected. Thus, heat shrinkable and LLDPE were found quite suitable for shrink wrapping and extending the shelf-life of cauliflower, since no discolouration or off-odours were detected in wrapped produce.

Quality and shelf life of shrink wrapped cauliflower in different poly films

Medium sized cauliflower (*Brassica oleracea* var. botrytis) curds after removing outer leaves, sorting and without washing were shrink wrapped in different poly films (heat shrinkable polyolefin film, LDPE, LLDPE, PVC) and stored at ambient and cold storage (2 ± 1°C, 90-95% RH). The results showed that unwrapped cauliflower reached threshold limit of 10.38 % PLW within 24 days of cold storage while shrink wrapped cauliflower had lost only 2.71 % of their initial mass after 54 days of storage under similar conditions. Brightness of cauliflower first increased (84.28 L*) for 6 days and then decreased (74.29 L*) up to 15 days of ambient storage. TSS, acidity and vitamin C were found highest (3.9°B, 0.15% and 23 mg / 100 g, respectively) in shrink wrapped cauliflower. However, decay loss was slightly more in shrink wrapped sample than in unwrapped ones under both storage conditions. The storage of unwrapped cauliflower at ambient temperature had only 2 to 3 days of shelf-life, after that spoilage and weight loss was found. Whereas, low temperature storage extended the shelf-life of cauliflower to 21 days and can further be extended to 32-35 days with maximum retention of white colour of curd with least butt discoloration, minimum weight and firmness loss and good sensory quality attributes when shrink wrapped in 15 micron heat shrinkable film. The use of cling wrap films should be avoided as this leads to accumulation of excessive moisture resulting in huge spoilage loss. Among



PLW during storage of film wrapped cauliflower

different plastic films, LLDPE and HS films were found most effective in forming a tight wrap indicating that these poly films could be a good substitute for wrapping the cauliflower head in PVC film.

Oil Expelling of Dehulled De-Skinned Groundnut using Screw Press

Optimization of important oil expelling parameters was carried out using dehulled deskinned groundnut and wheat bran as a source of fibre at variable sample moisture as well as press head temperature in two sets of experiments. Box-benken design of response surface methodology with three independent process parameters and experimental runs were planned using Design Expert 8.0 software. The moisture content of all the experimental samples was kept constant as 8%. Important oil expelling *i.e.* independent parameters *viz.* oil recovery, residual oil in meal, press rate, sediment in oil, oil and meal temperature, free fatty acid (FFA) value were considered as dependent variables. A Komet screw press (model CA59G, Komet IBG Monforts GmbH, Monchengladbach, Germany) was used for oil expelling purposes. Oil recovery and residual oil in cake affected due to variation in wheat bran, dehulled and deskinned groundnut, sample moisture as well as press head temperature. Optimization was done to obtain the best experimental combination for higher oil recovery, low residual oil in meal, sediment in oil, press rate and FFA in oil. This study indicated that 85.6% dehulled deskinned groundnut and 14.4% wheat bran with 8% sample moisture may be considered for oil expelling of dehulled deskinned groundnut at 66.5°C press head temperature.

Optimization of X-Ray Pretreatment on Mustard Seeds to Obtain Higher Oil Recovery

X-ray pretreatments were done at different volts (2, 4 and 10 volt with control sample i.e. without any pretreatment of x-ray) for structure electron microscopic evaluation of mustard seeds. It was observed that electromagnetic waves work on lipo-protein linkage and loosen the chemical bonding between them so that oil may be released with less pressure during the processing in mechanical expeller which increases the oil recovery i.e. 6 % higher oil recovery which was found with pretreatment of 4 volt of X-ray when compared to normal oil yields.

Optimization of Ultrasound Pretreatment on Mustard Seeds to Obtain Higher Oil Recovery

Effect of ultrasound pre-treatment on mustard seeds, at different frequencies such as 2MHz, 8 MHz and 13 MHz with constant time interval of 5 min on oil recovery and quality after mechanical expression was studied. Increase (1.5%) in oil recovery with ultrasound pretreatment at frequency of 2 MHz on mustard seeds was observed. The oil quality has also been evaluated for stability and observed that no quality loss occurred (fatty acid composition was not affected) with the pretreatment of ultrasound. SEM analysis is carried out to see the effect of ultrasound on oil recovery and it was found that the capillaries were punctured and oil was released with less pressure developed in mechanical expression with pretreatment of 2 MHz frequency of ultrasound prior to mechanical expression. Quality parameters such as color value of ultrasound treated samples were evaluated and value varied from 82-82.5 while control sample showed value of 82.5. Acid value of control sample was 0.852 mg KOH/g while it was in range from 1.122 mg KOH/g in treated oil samples. Rancimat value at 180°C was 0.04 h for control and 0.06 h for treated samples. Rancimat value at 10°C was also studied and it was 3.07 h for control and ranged from 3.2 – 4.22 h for treated samples.

Food Quality and Safety

Optimization of Process for Detection of Starch Adulteration in Spices

Process for detection of starch in spices has been standardized. Different spiked samples of chilli, turmeric and coriander were tested for detection of starch adulteration using standardized method. The results showed that the test could detect even (0.1%) i.e 100 mg of starch adulterated in the 100 g of spice samples.

Optimization and Validation of Process Protocol for Detection of Calendula Adulteration in Saffron

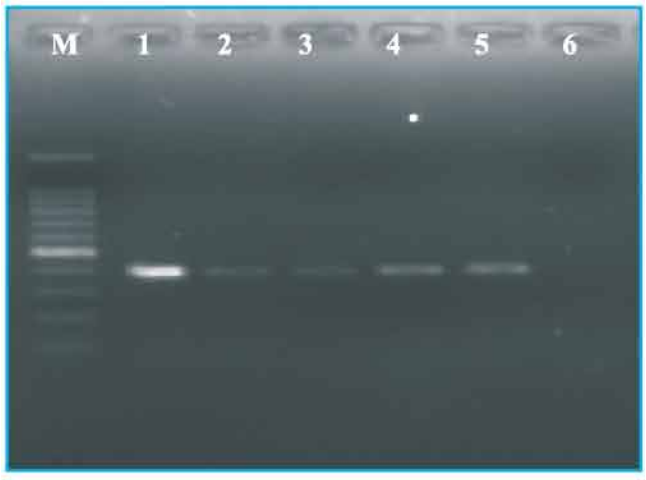
Saffron owing to its high market value is frequently mixed with substances and is adulterated to increase its volume or weight. Calendula is one such adulterant. Efforts was made to validate and optimize PCR based methods for detection of calendula adulteration in saffron. High molecular weight genomic DNA with better yield was obtained from different calendula varieties and saffron stigmas by modified CTAB-SDS DNA method (Moller et al., 1992). PCR based SCAR marker: ScCO390 (Torelli et al., 2014) and DNA barcodes: ITS2, rbcL and psbA-trnH (Chen et al., 2010) primers were synthesized and used for further optimization.

Amplification was performed as follows 94 °C for 7 min, 35 cycles of 94 °C for 1 min, gradient temperatures (52 °C- 60 °C) for 1:30 min, 72 °C for 1:30 min, followed by one cycle of 72 °C for 5 min. PCR conditions for DNA barcodes were optimized by varying annealing temperature in the range of 48-55°C and $MgCl_2$ concentration from 1.5mM-2.5mM. PCR reaction was conducted on approximately 40 ng of DNA template, in a 25 µL reaction containing 1X Standard Taq reaction buffer (10 mM Tris-HCl, 50 mM KCl and 1.5 mM $MgCl_2$), 0.2 mM dNTPs mix, 10 pmol forward and reverse primer respectively and 0.5 units of Taq DNA polymerase. Magnesium concentration was varied in Taq reaction buffer. Amplification was performed as follows 94°C for 5 min, 35 cycles of 94°C for 1 min, gradient temperatures for 1 min, 72°C for 1:50 min, followed by one cycle of 72°C for 7 min. The amplification product was resolved on 1.5% agarose gel and visualized under UV light in a gel documentation system.

Process protocol for amplification and validation of calendula adulteration in saffron with SCAR markers

PCR reactions were carried out by following the above mentioned conditions for SCAR marker ScCO390. An annealing temperature of 55°C and 2mM $MgCl_2$ was found to be optimum. Amplification product of 390 bp was observed.

The PCR reactions for mixture of Calendula in saffron were carried out in 25 µL reaction containing 1X Standard Taq reaction buffer (10 mM Tris-HCl, 50 mM KCl and 1.5 mM $MgCl_2$), 0.2 mM Deoxynucleotide mix, 10 pmol forward and reverse primer respectively and 1.25 units of Taq DNA polymerase and amplification was performed as follows 94 °C for 7 min, 35 cycles of 94 °C for 1 min, 55 °C for 1:30 min, 72 °C for 1:30 min, followed by one cycle of 72 °C for 5 min. On PCR amplification of mixture of calendula and saffron, SCAR marker ScCO390 was able to detect as low as 3% adulteration.



Amplification of calendula by primer ScCO390 where; M-100bp Ladder, Lane 1- 6; pure calendula, 3% calendula in Saffron, 5% calendula in saffron, 7% calendula in saffron, 10% calendula in saffron and pure saffron

Process protocol for amplification of ITS2 in calendula and saffron

PCR amplification of calendula with ITS2 was optimized as per the details given above. An annealing temperature 50°C and 2mM $MgCl_2$ was found to be optimum that yielded the product of approximately 500 bp. In case of saffron also, an annealing temperature of 50°C and 2mM $MgCl_2$ yielded the product of approximately 500 bp. Therefore, the possibility of using ITS2 DNA barcode for detection of calendula adulteration in saffron is nullified.

Optimization of Process Protocol for Amplification and Validation of Calendula Adulteration in Saffron with psbA-trnH barcode

PCR amplification with psbA-trnH at optimum annealing temperature 50°C and 2mM $MgCl_2$ yielded the product of approximately 665 bp for saffron and 500bp for calendula. As there was significant difference in the product size and reproducible results were obtained, the psbA-trnH DNA barcode could be used as marker for adulterant calendula detection in saffron.

Amplification of calendula and saffron with psbA-trnH. Lane no. M: 100bp DNA ladder; Lane 1-7: Pure calendula , 1% calendula in Saffron, 3% calendula in Saffron, 5% calendula in Saffron, 7% calendula in Saffron, 10% calendula in Saffron and Pure Saffron

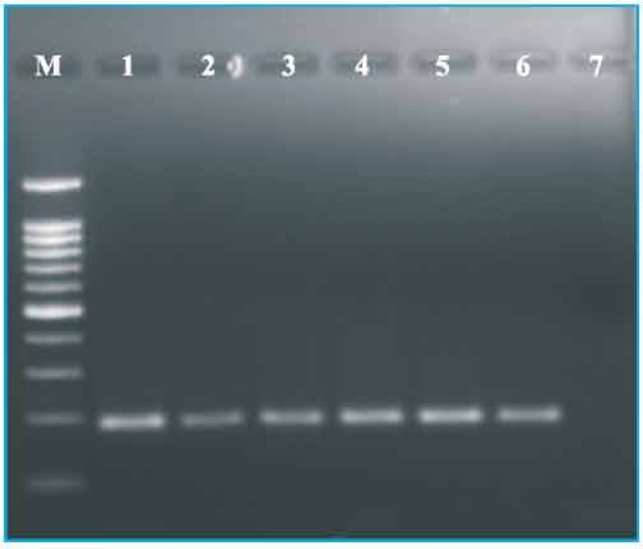
The PCR reactions for mixture of calendula in Saffron were carried out in 25 µL reaction containing 1X Standard Taq reaction buffer (10 mM Tris-HCl, 50 mM KCl and 2 mM $MgCl_2$), 0.2 mM Deoxynucleotide mix, 10 pmol forward and reverse primer, respectively and 1.25 units of Taq DNA polymerase and amplification was performed as follows 94°C for 5 min, 35 cycles of 94°C for 1 min, 50°C for 1 min, 72°C for 1:50 min, followed by one cycle of 72°C for 7 min. Calendula concentration of as low as 1% was detected by using psbA-trnH DNA barcode.

As the primer set psbA-trnH was able to detect both adulterant and saffron simultaneously, it can be used as a perfect marker for detecting the adulterant and authenticating the saffron at the same time.

Optimization and Validation of Process Protocol for *Safed Jeera* and Black *Jeera* by Specific Markers and DNA Barcodes

Process protocol for amplification of specific marker in *safed jeera*

Kala jeera (*Bunium persicum Bioss.*) is a high value herbaceous spice widely used for culinary,



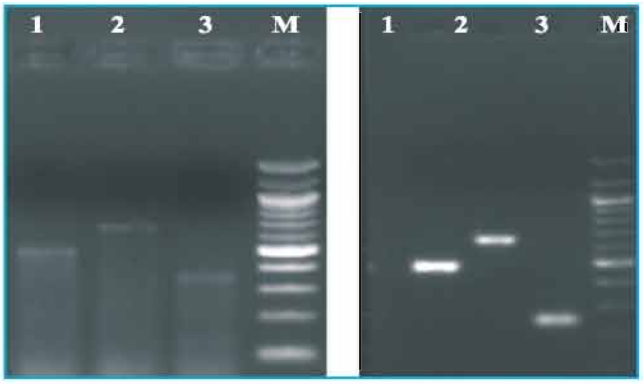
Amplification of *safed jeera* and *kala jeera* with Cum, where; Lane no. M: 100bp DNA ladder; Lane 1-7: Pure *safed jeera*, 1% *safed jeera* in *kala jeera*, 3% *safed jeera* in *kala jeera*, 5% *safed jeera* in *kala jeera*, 7% *safed jeera* in *kala jeera*, 10% *safed jeera* in *kala jeera*, pure *kala jeera*

flowering, perfumery and carminative purposes. It is known worldwide for its medicinal value and is known by different names. *Kala jeera* has been mistakenly referred as *Cuminum cyminum* and is often adulterated with it.

The primer was optimized and standardized to be used as a specific marker for the detection of *safed jeera* (Cumin). PCR reactions for SCAR markers were conducted. Amplification was performed as follows 94°C for 7 min, 35 cycles of 94°C for 1 min, gradient temperatures(55°C- 65°C) for 1:30 min, 72 °C for 1:30 min, followed by one cycle of 72°C for 5 min. Temperature of 55°C was found optimum as it provided maximum intensity single amplicon.

Process Protocol for Amplification of ITS, rbcL and psbA-trnH DNA Barcode in *Safed Jeera* and Black *Jeera*

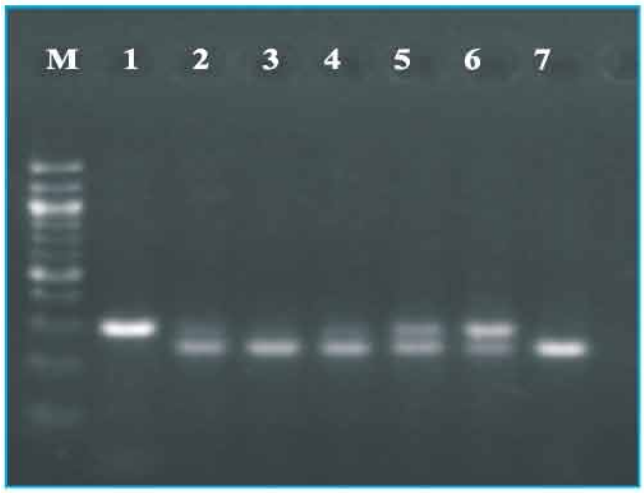
Annealing temperature of 50°C and 2mM $MgCl_2$ concentration was found to be optimum for PCR amplification of *safed jeera* and black *jeera* with all the three DNA barcodes namely, ITS2, rbcL and psbA-trnH. At optimized conditions, the primer sets ITS2, rbcL and psbA-trnH yield single amplification products of size approximately 500bp, 650bp and 300bp, respectively.



Amplification of a. *safed jeera* and b. *kala jeera*, where; Lane no. 1: ITS2, Lane no. 2- rbcL, Lane no. 3- psbA-trnH and Lane no. M: 100bp DNA ladder

Validation of process protocol for detection of *safed jeera* adulteration in black *jeera* in different concentrations by DNA barcodes

Due to the difference in the amplification product size of psbA-trnH in black *jeera* and *safed jeera*, it could be used as marker for the detection of *safed jeera* adulteration in black *jeera*. Amplification was performed as follows 94°C for 5 min, 35 cycles of 94°C for 1 min, 50°C for 1:30 min, 72°C for 1:00 min, followed by one cycle of 72°C for 7 min. *Safed jeera* concentration of as low as 10% was detected by using primer set psbA-trnH.



Amplification of *safed jeera* and black *jeera* with psbA-trnH, where; Lane no. M: 100bp DNA ladder; Lane 1-7: pure *safed jeera*, 10% *safed jeera* in black *jeera*, 20% *safed jeera* in black *jeera*, 30% *safed jeera* in black *jeera*, 40% *safed jeera* in *black jeera*, 50% *safed jeera* in black *jeera* and pure black *jeera*

Quality Analysis of Packaged Mushroom and Pomegranate Arils

Experiments were carried out to determine the respiration rate of mushroom stored at 0, 5 and 10°C. Measurement of respiration rate of mushroom was carried out by a closed system method at three selected temperatures. An air tight container of known volume represents a static or closed system to measure the respiration rate of a commodity under the selected environmental conditions. The initial atmosphere inside the sealed container containing a known weight of the produce is ambient. Respiration rate of packed mushroom, showed consumption of in-pack O_2; unsteady state O_2 and CO_2 prevailed till 6 h with slight fluctuation. The equilibrated O_2 and CO_2 levels were attained around 9 h and were largely influenced by the temperature differential of respiration rate. RCO_2 for mushroom was found to be

65.64, 99.18 and 118.93 mg CO_2/kg/h at 0°C, 5°C and 10°C, respectively. pH of packaged mushroom did not show considerable change with storage time. L value of mushroom stored at 10 and 15°C, reach to a level of 74.57 and 68. 97, respectively within 3rd day of storage while L value of 5°C stored sample was found to be 76.13 after 6th day of storage. Sample stored at 5° C was found to be comparatively better than those stored at 10°C and 15°C.

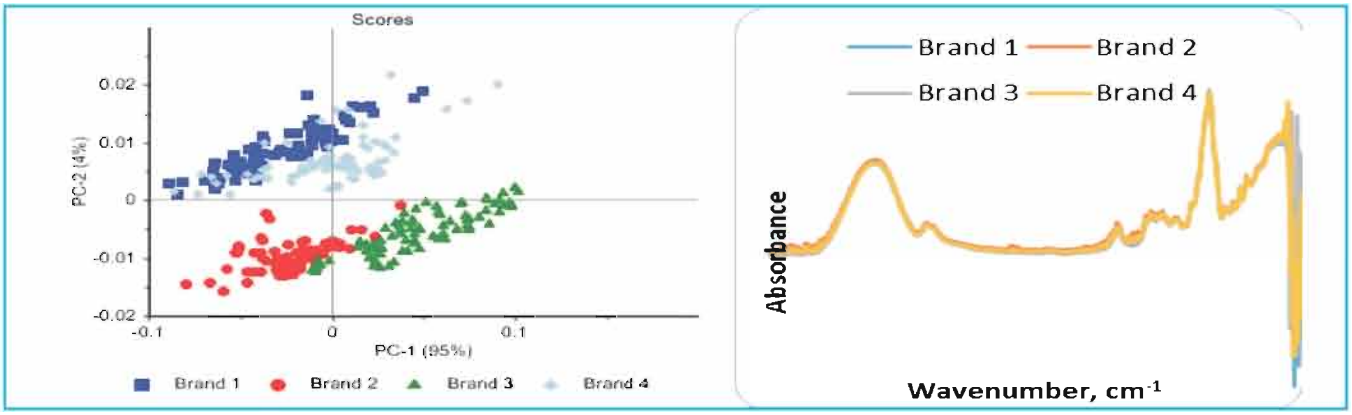
In order to study the effect of microbial growth on headspace gas concentration, microbial (bacterial) growth was monitored in closed tube. Growth of bacteria was recorded in terms of cfu/ml and increase in turbidity i.e absorbance at 600 nm. A close relation was observed between microbial population in closed tube and gas concentration.

Experiments were conducted on quality parameters (TSS, pH, colour, microbiological, phenol content) of pomegranate arils during storage at three different temperature (5, 10, 15 °C) along with monitoring of headspace gas concentration. Results showed that pH of the pomegranate juice of arils stored at 5° C was found to be in range of 4.024 to 3.9 till 14th day of storage while those of 10°C and 15°C stored samples reached to a level of 3.7 and 3.6 after 2nd day of storage. The sample stored at 5° C was found acceptable with respect to microbial quality for larger period (till 8th day of storage) as compared to those stored at 10°C and 15°C. The acceptability of 10°C and 15°C stored pomegranate arils was found to be till 2nd and 1st day of storage only with respect to microbiological quality.

Development of Spectroscopic Techniques for Detection of Adulteration in Honey

Four commercially available brands of honey (500g pack size each) were collected from local market. Fourier transform infrared (FTIR) spectrometer equipped with attenuated total reflectance (ATR) diamond crystal cell was used to acquire spectra of honey samples. Samples were placed in direct contact with Diamond ATR crystal using a Pasteur-pipette. All together 600 spectra, (150 samples of each brand of honey) were acquired using software OPUS (7.2 Build, Bruker Optik GmbH), with simultaneous physico-chemical quality parameters (e.g TSS, acidity, pH, total sugar, reducing sugar, moisture, ash content, glucose fructose ratio, diastase activity). Results showed that pH (4.27-4.75) and TSS (80.5-80.9) of all the brands fell in almost same range. Moisture content is another important quality parameter of honey. Moisture content of brand 3 was lowest (17.66%) while very little variation was observed amongst the rest of the 3 brands (18.67-18.93%). Moisture content of all the honey samples were well within the range of FSSAI standards and as reported by many workers. Total sugar content of honey samples ranged from 66.18 to 78.00%. Highest sugar content was observed in brand 3 and lowest in brand 1.

Principal component analysis (PCA) spectral data showed clustering of specific wave number region indicating variation in chemical composition of honey, at 5% significance level analyses is under progress to identify the chemical component responsible for variation.



Principal component scores plot depicting clusters of pure and spiked honey

AICRP on Post-Harvest Engineering and Technology

Modified ANGRAU Polyhouse Solar Dryer for Chillies (Bapatla Centre)

Multipurpose solar dryer of capacity 22-24 q for drying of chillies has been earlier developed at the centre. In the modified version, the capacity of the polyhouse dryer was enhanced from 24 to 120 q. Manual ventilators were replaced with well-designed turbo jet ventilators to avoid condensation problem. Wiggle wire and wiggle channels were used in place of polygrip assembly. Temperature built up in the dryer was recorded 12-16°C higher than ambient temperature. It takes 7-9 days to complete drying of chillies to safe moisture levels (10-12% wet basis). The quantity of discoloured pods was 3-4% whereas in open yards using sunshine (OYSD), it ranged between 13-16%. Aflatoxin levels of polyhouse solar dried chilly samples were estimated to be < 5 ppb that is within tolerance limit. In terms of colour retention, pungency and oleoresin values, polyhouse dried samples fared much better than OYSD samples.

Modified ANGRAU polyhouse solar dryer for chillies

Fermented Beverages from Banana Pseudo-Stem (Bengaluru Centre)

AICRP on PHET, Bangalore centre focused on value addition to banana pseudo-stem through microbial fermentation in order to develop value added fermented beverages using yeast and lactic acid bacteria.

Yeast fermented banana pseudo-stem alcoholic health beverage

Banana pseudo-stem core juice was filled in the sterilized glass bottles and inoculated with 8% broth culture of yeast (*S. ellipsoideus*) containing 10^7cfu/ml. The inoculated glass bottles were made air-tight with rubber cock and kept for 6 days for fermentation under room temperature. The fermented juice was filtered using muslin cloth and filled into sterilized bottles. The yeast fermented juice was analyzed for biochemical characteristics and also subjected to sensory evaluation. The acceptability of yeast fermented banana core alcoholic beverage was found to be very good for consumption. The beverage had a pH 3.63, TSS 8.13° brix, titrable acidity 0.03%, alcohol content 7.23% and overall acceptability score of 16.5/20.0.

Banana pseudo-stem

Centre core

Fermented beverage from centre core

Lactic acid fermented banana pseudo-stem non-alcoholic health beverage

Banana pseudo-stem core juice was prepared using 20% core pulp, 5-10% honey and 60% water and the TSS was adjusted to 10-12° Brix by adding cane sugar. The prepared juice was heated to 65-70° C for 5 min and allowed to cool. After cooling, the juice was filled into the sterilized glass bottles and inoculated with 8% broth culture of lactic acid bacteria (*L. acidophilus*) containing 10^7 cfu/ml. The inoculated glass bottles were made air-tight with rubber cock and kept for 6 days at 33°C for fermentation. This Lactic acid fermented banana core non-alcoholic health beverage had pH 4.57, TSS 8.9 brix with lactic acid bacterial population 5.1 x10^6 cfu/ml. The overall acceptability sensory score was 11.5 /20.0 and was good for consumption.

Pongamia Decorticator (Bangalore Centre)

Pongamia decorticator is a semi-automatic primary processing equipment used to separate the kernel from pongamia pods. It consists of feed hopper, decortication unit, air blower and screening unit for shell separation and grading of decorticated pongamia kernels, power transmission unit and collecting outlets. The overall dimension (l x w x h) of the machine is 1220 x 686 x1880 mm. The capacity of the machine is 250 kg/h. The cost of the machine is approximately Rs. 40,000/. The decortication efficiency of the machine varies between 83-95%. The main component of pongamia decorticator is the decortication unit consisting of a rotating drum with ribbed (horizontal sharp edge flutes) surface and an adjustable concave with ribbed (inclined) projections. The speed of the decorticating drum varies between 300 to 400 rpm. The nipping and shearing action developed with the help of rotating drum and stationary concave helps to dehull pongamia pods. The dried pongamia pods are fed to hopper and semi-automatically released to decortication chamber with the help of feeder. In decortication chamber, the rotating drum and stationary concave helps in shelling the pods due to nipping and shearing action developed upon pods. After decortication, the shells are blown-off and kernels are fractionated with the help of air screen separation unit. The grades of pongamia kernels may be collected at different outlets.

Pongamia decorticator

Turmeric Washer (Coimbatore Centre)

A continuous type mechanical washer was developed for removing field dirt, soil particles and other unwanted materials from the turmeric. The

Inside view of turmeric washer

main components of the washer are feeding chute, cylindrical rotary drum, water spray assembly, outlet chute, motor, pump, frame and water collecting tray. The washer consists of a rotary drum of 180 cm long and 60 cm diameter. The drum is made of stainless sheet with rectangular holes of 6 mm diameter punched on it. The perforation percentage is given as 60% and it inclined at 25° to the ground. The feeding chute is mounted on feed end of the drum for loading of the turmeric rhizomes. The feeding chute is made of stainless steel sheet in a trapezoidal shape. The dimensions of the chute are: top width- 44 cm; bottom width- 10 cm; length- 50 cm; and height- 10 cm. The sheet thickness is 2 mm and the overall slope of the chute is 20°. The water spray assembly is made of GI pipe of 210 cm length. On the pipe, 17 holes are drilled at an interval of 10 cm. The diameter of the hole is 4 mm. A gate valve is provided to control the water flow rate into the drum. A rectangular tank of size 200 x 61 x 25 cm coupled with a pump is fixed below the rotating drum for recirculation of spray water. The washed turmeric is received at a trapezoidal shaped collection chamber of 46 cm top width, 20 cm bottom width, 50 cm length and 10 cm height. The washing efficiency obtained was 88% at a speed of 30 rpm and a drum inclination of 9°. The maximum handling capacity is 450 kg/h.

Rotary Dryer for Turmeric Rhizomes (Coimbatore Centre)

A batch type dryer for drying turmeric rhizomes was designed and developed. The capacity of the dryer is 500 kg per batch. It uses biomass as fuel. Drying of turmeric rhizomes takes place in cascading and mixing condition in drying chamber. To facilitate free fall of turmeric during rotation, 25% volume of the chamber is left free. A cylindrical type furnace was constructed with 1 m diameter and 1.2 m length. It consists of burning chamber, fresh air inlet, hot air outlet, fuel chamber and ash outlet. A cylindrical burning chamber of 0.26 x 0.18 m is provided to burn biomass. A chimney with circular cross section 0.15 m diameter is fixed at the top of the furnace. The furnace is provided with the tapered end of 0.35 m diameter and 1.8 m length to pass the hot air from furnace to blower. In order to prevent the heat loss, insulation has been provided over the furnace. A blower is connected to one end of the furnace to suck the hot air and pass it to plenum chamber. A reduction gear box having a speed reduction ratio of 10:1 is used in conjunction with a motor and a set of pulleys to rotate the drying chamber (drum) at the required speed. The main frame support is rotary drum with dimensions of 1270 x 1600 x 2600 mm made of mild steel sheets and angles.

Trials were conducted for a range of drying air temperatures from 50 to 70° C. At a temperature of 70°C, air velocity of 3 m/s and drum rotational speed of 9 rpm, turmeric has dried faster in 33 h. Maximum retention of curcumin was found at temperature of 50°C, air velocity of 3 m/s and drum rotational speed of 9 rpm. The lightness of the turmeric decreased as the drying temperature increased from 50°C to 70°C whereas the yellowness (b* value) of turmeric was higher at 50°C, 9 rpm and 3 m/s. The higher essential oil content of 3.93 % was observed at 50°C, 9 rpm and 3 m/s of air velocity.

Bamboo Shoot Peeling Machine (Imphal Centre)

A power operated bamboo shoot peeling machine was developed at Imphal centre. The machine has a mild steel roller of 20 mm diameter, on which number of spring bars are radially fixed with varying heights in a tapered manner. The roller is driven by ½ hp motor mounted on a rectangular

Bamboo shoot peeling machine

framework made of 1.5 inch angle iron. The speed of motor can be maintained at 80-100 rpm with the help of varying diameter pulley. The rotating roller

mounted on the main frame is used to strip off the peels/ sheaths of bamboo shoots pressed against the rotating spring spikes. A mild steel holder clamp is provided to hold the bamboo shoot which can control the depth of cutting. Due to scratching action of spikes, peels get detached from the main stalks. The cost of developed machine is around Rs. 15,000/-. The developed bamboo shoot peeling machine can peel 50-60 units of bamboo shoots per hour.

Meat *Jalebi* (Khanapara Centre)

Ready-to-Eat (RTE) foods are increasingly popular with the consumer due to their convenience of consumption, ease of preparation and storage and consumer appeal. Meat *jalebi* is a new product Freshly slaughtered pork chicken is first deboned and fat and skin was separated. Non meat ingredients including black gram, corn flour, wheat flour and *besan* were soaked in water for rehydration and ground into paste with the help of a mixer/grinder. The batter was allowed to ferment by normal fermentation process for 24 h. The chicken kept in chilling condition was taken out and minced and ground into paste. The meat portion, non-meat ingredients, vegetable oil, curd, salt, baking powder and all other spices were added and mixed properly to form an emulsion. The emulsion was be deep fried in vegetable oil in the traditional shape of *jalebi*. The meat *jalebi* may be served hot with readymade sauce.

Pilot Plant for Extraction of Pectin from *Kinnow* Peel (Ludhiana Centre)

A batch type pilot plant (50 kg capacity) was established for production of pectin from *kinnow* waste at Ludhiana centre. The various components of the pilot plant are peel bin collector (stainless steel SS 304 grade) for collection of peel; peel drier-cum tray drying oven (thermostatically controlled, double door with forced air blower) for drying of peel; grinder (chamber fitted with hopper along with three delivery SS sieve brush) for grinding of dried peel; powder collector bin (stainless steel SS 304 grade) for collection of powder; stirrer with heater (max. capacity 250 rpm and temperature 60-80°C for extraction of pectin); filtration unit for filtration; flash evaporator (buchi type); mixing tub with stirrer; basket centrifuge; oven (double walled temperature controlled); pH meter for setting the pH of extraction solution. The optimum process variables for pectin extraction from *kinnow* peel with HNO_3 and HCl method were 73.4°C temperature, 2.0 pH and 63 min of extraction time which gave pectin yield 15.6% at 75.0°C temperature, 2.0 pH of solution and 60.5 min of extraction time gave pectin yield 15.7%. The total investment incurred on different machinery/component of plant was Rs 4.95 lakhs.

Pilot Plant for Production of Probiotic Fruit Juices (Ludhiana Centre)

Probiotic foods are a group of health promoting functional foods with large commercial interest and growing market shares. An attempt has been made to formulate probiotic juices from guava, *kinnow* and mango with stable and viable beneficial bacterial count in the recommended dose (10^6 cfu/ml) with shelf life of one month. A pilot plant (50 L capacity) was established at the centre for production of probiotic fruit juices from *kinnow*, mango and guava. The pilot plant includes screw type juicer (capacity 100 kg/h), pulverizer (capacity 50 kg/h), stainless steel bin (capacity 50 L), batch pasteurizer (capacity 50 L) and pneumatic bottling unit. The total cost of machinery is about Rs 5.0 lakhs.

Refrigerated Fish Vending and Display Unit (Mangalore Centre)

Earlier developed fish vending and display unit at the centre is converted into refrigerator based on vapour compression refrigeration system using solar energy as an alternate for electricity and ice to make it efficient in the areas with no grid supply. Unit is made of food grade stainless steel and has capacity of 224 L (100 kg fish). It has three compartments for 3 different fish sizes, fitted with toughened glass for better display. Unit also has facility for cutting/processing of fish with separate waste collection tank, detergent tank, fresh water tank, packing, drawer for keeping money as well other belongings. It has drain valve to remove waste water

Refrigerated fish vending and display unit

and can be easily washed. The cost per unit is Rs. 35,000/-. The shelf life of mackerel and pink perch in the unit was achieved upto 8 and 10 days, respectively.

Multi-Mode Solar Drier (Raichur Centre)

Raichur centre has designed and developed a multi-mode solar drier to achieve controlled dehydration process and premium product. The developed multimode dryer can utilize different sources of energies viz., solar, photo voltaic cells and electrical energy. The different sources are combined mainly to supplement the solar energy during day time (if required) and to continue the drying process during night hours. The capacity of dryer is 100 kg with dimensions of 0.75 m length, 2.0 m width and 1.5 m height covered with 200 micron UV stabilized thermic sheet. It consists of natural turbo ventilator, which removes evaporated moisture from the drying chamber. It has 10 trays, each tray can hold around 10 kg of meat products and an electric heater (2 kW) for heating during night hours. The dryer is provided with digital temperature controller and automatic switch on and off facility. The temperature inside the dryer can be maintained at desired level (40-80°C) depending upon the crops/commodities to be dried. The cost is Rs. 1.50 lakh/unit.

Multi-mode solar drier

Pilot Plant for Osmotic Dehydration of Fruits (Solan Centre)

Solan centre has established a pilot plant for osmotic dehydration of fruits. The unit consists mainly two parts: 1. Rectangular main frame (775×480×1225 mm) fabricated by using 50×50×6 mm mild steel angle to hold osmotic rector, motor and pump assembly and 2. Frame to hold mixing chamber. A cylindrical steel chamber of 360 mm diameter and 465 mm clear height is used as mixing chamber. One heating element is fixed at the top container of the osmotic dehydration unit to heat the sugar syrup and another element in fruit holding container for maintaining the temperature during osmosis. A thermocouple is attached to the heating device to maintain the temperature during the process. A stainless steel container of size 330 mm diameter and 440 mm inner height is used as osmotic reactor. A stainless steel round shelf type holding pan of capacity 6 kg fruits is provided to hold the fruits. A positive displacement pump (1 hp) is placed to pump the sugar syrup from mixing chamber to osmotic reactor and another 1 hp motor has been provided for rotating the holding chamber.

For the preparation of osmotically dried destoned plums and apricot, fruits were initially washed with 0.5% NaOH solution for 30 s followed by thorough washing. The washed fruits were dipped in the hypertonic sugar solution of 70°B for 12 h; drained, destoned and dried mechanically at 55°C. The dehydration is done to a moisture content of 12-

Osmo-dehydrated apricot, kiwi and plum

14 %. The left over syrup was utilized for the preparation of appetizer and spiced RTS. In case of kiwi fruit, slices were blanched for 15 s followed by dipping in hypertonic sugar solution of 70°B for 12 h, drained and dried mechanically at 55°C. The osmotically dehydrated kiwi slices were coated with a mixture of ingredients containing *ajwain* powder (5 g), mint powder (10 g), salt (10 g) and black salt (10 g). The capacity of machine is 15 kg fruits per cycle.

Apple Seed Extractor (Solan Centre)

Motorized apple seed extractor with capacity of 180 kg/h has been also designed and developed. It has two chambers; one for milling of cores provided with 4 knives, 4 shafts and flow of water jets and another seed extraction chamber provided with 6 knives and 5 shafts and with flow of water jets. Two SS sieves with holes are provided in the extraction chamber taking into consideration the size of seeds. The pulp and wastage can be separated in the upper sieve whereas the seeds are collected in the sieve provided in lower part of the separator.

Multipurpose Women Friendly Seed Extractor for Ash Gourd, Cucumber and Pumpkin (Tavanur Centre)

Tavanur centre has developed a user friendly mechanical seed extractor for ash gourd, cucumber and pumpkin. The seed extractor consists of seed extraction tool, motor, vegetable holder, frame and discharging chute. In order to reduce the drudgery in operation especially for women laborers, a lever mechanism is adopted. The important part of the machine is the extraction tool which diameter can be varied according to the placental diameter of the fruit. The principle is to penetrate the rotating extraction tool with a handle into the placental region of vegetable after adjusting its diameter which helps in scraping out the seeds along with the pulp from the centre and surrounding mesocarp portion. In order to reduce the drudgery in operation, holders having the shape of a frustum are provided based on the structure and the diameter of ash gourd, cucumber and pumpkin. A DC motor is used having the power of 17 W. The speed of rotation is standardized as 80 rpm. Seed extraction efficiencies of these vegetables are in the range of 99 to 100%. The capacity of seed extractor for ash gourd, cucumber and pumpkin is 350 kg/h, 215 kg/h and 110 kg/h, respectively.

Gender Friendly Continuous Cocoa Pod Breaker (Tavanur Centre)

The continuous cocoa pod breaker consists of hopper, metal rollers, chute, rotating cylindrical strainers, frame, prime mover and pulleys. Cocoa fruit can be fed manually into breaker unit through hopper. Tangential force of the roller pushes the cocoa pod towards the gap resulting in breakage. Cocoa pod, kernels and placenta then discharged to strainer through chute. Rotation of strainer separates the cocoa kernels from cocoa pod and placenta, and passes through the pores of the strainer. It is collected and can be directly send for fermentation process. The broken pods remains above the strainer and separated.

Performance of the machine was evaluated in terms of capacity, energy requirement, percent bean damage, percent bean recovery, shelling efficiency

and machine efficiency. The average capacity and efficiency of cocoa pod breaker was 574.5 kg/h and 95-98 percent, respectively. Bean damage percentage was 0.5. The shelling efficiency and beans separation efficiency of the strainer at 45° inclination were 96.42 and 86.5 percent, respectively. The total time required for breaking 100 kg cocoa pods and collection of the beans for mechanical and manual method was 10 and 56 min, respectively.

Thermoplastic Cassava Starch Composites based Biodegradable Products (Trivandrum Centre)

Cassava starch is an ideal raw material for the production of environment friendly biodegradable composites to replace synthetic polymer based products. Thermoplastic sheet with cassava starch-glycerol blends were prepared at temperature (130-150°C), pressure (120-140 bar) and glycerol (30-50 %) and the physico-mechanical and functional properties of the sheets were evaluated. Glycerol content in the mix had positive quadratic effect whereas, temperature and pressure had no effect on the moisture content of the TPS. Density was found to decrease linearly with respect to temperature whereas, glycerol content had a positive linear effect. Maximum tensile strength of 1.08 Nmm^{-2} was obtained for the sample made at 140°C and 140 bar with 50% glycerol where the minimum of 0.16 Nmm^{-2} was obtained for the TPS made at 150°C and 130 bar with 30% glycerol. Percent elongation increased linearly with temperature of pressing and decreased linearly with glycerol content whereas pressure had no effect. The highest solubility was observed as 35.8% for the sheets made at 150°C and 120 bar with 40% glycerol. Thermoplastic sheets from cassava starch with glycerol as plasticizing agent were produced by thermo pressing method. Moisture content of the sheet ranged from 8.9 to 24.1%, total colour difference from 25.78 to 51.87, yellowness index from 24.13 to 50.13 tensile strength from 0.16 to 1.08 Nmm^{-2}, elongation at break from 6.18 to 10.62% and solubility from 7.7 to 35.8%.

Thermoplastic sheets with cassava starch-cassava stem powder - glycerol blends were also developed with the following properties: moisture content from 8.8 to 19.2%, density from 799 to 1552 kg m^{-3}, total colour difference from 50.59 to 64.36, yellowness index from 30.89 to 64.28, tensile strength from 0.16 to 1.65 Nmm^{-2}, elongation at break from 10.99 to 42.18% and solubility from 7.21 to 33.27%. Thermoplastic sheets with cassava starch- coconut pith-glycerol blends were also developed and the resulting sheets have moisture content ranged from 8.2 to 18.2%, density from 793 to 1875 kgm^{-3}, total colour difference from 48.65 to 73.54, yellowness index from 15.7 to 31.70, tensile strength from 0.16 to 1.37 Nmm^{-2}, elongation at break from 5.69 to 44.61% and solubility from 16.8 to 32.79%. Thermoplastic sheet from cassava starch added with glycerol and bentonite clay were developed with the following properties: moisture content: 7.63 to 18.10%, tensile strength:0.33 to 4.06 N/mm^2, elongation at break: from 4.44 to 21.96% and solubility from 56.25 to 100%.

Continuous Garlic Clove Peeler (Udaipur Centre)

The garlic clove peeler developed by Udaipur centre mainly consists of a stainless steel peeling chamber (160 mm diameter, 300 mm long) mounted on a mild steel angle frame. A 10 mm galvanized iron pipe is inserted and positioned at a height of 140 mm from the bottom of the peeling chamber to discharge the air from the compressor. Rubber ring gasket is provided under the chamber wall to prevent the air leakage. The top portion of the pressure chamber is connected with a 40 mm diameter stainless steel pipe. The peeled husk is carried away with air. A hopper is provided at upper portion of the peeling chamber for feeding the garlic cloves. A circular stainless steel plate is fitted at the bottom of the peeling chamber which works as outlet. The peeled cloves come out when this circular stainless steel plate is opened and collected in collection tray. The feeding of unpeeled cloves as well as outlet of peeled cloves is mechanized by

providing pneumatic regulators of 0-7 kg/cm^2 (Air Max India, Coimbatore) and air cylinders. One pneumatic cylinder of 50 mm diameter and 100 mm stroke is connected to feeding section and the other pneumatic cylinders of 50 mm diameter and 150 mm stroke are attached with outlet lid of peeling chamber. The supply of the compressed air to the peeling chamber can be regulated by pneumatic regulator (16 kg/cm^2) and hand levers to operate the machine. The mechanical operation i.e. regulation of opening and closing timings for compressed air jet, feeding and outlet lids by means of pneumatic controls are automated through electronic control panel. The capacity of machine is 12 kg/h.

Impact Assessment of Technologies of ICAR-CIPHET, AICRP on PHET and AICRP on PET

Impact assessment study was undertaken to assess and enumerate economic and social benefits accrued due to adoption of technologies of ICAR-CIPHET, AICRP on PHET and AICRP on PET. During this year, survey was conducted to collect primary data in Almora district of Uttarakhand on polyhouse technology (AICRP on PET); Khanna Food Products, Ludhiana (ICAR-CIPHET license of low fat meat technology); Gill Food, Alipur, Jalandhar (ICAR-CIPHET technology of groundnut and soybean technology); Organic *jaggery* unit, Hansi, Haryana (AICRP on PHET) and *Kinnow* waxing and grading units, Abohar region (technology promoted by ICAR-CIPHET). Besides, data pertaining to performance of agro processing centres (APC) collected by AICRP on PHET centres were compiled and analyzed. It is evident from the results that these technologies are economically viable and have multidirectional benefits to the entrepreneurs and society, and some of them have potential to double the farmers' income. For instance, establishing *Jaggery* production unit (Fixed capital investment =Rs.9.75 lakh) in production catchments, able to earn profit of Rs. 3.06 lakh from processing of one hectare of sugarcane, while, farmers are getting approximate gross returns of Rs. 1.87 lakh/ha by selling sugarcane at existing prices @Rs. 300/q, and that too depends on timely payments by sugar industry. Value addition was found to the tune of 204% for *jaggery* production. Moreover, production of *jaggary* from organic sugarcane is able to fetch high prices in the market, whereas, no price differential mechanism adopted by sugar mills for organic and inorganic sugarcane. Second, such example experienced in case of cultivation of vegetables in poly-house in hilly area, where farmers able to increase production and income more than double. Intangible benefits in the form of formation of *Kisan* Club namely '*Bhagartola* –I & II' were also noticed. Further, economics of soya/ peanut processing clearly indicated that one can earn Rs. 1.0 to 1.25 lakhs per month with a capital investment of Rs. 12.0 lakhs. Importantly, one such unit generates employment to 5 persons on regular basis and adds to the income of 20 retailers and 25 distributors those are involved in marketing of soya paneer, soya milk, etc. ICAR-CIPHET efforts in terms of promoting for *kinnow* waxing and grading units have spill over/demonstration effect. On an average, one *kinnow* waxing and grading unit (capacity= 10 t/h) able to earn profit of Rs. 17 lakh/season and provide employment to around 85 persons for a period of 3 months. Waxing and grading enhanced the shelf life of *kinnow* (50 days) lead to export (92 container @ 27t each) to Dubai, Bangladesh, Indonesia, Philippines, Russia during 2016-17. Our entrepreneur Khanna Food Products, meat processing unit (Capacity 100kg/day) earned profit of Rs 2.57 lakh /month through selling a range of variety of products such as Chicken Burger Patty, Seek Kabab, Nugget, Salami, Sausages, Garlic Finger, Ball, Lollypop and Bite and enterprise is economically viable, as benefit-cost ratio is 1.34. The monetary output at national level from the Agro Processing Centres (160 Nos) established under guidance of AICRP on PHET has been estimated to the tune of Rs. 838.40 lakh per annum. These APCs are able to establish forward and backward linkages. Besides, intangible benefits such as consumers' satisfaction on quality, indirect employment in marketing of processed products were noticed.

Study on Storage Losses of Food Grains in FCI and CWC Warehouse and to Recommend Norms for Storage Losses in Efficient Warehouse System

This study was initiated in July 2013 for a period of four years in selected 45 godowns and 18 CAP storage which covers 13 agro-climatic regions covering 46 locations in 21 states and one UT. The progress of the project was monitored and loss/gain (%) were estimated (commodity wise and depot wise) for the stocks liquidated. The preliminary results indicating that losses of wheat under godown were in the range of 0.01 (6 months) to 5.76 percent (18 months) in case of FSD Phulwari sharif and FSD New Guwahati, respectively. The maximum gain in wheat was observed 2.79 percent after 21 months in FSD Barwala whereas minimum gain of 0.01 percent (6 months) in CWC Karnal III. In case of wheat (CAP), losses ranged from 0.11 (6 months) to 1.56 percent after 12 months in FSD Nalgonda. However, gain under wheat (CAP) recorded highest in FSD Moga (i.e. 2.04 percent after 9 months of storage and minimal gain of 0.01 percent after 12 months in FSD Dhamora. The storage losses in paddy (CAP) observed 1.39 to 5.95 percent in FCI Dhamtari after three month storage and FSD Moga after 12 months storage, respectively. Losses in rice 0.02 percent after 3 months storage in FSD Whitefield to 3.87 percent after 21 and 27 months of storage in FSD Naraina and CWC, Gulbarga II. Gain in rice was observed between 0.60 to 1.29 percent after 21 months storage in FSD Barwala and 15 monhts in CWC Gulbarga II, respectively. Maize study was undertaken for one year in SWC Chindwara, Madhya Pradesh. The losses in maize were found to the tune of 2.16 to 4.90 percent after 3 and 6 months of storage but subsequently we were asked to drop since there was only one depot for maize. The observations on physical and microbial quality parameters of the commodity are being recorded fortnightly and liquidation is being done at quarterly basis. Besides, environmental data of the depot are also recorded on daily basis.

AICRP on Plasticulture Engineering and Technology

Poly-house for Cultivation of Mushroom during Summers in Punjab (ICAR-CIPHET, Abohar centre)

ICAR-CIHET, Abohar centre developed structure for mushroom cultivation which has overall dimensions (length 14.63 m, width 3.66 m and height 4.27 m). Floor of the structure has been kept at 0.9 m depth below the ground level. Structure has multilayered roof composed of iron net (half inch mesh), polythene (25 micron thick), jute (2-3 mm thick), EPF thermocol (8 mm thick) and UV stabilized polythene (300 gsm). Data on various aspects viz. temperature profile in polyhouse, heat gain and cooling in polyhouse was analyzed. Microclimate inside structure found that lower tier showed considerably lower temperatures (about 10°C) compared to other tiers. It might be due to the height of the structure and depth of the floor. Two crops of button mushroom and one crop of dhingri mushroom can be grown in the structure in a year. Cost of the structure is around Rs. 1,80,000/- and approximately Rs. 1,70,000/- can be earned from the structure per annum.

Poly-house for cultivation of mushroom

- ICAR-CIPHET mushroom polyhouse could provide desired temperature (28-35°C) and RH (80%) using evaporative cooling arrangements. Favorable temperature and RH were achieved by operating fan-pad system for 50 min and foggers for 40 min.
- During October, average ambient air temperature was 31°C whereas structure maintained inside temperature between 23-31°C. With evaporative cooling, inside temperature and RH were altered to 22-27°C and $\geqslant$ 80%, respectively. These conditions were suitable for spawn run of button mushroom. Similarly, during November, structure could provide 20-23°C temperature and RH $\geqslant$ 80%. These conditions were found suitable for spawn run and case run of button mushroom. Similar results were observed in February and early-March also.
- Study revealed that oyster mushroom can be efficiently cultivated in hot and arid region from May to early-July in ICAR-CIPHET Mushroom polyhouse. Similarly, cultivation of button mushroom can be started in October month (one month earlier) and it can be carried till early-March in hot and arid region using developed mushroom polyhouse.
- Cost-benefit ratio of the structure was determined as 1.38.

Design and Evaluation of Earth Tube Heat Exchanger Coupled Greenhouse for Hot and Arid Region

During the year, it was intended to develop an Earth Tube Heat Exchanger (ETHE) coupled

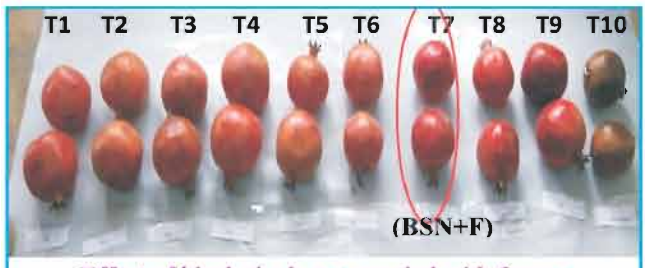
greenhouse suitable for hot and arid regions. Major findings are as follows:

- Optimum depth for installation of ETHE system in hot and arid region (waterlogged) of Punjab was found as ⩾1.8 m
- Optimum volume of greenhouse that could be cooled with ETHE system (depth 2 m, pipe dia. 50.8 mm, pipe length 64 m, material GI pipes) was found to be 65 m^3
- Optimum volume of greenhouse that could be cooled using ETHE in combination with shade net, ventilation and foggers was found as 105 m^3
- Cooling arrangement comprising of ETHE + black shade net + foggers + ventilation could reduce the greenhouse temperature by 6.7°C when ambient temperature varied from 45-50°C
- High temperature (45-49°C) and low RH (10-15%) during May-June months severely affected crops cultivation in hot and arid region. However, ETHE coupled greenhouse was found suitable for this purpose. Crop growth and health was better in greenhouse compared to open field cultivation

Development of Semi-Permanent Shade Net House to Reduce the Sun Burn of Pomegranate Fruits in Hot and Arid Region of Punjab

Five different shade nets with different colour and shade percentage (Green shade nets 35%, Red shade nets 50%, Black shade net 50%, Green shade net 50%, and 50 % black shade net in combination of fogger) were used in the experiment. Fogger and micro sprinkler were installed at the height of 2.5 meter with the help of bamboo. Rest two treatments (Kaolin 4% and borax 0.4%) were applied in three times during the fruit development stage.

Semi-permanent shade net house reduced the temperature and solar radiation by 3-5°C and 35 to 50%, respectively during peak hot period. Therefore, the attack of sunburn was lower under shade net structures. Minimum sunburn attack under black shade net coupled with fogger (T7) was 4 % as compared to 15% under open field condition (T10) (Fig.4.1). Deep red aril was found under black shade net house coupled with fogger. Black shade net



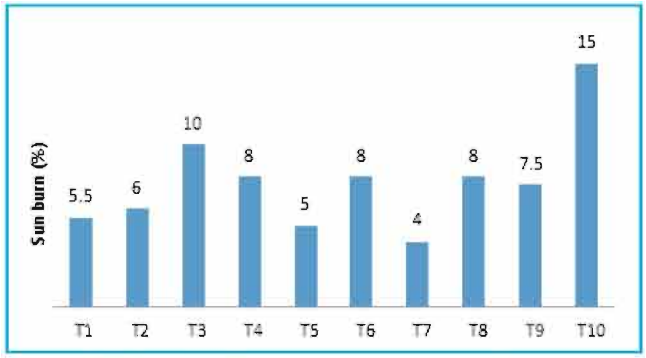
Effect of black shade net coupled with fogger

Shade nets in field

Sun burn in pomegranate

house coupled with fogger resulted in deep red aril color (L, a, b value as 22.45, 45.25 and 0.12 respectively) compared to open field condition (46.20, 39.25 and 8.34, respectively). Major findings are:

- The sunburn and fruit cracking in pomegranate fruit can be reduced by installation of black shade net (50%) over plants after complete fruit set. This net should necessarily be removed after harvesting to attain tangible plant growth.
- Installation of black shade net (50%) in combination with overhead foggers from May to August or up to harvesting reduces the sunburn up to 4% as compared to 15-17% sunburn in plants without any shade.
- Installation of black shade net (50%) in combination with overhead foggers imparted redness to peel and aril, increased juice recovery



Effect of different treatment on sunburn disorder of pomegranate

and reduced the temperature stress in pomegranate fruits.

Heating and Cooling of Polyhouse using Earth Tube Heat Exchanger (ICAR-NEH, Barapani Centre)

Optimum length of heat exchanger (flow rate:12 m^3/h) was found to be 36 m as at this length performance of heat exchanger was the best with lowering of temperature by 14^{0}C. Considering the price for electricity consumption in Meghalaya @Rs.2.25/kwh under agriculture practice, the cost comes up to Rs.22.5/-day and fixed charge @ Rs. 50/- month. If it is considered under Industrial use, the cost of operation per day @ Rs 5.2 as Rs. 52/- + fixed charge @ Rs.90/- month.

Performance of Asparagus Cultivation within Naturally Ventilated Polyhouse (NVP) as Compared to Open Field Condition (CAU, Gangtok Centre)

Drip irrigation + mulch inside polyhouse was the best for growth of Asparagus in Sikkim conditions. Maximum biometric parameters plant height (18.20), number of shoots/plant (165) and canopy diameter (39 cm) in the treatment was observed. The earliest sprouting in 37 days was observed in Drip + mulch inside polyhouse as compared to 53 days in open conditions.

Asparagus cultivated in NVP

Effect of Coloured Plastic Mulches on Tomato Crop (JAU, Junagadh centre)

Red plastic mulch was found to be better with crop parameters viz., plant height (95.50 cm), no. of branches/plant (20.25), no. of fruits/plant (51.93) and weight of fruits/plant (3.82 kg). Yield of the tomato crop (84.8 t/ha) red mulch, silver mulch (73.63 t/ha) and minimum yield of tomato was found in control (52.59 t/ha).

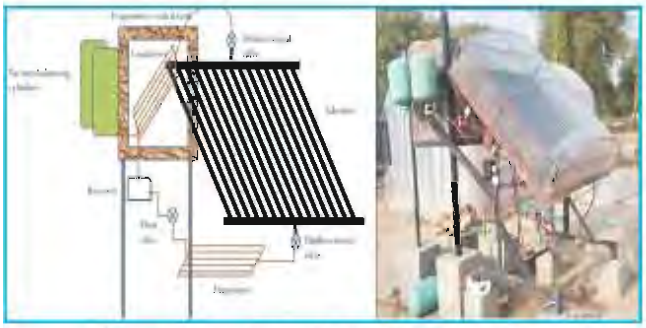
Coloured plastic mulches on tomato crop

Modified Adsorption Cooling System (ICAR-CIPHET, Abohar Centre)

It contains adsorber, condenser, evaporator, receiver, check valve, float valve and needle valve. Methanol is supplied to adsorber during which it is adsorbed on the surface of activated charcoal. This process liberates considerable amount of heat. During day hours, solar energy falls on the adsorber which increases the adsorber's temperature and thus supplies enough heat to liberate methanol from the surface of the activated charcoal. Further, methanol vapours enter in to water cooled condenser through uni-directional check valve. Condensed methanol enters in to float valve through receiver and then in to evaporator coil through needle valve. Methanol receives latent heat of vaporization from evaporator coil and gets evaporated by cooling the evaporator coil. Methanol vapour then enters in to adsorber and thus completes the cooling cycle. Major findings are:

- Appropriate sequence with better performance was found as adsorber – check valve – condenser – receiver – float valve – needle valve – check valve – adsorber.

- Solar energy based adsorption cooling system developed at ICAR-CIPHET Abohar was found suitable in lowering the temperature of cooling coil by 18°C (reduced the temperature from 38 to 20°C).
- Complete working cycle was achieved. Efforts are being made to increase the number of cycles



Solar energy based adsorption cooling system solar collector

Filter for Desalination of Water for Micro-Irrigation (PAU, Ludhiana Centre)

Rice husk ash was proved to be best adsorbent which reduce SAR value from 18.75 to 8.84 of simulated saline water using column method at optimum contact time. In drip irrigation system, initially the SAR value decreased to 5.61 meq/l from 18.75 meq/l of simulated saline water. After 300 min, decrement in SAR value of saline water becomes almost constant. SAR value of saline water was 10.32 meq/l, after 500 min when 800 l of saline water had been passed through filter section at rate of 1.6 l/min.

Desalination system for water

Development of Mulch Laying Machine (MPUAT, Udaipur centre)

Field performance test was conducted for plastic mulch laying machine developed by MPUAT, Udaipur centre. Results revealed that the time required to cover 0.1 ha was 1 h 19 min with a speed of operation of 1.69 km/h. The effective field capacity was 0.10 ha/h and the field efficiency was 61.47 % and the labor requirement was 52.88 man-h/ha. Cost of machine is around Rs 2500/- approximately. Two persons are required to operate the machine and can lay 60 / h.

Trial of mulch laying machine on the field

Mobile Fish Vending Trolley for Hygienic Fish Marketing (ICAR-CIFA, Bhubaneshwar centre)

Prototype of fish vending unit was developed at ICAR-CIFA centre for hygienic fish marketing. Fibre Reinforced Plastic (FRP) is the base material for the carriage. It is 4'x2'9"x2'6" in terms of dimension. The capacity of unit is 100 kg with specialty of the carriage is its unibody design as all the facilities and equipments are integrated into it. An ice box of size 2'x2'9"x2'6" is integrated in the carriage box and packed with 1" thick Polyurethane Foam serve as insulating material. The cost of fabrication of the whole system was kept around Rs. 50,000/-.

Mobile fish vending trolley

POST-HARVEST MACHINERY AND EQUIPMENT (PHME) TESTING CENTRE

Post-harvet machinery and equipments received for testing during 2016-17

Sr. No.	Name of the Industry	Name of the Machine	Testing Fee Received (Rs.)	Date on which Fee Received	Status of Testing
1.	Matharu Industries Pvt. Ltd., Faridkot	Maize grain dryer	2,69,675	04/07/2016	Completed
2.	Indosaw, Ambala	*Daal* mill	1,12,355	06/06/2016	Completed
3.	Shri Balaji Industries, Pune	Cleaner cum grader	1,12,355	03/10/2016	Completed
4.	Shri Balaji Industries, Pune	Flour/Rawa machine	57,155	03/10/2016	Completed
5.	Aero Scientific Industries, Ambala	*Daal* mill	1,12,355	07/10/2016	Completed
6.	Tool Tech solutions, Jalna	Flour mill	57,155	14/10/2016	Ongoing
7.	Tool Tech solutions, Jalna	a) Pulveriser (wheat)	49,450	14/10/2016	Ongoing
		b) Pulveriser (chilly)	19,780	01/03/2017	
8.	Venkatesh Agro Engineering works, Jalna	Pounding machine (chilly)	73,600	17/10/2016	Ongoing
9.	Jagdamba Agro Engineering, Jalna	Vermicelli machine	55,315	30/10/2016	Ongoing
10.	Maa Durga Plastics Products , Akola	Mini *Daal* mill	1,12,355	03/01/2017	Machine yet to be received
11	Jagdamba Agro Engineering, Jalna	a) Pulveriser 2 in 1 (Jowar)	73,600	01/03/2017	Ongoing
		b) Pulveriser 2 in 1 (turmeric)	29,440	01/03/2017	Ongoing
12.	Sri Balaji Industries, Coimbatore	12" Pulveriser	73,600	30/03/2017	Machine yet to be received
13.	Sri Balaji Industries, Coimbatore	14" Flour mill	57,155	30/03/2017	Machine yet to be received
14.	Sri Balaji Industries, Coimbatore	16" Flour mill	1,12,355	30/03/2017	Machine yet to be received
15.	Sri Balaji Industries, Coimbatore	18" Flour mill	1,12,355	30/03/2017	Machine yet to be received
16.	Sri Balaji Industries, Coimbatore	Ragi cleaning and destoning (2.5hp)	1,12,355	30/03/2017	Machine yet to be received
17.	Sri Balaji Industries, Coimbatore	Ragi cleaning and destoning (3hp)	1,12,355	30/03/2017	Machine yet to be received
18.	Sri Balaji Industries, Coimbatore	SS Pulveriser	73,600	30/03/2017	Machine yet to be received
19.	Sri Balaji Industries, Coimbatore	Rawa/cattle feed machine	1,12,355	30/03/2017	Machine yet to be received
		Total	**19,00,720**		

TRAINING AND CAPACITY BUILDING

HRD Budget Utilization in 2016-17

Allocated Budget (Rs. in lakhs)	Budget Utilized (Rs. in lakhs)
3.98	3.97

Following staff of ICAR-CIPHET Ludhiana/Abohar undergone training during the year 2016-17

Scientific Staff

Sr. No.	Name of Scientist & Designation	Title of Training	Duration	Place
1	Dr Manoj Kumar Mahawar, Scientist	ICAR sponsored 21days winter school on "Manufacturing Technology of Agricultural Equipment"	Sep 01-21, 2016	ICAR-CIAE Bhopal
2	Dr V Eyarkai Nambi, Scientist	Winter school on "Recent trends in Seed Production, Post-Harvest Handling and Value Addition Techniques for Effective Seed Supply Chain"	Sep 14-Oct 04, 2016	Seed Centre, Tamil Nadu Agricultural University, Coimbatore
3	Dr Vijay Singh Meena, Scientist	Winter school on "Recent Advances in Post-Harvest Management of Fruits, Vegetables and Flowers for Minimization of Quantitative and Qualitative Losses"	Nov 02 –22, 2016	ICAR-IIHR, Bengaluru
4	Mr Vikas Kumar, Scientist	Value Addition to Livestock Products and Entrepreneurship Development	Jan16-23, 2017	DLPT, GADVASU, Ludhiana
5	Dr Ranjeet Singh, Scientist	Competency Enhancement Program for Effective Implementation of Training Functions	Feb 21-23, 2017	ICAR-NAARM, Hyderabad

Administrative Staff

Sr. No.	Name & Designation	Title of Training	Duration	Place
1	Sh Pawan Kumar, AAO Sh Sanjay Kumar Gaur, LDC HCP Division, Abohar	Knowledge Enhancement on " Payroll & HR Methods"	Apr 18-19, 2016	ICAR-IASRI, New Delhi
2	Mrs Jasvir Kaur, Assistant	Training programme on ICAR-ERP modules	Aug 16-20, 2016	ICAR-IASRI, New Delhi
3	Sh Kunwar Singh, Assistant Sh Mohan Lal, Assistant	Supply Chain Management (Procurement and Store)	Jun 09-10, 2016	ICAR-IASRI, New Delhi
4	Sh Raj Kumar, SAO Sh Kunwar Singh, Assistant Sh Mohan Lal, Assistant Sh Iqbal Singh, UDC Sh Vishal Kumar, Sr Technical Assistant	Implementation of NIC's e-Procurement Solution	Jun 16-17, 2016	ICAR-IARI, New Delhi
5	Sh Pawan Kumar, AAO HCP Division, Abohar	Orientation Course in Record Management for Record Officers	May 18-20, 2016	National Archives of India, New Delhi
6	Sh Raj Kumar, SAO Sh Tarsem Singh Purba, Assistant	RTI Request/ Application & Appeal Management System (RTI-MIS)	Oct 21, 2016	NASC Complex, New Delhi

Technical Staff

Sr. No.	Name & Designation	Title of Training	Duration	Place
1	Sh Bhajan Singh, Sr Technical Assistant	Food Processing, Packaging and Value Addition of Agriculture and Livestock Produce	Jul 29-Aug 12, 2016	ICAR-CIPHET , Ludhiana
2	Sh Hardev Singh Sekhon, Sr Technical Assistant	Automobile Maintenance, Road Safety and Behavioural Skills for Regular Drivers in Technical Grades	Mar 6-10, 2017	ICAR-CIAE, Bhopal

Trainings organized for various categories

Farmers Trainings (2016-2017)

Progressive Farmers Training

Two progressive farmers namely Shri Dhunda Singh and Smt Bachno Devi from district Kathua, Jammu & Kashmir were provided three days training on "Handling and processing of turmeric" during June 2 to 4, 2016. Both the farmers were trained on basics and various operations involved in turmeric processing, handling, cleaning and processing of raw turmeric, estimation of moisture level in raw turmeric, drying of turmeric and packaging techniques for turmeric powder. The training was coordinated by Dr Sandeep Mann, Principal Scientist, and Dr Rahul Kumar Anurag, Scientist (Sr. Scale), ICAR-CIPHET.

Farmers Training on Post Harvest Management of Agricultural Produce

TOT Division organized three day training programme for 30 farmers from Nashik, Maharashtra on Post Harvest Management of Agricultural Produce from December 1 to 3, 2016. This training was

sponsored by Agriculture Technology Management Agency (ATMA), Nashik, Maharashtra. Training was coordinated by Dr Sandeep Mann, Principal Scientist and Er Yogesh Kalnar, Scientist.

Farmers Training on Groundnut Processing

Training was imparted for two farmers Shri Ranveer Singh and Shri Charn Singh Brar from Village Bagha Purana, Moga, Punjab on "Production of groundnut milk and groundnut *paneer*" during 26-28 July, 2016. The training was coordinated by Dr Ranjeet Singh, Senior Scientist, ICAR-CIPHET.

Training for Farmers from Wardha, Maharashtra

A five day training programme was organized by for 30 farmers from Wardha district of Maharashtra on Post Harvest Management of Agricultural Produce from December 5 to 9, 2016. This training was sponsored by Agriculture Technology Management Agency (ATMA), Wardha, Maharashtra. Training was coordinated by Dr Sandeep Mann, Principal Scientist, Dr Renu Balakrishnan, Scientist and Mr Vikas Kumar, Scientist.

Farmers Training Programme

Thirty farmers from Nagpur, Maharashtra was given training by TOT Division on Post Harvest Management of Agricultural Produce from February 21 to 23, 2017. This training was sponsored by

Agriculture Technology Management Agency (ATMA), Nagpur, Maharashtra. Training was coordinated by Dr Sandeep Mann, Principal Scientist and Dr Khwairakpam Bembem, Scientist.

Training on Post-Harvest Management

TOT Division, ICAR-CIPHET has organized three day training programme for 30 farmers from Osmanabad, Maharashtra on Post Harvest Management of Agricultural Produce from March 8 to 10, 2016. This training was sponsored by Agriculture technology Management Agency (ATMA), Osmanabad, Maharashtra. Training was coordinated by Dr Sandeep Mann, Principal Scientist and Dr Rahul Kumar Anurag, Scientist (Sr. Scale).

Technical Staff Training (2016-2017)

Human Resource Development Training for Technical Staff from ICAR

ICAR-CIPHET organized training programme for technical staffs of ICAR from July 29 to August 12, 2016 on "Food Process Packaging and Value Addition of Agriculture and Livestock Produce". The training was sponsored by Human Resource Section, ICAR, New Delhi. The training was attended by 19 technical

officers of ICAR. Training was coordinated by Dr Sandeep Mann, Principal Scientist, Dr Ranjeet Singh, Senior Scientist and Dr VE Nambi, Scientist.

Training on "Handling and Operations of Instruments related to Food Testing"

A training on "Handling and Operations of Instruments related to Food Testing" was organized for technical staff and M.Tech students from College of Agricultural Engineering & Post Harvest Technology, Ranipool, Gangtok, Sikkim during June 04 to 18, 2016. It was sponsored by Central Agricultural University, Imphal. The training consisted of lectures and demonstrations involving the explanation of the basic principles of food testing as well as some advanced instrumentation involving, Gas Chromatography, HPLC, Differential Scanning Calorimetry and Atomic Absorption Spectrophotometer. An exposure visit to the Punjab Biotechnology Incubator-Agri & Food Testing Laboratory was also made to show the functioning of a national level food testing laboratory. The training was coordinated by Dr. Armaan U. Muzaddadi, Sr. Scientist, and Dr. Rahul Kumar Anurag, Scientist (Sr. Scale). Experts involving ICAR-CIPHET scientists delivered lectures and trained the participants on various equipments involved in food testing.

Technical Officers Trainings (2016-2017)

Capacity Building Training for Agricultural Officers

A five days capacity building training was organized for 16 agricultural extension officers from Odisha (2nd Batch) during July 11-15, 2016. This training programme was sponsored by Government of Odisha and coordinated by Dr RK Gupta, Director, ICAR-CIPHET, Dr Sandeep Mann, Principal Scientist and Dr Rahul Kumar Anurag, Scientist (Sr. Scale).

Entrepreneurship Development Program (EDP)

EDP on "Tomato Processing and Value Addition"

An Entrepreneurship Development Program (EDP) on "Tomato Processing and Value addition" was organized from October 04 - 06, 2016 at HCP Division, ICAR-CIPHET Abohar. Five farmers/ entrepreneurs from village Kera Kheda, Abohar have participated in this EDP training including two

women entrepreneurs. The programme was organized by Dr DM Kadam Dr. Manoj Kumar Mahawar, Dr Prerna Nath, Dr Kirti Jalgaonkar, Sh. Rajeev Sharma and Ms. Kalyani Sharma.

EDP on "*Aonla* Processing and Value Addition"

An EDP on "Aonla Processing and Value Addition" was organized under CRP on Secondary Agriculture during October 25-27, 2016 at HCP Division, ICAR-CIPHET Abohar. Six farmers/ entrepreneurs have participated in this EDP training including two women entrepreneurs.

EDP on "Production, Packaging and Value Addition of Mushroom"

EDP on "Production, Packaging and Value Addition of Mushroom" was organized under CRP on Secondary Agriculture Project during November 8-10, 2016. A total of 9 farmers participated in the training programme.

EDP on "Pomegranate Processing and Value addition"

EDP on "Pomegranate Processing and Value Addition" under CRP on Secondary Agriculture was organized from November 23 -25, 2016 for entrepreneur Hemant Wakchaure from Maharashtra.

Summer School/ Winter School

ICAR sponsored Summer School on "Engineering and Technology Innovations in Developing Health Foods"

ICAR-CIPHET, Ludhiana has organized a 21 days ICAR sponsored Summer School on "Engineering and Teehnology Innovations in Developing Health Foods" from June 08-28, 2016. Dr R K Gupta was the Course Direetor and Dr Sangita Bansal and Er Dhritiman Saha were the Co-Course Directors of the summer school. The course had been designed to give participants a complete exposure to the different technology and engineering interventions required for processing of health foods. The main objective for organizing this summer school was to bring together multidisciplinary researchers/scientists working in food sector and to apprise them of the recent developments in the field of health foods. Twenty five participants from thirteen states and from different disciplines attended the summer school. This course

provided an opportunity to the participants to interact with subject-experts and fellow workers from different parts of the country and to update themselves with the latest information in the field.

ICAR Summer School on "Approaches to Identification, Quantification and Reduction of Post-Harvest Losses in India"

A summer school of 21 days duration on "Approaches to Identification, Quantification and Reduction of Post-Harvest Losses in India" was organized at ICAR-CIPHET, Ludhiana. This summer school was sponsored by Agricultural Education Division of ICAR under its capacity building program. The courses started on August 17, 2016 with 23 young scientists and assistant professors from different agricultural universities and ICAR institutions in the country. Dr SK Nanda was the Course Director and Dr RK Vishwakarma and Dr Ranjeet Singh were the Course Co-Directors of this programme.

Model training course on "Processing, Value Addition and Entrepreneurship Development in Food Agri-Business"

Model Training Course (MTC) on "Processing, Value Addition and Entrepreneurship Development in Food Agri-Business" was sponsored by Directorate of Extension, DoAC&FW, Ministry of Agriculture & Farmers Welfare (GoI) and organised at ICAR-CIPHET, Ludhiana during November 14 – 21, 2016. Dr DM Kadam was the Course Director and Dr Ranjeet Singh and Dr VE Nambi were the Course Co-Directors of the training programme. A total of 23 participants attended the training programme from all over India. The training covered overall aspects of entrepreneurship development especially in the field of processing and value addition of agricultural commodities.

Model Training Course on "Post-Harvest Supply Chain/Cold Chain Management of Vegetables"

A model training course on "Post-Harvest Supply Chain/Cold Chain Management of Vegetables" was conducted during 12 to 19, December 2016 at ICAR-CIPHET, Ludhiana sponsored by Directorate of Extension (DOE), Ministry of Agriculture and Farmer Welfare for the benefit of extension person/officers working under agriculture and allied departments of state government, Agricultural Universities/ ICAR institutes and relevant universities/ organizations. Dr RK Viswakarma was the Course Director and Dr Yogesh Kumar and Dr VE Nambi were the Course Co-Director of the training programme. A total of 7 participants from across the country had participated in the course. The training covered major topics related to secondary processing of fruits and vegetables into value added products, recent advances in grading of vegetables, basic unit operations in vegetable processing, post-harvest management of vegetables, primary and minimal processing of vegetables, etc.

Students Training during 2016-17

One hundred and forty four students (graduation and post-graduation level) from different universities/institutes have undergone training at ICAR-CIPHET during 2016-17 on different topics related to post-harvest technology.

Students Training 2016-17

Sr. No.	Name of College /University	Duration of Training	Degree	No. of Students
1	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Kerala	Apr 20 - May 20, 2016	B. Tech (Food Engg.)	09
2	Shiv Shankar College of Agricultural Engineering, Miarjgaon, Karjat, Ahmednagar, Maharashtra	May 10 - Jun 10, 2016	B. Tech (Agri. Engg.)	05
3	College of Agricultural Engineering & Technology, Navsari Agricultural University Parsi Tekra, Dediapada, Narmada, Gujarat	Jun 01-30, 2016	B. Tech (Agri. Engg.)	10
4	College of Agricultural Engineering & Technology, Orissa University of Agricultural & Technology, Bhubaneswar, Orissa	Jun 01-30, 2016	B. Tech (Agri. Engg.)	03
5	College of Agricultural Engineering & Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parkhani, Maharashtra	Jun 01-30, 2016	B. Tech (Agri. Engg.)	07
6	College of Agricultural Engineering, Jawahar Lal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh	Jun 01-30, 2016	B. Tech (Agri. Engg.)	10
7	Soil and Water Engineering Department, College of Agricultural Engineering & Technology (JAU), Junagadh, Gujarat	Jun 01-30, 2016	B. Tech (Agri. Engg.)	13
8	College of Agricultural Engineering & Technology, Dr PDKV Krishi Vidyapeeth, Akola, Maharashtra	Jun 01-30, 2016	B. Tech (Agri. Engg.)	05
9	College of Agricultural Engineering & Technology, Anand Agricultural University, Godhra, Gujarat	Jun 01-30, 2016	B. Tech (Agri. Engg.)	05
10	College of Agricultural Engineering & Technology, Dr. B.S. Konkan, Krishi Vidyapeeth, Dapoli, Maharashtra	Jun 01-30, 2016	B. Tech (Agri. Engg.)	09
11	College of Agricultural Engineering & Technology, CCS Haryana Agricultural University, Hisar, Haryana	Jul 01 - 31, 2016	B. Tech (Agri. Engg.)	16
12	DAV College Jalandhar, Mahatama Hans Raj Road, Jalandhar, Punjab	Jul 01 - 31, 2016	B. Sc.	01
13	College of Agricultural Engineering & Technology, P.A.U., Ludhiana, Punjab	Jul 01 - 31, 2016	B. Tech (Agri. Engg.)	03

Sr. No.	Name of College /University	Duration of Training	Degree	No. of Students
14	College of Agricultural Engineering & Technology, Orissa University of Agricultural & Technology, Bhubaneswar, Orissa	Jul 01 - 30, 2016	B. Tech (Agri. Engg.)	03
15	Professor Jayashankar Telangana State Agril. University, College of Agricultural Engineering, Telangana	Jul 27 -Nov 26, 2016	B. Tech (Agri. Engg.)	05
16	College of Agricultural Engineering & Technology, Dr. PDKV Krishi Vidyapeeth, Akola, Maharashtra	Aug 08–29, 2016	M. Tech	05
17	Kelappaji College of Agricultural Engineering & Technology, Kerala Agricultural University, Tavanur, Kerala	Aug 08–29, 2016	M. Tech	04
18	Acharya N.G. Ranga Agricultural University, College of Agricultural Engineering Bapatla, Guntur District, Andhra Pradesh	Sep 01 -30, 2016	M. Tech (Agri. Engg.)	06
19	Sher-e-Kashmir University of Agricultural Science & Technology, Shalimar Campus, Kashmir	Dec 02-31, 2016	B. Tech (Agri. Engg.)	12
20	College of Agricultural Engineering & Technology, Dr. PDKV (Krishi Vidyapeeth) Akola, Maharashtra	Jan 01-Apr 30, 2017	B. Tech (Agri. Engg.)	05
21	Department of Food Science, Nutrition & Technology of CSKHPKV, Palampur, Himachal Pradesh	Jan 16-Apr 30, 2017	B. Tech (Food Engg.)	03
22	Faculty of Agricultural Engineering, Pusa, Samastipur, Bihar	Feb 01-May 31, 2017	B. Tech (Agri. Engg.)	05

Professional Attachment Training

Dr Khwairakpam Bembem did her training at Agricultural Produce and Processing Division, ICAR-CIAE, Bhopal *w.e.f.* May 12 to August 11, 2016. She worked on "Development of Nutritious Beverage for Geriatric and Convalescent Patients" under the guidance of Dr Dipika A Murugkar, National Fellow, ICAR-CIAE. During this period, she also got familiarized with the facilities available in the institute and participated in one week soy processing training.

Mr Vikas Kumar has undergone three months Professional Attachment Training at Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur from May 11 to August 11, 2016. He worked under the guidance of Dr P Srinivasa Rao, Associate Professor on 'High Pressure Processing of Acid Pre-treated Hilsa (*Tenualosa ilisha*) Fillets'. For his PAT work, he has been awarded first prize in International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) in Poster Session on 'Livestock Products Process Engineering, Safety and Quality Assurance' organized at GADVASU, Ludhiana during 10-12th, November, 2016.

Er Yogesh Kalnar Bhaskar did his professional attachment training at ICAR-CIAE Bhopal from May 28 to August 27, 2016. The training programme

imparted practical experience on the areas of 3D printing, PTC Creo (Computer-aided design), Programmable Logic Controller (PLC), MATLAB with Image Processing toolbox, Hyper Spectral Imaging Technology (400-1000 nm) and Arduino (open source Hardware and software).

Dr Renu Balakrishnan completed her three month professional attachment training in two different institutes. She has done one month training (May 12 to June 11, 2016) under the guidance of Dr A K Singh, Head, Department of Processing and Food Engineering, College of Agricultural Engineering and Technology, PAU, Ludhiana. During this period she got familiarized with the facilities available in COAET, PAU. She was also exposed to Agro Processing Centre (Sat Sahib Floor Mill) established under the All India Co-ordinated Research Project on Post-harvest Engineering and Technology by the Department of Processing and Food Engineering, PAU. A review based work "Beyond Production: Opportunities for Small Farmers' Development" was also done as a part of the one month professional attachment training. Then another two month training was done under Dr PC Bargale, Head, Technology Transfer Division, ICAR-CIAE, Bhopal from June 13 to August 12, 2016. During this period she has done two research works (1) Impact Assessment of ICAR-CIAE Intervention in Village Bagroda (2) Assessment of ICAR-CIAE KVK Activities in Village Jamuniakala.

Dr Pankaj Kumar Kanujia completed his professional attachment training under Dr Neelam Patel, Principal Scientist and In-charge, Centre for Protected Cultivation Technology, IARI, New Delhi from May 12, 2016 to August 11, 2016. During three month professional attachment training period, he worked on "Studies on Different Type of Greenhouses and Post-harvest Quality Aspects of Different Vegetables under Protected Cultivation".

Dr Narendra Negi did his professional attachment training under the supervision of Dr Ram Asrey, Principal Scientist, Division of Food Science and Postharvest Technology, IARI New Delhi from May 12, 2016 to August 11, 2016. During the training the research work was conducted on ripening of fruit. A study on the effect of exogenous ethylene application on ripening of mango and capsicum was carried out with the objectives (1)To standardize the optimum ethylene doses for uniform ripening of mango cv. Kesar and (2) To study the effect of exogenous ethylene application on colour break of capsicum cv. California Wonder.

Dr Pankaj Kumar completed his three months professional attachment training at ICAR-NDRI, Karnal from November 17, 2016 to February 16, 2017. During this period, he was exposed to processing divisions/ plants such as Experimental Dairy Plant, Dairy Chemistry Division, Model Dairy Plant (MDP) and Dairy Technology Division which enriched his knowledge about latest technology pertaining to dairy sector. The study and design of evaporators considering thermal and mechanical aspects strengthened his skill about designing of process equipment and machinery. This training also helped him in developing and refining his soft skills regarding concept and application of Auto CAD software.

Dr Chandra Sekar have undergone Professional Attachment Training for the period of three months from November 17, 2016 to February 18, 2017 at Indian Institute of Crop Processing Technology (IICPT), Thanjavur. At IICPT he has worked under the guidance of Dr M Loganathan and worked on "Phosphine Release Kinetics and Interstitial Phosphine Concentration in Bulk Paddy".

Professional Attachment Training Organized for Newly Joined ARS Scientists at ICAR-CIPHET

Dr Vaibhav Kumar, Scientist (Bio Chemistry) from ICAR-IIPR, Kanpur attended professional attachment training for 3 months period at ICAR-CIPHET, Abohar during May 18, 2016 to August 17, 2016.

Sh Om Parkash, Scientist (APE), ICAR- Central Arid Zone of Agricultural Research, Jodhpur attended three months professional attachment training at ICAR-CIPHET, Ludhiana from November 18, 2016 to February 17, 2017.

Ms Khushbu Kumari, ARS Scientist (Agricultural Structure & Food Engineering), ICAR-National Dairy Research Institute, Karnal attended three months Professional Attachment Training at ICAR-CIPHET, Ludhiana from November 28, 2016 to March 03, 2017.

TECHNOLOGIES TRANSFERRED/ LICENSED/ PATENT FILED

Technologies Transferred

Sl. No	Technology	Contracting Party	License Fee (Rs.) (excluding service tax)	Date of Signing Agreement	Type	Innovator
1	Nutritious functional chapatti flour	M/s Saraswati Rice & General Mills, Village Ponna, Aligarh Road, Jagraon, Punjab -142 026	11,000	Jul 2, 2016	Licensing and training of non-IP protected technology	Dr Mridula D
2	Mechanized system for popping and decortications of makhana seeds	Mr. Varun Gupta, Proprietor M/s Jwala Engineering and Consultancy Services, # 354, Sector-2, Growth Centre, Saha, Ambala, Haryana-133104	1,57,500	Dec 19, 2016	Amendment and renewal of IP protected technology	Dr SN Jha Dr RK Vishwakarma
3	Low fat meat emulsion and process for making the same	Mr. Bhanu Partap Singh S/o Mr. Inderpal Singh, H.No. B-8/120, G.T. Road, Phillaur, Punjab-144 410	60,000	Jan 11, 2017	Licensing and training of IP protected technology	Dr Yogesh Kumar Dr K Narsaiah Dr Tanbir Ahmad
4	Dried onion flakes and powder	Mr. Prashant Agrawal, Shree Shyam Enterprises, Nirmani, Madhya Pradesh –451 441	25,000	Feb 9,2017	Licensing and training of non-IP protected technology	Dr DM Kadam

Patent Filed

Sl.No.	Title	Application No.	Date of Filing	Inventors
1	Grader for oblong and round fruits and vegetables	201611018794	1.06.2016	Dr RK Vishwakarma Dr VE Nambi Dr RK Gupta Dr Ramesh Kumar
2	Live Fish Carrier System and method of transportation of live fish therein	201611032728	26.09.2016	Dr Armaan U Muzaddadi Dr SK Nanda

EXTENSION ACTIVITIES

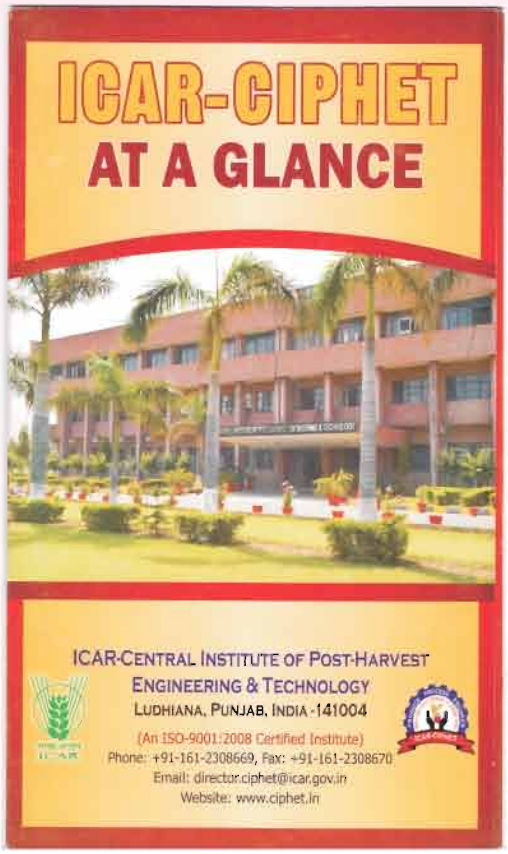
Participation in Exhibitions/*Melas*:

Sr. No	Exhibition/*Mela*	Date	Venue
1	*Kisan Mela*	Sep 22-23, 2016	PAU Campus, Ludhiana
2	Exhibition, National Conference on Innovative Food Processing Technologies for Food and Nutritional Security	Sep 29-30, 2016	ICAR-CIPHET, Ludhiana
3	Exhibition organized by KVK Shikopur (Gurgaon) on the theme 'Waste to Wealth'	Oct 27, 2016	Gurgaon
4	12thedition of CII Agro Tech	Nov 19 – 22, 2016	Chandigarh
5	*Krishi Kumbh* - Regional Agricultural Fair 2016	Nov 28-30, 2016	Muzaffarnagar, Uttar Pradesh
6	4th Assam International Agri- Horticultural Fair	Jan 06 – 09, 2017	Khanapara, Guwahati, Assam
7	Citrus Show cum Seminar organized by Regional Fruit Research station PAU, Abohar	Feb 8, 2017	Regional Fruit Research station PAU, Abohar
8	National Agricultural Fair – *Krishi Unati Mela* 2017	Mar 15-17, 2017	IARI, New Delhi
9	*Kisan Mela*	Mar 24 – 25, 2017	PAU Campus, Ludhiana

Kisan Mela, PAU Campus, Ludhiana, March 24-25, 2017

Pamphlets/Posters

Pamphlets of different technologies were prepared and printed in Hindi, English and Punjabi for end users


ICAR-CIPHET
AT A GLANCE
ICAR-CENTRAL INSTITUTE OF POST-HARVEST
ENGINEERING & TECHNOLOGY
LUDHIANA, PUNJAB, INDIA -141004
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Phone: +91-161-2308669, Fax: +91-161-2308670
Email: director.ciphet@icar.gov.in
Website: www.ciphet.in


PRESERVATION AND STORAGE STRUCTURES
Evaporative cooled structure/ room (2 and 5 ton)
Porous bricks
Shadenet & insect net polyhouse
Modified atmospheric packaging of different vegetables
Minimal processing of vegetables
Shrink wrap packaging of fruits and vegetables
PROCESS / PRODUCT
Iron fortified rice
Sorghum-soy-blended biscuit
Energy efficient Bengal gram sattu making technology
Pearl millet based extrudates and vegetable blended pasta
Pearl millet based ready to reconstitute upma, halwa and weaning mix
Sunflower kernel based confectionary products
Groundnut based flavoured beverage, curd and paneer
Dried onion flakes and powder
Ginger powder
Carrot and beetroot powder
Pomegranate jam, jelly, marmalade, anardana hazmhazam & grenadine
Ber candy, canned ber, preserve
Aonla candy, pickle, murabba, beverage
Blended guava leather/bar
Green chilli puree and powder
Ready to constitute makhana kheer mix
Vegetable blended value added meat products (chicken nuggets, sausages and patties)
Method of determining maturity and edible quality of mango
Cattle feed from potato industry waste
Training
ICAR-CIPHET conducts regular training programmes on Post-Harvest Technologies for line department officers, farmers & budding entrepreneurs.
Undergraduate and Postgraduate Students are also offered trainings as per their course curricula.
Evaporative cooled structure
Peanut milk and paneer
Makhana kheer mix
Guava leather bar
Green chilli puree
Services offered to National / International Clientele
Contract research/ Consultancy
Testing of Food and Agricultural Products
Testing of post-harvest equipments and machinery
Entrepreneurship Development Programme
Specific certificate courses
Compiled and edited by:
Dr R K Gupta, Director, ICAR-CIPHET
Dr Sandeep Mann, Principal Scientist
Dr Armaan U. Muzaddadi Sr Scientist
Dr Rahul K. Anurag, Scientist
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Agri-search with a human touch
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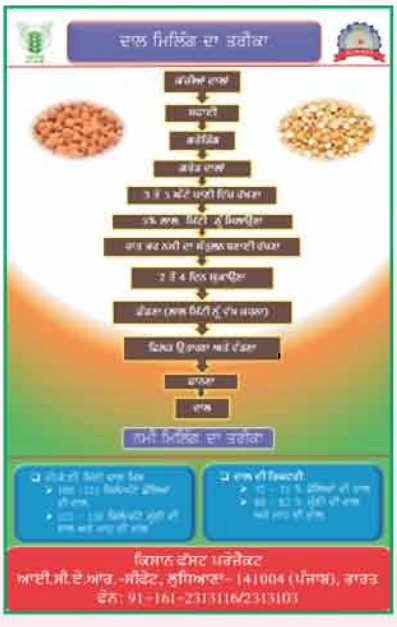
ਦਾਲ ਮਿਲਿੰਗ ਦਾ ਤਰੀਕਾ
ਸੁਸਰ ਮਿਲਿੰਗ ਦੇ ਤਰੀਕੇ
ਕਿਸਾਨ ਫੱਸਟ ਪਰੋਜੈਕਟ
ਆਈ.ਸੀ.ਏ.ਆਰ.-ਸੀਫੈਟ, ਲੁਧਿਆਣਾ- 141004 (ਪੰਜਾਬ), ਭਾਰਤ
ਫੋਨ: 91-161-2313116/2313103


Pulse Milling Methods
Raw Pulse
Cleaning, Grading
Graded pulses
Pitting
Scratched pulses
Addition of oil
Scratched and oil treated pulses
Sundrying and tempering (3-4 days)
Addition of 1-1% water by spraying and overnight moisture equilibration
De-husking and splitting
Aspiration
Sieving
Dhal
Dry Milling method
Farmer First Project
ICAR-CIPHET, Ludhiana- 141004 (Punjab), India
Phone: 91-161-2313116/2313103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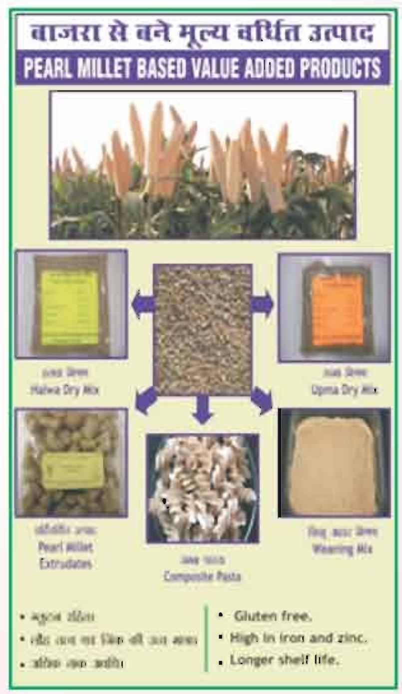
Bilingual Technology Charts for Exhibitions/ *Mela*



Farmers/Officers/Students visited ICAR-CIPHET during 2016-17

Sr. No.	Visitor Name & Address (with Description)	Visitors	Date of Visit	Facilitated by
1	Department of Horticultural, Manipur	14 (F) + 3(O)	Apr 02, 2016	Dr Arvind Jaiswal, Sh Bhajan Singh
2	IICPT, Thanjavur, Tamil Naidu	37 (S) + 2(O)	Apr 04, 2016	Dr RK Anurag
3	KCAET, Tavanur, Kerala Agricultural University	37 (S) + 1(O)	Apr 21, 2016	Dr RK Anurag
4	KVK Officials from Zone I	5 (O)	May 25, 2016	Dr Sandeep Mann
5	PAU, Ludhiana	17 (S)	May 26, 2016	Dr RK Anurag
6	Dept of Agriculture Extension, PAU, Ludhiana	11 (S)	Jun 07, 2016	Dr Sandeep Mann
7	NDRI, Karnal, Haryana	26 (S)	Jun 15, 2016	Dr RK Anurag
8	ATMA, Hanumangarh, Rajasthan	40 (F)	Sep 09, 2016	Dr A U Muzadaddi
9	NABARD	21 (O)	Sep 24, 2016	Dr Sandeep Mann
10	College of Agriculture, UAS, Raichur	78 (S) + 4 (O)	Sep 27, 2016	Mr Vikas Kumar, Dr Ranjeet Singh
11	College of Agriculture, V. C. Farm, Mandya, Karnataka	40 (S) + 3 (O)	Sep 28, 2016	Dr RK Anurag, Er Yogesh Kalnar
12	College of Agriculture, Hassan, Karnataka	57 (S) + 3 (O)	Sep 30, 2016	Dr K Bembem, Er Yogesh Kalnar
13	Young farmers, Punjab	40 (F)	Oct 14, 2016	Dr RK Anurag, Sh Bhajan Singh
14	Sri Karan Narendra Agriculture University, Jabnour, Rajasthan	50 (F)	Oct 21, 2016	Mr Vikas Kumar, Er Yogesh Kalnar
15	GKVK, UAS, Bangalore	52 (S) + 3 (O)	Nov 07, 2016	Dr RK Anurag, Er Yogesh Kalnar
16	Farmers, Ajmer, Rajasthan	44 (F)	Nov 07, 2016	Mr Vikas Kumar, Sh Bhajan Singh
17	College of Horticulture, Kolar, University of Horticultural Sciences, Bagalkot.	60 (S) + 3 (O)	Nov 14, 2016	Mr Vikas Kumar, Er Yogesh Kalnar
18	Department of Food & Nutrition, PAU, Ludhiana	15 (S)	Nov 30, 2016	Dr Ranjeet Singh

Sr. No.	Visitor Name & Address (with Description)	Visitors	Date of Visit	Facilitated by
19	PAMETI, Ludhiana	30 (F) + 1 (O)	Dec 07, 2016	Dr Ranjeet Singh
20	College of Horticulture, IGKV, Raipur	35 (S) + 2 (O)	Jan 11, 2017	Dr RK Anurag, Dr Renu Balakrishnan
21	College of Agriculture, Padnakkad, KAU	49 (S) + 3 (O)	Feb 23, 2017	Mr Vikas Kumar Dr Renu Balakrishnan
22	College of Horticulture UHS Campus, Bangalore	4 (O)	Feb 24, 2017	Dr RK Anurag, Dr Renu Balakrishnan
23	CTAE, MPUAT, Udaipur	36 (S) + 2 (O)	Feb 28, 2017	Er Yogesh Kalnar , Dr Renu Balakrishnan
24	ATMA, Vidisha (MP)	7 (O)	Mar 02, 2017	Sh Bhajan Singh
25	Horticulture Development Officer, Banga (SBS Nagar)	25(F) + 1(O)	Mar 03, 2017	Dr Sandeep Mann, Er Yogesh Kalnar, Dr Renu Balakrishnan
26	Extension Education, PAU, Ludhiana	12 (S)	Mar 06, 2017	Dr RK Anurag
27	Department of Horticulture, , Dhaulpur, Rajasthan	48 (F) + 2 (O)	Mar 08, 2017	Mr Vikas Kumar, Sh Bhajan Singh
28	SKAUST, Srinagar	35 (S) + 3 (O)	Mar 25, 2017	Mr Vikas Kumar, Dr Renu Balakrishnan

*O: Officers, F: Farmers, S: Students

Distinguished Visitors

Sr No	Visitors	Date of Visit
1	His Excellency Eng. Afonso Pedro Canga, Minister of Agriculture & Rural Development, Republic of Angola along with his team	May 27, 2016
2	Dr SN Jha, ADG (PE), ICAR, New Delhi	May 16-17, 2016
3	Dr K Alagusundaram, DDG (Agri. Engineering), ICAR, New Delhi	Jun 08, 2016
4	Dr Gurbachan Singh, Hon'ble Chairman ASRB	Jul 07-08, 2016
5	Dr Kanchan Kumar Singh, ADG (F. Engg.), ICAR, New Delhi	Jul 21, 2016
6	Dr SN Jha, ADG (PE), ICAR, New Delhi	Aug 23-24, 2016
7	Dr NS Rathore, DDG (Education), ICAR, New Delhi	Aug 28, 2016
8	Dr K Alagusundaram, DDG (Agri. Engineering), ICAR, New Delhi	Sep 29, 2016

Industrial Interface Meet:

Sr. No.	Programme	Date	No of Participants
1	Interface meet for farmers, manufacturer, entrepreneur at ICAR - CIPHET, Abohar	Sept 19, 2016	50
2	Interface meet for farmers, manufacturer, entrepreneur at CCSHAU, Hisar	Oct 21, 2016	110

Radio Talks

Dr Vijay Singh Meena delivered a radio talk on the topic *Anar mai Gunvatta Sudhar* through All India Radio, Jalandhar.

EVENTS ORGANIZED

Institute Research Council (IRC) Meeting

The 25th Institute Research Council Meeting was held during May 17-19, 2016 at ICAR-CIPHET, Ludhiana under the Chairmanship of Dr RK Gupta, Director, ICAR-CIPHET, Ludhiana. Dr SM Ilyas, Former Director, ICAR-NAARM Hyderabad, Prof. B S Khatkar, Dean & Chairperson, Department of Food Technology, Guru Jambheshwar University, Hisar and Dr W S Dhillon, Former Director, PHPTC, PAU, Ludhiana were the invited experts. Member Secretary, IRC presented the Action Taken Report (ATR) on suggestion/recommendation of the last IRC held during June 06-07, 2015. Salient

achievements of each divisions were thereafter presented by the respective Head of Divisions, followed by presentations of new project proposals (RPP-I), ongoing projects (RPP-II) and completed projects (RPP-III).

National Conference on "Innovative Food Processing Technologies for Food and Nutritional Security"

National Conference on "Innovative Food Processing Technologies for Food and Nutritional Security" was jointly organized by ICAR-CIPHET, Ludhiana and Association of Food Scientists and Technologists (India) Ludhiana Chapter at ICAR-CIPHET, Ludhiana during September 29-30, 2016. The conference was inaugurated by Dr K Alagusundaram, DDG(Agriculture Engineering), ICAR. Dr AS Nanda, VC, GADVASU was the Guest of Honour on the occasion. He highlighted the need of mission mode approach to convert the research outputs into sound commercial and viable technologies. About 200 delegates from different corners of the country attended the conference. The conference was sponsored by Ministry of Food

Processing Industries, (MoFPI), Govt. of India. Several experts viz. Dr Sushil Kumar (Former Vice-Chancellor, ICAR-NDRI), Dr SM Ilyas (Former Director, NAARM, Hyderabad), Dr Nawab Ali (Ex-DDG, ICAR), Dr RT Patil (Former Director ICAR-CIPHET), Dr AS Bawa (Ex-Director, DRDO-DFRL, Mysore), Dr RP Kachru (Ex- ADG Engg., ICAR), Professor Narpinder Singh, President AFST (I) etc. attended the conference and shared their views. Dr DN Yadav, Principal Scientist, ICAR-CIPHET, Dr Sangita Bansal, Senior Scientist, ICAR-

CIPHET and Dr Baljit Singh, Professor, Department of Food Science & Technology, PAU, Ludhiana and Secretary AFST (I), Ludhiana Chapter were the conveners of this conference.

XII Annual Workshop of AICRP on PET

XII Annual Workshop of AICRP on Plasticulture Engineering and Technology was held at MPUAT Udaipur during December 15 – 16, 2016. There were 80 participants including Research Engineers and Scientists from 12 cooperating centres, renowned experts, guest speakers, ADG (PE) from ICAR, representatives from industries and students participated and deliberated during the workshop.

Workshop of ICAR-AICRP on Post Harvest Engineering & Technology and Review Meeting of CRP on Natural Fibres, Health Foods & Secondary Agriculture"

The 32nd Workshop of ICAR-AICRP on Post Harvest Engineering and Technology was at ICAR-CIPHET, Ludhiana held during 7-9 March 2017. Dr K Alagusundaram, DDG (Engg.) was the chairman of the Workshop and Dr S N Jha, ADG (PE) was the co-chairman. Dr B S Dhillon, Vice-Chancellor, PAU Ludhiana, was the Chief Guest of Inaugural session. Dr C T Devadas, Former Dean, AEC&RI, TNAU, Coimbatore and Dr V K Seghal, Ex-Research

Engineer, AICRP on PHET Ludhiana Centre were the invited experts for the workshop. Dr R K Gupta, Director, ICAR-CIPHET Ludhiana and I/c AICRP on PHET presented the progress and achievements of AICRP on PHET centres for last one year. Detailed progress was presented by respective AICRP on PHET Centres in the technical session organized sector-wise, viz. Food Grains, Horticultural Crops, Jaggery and Livestock Produce sectors. Besides, a workshop on ICAR-FCI sponsored was held on March 9, 2017.

Technical session on ICAR-FCI project

AICRP on PHET organised one technical session on ICAR-FCI project on "Study on determining storage losses in food grains in FCI and CWC warehouses and to recommend norms for storage losses in efficient warehouse management" at IASRI, New Delhi on 22 April, 2016 to refine and discuss necessary corrections/modifications required in Data Entry Software.

Workshop cum Training Programme on ICAR-FCI Project

A workshop cum training programme on ICAR-FCI project on "Study on determining storage losses in food grains in FCI and CWC warehouses and to recommend norms for storage losses in efficient warehouse management" was held at IASRI, New Delhi during 30-31 August, 2016.

Agri Business Incubation (ABI) Centre

Agri Business Incubation (ABI) Centre team Dr DM Kadam, Principal Scientist (APE) and PI, Dr Ranjeet Singh, Senior Scientist (APE), Co PI, Mrs Surya Tushir, Scientist (Agril. Microbiology) and Co PI, Er Indore Navnath Sakharam, Scientist (ASEM) organized the given below: launch workshop, Sensitization workshop on entrepreneurship development for students of North Indian Universities, workshop on crazy business ideas for students.

Launch Workshop of Agri Business Incubation (ABI) Centre

Dr.Nawab Ali, Former DDG (Engg), ICAR, New Delhi inaugurated Agri Business Incubation (ABI) Centre team organized launch workshop at ICAR-CIPHET on June 28, 2016. This workshop was attended by 50 participants. ABI unit of ICAR-CIPHET serve as the hotspot for the budding entrepreneurs so that they could get management and

marketing support along with scientific inputs and incubation facilitics. Institute has provision to provide its pilot plant facilitics to thc entrepreneurs as incubatees which will hclp to protect newcomers from high investment risk at initial stages. Once incubate is confident then he/she can start his/her own factory/industry and all possible help will be extended to them.

One day Workshop on Crazy Business Ideas for B.Tech Students

Under the aegis of Agri Business Incubation (ABI) Centre organized one day workshop on "Students Crazy Business Ideas for trainee students" on June 29, 2016 under Agri Business Incubation (ABI) Centre at ICAR-CIPHET Ludhiana. Dr Ashok Kumar, ADR, PAU, Ludhiana was thc Chicf Guest of the programme. Thirty participants attended this programme. Ten trainee students presented their crazy business ideas and best three were given certificates.

Sensitization Workshop on Entrepreneurship Development for Students of North Indian Universities

One day workshop on "Sensitization Workshop on Entrepreneurship Development for Students of North Indian Universities" was organized on July 5,

2016 under the activities of Agri Business Incubation (ABI) Centre in collaboration with ICAR-NAARM, Hyderabad. Dr SK Nanda, Head, FG&OP Division and I/c Director was the chief guest of the programme. Around 85 participants attended this programme. About 15 groups presented their business ideas and best three were awarded with cash prize and certificates.

Vigilance Awareness Week

ICAR-CIPHET, Ludhiana has organized Vigilance Awareness Week from October 31-November 5, 2016 in which a number of events were organized. The week started with the pledge taking ceremony which was observed at both the campuses i.e. Ludhiana and Abohar of ICAR-CIPHET and all the scientists, officers and staff was present during the occasion. On November 01, 2016, a poster competition was organized and prizes (1st & 2nd) were awarded. On November 02, 2016, a slogan competition was organized and 02 best slogans (01 Hindi and 01 English) were awarded. In addition, a number of vigilance related posters were displayed at various places of Ludhiana and Abohar campuses of institute. The week concluded on November 05, 2016 with presentation of awards for the competitions and an appeal by the Director, ICAR-CIPHET, Ludhiana to the institute's employees to be honest and vigilant.

Communal Harmony Campaign Week

ICAR-CIPHET observed Communal Harmony Campaign week from November 19- 25, 2016 and the Flag Day on November 25, 2016 of the National Foundation for Communal Harmony. While the flagday spreads the message of communal harmony and national integration, the Institute raised fund of Rs. 2026 to enhance the resources of the foundation.

Krishi Shiksha Divas

Agriculture Education Day (*Krishi Shiksha Divas*) was celebrated on December 3, 2016 at ICAR-CIPHET, Ludhiana. A number of activities like debate, essay writing and poster competitions were organised at ICAR-CIPHET.An interactive meeting with students of GRD Academy School was arranged and they were briefed about Agriculture Education Day. Besides this, a video of agricultural technologies developed at ICAR-CIPHET was also showcased for them. Also, processed products developed by ICAR-CIPHET were distributed to farmers and school students during the event.

Soil Health day

ICAR- CIPHET celebrated World Soil Day on December 5, 2016 to create awareness among farmers about the importance of soil in our life. A special lecture was organised on "Soil health cards and its benefits for farmers"in which farmers took keen interest. The lecture was delivered by Dr.Kuldip Singh, Senior Soil Chemist, Department of Soil Science, PAU, Ludhiana. Scientists from ICAR-CIPHET visited Malakpur-Bet under Ludhiana district, interacted with farmers about the importance of soil and soil testing on the occasion. Literatures were also distributed to the farmers at Malakpur-Bet village.

National Productivity Week

National Productivity Week was celebrated during February12-18, 2017. A number of activities

viz. slogan, poster and essay writing competitions were organized on the theme 'From waste to profit through Reduce, Recycle and Reuse' at ICAR-CIPHET, Ludhiana during this week.

National Science Day-2017

ICAR-CIPHET, celebrated National Science Day on February 28, 2017 in School for Deaf Children, Hambran road, Ludhiana. On this occasion, team of scientists from ICAR-CIPHET, organized a poster competition for the students of class VI- XI.Dr.ManjuBala, Sr. scientist, FG & OP Division and Chairman, Organizing Committee of National Science Day, briefed about the importance of the day to students and teachers and it was interpreted for the students by a teacher from the school.First 10 winners were awarded certificates.

ICAR's 21st All India Entrance Examination

ICAR-CIPHET successfully conducted the ICAR's 21st All India Entrance Examination for admission to U.G., P.G. and Ph.D. degree programmes [AIEEA-UG/PG & AICE-SRF-(PGS)-2016] in Agriculture and Allied Science subjects during May 21 – 22, 2016.

Swachhta Pakhwara

The intensive National *Swachhta Pakhwara* was celebrated from October 2 – 16, 2016 by taking

'Swachhata Shapath' (Cleanliness Pledge) by all staff members followed by intensive cleanliness activity in and around the campus. On the occasion Director ICAR-CIPHET emphasized the importance of the mission of *'Swachh Bharat'* and spread the message of cleanliness.

General masses were made aware of the *'Swachh Bharat'* mass movement by circulating notices. To mark the event grand success, numerous *Swachhta* related activities were planned and successfully accomplished. All the staff-members of ICAR-CIPHET actively took part in the cleanliness drive.

Swaccha Bharat Abhiyan at ICAR-CIPHET, Abohar

An extensive cleanliness drive was organized at ICAR-CIPHET Abohar on regular basis under

Swaccha Bharat Abhiyan campaign. Office building, laboratories, workshop building, agro-processing centre, main roads, farm roads, residential colony etc. were cleaned during *Swaccha Bharat Abhiyan*. All the staff members of ICAR-CIPHET Abohar actively participated in this cleanliness drive.

हिन्दी कार्यशालाओं का आयोजन

सीफेट, लुधियाना में 25 जून 2016 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में डॉ. अनिल कुमार गुप्ता, सहायक प्रबंधक (राजभाषा), न्यू इंडिया इंश्योरेंस कंपनी लिमिटेड मंडल कार्यालय–1, जालंधर, पंजाब ने 'सूचना प्रौद्योगिकी में हिंदी' और 'साधारण टिप्पणियां एवं वाक्यांश' विषयों पर अपनी प्रस्तुति दे कर सभी को लाभान्वित किया।

सीफेट, लुधियाना में 27 सितंबर 2016 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्री संजीव चटानी (राजभाषा) प्रशासनिक अधिकारी, न्यू

इंडिया इंश्योरेंस कंपनी लिमिटेड, माल रोड़ लुधियाना ने सरकारी कार्यालयों में और 'नियम एवं अधिनियमः राजभाषा नीति' विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया हिंदी में पत्राचार।

सीफेट लुधियाना में 24 मार्च 2017 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्रीमती किरण साहनी, सहायक निदेश (राजभाषा) एवं सदस्य सचिव (न.रा.का.स.), लुधियाना ने 'राजभाषा संबंधी नीति निर्देश' एवं 'राजभाषा शब्दावली और अभ्यास' विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।

सीफेट, लुधियाना में 5 नवम्बर 2016 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्री अनिल कुमार गुप्त, सहायक प्रबंधक (राजभाषा), न्यू इंडिया

इंश्योरेंस कंपनी लिमिटेड, मंडल कार्यालय–1, जलंधर, पंजाब ने 'कार्यालयों में हिंदी का प्रचार–प्रसार और भाषा, परिभाषा एवं आचार–व्यवहार विषयों पर अपनी प्रस्तुति देकर सभी को लाभान्वित किया।

हिन्दी पखवाड़ा, 2016

विगत वर्षों की भांति इस वर्ष भी संस्थान में हिन्दी पखवाड़े का आयोजन 14–28 सितम्बर, 2016 तक किया गया। हिन्दी पखवाडे का समापन समारोह दिनांक 28–09–2016 को इस संस्थान के सभाकक्ष में हुआ। इस समापन समारोह के मुख्य अतिथि डा. आर.टी. पाटिल, पूर्व निदेशक, भा.कृ.अनु.प.–सीफेट, लुधियाना रहे। इस वर्ष संस्थान में हिन्दी पखवाड़े के दौरान अलग–अलग 11 प्रतियोगतायों का आयेजन किया गया। हिन्दी पखवाड़े के दौरान करवाई गई प्रतियोगिताओं के विजेताओं को डा. आर.के. गुप्ता, निदेशक, भा.कृ.अनु.प–सीफेट, लुधियाना द्वारा नकद पुरस्कार एवं प्रशास्ति पत्र वितरित किए जबकि डा. आर.के. सिंह, परियोजना समन्वयक (पी.ई.टी) एवं अध्यक्ष हिन्दी पखवाड़ा समिति ने हिन्दी पखवाड़े के अंर्तगत हुई प्रतियोगितायों का विवरण दिया।

समापन समारोह में मुख्य अतिथि ने संस्थान के अधिकारियों एवं कर्मचारियों द्वारा राजभाषा के प्रति अति उत्साह दिखाने के लिए प्रसन्नता व्यक्त की एवं सभी को हिन्दी भाषा को बढ़ावा देने के लिए कहा। संस्थान के निदेशक ने कहा कि इस संस्थान के वैज्ञानिकों एवं तकनीकी अधिकारियों को भी हिन्दी में कार्य करना चाहिए ताकि वे भी नकद पुरस्कार प्राप्त कर सके।

निष्कर्ष–हिन्दी पखवाड़ा बहुत ही अच्छे ढ़ंग से सम्मपन हुआ। संयोजको द्वारा सभी प्रतियोगितओं को बहुत ही बढ़िया ढंग से करवाया गया। इस वर्ष ज्यादातर

प्रतियोगितायों में इस संस्थान के अधिकारियों एव कर्मचारियों ने बढ़ चढ़ कर भाग लिया। समापन समारोह भी बहुत अच्छे ढ़ंग से संपूर्ण हुआ। अच्छे ढ़ंग से संपूर्ण हुआ।

हिंदी पखवाड़े के अंतर्गत आयोजित विभिन्न प्रतियोगिताएं एवं परिणाम (भाकृअनुप–सीफेट, लुधियाना)

क्रम संख्या	प्रतियोगिता का नाम	विजेता प्रतियोगी	स्थान
1	हिन्दी कम्प्यूटर टंकण प्रतियोगिता	श्री इक्बाल सिंह श्री बी.सी कटोच श्री अवतार सिंह	प्रथम द्वितीय तृतीय
2	हिन्दी नोटिंग/ड्राफिटंग प्रतियोगिता	श्री कुंवर सिंह श्री अवतार सिंह श्री इक्बाल सिंह	प्रथम द्वितीय तृतीय
3	प्रार्थना पत्र प्रतियोगिता	श्री मनोज कुमार श्रीमती वीरां बाली श्री सुखवीर	प्रथम द्वितीय तृतीय
4	हिन्दी अनुवाद प्रतियोगिता	श्री विशाल कुमार श्री जगतार सिंह श्री यशपाल सिंह	प्रथम द्वितीय तृतीय
5	निबंध प्रतियोगिता	श्रीमती लीना कुमारी डॉ. योगेश कुमार श्री विकास कुमार	प्रथम द्वितीय तृतीय
6	तत्काल भाषण प्रतियोगिता	श्री विशाल कुमार श्री अवतार सिंह श्री विकास कुमार	प्रथम द्वितीय तृतीय
7	प्रशनोत्तरी प्रतियोगिता	श्री कुंवर सिंह, श्री अवतार सिंह, श्री यशपाल सिंह डॉ. प्रनीता जयसवाल, श्रीमती लीना कुमारी, डॉ. के नरसईया डॉ. अरविन्द जयसवाल, ई. दृतिमान साहा, ई चंदन सोलंकी	प्रथम द्वितीय तृतीय
8	एक दिवसीय हस्तलिखित पोस्टर प्रतियोगिता	डॉ. योगेश कुमार श्रीमती सूर्या तुषीर श्री कुंवर सिंह	प्रथम द्वितीय तृतीय
9	वाद–विवाद प्रतियोगिता	डॉ. योगेश कुमार श्री विशाल कुमार ई. असरार अहमद बशीर	प्रथम द्वितीय तृतीय
10	विज्ञान संबंधित संगोष्ठी प्रतियोगिता	डॉ. अनिल कुमार दीक्षित डॉ. इन्दोर नवनाथ सखाराम श्री विकास कुमार	प्रथम द्वितीय तृतीय

हिंदी पखवाड़े के अंतर्गत आयोजित विभिन्न प्रतियोगिताएं एवं परिणाम (भाकृअनुप–सीफेट, अबोहर)

क.सं	प्रतियोगिता का नाम	परिणाम		
		प्रथम	द्वितय	तृतीय
1.	हिन्दी अनुवाद	श्री पवन कुमार, सहा प्रषा अधिकारी	श्री राजीव षर्मा तकनीकी सहायक	डा. पंकज कन्नोजिया, वैज्ञानिक
2.	हिन्दी टंकण	श्री संजय कुमार गोड, अ.श्रे.लि.	श्री दविन्द्र कुमार, तकनीकी सहायक	श्री मोहन लाल सहायक
3.	निबन्ध लेखन	डा. भारत भूशण, वैज्ञानिक	श्री पवन कुमार, सहा. प्रषा. अधिकारी	डा. पंकज कन्नोजिया, वैज्ञानिक श्री नरेन्द्र नेगी, वैज्ञानिक
4.	कविता लेखन	श्री राजीव षर्मा तकनीकी सहायक	श्री नरेन्द्र नेगी, वैज्ञानिक	श्री डुकारे अजिनाथ, वैज्ञानिक
5.	पोस्टर प्रस्तुतीकरण	डा. विजय सिह मीणा, वैज्ञानिक	ई. बिबवे भूशण रत्नाकार, वैज्ञानिक	श्री डुकारे अजिनाथ, वैज्ञानिक
6.	तत्काल भाशण	श्री पवन कुमार, सहा. प्रषा. अधिकारी	डा. सुनील कुमार वरिश्ठ वैज्ञानिक	श्री पवन कुमार, तकनीकी सहायक
7.	हिन्दी वैज्ञानिक संगोश्ठी	ई. बिबवे भूशण रत्नाकार, वैज्ञानिक	डा. सुनील कुमार वरिश्ठ वैज्ञानिक	डा. भारत भूशण, वैज्ञानिक
8.	प्रश्नोतरी प्रतियोगिता	डा. भारत भूशण, वैज्ञानिक श्री राजेष कुमार तकनीकी अधिकारी श्री पवन कुमार, तकनीकी सहायक	डा. काले सखाराम जगन, वैज्ञानिक डा. पंकज कन्नोजिया, वैज्ञानिक श्री दविन्द्र कुमार, तकनीकी सहायक	डा. विजय सिह मीणा, वैज्ञानिक श्री नरेन्द्र नेगी, वैज्ञानिक श्री पवन कुमार, सहा. प्रषा. अधिकारी
9.	हिन्दी में कार्य करने के लिए विशेष पुरस्कार	श्री माहन लाल, सहायक	श्री पवन कुमार, सहा. प्रशा अधिकारी	श्री संजय कुमार गोड़, अ.क्षे.लि,

Mera Gaon, Mera Gaurav Scheme

❖ Dr Sunil Kumar, Senior Scientist (Bio-chem), Dr Bharat Bhushan and Er Bibwe Bhushan Scientist (APE), visited Khubban village, Tehsil: Abohar on 30 July 2016 to carry out baseline survey

❖ Dr Ramesh Kumar, Dr Sakharam Kale, Dr Narender Negi and Mr Prithviraj (STO) visited Ramsara, Baghu, Amarpura and Bahawal Wasi villages on 30 August, 2016 as part of *Mera Gaon Mera Gaurav* Programme

❖ Dr D M Kadam, Dr Vijay Singh Meena, Dr Manoj Kumar Mahawar, Dr Kirti Jalgaonkar and Mr Rajesh Kumar (STO) visited selected villages (Bahawal Wasi, Kera Khera and Sucha Singh) interacted with the farmers under the '*Mera Gaon Mera Gaurav*' scheme on 24.09.2016.

LINKAGES AND COLLABORATIONS

ICAR-CIPHET inks MoU with APEDA

ICAR-CIPHET signed MoU with APEDA for a collaborative study on "Development of automated fumigation chamber for treatment of grapes with CO_2 and SO_2 and standardization of treatment protocol for export market access to New Zealand" on August 30, 2016.

ICAR-CIPHET signs MoU with HAU, Hisar

ICAR-CIPHET and Chaudhary Charan Singh Haryana Agricultural University (HAU) have entered into an agreement on October 22, 2016 under which both institutions will cooperate with each other in academic and research pursuits.

KVK ACTIVITIES

KVK Inauguration

Shri Vijay Sampla, Honourable Minister of State for Social Justice and Empowerment, Government of India inaugurated Krishi Vigyan Kendra in Fazilka district of Punjab at ICAR-CIPHET, Abohar on 25th December 2016. On this occasion Shri Surjit Kumar Jyani, Honourable Minister of Health, Government of Punjab, Dr R K Gupta, Director, ICAR-CIPHET, Dr Rajbir Singh, Director, ICAR-ATARI, Zone-I and Ms Indu Kalia, District Commissioner, Fazilka were also present.

Training under KVK

Training programme on fruits and vegetable processing was organized from January 18, 2017 to February 07, 2017 at KVK, ICAR-CIPHET, Abohar. Thirty girl students from Government Senior Secondary School took part in this training.

A one day training program was organized on fruits and vegetable processing at KVK, ICAR-CIPHET, Abohar on March 03, 2017. Twenty three anganwari workers from Abohar block took part in this training.

AWARDS AND RECOGNITIONS

Sr. No	Name of Awardee	Name of Award
1.	AICPR on PHET	• **Chaudhary Devi Lal Outstanding All India Coordinated Research Project Award (2015)** for outstanding performance in terms of linkages and research output and its Impact
2.	ICAR-CIPHET, Ludhiana	• **ISO 9001:2015 certificate** for operating Quality Management System **Appreciation Award in *Krishi Unnati Mela* (2017)** for showcasing and demonstrating their technologies
3.	Dr Anil Kumar Dixit	• **Dr Rajendra Prasad Puruskar (2015)** for book (Hindi) co-authored
4.	Dr A U Muzaddadi	• **Honoured** during Punjab Fish Festival (2016)
5.	Dr Manju Bala	• **Young Scientist Award (2016)** for her outstanding contribution in the field of Biochemistry from Society for Scientific and Development in Agriculture and Technology **Distinguished Scientist Award (2016)** from M.N.S Medical and Educational Society of Bikaner on July, 2016 **Reviewer Excellence Award (2016)** from Agriculture Research Communication Center (ARCC), Karnal, Haryana.
6.	Dr Sangita Bansal	• **Scientist of the Year Award (2016)** from Society for Recent Development in Agriculture during GAIC-2016 held at NIU, Noida during November 27-29, 2016
7.	Dr Ranjeet Singh	• **Young Scientist Associate Award (2017)** by Bioved Society during 19th Indian Agricultural Scientists and Farmers Congress held at Allahabad during February 18-19, 2017. **Best Worker Award** (Scientific category) during ICAR-CIPHET Foundation day ceremony on December 29, 2016 held at ICAR-CIPHET, Ludhiana

Sr. No	Name of Awardee	Name of Award
8.	Dr V Eyarkai Nambi	• **Young Scientist Associate Award (2017)** by Bioved Society during 19th Indian Agricultural Scientists and Farmers Congress held at Allahabad during February 18-19, 2017
9.	Dr K Narsaiah, Dr SN Jha, Dr Pranita Jaiswal, Dr AK Singh, Dr PP Kaur, Dr R Sharma and Dr R Kumar	• **Best Paper Award (2016)** for paper entitled "Kinetic binding analysis of bio-molecular interactions using surface plasmon resonance system" published in Journal of Agricultural Engineering 53 (2): 38-44, under the section Crop Processing, Dairy and Food Engineering, in 51st ISAE convention organized at CAET, CCSHAU, Hisar from February 16-18, 2017
10.	Dr SJ Kale, Dr VS Meena, Dr RK Vishwakarma, Dr RK Singh, and Dr RK Gupta	• **Best Oral Presentation Award (2017)** for their paper "Development of mushroom polyhouse structure for hot and arid region" presented in the National Conference on Agro-Processing Based Entrepreneurship Development for Sustainable Livelihood held at Dr. PDKV, Akola during February 22-23, 2017
11.	Mr Vikas Kumar	• **Best Poster Award (2016)** on "Livestock Products Process Engineering, Safety and Quality Assurance" in International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) held at GADVASU, Ludhiana during November 10-12, 2016
12.	Ms. Minaxi Sharma, Dr K Narsaiah, Mr Kandi Sridhar and Ms Alka Chaudhary	• **Best Poster A ward (2016)** for their poster on "Fortification of bread with hybrid microencapsulation of flaxseed and garlic oil" in National Conference on Innovation Food Processing Technology for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016
13.	Singh R, Sivakumar S, Veena N, Mehta N, Dr K Narsaiah and Ms. Minaxi Sharma	• **Best Poster Award (2016)** for their poster on "Study on effect of amplitude and time of the ultrasonication on the properties of encapsulation resveratrol" in International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) held at GADVASU, Ludhiana during November 10-12, 2016

Sr.No	Name of Awardee	Name of Award
14.	Kumar D, Kumar N, Mehta MK, Chatli K, Dr K Narsaiah, Kaur OP, Malav and Kumar P	• **Best Poster Award (2016)** for their poster on"Development of Cinnamon Oil Bioactive Emulsion as Preservative for Storage Quality of Chevon Balls" in International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) held at GADVASU, Ludhiana during November 10-12, 2016
15.	Sivakumar S, Ravneet S, Harshita S, Nithin M, Dr K Narsaiah and Ms. Minaxi Sharma	• **Best Poster Award (2017)** for their poster on "A study on effect of heating and pH on particle size of different protein based coating material used for encapsulation of resveratrol emulsion" in National Conference on Food Processing India held at GJUST, Hisar during March 3-4, 2017
16.	Dr Manjunatha BS, Dr Chetana A, Dr Bandeppa, Dr AS Dukare, Rathi MS and Sangeeta P	• **3rd Best Poster Award (2016)** for their poster "Functional and genetic characterization of osmotolerant endophytic bacteria isolated from pearl millet cultivars" in IPS 6th International Conference on Plants Pathogens and People held at NASC Complex, New Delhi during February 23-27, 2016
17.	Dr D N Yadav	• **Reviewer Excellence Award (2016)** from Agriculture Research Communication Center (ARCC), Karnal, Haryana
18.	Dr K Narsaiah	• **Recognized as Fellow (2016)** of Institution of Engineers (India)

PUBLICATIONS

Research Papers

Ahmad T, Gaikwad NN, Kumar Y and Anurag RK (2016). Ergonomic design and development of poultry dressing table for hygienic processing. Journal of Agricultural Engineering, 53(3): 34-39.

Anurag RK, Ahmad I, Alam T and Bhardwaj A (2016). Rheological behaviour of three varieties of Indian mango-Langra, Chausa and Dashehari by using power law model. International Journal of Processing and Post Harvest Technology, 7 (2): 210-219.

Bala M, Goswami D, Tyagi SK andGupta RK (2016). Response surface methodology for extraction of phenolic compounds from safflower (*Carthamus tinctorius* L.) seed meal. Asian Journal of Chemistry, 28 (11): 2482-2486.

Bansal S, Mangal M, Sharma SK and Gupta RK (2016). Non-dairy based probiotics: A healthy treat for intestine. Critical Reviews in Food Science and Nutrition, 56(11): 1856-1867.

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Barnwal P, Singh KK and Mridula D (2016). Development of a power operated flaxseed dehuller. Agricultural Engineering Today, 40(3):28-34.

Bashir AA, Sinha JP, Jha GK and Chopra S (2016). Drying kinetics for vegetable seeds with zeolite beads. Indian Journal of Agricultural Sciences, 86(12): 1630-4.

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Nath P (2016). 'Valorization of red capsicum (*Capsicum annuum* L.) for development of nutraceutical enriched yoghurt. Paper presented in 25th Indian Convention of Food Scientists and Technologists on Food Processing for Sustainable Agriculture and Industry held at Guru Nanak Dev University, Amritsar, Punjab during 10-12 November, 2016.

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Anurag RK (2016). Minimal processing of fruits and vegetables. In: Compendium of ICAR sponsored summer school on "Engineering and Technology Innovations in Developing Health Foods" organised at ICAR-CIPHET, Ludhiana during 08-28 June, 2016. pp 221-230.

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Kumar S and Kumar R (2016). Industrial enzymes in post-harvest processing, preservation and value addition. In: Compendium of ICAR Summer School on "Approaches to Identification, Quantification and Reduction of Post-Harvest Losses in India" organized at ICAR-CIPHET, Ludhiana during 17 August – 06 September, 2016.pp.121-130.

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Singh RK, Indore NS, Narayan M and Singh S (2016). Low cost polyhouse for production of off season vegetables. In: Compendium of Model training course on "Post-Harvest Supply Chain/Cold Chain Management of Vegetables" organised at ICAR-CIPHET, Ludhiana during 12-19 December, 2016. pp. 15-17.

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Yadav DN (2016). Extraction of protein from de-oiled oilseeds cake: Concept and technology in Compendium of Model training course on "Processing, Value Addition and Entrepreneurship Development in Food Agri-Business" organized at ICAR-CIPHET, Ludhiana during 14-21 November, 2016. pp. 174-178.

Yadav DN (2016). On farm value addition technologies for marketable produce. In: Compendium of ICAR Summer School on "Approaches to Identification, Quantification and Reduction of Post-Harvest Losses in India" organized at ICAR-CIPHET, Ludhiana during 17August – 06 September, 2016. pp. 188-192.

Yadav DN (2016). Processing of groundnut and soybean for production of dairy analogues. In: Compendium of Model training course on "Processing, Value Addition and Entrepreneurship Development in Food Agri-Business" organized at ICAR-CIPHET, Ludhiana during 14-21 November, 2016. pp. 95-103.

Participation in Conferences/ Seminars/ Meetings

Anil Kumar Dixit (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

Anil Kumar Dixit (2016). Attended industry interface meet for entrepreneurs and farmers organized by ICAR-CIPHET held at HAU, Hisar on October 21, 2016.

Anil Kumar Dixit (2016). Chaired session on Emerging Technologies. International Conference on Emerging Technologies in Agricultural and Food Engineering held at IIT Kharagpur during December 27-30, 2016.

Arun Kumar TV (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

AU Muzaddadi (2016). International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) held at GADVASU, Ludhiana during November 10-12, 2016.

AU Muzaddadi (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

AU Muzaddadi (2016). Punjab Fish Festival organized by Department of Fisheries, Govt. of Punjab and National Fisheries Development Board, Hyderabad held at GADVASU, Ludhiana during April 24-25, 2016.

Bharat Bhushan (2016). International Conference on Nutraceuticals and Functional Foods – The Challenges and Opportunities held at Anand Agricultural University, Anand, Gujarat during December 06-08, 2016.

Chandan Solanki (2016). International Conference on Nutraceuticals and Functional Foods – The Challenges and Opportunities held at Anand Agricultural University, Anand, Gujarat during December 06-08, 2016.

Chandan Solanki (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Dattatraya M Kadam (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

Dattatraya M Kadam (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Dattatraya M Kadam (2017). National Conference on Agro-Processing based Entrepreneurship Development for Sustainable Livelihood held at Dr. PDKV, Akola during February 22-23, 2017.

Dattatreya M. Kadam (2016). Workshop on Testing of Agricultural Equipments held at Central Farm Machinery Training and Testing Institute, Budni, Madhya Pradesh during April 4-5, 2016.

Dhritiman Saha (2016). International Workshop on Milk: Naturally Nanostructured Food organized by NDRI, Karnal in association with University of Queensland, Australia during November 30, 2016.

Dhritiman Saha (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana, Punjab during September 29-30, 2016.

DN Yadav (2016). 25th Indian Convention of Food Scientists and Technologists on Food Processing for Sustainable Agriculture and Industry held at Guru Nanak Dev University, Amritsar, Punjab during November 10-12, 2016 and delivered invited talk on "Micro-filtration process for extraction of protein from sunflower de-oiled cake: Effect of processing parameters"

DN Yadav (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

DN Yadav (2017). National Conference on Food Processing India held at Guru Jambheshwar University of Science and Technology, Hisar, Haryana during March 3-4, 2017 and delivered invited lecture on "Oilseeds cake protein : Processing & utilization for human consumption".

Dukare Ajinath (2017). National Workshop on Computational Tools for Genomics and Proteomics Data Analysis held at ICAR-NBAIM, Mau (UP) during February 14-17, 2017.

Dukare Ajinath (2017). 2nd National Conference on Trends in Nanobiotechnology held at CCS Haryana Agricultural University, Hisar during November 29-30, 2016.

Indore Navnath Sakharam (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Jalgaonkar Kirti Ramesh (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Kale Sekharam Jagan (2017). National Conference on Agro-Processing based Entrepreneurship Development for Sustainable Livelihood held at Dr. PDKV, Akola during February 22-23, 2017.

Manju Bala (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana, Punjab during September 29-30, 2016.

Manju Bala (2016). International Workshop on Milk: Naturally Nanostructured Food organized by NDRI, Karnal in association with University of Queensland, Australia during November 30, 2016.

Manju Bala (2017). International Conference on Technological Advancement for Sustainable Agriculture and Rural Development (TASARD-India, 2017) held at NASC Complex, New Delhi during February 20-22, 2017.

Manoj Kumar Mahawar (2016). International Conference on Nutraceuticals and Functional Foods – The Challenges and Opportunities held at Anand Agricultural University, Anand, Gujarat during December 06-08, 2016.

Manoj Kumar Mahawar (2017). International Conference on Oilseed Brassica held at DRMR, Jaipur, Rajasthan during February 23-27, 2017.

Mridula D (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana, Punjab during September 29-30, 2016.

Pranita Jaiswal (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Prerna Nath (2016). 25th Indian Convention of Food Scientists and Technologists on Food Processing for Sustainable Agriculture & Industry held at Guru Nanak Dev University (GNDU), Amritsar, Punjab during November 10-12, 2016.

Ramesh Kumar (2016). 7th Indian Horticulture Congress held at IARI, New Delhi during November 15-18, 2016.

Ranjeet Singh (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

Ranjeet Singh (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Ranjeet Singh (2017).19th Indian Agricultural Scientists and Farmers' Congress held at Allahabad during 18-19 February, 2017.

Renu Balakrishnan (2017). National Symposium on Advances in Agriculture through Sustainable Technologies and Holistic Approaches held at International Centre, Goa during February 15-17, 2017.

RK Gupta (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

RK Gupta (2016). Attended 10th meeting of Technical Scrutiny Committee for evaluating the proposals for Setting Up/up-gradation of Food Testing Laboratories held at NASC Complex, New Delhi during May 6, 2016.

RK Gupta (2016). Attended 278th meeting of the Board of Management of the Punjab Agricultural University held on July 12, 2016.

RK Gupta (2016). Attended 279th meeting of Board of Management, PAU, Ludhiana held at PAU Camp Office, Mohali during November 10, 2016.

RK Gupta (2016). Attended 3rd Indian Grain Storage Group Meeting held at New Delhi during April 22-23, 2016

RK Gupta (2016). Attended 46th meeting of Research Council of CSIR-CSIO held at CISR-CSIO, Chandigarh during November 17-18, 2016.

RK Gupta (2016). Attended AICRP on PET Workshop held at MPU&T, Udaipur during December 15-16, 2016.

RK Gupta (2016). Attended India International Science Festival (IISF-2016) held at CSIR-National Physical Laboratory (CISR-NPL), New Delhi during December 12, 2016 and presented invited paper.

RK Gupta (2016). Attended industry interface meet for entrepreneurs and farmers organized by ICAR-CIPHET held at HAU, Hisar on October 21, 2016.

RK Gupta (2016). Attended Kisan Sammelan held at Krishi Vigyan Kendra, Samarala during September 25, 2016.

RK Gupta (2016). Attended meeting of National Steering Committee pertaining to FCI project held on August 29, 2016 at Chennai.

RK Gupta (2016). Attended meeting of Ready-to-Eat Foods and Specialized Products Sectional Committee, FAD 24 at New Delhi during December 12, 2016.

RK Gupta (2016). Attended meeting with ICMR officials pertaining to CRP on Health Foods at New Delhi during December 28, 2016.

RK Gupta (2016). Chaired technical session of 25th Indian Convention of Food Scientists and Technologists on Food Processing for Sustainable Agriculture and Industry held at Guru Nanak Dev University, Amritsar, Punjab during November 11, 2016.

RK Gupta (2016). Delivered a technical lecture on World Food Day Function held at CCSHAU, Hisar during October 22, 2016.

RK Gupta (2016). Delivered an inaugural lecture on innovative approaches in PHM in summer school for the students of CFT at Allahabad University on June 1, 2016.

RK Gupta (2017). Attended Directors Conference held at New Delhi during February 14-15, 2017.

RK Gupta (2017). International Conference on Technological Advancement for Sustainable Agriculture and Rural Development (TASARD-India, 2017) held at NASC Complex, New Delhi during February 20-22, 2017.

Sandeep Mann (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

Sandeep Mann (2016). Attended industry interface meet for entrepreneurs and farmers organized by ICAR-CIPHET held at HAU, Hisar on October 21, 2016.

Sandeep Mann (2016). Conference on 'Making Indian Agricultural Sustainable' held at Hotel Shivalik View, Sector-17, Chandigarh during November 21, 2016.

Sandeep Mann (2016). International Conference on Emerging Technologies in Agricultural and Food Engineering held at IIT Kharagpur during December 27-30, 2016.

Sandeep Mann (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Sangita Bansal (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana, Punjab during September 29-30, 2016.

Sangita Bansal (2016). International conference on Global Agriculture & Innovation Conference (GAIC-2016) held at Noida International University, Noida, UP during November 27-29, 2016.

Sangita Bansal (2017). International Conference on Technological Advancement for Sustainable Agriculture and Rural Development (TASARD-India, 2017) held at NASC Complex, New Delhi during February 20-22, 2017.

SK Tyagi (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Sunil Kumar (2016). International Conference on Nutraceuticals and Functional Foods – The Challenges and Opportunities held at Anand Agricultural University, Anand, Gujarat during December 06-08, 2016.

Sunil Kumar (2016). National Conference on Basic and Applied Researches in Plants and Microbes held at Punjabi University, Patiala during November 03-05, 2016.

Sunil Kumar (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Surya Tushir (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

Surya Tushir (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Swati Sethi (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

V Eyarkai Nambi (2016). 10th International Conference on Controlled Atmosphere and Fumigation in Stored Products held at The Ashoka, New Delhi during November 7-11, 2016.

Vijay Singh Meena (2016). National Conference on Innovative Food Processing Technologies for Food and Nutritional Security held at ICAR-CIPHET, Ludhiana during September 29-30, 2016.

Vikas Kumar (2016). Conference on Making Indian Agricultural Sustainable held at Hotel Shivalik View, Sector-17, Chandigarh during November 21, 2016.

Vikas Kumar (2016). Conference on Initiative to Double Farmer's Income organized by Grant Thornton India working for Farmers Producer's Organization Income, Ludhiana during October 22, 2016.

Vikas Kumar (2016). International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) held at GADVASU, Ludhiana during November 10-12, 2016.

Yogesh Kumar (2016). International Symposium and 7th Conference of Indian Meat Science Association (IMSACON-VII) held at GADVASU, Ludhiana during November 10-12, 2016.

RESEARCH PROJECTS

Institute Funded Projects

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator
1.	Development of animal handling and automated cooling systems for dairy farms.	January, 2013	December, 2016	Dr K Narsaiah
2.	Development of hybrid cold storage structure for onion and tomato.	March, 2013	September, 2016	Dr RK Vishwakarma
3.	Processing of buckwheat, amaranth and oat.	January, 2013	March, 2017	Dr Mridula D
4.	Development of continuous primary processing and shrink packaging line for cauliflower and cabbage	October, 2013	March, 2017	Dr RK Vishwakarma
5.	Development of fat replacer and hydrocolloid from pearl millet and barley.	October, 2013	September, 2016	Dr DN Yadav
6.	Development of vegetable mixed-wadi making system	October, 2013	March, 2017	Dr Sandeep Mann
7.	Design and development of Wonder Bag for wheat storage	July, 2014	June, 2017	Dr Sandeep Mann
8.	Development of nutritious and convenience foods using extrusion processing technique for 'at risk' children.	July, 2014	June, 2017	Dr Mridula D
9.	Development of a process for extraction and utilization of low methoxyl pectin from citrus fruit residue	April, 2014	June, 2017	Dr Sunil Kumar
10.	Impact Assessment of Technologies from CIPHET and AICRP on PHET and PET	June, 2014	May, 2017	Dr Anil Dixit
11.	Design development and evaluation of equipments/machine and storage structures for primary processing and low temperature storage of onions in bulk.	July, 2015	June, 2018	Dr DM Kadam
12.	Development and evaluation of active ethylene absorbing packaging film material for selected climacteric fruits.	July, 2015	June, 2017	Dr Rahul K Anurag
13.	Development of quality sensing system for mushroom and minimally processed pomegranate arils	July, 2015	June, 2017	Dr Pranita Jaiswal
14.	Development and mechanization of low fat high fibre functional meat products	July, 2015	June, 2018	Dr Yogesh Kumar

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator (2015-16)
15.	Development of improved Process and Machinery for enhanced Dhal Recovery from Pigeon Pea	July, 2015	June, 2018	Dr RK Vishwakarma
16.	Development of process protocol for extraction of anthocyanins from pigmented indigenous rice varieties and its utilization in functional foods	July, 2015	June, 2017	Dr SK Nanda
17.	Development of process protocol for gluten analogue and its application in maize and millets flour	July, 2015	June, 2017	Dr Manju Bala
18.	Newer methods for energy efficient oil extraction and novel product development from mustard seed	July, 2015	June, 2018	Dr SK Tyagi
19.	Development of technology for destalking and packaging of dried chillies	July, 2015	June, 2017	Er Kirti R Jalgaonkar
20.	Process Protocol for production of quality Green Raisins	July, 2015	June, 2017	Ms Prerna Nath Kale
21.	Development of composite peeler cum juice extract for sweet orange and kinnow	July, 2015	June, 2017	Dr Manoj Kumar Mahawar
22.	Development of National Database on NARES Technologies in Post-Harvest Sector	July, 2015	June, 2018	Dr RK Gupta
23.	Development and Evaluation of Eco-Friendly mustard based antimicrobial formulation using other botanicals for eradication of bacterial blight in pomegranate	April, 2016	March, 2018	Dr SK Tyagi
24.	Development of spectroscopic techniques for instant detection of honey adulteration	April, 2016	March, 2019	Dr Pranita Jaiswal
25.	Development of rapid spectroscopic and molecular techniques for detection of animal species in meat products	April, 2016	March, 2018	Dr Yogesh Kumar
26.	Bio transformation of Corn by-products for protein and other value added products.	April, 2016	March, 2018	Ms Surya
27.	Development of real time monitoring system for transportation of perishables	April, 2016	March, 2019	Dr RK Vishwakarma
28.	Development of testing kits for detecting adulterants in selected spices	April, 2016	March, 2018	D r Manju Bala
29.	Development of groundnut based milk powder analogue	April, 2016	March, 2017	Dr SK Nanda
30.	Design and development of dehumidified hot air dryer for maize	April, 2016	March, 2019	Dr Arun Kumar TV

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator (2015-16)
31.	Design and development of microwave assisted continuous popping system for selected food grains	April, 2016	March, 2018	Er Chandan Solanki
32.	Development of improved flaking system for small scale production of rice flakes	April, 2016	March, 2019	Er Dhritiman Saha
33.	Development of convenient breakfast products using sprouting and extrusion technology	April, 2016	March, 2018	Dr Swati Sethi
34.	Utilization of fruit waste and plant extracts in developing antimicrobial coatings for extending shelf-life of fruits and vegetables	April, 2016	March, 2018	Dr Sunil Kumar
35.	Design and Development of Mechanized System for Fruit Bar Manufacturing	April, 2016	March, 2018	Er Kirti Jalgaonkar
36.	Development of technology for de-poding and preservation of cowpea & green pea legumes	April, 2016	March, 2018	Er BB Ratnakar
37.	Development of woman-friendly semi-automatic fish cleaning-cum-dressing system	April, 2016	March, 2017	Dr AU Muzaddadi
38.	Development of user friendly android based mobile application (Mobile app) for technology dissemination and outreach program on post-harvest processing and value addition	April, 2016	March, 2018	Dr Ranjeet Singh
39.	Development of smart device for automatic detection and identification of insects in stored grains using machine	April, 2016	March, 2019	Dr VE Nambi
40.	Skill development and capacity building for income generation and employment security through agro-processing	April, 2016	March, 2018	Dr Ranjeet Singh

Externally Funded Projects

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator	Funding Agency
1.	Technology for enhancing oil recovery and production of edible grade de-oiled meal from sunflower and groundnut and their diversified uses.	July, 2013	Jan, 2017	Dr Mridula D	DST
2.	Development of molecular tools for detection of adulteration of medicinal oilseeds and spices for value addition and processing.	October, 2013	September, 2017	Dr Sangita Bansal	NMPB
3.	Study on determining storage losses in food grains in FCI and CWC warehouses and to recommend norms for storage losses in efficient warehouse management.	July, 2013	June, 2017	Dr RK Gupta	FCI
4.	Development of nano -biocomposite based construction material for storage of food grains	November, 2013	October, 2017	Dr DM Kadam	DST
5.	Studies and refinement of live -fish carrier system for mass transportation of table fish, brooders, fingerlings and aquarium fishes.	August, 2014	August, 2017	Dr AU Muzadaddadi	NFDB
6.	Development of food Bio -polymer based micro & nano scale delivery systems for bioactive ingredients in functional foods (Under Award of ICAR -National Fellow)	January, 2015	January, 2020	Dr K Narsaiah	ICAR-National Fellow
7.	Post-Harvest Machinery and Equipment Testing Centre at ICAR-CIPHET, Ludhiana	August, 2015	July, 2018	Dr RK Gupta	DoAC
8.	Establishment of Agri-Business Incubation (ABI) Centre at ICAR-CIPHET, Ludhiana	January, 2016	March, 2017	Dr Ranjit Singh	NAIF
9.	Pollution Control of Rice Husk Fly Ash by its Effective Utilization for Novel Product Development	February, 2016	January, 2018	Dr SK Tyagi	ICAR
10.	Development of automated fumigation chamber for treatment of grapes with CO2 and SO2 and standardiz ation of treatment protocol for Export market access to New Zealand	April, 2016	March, 2017	Dr RK Vishwakarma	APEDA
11.	Processing and Value Addition of Agricultural Produce for Enhancing Farmers income and Employment in Production Catchment under Farmer FIRST Programme (FPP)	February, 2017	January, 2019	Dr Sandeep Mann	ICAR
12.	Trial on storage losses in the newly constructed warehouse and conventional warehouse	November, 2016	December, 2016	Dr RK Vishwakarma	CWC

Consortium Research Platform (CRP) on Health Foods

Sr. No.	Project Title	Date of Start	Date of completion	Principal Investigator
1.	Development of micronutrients enriched flour formulation and food products	April, 2015	March, 2017	Dr Mridula D
2.	Development of protein isolates and concentrates from de-oiled cakes and their application in health foods	April, 2015	March, 2017	Dr DN Yadav
3.	Development of functional beverages and food products from fruit, vegetables and herbs for high risk groups (obesity, CVD, diabetes etc.)	April, 2015	March, 2017	Dr Sunil Kumar

Consortium Research Platform (CRP) on Secondary Agriculture

1.	Establishment of modern fruits and vegetables Agro Processing Centre (APC)	April, 2015	March, 2017	Dr RK Vishwakarma
2.	Value addition of Makhana and its by -products	April, 2016	March, 2017	Dr RK Vishwakarma

AICRP on PET, HCP Division, ICAR-CIPHET, Abohar

1.	Design and development of composite Solar Air-conditioning System coupled farm level cold store for hot and arid region	January, 2015	December, 2016	Dr Kale SJ
2.	Design and evaluation of Earth Tube Heat Exchanger coupled greenhouse for hot and arid region	January, 2015	December, 2016	Dr Kale SJ
3.	Design and development of mushroom polyhouse structure suitable for hot and arid region	January, 2015	December, 2016	Dr Kale SJ
4.	Development of semi-permanent shadenet house to reduce the sun burn of pomegranate fruits in hot and arid region	January, 2015	December, 2016	Dr VS Meena

RESEARCH ADVISORY COMMITTEE

Research Advisory Committee of the ICAR-CIPHET, Ludhiana for the period of three years *i.e.* January 22, 2015 to January 21, 2018.

S No	Name and Address	Designation	Contact Details
1.	**Dr B S Bisht** Former ADG, ICAR & Director Birla Institute of Applied Sciences Bhimtal, Nainital Uttarakhand-263 136	Chairman	Ph: 05942 - 247032/247921/247095 Mob: 094109-05454 Fax: 05942-247095 Email: director@birlainstitute.co.in
2.	**Dr B Ranganna** Professor Emeritus University of Agricultural Sciences J-Block, GKVK Campus Bangalore-560 065, Karnataka	Member	Ph. 080 - 23330153 (O) Ext. 346 Fax: 080 - 23330277 Mob: 097400-10564, 094498-66931 Email: rangannab@gmail.com
3.	**Prof Susanta Kumar Das** Professor Agricultural & Food Engineering IIT, Kharagpur-721 302, West Bengal	Member	Ph: 91-03222-283112/113 Mob. 094340-68741, 094753-49779 Fax. 91-03222-278224 Email: skd@agfe.iitkgp.ernet.in susantaiitkgp@gmail.com
4.	**Dr Pitam Chandra** Professor & Head Department of Food Engineering NIFTEM, Kundli Sonepat-131 028, Haryana	Member	Ph: 91-130-2281099 Email: pc1952@gmail.com
5.	**Dr Ashok Kumar** ADR (Food Science, Nutrition and Engineering) Punjab Agricultural University Ludhiana –141 004 (Punjab)	Member	Mob: 98728-76077 Email: akdevgan@pau.edu
6.	**Dr Sanjod Kumar Mendiratta** Head Livestock Products Technology Division IVRI, Izatnagar-243 122, U.P.	Member	Mob: 094124-45311 Email: mendiratta_65@yahoo.co.in
7	**Dr R K Gupta** Director ICAR - CIPHET, PO: PAU Campus Ludhiana-141 004 (Punjab)	Member	Ph. 0161-2308669, 2313102 Fax: 0161-2308670 Mob: 098728-59024 Email : rkguptaciphet@gmail.com : director.ciphet@icar.gov.in
8	**Dr S N Jha** (Ex-Officio) Assistant Director General (PE) Indian Council of Agricultural Research Room No.-407, Krishi Anusandhan Bhawan-II, Pusa, New Delhi -110012	Member	Ph. 011-25846492 Mob: 094176-01715 Email: snjha_ciphet@yahoo.co.in
9.	**Dr D M Kadam** Senior Scientist, AS&EC Division, ICAR-CIPHET, PO: PAU Campus Ludhiana-141 004, Punjab	Member Secretary	Ph. 0161-2313123 Fax: 0161-2308670 Mob: 94175-96894 Email: kadam1k@yahoo.com

INSTITUTE MANAGEMENT COMMITTEE

S No	IMC Members	Contact Details
1.	The Assistant Director General (PE) Division of Agricultural Engineering Indian Council of Agricultural Research Krishi Anusandhan Bhawan-II, Pusa New Delhi-110 012	Telefax : 011-25846492 Mob. No. 09417601715 (Dr. S.N. Jha) Fax: 011-25842660 Email : snjha_ciphet@yahoo.co.in
2.	Dr S K Jha Principal Scientist (AS&PE) PHT Centre Indian Agricultural Research Institute Pusa, New Delhi –110012	PA to Director : 011-25843375, 011-25842367 Mob. No. 09868427205 (O) 25842155 Fax : 011-25846420 Email: skj_ageg@iari.res.in
3.	Dr Nachiket Kotwaliwale Head (APPD) Central Institute of Agricultural Engineering Nabi Bagh, Berasia Road Bhopal –462 038	EPBAX : 0755-2521000-1 PA to Director : 0755-2737191 Tel: 0755-2521110 Mob. No. 09425522421 Fax : 0755-2734016 Email : nachiket.kotwaliwale@gmail.com
4.	Dr S K Chattopadhyay Head, MP Division Central Institute for Research on Cotton Technology (CIRCOT) Adenwala Road, Matunga (East) Mumbai -400 019	PA to Director: 022-24146002 Mob. No. 09850083130 Fax : 022-24157239, 24130835 Email : drskchattopadhyay@gmail.com
5.	Dr Gautam Basu Head, MP Division National Institute of Research on Jute & Allied Fibre Technology (NIRJAFT) 12, Regent Park Kolkata -700040 (West Bengal)	PA to Director: 033-24711807 Phone No. 033-24212115-17, Ext. 215,265 Mob. No. 09433003241 Fax : 033-24712583 Email : gbose91@gmail.com
6.	Sh Abhijit Shantaram Rokade Shukrawar Peth, House No. 5 Taluka-Junnar, Distt. Pune-410 502 Maharastra	Mob. No. 09423011236, 09604561769 Email: grapessywines_beverages@yahoo.com
7.	The Director of Agricultural Department of Agriculture, Punjab Kheti Bhawan, Phase-6 Near Dara Film Studio Mohali, Chandigarh-160055	Tel: 0172-2970602 Mob. No. 9814138939 (Dr. Gurdial Singh) Fax : 0172-2970609 Email: directoragriculturepunjab@gmail.com PA's Email: agril67@gmail.com

S. No.	IMC Members	Contact Details
8.	The Finance & Accounts Officer Indian Institute of Wheat and Barley Research Karnal-132001 (Haryana)	Tel : 0184-2266762 Mob. No. 09050905843 (Sh. Jagdish Chander) Fax : 0184-2267390 Email: pao.dwr@gmail.com
9.	The Director of Research Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya (CSKHPKV) NH 20, Palampur-176062 Himachal Pradesh	Tel: 01894-230406 (O) 01894-231051 (R) Mob. No. Fax: 01894-230406, 230511
10.	Director (Horticulture) Govt. of Gujarat Directorate of Horticulture First Floor, Krishi Bhawan Sector 10 A, Gandhi Nagar-382 010 Gujarat	Dr. R.S. Sherasiya Tel: 079-23256104 079-23256013/23256227 PS (Sh. Chandresh) 09377829020 Mob. No. 09978405029 Fax: 079-23256113 Email: sherasiyara@yahoo.co.in dir-bag@gujarat.gov.in
11.	Sh. Sharanjit Singh S/o Sh. Sukhdeep Singh H. No. 109, Narula Colony Near Budha Dal Public School Lower Mall Road, Patiala-147021 Punjab	Mob. No. 9855055517 (Self) Mob. No. 9855470007 ®

PERSONALIA

New Joining

Name of the Officials	Date of Joining	Designation
Dr R K Singh	16.08.2016	Project Coordinator, (PET)
Er Yogesh Kalnar	11.04.2016	Scientist
Dr Khwairakpam Bembem	11.04.2016	Scientist
Dr Renu Balakrishnan	11.04.2016	Scientist
Sh Vikas Kumar	11.04.2016	Scientist
Dr Pankaj Kumar Kannaujia	11.04.2016	Scientist
Dr Narender Negi	11.04.2016	Scientist
Dr Pankaj Kumar	13.10.2016	Scientist
Dr V Chandrasekhar	15.10.2016	Scientist

Transfers

Name & Designation	Date of Transfer	Name of Place
Dr Vijay Singh Meena, Scientist	20.03.2017	ICAR-NBPGR, New Delhi
Dr Narender Negi, Scientist	20.03.2017	ICAR-NBPGR, New Delhi
Dr Arvind Kumar Jaiswal, Scientist	22.03.2017	ICAR-CPRS-Jalandhar regional Station of CPRI, Shimla
Sh Raj Kumar, SAO	31.03.2017	ICAR-NDRI, Karnal
Sh Rajinder Kumar Raheja, LDC	31.05.2016	ICAR-ATARI, PAU

INSTITUTIONAL STAFF

At Ludhiana Campus

Scientific

Name	Designation	Discipline
Dr. R.K. Gupta	Director	Agricultural Structures & Process Engineering
Dr. R K Singh	Project Coordinator	Soil Water Conservation Engineering
Dr. S.K. Nanda	Head, FG&OP	Agricultural Structures & Process Engineering
Dr. S.K. Tyagi	Pr. Scientist	Chemical Engineering
Dr. K. Narsaiah	Pr. Scientist	Agricultural Structures & Process Engineering
Dr. Mridula Devi	Pr. Scientist	Food & Nutrition
Dr. Anil Kumar Dixit	Pr. Scientist	Agricultural Economics
Dr. Deep Narayan Yadav	Pr. Scientist	Food Technology
Dr. Pranita Jaiswal	Pr. Scientist	Microbiology-Plant Science
Dr. Sandeep Mann	Pr. Scientist	Agricultural Structures & Environmental Management
Dr. Dattatrya M. Kadam	Pr. Scientist	Agricultural Structures & Process Engineering
Dr. Sangita Bansal	Sr. Scientist	Biotechnology (Plant Science)
Dr. Manju Bala	Sr. Scientist	Biochemistry (Plant Science)
Dr. A. U. Muzaddadi	Sr. Scientist	Fish Processing Technology
Dr. Ranjit Singh	Sr. Scientist	Agricultural Process Engineering
Er. M. K. Grewal**	Scientist	Agricultural Structures & Process Engineering
Er. Eyarkai Nambi, V.	Scientist	Agricultural Structures & Process Engineering
Dr. Yogesh Kumar	Scientist	Livestock Product Technology
Dr. Tanbir Ahmad**	Scientist	Livestock Product Technology
Mrs. Deepika Goswami**	Scientist	Food Technology
Dr. Rahul Kumar Anurag	Scientist	Food Technology
Mrs. Leena Kumari	Scientist	Electronics & Instrumentation
Mrs. Surya	Scientist	Agricultural Microbiology
Dr. Swati Sethi	Scientist	Food Technology
Er. Chandan Solanki	Scientist	Agricultural Process Engineering
Er. Dhritiman Saha	Scientist	Agricultural Process Engineering

** on study leave

Name	Designation	Discipline
Er. Arun Kumar T.V	Scientist	Agricultural Process Engineering
Er. Akhoon Asrar Bashir	Scientist	Agricultural Structures & Environmental Management
Er. Indore Navnath Sakharam	Scientist	Agricultural Structures & Environmental Management
Er. Kalnar Yogesh Bhaskar	Scientist	Agricultural Process Engineering
Dr. Khwairakpam Bembem	Scientist	Home Science
Dr. Renu Balakrishnan	Scientist	Agricultural Extension
Mr. Vikas Kumar	Scientist	Fish Process Technology
Dr. Pankaj Kumar	Scientist	Agricultural Process Engineering
Dr. V. Chandrasekhar	Scientist	Agricultural Process Engineering

Administrative

Name	Designation
Sh. Raj Kumar	SAO
Sh. Manni Lal	AF&AO
Sh. B.C. Katoch	AAO
Sh. Kunwar Singh	Assistant
Sh. Avtar Singh	Assistant
Sh. Tarsem Singh Purba	Assistant
Smt. Jasvir Kaur	Assistant
Sh. Gurdial Singh	UDC
Sh. Harbhupinder Singh	UDC
Sh. Iqbal Singh	UDC
Sh. Ashwani Kumar	UDC
Smt. Sunita Rana	LDC
Sh. Ram Khelawan Yadav	LDC
Sh. Sohan Lal	LDC
Sh. Sughar Singh Verma	PS to Director

Technical

Name	Designation
Dr. V.K. Saharan	Chief Technical Officer
Dr. Mukund Narayan	Technical Officer (Agril. Structure)
Sh. Gurdeep Singh	Technical Officer (Lab. Tech.)
Sh. Hardev Singh Sekhon	Sr. Technical Assistant (Driver)
Sh. Beant Singh	Sr. Technical Assistant (Driver)
Sh. Vishal Kumar	Sr. Technical Assistant (DEO)
Sh. Lakhwinder Singh	Technical Assistant (Fitter)
Sh. Bhajan Singh	Technical Assistant (Fitter)
Sh. Jaswant Singh	Technical Assistant (Welder)
Smt. Sonia Rani	Technical Assistant (DEO)
Sh. Jaswinder Singh	Technical Assistant (Machinist)
Sh. Jagtar Singh	Technical Assistant (Electrician)
Sh. Pradip Kumar	Technical Assistant (Field Asstt.)
Sh. Yashpal Singh	Sr. Technician (Field Asstt.)
Sh. Satwinder Singh	Sr. Technician (Lab. Technician)
Sh. Swarup Singh	Technician (Lab. Technician)

Supporting

Name	Designation
Sh Sukhbir	Skilled Support Staff
Smt Viran Bali	Skilled Support Staff
Sh Manoj Kumar	Skilled Support Staff

ICAR-CIPHET, Abohar

Scientific

Name	Designation	Discipline
Dr. R. K. Vishwakarma	Sr. Scientist	Agricultural Structures & Process Engineering
Dr. Ramesh Kumar	Sr. Scientist	Horticulture
Dr. Sunil Kumar	Sr. Scientist	Biochemistry (Plant Science)
Dr. Bharat Bhushan	Scientist	Biochemistry (Plant Science)
Dr. Prerna Nath	Scientist	Food Technology
Dr. Manoj Kumar Mahawar	Scientist	Agricultural Process Engineering
Dr. Kale Sakharam Jagan	Scientist	Agricultural Structures & Environmental Management
Dr. Jalgaonkar Kirti Ramesh	Scientist	Agricultural Process Engineering
Dr. Bibwe Bhushan Ratnakar,	Scientist	Agricultural Process Engineering
Dr. Dukare Ajinath Shridhar	Scientist	Agricultural Microbiology
Dr. Pankaj Kumar Kannaujia	Scientist	Vegetable Science

Administrative

Name	Designation
Sh Pawan Kumar	AAO
Sh Mohan Lal	Assistant
Sh Sanjay Kumar Gaur	LDC

Technical

Name	Designation
Sh Prithvi Raj	Sr. Technical Officer (Filed Form.)
Sh Rajesh Kumar	Sr. Technical Officer (Filed Form.)
Sh Ganpat Ram	Technical Assistant (Driver)
Sh Devinder Kumar	Technical Assistant (Fitter)
Sh Dalu Ram	Technical Assistant (Fitter)
Sh Pawan Kumar	Technical Assistant (Electrician)
Sh Hardeep Singh	Technical Assistant (Turner)
Sh Rajiv Sharma	Technical Assistant (Lab. Technician)

Supporting

Name	Designation
Sh Surinder Kumar	Skilled Support Staff

Annexure - I

RESULTS - FRAMEWORK DOCUMENT (RFD)

(2015 – 2016)

SECTION 1:

Vision, Mission, Objectives and Functions

Vision

Higher profitability of agricultural production systems through efficient post harvest engineering and technological interventions

Mission

Creating prosperity through minimization of post harvest losses and increase in value addition to produce and by-products from crops, horticulture, livestock and fisheries sector.

Objectives

1. To design, develop and evaluate post-harvest processing equipment, tools and gadgets
2. To develop process protocols and value added products
3. To organize human resource development and capacity building programmes

Functions

- To undertake basic, applied and adaptive engineering and technology research in post production sector of produce of plant origin, livestock and aquaculture produce including agricultural and environmental control, quality and safety.
- To act as national institute for research, education/teaching and training in post harvest engineering and technology
- To act as national repository of information on processes, equipment, products and technologies on post harvest engineering and technology
- To transfer technology and provide advisory and consultancy services and promote entrepreneurship
- To develop and strengthen linkages with the private and public sector in the mandated areas

Annual (April 1, 2015 to March 31, 2016) Performance Evaluation Report of RFD of RSCs i.e. Institutions for the year 2015-2016

S.No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Target/Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw score	Weighted score
							100%	90%	80%	70%	60%		(%)	(%)
1.	To design, develop and evaluate post-harvest processing equipment, tools and gadgets	25	Design & development of post harvest processing equipment, tools and gadgets	Equipment designed and developed	Number	15	10	8	6	4	2	**11**	**100**	**15**
			Testing and evaluation of post harvest processing equipment, tools and gadgets	Final validated design of machine	Number	10	9	7	5	3	1	**9**	**100**	**10**
2.	To develop process protocols and value added products	22	Development of process protocol	Process protocols	Number	10	13	11	9	7	5	**13**	**100**	**10**
			Development of value added products	Value added products	Number	12	8	7	6	5	4	**12**	**100**	**12**
3.	To organize human resource development and capacity building programmes	33	Transfer of technology, capacity building	Trainings, FLDs, Exhibitions & Licensing of improved postharvest technologies	Number	23	36	30	24	18	12	**62**	**100**	**23**

			Documentation and IPR management	Patents filed	Number	02	4	3	2	1	0	**00**	**00**	**00**
				Other Pub. (Leaflets, Brochures, success stories, News items, Newsletters, mass media etc.)	Number	08	30	25	20	15	10	**35**	**100**	**08**
4.	Publication /Documentation	05	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	11	9	7	5	3	**17**	**100**	**3**
			Timely publication of the Institute Annual Report (2014-2015)	Annual Report published	Date	2	June 30, 2015	July 2, 2015	July 4, 2015	July 7, 2015	July 9, 2015	**June 11, 2015**	**100**	**2**
5.	Fiscal resource management	02	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90	**99.8**	**100**	**2**
6.	Efficient functioning of the RFD system	03	Timely submission of draft RFD for 2015-2016 for approval	On-time submission	Date	2	March 21, 2015	March 23, 2015	March 25, 2015	March 20, 2015	March 21, 2015	**March 21, 2015**	**100**	**2**
			Timely submission of results of RFD 2014-2015	On-time submission	Date	1	May 1, 2015	May 2, 2015	May 5, 2015	May 6, 2015	May 7, 2015	**May 1, 2015**	**100**	**1**

7.	Enhanced Transparency/ Improved Service delivery of Ministry / Department	03	Rating from Independent Audit of implementation of Citizen's Client's Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80	**100**	**100**	**2**
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80	**100**	**100**	**1**
8.	Administrative reforms	07	Update organizational strategy to align with revised priorities	% of Implementation	%	2	100	90	80	70	60	**90**	**90**	**1.8**
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of Corruption (MSC)	% of Implementation	%	1	100	90	80	70	60	**100**	**100**	**1**
			Implementation of agreed milestones for ISO 9001	% of Implementation	%	2	100	95	90	85	80	**100**	**100**	**2**
			Implementation of milestones of approved Innovation Action Plans (IAPs)	% of Implementation	%	2	100	90	80	70	60	**100**	**100**	**2**
													Composite Score =	**97.80%**
													Rating	**Excellent**

*Percent achievable Targets = Consolidated Achievements/ Targets under 90% column X 100

Total Composite Score: 97.80%

1. Procedure for computing the Weighted and Composite Score
2. Weighted score of a Success indicator = Weight of the corresponding Success Indicator x Raw Score / 100
3. Total Composite score = Sum of Weighted scores of all the Success indicators.
4. Raw score for achievement = Obtained by comparing achievement with agreed target values. Example : Values between 80% (Good) and 70% (Fair), the raw score is 75%.

Departmental Rating	Value of Composite Score
Excellent	100-96%
Very Good	95-86%
Good	85-76%
Fair	75-66%
Poor	65% and below

भाकृअनुप-केन्द्रीय कटाई-उपरांत अभियांत्रिकी एवं प्रौद्योगिकी संस्थान,
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