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ANNUAL REPORT

2018-19

भाकृअनुप - केंद्रीय रोपण फसल अनुसंधान संस्थान
कासरगोड़ 671124 केरल

ICAR- Central Plantation Crops Research Institute
Kasaragod - 671124, Kerala

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ICAR-CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

KASARAGOD 671 124, KERALA, INDIA

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PREFACE

Coconut, arecanut and cocoa are important plantation crops of India which exert profound influence on the rural economy by supporting the livelihoods of 25 million people in the country. Plantation crops has a major role in the national agrarian economy, with annual contribution to the tune of ₹ 14,200 crores to the national GDP and foreign exchange earnings of about ₹ 2440 crores. However, of late these crops are confronted with various macro and micro level crises. The year 2018-19 witnessed unprecedented floods in Kerala, cyclone *Titli* in Andhra Pradesh and cyclone *Gaja* in Tamil Nadu that resulted in considerable losses to the plantation sector. The Indian Council of Agricultural Research was in the forefront to assess the yield and crop loss due to these natural calamities. It is highly gratifying for ICAR-CPCRI, being the nodal agency, to complete the task in time by effectively coordinating with respective ICAR Institutes, State Agricultural Universities and other stakeholders.

Pests and diseases were also equally challenging, especially the outbreak of rugose spiraling whitefly (*Aleurodicus rugioperculatus* Martin) in several coconut growing tracts in the country. The scientific consensus at the Institute is to recommend a conservation biological control strategy having a pesticide holiday to allow build-up of natural enemies together with augmentative release of selected parasitoids like *Encarsia guadeloupe* and providing adequate nutrients to improve overall health of the palm.

The post World Trade Agreement (WTA) and ASEAN Treaty regimes have witnessed integration of plantation economies across the globe that resulted in fierce competition among producing countries. The Institute has been closely monitoring the prevailing global trends in this sector to tackle current challenges and get equipped with contingency plans in the face of any new exigencies emerging. The succinct activities in this direction carried out at ICAR-CPCRI in the year 2018-19 and salient research findings are presented thematically in this Annual Report.

Progress of research under various Institute funded as well as externally funded programmes have been gratifying. Varietal improvement programmes have led to identifying promising accessions suitable for release as new varieties. Molecular tools for genome characterization and functional annotation have further strengthened the process of selection. To complement, cropping and farming systems research have designed profitable and sustainable cropping/ farming system models. Integrated disease and pest modules have been further refined with the focus on environmental safety and sustainability. Climate sustainability and adaptability research indicated traits of agronomic importance, to be further exploited in breeding efforts. Efforts in value addition have resulted in new products, improving the profitability of agri-business ventures that reflected in 21 MoAs signed. The ToT efforts have been further intensified, making tremendous outreach across the whole growing regions including socially and economically backward farmers with activities under SCSP and TSP. The Institute took leadership in conducting the State level 'Krishi Unnati Mela' during 27th-30th December, 2018 at Thrissur. The accomplishments of the two KVKs and the AICRP on Palms are also presented in this report.

We place here on record our gratitude to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for his constant support, guidance and immense encouragement. We are thankful to Dr. Anand Kumar Singh, Deputy Director General (Horticultural Science), Dr. W. S. Dhillon, Asst. Director General (HS-II), and other colleagues from the Division of Horticultural Science for their cooperation and support. My sincere thanks are also due to Dr. P. Chowdappa, former Director, ICAR-CPCRI, members of Institute Management Committee and chairman and members of Research Advisory Committee. I thank our farmers and other clientele, colleagues for their involvement in various activities of the Institute and the editorial team for bringing out this Annual Report in time.

Kasaragod
31.05.2019

(Anitha Karun)


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कार्य सारांश

नारियल, सुपारी और कोको का सुधार, ताड़ एवं कोको में जैव प्रौद्योगिकीय अन्वेषण, ताड़ एवं कोको में उत्पादन प्रौद्योगिकी, ताड़ एवं कोको में रोगों का समीकृत प्रबंधन, ताड़ एवं कोको में कीट एवं सूत्रकृमियों का समीकृत प्रबंधन, उत्पादन, शरीरक्रिया विज्ञान, जैवरसायन और ताड़ एवं कोको में मूल्य शृंखला प्रबंधन और ताड़ एवं कोको के लिए आर्थिकी एवं सॉख्यिकीय पहलू और प्रौद्योगिकी का हस्तांतरण जैसे सात मुख्य कार्यक्रमों के अधीन मुख्य फसलों पर अनुसंधान जारी किया जाता है। इस अवधि में बाहर से निधि प्रदत्त 26 परियोजनाओं सहित कुल 47 अनुसंधान परियोजनाएँ प्रचालन में थी।

पादप आनुवंशिक संसाधन संरक्षण के अधीन वर्तमान में विश्व का सबसे बड़ा जीन बैंक, 455 नारियल, 178 सुपारी और 515 कोको जननद्रव्यों का अनुरक्षण प्रक्षेत्र जीन बैंक में संस्थान द्वारा किया जाता है। नारियल के आनुवंशिक आधार के संवर्द्धन के लिए लिटिल अण्डमान, बिहार और असम से संग्रहण के लिए विशेष जर्मप्लाज़म पहचान लिया गया। कर्नाटक से मोटा और लंबी सुपारी और बौनी और अर्ध लंबी प्रकार ग्रेट निकोबर और लिटिल निकोबर से संग्रहण किया गया।

कोको संग्रहण में तमिलनाडु से संग्रहित एक क्रियोल्लो, चार फोरास्टिरो/अमेलोनाडो, दो ट्रिनिटारियो प्रकार भी सम्मिलित है जिनका बीन सूचकांक उच्च है।

पिछले वर्ष के शोध प्रयास के परिणाम से 20 नारियल प्रजातियॉं, 11 सुपारी और 8 कोको प्रजातियों का विमोचन किया जा सका। फेडरेटड मलयन स्टेट लंबी से उच्च उपज देने वाली नारियल आई एन डी 010 एस सेलेक्शन जिससे 148 गुठली /ताड़/वर्ष उपज प्राप्त किया जाता है और जो खोपड़ा, डाब और पुष्पगुच्छ रस उत्पादन के लिए उचित है, उपजातिय विमोचन के लिए उचित पायी गयी और पश्चिम घाट और तमिलनाडु के तटीय मैदानों में और अर्ध बंजर क्षेत्रों में खेती के लिए उचित पायी गयी।

सुपारी में मृदुल गुठली प्रक्रमण अध्ययन से यह देखा गया कि एस सी आर डीटीसी 18, कामरूप और दंगपारा प्रजाति में उच्च मृदुफल क्षमता पायी गयी।

नाईजीरियन मूल का वी टी एल सी 13 और वी टी एल सी 20 क्लोन्स के साथ 3 कि ग्रा सूखा बीन उपज/पेड़/वर्ष सुपारी और नारियल फसलन पद्धति में कृषि के लिए उचित क्लोन्स पहचान लिया गया।

नारियल संकर डब्ल्यू ए टी x एन ए टी, पी एच ओ टी x जी बी जी डी, डब्ल्यू सी टी x सी आर डी, सी जी डी x एल सी टी, सी जी डी x सी आर डी, एम वाई डी x एन एल जी डी और एम वाई डी x जी बी जी डी आदि उच्च उपज क्षमतावाली पहचान लिया गया। विट्टल और काहिकुची में सुपारी बौनी संकरों के बीच सुमंगला हिरेहल्ली बौनी उच्च उपज प्रदान करने वाली रिकॉर्ड किया गया लेकिन मोहितनगर में हिरेहल्ली बौनी x मंगला उच्चतम उपज देने वाली रिकॉर्ड की गयी। कोको संकरों में वी टी एल सी पी 8 और वी टीसीएलसी पी 9 जैविक और अजैविक तनाव सक्षमता और उच्च उत्पादन क्षमता (2.53 कि.ग्रा. सूखा बीन्स/पेड़/वर्ष) सुपारी और नारियल बागों के अधीन उच्च घनता रोपाई के लिए उचित पायी गयी।

नारियल पराग संसाधन सुविधा की स्थापना केरल के 12 जिलों में की गई। केरल के 12 जिलों में 31 सामुदायिक नर्सरियाँ स्थापित की गई। केरल के 12 विभिन्न जिले के चुने गए मातृ ताड़ों से कुल 44115 बीज गुठली संग्रहित की गयी। भाकृअनुप-केंरोफअसं, क्षेत्रीय केंद्र, कायम्कुलम में नारियल पराग प्रशीत परिरक्षण सुविधा और जड़ मुर्झा प्रचलित क्षेत्रों में 6 विकेंद्रिकृत नारियल नर्सरी की स्थापना की गयी।

कुल 5,31,075 गुणी रोपाई एकक मुख्य फसलों में उत्पादन किया गया जिसमें 1,04,694 नारियल बीज (648689 संकर) 3,68,918 सुपारी बीज गुठली /पौध और 15,602 कोको पौध/ ग्राफ्ट और 41,861 बीज फली का उत्पादन किया गया।

ऊत संवर्द्धन से बहु गुणन में नारियल के अप्रौढ़ फूल पौध से पौध प्राप्त किया जा सकता है। नारियल (प्ल्युमूलार ऊत और सुपारी (भ्रूण जनित कैलस) के लिए वी क्रायो मेश/वी क्रायो प्लेट विधि के लिए प्रशीत परिरक्षण कार्यविधि का मानकीकरण किया गया। एकल भित्ति का कारबन नानोट्यूब का उपयोग नारियल अण्डभ्रूण में प्रशीत परिरक्षण के बाद उद्धार बढ़ाने में सहायक है। भ्रूण (नौ प्रजाति), पराग (छह प्रजाति) और डी एन ए (12 प्रजाति) के रूप में नारियल जननद्रव्य का प्रशीत परिरक्षण राष्ट्रीय क्रायोजीन बैंक, भाकृअनुप-एन बी पी जी आर, नई दिल्ली में किया गया है।

भाकृअनुप-केंरोफअसं और एस पी आई सी एग्रो बायोटेक केंद्र से लगभग 650 सुपारी ऊत संवर्द्धित पौध विकास के विभिन्न अवस्थाओं में बौनी, बौनी संकर और पीला पत्ता रोग प्रतिरोध ताड़ से प्राप्त किया गया। कल्परस एक रेड्यूसिंग एजेंट के रूप में उपयोग कर ग्रीन सिंथसिस माध्यम से तैयार किया गया। सिल्वर नानोपार्टिकल्स सुपारी इन विट्रो कल्चर्स में जीवाणु संदूषण निहित है।

एस सी ए आर मार्केर्स विकसित किया गया और अरिका अंतर विशिष्ठ संकर के पहचान के लिए मान्यता दी गई। जिब्बेरेलिक अम्ल में निहित जीन नारियल में जैव संश्लेष मार्ग का कृन्तकीकरण किया गया।

फसलन /सस्यन पद्धति परीक्षण के अधीन नारियल आधारित समीकृत कृषि पद्धति काली मिर्च, केला, चारा घास, डेयरी, मुर्गीपालन, बकरीपालन और मत्स्यपालन से 5,32,240/- रुपए प्रतिवर्ष आय जो इकफसल नारियल से प्राप्त आय की तुलना में चार गुना है।

समीकृत कीट प्रबंधन के साथ चारा घास बाजरा नेपियर के अन्तरफसलन के नारियल बाग में अन्तरस्थल में (50 प्रतिशत कार्बनिक पुनः चक्रण + आर डी एफ का 50 प्रतिशत)या पूरा कार्बनिक पोषण प्रबंधन से 126 और 118 टन/हेक्टर उपज क्रमशः प्राप्त किया गया। समीकृत कीट प्रबंधन के साथ अनुरक्षित नारियल बाग जिसमें नारियल, काली मिर्च, केला, जातिफल और दालचीनी का सघन बहुजातिय फसलन पद्धति या पूर्ण जैविक क्षेत्र से समतुल्य नारियल उपज 162 से 173 गुठली/ताड़/वर्ष प्राप्त किया गया।

हेलिकोनिया, अल्पिनिया जाति जंगलकिंग नारियल परिस्थिति में उचिल फूल फसल है जिससे अप्रैल-मई को छोडकर वर्ष भर फूल उत्पादन होता है।

काहिकुची में सुपारी आधारित सघन बहुजातिय फसलन पद्धति में सुपारी, केला, हल्दी अम्ल, नींबू और अनानास पुनःचक्रित जैवभार के साथ अनुमोदित उर्वरक का 1/3, जैव उर्वरक और हरा उर्वरक सुपारी के लिए पर्याप्त है जबकि अन्तरफसल के लिए अनुमोदित उर्वरक का 2/3 आवश्यक है। काहिकुची में किए गए अध्ययन से यह देखा गया कि पूरे वर्ष सुपारी बाग में सब्जी का वर्द्धन साध्य है। जो कृषकों के लिए वर्ष भर आय प्राप्त करने में सहायक होगा।

पौधों और तरुण ताड़ों के लिए पोषण मिश्रण का प्रयोग जैसे कल्प पोषक और फल देने वाले ताडों के लिए कल्पवर्द्धिनी के प्रयोग से नारियल में पोषण मात्रा में सुधार पायी गयी और पौधों की वृद्धि में सुधार पायी गयी। चूर्ण, डोलोमाइट, जिप्सम के साथ मुख्य, द्वितीय और सूक्ष्म पोषण के प्रयोग से मृदा उर्वरता स्थिति और नारियल के उपज में सुधार के साथ दक्षिण केंद्रीय लैटराइट में अम्लता में कमी का परिणाम होता है।

कृषि के साथ जैविक और अजैविक खादों का प्रयोग सम्मिलित नारियल पर स्थायी खाद प्रयोग परीक्षण में और बिना खाद प्रयोग परीक्षण में पोषण की लभ्यता सूक्ष्मजीव सुधारा गया है और उसके द्वारा नारियल की उपज में सुधार हुआ। बौनी ताड़ो को मृदा परीक्षण आधारित पोषक आवश्यकता की पूर्ति की गई। 530:150:1200 ग्रा नाईट्रोजनः फोसफोरसः पोटाश प्रति ताड़ प्रति वर्ष, आधार में लोभिया का वर्द्धन 15 कि ग्रा/ताड/वर्ष वर्मीकंपोस्ट और 5 कि ग्रा /ताड़ /वर्ष नीम केक से जड मुर्झा रोग प्रभावित क्षेत्रों में अनुकूल रूप से उच्च उपज रिकार्ड किया गया।

निरंतर डाब की कटाई नारियल की वृद्धि या उपज पर प्रतिकूल से प्रभावित नहीं है। और उच्च उपज और आय कृषकों द्वारा प्राप्त की जाती है।

पीला पत्ता रोग प्रभावित सुपारी बाग में रोग सूचकांक कम करने में पॉलिथीन मल्चिंग सहायक है। जैविक संशोधन के साथ केंचुए

आहारनाली सूक्ष्म जीवसमूह (माईक्रोबायोटा) का उपयोग कर वायुजीवि कंपोस्ट बनाना और नारियल पत्ता वर्मीकंपोस्ट बनाने में उपयुक्त केंचुए मृदुफल छिल्का का कंपोस्टिंग बढ़ाने में सहायक है।

लभ्य जैव संसाधनों के उपयोग का विविधीकरण की ओर एक प्रयास के रूप में, 'केरा प्रोबायो' जीवाणु सिमेंट उत्पादन और बायोडिपोसिशियन गुणों का उपयोग किया गया।। अजैविक तनाव परिस्थिति जैसे निम्न/उच्च पी एच और ताप और नमक की अधिकता के लिए नारियल पी जी पी आर के लिए पारिस्थितिक सहिष्णुता मूल्य का अंकन किया गया। काहिकुची से संग्रहित जीवाणु वियुक्तों से सुपारी के लिए सूक्ष्मजैविक सहजीविता का विकास किया गया। बहु पादप लाभकारी गुणों (आई ए ए उत्पादन, फोसफोरस, ज़िंक, सिलिकन और पोटाश विलेयीकरण) को दिखाते जड़ मुर्झा रोग प्रभावित क्षेत्रों में स्पष्ट रूप से स्वस्थ नारियल के मूल परिवेश से सात वियुक्तों को पहचान लिया गया।

रोग के समीकृत प्रबंधन के अधीन आंध्रप्रदेश और केरल राज्य से संग्रहित शीर्षारंभी क्षय रोग प्रभावित कोको नमूने से रोगजनकता पुष्टि कर *लासिडिप्लोडिया स्ट्रेइन्स* एकलित किया गया।

तिरूवारूर जिले में मन्नारगुडी ब्लॉक, तंजावूर जिले में पाटुकोटाई, ओरतनाडु और मदुक्कुर ब्लॉक और तमिलनाडु के पादुकोट्टाई जिले में अरन्तंगी और अलंगादी में नारियल ताड़ का एक नया घातक रोग प्रचलित पाया गया।

सुपारी के फल सड़न रोग के प्रबंधन के लिए 1 प्रतिशत बोर्डो मिश्रण के जैसे कारबोक्सिलिक अम्ल समूह का मन्डिप्रोपमिड एक अर्ध सर्वांगीण फफूंदनाशी है।

एन्कार्सिया गुडेलूपे, सूटी फफूंदी अपमार्जक भृंग *लियोक्राइनस नीलगिरीअनस* यथावत् परिरक्षण और ताड़ स्वास्थ्य प्रबंधन नीतियों (पोषण एवं जल) को स्वीकार कर कीटों के समीकृत प्रबंधन के अधीन रूक्षपृष्ठी सर्पिल सफेद मक्खी का जैवधमन विकास किया गया।

रूक्षपृष्ठी सर्पिल सफेद मक्खी द्रुत गति फैलाव में उचित जैव नियंत्रण तकनीकी का समय बद्ध हस्तक्षेप और उन्नयन एक बडा ललकार है। कीट प्रतिक्रमण और लगातार आय प्राप्त करने के लिए नारियल और अंतरफसल के साथ पारिस्थितिक जैवइंजीनियरिंग का विकास किया गया।

रोग निरोधी पत्ता नाली में वनस्पति केक रखना / वनस्पति लेप का लेपन, नाईलॉन जाल बनाना आदि तरुण ताड़ों में नारियल काला सिरवाली भृंग के विरुद्ध नियंत्रण के लिए प्रभावी है। सुपारी तकुआ कीड़ा *मिरकारवल्होिया अरिकेशिया* के विरूद्ध थाइमेथोक्सम थैली जून-जुलाई की अवधि में पत्ता नाली में (2 ग्रा) प्रति ताड़ दर में रखना रोग निरोधी उपचार के रूप में पाया गया। 50-60 लाख आई जेस /ताड़ दर में कीटरोग जनक सूत्रकृमि जल निलम्बन का अनुक्रमिक प्रयोग से सुपारी मूल ग्रब का प्रबंधन किया जा सकता है।

उत्थित कार्बनडायऑक्साइड, उच्च तापमान, जल कमी और लवणता पर जलवायु परिवर्तन प्रभाव की प्रतिक्रिया अध्ययन किया गया। Tmax और Tmin की वृद्धि पश्चिम तट की तुलना में पूर्वी तट में पिछले दस वर्ष की अवधि में उच्च है। पश्चिम तट और पूर्वी तट क्षेत्रों में वर्षा में महत्वपूर्ण कमी पायी गयी है। उच्च तापमान की अनुक्रिया में जीनप्ररूप के पराग अंकुरण में विस्तृत परिवर्तन देखा गया। नारियल के लंबी जीनप्ररूप को बौनी की तुलना उच्च रंध्री संख्या पायी गयी और उससे अधिक जलोपयोग और अधिक जैवभार उत्पादन होता है। सागर पानी की प्रतिस्थापना के कारण पौधों की वृद्धि और जैवभार संचयन 25 प्रतिशत तक प्रभावित नहीं है।

वर्धनशक्ति से संपन्न अवस्था में नियंत्रणाधीन और जल सीमित परिस्थिति के अधीन दो तुलनात्मक कोको जीनप्ररूप (वी टी एल सी सी 22 और वी टी एल सी सी 15) का राईबोन्यूक्लिक अम्ल अनुक्रमणन जल तनाव कमी के साथ आणविक चिह्नक संबंधित पहचान लिया गया।

मूल्य शृंखला प्रबंधन के अधीन विभिन्न वर्जिन नारियल उत्पाद के जैवरासायनिक मापदण्ड के लिए मानकों को निश्चित किया गया।

वर्जिन नारियल तेल की स्थूलता रोधी और हैपोलिपिडिमिक प्रभाव नैदानिक परीक्षण में सिद्ध किया गया। नारियल और कोको का मूल्य वर्द्धित उत्पन्न जैसे न्यूट्रिबार, नारियल दूध, पनीर, नारियल शक्कर आधारित डार्क चोकलेट का विकास किया गया। नारियल दूध चूर्ण आधारित फेन मेट सुखाने के लिए प्रक्रमण/नयाचार का मानकीकरण किया गया। नारियल दूध चूर्ण आधारित पकाने को तैयार खीर मिश्रण का इष्टतमीकरण किया गया। उत्सारण प्रक्रिया स्थिति और कच्चा सामग्री अनुपात नारियल दूध अवशेष के लिए, वी सी ओ केक और बाहर निकाला हुआ नारियल चूषकांग समृद्ध उत्पाद श्रेष्ठ बनाया गया। पाइलट स्तर उत्पादन के लिए लाइन निष्कासन पद्धति संस्थापित की गयी।

नारियल दूध पैकिंग और कल्परस परिरक्षण के लिए प्रारंभिक स्तर निर्जीवाणुकरण एकक की संस्थापना की गई। कल्पपरस में सूक्ष्माणुवीय प्रोफाइल और प्रोबायोटिक पहचान लिया गया।

मृदु नारियल काट-छांट के लिए एक आदि प्ररुप मशीन का विकास किया गया। काट-छांट मृदु नारियल के लिए परिरक्षण नयाचार सर्वोत्तम बनाया गया। और प्रौद्योगिकी का वाणिज्यिकीकरण किया गया।

नारियल आधारित एक शाकाहारी उत्पाद प्रशीतित नारियल स्वादिष्ट खाद्य विकसित कर भाकृअनुप-संस्थापना दिवस 2018 में प्रवर्तन किया गया। यह प्रौद्योगिकी मसेर्स हांग्यो आईस क्रीम्स, मंगलूर को हस्तांतरण किया गया। प्रशीतित नारियल स्वादिष्ठ उत्पाद के लिए एक प्रायोगिक स्तर प्लांट भाकृअनुप-केंरोफअसं में स्थापित किया गया।

विभिन्न मृदा एवं जल संरक्षण उपाय प्रारंभ किया गया। मृदा की जल धारण क्षमता सुधारने और संस्थान के फार्म में मुख्य फसलों की वृद्धि पर इसका प्रभाव सुधारने के लिए पानी जमा करने की संरचना का विकास किया गया।

सुपारी में सस्य रसायन फुहारने के लिए एयर ब्लास्ट फुहारक का प्रदर्शन भाकृअनुप-केंरोफअसं, क्षेत्रीय केंद्र, विट्टल में किया गया। नारियल में सस्य-रसायन वितरण के लिए तीन विभिन्न रूपभेद ट्रैक्टर पी टी ओ चालित फुहारक का रूपांकन किया गया।

किडु, काहिकुची और कासरगोड में सामाजिक विज्ञान सम्मुख में 142 प्रशिक्षण, 65 अग्रणी प्रदर्शनी और 3 किसान मेला आयोजित की गयी। 29 प्रदर्शनियों में भाग लिया, 28 उद्यमकर्ता विकास कार्यक्रमों का आयोजन किया गया। इस वर्ष की अवधि में 1.70 लाख मूल्य का 21 प्रौद्योगिकी वाणिज्यिकीकरण किया गया। आदिवासी उप योजना और अनुसूचित जाति उप योजना के अधीन सामाजिक और आर्थिक रूप से पिछड़े समुदायों के हित के लिए एकीकृत आदिवासी विकास प्राधिकार, पदेरु, विशाखपट्टनम, आन्ध्र प्रदेश के सहायोग के साथ विभिन्न कार्यक्रम आयोजित किए गए जिसमें 90 आदिवासियों के क्षेत्रों में 5400 नारियल पौधों की रोपाई कार्यक्रम भी थे। अनुसूचित जाति उप योजना के अधीन तमिलनाडु में गजा प्रभावित क्षेत्रों में नारियल नर्सरियॉ लगाने के लिए प्रबल प्रयास किया गया था। प्रकाशन जैसे 2 डि वी डी, पॉच ई-प्रकाशन छह किताब, 8 फॉल्डर्स, छह तकनीकी बुलेटिन का प्रकाशन किया गया।संस्थान वेबसाइट नियमित रूप से अद्यतन किया जाता है। सामाजिक माध्यम जैसे यू ट्यूब, 35 वीडियो और फेसबुक वर्तमान सूचनाओं के साथ अद्यतन किया गया। आन्ड्राइड एप ई-कल्प का अद्यतन अधिक डाटाबेस और पॉच भाषाओं में वास्तविक काल सहाय के साथ सुलभ है। विभिन्न प्रौद्योगिकियॉ और संस्थान गतिविधियों के संबंध में अद्ययतन के साथ जनसंचार माध्यम जैसे आकाशवाणी और प्रिंट मीडिया नियमित रूप से अंकन किया गया।

नारियल पोर्टल और सॉख्यियकीय और संगणनात्मक प्रयोग-आर प्लाटफार्म पर अद्यतन किया गया। प्रौद्योगिकियों का प्रभाव निर्धारण के लिए पद्धति का विकास किया गया। विस्तृत सर्वेक्षण का आयोजन कर कीट और रोग, केरल में बाढ़, आंध्रप्रदेश, तमिलनाडु और उड़िसा में तूफान के कारण फसल नाश का निर्धारण किया गया।।

आलप्पुषा जिले में 1627 हेक्टर में 1000 कृषक परिवारों को सम्मिलित कर कृषकों की आमदनी दुगुनी करने के लिए भागीदारी प्रौद्योगिकी समीकृत जो नीतिबद्ध और पहल सम्मिलित, कार्यक्रम आयोजित किया गया।

नारियल में प्रौद्योगिकी हस्तांतरण पहल के लिए एन आई पी एच एम के साथ संबंध, कासरगोड़ जिला में जैविक कृषि नीतियों के लिए कृषि निदेशालय, लक्षद्वीप में नारियल क्षेत्र के विकास के लिए एन एच एम के साथ संबंध आदि इस अवधि में किए गए मुख्य सहयोगी प्रयास है।

सी ए सी पी सिफारिशें, नीति चर्चा और विभिन्न फ्लाटफार्म पर विचार विमर्श जैसे व्यापार में आई एल ओ सम्मेलन आदि नीति स्तर हस्तक्षेप में सम्मिलित है। प्रारंभिक प्रक्षेत्र सर्वेक्षण आयोजित कर उपभोग तरीका और सुपारी उपभोगों की स्वास्थ्य स्थिति का अध्ययन किया गया। जिससे सुपारी खानेवाले और नहीं खाने वालों के बीच स्वास्थ्य में कोई अन्तर नहीं पाया गया।

इस वर्ष की अवधि में संस्थान द्वारा प्रारंभ की गई अन्य मुख्य गतिविधियों में मेसर्स जेनरल एयिरोनोटिकल प्राइवेट लिमिटेड भारतीय विज्ञान संस्थान, बैंगलूर के साथ समझौता ज्ञापन - सुपारी रोपण में सस्य रसायन फुहारने के लिए बिना मानव से एरियल वाहन प्रौद्योगिकी का उपयोग जिसका विवरण इस रिपोर्ट की आगामी पृष्ठों में प्रस्तुत किया गया है।

III. Executive Summary

Research on mandate crops were carried out under seven major programmes, namely, 'Improvement of coconut, arecanut and cocoa', 'Biotechnological investigations in palms and cocoa', 'Production technology in palms and cocoa', 'Integrated management of diseases in palms and cocoa', 'Integrated management of pests and nematodes in palms and cocoa', 'Production physiology, biochemistry and value chain management in palms and cocoa' and 'Economics and statistical aspects and transfer of technology for palms and cocoa'. A total of 47 research projects including 26 externally funded projects were active during the period.

Under plant genetic resources conservation, currently, the Institute maintains the world's largest coconut germplasm (455 nos.), largest arecanut germplasm (178 nos.), and germplasm of cocoa (515 nos.) in the field gene banks. Towards enrichment of genetic base of coconut, trait specific germplasm have been identified based on collections from Little Andamans, Bihar and Assam. Arecanut collections, comprising of one each of bold and longer nuts from Karnataka and dwarf and semi tall types from Great Nicobar and Little Nicobar Islands, were collected. Cocoa collection includes the current year's addition of one Criollo, four Forastero/ Amelonado and two Trinitario types from Tamil Nadu, characterised with high bean index.

Concerted research efforts over the years have resulted in the release of 20 coconut, 11 arecanut and eight cocoa varieties. High yielding coconut IND 010S selection from Federated Malayan State Tall (FMST), with a yield of 148 nuts palm^{-1} year^{-1}, suitable for copra, tender nut and inflorescence sap production has been identified for varietal release for cultivation in Western Ghats and coastal plains and semi-arid region of Tamil Nadu.

Tender nut processing studies in arecanut indicated higher tender nut yield potential of the accessions SCRDTC-18, Kamrup and Dangapara.

In cocoa, VTLC 13 and VTLC 20 clones of Nigerian origin, with 3 kg dry bean yield tree^{-1} year^{-1}, have been identified as promising clones for cultivation in arecanut and coconut cropping systems.

The coconut hybrids WAT x NAT, PHOT x GBGD, WCT x CRD, CGD x LCT, CGD X CRD, MYD x NLGD, and MYD x GBGD were characterised with high yield potential. Among the arecanut dwarf hybrids, Sumangala x Hirehalli Dwarf recorded the highest yield at Vittal and Kahikuchi, while at Mohitnagar, Hirehalli Dwarf x Mangala recorded the highest yield. Cocoa hybrids *viz*., VTLCP8 and VTLCP9, with biotic and abiotic stress tolerance and high yield potential (2.5-3 kg dry beans tree^{-1} year^{-1}), were found suitable for high density planting under arecanut and coconut gardens.

Coconut pollen processing facility and 31 community nurseries were established in 12 districts of Kerala. A total of 34,115 seed nuts were collected from identified mother palms from these districts. Coconut pollen cryo-

preservation facility was established at ICAR-CPCRI Regional Station, Kayamkulam and six decentralized coconut nursery in the root (wilt) prevalent tracts.

A total of 5,31,075 quality planting units, comprising of 1,04,694 coconut seed nuts/seedlings (including 64,869 hybrids), 3,68,918 areca seed nuts/seedlings and 15,602 cocoa seedlings/ grafts and 41,861 cocoa seed pods were produced during the year.

Immature inflorescence culture in coconut resulted in production of *in vitro* plantlets. Procedure for V-cryo mesh/ V-cryo plate method for coconut (plumular tissue) and arecanut (embryogenic callus) cryopreservation has been standardized. Use of single walled carbon nanotubes (SWCNT) enhanced post cryopreservation recovery in coconut zygotic embryos. Cryo-conservation of coconut germplasm in the form of embryos (nine accessions), pollen (six accessions) and DNA (12 accessions) has been undertaken at National Cryo Gene Bank, ICAR-NBPGR, New Delhi.

About 650 arecanut tissue cultured plantlets, in different stages of development, have been obtained from dwarf, dwarf hybrids and YLD resistant palms in ICAR-CPCRI and M/s SPIC Agro Biotech Centre, Coimbatore. Silver nanoparticles, prepared through green synthesis utilizing Kalparasa® as reducing agent, successfully contained bacterial contamination in arecanut *in vitro* cultures.

SCAR (sequence characterized amplified region) molecular markers have been developed for identification of *Areca* inter-specific hybrids and were validated. Genes involved in gibberellic acid (GA) biosynthetic pathway in coconut have been cloned.

Genome of dwarf coconut cultivar Chowghat Green Dwarf was assembled using different paired-end and mate-pair Illumina reads and long reads from PacBio single molecule sequencing. Genes involved in gibberellic acid biosynthesis and oil biosynthesis have been mined from the genome data.

In cropping/ farming systems trials, adoption of coconut based integrated farming system including black pepper, banana, fodder grass (CO-5), dairy, poultry, goatery and aquaculture resulted in generation of income of ₹ 5,32,240/- ha^{-1} $year^{-1}$, which was four-times higher as compared to monocrop of coconut.

Intercropping of fodder grass hybrid Bajra Napier (CO 5) in the interspaces of coconut garden with INM (50 % organic recycling + 50 % of RDF) or fully organic nutrient management recorded a yield of 126 tons ha^{-1} and 118 tons ha^{-1}, respectively. The coconut based high density multi species cropping system involving coconut, black pepper, banana, nutmeg and cinnamon, maintained with either recommented INM or fully organic was at par in terms of coconut yield realising yield of 162 to 173 nuts $palm^{-1}$ $year^{-1}$.

Apart from *Heliconia*, *Alpinia var*. Jungle King was identified as a suitable flower crop in coconut ecosystem producing flower throughout the year except in April-May.

At Kahikuchi, in arecanut based high density multispecies cropping system involving arecanut, banana, turmeric, acid lime and pineapple, 1/3rd of recommended fertilizer with recycling biomass, biofertililzer and green manure was sufficient for arecanut, whereas, intercrops needed 2/3rd of recommended fertilizer. Studies at Kahikuchi have shown that it is possible to grow vegetables in arecanut garden throughout the year, which helps farmer to get income round the year.

Application of micro nutrient mixtures 'Kalpa Poshak' for seedlings and juvenile palms and 'Kalpa Vardhini' for bearing palms have shown improvement in nutrient content in the coconut palms and improved growth in seedlings.

In the permanent manurial trial on coconut involving application of organic and inorganic manures with tillage, and without application of manures, microbes have improved the availability of nutrients and thereby improved the yield of coconut.

The dwarf palms supplied with 100 per cent soil test based nutrient requirement (530:150:1200 g N:P_2O_5:K_2O $palm^{-1}$ $year^{-1}$) along with raising and incorporation of cowpea in basin, vermicompost (15 kg $palm^{-1}$ $year^{-1}$) and neem cake (5kg $palm^{-1}$ $year^{-1}$) recorded consistently higher yield in RWD affected area.

Continuous harvesting of tender nut did not adversely affect the growth and yield of coconut and accrued higher yield and income to farmers.

Polythene mulching has shown to reduce the disease index in YLD affected arecanut gardens.

Aerobic composting using earthworm gut microbiota with organic amendments followed by coconut leaf vermicomposting earthworms enhanced the composting of tender nut husk.

As an effort towards diversification of utilization of available bioresources, Kera Probio® was used for producing bacterial cement and bio deposition properties.

Ecological tolerance values were worked out for coconut PGPR for abiotic stress conditions such as low/high pH and temperature and excess of salts.

Microbial consortia for arecanut have been developed from the bacterial isolates collected from Kahikuchi.

Under integrated management of diseases, *Lasiodiplodia* strains were isolated from die-back disease affected cocoa samples collected from Andhra Pradesh and Kerala states, confirming pathogenicity.

A new lethal disease of coconut palm was found prevalent in Mannargudi block in Tiruvarur district; Pattukottai, Orathanadu and Madukkur blocks in Thanjavur district and Aranthangi and Alangadi in Pudukottai district of Tamil Nadu.

Mandipropamid, a semi systemic fungicide belonging to carboxylic acid amide groups was found to be equally effective in comparison with Bordeaux mixture (1%) for management of fruit rot of arecanut.

Under integrated management of pests, strategies for bio-suppression of Rugose Spiralling Whitefly (RSW), by conservation biological control using *Encarsia guadeloupae, in situ* preservation of sooty mould scavenger beetle *Leiochrinus nilgirianus* and adoption of palm health management strategies (nutrition and water), were developed. In order to contain the fast spreading RSW, timely intervention and promotion of suitable bio-control techniques has become a great challenge. Ecological bio-engineering with coconut and intercrops has been developed for pest regression and obtaining sustainable income.

Prophylactic leaf axil placement of botanical cake / swabbing of botanical paste, nylon netting were found to be effective control measure to tackle coconut black beetle infecting juvenile palms. Leaf axil placement of two thiamethoxam sachet (2 g) against arecanut spindle bug, *Mircarvalhoia arecae,* was found as a suitable prophylactic treatment during June-July. Management of arecanut root grubs could be achieved through sequential application of entomopathogenic nematodes aqua suspension @ 50-60 lakh IJs palm^{-1} (1.5 billion IJs ha^{-1}).

The response of coconut to elevated CO_2, high temperature, water-deficit and salinity has been studied. The increase in T_{max} and T_{min} was high in East Coast compared to West Coast during the last 10 years. Wide variability was observed in pollen germination across genotypes in response to high temperature. Tall genotypes of coconut were found to have high stomatal number compared to the dwarfs and thus, use more water and produce more biomass. Growth and biomass accumulation in seedlings are not affected up to 25 per cent substitution with sea water.

RNA sequencing of two contrasting cocoa genotypes (VTLC-22 and VTLC-15) under controlled and water-limited conditions at vegetative stage identified molecular signatures associated with water-deficit stress.

Standards have been defined for the physico-chemical parameters of various VCO products. Anti-obesity and hypolipidimic effects of VCO have been proven in animal trials. Value added products of coconut and cocoa such as nutribar, coconut milk paneer and coconut sugar-based dark chocolate have been developed. The process/ protocol for foam mat drying based coconut milk powder has been standardized. Coconut milk powder-based ready-to-cook *kheer* mix has been optimized. Extrusion process conditions and raw material ratio for coconut milk residue, VCO cake and coconut haustorium enriched extrudates have been optimized. Line extrusion system for pilot level production has been installed.

Pilot-level pasteurization unit has been installed for coconut milk packaging and Kalaparasa® preservation. Microbial profile and probiotics in Kalaparasa® have been identified. A prototype for tender coconut trimming has been developed. Preservation protocol for trimmed tender coconut has been optimized and the technology has been commercialised.

Frozen coconut delicacy-a vegan product based on coconut- has been developed and launched during the ICAR-Foundation Day 2018. This technology has been transferred to M/s Hangyo Ice Creams Pvt. Ltd., Mangaluru. A pilot level plant for frozen coconut delicacy

production has been installed at Agro-Processing Complex, ICAR-CPCRI, Kasaragod.

An air blast sprayer for spraying of agro-chemicals in arecanut has been demonstrated in ICAR-CPCRI, RS, Vittal. Three different variants including the tractor Power Take Off (PTO) operated sprayers for the delivery of agro-chemicals in coconut have been designed.

Evaluation of technical soundness of water harvesting structures such as Loose Boulder Check Dam (LBCD) and Dry Rubble Check Dam (DRCD) revealed that the stability of LBCD (only 19 % was intact) was much inferior to that of DRCD where nearly half of the dams were intact (43 %).

In the Social Sciences front, 142 trainings, 65 frontline demonstrations and three Kisan Melas, one each in Kidu, Kahikuchi and Kasaragod, were conducted. To reach the socially and economically backward communities, different programmes were conducted under Tribal Sub Plan (TSP) and Scheduled Caste Sub Plan (SCSP). Activities under TSP were conducted in collaboration with Integrated Tribal Development Authority, Paderu, Visakhapatnam, Andhra Pradesh that include planting of 5400 coconut seedlings in 90 tribal holdings. Under SCSP, thrust has been given to raise coconut nurseries in *Gaja* affected areas in Tamil Nadu. During the year, the Institute has participated in 29 exhibitions, conducted 28 entrepreneurship development programmes and MoAs were signed for 21 technology commercialisations, worth ₹ 7.0 lakhs. Publications including two DVDs, five e-publications, six books, eight folders and six technical bulletins were brought out. Institute website is being updated regularly. Social media such as YouTube, with 35 videos and Facebook with latest information were updated. Android app 'e-Kalpa' was updated with more databases and is available in five languages with real-time support. Mass media such as All India Radio, Doordarshan and print media were regularly appraised with the updates about the various technologies as well as the institutional activities.

Coconut portal and software for statistical and computational applications on R platform were updated. Methodologies for impact assessment of technologies were developed. Crop losses in coconut and arecanut due to pests and diseases and flood in Kerala, cyclones in Andhra Pradesh, Orissa and Tamil Nadu have been assessed by conducting extensive field surveys. The staff members of ICAR-CPCRI had raised to the occasion and contributed ₹ 7.0 lakhs to the Kerala Chief Minister's flood relief fund.

Participatory technology integration was done in Alappuzha district covering 1627 ha involving 1000 farm families for evolving strategies and approaches for doubling farmer's income. Linkages with National Institute of Plant Health Management (NIPHM) for technology transfer approaches in coconut, Directorate of Agriculture, Kerala for organic farming strategies in Kasaragod district, and with National Horticulture Board (NHB) for development of coconut sector in Lakshadweep were the important collaborative efforts during the period.

The institute has provided policy insights pertaining to plantation sector to the State Agricultural Prices Board, Commission for Agricultural Costs and Prices (CACP) and WTO Cell-Government of Kerala for shaping the International Free Trade Agreements towards livelihood security of farmers. Consumption pattern and health status of arecanut consumers were studied by conducting a pilot field survey which did not show any significant difference in health between arecanut chewers and non-chewers.

Other important activities initiated by the Institute during the year include, a MoA with M/s General Aeronautics Pvt. Ltd., IISc, Bangalore to utilize unmanned aerial vehicle (UAV) technology for spray of agro-chemicals in arecanut plantations. Various workshops and interfaces with stakeholders have been conducted, details of which are presented in the ensuing pages of this report.

IV. Vision, Mission and Mandate

To develop ICAR-CPCRI as a technology generation and repository centre, wherein the Institute strives to showcase, demonstrate and compare world-wide technologies in the commodity chains of coconut, arecanut and cocoa to make India the global leader.

To develop technologies that enhance resource use efficiency, profitability and livelihood security of people who depend on plantation crops.

- Basic, strategic and applied research to enhance sustainable productivity, quality and utilization of coconut, arecanut and cocoa,
- Repository of plantation crops genetic resources and scientific information,
- Transfer of technology, capacity building and impact assessment of technologies,
- Coordinate research and validation of technologies on plantation crops through AICRP on Palms.

V. INSTITUTE PROFILE

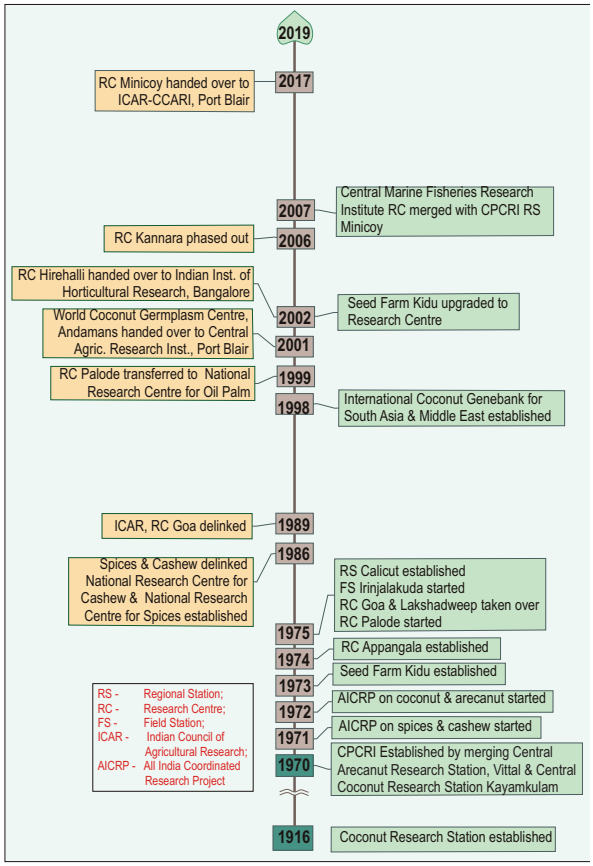
ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), one of the premier research institutions in the National Agricultural Research System of India, is presently mandated to conduct research in plantations crops (coconut, arecanut and cocoa). It had a modest beginning with its lineage tracing back to the Coconut Research Station started in 1916 in the South Kanara district of erstwhile Madras presidency (of present Kasaragod district of Kerala in South India). Since its inception, it has served the cause of science and society with distinction through exemplary research, generation of appropriate technologies and development of skilled human resource.

i. Historical perspective

The Coconut Research Station at Kudlu (Kasaragod) was taken over by the Indian Central Coconut Committee and established the Central Coconut Research Station (CCRS), Kasaragod in 1947 and in 1949; the Central Coconut Research Station (CCRS) at Kayamkulam was also established exclusively for tackling diseases in coconut. Coconut research became an integral part of the national agricultural research system in 1966 when the Indian Central Coconut Committee was abolished and the coconut research was taken over directly by the Indian Council of Agricultural Research. In 1970, the Central Plantation Crops Research Institute was established with the headquarters at Kasaragod, by merging the Central Coconut Research Stations at Kasaragod and Kayamkulam and the Central Arecanut Research Station at Vittal along with its five substations at Kannara, Mohitnagar, Kahikuchi, Hirehalli and Palode.

Since 1986, crops like spices, cashew, and oil palm were taken out of the purview of the institute with the formation of exclusive research institutions like Indian Institute of Spices Research, Kozhikode, Directorate of Cashew Research, Puttur and Indian Institute of Oil Palm Research, Pedavegi, respectively. Some of the erstwhile Research Centres at Hirehalli, Palode, Appangala, Kannara, Port Blair and Minicoy were either handed over to sister ICAR institutions or phased out. At present, the mandated crops are limited to coconut, arecanut and cocoa and the research and frontline extension aspects of these crops are carried out under five divisions *viz.,* Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post

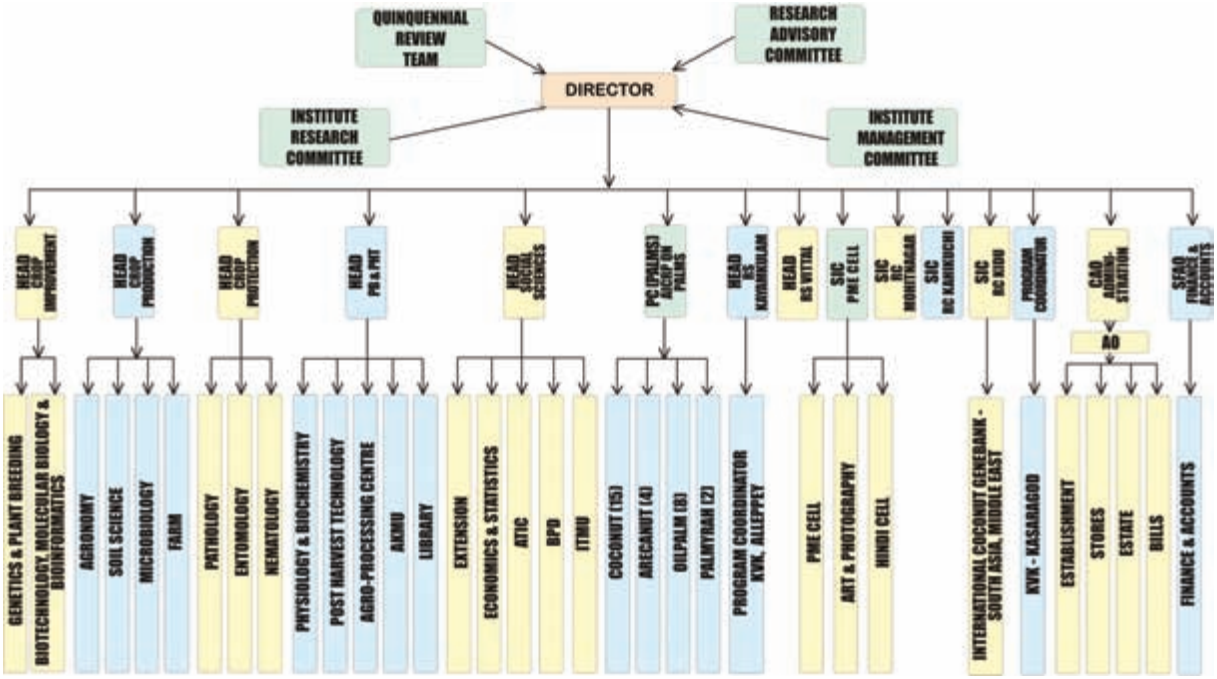
MILESTONES IN THE TIMELINE OF ICAR-CPCRI



Harvest Technology and Social Sciences at the Institute. The Regional Station at Kayamkulam (Kerala) is mandated to work on pests and disease problems in coconut, while the Regional Station at Vittal (Karnataka) caters to research and extension in arecanut and cocoa. The Research Centres at Kahikuchi (Assam) and Mohitnagar (West Bengal) undertake location-specific research in these crops, while the Research Centre at Kidu (Karnataka) hosts the International Coconut Gene Bank for South-Asia (ICG-SA) and also caters to the large-scale production of quality planting materials in the mandate crops. Besides, there are two KVKs (at Kasaragod and Kayamkulam) functioning under the Institute.

The All India Co-ordinated Coconut and Arecanut Improvement Project (AICCAIP) started functioning from 1972 at CPCRI, Kasaragod and was later renamed as All India Coordinated Research Project (AICRP) on Palms in 1986. The AICRP on Palms has 15 centres working on coconut, four on arecanut, eight on oil palm and two on palmyrah.

ii. Organogram



iii. Achievements at a Glance

Plant Genetic Resources

ICAR-CPCRI maintains the world's largest repository in coconut with 455 accessions (323 indigenous and 132 exotic genotypes) from 28 countries, 178 germplasm collections in arecanut of which 23 are exotic and 515 cocoa germplasm collections. International Coconut Gene bank for South Asia & Middle East (ICG-SA & ME) was established under a tripartite agreement among ICAR-FAO-ITPGRFA. The Institute also hosts the National Coconut Gene Bank (NCGB) and serves as the National Active Germplasm Site (NAGS) for coconut, arecanut and cocoa.

Till date, 20 improved coconut varieties including six hybrids have been released for commercial cultivation. The high yielding varieties are capable of yielding up to 6.28 tonnes of copra ha^{-1} annually, as compared to 2.96 t copra ha^{-1} in West Coast Tall local. Eleven improved varieties of arecanut, including nine selections and two dwarf hybrids have been released. The varieties with annual average yield up to 4.15 kg dry kernel $palm^{-1}$ yr^{-1} and higher dry kernel recovery, in comparison to South Kanara Local (2 kg dry kernel $palm^{-1}$ yr^{-1}), have significantly improved arecanut productivity in the country. In cocoa, eight high yielding varieties have been released from the institute, which include three elite clones and five hybrids, which yield up to 3.0 kg dry bean $tree^{-1}$ yr^{-1} with varying processing qualities, as compared to 1.0 kg dry bean $tree^{-1}$ yr^{-1} in the existing cocoa plantations.

The institute has been producing quality planting materials in coconut, arecanut and cocoa for distribution to farmers and other stakeholders. Seed gardens of improved varieties have been established in the institute as well as in farmer's garden to augment planting material production. ICAR-CPCRI nurseries at Kasaragod, Kidu, Kayamkulam and Vittal were graded with 'four-star' status in the five star scale by the National Horticulture Board. Quality planting materials are being produced to an extent of 1.05 lakh coconut seed nuts including 65,000 hybrids, 4.0 lakh arecanut seed nuts including 1.0 lakh seedlings and 58,000 cocoa seedlings annually. Farmer participatory planting material production of dwarf / semi tall varieties and hybrids was undertaken in collaboration with Kerala state Department of Agriculture & Farmers Welfare in 12 districts of Kerala, and coconut pollen processing cum storage centres were established in all the districts.

Biotechnology and Bioinformatics

Achievements in biotechnology include standardization of embryo culture protocol for germplasm exchange, standardization of regeneration protocol for inflorescence tissues of arecanut and cryopreservation of coconut embryo and pollen. In arecanut, the protocol developed for somatic embryogenesis and plantlet regeneration from immature inflorescence explants has been commercialized. A simple and easy vitrification protocol has been developed for cryopreservation of coconut zygotic embryos from both tall and dwarf accessions. The protocol developed for cryopreservation

of coconut pollen for the first time by ICAR–CPCRI has been commercialized. this would be instrumental in enhancing hybrid seed production as it facilitates year round availability of coconut pollen for all stakeholders across the coconut growing states of India.

Sequence Characterized Amplified Regions (SCAR) markers have been developed for confirming the hybridity at seedling level in both coconut and arecanut. A panel of SSR markers has been identified for confirming the hybridity of D x T hybrids (CGD x WCT) which will ensure supply of genuine hybrid material to farmers. Transcriptome analysis of response of coconut to root (wilt) disease and somatic embryogenesis have been undertaken and up/ down-regulated transcripts have been identified. Transcriptome analysis of coconut embryogenic calli, derived from plumular explants of West Coast Tall, has resulted in the identification of 14 genes with important roles in somatic embryogenesis.

ICAR-CPCRI hosts the Distributed Information Sub Centre (Sub-DIC) under the Biotechnology Information System Network (BTISnet), the Bioinformatics Centre and Agri-Bioinformatics Promotion Centre (ABPC). Various tools and databases have been developed under these centre which include MAPS (Microsatellite Analysis and Prediction Software), stand alone EST-SSR analysis pipeline (SEMAT), prediction tools for resistant gene analogues and enzymes in gibberellic acid biosynthesis using machine learning algorithms, prediction of miRNAs in date palm, coconut and *Phytophthora* spp. and transcriptome based reconstruction of carotenoid biosynthetic pathway in cocoa and gibberellic acid biosynthetic pathway in coconut.

Cropping and Farming Systems

Coconut or arecanut based inter/ mixed, multi-species cropping as well as mixed farming systems have been developed by integrating livestock to increase total productivity. The coconut based cropping system using multi-species cropping of coconut with black pepper, banana, nutmeg, pineapple, ginger, turmeric and elephant foot yam generated a net income of ₹ 3.7 lakhs ha^{-1}, which is 164% higher than that of coconut monocrop (₹ 1.4 lakhs), while the coconut based mixed farming system (CMFS) comprising coconut, black pepper, banana, cross bred cows, poultry birds, goat, and pisciculture generated a net return of ₹ 5.32 lakhs ha^{-1}, which was four-times higher as compared to monocrop of coconut.

Arecanut based cropping system with cocoa, banana and black pepper as component crops generated net return as high as ₹ 8.8 lakhs ha^{-1}, which is 132% higher than that of arecanut monocrop (₹ 3.80 lakhs). Similarly, cropping systems like arecanut + vanilla, arecanut + medicinal and aromatic plants, and arecanut + cocoa have generated 68%, 53%, and 26% higher net returns, respectively over arecanut monocrop. Arecanut based mixed farming system with dairying, freshwater aquaculture and fodder grass (Hybrid Napier) components generated net return up to Rs. 6.6 lakhs ha^{-1}, which is 74% higher than that of arecanut monocrop. In addition to the economic benefits, the systems ensure food and nutritional security coupled with sustainability and environmental services.

Drip irrigation in arecanut, coconut and cocoa has reduced the use of water to the extent of 35-40 per cent, with increase in yield by 30-40 per cent. Drip fertigation in these crops has reduced the use of chemical fertilizer from 50 to 75 per cent, with increase in yield by 30-40 per cent. *In situ* soil and water conservation techniques such as half-moon bund reinforced with pineapple planting, trench filled with coconut husk and bund reinforced with pineapple planting and providing catch pits help in augmenting the soil moisture availability in coconut plantations having mild slope and could enhance coconut yield up to 60%. This could reduce soil erosion from 2.73 t ha^{-1} to 0.02 t ha^{-1} and consequent reduction of nutrient loss due to soil erosion (N from 7.98 to 0.36 kg ha^{-1}, P from 12.52 to 0.9 kg ha^{-1} and K from 28.5 to 1.1 kg ha^{-1}).

Bioresources utilization

Coconut gardens of one hectare area can generate up to eight tonnes of leaf biomass residues every year. From this, 3-4 tonnes of vermicompost could be produced annually using the local isolate of *Eudrilus* sp. or 1,660 kg of fresh mushroom can be generated that adds more than ₹ 50,000 per year to the farmer's income. After coconut leaves are vermicomposted, earthworms are to be separated for which a 'push-pull' strategy was successfully adopted to harvest earthworms from vermicompost heaps through the use of behaviour-modifying stimuli. This will make sorting of earthworms easy and reduce labour requirement of the farmers who have taken up vermicomposting technology. Vermiwash, produced from coconut waste vermicomposting unit, is a good liquid fertilizer for organic farming. On farm coir pith composting technology has been developed to produce organic input to the plantation and also as soil-less medium for production of quality planting material.

Arecanut and cocoa gardens generate biomass (4-5 and 0.7-0.8 tonnes ha^{-1}, respectively) and they could be

effectively utilized for production of oyster mushroom and livestock feed, in addition to vermicompost. Recyclable biomass in arecanut supplies approximately 95 g N, 10 g P_2O_5 and 110 g K_2O palm^{-1} yr^{-1}, which can save the cultivation cost to the extent of Rs. 5,200 ha^{-1}.

In the area of microbial bioresources, plant growth promoting rhizobacteria (PGPR) based bioinoculant products, 'Kera Probio®' containing *Bacillus megaterium* and 'Cocoa Probio®' containing *Pseudomonas putida* have been released for production of healthy coconut and cocoa seedlings.

A farmer-friendly method for mass-production of bioinoculants utilizing a blend of mature coconut water, rice gruel and biochar, which are locally available, was standardized. Using this method, contaminant-free bioinoculants can be mass-produced from starter cultures by farmers themselves, on their own farm, for immediate field application. The method is easily comprehensible by the farmers and does not require any costly instrument/equipment.

Two nutrient mixtures 'Kalpa Poshak'- for juvenile palms and 'Kalpa Vardhini' - for adult bearing palms were developed at ICAR-CPCRI RS, Kayamkulam. Soil application of Kalpa Poshak @ 100 g/palm in four splits to 20 months old Kalpa Sankara hybrids resulted in enhanced leaf potassium status (1.68%) and recorded the highest content of Ca (0.447%) and Mg (0.171%). This also resulted in increased height, no. of split leaves and collar girth. One year after application of Kalpa Vardhini for adult palms (@ 500g/palm), the improvement in nut yield over the pre treatment was eight per cent.

Reducing crop losses

Bud rot, stem bleeding, basal stem rot and root (wilt) of coconut; fruit rot, inflorescence die back and yellow leaf disease of arecanut and black pod and stem canker in cocoa are the major diseases that cause substantial crop losses. Integrated disease management strategies developed for the major diseases over the years have resulted in saving of thousands of coconut and arecanut palms and reduced the economic loss due to black pod diseases in cocoa. Most importantly, the disease management strategies are being continuously refined considering the changes in pathogen population, soil and climatic factors and screening of new and native bioagents or fungicides or host plant resistance.

Prophylactic treatments with Bordeaux mixture (1%) or *Trichoderma* coir pith cake in the innermost leaf axil of coconut with the onset of monsoon (first week of June) can prevent the appearance of bud rot in disease endemic areas.

Basal stem rot disease caused by *Ganoderma lucidum* is another major disease of coconut and soil application of *Trichoderma* enriched neem cake (5 kg palm^{-1}) at quarterly interval was found very effective in reducing the disease incidence.

Root (wilt) disease of coconut caused by phytoplasma is another major disease. Integrated disease management strategies involving farm and palm hygiene, application of soil test based nutrients NPK (N: 500 g, P: 300 g K: 1250 g palm^{-1} yr^{-1} in two splits in May –June and August – September), 250 g $MgSO_4$ palm^{-1} yr^{-1}, irrigating the palms (250 L water palm^{-1} week^{-1}) during summer months, basin management with green manure crops like cowpea and control of leaf rot by application of hexaconazole 5 EC @ 2ml in 300 ml water, could increase the yield up to 83 per cent depending on severity of the disease.

Phytoplasmal etiology of YLD of arecanut has been established and management of the affected gardens with soil test based application of NPK (N:100g, P:40g, K:140g per palm^{-1} yr^{-1} application of FYM @ 12 kg palm^{-1} yr^{-1} with summer irrigation (20 L water palm^{-1} day^{-1}) and improving drainage during rainy season has been advocated.

Clean and green innovative pest management technologies have been developed and field validated for the bio-suppression of rhinoceros beetle, red palm weevil, leaf eating caterpillar and eriophyid mite infesting coconut. Integrated Pest Management (IPM) module for the management of rhinoceros beetle through integration of biocontrol agents *viz.*, *Oryctes rhinoceros* nudivirus (OrNV), Green Muscardine Fungus (GMF), *Metarhizium anisopliae*, botanicals (leaf axil filling with neem/ marotti/ pongamia cake @ 250 g mixed with equal volume of sand) and aggregation pheromone embedded nanomatrix trap @ 1trap ha^{-1} has been developed.

Integrated management technologies involving complete destruction of infested palm, close monitoring and sustained surveillance for early diagnosis, leaf axil filling of chlorantraniliprole sachet, curative management with imidacloprid (0.02%) and pheromone trap @1 trap ha^{-1} were found effective in the management of red palm weevil.

For the bio-suppression of leaf eating caterpillar, augmentative release of stage-specific parasitoids *viz., Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids per palm, removal of heavily damaged outer three leaves and improving soil and palm health of infested palms reduced the leaf damage to 95.3 per cent in a period of 12-15 months.

IPM technologies for the suppression of eriophyid mite developed by ICAR-CPCRI involving two per cent neem oil-garlic emulsion spray, root feeding of azadirachtin 10000 ppm @ 10 ml + 10 ml water and soil and palm health management practices reduced pest incidence to the tune of 71.4 per cent.

Integrated pest management strategies involving soil application of neem cake (2 kg palm^{-1}), drenching the root zone with chlorpyrifos 20 EC @ 2.5 ml L^{-1} or imidacloprid 17.8 SL @ 675 ml ha^{-1} or bifenthrin 10 EC @ 20 litre ha^{-1} and entomopathogenic nematodes (EPN), *Steinernema carpocapsae* @ 1.5 IJ ha^{-1} during May-June and September-October reduced the areacanut white grub population significantly. Placement of the neonicotinoid, thiamethoxam (2 g) in perforated poly sachets on the innermost two leaf axils of areca palms during April-May safeguarded arecanut palms from spindle bug damage. IPM strategies, developed for phytophagous mites and pentatomid bugs, involves the spraying of neem oil emulsion (0.5%) has been found effective in controlling these sporadic pests on arecanut.

Under integrated management of pests, bio-suppression of Rugose Spiralling Whitefly (RSW) by conservation biological control using *Encarsia guadeloupae, in situ* preservation of sooty mould scavenger beetle *Leiochrinus nilgirianus* and adoption of palm health management strategies (nutrition and water) were developed.

Climate Resilient Technologies

Coconut, arecanut and cocoa are highly sensitive to climate change variables like high temperature and water deficit stress. The impact of elevated carbon dioxide [ECO_2] and elevated temperature [ET], on coconut seedlings was studied in an open top chamber. The study indicated that the present level of biomass could be produced in future climate with less expense of water due to high water use efficiency observed under [ECO_2]; however, at high temperature, biomass production would be less. As an adaptive strategy, coconut genotypes were phenotyped for water deficit and high temperature stress. At 100 per cent Field capacity (FC), tall genotypes exhibited high WUE (3.5 g biomass l^{-1} water), while at 25 per cent FC, dwarf genotypes had high WUE (3.8 g biomass l^{-1} water). Tall genotypes had highly sensitive stomata while, dwarfs exhibited better root growth under stress. Tall cultivars (Kalpa Pratibha and Kalpatharu) showed relatively high wax content than dwarf varieties.

At the reproductive phase, pollen germination was found to be very sensitive to high temperature. It was 63 per cent at 30^{o}C and got drastically reduced to 14 per cent at 45^{o}C. In all the temperatures, WCT had high pollen germination (58%), while it was least in MYD (37%). A clear distinction between the talls and dwarfs in terms of pollen germination at high temperatures, which can be an important selection criterion in evolving varieties with tolerance to high temperature. As a climate change mitigation strategy, the areca based HDMSCS in North East significantly sequestered the carbon into the soil and SOC increased to 52.796 t ha^{-1} as against 44.541 t ha^{-1} of fallow lands. Similar sequestration was also seen in coconut based cropping systems.

As a measure of water conservation, institute has developed hydraulically efficient, environmentally compatible and cost effective filtration systems and structures for roof water harvesting, run-off collection, storage and percolation tanks. Low-cost water harvesting structures like check dam, sub surface dam, vented cross bars, storage structures using ferro-cement technology could augment surface/ sub surface water resources.

Product diversification, value addition and mechanization

The institute has developed and refined the 'Coco-sap chiller' technology for collecting fresh, hygienic and unfermented coconut inflorescence sap (Kalparasa). In an effort towards product diversification and value addition, coconut milk residue based extrudate (Kalpa Krunch), pasta, rusk and fried snacks have been developed. Similarly, 'Kalpa Bar' (coconut sugar based dark chocolate) and 'Kalpa Drinking Chocolate' have been developed in collaboration with CAMPCO Limited, Puttur. Frozen coconut delicacy-a vegan product based on coconut- has been developed and launched during the ICAR-Foundation Day 2018. This technology has been transferred to M/s Hangyo, Mangalore. A pilot level plant for frozen coconut delicacy production has been installed at Agro-Processing Complex, ICAR-CPCRI, Kasaragod

The safety attachment incorporated by ICAR-CPCRI to Chemberi Joseph model of climbing device has become

an effective solution since it could be operated even by women with proper training. This gives much required confidence to the climbers, especially the beginners. Apart from this, machineries and gadgets developed for labour saving and gender main streaming *viz*., power operated coconut and arecanut husking machines, coconut de-shelling and shell removing machines for copra making and wet processing respectively, tender coconut punch and cutter, copra and coconut chips dryers of varying capacities and using different fuel sources, testa remover, manual and power operated coconut slicing machines, coconut milk expellers of various capacities, VCO cookers, VCO fermentation tank and copra moisture meter are the other major contributions from the institute. A recent addition to this impressive array of gadgets is the gender-friendly self loading arecanut dehusking device (with dust control) along with the arecanut grading attachment.

Pilot-level pasteurization unit has been installed for coconut milk packaging and Kalaparasa® preservation. Microbial profile and probiotics in Kalaparasa® have been identified. A prototype for tender coconut trimming has been developed. Preservation protocol for trimmed tender coconut has been optimized and the technology has been commercialised.

Capacity Building Programmes

For technology transfer, efforts have been made to adequately promote the mandate crops of the institute through effective extension activities including trainings, farmer participatory approaches in technology development and dissemination and production and distribution of planting materials of mandate crops. Training and frontline demonstrations on selected technologies, institutional and off campus training programmes for extension personnel and farmers and research-extension-farmer interface programmes have been conducted. Besides, the institute has participated in exhibitions, radio talks, television interviews, phone-in programme and press meets.

Applications of ICT tools like videoconferencing to develop linkages with various stakeholders were implemented. Statistical Databases were created, technical bulletins, CD ROMs, extension pamphlets, information brochures published. Krishi Vigyan Kendras under the institute catered to the training needs of farmers of Kasaragod and Alappuzha Districts in Kerala State. Cyber extension programmes were further strengthened with the addition of mobile video conferencing unit. Mobile video conferencing unit is being utilized for facilitating the Research-Extension-Farmer interface. The Institute website (http://www.cpcri.gov.in) is being updated regularly with latest information. E-Kalpa, an android mobile app and coconut portal were developed for better coverage of information to the end users. Besides, several innovative steps were taken to meaningfully engage the visual and print media for disseminating the research accomplishments to the farming community.

Socio-economic studies and Policy Interventions

Quantitative analysis along with qualitative studies on the recent price movements and trade concerns were conducted. The influence of international prices on the domestic sector and the impact thereof were also studied. Consultancy briefs (yearly basis) on production and trade aspects of the coconut sector were submitted to Commission for Agricultural Costs and Prices (CACP) as inputs to facilitate the fixation of Minimum Support Prices of Copra. Cost of production of coconut in Kerala State, India, based on data from a well-managed coconut garden, is Rs 8.94 per nut. In this scenario, about 56 per cent of the total cost incurred is due to labour charges, which shows higher per unit labour charges, directly attributed to higher labour demand and higher cost of labour in the recent times. The institute has provided policy insights pertaining to plantation sector to the State Agricultural Prices Board and WTO Cell-Government of Kerala for shaping the International Free Trade Agreements towards livelihood security of farmers. It is also pertinent that the institute has provided key inputs and suggestions to International Labour Organization (ILO) on plantation crops in view of employment and skill aspects in post flood situation in Kerala.

Statistical Models to Improve Field Experiments

Analysis of covariance technique in field experiments is made more robust/flexible by taking the relationship between the response variable and covariate as non-parametric instead of linear. Semi-parametric additive regression model has been proposed to estimate/eliminate the positional effect in field experiments, when the number of experimental units is comparatively small. Crop production model in arecanut was developed based on semiparametric regression technique. A data driven technique was developed to estimate the trend and relative growth rate of time series data. The method was extended for handling sudden shifts or changes in the trend or growth rate functions by adding dummy variables for the jumps. It has been applied to estimate

trend and growth rate of area, production and yield of major crops in India. Robust spatial smoothing technique was developed to estimate the spatial effect of a field in the presence of outliers or extreme observations. It is based on fitting M-type robust nonparametric spatial regression following iterative kernel weighted local regression surface technique. Yield prediction in cocoa was done using biometrical/partial harvest data. Besides, weather based crop yield modelling was carried out in mandate crops. Pest and disease incidence and severity were regularly assessed employing appropriate sampling strategies in Kerala and Karnataka. Crop loss due to flood (Kerala) and cyclones (*Titli* in Andhra and Odisha, *Gaja* in Tamil Nadu) during the year were assessed based on extensive field surveys. Customized programs in SAS, R and MATLAB for the specific data analytic requirements. A field survey was undertaken in three districts of Karnataka to study the pattern of arecanut chewing, perceptions about health benefit, risks and socio economic factors. Arecanut chewing with tobacco was common than without tobacco in these regions. Majority of the respondents perceived that chewing had beneficial effects like increasing taste, digestion, pleasure and reducing tooth pain. There was no evidence of significant difference in health issues between arecanut chewers and non-chewers.

Impact of CPCRI technologies

In the case of coconut, studies on rate of adoption of the selected technologies showed that about 12 per cent of farmers in Kerala adopted coconut hybrids and improved varieties. Around 13.6 per cent of total area in Karnataka is presently under released arecanut varieties. The economic impact of released arecanut varieties in monitory terms was estimated to be ₹ 421 million yr^{-1}. The impact assessment of arecanut based cropping systems in coastal region of Karnataka revealed that total economic impact in monetary terms due to adoption of cropping systems in the region was around ₹ 1022 million yr^{-1}. There would be an economic impact to the tune of ₹ 1604 lakhs yr^{-1} from the planting materials supplied from the institute, considering the fairly long economic life span of coconut palms.

Based on data available from Kozhikode district, the methodology for computing the yield and economic advantage was developed. The estimates of density of bearing palms, average yield per palm and percentage area under the category were worked out. Yield advantage is determined as the difference of per palm yield of holdings where the technology adopted and that of the rest in the holding-category. Accordingly the yield advantage from the technologies with regard to small holding category was worked out to be 40.07 million nuts. The economic impact of technologies in the Kozhikode district was then obtained as ₹ 2962.46 million. Extrapolating this result to national level would give ₹ 51802.80 million as the economic impact.

Stations, Centres and Priority Areas of Research

Headquarters

KASARAGOD (Estd.: 1916)
Crop: Coconut and Cocoa, Area 78 ha; 10.7m MSL

Priority areas of research: Genetic resources management, breeding, biotechnology, water and nutrient management, organic cultivation, cropping/ farming system, microbiology, pests and diseases management, physiology and biochemistry, value addition and farm mechanisation, economics, statistics and transfer of technology. Various activities are envisaged under five divisions *viz*., Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post Harvest Technology and Social Sciences.

Regional Stations

KAYAMKULAM (Estd.: 1947)
Crop: Coconut, Area 24.17 ha, 3 m MSL

Priority areas of research: Etiology and management of root (wilt) and other diseases, pests and nematodes management.

VITTAL (Estd.: 1956)
Crop: Arecanut and Cocoa, Area 68.34 ha; 58 m MSL

Priority areas of research: Genetic resources management, breeding, production and protection, cropping systems and drought tolerance.

Research Centres

KAHIKUCHI (Estd.: 1958)
Crop: Arecanut and Cocoa, Area 15.76 ha; 48 m MSL

Priority areas of research: Cropping system, crop protection and production of quality planting materials.

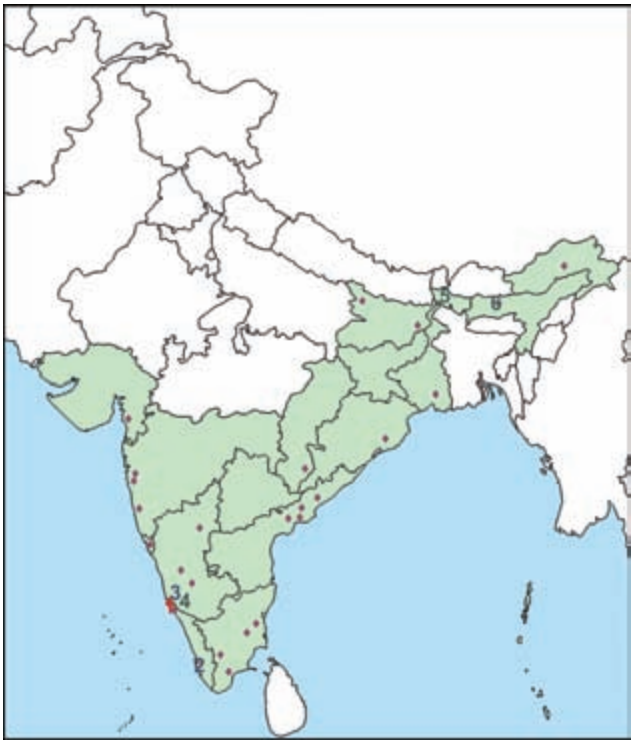
KIDU (Estd.: 1972)
Crops: Coconut, Arecanut and Cocoa, Area 120 ha; 281 m MSL

Priority areas of research: National coconut gene bank, International Coconut Gene bank for South Asia and Middle East (ICG-SAME), soil and water conservation, quality planting material production.

MOHITNAGAR (Estd.: 1958)
Crops: Coconut and Arecanut, Area 25.99 ha; 91.3 m MSL

Priority areas of research: Genetic resources management, cropping system, soil, water and nutrient management.

Location of Stations / Centres under ICAR- CPCRI



1. **ICAR-CPCRI, KASARAGOD, KERALA**
2. REGIONAL STATION, KAYAMKULAM, KERALA
3. REGIONAL STATION, VITTAL, KARNATAKA
4. RESEARCH CENTRE, KIDU, KARNATAKA
5. RESEARCH CENTRE, MOHITNAGAR, WEST BENGAL
6. RESEARCH CENTRE, KAHIKUCHI, ASSAM

▲ KRISHI VIGYAN KENDRAS

◆ AICRP ON PALMS CENTRES

Staff Strength

as on 31-03-2019

ICAR-CPCRI			
Category	**Sanctioned**	**In position**	**Vacant**
Scientific	84	71	13
Technical	114	79	35
Administrative	89	49	40
Supporting	258	107	151
Canteen	10	5	5
Total	555	311	244
ICAR-KVK, KASARAGOD			
Scientific	1	1	0
Technical	11	7	4
Administrative	2	0	2
Supporting	2	1	1
Total	16	9	7
ICAR-KVK, ALAPPUZHA			
Scientific	1	1	0
Technical	11	9	2
Administrative	2	1	1
Supporting	2	2	0
Total	16	13	3
Grand Total	**587**	**333**	**254**

Budget and Expenditure

Rs. in crores

Head	Allocation	Expenditure
Budget	73.9677	73.8651
Revenue generation	7.1268	

Details in chapter XXIII – Budget and Expenditure

VI. RESEARCH ACHIEVEMENTS

1. Genetic Resources Management

Germplasm enrichment and conservation

Coconut

Three distinct types, *viz*., with thin husk, very short petiole and compact stout stem and crown traits, were identified from Dugong Creek area of Little Andaman. These will be added to the National Coconut Gene Bank. Palms tolerant to cold were identified in farmers field and also at the DSP Farm of CDB at Singheshwar in Bihar, and a palm with visibly longer stipules in inflorescences in Kamrup district of Assam. Complementary conservation of core germplasm as embryos, pollen and DNA was undertaken, with cryo-conservation of embryos in 10 accessions, cryopreservation of pollen of eight accessions and DNA banking of 115 palms of 13 accessions.

Arecanut

Two germplasm, one with bold nuts and another with elongated fruits were collected from Dakshina Kannada district of Karnataka. Six diverse dwarf and semi tall arecanut types with varied fruit nut size and shape were collected from Great Nicobar and Little Nicobar. Rare arecanut palms *viz*., inflorescence directly converted into seedlings, palm with two crowns, multiple crowns (Fig. 1.1) were observed in Dakshina Kannada District of Karnataka. A tree with chimera effect was observed in Mangala population in a farmer's garden in Puttur Taluk, Dakshina Kannada District. The tree exhibited

Fig. 1.1. Arecanut palms with two (right) and multiple crowns (left)

variegation (green and yellow stripes) on one side of the stem, which was observed in the leaves as well as bunches (Fig. 1.2) on that side. Further, a unique young palm (4-5 years old) was observed in South Kanara Local population in a farmer's garden in Puttur Taluk, wherein inflorescences were directly transformed into vegetative tissues (Fig. 1.3).

Fig. 1.2. Arecanut bunches with variegated fruits

Fig. 1.3. An unique arecanut palm, with inflorescences converted to vegetative tissue

Cocoa

Cocoa germplasm holding was enriched with the collection of one Criollo, four Forastero/ Amelonado, and two Trinitario types characterized with high bean index from Bethany Estate/ Kudakkasseril Plantations in Surulode and Kulasekaram areas of Kanyakumari district, Tamil Nadu, raising the total conserved cocoa accessions in the field gene bank at ICAR-CPCRI, Regional Station, Vittal, to 515 accessions.

Germplasm characterization and evaluation

Coconut

Evaluation of germplasm

Annual inflorescence production, female flower and fruit yield were recorded in the conserved germplasm, both in the National Gene Bank as well as International Coconut Gene Bank. Annual growth characters, including initiation of flowering, were recorded in the conserved germplasm in the juvenile phase. Among the conserved germplasm, higher annual nut/copra yield (>23 kg copra palm^{-1} year^{-1}) was observed in 18 accessions. Eight other accessions had high copra out turn.

Among the accessions conserved in International Coconut Genebank for South Asia and Middle East (ICG-SAME) and Indian germplasm at Kidu, higher nut yield was recorded in 21 accessions among the talls and five accessions among the dwarfs.

At Kidu, among the conserved indigenous germplasm, higher nut yield was recorded in nine tall accessions. Analysis of the vegetative, inflorescence, fruit, tender nut traits of 30 accessions, conserved in the International Coconut Genebank and National Gene Bank at Kidu, revealed significant variations for almost all the traits.

Fig. 1.4. Coconut accessions with high yield potential: a) BARI Narikel II, b) Panama Tall, c) Chandan Nagar Tall, d) Uzirpur Tall

BARI Narikel II, Panama Tall, Uzirpur Tall, Chandan Nagar Tall and Agailjhara Tall recorded higher yield potential (Fig. 1.4). Studies on tender nut traits in these 30 accessions indicated Agailjhara Tall, Khairtala Tall, Uzirpur Tall and Bhagarpara Tall to be better among talls for tender nut purpose and Sri Lankan Red Dwarf II and Chowghat Orange Dwarf among dwarfs.

At Mohitnagar, evaluation of different accessions under sub-Himalayan Terai region showed variations in trunk height and girth, number of leaves and number of nuts palm^{-1} year^{-1}. Among the accessions in the bearing phase, higher nut yield among the 21 tall accessions was recorded in BARI Narikel I (119 nuts palm^{-1} year^{-1}) followed by Chinasukhania Tall (85 nuts palm^{-1} year^{-1}) and Agailjhara Tall (77 nuts palm^{-1} year^{-1}), while COD (53 nuts palm^{-1} year^{-1}) recorded higher yield than the other four dwarfs (Malayan Orange Dwarf, Malayan Green Dwarf, Malayan Yellow Dwarf and Chowghat Green Dwarf). Kera Sankara (52 nuts palm^{-1} year^{-1}) recorded comparatively high nut yield among the hybrids (Kera Ganga, Chandra Laksha, Kera Sankara, Chandra Sankara and Laksha Ganga) under evaluation.

At Kahikuchi, annual nut yield was recorded on 15 coconut varieties. The fruit component characters of these varieties were studied under Assam conditions. Kera Sankara produced higher annual nut yield (103 nuts palm^{-1} year^{-1}), while Assam Tall recorded higher values for fruit weight (1133 g), weight of dehusked fruit (911 g), length of dehusked fruit (19.10 cm), fresh kernel weight (416 g) and shell weight (177 g). Higher percentage of husk to fruit weight was recorded in Kera Ganga (43.41%). Tender nut water content was also recorded in the genotypes and Laccadive Ordinary Tall (448 ml) recorded higher tender nut water volume followed by Fiji Tall (441 ml). Among the 13 local genotypes under evaluation at the Centre, higher annual fruit yield was recorded in KKHC 5 (49 nuts palm^{-1} year^{-1}) followed by KKHC 4 (45 nuts palm^{-1} year^{-1}). Observations on fruit component characters in these genotypes indicated higher fruit weight (1350 g), nut weight (815 g), fresh endosperm thickness (1.43 cm), fresh kernel weight (418 g) and shell weight (238 g) in KKHC 1 and higher percentage of husk to fruit weight in KKHC 5 (52.53%).

Eleven accessions conserved at Kasaragod including eight tall and three dwarfs, were evaluated for vegetative, inflorescence, fruit component and tender nut traits. Philippines Kalambhahim Tall recorded the highest plant height, petiole length, leaflet length, inflorescence length, spikelet length, fruit weight, fruit length, fruit breadth, husk thickness and oil content, while Gudanjali Dwarf recorded the lowest.

Sweet kernel trait was found to be expressed in the seedling progenies, with six of the nine palm progenies of Mohacho Narel from Ratnagiri, exhibiting this trait. Overall, the sweet kernel fruits per palm varied from 0-58% in the individual palm progenies, with one palm in NSD1 family showing up to 80% sweet kernel fruits.

Population studies

Population studies are in progress with West Coast Tall and Jamaican Sanblas Tall population. Preliminary studies in Jamaican Sanblas Tall indicated overall similarity for palm morphology between the first generation palms conserved at the field gene bank at Kasaragod and the second generation regenerated population conserved in the field gene bank at Kidu. Further, the regenerated conserved population showed 89% similarity for vegetative characters, based on Jaccard's coefffcient.

Screening for abiotic/biotic stress

Among the 15 putative cold tolerant lines from West Bengal, under evaluation at Research Centre Mohitnagar, higher plant height as well as trunk girth was recorded in North Bengal 1 followed by Lataguri-II. Cold injury symptoms, during the current year, were relatively minimal in these palms. Screening of seedlings of Kenthali Orange Dwarf and Jamaica Tall for abiotic stress tolerance is in progress at Kasaragod. Further, preliminary studies on leaflet anatomy in 15 accessions including six dwarfs, indicated relative differences in bulbiform cells as well as vascular tissues, with possible role in relative tolerance to drought stress.

Incidence of eriophyid mite was recorded at Kasaragod, randomly on 70 palms during December 2018. The nuts infested was observed to be 60.84% and damage grade based on ICAR-CPCRI scale was found to be high with score of 2.17. Differential varietal response was noticed among the palms studied, with eriophyid mite infestation, ranging from 30.51% to 92.31% (Fig. 1.5). While Kalpa Haritha recorded the least eriophyid mite

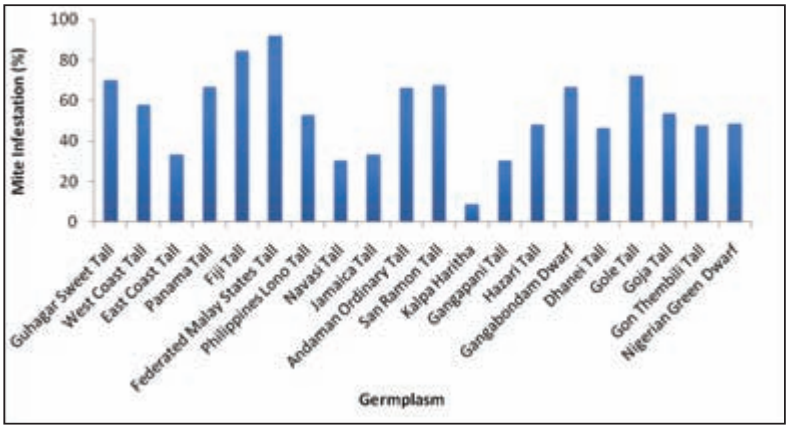


Fig. 1.5. Differential eriophyid mite infestation in fruits of selected coconut germplasm

incidence, relatively lesser mite incidence was found in Navasi Tall (30.51%), Gangapani Tall (30.54%), Jamaica Tall (33.33%) and East Coast Tall (33.33%).

Coconut leaves from Orange Dwarf infested with rugose spiraling whitefly showed reduction of photosynthates *viz*., total sugars (15.89%), reducing sugars (23.63%) and total starch (24.62%), respectively compared to the healthy (insect free) leaves.

Response of genotypes to inflorescence sap production and quality

Nine tall accessions were evaluated for inflorescence sap yield (Fig. 1.6) and their quality profile. Preliminary observations, indicated higher sap yield in Nigerian Tall (2.1 l day^{-1}) and lowest sap yield of 370 ml day^{-1} in East Coast Tall. Duration of sap production varied among the accessions (Fig. 1.7). Days taken for initiation of sap flow varied from 16 to 24 days, with Nigerian Tall, Hazari Tall and Gangapani Tall starting to trickle sap early while it was late in East Coast Tall. Biochemical parameters *viz*., total and reducing sugar, protein and amino acids of the inflorescence sap were determined. The pH of sap varied from 6.1 to 7.0. TSS was found to be high in WCT (14.8º Brix). Highest total sugar content (12.4 g 100 ml^{-1}) was recorded in West Coast Tall and lowest in Nigerian Tall and Navasi Tall (11.3 g 100 ml^{-1}). Higher protein content of 560.2 mg 100 ml^{-1} was recorded in West Coast Tall and lesser values in Nigerian Tall (458.6 mg 100 ml^{-1}), with similar trend observed for amino acid content (West Coast Tall - 596 mg 100 ml^{-1} and Nigerian Tall - 504 mg 100 ml^{-1}).There was no significant variation among the accessions with regard to reducing sugar content and it ranged from 1.6 to 1.9 g 100 ml^{-1}.

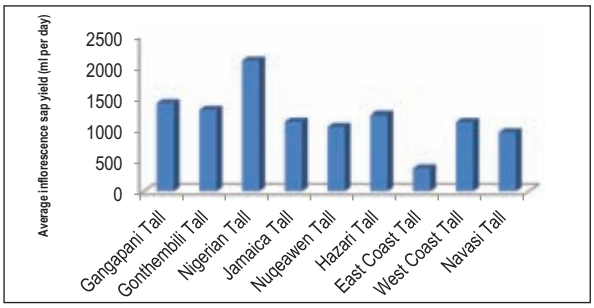


Fig. 1.6. Inflorescence sap yield in different coconut accessions

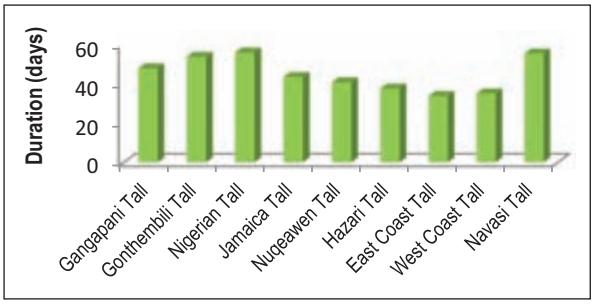


Fig. 1.7. Duration of sap production in individual spadices of different accessions

A simple correlation analysis undertaken to understand the traits influencing the sap yield showed that, duration of the sap production had no significant positive correlation with sap yield, while the length and median circumference of the inflorescence showed significant positive correlation with sap yield.

Evaluation for endosperm milk yield and quality

Fourteen genotypes, including germplasm accessions and released varieties were selected for studying the endosperm milk yield and milk quality parameters *viz*. moisture, density, pH, total solids and crude fat content. Differences in milk yield per nut were observed between the genotypes (Fig. 1.8). San Ramon Tall, Cochin China Tall, Federated Malay States Tall, Jamaica Tall and Chandra Sankara, showed high endosperm content and were suitable for endosperm milk production. Dwarfs, in general, gave lesser milk yield, owing to the lesser endosperm content, with Andaman Yellow Dwarf giving the highest percentage of first milk on extraction. Among the Mohacho Narel population, higher endosperm milk yield, albeit with low fat content, was recorded in fruits having sweet endosperm compared to fruits with normal endosperm.

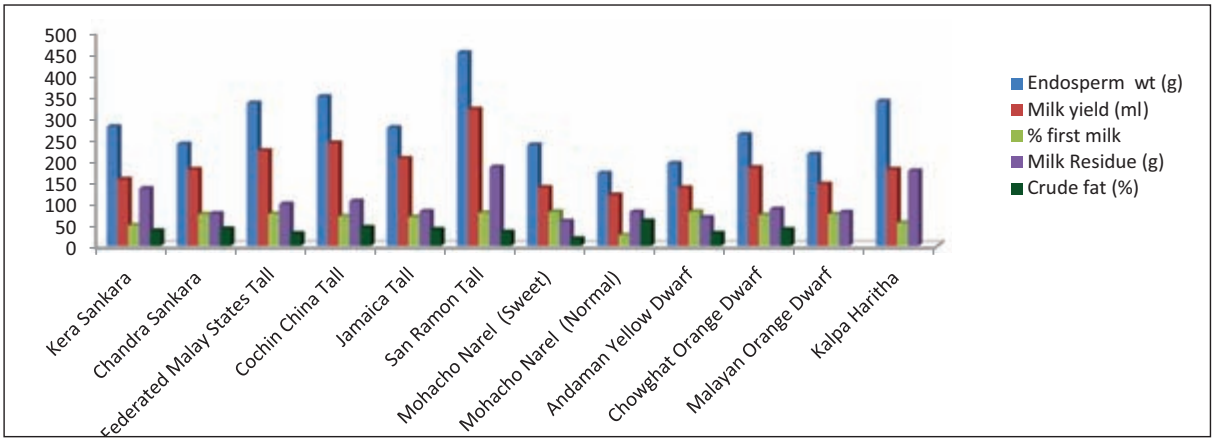


Fig. 1.8. Endosperm milk yield in different coconut genotypes

Germination and Seedling studies

Studies on seed nut germination and seedling traits were undertaken in a core set of 30 accessions of diverse geographical origin. This study highlighted the potential of sprouting characteristics along with seedling traits as descriptor traits, for germplasm characterization and identification of varieties. Significant differences were observed between accessions for the seedling traits. The height of the one year old seedling was highest in the accession Philippines Ordinary Tall (229 cm) and least in Laccadive Micro Tall (119 cm), while Markham Tall showed higher values for seedling biomass, in terms of both higher shoot and root weight. Slow germinating accessions *viz.,* Tiptur Tall, West Coast Tall, Laccadive Micro Tall and Java Tall produced significantly lesser number of leaves, with absence of split leaves, while highest number of split leaves (6) was recorded in early germinating Kalpa Haritha. High correlation was observed between seedling growth parameters recorded at different stages of growth in the nursery, suggesting the possibility of selecting true-to-type seedlings at the VI month stage itself.

Flow cytometry and ploidy studies

Flow cytometric analysis was carried out to determine intra-specific variation for nuclear DNA content in 20 accessions (14 talls and 6 dwarfs) of diverse geographical origin. The relative 2C DNA content was estimated in young leaves of adult palms using *Pisum sativum* cv. Citrad (2C=9.09 pg) as an internal reference standard (Fig. 1.9). Significant differences for 2C DNA content was observed, ranging from 5.73 pg in Chowghat Orange Dwarf to 6.25 pg in Guam Tall II. The mean 2C DNA content of tall accessions was high (6.07 pg $2C^{-1}$) compared to the dwarfs (5.89 pg $2C^{-1}$), corresponding to 1C genome size of 2968.23 Mb and 2880.21 Mb, respectively.

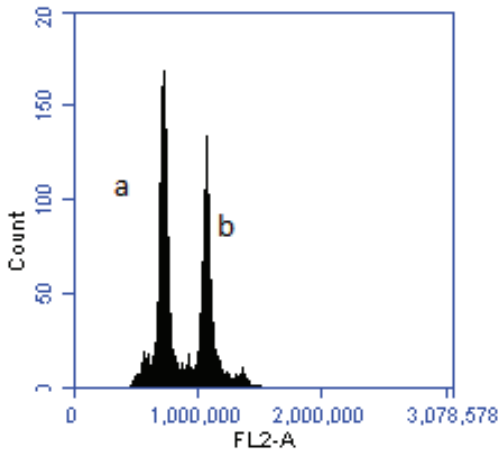


Fig. 1.9. Flow cytometry histogram showing G0/G1 peak of coconut (a) and pea (b)

Pollination for conservation and multi-location evaluation

Assisted pollination for production of breeder seed of parental lines and germplasm accessions was undertaken in 24 genotypes and 7366 female flowers were pollinated. Nuts from 1728 accessions were sown in the nursery for generation of planting material for experimental purpose/conservation. Further, assisted self-pollination was undertaken in a San Ramon Tall palm producing pink mesocarp and four nuts have been harvested and sown in the nursery for developing an elite line.

World Coconut Germplasm Centre, Andamans – conservation and multiplication

Pollen sample of Niu Leka Dwarf and Hari Papua Dwarf was sent from WCGC, ICAR-CIARI, Port Blair to ICAR-

CPCRI, Kasaragod for effecting crosses. Pollen of Cochin China Tall and San Ramon Tall were received from Kasaragod and used for effecting D x T crosses at Port Blair. A total of 1900 female flowers were pollinated from January to March 2019 in various accessions and production of D x T and D x D hybrids.

On farm trials

Evaluation trial of released varieties (Kalpa Sreshta, Kalpa Pratibha, Kalpatharu, Kalpa Mitra, Kera Chandra, Kalparaksha, Kalpa Surya, Kalpa Jyothi and Chowghat Orange Dwarf) and varieties identified for release (IND010S, Chowghat Orange Dwarf x West African Tall, Chowghat Orange Dwarf x Laccadive Ordinary Tall), was taken up during the year, in a farmer's field in Nagercoil, Tamil Nadu. About 29 seedlings in six lines were provided for gap filling. Robust initial growth was observed in Kera Chandra, Kalpa Pratibha, Kalparaksha and IND010S.

***In situ* characterization of new ecotypes**

In situ characterization was initiated in *Adinadu thengu*, a local ecotype of Kollam district of Kerala. A total of eight pink husked WCT palms were identified from Kattanam, Kareelakulagara, Pathiyoor and Pallana of Alappuzha district.

Development of improved varieties

Variety release proposal of Kalpa Shatabdi, dual purpose coconut variety suitable for tender nut and copra and characterized with relatively large size fruits was submitted for the consideration of the Central Variety Release Committee**.**

A high yielding selection of Federated Malay States Tall (IND 010S) was identified for release for cultivation in the coconut growing tracts of Kerala, Karnataka, Tamil Nadu as a multi-purpose variety suitable for copra, tender nut as well as inflorescence sap production, and recommended for presentation in the Annual Group Meeting of the All India Coordinated Research Project of Palms. The variety gives higher average yield of 148 nuts palm^{-1} year^{-1} under irrigated conditions, which is 34.55% higher than the local control (West Coast Tall). The estimated copra yield of 27.23 kg palm^{-1}, is 40.65% higher than West Coast Tall. This variety recorded 34.78% higher inflorescence sap yield than West Coast Tall, with an average sap yield of 31 litres inflorescence^{-1}.

Arecanut

Evaluation of germplasm

Vittal: Observations were recorded in the arecanut germplasm under evaluation for yield and other economic traits. The highest nut yield was recorded in VTL-54 followed by Saigon and VTL-51. Accessions *viz.*, Diveagar, Mahuva-B, Rangron were identified for their bold nuts.

Mohitnagar: Among the accessions planted in the year 1988, more number of nuts palm^{-1} and higher chali yield palm^{-1} was recorded in Mohitnagar followed by VTL-5. Among the eight accessions planted in the year 1990, higher chali yield palm^{-1} was recorded in Kamrup and Sweet Arecanut. Similarly, among the accessions planted in the year 1991, and 1992, higher chali yield was recorded in VTL-27 and VTL 18, respectively.

Kahikuchi: Among the 18 local arecanut genotypes evaluated for growth performance under Assam condition, Borehat recorded higher plant height, stem girth and more number of leaves, while higher number of nodes per metre was recorded in the accession Birubari.

Estimation of DNA content/ genome size

A flow cytometric protocol for estimation of DNA content/ genome size in arecanut was standardized and genome size of nine released varieties *viz*., Mangala, Sumangala, Sreemangala, Mohitnagar, Swarnamangala, Kahikuchi, Madhuramangala, Nalbari and Shatamangala were estimated. DNA content ranged from 6.34 pg 2C^{-1} to 6.71 pg 2C^{-1}, with estimated average genome size of 3.2 Gb per haploid set.

Observations on polyembryony in arecanut

In the arecanut nursery at Regional Station, Vittal, polyembryony was observed, with 2-4 seedlings seed nut^{-1} (Fig. 1.10). Among the 95 twins (2 seedlings nut^{-1}) observed, majority were in the variety Swarnamangala (34) and the lowest (7 each) in Mangala and Sumangala. Mohitnagar, Sreemangala and Shatamangala varieties showed 25, 12 and 10 such seedlings. Similarly, among the 20 triplets (3 seedlings nut^{-1}), highest number was observed in Swarnamangala (8), followed by Mohitnagar (6) and Shatamangala (3), with one each

Fig. 1.10. Arecanut seed nuts producing one, two, three and four seedlings nut^{-1}

in Sumangala, Sreemangala and South Kanara Local. Only one quadruplet (4 seedlings nut^{-1}) was recorded (Sreemangala variety).

Albino phenotypes in *Areca catechu* L.

Large number of albino seedlings in Shatamangala variety was observed in the nursery at Regional Station, Vittal (Fig. 1.11). This is the first report on occurrence of large scale albino seedlings in arecanut. The albino as well as normal seedlings appeared similar in gross morphology, except for the absence of chlorophyll pigmentation in the albinos. The albino seedlings, unable to photosynthesize, gradually died, within few weeks after germination. Analysis of basic leaf nutrient status of normal and albino seedlings (Table 1.1) indicated considerable differences in the leaf nutrient status. The normal seedlings showed lower levels of nitrogen, potassium, zinc and boron. While the albino seedlings showed 1.5-2.5 fold higher concentration of nutrients like nitrogen, phosphorus, potassium, magnesium, sulphur, iron, copper and zinc than the normal seedlings. When compared with critical limits, nitrogen, calcium and boron were deficient in albino sample. The accumulation of nutrients in albino plants might be due to the absence of chlorophyll.

Estimation of the nuclear DNA content from leaf samples of both normal and albino seedlings, using flow cytometry indicated similarity in DNA content (Fig. 1.12), implying that the albinism observed in seedling progenies of Shatamangala variety is not due to gross ploidy variations.

Fig. 1.11. Albino and normal seedlings of Shatamangala variety

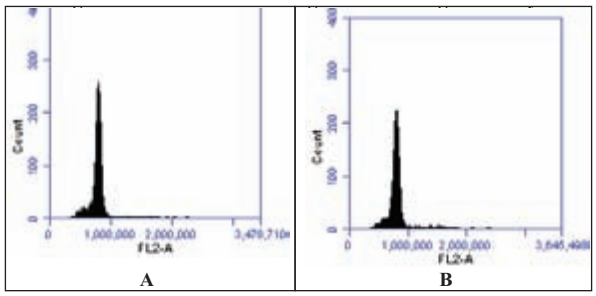


Fig. 1.12. Flow cytometric analysis of nuclear DNA content in Shatamangala: normal seedlings (A) and albino seedlings (B)

Tender nut processing studies in indigenous germplasm

Tender nut processing studies were undertaken in 43 indigenous accessions and six dwarf hybrid combinations. The accessions, SCRDTC-18, Kamrup, Dangapara, Thargira and Cal-6 showed high tender nut yield potential (Fig. 1.13).

Table 1.1. Leaf nutrient content of normal and albino seedlings of Shatamangala variety of arecanut

Leaf type	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	B (ppm)
Normal	1.41	0.23	1.06	0.62	0.26	0.54	344.34	82.46	13.76	28.28	28.0
Albino	2.35	0.44	2.68	0.55	0.46	1.45	547.45	87.7	35.78	48.35	30.3

Fig. 1.13. Processed red nuts of indigenous accessions: a) Kamrup, b) Dangapara, c) Thargira

Biochemical characterization of germplasm

Among the 18 accessions evaluated for arecoline content, the lowest (0.512 g 100 g^{-1}) and the highest (2.182 g 100 g^{-1}) arecoline content were recorded in Cal-6 and Cal-29, respectively.

Total phenol content was estimated in 32 indigenous accessions. Higher total phenol content of 22.23, 20.133 and 20.08 g GAE was recorded in Moralpara, Boragiri and Goralbari, respectively and the lowest of 1.9527 and 1.6832 g GAE in Cal-29 and Cal-32, respectively.

Growth performance of wild species and related genera in YLD screening trial

Growth traits were recorded in wild species and related genera of arecanut viz., *Areca triandra, Areca microcalyx, Actinorhytis calapparia* and *Normanbya normanbyi* in the YLD screening trial. No symptoms of YLD was observed in the wild species as well as related genera.

Cocoa

Morphological and biochemical characterization

Forty five cocoa genotypes were assessed for leaf and flower characters: 25 genotypes had green flushes, 19 slight anthocyanin and VTLC 24 had intense anthocyanin content. Creamy white colored sepals were found in 30 genotypes and green pedicel in 15 genotypes.

Biochemical analysis was undertaken in 20 Peruvian cocoa collections: DPPH antioxidant scavenging activity ranged from 62-92.37% and was found to be higher in the clone VTLC 62 (ICS-96) followed by VTLC 213 and in the Trinitario type clones, VTLC 207 and VTLC 72. The total phenol and procyanidin content correlated significantly with antioxidant activity and has potential in qualitative improvement of cocoa.

Promising cocoa collections

Among the exotic clones, 18 clones comprising of Upper Amazon Forastero, Trinitario, Nigerian and Pound collections yielded 101-205 pods $tree^{-1}$ $year^{-1}$ and have been utilized for area expansion programme in Andhra Pradesh.

Descriptor traits

To facilitate DUS testing, germplasm characterization was undertaken to develop DUS descriptors traits. Based on in depth observations, the following characters were identified for further study and development of DUS test guidelines. Distinct morphological traits were observed in different plant parts (Fig. 1.14).

Leaf base *Leaf apex/ colour* *Floral traits*

Fig. 1.14. Leaf colour, base and apex and floral traits in cocoa

Leaves - anthocyanin pigmentation in young flushes, shape of leaf base and leaf apex.

Flowers - anthocyanin in flower sepals, pedicels, length of pedicel.

Fruits - colour, type, shape, apex, bottle neck, surface rugosity of cherelles and pods.

Quantitative characters - size of pods, weight of pods, thickness of husk, number of beans per pod and bean size (from weight of single dry bean) were documented in different cocoa varieties.

Screening of clones for drought tolerance and shade tolerance

Seven Nigerian clones are under evaluation as root stocks for drought tolerance. Pre-treatment morphological observations were recorded on both clones and seedlings and following treatment with varying moisture levels were imposed (100% FC, 50% FC and 20% FC). Total phenol content, peroxidase, catalase enzyme activities were estimated following water-deficit treatment. The clones viz., NC 23, NC 29 and NC 42 were found to exhibit greater drought tolerance.

Screening of clones for shade tolerance has been initiated. Pre-treatment morphological observations were recorded in eight varieties and four parental clones after open field planting and are being evaluated under 50%, 75% and 95% shade levels.

Screening of clones for black pod rot and tea mosquito bug resistance

Nineteen Nigerian clones were assessed for tolerance to tea mosquito bug based on the damage assessment in flushes during the month of December, but all clones were found to be susceptible. Among the hybrids, cocoa plants under shade of Kola (*Cola nitida*) trees showed fewer incidences of tea mosquito bug infestation in flushes, cherelles and pods.

Black pod rot damage was severe both in the monsoon and post monsoon seasons, due to heavy rainfall of >4000 mm during the year. Twenty six year old trees of resistant clones ICS6 and SCA6 were affected by rot, whereas, 14 year old trees of the same genotypes and their hybrid ICS-6 x SCA-6 showed less damage in the gardens where arecanut and cocoa were planted at 3.3 m x 3.3 m spacing.

Promising cocoa clones

Based on observations from clonal evaluation trials over 15 years, VTLC 13 (NC 20) and VTLC 20 (NC 30) (Fig. 1.15, 1.16) have been identified as promising with high yield potential and adaptation. The salient features are: Canopy area - 15.6-19 m^2; No. of pods $tree^{-1}$ - 60; Green to yellow pod colour; No. of beans pod^{-1} - 43-44; Bean index - 1-1.11 g; Dry bean yield $tree^{-1}$ - 2.5-3 kg; Shelling - 11-13%; Nib recovery - 87-88%; Fat content - 54-55%.

Fig. 1.15. High yielding VTLC 13 clone

Fig. 1.16. High yielding VTLC 20 clone

Qualitative improvement

Minimal processing methods of fermentation (Fig. 1.17) with small wooden box, basket made of locally available forest vines, reusable plastic trays were used to process 5-15 kg wet beans of cocoa for farm level processing to get plumpy beans of good quality. The basket technique was found feasible for farmers to efficiently undertake primary processing at home and thereby get higher price by selling dry beans instead of wet beans.

Fig. 1.17. Methods of fermentation; a) Mini Box, b) Basket, c) Tray Fermentation

Germplasm Utilization

Coconut

Hybrid evaluation trial

In hybrid evaluation trials (planted during 2013 and 2014), comprising of 28 D x T hybrid combinations at Kasaragod and Kidu, flowering was observed in 20 combinations. In the hybrid evaluation trial planted at Kidu during 1996, West African Tall x Natava Tall and Philippines Ordinary Tall x Gangabondam Green Dwarf has been noted as promising hybrids for better bunch and nut yield.

In the hybrid evaluation trial planted at Kidu in 1998, West Coast Tall x Cameroon Red Dwarf and Chowghat Green Dwarf x Laccadive Ordinary Tall have been giving better performance for the total number of bunches and nut yield.

In Dwarf x Dwarf trial planted at Kidu in 2003, Chowghat Green Dwarf x Cameroon Red Dwarf, Malayan Yellow Dwarf x Niu Leka Dwarf, Malayan Yellow Dwarf x Gangabondam Green Dwarf showed better performance in terms of bunch and tender nut production.

Cross pollination for producing 21 hybrid combinations was carried out at Kasaragod. Hybrid seed nuts from 33 cross combinations and *inter se* nuts from eight accessions were sown for raising nursery. In Kidu, 1761 hybrid nuts from the 23 cross combinations were sown in poly bags.

Development of coconut inbreds

In the inbred development programme, 122 S_3 seedlings from six S_2 families have been established in the field. Difference in growth characters was observed in S_3 seedlings (Fig. 1.18).

Open pollinated seedlings of Malayan Yellow Dwarf x Niu Leka Dwarf and Malayan Yellow Dwarf x Chowghat Green Dwarf palms were raised for progeny study. Self

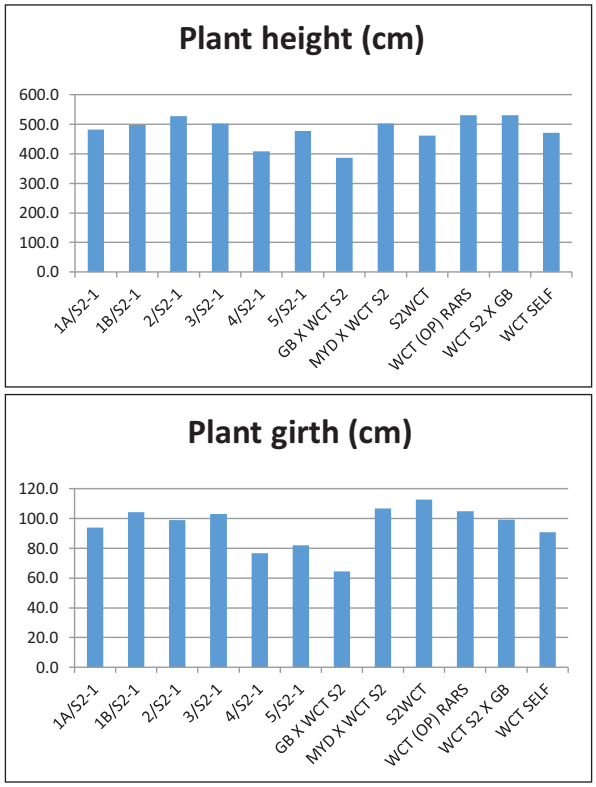


Fig. 1.18. Difference in growth characters among S_3 palms

pollination was carried out in Malayan Yellow Dwarf x Niu Leka Dwarf palms and seedlings established for the progeny study.

Performance assessment of coconut hybrids in farmers' field

Performance assessment of D x D hybrids in farmers' garden in Karnataka and Andhra Pradesh were continued. Performance assessment of newly released hybrids *viz*., Kalpa Samrudhi and Kalpa Sreshta is in progress at farmer's gardens in Karnataka, Kerala, Andhra Pradesh and Tamil Nadu.

Pollen and nectar compatibility studies

Pollen and nectar compatibility was studied in 10 coconut varieties *viz*., West Coast Tall, Philippines Ordinary Tall,

Laccadive Ordinary Tall, Cochin China Tall, Chowghat Orange Dwarf, Malayan Orange Dwarf, Malayan Green Dwarf, Malayan Yellow Dwarf, Chowghat Green Dwarf and Gangabondam Green Dwarf. Seasonal variation was observed in concentration of nectar in all the varieties. Pollen germination varied from the 50-60% during the winter season (Table 1.2).

Table 1.2. Percentage of pollen germination in nectar (pollen and nectar compatibility in coconut)

Pollen Source	Nectar source					
	LCT	WCT	MOD	MGD	CGD	CGD
	1:50 d	1:50 d	1:20 d	1:20 d	1:20 d	1:50 d
CGD	39.8	55.4	38.3	33.0	31.0	25.2
COD	60.8	43.3	56.5	48.2	26.0	9.3
PHOT	54.8	20.0	71.8	49.4	8.1	29.4
LCT	61.6	11.7	46.1	55.0	27.4	19.4
GBGD	47.7	50.1	50.9	51.2	29.7	16.0
MYD	56.2	53.3	39.5	56.4	21.5	21.1
WCT	52.8	50.8	61.5	61.9	40.4	39.1
CCNT	46.7	24.4	60.6	61.1	24.6	22.9
MGD	48.1	59.7	66.7	64.1	9.7	12.4
MOD	31.2	50.8	55.9	66.5	31.2	26.1

1:50 d = 50 times dilution; 1:20 d = 20 times dilution

Unique dwarf palm

Conservation of unique palm characterized with very dwarf stature, identified from Lakshadweep population, was done by planting the same at ICAR-CPCRI, Kasaragod in 2010. The palm had started flowering in 2014, but there has been no fruit set. Pollen from unique dwarf was used for pollinating Chowghat Orange Dwarf to conserve the gene in the back ground of Chowghat Orange Dwarf genotype. Fifty four Chowghat Orange Dwarf x Unique Dwarf seedlings of different petiole colors: light green (29); orange (12); light brown (13) were field planted at Kasaragod during 2018.

Karyotyping in coconut

The karyomorphology of five morphologically distinct coconut accessions including two tall (West Coast Tall and Andaman Giant Tall) and three dwarf accessions (Chowghat Orange Dwarf, Gangabondam Green Dwarf and Malayan Yellow Dwarf) was studied. The 16 pairs of chromosomes were numbered from 1 to 16 in descending order of length and centromere position, average chromosome length (µm), relative chromosome length (µm) and arm ratio were determined.

All the chromosomes observed from the five accessions could be described as medium sized with length ranging from 1.61 to 5.12 µm. Among the accessions, the total chromosome length varied from 40.67±2.47 µm (Chowghat Orange Dwarf) to 55.21±4.31 µm (Andaman Giant Tall). In the two tall accessions, out of 16 pairs, 12 pairs of chromosomes showed median primary constrictions and the remaining four pairs had sub median constriction. The three dwarf accessions, showed only four pairs with sub median constriction while the remaining 13 pairs had median chromosomes.

Breeding for resistance to root (wilt) disease

In the evaluation trial involving 13 tall accessions planted during 2014, the highest incidence of root (wilt) disease was observed in Federated Malay States Tall and San Ramon Tall (12.5%) followed by Java Tall, Guam Tall and Kalpa Haritha (8.33%). Root (wilt) disease was not observed in Andaman Ordinary Tall, Philippines Ordinary Tall and Tiptur Tall. Among the tall accessions evaluated, Kalpa Haritha was found to be the most precocious followed by Cochin China Tall. Initial yield of first three harvests ranged from 5 to 55 nuts palm^{-1} and was the highest in Philippines Laguna Tall (25.4 nuts palm^{-1}). Nut characters of these accessions were also studied and the highest fruit weight was recorded in St. Vincent Tall (2203 g) followed by Federated Malay States Tall (2048 g). Weight of husked fruit (1211 g), volume of tender nut water (473 ml) and copra content (262 g) were the highest in Federated Malay States Tall.

In the evaluation trial involving six green dwarfs (Fig. 1.19), after six years of planting, root (wilt) disease incidence was the highest in Niu Leka Dwarf and Gangabondam Green Dwarf (7.4%), while other varieties remained healthy. The average yield was the highest in Kalpasree (92.8 nuts palm^{-1}) followed by Gudanjali Dwarf (89.30 nuts palm^{-1}). The Green Dwarf varieties were evaluated for tender nut purpose and significant differences were observed for characters such as weight of tender nut, volume of water and TSS. Fruit weight at tender nut stage was the highest in Niu Leka Dwarf (2180 g) followed by Kalparaksha (1864 g) and the lowest in King Coconut (1296 g). However, volume of water was the highest in King Coconut (563 ml) followed by Gangabondam Green Dwarf (470 ml) and the lowest content was in Gudanjali Dwarf

(257 ml). The highest TSS in tender nut water was recorded in Gangabondam Green Dwarf (7.12° Brix) followed by Chowghat Orange Dwarf (6.8° Brix), a variety released for tender nut purpose and both were on par. TSS was the lowest for Andaman Green Dwarf (5.36° Brix). There was no significant difference in the *p*H of the tender nut water of different varieties and the value ranged from 5.06 to 5.34. Organoleptic evaluation conducted with different tasters indicated that maximum score (4) was for Gangabondam Green Dwarf and rated as 'very good'. Tender nut water of other varieties *viz.,* Niu Leka Dwarf, Kalpasree, Kalparaksha, Andaman Green Dwarf and Chowghat Orange Dwarf was rated as 'Good' and that of King Coconut was rated as 'average'.

Fig. 1.19. Evaluation of green dwarf varieties of coconut

Evaluation of second generation progenies of disease free West Coast Tall planted during 2012 showed that the average yield was the highest for *inter se* mated WCT palms (38.75 nuts palm^{-1}) compared to self (24.70 nuts palm^{-1}). After seven years of planting, the root (wilt) disease was recorded to be 3.9% in both self and *inter se* WCT palms. Nut character studies revealed that fruit weight (1584 g), husked fruit weight (910 g), volume of water (274 ml), kernel thickness (1.4 cm), weight of shell (190 g) and copra content (252 g) were more for *inter se* WCT palms and length of fruit (21.45 cm) and husk thickness (1.71 cm) were more for self progenies.

In the evaluation trial involving different dwarfs and its hybrids planted during 2009, the lowest incidence of root (wilt) disease was continued to be recorded in Chowghat Green Dwarf x West Coast Tall (15.6%) followed by Chowghat Green Dwarf x Malayan Green Dwarf (17.8%). Average yield was the highest in Chowghat Green Dwarf x West Coast Tall (74.30 nuts palm^{-1}) followed by Chowghat Green Dwarf x Malayan Green Dwarf (56.2 nuts palm^{-1}).

Arecanut

Hybrid evaluation trial

Evaluation of eight dwarf hybrids involving Hirehalli Dwarf and released varieties *viz.*, Mangala, Sumangala, Sreemangala, Mohitnagar at Vittal (Karnataka), Mohitnagar (West Bengal) and Kahikuchi (Assam) revealed that the hybrid Sumangala x Hirehalli Dwarf recorded the highest yield of 288 nuts palm^{-1} year^{-1} and 221 nuts palm^{-1} year^{-1} at Vittal and Kahikuchi, respectively. While at Mohitnagar, Hirehalli Dwarf x Mangala recorded highest yield of 145 nuts palm^{-1} year^{-1}.

At Vittal, among the 16 tall hybrid combinations under evaluation for yield traits, Shriwardhan × Sumangala, recorded highest dry kernel (chali) yield of 3.56 kg palm^{-1} year^{-1} followed by the hybrid Sreemangala × Mangala with 3.5 kg dry kernel palm^{-1} year^{-1}

Screening of dwarf hybrids and tissue cultured plants for yellow leaf disease (YLD) tolerance/resistance is in progress in the farmers gardens in YLD hot spot areas. Morphological traits such as plant height, stem height, stem girth, number of nodes, number of leaves was recorded and disease indexing was also done in dwarf hybrids and tissue cultured plants at YLD endemic area. The dwarf hybrids and tissue cultured plants showed yellowing symptoms.

Inter-specific crossing between *Areca triandra* x *A. catechu* (Mangala) and *Areca catechu* (Mangala) x *Areca triandra* has been carried out for screening against fruit rot and YLD. Total of 665 and 354 flowers were pollinated for production of *A. triandra* x Mangala and Mangala x *A. triandra,* respectively and fruit setting was observed (Fig. 1.20).

Fig. 1.20. Fruits harvested from inter-specific crosses: a) Areca triandra x Areca catechu, b) Areca catechu x Areca triandra

Cocoa

Hybrid evaluation trial

Promising cocoa hybrid from progeny/ clonal trial over 12 years

Hybrid VTLCP 9 (Fig. 1.21) of the cross I-56 x III-35 yielded 62-65 pods from trees of 18-20 m^2 canopy, with

40-41 beans pod^{-1}, 1.10 g single bean weight and an average 3 kg dry bean yield tree^{-1} year^{-1} both under arecanut and coconut. These are suitable for chocolate industry with 12-13% shelling, 87-88% nib recovery and 50% fat content. It exhibited tolerance to black pod rot disease, tea mosquito bug damage and also tolerance to low moisture stress. This is amenable for high density planting.

Fig. 1.21. Promising hybrid, VTLCP 9

Studies on compatibility reaction in selected cocoa clones and breeding

A tree showing both self and cross incompatible reaction for the past four years was identified at Vittal station and marked for further artificial pollination, molecular and gene expression studies.

Planting Material Production

Production of planting material of mandate crops was undertaken in different centres, resulting in revenue generation to the tune of Rs. 191.18 lakhs (Table 1.3).

In addition, at Kahikuchi centre, 25,000 arecanut seedlings of Kahikuchi variety and 5,000 black pepper cuttings of Panniyur and Karimunda varieties were raised for distribution to the farmers (Fig. 1.22)

Fig. 1.22. Planting material production of arecanut and black pepper at Kahikuchi

Cryo-preservation of coconut pollen

A total of 600 vials of coconut pollen collected from healthy and high yielding WCT palms located in root (wilt) disease hotspots are being stored in deep-freezer and liquid nitrogen. Pollen germination test was routinely carried out to ascertain the viability of the stored pollen. The stored pollen was used for hybridization and yielded normal fruit setting (25%).

Refining ground pollination technique

The ground pollination technique was modified to enable artificial pollination on parental lines of coconut and facilitate production of foundation/hybrid seed nuts. The refinements include using flexible PVC pipe (6 mm diameter) instead of 8 mm diameter clear PVC tube. The

Table 1.3. Seed production in coconut, arecanut and cocoa

Crop	Planting material	Kasaragod	Vittal	Kayamkulam	Kidu	Total
Coconut	Varieties	24133	-	7538	8154	39825
	Hybrids	41654	-	-	23215	64869
	Sub total	65787	-	7538	31369	104694
Arecanut	Seed nuts	-	3966	-	274680	278646
	Seedlings	-	80022	-	10250	90272
	Sub total	-	83988	-	284930	368918
Cocoa	Pods	-	35564	-	6297	41861
	Seedlings	-	12273	-	3329	15602
	Sub total	-	47837	-	9626	57463
Total		**65787**	**131825**	**7538**	**325925**	**531075**

vertical air blower powered by a 12 volt battery used for pumping the pollen-talc mixture was replaced with 5 l hand pump pressure sprayer. To aid uniform dusting of pollen-talc mixture onto receptive female flowers inside the pollination bag, a 6 mm micro sprinkler attached to 6 mm adapter was fixed onto the top end of the PVC pipe inserted inside the pollination bag.

Up scaling production of elite planting material for the root (wilt) disease prevalent tract

Large-scale production of elite and hybrid seedlings of coconut for the root (wilt) disease prevalent tracts was taken up with funding support from the Government of Kerala. A total of 360 Chowghat Green Dwarf and 40 West Coast Tall palms were selected from farmers' plots located at Chavara, Chengannur, Clappana, Illickal, Kallisserry, Kidapram North Kochumuri, Kottayam, Kottukulangara, Kummanam, Munroe Island, Panmana, Pathinachilchira, Podiyadi, Prayar and Puthupally and utilized in hybridization programme for production of Kalpa Sankara hybrids. About 20,989 Chowghat Green Dwarf seed nuts were collected from root (wilt) disease hotspots. Further, 4,369 CGD x WCT seed nuts from previous year's pollination work were harvested.

Farmer participatory planting material production

Farmer participatory planting material production of dwarf / semi tall varieties and hybrids was undertaken with funding support of the Kerala state Department of Agriculture & Farmers Welfare in 12 districts of Kerala (excluding Wyanand and Idukki). During the year, participatory selection of dwarf and tall mother palms from farmers plots, labeling and geo-tagging was undertaken for a total of 6799 parental palms (3652 Chowghat Orange Dwarf, 1078 Chowghat Green Dwarf, 74 Malayan Yellow Dwarf and 1995 West Coast Tall) located in different blocks of the 12 districts (Kasaragod, Kannur, Kozhikode, Malappuram, Palakkad, Thrissur, Ernakulum, Kottayam, Pathanamthitta, Allapuzha, Kollam and Thiruvananthapuram). Thirty community nurseries under different Farmer Producer Organizations including Kera Gramam and CPFs were identified in the selected 12 districts for sowing seed nuts of dwarfs as well as hybrids. Trainings were conducted on mother palm selection, hybridization techniques, seed nut selection, and seedling selection and nursery management for the benefit of all stakeholders in different locations in the selected districts.

Coconut pollen processing cum storage centre was established in each district in collaboration with Dept. of Agriculture Development and Farmers' Welfare. Pollination for hybrid seed production has been initiated in 450 West Coast Tall, 290 Chowghat Orange Dwarf and 110 Chowghat Green Dwarf palms. DNA was isolated from West Coast Tall and Chowghat Orange Dwarf parental lines as well as hybrid seedlings for validating molecular markers linked to hybrids in coconut.

2. Biotechnological Investigations

Coconut tissue culture

Use of embryonic shoot meristem from zygotic embryo

Effect of lower levels of activated charcoal in culture medium

Experiments involving lower levels of activated charcoal (0.25 g l^{-1}) in Y3 culture media supplemented with either 2,4-D (5 mg l^{-1}) or picloram (5 mg l^{-1}) resulted in hard and non-friable calli. However, some meristemoids were obtained, which were sub-cultured to Y3 media consisting of BAP (1 mg l^{-1}) and TDZ (2 mg l^{-1}), maintaining similar concentration of activated charcoal (0.25 g l^{-1}) and transferred to light to obtain regeneration.

Use of immature inflorescence

A total of 14 immature inflorescences from West Coast Tall (WCT) palms, with outer spathe length ranging from 2 cm to 25 cm, were collected and tiny rachillae bits were inoculated in Y3 media supplemented with 2,4-D (1 mg l^{-1}). After 8 months of incubation in dark with monthly subculturing to same media, the cultures were transferred to ½ MS media supplemented with 1 mg l^{-1} each of NAA and BAP and kept under diffused light for a period of one month followed by 16 hours light.

The shoot like outgrowths of Chowghat Green Dwarf (CGD) explants, inoculated during the previous year, gradually turned green in light condition, after multiple shoot formation was observed in ½ MS media supplemented with 1 mg l^{-1} each of NAA and BAP. These multiple shoots were separated and the individual shoots were cultured in shoot regeneration media containing Y3 media with 1 mg l^{-1} each of 2iP and BAP. The number of shoots per rachilla varied from 1 to 7.

WCT plantlets, from the previous year, with well developed shoots having 3-4 leaves were transferred to various combinations of rooting media. Maximum rooting (17.14%) was observed in media containing ½ Y3+ NAA (1 mg l^{-1})+ IBA (5 mg l^{-1}) followed by ½ Y3 + NAA (2 mg l^{-1}) + IBA (5 mg l^{-1}) + charcoal (2.5 g l^{-1}). A total of eight plantlets with well developed roots were washed in tap water and kept in 1% carbendazim followed by 1000 ppm IBA solution for one hour each. The plantlets were planted in small disposable plastic cups filled with sterile coco-peat and perlite in 3: 1 ratio with a pinch of humic acid. These cups were placed in plastic storage container and were covered with cling wrapping film so as to develop high humidity. New leaves emerged in four plantlets after three months of sterile hardening (Fig. 2.1).

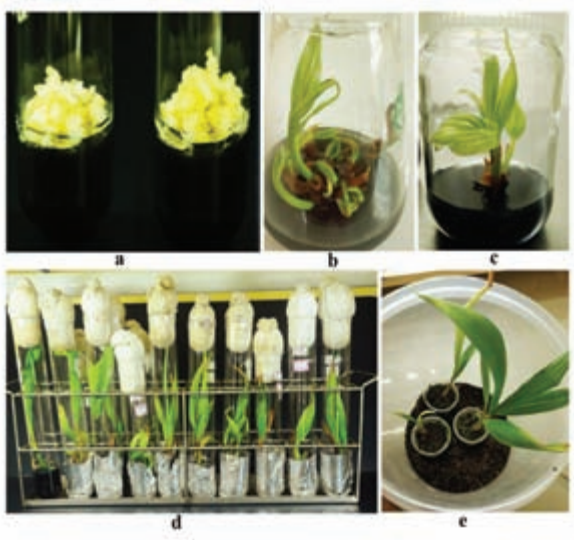


Fig. 2.1. Immature inflorescence culture. Rachille bits one after inoculation (a), multiple shoot formation (b), plantlet in shoot regeneration media (c), plantlets in rooting medium (d) and in vitro hardening (e).

Use of seedling shoot meristem

An experiment was initiated with shoot meristem and cabbage of two years old coconut seedlings as explants and by inoculating them on to different basal media *viz.*, Y3, MS, WPM and M72. Picloram at different concentrations (48, 60 and 72 mg l^{-1}) was used as the auxin source in the above basal media along with 1 or 2.5 g l^{-1} of activated charcoal. Initial results revealed M72 and MS medium to be better as far as browning of the tissues was concerned. Cultures turned brown at higher concentrations of picloram during subsequent subculturing. Preliminary results indicated calli initiation after an incubation period of three weeks in M72 and MS medium supplemented with 48 mg l^{-1} picloram and 2.5 g l^{-1} of activated charcoal.

Use of endosperm explants

Calli from immature endosperm tissues were initiated from seven month old nuts of different accessions: talls *viz*., Laccadive Micro Tall, Laccadive Ordinary Tall, West Coast Tall, Andaman Giant Tall and Philippine Ordinary Tall and dwarfs *viz.*, Chowghat Orange Dwarf, Chowghat Green Dwarf, Malayan Yellow Dwarf, Malayan Orange Dwarf and Gangabondam Green Dwarf.

Tissue culture in arecanut

***In vitro* multiplication of Hirehalli Dwarf, dwarf hybrids and YLD-free palms**

Three inflorescences of dwarf hybrids (two VTLAH1 and one VTLAH2) and two of Hirehalli Dwarf were collected and inoculated and 10 inflorescences of dwarf hybrids were handed over to M/s SPIC ABC Coimbatore for mass multiplication. At present, around 100 cultures, consisting of both embryogenic calli and somatic embryos of dwarf hybrids, are being maintained. From the immature inflorescence cultures inoculated in the previous year, around 150 plantlets of dwarf hybrids could be obtained and are in different growth stages in light room. Six plantlets of dwarf and dwarf hybrids have been hardened *ex vitro*. Twenty immature inflorescences from apparently healthy palms in YLD hotspot areas of Sringeri, Karnataka were collected for initiating the cultures. Fifteen inflorescences were handed over to M/s SPIC ABC and five inflorescences were cultured at the institute. Till date, around 450 apparently YLD free healthy plantlets and 10 VTLAH2 plantlets are in different growing stages in the light room at M/s SPIC ABC Coimbatore (Fig. 2.2).

Fig. 2.2. Callusing, somatic embryogenesis and plantlet regeneration in immature inflorescence explants from healthy palms in YLD hot spots of Sringeri in Karnataka.

Molecular studies on *in vitro* recalcitrance

Transformation studies using genes involved in somatic embryogenesis in model plants/coconut

Promoter of β-tubulin gene was cloned into pBI121 GUS binary vector and mobilized into *A. tumafaciens* EHA 105 by freeze-thaw method. Activity of β-tubulin promoter was confirmed through *Agrobacterium* mediated transformation in endosperm callus derived from Chowghat Orange Dwarf coconut. Amplification of *SERK* (somatic embryogenic receptor-like kinase) gene was achieved from callus of West Coast Tall coconut. It was cloned into binary vector pBI121: TUB and pBI121:35S construct after removing GUS reporter gene and mobilized into *A. tumafaciens* EHA 105. Callusing pattern is being tested in embryonic shoot meristem and zygotic embryo explants of coconut which were transformed by *Agrobacterium*.

Cryopreservation studies

Cryopreservation of coconut embryonic shoot meristem

Embryonic shoot meristem of coconut was cryopreserved using aluminium V-cryoplate and V-cryomesh methods.

Explants pre-grown in Y3 medium with 0.4 M sucrose for three days were fixed in V-cryoplates or V-cryomeshes for the encapsulation with calcium alginate. Explants were then dehydrated for 45 and 90 minutes in PVS3 solution and subjected to cryopreservation. Dehydration for 90 minutes was found to improve the post cryopreservation recovery, as evidenced by recovery percentages of 22 and 28 in V-cryoplate method and 50 and 63 in V-cryomesh method, for 45 and 90 minutes dehydration, respectively (Fig. 2.3).

Cryopreservation of arecanut embryogenic calli

Embryogenic calli obtained from immature arecanut inflorescence cultures (dwarf hybrid) were pre-grown in Y3 medium supplemented with sucrose (0.2, 0.3 and 0.4 M) for three days and later desiccated using plant vitrification solution 3 (PVS3) for 30 minutes after affixing on cryoplates. The results showed 8-10% recovery of cryopreserved embryogenic calli that resulted in normal plantlet production. The clonal fidelity studies, using SCoT marker, showed no variation between cryopreserved calli in comparison to the original calli (Fig. 2.4).

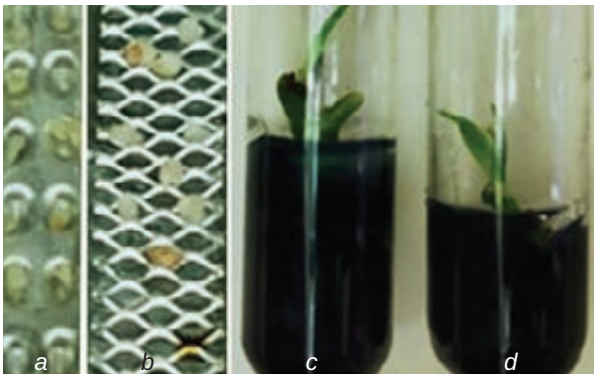


Fig. 2.3. Use of cryoplate (a) and cryomesh (b) in cryopreservation of coconut embryonic shoot meristem explants. Regenerated plantlets post cryopreservation from cryomesh (c) and cryoplate (d).

Studies on effect of nanoparticles on coconut embryo cryopreservation

Effect of exogenous supplementation of carbon nanomaterial (single walled carbon nanotubes; SWCNT), incorporated in PVS3 at three concentrations *viz*., 0.3, 0.5, and 0.7%, on post-cryopreservation recovery was studied. Results indicated that addition of SWCNT's to PVS3 enhanced the germination percentage post cryopreservation, with PVS3 supplemented with 0.5% of SWCNT's found to be most effective with two-fold increment in germination rate as compared to control (33%).

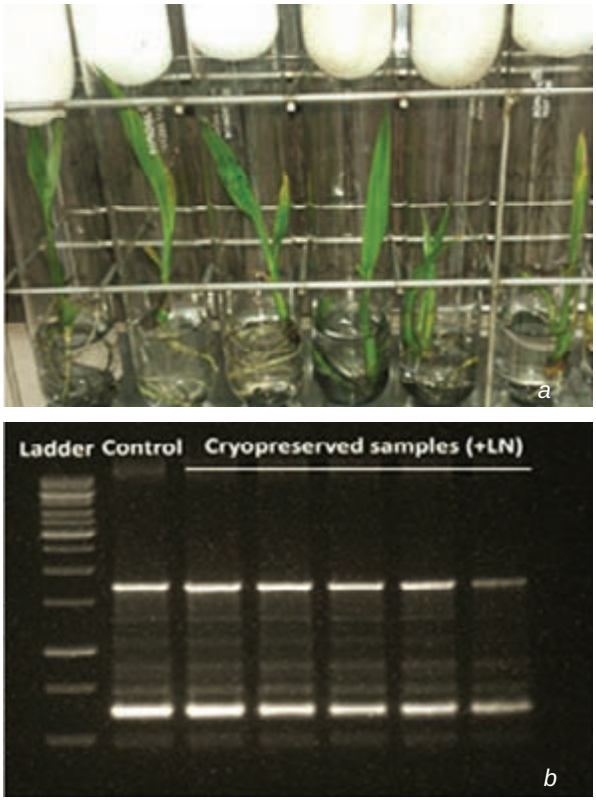


Fig. 2.4. Regenerated arecanut plantlets from cryopreserved embryogenic calli (a) and clonal fidelity studies using SCoT 13 marker (b).

Germination after cryopreservation was 33% in control whereas, it was 52, 67 and 47% in 0.3, 0.5 and 0.7% of SWCNT treatments, respectively. Further growth attributes like shoot length in germinated embryos suggest that 0.5% SWCNT treatment was better with an average shoot length of 1.4 cm while it was 0.7 cm in control three weeks after germination.

Fertility studies of coconut pollen collected and cryopreserved during monsoon season

Studies using five month old (stored) pollen, collected and cryopreserved during peak monsoon (July) season, for pollination indicated normal nut set (31%) in inflorescences, indicating fertility of the cryoprserved pollen. An average setting of eight nuts was obtained from 24 female flowers of West Coast Tall pollinated with cryopreserved pollen of Chowghat Orange Dwarf.

Molecular characterization

Targeted resequencing of genes involved in gibberellic acid biosynthesis (plant habit) in accessions displaying variations for the traits

Mining of full length genes involved in gibberellic acid (GA) biosynthesis was carried out from genomes of

tall (Hainan Tall) and dwarf (Chowghat Green Dwarf) cultivars. Full length coding regions of the seven GA biosynthetic pathway genes were cloned from CGD. The deduced amino acid sequence of all the seven GA biosynthetic genes shared high identity with similar functionally characterized palm GA genes. *In silico* structural and functional analysis were carried out and secondary and tertiary structures were identified. High-resolution melting (HRM) analysis, using the small amplicon assay, was utilized for identification of SNP variations and assaying genotypic differences in coconut palms possessing contrasting phenotypes. Coding regions of *GA20ox*, *GA3ox* and *GA2ox* genes, from tall and dwarf coconut accessions were sequenced. A comparison of sequences among the tall and dwarf palms revealed the existence of single nucleotide polymorphism (SNPs) in *GA20ox* and *GA2ox* genes between the two types. These sequence differences were utilized to develop markers, via HRM analysis, and these markers could clearly differentiate the tall and dwarf accessions.

Bioinformatics

Development of gene prediction algorithms for analysis of coconut genome data

Protein sequences of Auxin Responsive Factors (ARFs), mined from Chowghat Green Dwarf genome data, formed the data set. The data set was divided into test and training sets with a ratio of 0.2:0.8, respectively and was subjected to feature extraction scripts with potential features such as amino acid composition and physicochemical properties, Composition Transition Distribution (CTD) and motif search. MEME was used to obtain predefined number of motifs individually from each palm family. Convolution Neural Network (CNN), implemented with Python library Keras run on Tensorflow backend, was used for prediction. Best architecture was chosen and further validated using repeated training. Finally, a web server has been developed which would enable user-friendly prediction of ARF genes from whole genome sequences.

3. Cropping System and Bioresources Management

Cropping / Farming System

Coconut based integrated farming systems (CBIFS) for enhancing farmer's income

The farming system model at ICAR-CPCRI, Kasaragod comprises of a one hectare coconut garden with pepper (trailed on the coconut trunk), banana (border of the plots), fodder grass (Hybrid Bajra Napier CO 5 in coconut interspaces), dairy unit (seven cows of Holstein Friesian and one Jersey cross bred), poultry (40 layers and 100 broilers), goats (13 does and one buck) and aquaculture (1000 fingerlings). From coconut based integrated farming system unit, 23100 coconuts, 16323 litres of cow's milk, 184.7 kg live weight of goat, 210 kg live weight of poultry birds, 50 kg live weight of layer birds, 625 eggs, 2535 kg banana, 329 kg black pepper and 109 kg fish could be obtained, resulting in a net income of ₹ 5,32,240 annum^{-1}, which is four-times higher as compared to coconut monocrop.

The fodder grass, hybrid Bajra Napier (CO 5) was grown as intercrop in coconut garden for three years (2015-16 to 2017-18) in red sandy loam soil with different nutrient management practices *viz*., organic alone (FYM/poultry/goat manure @ 15 t ha^{-1} + cow shed washing), integrated nutrient management (INM) with 50% organic manure + 50% of RDF and chemical fertilizers alone (100% RDF). The fodder grass CO 5 responded well to the combined use of chemical fertilizers and organic manures (Table 1), with highest green foliage yield realized with INM (126 t ha^{-1} year^{-1}), followed by organics alone (118 t ha^{-1} year^{-1}). The increased yield was due to cumulative effect of improvement in height and number of tillers produced, and implying that adoption of integrated nutrient management resulted in sustainable high yield of fodder in the coconut ecosystem.

Intercropping of fodder grass did not adversely affect coconut yield. The coconut palms under intercropping of fodder grass with INM recorded higher yield (127 nuts palm^{-1} year^{-1}) which was on a par with organic treatment (122 nuts palm^{-1} year^{-1}) and significantly differed from application of chemical fertilizers (110 nuts palm^{-1} year^{-1}) and monocropping of coconut (114 nuts palm^{-1} year^{-1}). Fodder grass intercropping with INM practices recorded 11 per cent increase in yield over monocroping of coconut and clearly demonstrated that intrecropping has a complementary effect on coconut productivity if proper nutrient management practices are adopted.

Arecanut based integrated farming system for enhancing income

The total inflow into the arecanut based integrated farming system (ABIFS) comprising of arecanut (0.16 ha), dairy (5-7 milking cows) and fishery components was ₹ 7,22,911, whereas, outflow from the system was ₹ 8,85,338. The net return from the system was thus

Table 3.1. Effect of different treatments on yield of green fodder and coconut

Treatment	Fodder yield (t ha^{-1})				Coconut yield (nuts palm^{-1})			
	2015	2016	2017	Average of three years	2015	2016	2017	Average of three years
INM	111	144	124	126	120	130	132	127
Organic	104	133	117	118	116	123	126	122
Chemical	80	106	92	93	99	112	119	110
Monocrop					101	118	124	114
CD (P=0.05)	22.1	16.1	18.7	15.3	4.4	6.2	5.7	5.9

₹ 1,62,427. Dairy component alone contributed to 94.8% to the total outflow from the system. On an average, organic waste recycling potential of arecanut + dairy system was 17.4 t, of which dairy unit alone contributed to 94% of the recyclable residue. Total milk yield was 23,444 litres and fresh cow dung production was 76.8 t. Total nutrient supply from ABIFS through recycling to the system was estimated at 318 kg N, 72 kg P, and 42 kg K year^{-1} which is sufficient to meet the N demand of 2.4 ha, P demand of 3.0 ha and K demand of 0.27 ha arecanut plantation. The contribution of arecanut to the total outflow was less due to high incidence of *Mahali* disease and thus, adoption of ABIFS is a better management strategy in view of losses caused due to abiotic stresses, and ecological imbalance in humid tropics.

Coconut based high density multi species cropping system

During 2017-18, the coconut yield did not differ significantly among the treatments: 165 nuts with 2/3rd RDF + recycling biomass (vermicompost), 162 nuts with 1/3rd RDF + recycling biomass (vermicompost) + biofertilizer application + green manuring + vermiwash application) and 173 nuts with fully organic with recycling biomass (vermicompost + biofertiliser application + green manuring + vermiwash application + husk burial + mulching coconut basin). The yield of intercrops were on par in all the treatments. Black pepper yield ranged from 686 to 749 kg ha^{-1} among the treatments. Banana yield ranged from 7 kg to 8 kg bunch^{-1} for Kadali variety and from 11 kg to 13 kg bunch^{-1} for Robusta variety. The net income from the system with different management systems ranged from ₹ 5,28,420 to ₹ 5,48,366, while the income from monocrop of coconut was Rs. 98,148. Thus adoption of high density multispecies cropping system in coconut with organic nutrient management practices improves the income of farmer by five times.

Performance of Alpinia and Strelitzia in coconut plantations

At ICAR-CPCRI, Regional Station, Kayamkulam, *Alpinia* (four commercial varieties *viz*. Alpinia 'Red', Alpinia 'Pink', Alpinia 'Kimi' and Alpinia 'Jungle King') and *Strelitzia* (birds of paradise) varieties were evaluated for their performance in two growing conditions i.e; open and as an intercrop in seven year old dwarf coconut plantation (Fig. 3.1 and 3.2). Among the varieties, Alpinia 'Jungle King' was found suitable for intercropping in coconut gardens, producing flowers throughout the year

Fig. 3.1. Alpinia 'Jungle King' intercropping in coconut garden at ICAR-CPCRI, Regional Station, Kayamkulam

Fig. 3.2. Strelitzia intercropping in coconut garden at ICAR-CPCRI, Regional Station, Kayamkulam

except during April-May. The inflorescences produced were of marketable standards with >1 m length and spike circumference of 20 cm. On the other hand, the growth and performance of *Sterletzia*, both as sole crop and intercrop in coconut garden, was poor.

Arecanut based high density multispecies cropping system at Kahikuchi

Arecanut based high density multispecies cropping system (HDMSCS) at Kahikuchi, involving arecanut as main crop and banana, pineapple, Assam lemon and turmeric as intercrops was grown with three types of nutrient application *viz*., (T_1) 2/3rd RDF + recycling of biomass, (T_2) 1/3rd RDF + recycling of biomass + biofertilizer + green manuring crops and (T_3) recycling of biomass + biofertilizer + green manuring crops + husk burial. The highest yield of arecanut (2.52 kg chali palm^{-1} year^{-1}) and pineapple (26.87 kg plot^{-1}) was recorded in T_2, whereas, the highest number of fruits (34.97 plant^{-1}) in Assam lemon intercrop was recorded with T_1. The C:B ratio of the treatments was 1:2.18 for T_1, 1:2.66 for T_2 and 1:1.92 for T_3.

Intercropping of seasonal horticultural crops under arecanut at Kahikuchi

Seasonal horticultural crops were grown as intercrops in arecanut garden to generate income throughout the year. Summer and winter vegetables were grown, based on climate feasibility and preference of the local consumer. Okra (*var*. Parbhani Kranti), amaranthus (Red type) and ash gourd (local type) in summer and cabbage (*var*. Veloce 5561), cauliflower (*var.* Girija), tomato (*var.* S-22) and brinjal (local type) in winter were grown as intercrops. Yield obtained from intercropped summer vegetables were: Okra - 1.55 t ha^{-1}, amaranthus - 1.29 t ha^{-1} and ash gourd - 3.40 t ha^{-1}. Yield of different winter vegetables grown were: cabbage - 6.66 t ha^{-1}, cauliflower - 4.44 t ha^{-1}, tomato - 9.07 t ha^{-1} and brinjal - 6.00 t ha^{-1}.

Nutrient and Water Management

Effect of organic farming on soil potassium status under coconut cultivation

Considering the fact that coconut is a heavy feeder of potassium and the potassium supply through organic manures is poor as compared to the supply through chemical fertilizers, studies on the effect of organic farming on soil potassium fractions is indispensable. Therefore, the changes in the potassium fractions in soil after 13 years of coconut cultivation under organic farming (various organic farming practices) were studied at ICAR-CPCRI Kasargod.

Analysis of K fractions in laterite soil after 13 years of organic cultivation of coconut indicated exchangeable K > non-exchangeable K > water soluble K. In the 0-60 cm soil profile, conventional farming system of recommended dose of inorganic and organic fertilizers recorded higher potassium content in the water soluble and exchangeable fraction as compared to the organic farming system but there was not much difference observed in the non exchangeable potassium fraction between the two methods of cultivation.

In case of the distribution of different potassium fractions at different soil depth, the surface soil (0-30 cm depth) showed higher exchangeable and non exchangeable potassium fractions under the organic farming system but the water soluble fraction was higher in the fertilizer applied system. This trend was reversed in the lower soil depth (30-60 cm) where the organic farming system showed lower exchangeable and non exchangeable potassium as compared to fertilized plot.

Nutrient mixtures for coconut

Soil application of Kalpa Poshak @ 100 g palm^{-1} in four splits to 20 month old Kalpa Sankara seedlings resulted in enhanced leaf potassium status (1.68%) and recorded the highest content of Ca (0.447%) and Mg (0.171%) compared to control (0.323% Ca and 0.121% Mg). The application also resulted in higher seedling height (4.01 m), number of split leaves (13) and collar girth (96.4 cm) compared to control (3.27 m height, 10.7 split leaves and 94.1 cm collar girth). One year after application of Kalpa Vardhini for adult palms (@ 500g palm^{-1}), the improvement in nut yield over the pre treatment was 8%.

Impact of harvesting tender nut and mature nut on the sustained productivity of coconut

The impact of tender nut harvesting on growth and production of coconut palm was studied in red sandy loam soil. Harvesting of tender nut throughout the year recorded significantly higher yield (187 tender nuts palm^{-1}) with 14 bunches palm^{-1} compared to other treatments *viz*., harvesting of tender nut and mature nuts for six months alternatively in a year, harvesting

tender nuts and mature nuts in alternate year, harvesting of alternate bunches for tender nut and mature nuts throughout the year. Harvesting of mature nuts throughout the year recorded the lowest yield (97 mature nuts palm^{-1}) with 12 bunches palm^{-1}. Continuous harvesting of tender nuts improved the income giving a higher net return of Rs. 2,64,768/- compared to the rest as there is higher tender nut yield and higher price for tender nuts.

Nutrient uptake by coconut grown in root (wilt) affected area

The uptake and distribution of major, secondary and micronutrients within the biomass of healthy and root (wilt) diseased palms grown in a tropical Entisol was studied. Nutrient concentration and dry matter content in the entire palm biomass were computed to estimate the total nutrient uptake. Uptake of nutrient such as N, P, K, Ca, Mg, S and B was significantly more in apparently healthy palms compared to the root (wilt) disease-affected palms irrespective of the intensity of the disease. Further, in the apparently healthy palms, potassium recorded the highest total uptake (1075 g palm^{-1}) than the other nutrients, followed by N (889 g) and calcium (389.7 g). In the case of P, the total uptake recorded by the apparently healthy palm was 109.4 g palm^{-1}. The average K uptake by the diseased palms, irrespective of the intensity, was 407.3 g palm^{-1}. The order of the total uptake of nutrients which showed a significant relation with the disease index was K>N>Ca>S>P>Mg in apparently healthy palms, whereas, it was N>K>Ca>S>P>Mg in diseased palms.

Except in the case of B, the total uptake of other micronutrients like Mn, Cu and Zn did not indicate any significant difference between healthy and diseased palms of different disease categories. The apparently healthy palm showed an uptake of 321.63 mg B palm^{-1}, whereas, it was 164.47 mg palm^{-1} in diseased palms.

Management of yellowing in coconut palms in root (wilt) affected areas

Yellowing of coconut leaves was observed in many root (wilt) affected areas. Considering that continued yellowing will lead to reduction in yield and to overcome the problem, a field demonstration trial with 40 palms was initiated in 2014 at Edava in Thiruvananthapuram district, Kerala. Soil test based application of nutrients *viz*., N (517 g), and K (1200 g) along with other inputs such as dolomite (2 kg), magnesium sulphate (500 g), coir pith compost (5 kg), trichoderma (100 g) as well as basin management with cowpea (100 g palm^{-1} basin) resulted in the gradual reduction in intensity of yellowing in leaves of root (wilt) disease affected palms, and enhancement of nut yield. The percentage of palms in the medium (31-60) and high (>60) category of yellowing intensity reduced from 52.5 to 32.4 and 22.5 to 10.8, respectively between 2014 and 2018. The percentage of palms with low intensity (<30) was 56.8 during 2018. Thus management practices had a significant impact on the reduction of yellowing, increase in soil and leaf nutrient status and nut production. The total K content in the 14th leaf which was 0.6% in 2014 increased to 1.75% in 2018. Improvement in Ca and Mg concentration was also observed after the application of treatments.

Nutrient management in dwarf coconut types

Adoption of 100% soil test based nutrient management + green manuring + vermicompost (15 kg palm^{-1}) + neem cake (5 kg palm^{-1}) consistently (for past five years) recorded the highest nut yield in the dwarf varieties *viz.,* Kalparaksha, Chowghat Orange Dwarf (COD) and Kalpasree. The yield in this treatment ranged from 45 to 101 nuts palm^{-1} year^{-1} with an average of 69 nuts palm^{-1} year^{-1}. This treatment also improved the palm health and recorded the lowest percentage of root (wilt) disease incidence (6.9). Root studies were conducted in healthy and disease advanced palms of Kalpasree and COD varieties. Observations were taken at 0-1 m, 1-2 m and 2-3 m distances from the base of the palm and four depths 0-30 cm, 30-60 cm, 60-90 cm and 90-120 cm at each distance. In healthy Kalpasree palms, the number of live primary roots were higher in 0-100 cm depth and their number increased from 30 to 120 cm at all distances. In the disease advanced CGD palm, live primary roots were more at depths 60-90 cm and 90-120 cm. In healthy COD palm, more number of primary roots were observed at 0-30 cm depth at 0-1 m distance where as more primary roots were seen in 30-60 cm layer at 1-3 m distance from the base of the palm.

Fertigation to enhance yield of hybrid coconut in root (wilt) affected area

A field experiment was initiated with different levels of nutrient application (ranging from 50-200% of soil test based values) supplied as drip fertigation and soil application of nutrient with drip irrigation in hybrid

coconut var. Kalpa Sankara. About 1/10th of fertilizer dose as per treatments were applied in the first year of planting in eight splits from February to May, 2018. Plant height ranged from 269 cm to 300 cm among the treatments and was not significantly different. Collar girth ranged from 33 cm to 38 cm and was not significantly different after first cycle of treatments (June 2018).

Soil K content in the top 25 cm was high with application of 200% of soil test based nutrient through drip (94.1 ppm) which was significant over other treatments and followed a decreasing trend from the highest to lowest quantity of nutrient application. The lowest value was noticed with soil application and drip irrigation. Leaf K status also showed the same trend with the maximum leaf K (2.1%) when 200% of soil test based nutrient was applied through drip.

Integrated nutrient management for arecanut at Kahikuchi

The future agriculture should aim at reducing dependence on fossil fuel products like chemical fertilizers and utilizing the locally available recyclable organic wastes. To work out the feasibility of such possibilities in arecanut, a trial was initiated at Kahikuchi with seven treatments having only organic and chemical fertilizers and their combinations as Integrated Nutrient Management (INM) *viz.,* no fertilizer (control), vermicompost (100%), vermicompost (200%), recommended chemical fertilizers (100%), vermicompost (50%) + chemical fertilizers (50%), vermicompost (1/3rd) + chemical fertilizers (2/3rd) and vermicompost (2/3rd) + chemical fertilizers (1/3rd). Among the different treatment combinations, application of vermicompost (2/3rd) + chemical fertilizers (1/3rd) recorded the maximum chali yield per palm per year (2.56 kg) followed by application of vermicompost (50%) + chemical fertilizers (50%) which recorded 2.49 kg chali palm^{-1} year^{-1}.

High density planting of cocoa in arecanut

High density planting is being followed in many crops like cashew, mango etc. which are amenable for pruning, with higher economic benefit. Feasibility of adopting this concept in cocoa was envisaged since cocoa is amenable to pruning. Grafts of cocoa variety Nethra Centura was planted during 2017 as a mixed crop with arecanut (var. Nalbari) in five different spacing's (S1: 1.35 m x 1.35 m x 2.7 m; S2: 1.35 m x 1.35 m; S3: 1.35 m x 2.7 m; S4: 2.7 m x 2.7 m; S5: 2.7 m x 5.4 m) with planting density ranging from 650 to 3712 plants ha^{-1}. The plant height in closely planted cocoa was restricted to 60 cm. The restriction of stem height by pruning and tipping produced more primary branches and thicker main stem. The stem girth was observed to be significantly higher in closely planted cocoa (11.9 cm) than wider spaced plants.

Techno-socio-economic assessment of soil and water conservation and water harvesting structures

Evaluation of technical soundness of water harvesting/ conservation structures

Loose Boulder Check Dam (LBCD) constructed using boulders from the vicinity of the check dam and Dry Rubble Check Dam (DRCD) constructed using blasted granite stones obtained from nearby granite quarries were investigated. Weight and shape of the construction materials were the major variants between these check dams. A total of 763 LBCD and 712 DRCD were randomly selected from different watersheds all over the state to study their stability. The check dams were ranked based on the stability after three rainy seasons. Among the 1475 temporary check dams, only 449 check dams (nearly 30%) were found to be intact and 545 check dams (nearly 37%) were found to be damaged. The stability of LBCD (only 19% were intact) was much inferior to that of DRCD where 43% of the dams were intact. Among the different methods of construction adopted, it was found that the cement concreting provided at the top of the check dam improved its strength. When 62% of the check dams provided with the cement concreting withstood three rainy seasons, only 21% of check dams without cement concreting remained intact.

Impact of water harvesting/ conservation structures to augment surface/ sub surface water resources

Ground water contributions from 36 check dams (12 constructed to irrigate rice and 24 constructed as percolation tank) were monitored. Average water depletion rate (sum of percolation and evapo-transpiration) was 2.5 cm day^{-1} in majority of the rice fields. Reservoirs of 12 check dams and its command area of rice fields contributed 20,50,716 m^3 of water,

with major (99.86%) contribution (20,47,822 m^3) from the rice fields because of the large command area as compared to the reservoir. The ground water contribution from reservoirs of 24 check dams which were not utilized for irrigating rice was a meager, 81,400m^3 only. The study revealed that the irrigation water potential and the local groundwater potential increased due to the construction of check dams. Average rise in water table was 78 cm with its sphere of influence <100 m in check dams constructed as a percolation tank. On the other hand, the rise in water table was 89 cm (sphere of influence>2km) in check dams constructed to irrigate rice fields.

Socio-economic impact of water harvesting/ conservation structures

Efficiency of the check dam improves by adopting proper maintenance activities such as silt removal and bed scratching at periodical intervals. However, these maintenance activities were not properly performed in many sites thereby reducing their storage capacity. Water harvested by the check dam improved the income and livelihood of people mainly due to the sustained agriculture and increased availability of water for various uses, especially for drinking. It could be concluded that managed aquifer recharge (MAR) through check dam was found to be one of the efficient methods to improve irrigation and livelihood of community.

Bio resource management in coconut, arecanut and cocoa

Microbial succession in soils of permanent manurial trial

Microbial analysis of soils (up to 30 cm depth) in rhizosphere region of coconut palms under permanent manurial trial was carried out using culture-dependent method, employing both general and differential culture media. Both general and function-specific microbial groups were studied and the results showed ecological succession of microbiota in response to environmental factors. Microbial succession pattern showed higher prevalence of fungi (Fig.3.4a) during summer months (pre-monsoon), taken over by general bacterial community (Fig.3.4b) including phosphate-solubilizers (Fig.3.4c) during the period of higher precipitation (monsoon), followed by a spurt in the population of fluorescent pseudomonads and nitrogen fixers after the rains receded (post-monsoon). Actinomycetes

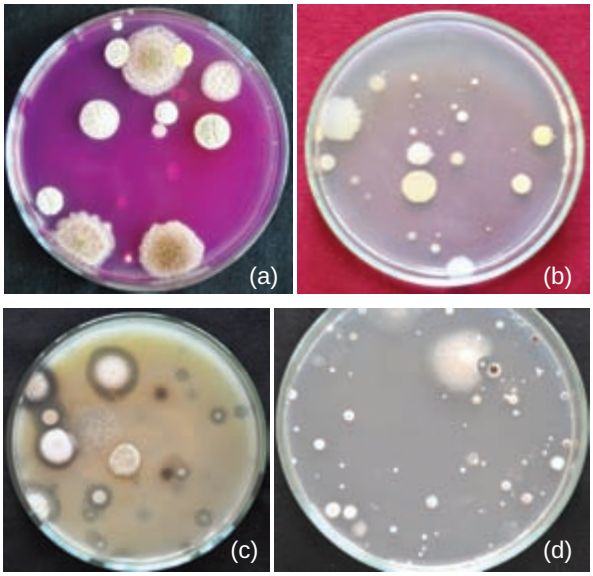


Fig. 3.3. Different groups of microorganisms –Fungi (a), Bacteria (b), Phosphate Solubilizers (c) and Actinomycetes (d) -enumerated in coconut rhizosphere soils in different seasons

(Fig.3.4d) group remained stable throughout with an occasional peak and dip during wet and warm season, respectively.

Microbial community in the rhizosphere and endophytic matrix of healthy coconut palms in root (wilt) disease affected tracts

Screening and identification of phytobeneficial rhizobacteria associated with healthy coconut palms in RWD tract of Kerala was carried out. One hundred and ten rhizobacterial isolates were screened *in vitro* for IAA production and solubilization of fixed forms of mineral nutrients. Among these, 54 isolates produced IAA in tryptophan-supplemented nutrient broth. Among the nutrient solubilizers, silicate solubilizers (57%) and phosphate solubilizers (48%) dominated. Zinc and potassium solubilization potential was observed in 21% and 16%, of the tested isolates, respectively. Seven isolates *viz.,* K_1HPSB_1, K_3HPSB_1, K_3HPSB_2, T_4HFB_9, T_4HFB_{11}, T_2PSB_3, T_6PSB_1 showing multiple phytobeneficial properties (IAA production, P, Zn, Si and K solubilization) were identified using biochemical tests and 16S rRNA gene sequencing. Five of the rhizobacterial isolates belonged to Enterobacteriaceae family including three *Enterobacter* spp. The isolate T_4HFB_9 belonged to *Acinetobacter* sp. of Moraxellaceae family under class Gammaproteobacteria. Another Gammaproteobacteria, the green fluorescent *Pseudomonas* isolate K_3HPSB_2, showed 99% sequence similarity with *Pseudomonas migulae* (Pseudomonadaceae) (Fig.3.4).

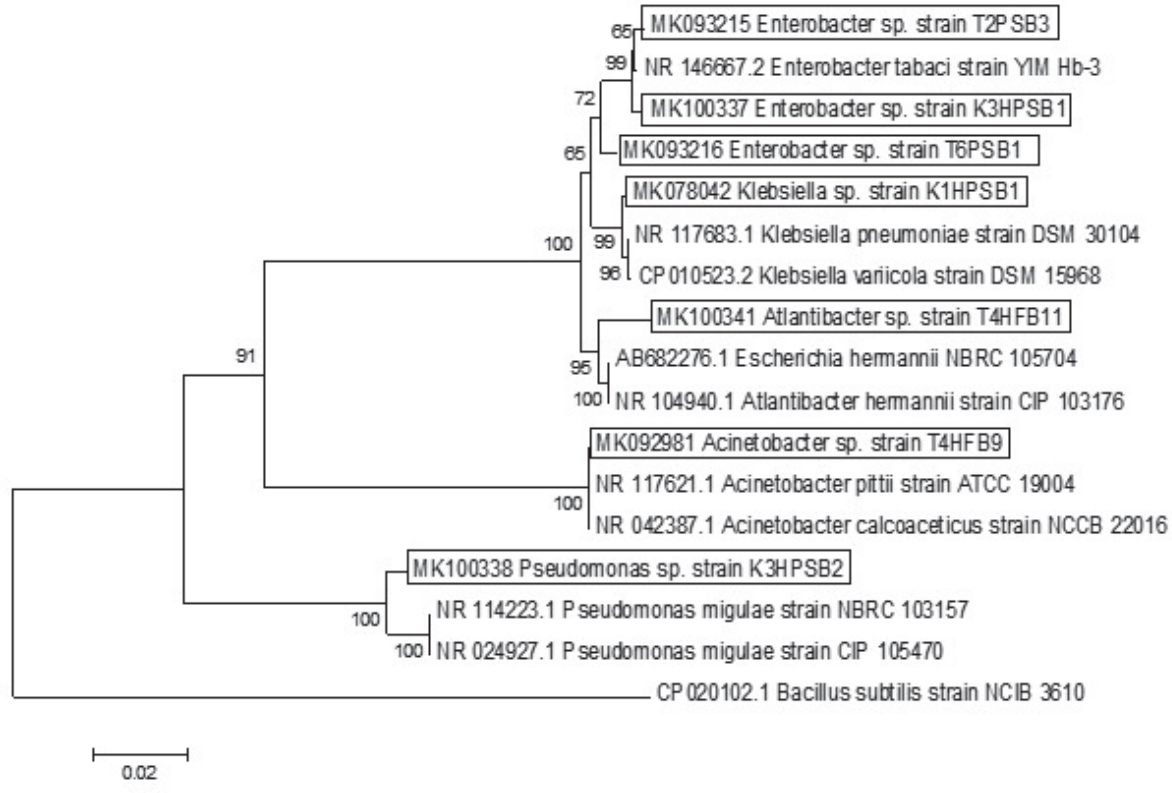


Fig. 3.4. Phylogram showing the genetic relationship among the PGPR strains and their closely related bacteria obtained from NCBI database

Seventeen root endophytic bacteria (isolated from healthy high yielding coconut palms in RWD tracts) with distinct colony morphotypes were screened for phytobeneficial traits. Of these, nine bacteria produced indoleacetic acid ranging from 0.2 to 4.7µg/mL. Six of 17 bacteria grew on nitrogen (N) free media indicating their N fixing potential, among which four were IAA producers. Seven isolates utilized ACC as their sole N source indicative of their ACC deaminase activity, of which four had nitrogen fixation and three had IAA production potential. Three isolates CRE2, CRE9 and CRE15 with all the above plant growth promoting traits were selected for further characterization. All the three bacteria were Gram positive rods with indole negative and catalase positive reactions. Based on 16S rRNA sequence analysis, CRE 2 and CRE 9 were identified belonging to *Bacillus subtilis*, while CRE 15 showed close similarity with *Bacillus shackletonii*. Based on these results, rhizobacterial consortium consisting of four selected strains of *Pseudomonas* sp., *Azospirillum* sp. and *Bacillus* sp., possessing multiple phytobeneficial traits was formulated. Comprising both epiphytic and endophytic microbes, isolated and screened from the rhizosphere of root (wilt) disease tolerant coconut palms, this consortium was found to have growth promoting effect in maize (Fig. 3.5). Evaluation of rhizobacterial consortia for growth promotion and disease suppression effects in coconut palms are in progress.

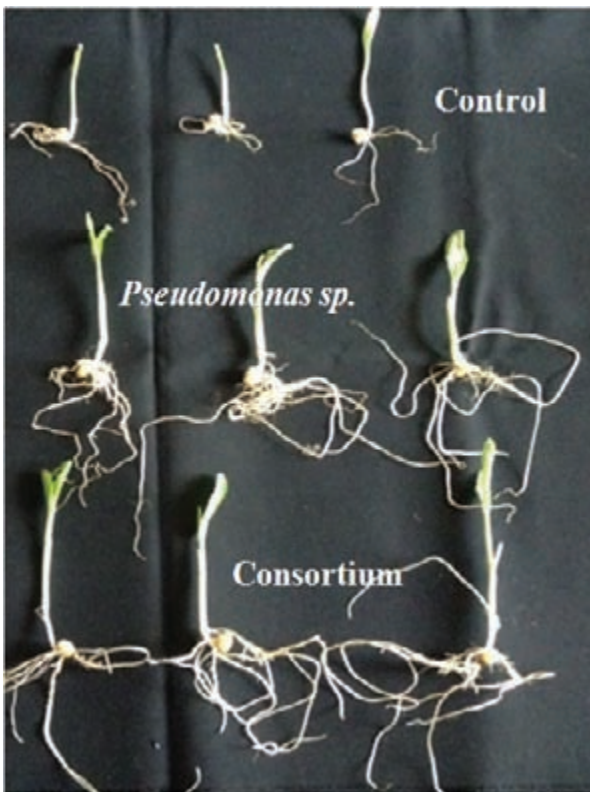


Fig. 3.5. PGPR in vitro evaluation studies

Biological studies of soil in yellow leaf disease (YLD) affected areas

Rhizosphere soil samples were collected from the traditional gardens and new plantings in low land paddy converted soils, comprising healthy and YLD infected arecanut gardens of Sullia, Karnataka and novel rhizobacteria *viz*., *Burkholderia* spp (AREB7, AREB11, ARsB9), *Delftia* sp. (RBC18-33), *Bacillus* spp. (*Bacillus tropicus* ARsB8, *Bacillus megaterium* RBC18-5, *Bacillus* sp. RBC18-11, RBA18-26), *Acinetobacter* sp. (RBC18-17; ARsB4; RBC18-2 ; RBA18-4; RBA18-13; RBC18-17) and *Pseudomonas* sp. (RBC18-25; RBA18-9) were isolated and studied for *in vitro* ACC deaminase and multiple mineral solubilization potential, aluminium tolerance and for their *in vivo* growth promoting potential in test crops (field pea and maize). *Burkholderia* sp. ARsB9 talc based formulation was studied and the shelf life was about seven months.

Composting of coconut husks

A two-stage approach for composting of tender and mature coconut husks has been developed. The first stage involved aerobic composting using earthworm gut microbiota with organic amendments and second phase using coconut leaf vermicomposting earthworms. Analysis of soils + coconut husk composts used as a potting mix to raise vegetables showed improved soil moisture retention and increased microbial populations involved in nutrient mineralization.

NGS-based metagenomic analysis of coconut husk composts

Microbiomes of mature and tender coconut husk composts, produced using a semi-static composting process, were analyzed by sequencing of metagenomic DNA from composts using culture-independent method targeting the hypervariable region of the gene encoding for 16S ribosomal RNA. The sequencing methodology adopted allowed sequencing of both culturable and non-culturable microbes directly from compost samples, providing insight into the biomass degradation-related microbial community composition. The microbiomes of both matured and tender coconut husk composts consisted of distinctively higher OTUs of Actinobacteria, Bacteroidetes, Chloroflexi, Candidate Division TM7, Acidobacteria and Verrucomicrobia compared to uncomposted coconut husks (Fig. 3.6). Candidate division TM7, now known as candidates *Saccharibacteria*, which remains unculturable to date, gave amplification during composting process and is known to possess a very versatile carbon metabolism.

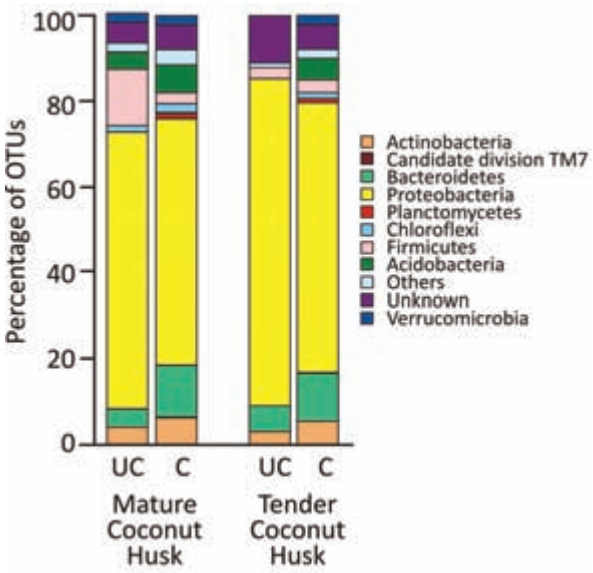


Fig. 3.6. Taxonomic assignment of bacterial phyla in the coconut husk composts (UC-Uncomposted; C-Composted)

Arecanut microbial consortia for Kahikuchi soils

Four bacterial isolates with multiple nutrient solubilization capacities along with nitrogen fixation ability were identified from a collection of 17 putative plant beneficial bacteria isolated originally from arecanut rhizosphere soils under organic and INM cultivation. These four isolates were identified as *Pseudomonas* sp., *Acinetobacter* sp. And *Burkholderia* spp. by PCR amplification of 16S rRNA gene using the universal primers F27/R1492 and Sanger's sequencing and the partial 16S rDNA sequences were submitted to NCBI (GenBank No. 121052, 121063-65). Two of these (*Pseudomonas* sp. and *Acinetobacter* sp.) were selected for developing microbial consortia formulation for arecanut for Kahikuchi soils based on their compatibility and higher solubilization potential of inorganic phosphorus, zinc and silicate.

Ecological tolerance of Kera Probio® bioinoculant

Kera Probio® is a talc-based bioinoculant recommended by ICAR-CPCRI for application in coconut seedlings to improve their health and vigour. After application, several environmental conditions impact its survival and performance in field. Hence, conditions such as

temperature, pH and salt levels for which it is best adapted were determined. Tolerance range of this bioinoculant for pH was much narrower (6.2-8.2) than for temperature (15-50°C) and salt levels (0.5-10% NaCl). The results suggest suitability of this bioinoculant even for salt-affected soils in high temperature zones. However, for acidic soils with pH<6.0, dolomite or lime application is desirable to correct the pH before application of this bioinoculant.

Macrofungi diversity in coconut gardens of ICAR-CPCRI

Macrofungi are just like other fungi albeit differing in their fruiting structures that are called mushrooms. Biomass of these macrofungi consists of largely unseen mass of interwoven thread-like hyphae growing in soil and/or plant tissues. These macrofungi become visible when fruiting bodies or mushrooms emerge above ground, their timing and production dependent on temperature and precipitation. So, these macrofungi can be described as fungi with large fruiting bodies such as mushrooms, brackets, or conks. Many different species of macrofungi appear naturally in the farms (coconut plots) of CPCRI (both Kasaragod and Kayamkulam) during the South-West monsoon, from early July to September period. Drenching of soil from monsoon rains after dry summer spell lead to germination of dormant spores and underground growth of a network of mushroom mycelium and the tropical humid climate with intermittent wet and dry periods aid in their emergence and induce physiological changes in fungal mycelium for fruiting body formation. Epigeous fruiting bodies of a host of macrofungi emerged naturally in various coconut plots of ICAR-CPCRI and with the assistance of experts from JNTBGRI, Thiruvananthapuram and NCMR, Pune for their definitive identification, were identified, as - *Polyporus arcularius, Daldinia concentrica, Volvariella volvaceae, Agaricus trisulphuratus*, *Termitomyces heimii*, *Macrocybe gigantea*, *Lentinus squarrosulus*, *Trametes* sp., *Gymnopilus zenkeri, Termitomyces eurrhizus, Leucocoprinus zeylanicus*, *Lenzites betulina*, *Macrocybe lobayensis*, *Volvariella* sp., with These macrofungi mainly belonged to the order Agaricales and high levels of humidity experienced during this period helped them to flourish. They were found growing solitary or in clusters in soil or on rotting plant debris in the coconut experimental plots. Among the macrofungi, saprophytic, symbiotic and parasitic types were observed. Most of them were mutually beneficial to ecosystem components.

Polypores (wood rotters) were the most commonly observed macrofungi, ranging from those growing in association with young coconut seedlings to some found colonizing a particular cropping system plot indicating their preference for specific substrates. Many of these macrofungi encountered in coconut gardens were assemblage of white-rotting lignicolous basidiomycetes, decaying litter and wood, providing critical ecological services through nutrient cycling and thus increasing soil fertility.

Termitomyces heimii, also called termite-fungus, was found in clumps, each clump with large number of epigeous sporocarps. *T. heimii*, symbiotically associates with termites and is an excellent edible mushroom, considered a delicacy in Kerala. *Macrocybe* spp., reported from both Kasaragod and Kayangulam farm, grew where there was buried rotten wood and are one of those giant wild edible mushroom species which can be cultivated (tastes like milky mushroom). However, parboiling before cooking is recommended for *M. lobayensis* to remove traces of hydrocyanic acid that is present. Microfungi diversity is shown in Fig. 3.7 to 3.21.

Fig. 3.7. Termitomyces heimii

Fig. 3.8 . Trametes sp.

Fig. 3.9. Volvariella sp.

Fig. 3.10. Agaricus trisulphuratus

Fig. 3.11. Macrocybe gigantea

Fig. 3.12. Leucocoprinus zeylanicus

Fig. 3.13. Macrocybe lobayensis.

Fig. 3.14 Polyporus arcularius

Fig. 3.15. Daldinia concentrica

Fig. 3.16a. Gymnopilus zenkeri

Fig. 3.16b Gymnopilus zenkeri bottom view

Fig. 3.17. Lentinus squarrosulus (Lower surface)

Fig. 3.18. Agaricus spp.

Fig. 3.19. Termitomyces eurrhizus

Fig. 3.20. Bracket fungus - Lenzites betulina

Fig. 3.21. Armillaria sp., a parasitic fungus

Farmer friendly method of bioinoculant production

A farmer-friendly method for mass-production of bioinoculants utilizing a blend of mature coconut water, rice gruel and biochar, which are locally available, was standardized. Using this method, contaminant-free bioinoculants can be mass-produced from starter cultures by farmers themselves, on their own farm, for immediate field application. The method is easily comprehensible by the farmers and does not require any costly instrument/equipment. The method was found suitable for mass-production of both bacterial and

fungal inoculants, including 'Kera Probio' and Cocoa Probio' cultures, which could attain their satisfactory viable population.

Organic nutrient management of coconut in root (wilt) disease affected tracts

Field experiment on nutrient management through organics for coconut in root (wilt) disease affected tract is being conducted at farmer's plot in Bharanikkav panchayath, Alappuzha district, Kerala. The treatments are: *in situ* organic matter recycling, + PGPR (Kera Probio) + *in situ* green manuring + Husk burial (T_1); *in situ* organic matter recycling, + PGPR (Kera Probio) + *in situ* green manuring + 25 kg cow dung (T_2); T_1 + 50 % recommended K_2O applied through sulphate of potash (T_3); T_2 + 50 % recommended K_2O applied through sulphate of potash (T_4) and chemical fertilizer application (T_5).

After four years, palms supplied with 50% recommended K_2O through sulphate of potash along with *in situ* organic matter recycling, green manuring and Kera Probio (100 g palm^{-1} year^{-1}) recorded higher nut yield (55.8 nuts palm^{-1} year^{-1}) with the lowest percentage of barren nuts, the reduction being 9.1% (12.5% to 3.4%).

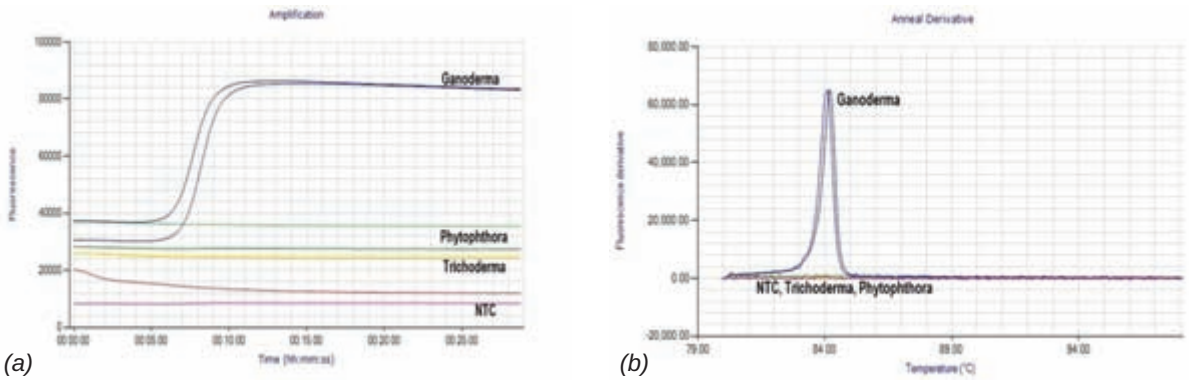
4. Integrated Management of Diseases

Diseases caused by the fungi *viz*. *Phytophthora* and *Ganoderma*, and phytoplasma are the major impediments of coconut and arecanut. Besides, the diseases caused by other pathogens namely *Lasiodiplodia theobromae, Thielaviospsis paradoxa* and *Colletotrichum* spp. have re-emerged in plantation crops. Though integrated diseases management strategies have been developed and refined over the years, these diseases cause considerable loss to plantation crops. Early and accurate diagnosis of diseases caused by these pathogens at field level is essential for effective management. Hence the present research work is focused on the development of diagnostics, characterization of pathogens and refinement of integrated disease management strategies.

Disease diagnostics

Molecular diagnosis of *Phytophthora* sp. and *Ganoderma* sp. associated with coconut

A loop-mediated isothermal amplification (LAMP) protocol for detection of *Ganoderma* sp. causing basal stem rot disease of coconut was developed using 'Genei® II' real-time LAMP reader. The LAMP primers targeted the small subunit ribosomal RNA gene of *Ganoderma* sp. The LAMP assay was successful as amplification, specific for *Ganoderma* sp. including DNA from pure culture of *Ganoderma* and from the symptomatic roots, was obtained. Non-target fungal pathogens such as *Phytophthora* and *Trichoderma* sp. did not show amplification (Fig. 4.1). External primers



(a) (b)

Fig. 4.1. Amplification plot (a) and annealing peak (b) of Ganoderma sp.

were used to amplify the target regions for validation. LAMP protocol for detection of *Phytophthora* species associated with coconut was also standardized using LAMP primers that are specific for internal transcribed spacer (ITS) region and *Ypt1* gene of the pathogen.

Identification of pathogen associated with dieback disease of cocoa

Severe dieback type disease symptoms were observed in cocoa plantations established in West Godavari district of Andhra Pradesh and also in Kasaragod region of Kerala state. The symptoms were characterized by initial yellowing of a few leaves in the terminal portion of the lower or middle branches which eventually dries up in two to three days. The drying starts from the tip of the branches and progresses downwards. Consequently, affected plants continue to decline and soon die (Fig. 4.2).

Three *Lasiodiplodia* strains, associated with this disease, were isolated from infected samples collected from Andhra Pradesh and Kerala states. These strains are characterized by grey color colonies with dense aerial mycelium, oval-shaped conidia, initially hyaline and then brown (20-25 × 10-16 µm in size) with a single septum and longitudinal striations (Fig. 4.3). Molecular identification of the pathogen was performed by sequencing the internal transcribed spacer (*ITS*), actin and beta-tubulin loci and a PCR assay with *L. theobromae* species specific primer (Fig.4.4). Pathogenicity tests further demonstrated that *L. theobromae* was the pathogenic organism associated with this disease in cocoa.

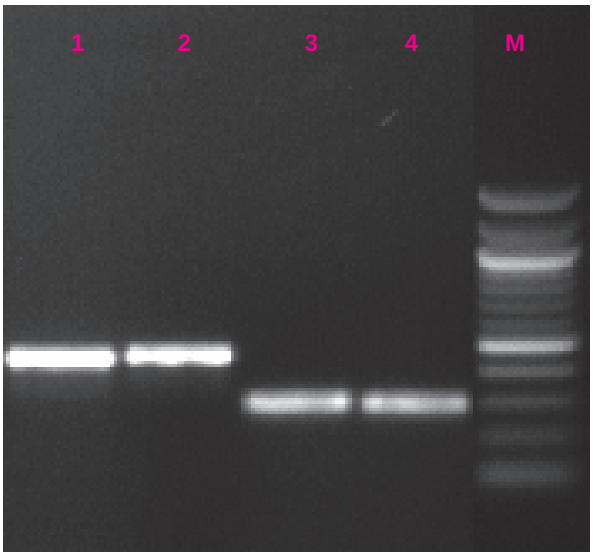


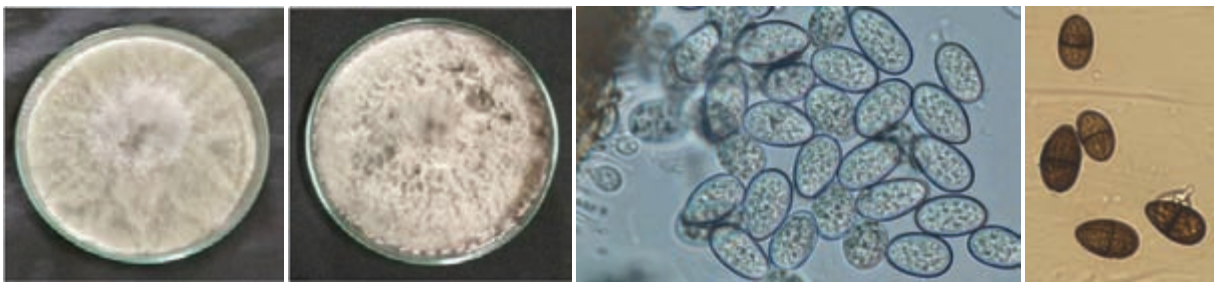
Fig. 4.4. PCR amplification of L. theobromae with β-tubulin (Lanes 1, 2) and actin (Lanes 3, 4), M:100 bp ladder

a) *Initial yellowing of leaves at the tip of branches*

b) *Drying of leaves and branches*

c) *Development of fungus on infected twigs*

Fig. 4.2. Symptoms of cocoa dieback disease



a) b) c) d)

Fig. 4.3. Morphology of L. theobromae: colony on potato dextrose agar plates (a & b), immature and mature conidia with striations (c and d)

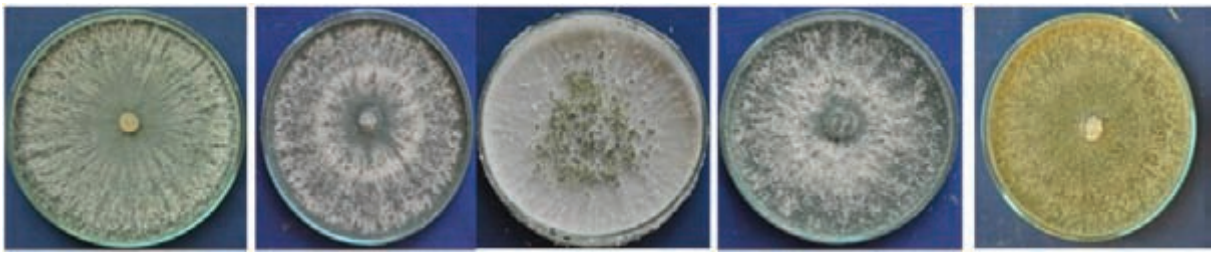
Collection and characterization of *Trichoderma* from arecanut based cropping system

A total of 30 *Trichoderma* strains were isolated from soils collected from different arecanut-based ecosystem such as arecanut monocrop, arecanut + cocoa, arecanut + pepper. These strains were identified based on morphological features (Fig. 4.5) and molecular confirmation of these strains is in progress. These native strains of *Trichoderma* have potential in arecanut disease management.

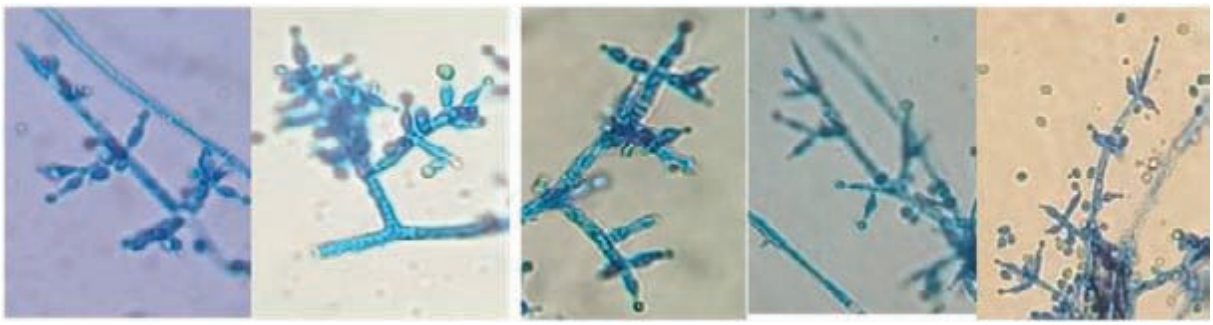
Disease management

Screening of fungicides against leaf rot pathogens

Leaf rot is an important fungal disease of coconut prominent in root (wilt) affected palms. The recommended management practice for controlling the leaf rot is by sole application of Hexaconazole 5EC @ 2 ml in 300 ml of water. Continuous application of the same fungicide over a long period may lead to build up of resistance. Hence, alternate fungicide spray in rotation is very essential for sustainable disease management practices. Hence, eight different fungicides were tested *in vitro* at various concentrations (0.025%, 0.05%, 0.075% and 0.1%) against leaf rot pathogens *viz.*, *Colletotrichum gloeosporioides* (Fig. 4.6) and *Fusarium* sp. (Fig. 4.7). Hexaconazole 5 EC was used as positive control. Among the fungicides tested *in vitro*, Thiophanate methyl 70% WP, Tebuconazole 25% EC and Flusilazole 12.5% + Carbendazim 25% EC were found to be effective and selected for field evaluation.



A



B

Fig. 4.5. Morphology of Trichoderma sp.: colony on potato dextrose agar plates (A), conidiophore and conidia (B)

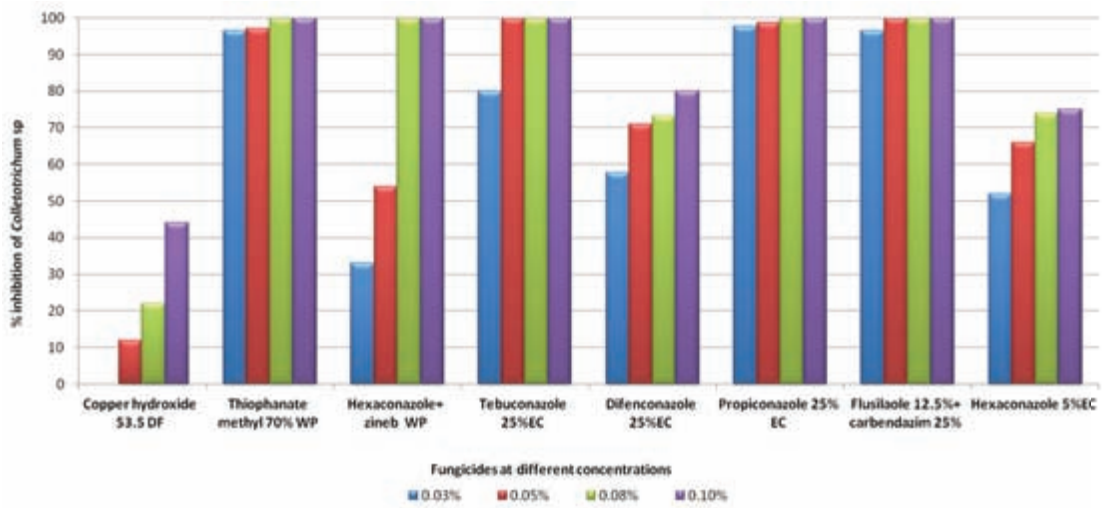


Fig. 4.6. Inhibition of Colletotrichum sp. at different concentration of fungicides

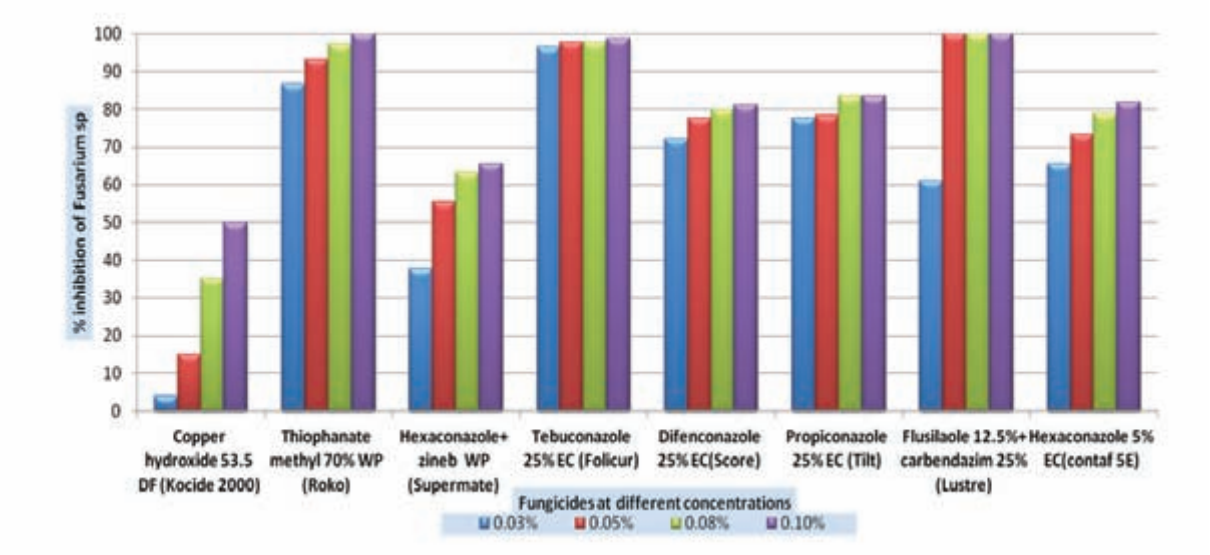


Fig. 4.7. Inhibition of Fusarium sp. at different concentration of fungicides

Management of stem bleeding disease of coconut

Field trial on the management of stem bleeding disease of coconut with different treatments involving fungicides like Hexaconazole 5 EC, Propiconazole 25 EC and *Trichoderma harzianum* (CPTD28) was conducted at Maicha, Kasaragod district of Kerala. Treatments were imposed at quarterly intervals after recording pre-treatment disease index. Significant reduction in disease index was recorded in all the three treatments such as Propiconazole 25 EC, Hexaconazole 5 EC and *Trichoderma harzianum* from 23.1 to 15% as compared to control (28.4%).

Demonstration of arecanut fruit rot disease management with Mandipropamid

Demonstration of fruit rot disease management using two selected fungicides *viz.*, 1% Bordeaux mixture and 0.5% Mandipropamid 23.3% SC was carried out at Vittal during 2018 monsoon season. The fruit rot disease incidence and severity was regularly monitored from June to September. There was 9% disease incidence and 7% severity with Mandipropamid 23.3% SC, while the respective indices were 22% and 19.4% with Bordeaux mixture (Fig. 4.8).

Management of inflorescence dieback disease of arecanut

Field trial to manage the inflorescence dieback disease of arecanut was conducted at Vittal using six selected fungicides such as Carbendazim 25% EC + Flusilazole 12.5% SC, Carbendazim 12% EC + Mancozeb 63%

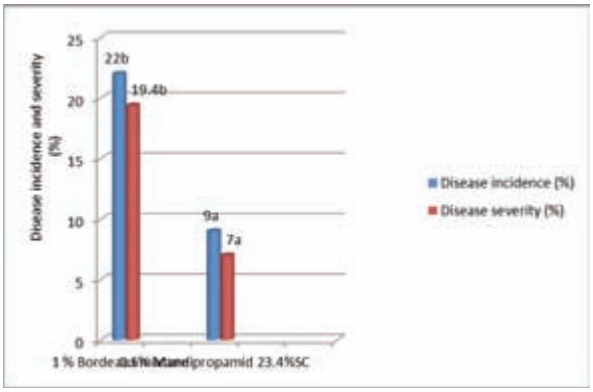


Fig. 4.8. Effect of prophylactic spraying with Mandipropamid (0.5 %) and Bordeaux mixture (1%) on arecanut fruit rot disease incidence and severity

WP, Propiconazole 25% EC, Chlorothalonil 78.12% WP, Zineb 68% WP + Hexaconazole 4% WP and Mancozeb 75% WP. Treatments were imposed at 30 days interval and observation on disease incidence was recorded during February to April. Carbendazim 25% EC + Flusilazole 12.5% SC treatment was found to be effective and recorded relatively less disease incidence (4.2%) followed by Propiconazole 25% EC (5.3%) and Chlorothalonil 78.12% WP (7.2%) as compared to control (20%).

Lethal wilt disease of coconut palms in Tamil Nadu

A new lethal wilt disease (LWD) of coconut palm was found prevalent in Mannargudi block in Tiruvarur district; Pattukottai, Orathanadu and Madukkur blocks in Thanjavur district and Aranthangi and Alangadi in Pudukottai district of Tamil Nadu. The average disease incidence was found to be 1.46%. The symptoms of the

a) b) c) d)

Fig. 4.9 (a-d): Symptoms of lethal wilt disease of coconut observed in Tamil Nadu

disease commence as abnormal shedding of fruits of all stages, inflorescence necrosis, yellowing and drying of leaves that progress from outer whorls to the spear region. The affected palm dies within 3-5 months after appearance of the disease symptoms (Fig. 4.9 a-d).

Inflorescence and spear leaf samples were collected from 60 symptomatic palms for etiological studies. DNA was isolated and subjected to PCR detection using phytoplasma specific primers P1/P6-R16F2n/ R16R2 and samples from 59 palms tested positive for phytoplasma corroborating the association of phytoplasma with the disease**.** The amplicons obtained from primary PCR were sequenced and the 16SrRNA sequences (GenBank Accession No. KY814724, MK617534) showed more than 99 per cent similarity with Aster yellows group phytoplasma. Based on the 16S rRNA sequences and virtual RFLP, the phytoplasma

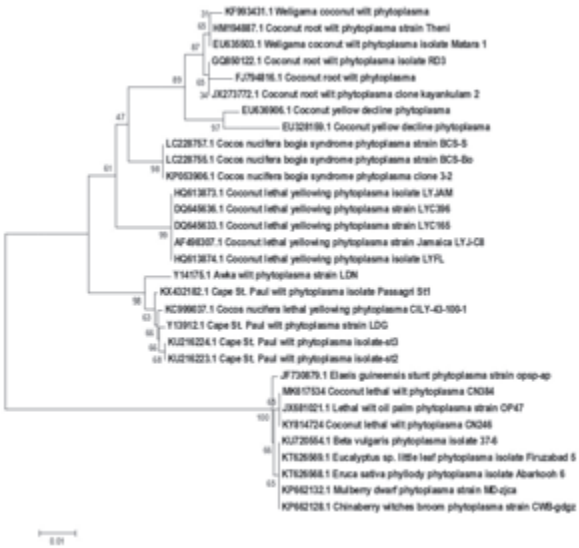


Fig. 4.10. Phylogenetic tree comparing 16S rDNA sequences of coconut lethal wilt disease phytoplasma with other phytoplasma groups infecting coconut

associated with lethal wilt disease has been identified as '*Candidatus* Phytoplasma asteris'-related strain belonging to 16SrI group (Fig. 4.10). The ribosomal protein (GenBank Accession No. MK614890), *SecY* and elongation factor (*Tu*) gene (GenBank Accession No. MK614889) sequences also showed 99% similarity with '*Candidatus* Phytoplasma asteris'.

The occurrence of disease was found to be non-aggregated and random suggesting the pattern of spread as leaps and jumps with the possible involvement of insect vectors in disease transmission. The preliminary surveys and light trap catches from diseased tract could not reveal any putative vector and search for the vector is in progress.

5. Integrated Management of Pests and Nematodes

Coconut rhinoceros beetle, *Oryctes rhinoceros*

Explorative surveys in coconut gardens in Kerala indicated natural incidence of OrNV infecting the black beetle grubs to the tune of 0.8% to 1.0%. Oral inoculation of OrNV into the grubs of rhinoceros beetle under laboratory conditions resulted in >90% susceptibility, indicating absence of Guam strain in the country. Entry of rhinoceros beetle through the collar region in juvenile palms is a serious challenge. Also, infrequent instances of tender nuts being bored by rhinoceros beetle are observed suggesting varied feeding options by the pest in the coconut system. A systematic monitoring and regular hooking out of beetles is re-emphasized in juvenile palms. Botanical formulations, applied in the form of pellets and paste on the spear leaf region, shielded the juvenile palms from rhinoceros beetle attack for three months. Application of botanical formulations also reduced frond damage by 72.5% compared to 67.5% reduction with chlorantraniliprole granules ($t<0.05$).

Nylon nets as passive trap

Protecting the vulnerable pest entry points in juvenile palms with nylon netting, *viz*., spear leaf base and adjoining leaf axils, proved effective in reducing pest incidence due to trapping of the rhinoceros beetles in the nets. During the 30 weeks of monitoring period (May 2018 to Dec 2018), 618 beetles (comprising 68% female and 32% male) were trapped from a plot of 120 juvenile palms. Per cent leaf damage was also reduced from 62.18 to 25.49 indicating that this component could be integrated with IPM packages for sustainable management of rhinoceros beetle in coconut plantations.

Ecological engineering

Engineering cropping pattern with coconut (Kalpa Sankara hybrid) and intercrops (nutmeg, rambuttan, banana, curry leaf, papaya and tuber crops) can be practiced to disorient the pests due to diversionary volatile cues. In this crop pluralism strategy, incidences of rugose spiralling whitefly, rhinoceros beetle, red palm weevil and eriophyid mite were found to be lower than in monocropped gardens. In addition, more number of vermicasts and pest defenders were observed. Entry and traverse movements of pollinators and natural enemies could disorient the coconut pests to a greater extent. A significant attraction of honey bees on coconut and coral vines was observed (Fig. 5.1). In this plot of 39 palms, in the root (wilt) disease endemic zone of Kerala, the average yield of Kalpa Sankara was found to be 181 nuts $palm^{-1}$ $year^{-1}$.

Fig. 5.1. Crop-habitat diversification for pest regression

Red palm weevil, *Rhynchophorus ferrugineus* Olivier

A prototype to detect the vibrations and acoustic signals from feeding grubs of red palm weevil was designed in collaboration with M/s Resnova, Kochi. The detector comprises of a sensor for acoustic detection and an electronic hardware for noise cancellation and signal amplification. Extensive field trials are being conducted to obtain consistency in signal capture. In the laboratory, capture of signals produced by the artificially introduced feeding grubs inside the coconut petiole was successful. Using independent component analysis and spectral subtraction techniques, the noise cancellation approaches were employed to separate the feeding signals of the grubs from unwanted noise (Fig. 5.2). Thus, acoustic signals produced by the grubs while feeding inside the coconut petiole had been successfully separated and filtered off from the ambient noise data (Fig. 5.3 & 5.4).

Fig. 5.2. Sensor and custom hardware developed by M/s Resnova for data collection (III iteration V2.1)

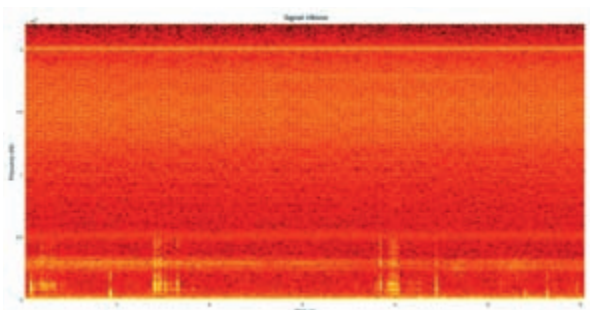


Fig. 5.3. Mapped zone plotted to frequency domain with the corresponding elements of the grub signals and the ambient noise.

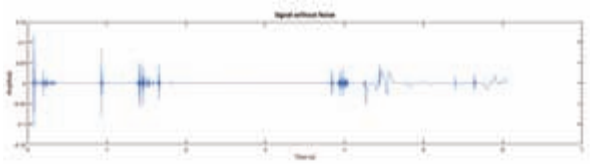


Fig. 5.4. Signal free from ambient white noises with prominent signals from feeding grub only

Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin

New distribution record

Geographic spread of rugose spiralling whitefly (RSW) was confirmed from the pest incidences in Nalbari and Kamrup districts of Assam infesting coconut, arecanut, ornamental yellow palm, banana and crotons during August 2018. Nevertheless, natural parasitism by *Encarsia guadeloupae* in RSW samples collected from these two districts was found to be 82.1%. The neuropteran predator green lacewing, *Pseudomallada astur* was also observed in Madhapur, Nalbari district where the pest population showed a declining trend. RSW population has witnessed a reduction immediately after monsoon in Andhra Pradesh and Tamil Nadu. However, increased incidence was noticed in certain gardens during winter months.

Seasonal incidence and displacement dynamics of rugose spiralling whitefly on coconut

Rugose spiralling whitefly incidence, at monthly intervals, was studied at Kayamkulam. In a 10 year Kalparaksha plantation, about 72% palms were infested by RSW, with 29.9% leaf infestation. Percentage leaflet damage/leaf was at 27%-41% during the period June-July 2018 and 23.7%-53.7 % during September 2018 to March 2019. RSW population ranged from 58-60/leaflet during June and July 2018 with percentage parasitism ranging from 63%-68%. RSW were totally wiped out by heavy rains in Alappuzha district, Kerala during August 2018 and the pest build up was observed from September 2018 with 7.3% leaflet damage and 18.46% parasitism by *E. guadeloupae.* Parasitism by *E. guadeloupae* steadily increased to 42%-50% during October-November along with increase in pest population (Table 5.1, Fig. 5.5).

Table 5.1. Life stages of RSW and parasitism by *E. guadeloupae*

Month	Average population of RSW leaflet^{-1} (number ± SE)				Parasitism by *E. guadeloupae* (%)
	Colony	Adult	Egg	Nymphs	
June 2018	8.9±1.05	3.1±0.83	41.9±3.35	10.8±1.27	69.5±1.86
July	8.4±0.77	2.2±0.71	48.4±4.48	7.4±0.66	64.6±1.68
August	0.00	0.00	0.00	0.00	0.00
September	3.3±0.64	1.7±0.69	45.6±4.80	3.1±0.83	18.5±4.69
October	4.4±0.67	2.4±0.74	59.4±5.39	21.5±2.82	42.1±2.66
November	4.2±0.69	2.2±0.69	50.8±3.93	11.5±2.73	50.7±3.50
December	8.7±1.16	3.1±0.67	8.4±3.70	41.9±5.73	23.9±7.54
January 2019	5.3±0.77	1.7±0.54	34.3±6.44	11.0±5.41	47.4±7.69
February	3.9±0.43	7.0±0.84	26.6±2.23	23.2±2.89	38.5±5.20
March	10.9±1.96	2.9±1.99	12.9±3.77	11.1±1.54	40.8±3.84

During December 2018, incidence of nesting whiteflies, *Paraleyrodes bondari* and *Paraleyrodes minei* was found to co-exist along with RSW. *E. guadeloupe* parasitism dropped to 23.8% during December 2018 due to displacement of RSW by nesting whiteflies, which are not parasitized by the aphelinid parasitoid. The nesting whiteflies co-existed with spiraling whitefly and outnumbered RSW during January to March 2019.

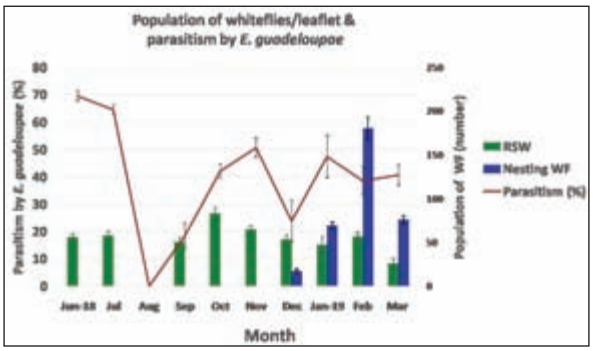


Fig. 5.5. Seasonal incidence of various whiteflies on coconut palms and parasitism (%)

Mass production of natural enemies of rugose spiralling whitefly

Rearing of RSW, on banana, custard apple, arrow root and soursop was unsuccessful. However, partial establishment of RSW was observed on Chowghat Orange Dwarf coconut seedlings. Though, RSW could lay eggs on all the hosts, colony formation has been found to be successful only on coconut. Host preference was found in the order of coconut > *Canna indica*> banana > cassava. A significant difference in RSW population was observed among the tested host plant species, with high nymphal population recorded on coconut (78.6 nymphs plant^{-1}) followed by canna (70.6 nymphs plant^{-1}), banana (47.6 nymphs plant^{-1}) and cassava (40.6 nymphs plant^{-1}).

Laboratory based rearing of the green lacewing predator, *Pseudomallada astur* was achieved by feeding the adult neuropteran fly on egg yolk or proteinex based semi-synthetic diet. Adult insects could lay stalked eggs on the sheets of paper inside the rearing container. The grubs that emerged out were found to be predatory on RSW adults and destroyed egg colonies (Fig. 5.6).

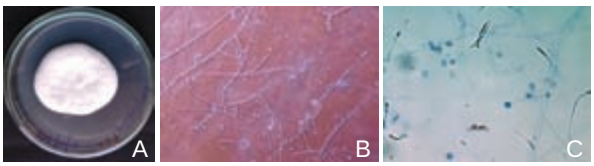


Fig. 5.7. Morphology of Simplicillium sp. A. White color colony with aerial mycelia on PDA; B. Conidiogenous cells and C. Conidia

Fig. 5.6. Stalked eggs, grubs and adult neuropteran fly, Pseudomallada astur

An entomopathogenic fungus *Simplicillium* sp. infecting rugose spiralling whitefly

An entomopathogenic fungus isolated from infected cadavers of *A. rugioperculatus* was identified as *Simplicillium* sp. (Cordycipitaceae: Hypocreales) based on morphological and molecular features. Preliminary investigation indicates that the culture filtrate of the *Simplicillium*s sp. was pathogenic to all stages of RSW. This is the first record of *Simplicillium* sp. infecting RSW and has greater potential to be developed as mycoinsecticide (Fig. 5.7).

Conservation biological control of RSW

Pesticide holiday and conservation biological control of the aphelinid parasitoid, *Encarsia guadeloupae* was found rewarding in the management of RSW. For augmentative release, parasitized pupae of RSW on coconut leaflet (10 cm) were distributed to farmers in Andhra Pradesh, Tamil Nadu and Assam. Spraying water in jet propulsion mode on undersurface of palm leaflets could dislodge the feeding niche of RSW and encourage parasitism. This strategy could subdue the pest population in an eco-friendly manner and safeguard the environment from deleterious chemicals and would encourage the buildup of natural enemies and scavenger beetle population.

Natural re-emergence of sooty mould feeding beetle, *Leiochrinus nilgirianus*

The sooty mould feeding Leiochrinid beetle, *Leiochrinus nilgirianus* Kaszab (Tenebrionidae : Coleoptera) was not observed from November 2017 to May 2018 after withdrawal of monsoon. With the onset of South-West monsoon showers in June 2018 at Kayamkulam, the immature stages of scavenger beetle re-emerged, feeding the sooty mould deposits and cleansing the palm leaflets. Damp conditions during monsoon period in Peninsular India encouraged the growth of these beetles that effectively scraps and feeds the sooty mould during the dry calendar phase. Field collected *L. nilgirianus* revealed sooty mould laden food bolus further confirming its feeding on sooty moulds in moist environment (Fig. 5.8).

Fig. 5.8. Gut of Leiochrinid beetle, Leiochrinus nilgirianus and adult beetles

Introductory 'Biological Scavenging' programme

'Biological Scavenging' programme by introducing the sooty mould feeding Leiochrinid beetle, *Leiochrinus nilgirianus* Kaszab from Kerala to Andhra Pradesh was launched by ICAR-CPCRI at Amalapuram, Andhra Pradesh (Fig. 5.9). Field release of the beetle was undertaken in the coconut groves of West Godavari district of Andhra Pradesh, Tamil Nadu and in several farmer's field in Assam. The establishment of these beetles would be ascertained further during 2019 in the bio-cleansing programme.

Fig. 5.9. Launch of introductory biological scavenging programme at Andhra Pradesh: release of Leiochrnid beetles by Dr. W.S. Dhillon, ADG, ICAR

Nesting whiteflies

Bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi

First field incidence of the neotropical invasive Bondar's nesting whitefly (BNW), on coconut palms from Kerala, India was reported. *P. bondari* constructs unique woolly wax nests on abaxial palm leaflets and possesses "X"-shaped oblique greyish bands on its wings. The genus is popularly known as "nesting" whitefly based on the pattern of wax formation around the immature stages and the adult whiteflies resting inside the fluffy tiny nest just like a bird in its brood. Occurrence of egg clusters, flat creamy yellow nymphs with prominent fibreglass strands from the dorsum and single thick flagellum, characteristic nest-like woolly wax around the pupae, and adults with oblique "X"-shaped grey bands on wings are some of the characteristic features of *P. bondari*. Puparial characters include one larger cephalic pore

and four abdominal compound pores about 33-35µm in diameter, and outer ring with ovoid cellular facets giving the appearance of stylized flower-petals. The last four abdominal compound pores are associated with simple discoidal pores as follows; compound pore no. 3 has 2 or 3 discoidal pores, compound pore no. 4 has two, and compound pores no. 5 and 6 have one each. Two to three discoidal pores are associated with the two reduced abdominal pores which are half the size of the larger abdominal pores and comprise 7-8 flower petal-like facets. The tongue-like lingula is extended beyond the posterior margin vasiform orifice with two pairs of apical setae. The operculum partially covers the lingula and the vasiform orifice. The male genitalia are characteristic with the apex of aedeagus possessing a single dorsal and ventral horn and a pair of apicolateral processes (Fig. 5.10).

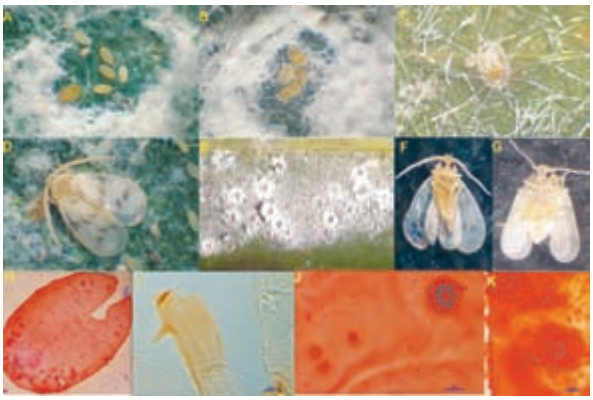


Fig. 5.10. Life stages of Bondar's nesting whitefly and diagnostic features: A. Eggs laid in clusters in woolly wax nest; B. Mobile crawlers; C. Puparium; D. Adult with X-shaped marking; E. Woolly wax-like nests on palm leaflets; F. Male abdomen; G. Female abdomen; H. Stained puparium with abdominal and cephalic compound pores; I. Male genitalia; J. Discoidal pores near the reduced abdominal pore; K. Abdominal compound pores with flower-petal like facets.

Partial mitochondrial cytochrome oxidase 1 (*CO1*) sequences (675 bp) of adult nesting whitefly (GenBank Acc. No. MK343480), shared 100% nucleotide identity with *P. bondari* isolate BNW 856-1 (Acc. No. KP032215.1), reported as a new invasive species in Florida USA in 2011. *P. bondari* has closer evolutionary linkage with *P. minei* as well as *Tetraleurodes perseae,* than with *P. pseudonaranjae*, while the spiralling whiteflies (*A. rugioperculatus* and *A. dispersus*) were distantly placed.

Occurrence of the non-native BNW, during the receding phase of rugose spiralling whitefly infestation on coconut indicates their probable simultaneous introduction and the emergence of BNW could be a case of competitive displacement due to the inability of the aphelinid parasitoid, *E. guadeloupae* to parasitize *P. bondari*. Association of *P. bondari* as a cryptic species in the colony of *A. rugioperculatus* cannot be ruled out as it emerges only during the diminishing phase of the rugose spiralling whitefly.

Neotropical nesting whitefly, *Paraleyrodes minei*

Field occurrence of the exotic neotropical nesting whitefly, *Paraleyrodes minei* Iaccarino in association with BNW, *Paraleyrodes bondari* Peracchi on coconut leaflets was found for the first time on coconut palms previously infested with the RSW. *P. minei* closely resembles *P. bondari,* but is devoid of the oblique grey bands on the wings and it constructs loosely woven woolly wax nests. Female *P. minei* are white but males are smoky grey. Cock-head like male aedeagus with two thin appendixes projected downwards is the unique feature for species-level identification of *P. minei* (Fig. 5.11). Detection of three non-native whiteflies of neotropical origin infesting coconut palms in India within a span of two years suggest their concurrent introduction. Invasive potential of *P. minei* due to its polyphagous nature and short life cycle calls upon strict policy frameworks in exchange of planting materials. Domestic quarantine should be strictly enforced to avoid spread of the pest to other coconut growing regions.

Partial mitochondrial cytochrome oxidase 1 (*CO1*) sequences (675 bp) of Neotropical nesting whitefly

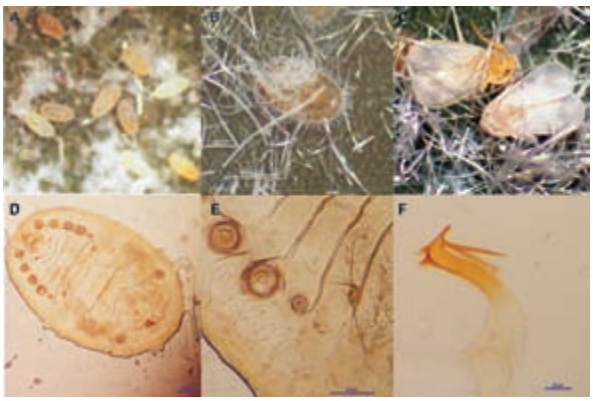


Fig. 5.11. Stages of neotropical nesting whitefly Paraleyrodes minei: A. Stalked eggs; B. Puparium with fibreglass like strands; C. Male and female adult; D. Characteristic cephalic and abdominal compound pores on stained puparium; E. Normal and reduced compound pores with flower-petal like facets; F. "Cock head" shaped male aedeagus

from Kayamkulam showed 100% identity with the *Aleurodicinae* sp. 1AMD-2015 (GenBank Acc. No. KP032214) reported from Florida USA. Based on the adult morphology, puparial characters and male genitalia the species identity was confirmed as *Paraleyrodes minei*. Hence, the nucleotide sequence was deposited as *P. minei* (GenBank Acc. No. MK421974), though it showed only 93% identity with earlier deposited *P. minei* accession (GenBank Acc. No. KX925200). Nucleotide sequences of Kayamkulam (GenBank Acc No. MK421974) and Kasaragod *P. minei* (GenBank Acc No. MK490947) showed 100% similarity with each other and with that of *Aleurodicinae* sp. 1AMD-2015 reported from Florida USA (Fig. 5.12).

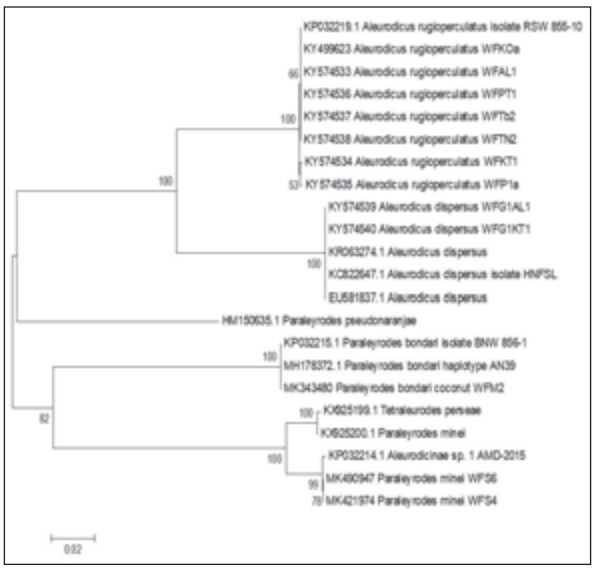


Fig. 5.12. Phylogenetic tree of nesting and spiralling whiteflies characterized from India

The appearance of three exotic whiteflies within a span of two years on coconut ecosystem highlights the increased bio-security risks arising from uncontrolled exchange of plant material and warrants strengthening of quarantine. The exchange of planting materials through liberalised trade and transboundary movement of such materials without proper pest risk analysis has to be dealt with strict reforms and policy frameworks. Surfacing of sucking pest complex and climate change are intrinsically related and possibly similar weather conditions prevailing in the native range of these whiteflies and Kerala, India could be another reason for their successful establishment.

Conservation of *Cybocephalus* sp. in the bio-suppression of nesting whiteflies

Grubs of the nitidulid predator, *Cybocephalus* sp. could feed on the stalked eggs of the nesting whiteflies (*P. bondari* and *P. minei*) and suppressed the invasive potential of nesting whiteflies in palm system. Conservation biological control using *Cybocephalus* sp. is suggested for the suppression of the nesting whiteflies (Fig. 5.13).

Fig. 5.13. Grub and adult Cybocephalus sp.

Evolutionary lineage of leaf beetles infesting coconut

Molecular characterization of two indigenous leaf beetles *viz*., spear leaf beetle, *Wallacea jarawa* from Port Blair, Bay Island and the coconut leaf beetle, *Callispa keram* from Kayamkulam, Kerala was performed by studying the mitochondrial cytochrome oxidase (*COI*) gene. Phylogenetic tree analysis revealed that the indigenous beetles are distantly placed from *B. longisimma* (Fig. 5.14). Prevalence of wide range of natural enemies of *C. keram* and *W. jarawa* could be one of the reasons for the non-establishment of *B. longissima* in the country. Furthermore, the indigenous leaf beetles are prevalent at a very low intensity.

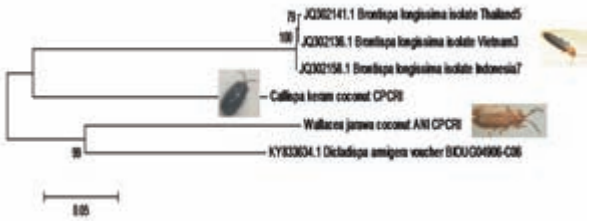


Fig. 5.14. Phylogenetic analysis of mitochondrial cytochrome oxidase gene of leaf beetles

Entomopthogenic nematodes

Discovery of a novel *Steinernema* sp. sustaining highest shelf life

A novel entomopathogenic nematode (EPN), *Steinernema* sp. CPCRI0804 recovered from Kayamkulam soils, Kerala was found superior in terms of higher shelf life as well as its efficacy against red palm weevil grubs. The infective juveniles (IJs) evinced more than 75% survival even after nine months of storage

at ambient temperature maintained in distilled water (Fig. 5.15). This is the first report of an EPN surviving for more than five months at ambient temperature without any additives. This isolate was also found to be highly virulent against red palm weevil grubs under laboratory condition, inducing 100% mortality when applied @ 200 IJs grub^{-1}. Natural occurrence of these EPN in this part of Kerala could be one of the reasons for limited occurrence of white grubs attacking crops.

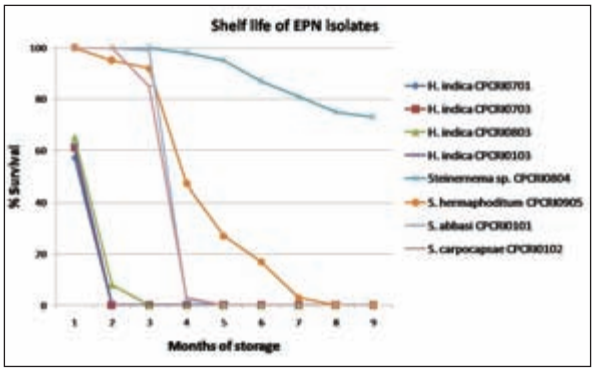


Fig. 5.15. Shelf life of different EPN isolates at ambient temperature

Delivery of EPN against white grub in coconut / arecanut plantation through EPN-infected host cadaver

Efficacy of field delivery mode of indigenous strains of entomopathogenic nematodes, *Steinernema carpocapsae* (CPCRI-SC1) and *Heterorhabditis indica* (CPCRI - HI1) were studied by releasing through aqueous soil drench @ 10 lakh IJs and placement of EPN infected greater wax moth, *Galleria melloenella* cadavers @ 5 numbers around the rhizosphere of each coconut and arecanut juvenile palms infested with white grubs (*Leucopholis* spp.) during pre-monsoon and post-monsoon seasons (Fig. 5.16). Among the treatments, nematode infested *Galleria* cadavers of both the strains of EPN caused significantly higher reduction of grub population (51.2%) followed by aqueous suspension (45.8%), in addition to higher persistence of EPN when applied through cadavers.

Fig. 5.16 (a). Application of EPN solution in rhizosphere of coconut palm; (b) Galleria cadavers infested with EPN, S. carpocapsae ; (c) Galleria cadavers infested with EPN, H. indica

Coconut leaf vermicompost as an effective carrier for solid-based EPN formulation

EPNs *S. carpocapsae* and *H. indica* were pre-amended in the coconut leaf vermicompost *via* aqueous solution (@ 20 lakh IJs kg^{-1} vermicompost) and EPN infected *Galleria* cadavers @ 25 numbers kg^{-1} vermicompost) (Fig. 5.17). The infective juveniles (IJs) could survive (>80%) and sustain the virulence for 90-days at 25^{0}C. Nematode virulence ascertained by *Galleria mellonella* infection indicated 100% mortality within 48 hours of inoculation. The nematodes migrated from the medium when the moisture percentage fell below 10 in the amended vermicompost. The use of coconut leaf vermicompost as carrier material for the formulation of EPN is environmentally friendly in pest suppression while simultaneously improving soil nutrients. EPN amended vermicompost formulation is readily available and easy to apply and the infective juveniles emerge from the medium once it comes in contact with water.

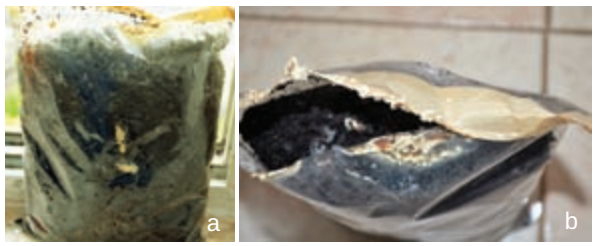


Fig. 5.17. (a) S. carpocapsae infected G. mellonella cadavers in pre-amended vermicompost; (b) Migration of IJs when moisture level reduce to below 10% in coconut leaf vermicompost

Organic management of vegetable pests with Entomopathogenic nematodes

Spraying 10 lakh infective juveniles (for 500 m^2 area) of *S. carpocapsae* aqua suspension at 15 days interval during the sporadic outbreak of leaf webbers in brinjal and okra (August-September) intercropped in coconut gardens, significantly reduced the pest infestation by 70%. The pest multiplication during post monsoon period was arrested in Kasaragod region resulting in pest free crop foliage and enhanced yield.

Pests of arecanut and cocoa

Evaluation of novel insecticides and biopesticides against arecanut spindle bug, *Mircarvalhoia arecae* (Miller and China)

Various insecticides and botanicals were field evaluated against arecanut spindle bug, *Mircarvalhoia arecae* damage for two consecutive years. Application of insecticide sachets significantly reduced the necrotic lesions on the spindles as well as on the leaves. Palms treated with Thiamethoxam sachets showed 5.42% and 4.17% leaf damage as compared to pre-treatment damage of 22.5% and 25.83%, respectively for two years (Table 5.2). Prophylactic application of sachets (@ 2 nos.), containing 2 g of Thiamethoxam, in spindle during June-July could protect the palms from spindle bug damage for a period of 3-4 months.

Fig. 5.18. Phylogenetic tree of H. picus by amplification of mitochondrial CO1 gene

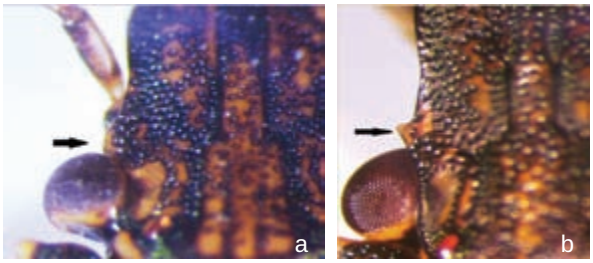


Fig. 5.19. (a) Spined Halyomorpha, (b) Normal Halyomorpha

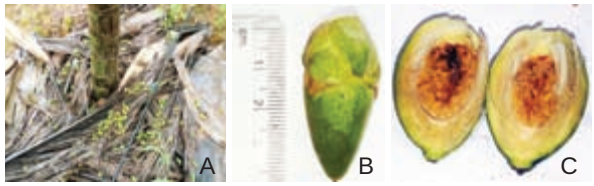


Fig. 5.20. Damage by Halyomorpha in arecanut: A. Tender nut drop; B. Nuts with pin prick marks; C. Kernel discolouration

Outbreak of Pentatoimid bug, *Halyomorpha picus* in arecanut

Severe tender nut drop in plantations, attributed to pentatomid bug, was observed in 2017-2018 from various arecanut growing areas of Karnataka and Kerala. The species was identified as *H. picus* based on morphological keys and molecular characterization. A phylogenetic tree was constructed based on the sequence information of mitochondrial *CO1* gene (Fig. 5.18). A morphotype of the pentatomid bug was also found from Kundadka region, Karnataka, wherein an antenna ocular spine was present in between antennae and compound eyes (Fig. 5.19). The nymphs and adults of pentatomid bug suck sap from inflorescence rachis and developing nuts, resulting in pin prick necrotic spots developing at the point of penetration. The kernel of infested nuts exhibit shriveling and drying with varying degrees of discolouration and such nuts shed prematurely (Fig. 5.20).

Incidence and crop loss estimation of pentatomid bug, *Halyomorpha picus* in arecanut

A cluster sampling survey was carried out during June 2018, in 80 gardens located in Bantwal, Puttur, Sullia

Table 5.2. Evaluation of insecticides and neem cake against arecanut spindle bug damage

Treatments	Spindle-leaf damage (%) in 2017			Spindle-leaf damage (%) in 2018		
	Pre- treatment	Post-treatment after		Pre- treatment	Post-treatment after	
		2 months	3 months		2 months	3 months
Imidacloprid	21.3 (4.60)	17.5 (4.15)^{b}	12.92 (3.59)^{b}	25 (4.98)	12.41 (3.51)^{b}	13.33 (3.65)^{c}
Thiamethoxam	22.5 (4.74)	8.4 (2.89)^{a}	5.42 (2.32)^{a}	25.83 (5.07)	7.08 (2.64)^{a}	4.17 (2.04)^{a}
Flonicamid	22.5 (4.74)	18.3 (4.23)^{bc}	11.67 (3.40)^{b}	25.41 (5.02)	12.91 (3.57)^{bc}	13.33 (3.65)^{bc}
Chlorantraniliprole	22.5 (4.74)	24.2 (4.88)^{bcd}	12.08 (3.44)^{b}	23.33 (4.80)	11.25 (3.33)^{ab}	12.08 (3.41)^{b}
Neem cake	19.6 (4.42)	20.4 (4.46)^{bcd}	13.33 (3.63)^{b}	26.23 (5.12)	10.41 (3.22)^{ab}	11.67 (3.41)^{b}
Control	25.0 (5.00)	27.9 (5.28)^{d}	16.25 (4.00)^{b}	26.67 (5.15)	18.3 3 (4.27)^{c}	17.08 (4.12)^{c}
CD (*P*= 0.05)	NS	1.0309**	0.8051*	NS	0.7121*	0.68**

Values in parenthesis are square-root transformed ; Figures followed by same alphabets are not significant (P=0.05)

and Belthangady taluks of Dakshina Kannada district of Karnataka, to assess the incidence of pentatomid bug, *Halyomorpha picus* infestation in arecanut. The results revealed that 13.16% to 20.66% areca palms were affected by *H. picus*. The highest incidence was recorded in Bantwal taluk (20.66%) and least in Belthangady taluk (13.16%). The pentatomid bug can cause yield loss in terms of tender nut drop up to 4.73%.

Bio-efficacy of insecticides and neem oil against tender nut drop caused by *H. picus* Pentatomid bug management trial was carried out in farmer's garden located in Kundadka region of Dakshina Kannada district. Among the various insecticides evaluated, spray of Clothianidin (0.24 g l^{-1}) and Pymetrozine (0.6 g l^{-1}) reduced the percentage of tender nut drop to the tune of 92%.

Infestation of red palm weevil in arecanut

Infestation by red palm weevil (*Rhyncophorus* sp.) in arecanut was found from ICAR-CPCRI, Vittal as well as from various areca growing tracts of Karnataka and Assam. The grubs bore through the soft tissues of the stem and crown leading to wilting, yellowing and drying of spindle and innermost leaves (Fig 5.21). Infested palms exhibited bore holes with or without extruded fibrous tissues and oozing from freshly made holes. In the advanced stages of infestation, the palm dies.

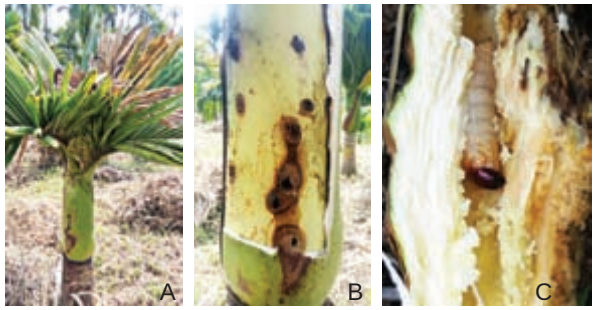


Fig 5.21. Symptoms of red palm weevil damage in arecanut: A. Drying of central leaves; B. Bore holes; C. Tunneling of stem

Plant protection campaign against pests and diseases

Technology support for plant protection campaign of coconut in 12 districts of Kerala has been envisaged with capacity building of extension officials (Fig. 5.22) and farmers, youth and women through innovative modes of technology dissemination. A significant knowledge gain of more than 70% could be accomplished among agricultural officers during the 16 capacity building programmes conducted for 376 participants. About 3300 farmers in different districts were empowered on advancements in palm health management through 46 training programmes. Good agricultural practices for doubling income, mass production of *Metarhizium majus* for the bio-suppression of rhinoceros beetle, development of *Trichoderma harzianum* cake for the management of bud rot, mass production of entomopathogenic nematodes were skillfully imparted to trainees.

Fig 5.22. 'Training programme for Agricultural Officers

6. Physiology, Biochemistry and Value Chain Management

Response to climate change variables, and phenotyping for high temperature, water-deficit and salt stress tolerance

It is imperative to comprehend the effects of climate change variables such as elevated CO_2 [ECO_2], elevated temperature [ET], salinity, water-deficit stress and nutrient dynamics in perennials such as plantation crops.

Response to ECO_2 and elevated temperature in OTC grown coconut seedlings

Long term exposure to elevated CO_2 [ECO_2] concentration in an open top chamber (OTC) enhanced the growth and biomass production in coconut seedlings (Fig. 6.1). At the end of three years, biomass production was at 29.9 kg when seedlings were grown under 700 ppm CO_2 as against the biomass of 14.9 kg for plants grown at ambient CO_2 (400 ppm). Plants under [ECO_2] accumulated higher biomass in roots and stem 27% and 52%, respectively at 700 ppm CO_2 as against 19% and 43%, respectively at 400 ppm CO_2 (Table 6.1). The plant at 700 ppm of CO_2 flowered early as compared to the seedlings under control and various other treatments. High biomass production under reduced stomatal conductance, owing to increased CO_2 concentration, improved the intrinsic water use efficiency (WUE) and whole plant WUE in coconut seedlings. It thus suggests

400 ppm [Ambient CO_2] *700 ppm [ECO_2]* *Ambient + 3°C [ET]*

Fig. 6.1. Effect of elevated CO_2 [ECO_2] and elevated temperature [ET] on the growth of coconut

that at the present level of moisture availability, coconut would produce more biomass under future climate characterized with [ECO_2]. However, concurrent increase in the atmospheric temperature would reverse the gain in biomass.

Table 6.1. Total biomass (kg plant^{-1}) production and its partitioning into various plant parts of the coconut seedlings grown under ambient CO_2 [control], elevated CO_2 [ECO_2] and elevated temperature [ET]

Plant parts	Treatments		
	400 ppm CO_2 [Ambient CO_2]	700 ppm CO_2 [ECO_2]	Ambient + 3 °C [ET]
Root	2.80 (19%)	8.18 (27%)	1.69 (19%)
Stem	6.43 (43%)	15.64 (52%)	3.50 (40%)
Leaf	5.71 (38%)	6.10 (20%)	3.49 (40%)
Total	**14.94**	**29. 92**	**8.68**

Phenotyping for water-deficit stress

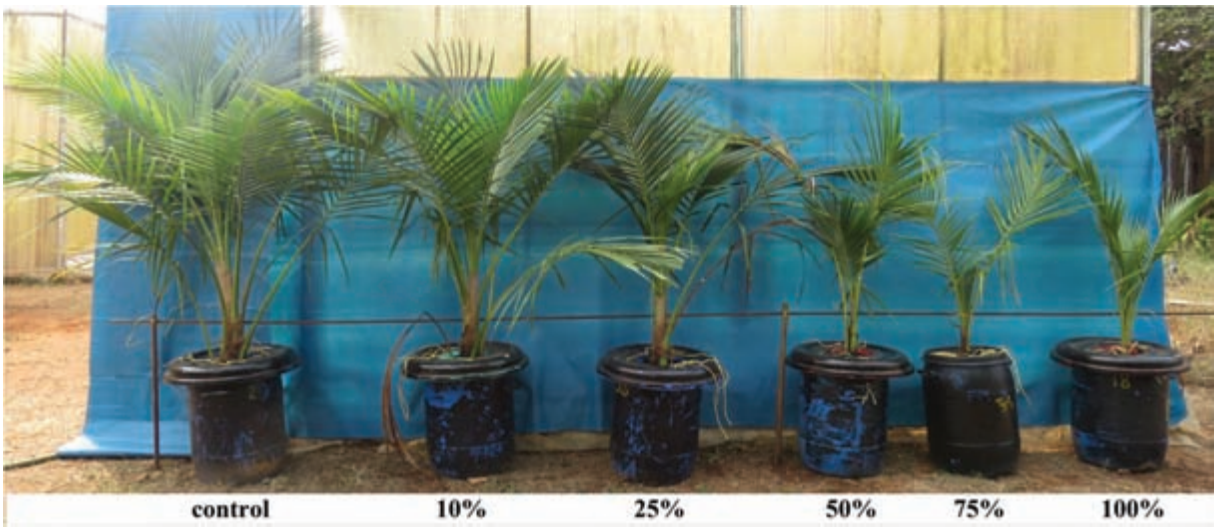
Tall cultivars *viz.,* Jamaica Tall and Federated Malay States Tall accumulated higher biomass over dwarf varieties *viz.,* Gangabondam Dwarf and Kenthali Dwarf when grown under same quantum of water input suggesting better WUE in talls over dwarfs. Drought avoidance mechanism like high root biomass and drought tolerant mechanism like epicuticular wax deposition, increased superoxide dismutase (SOD), peroxidase (POD) and polyphenol oxidase (PPO) activity were prominent for talls. Also, talls under water-deficit stress partitioned higher biomass towards roots plausibly to facilitate better extraction of water.

Salt tolerance of coconut seedlings

Rising sea level as a consequence of climate change is projected to limit the growth and productivity of coconut in coastal areas due to high tidal swell and salt water incursions. Growth and biomass accumulation of hydroponically grown coconut seedlings was not affected up to 25% substitution of hydroponic solution with sea water (Fig. 6.2). However, beyond that level, there was significant decline in leaf water potential, photosynthesis, seedling collar girth, and biomass accumulation.

High temperature effect on female flower receptivity and fertilization in coconut

The effect of high temperature was evaluated on the stigmatic receptivity and fertilization of coconut *in planta*. It requires around five days from pollen germination for pollen tube to reach the ovule in coconut. High temperature reduced stigmatic receptivity i.e., the stigma loses the capacity to offer support first for pollen germination and second for pollen penetration. The effect of temperature was more pronounced on pollen germination in some of the genotypes namely PHOT, CCNT, GBGD, CGD, CRD and MYD. At 40°C, the stigmatic surface dries and thus prevents germination



Control (hydroponics nutrient composition) | *10% sea water substitution* | *25% sea water substitution* | *50% sea water substitution* | *75% sea water substitution* | *100% sea water substitution*

Fig. 6.2. Effect of sea water treatment on coconut seedlings with substitution of hydroponics solution with sea water at various concentrations

capacity of the pollen. This deleterious effect of temperature on the stigmatic receptivity and pollen germination might have a significant influence on the performance of crop in the field conditions. Practically, this approach could also provide a screening criterion for identifying coconut genotypes with high temperature tolerance.

RNA-Seq analysis reveals molecular response of cocoa under water-deficit stress

Water-deficit stress is one of the most important constraints that affect the productivity of cocoa. RNA-Seq has a potential to dissect the molecular mechanism underlying the stress tolerance. Hence, total RNA extracted from the leaves of two contrasting Indian cocoa genotypes (VTLC 22 and VTLC 15) under controlled (C) and water-limited (WL) conditions at vegetative stage was subjected to pair-end library preparation with *Illumina TruSeq* Stranded mRNA Library Preparation protocol. The libraries were sequenced using 2 x 150bp PE chemistry on *Illumina* platform and ~ 7 GB data per library has been generated. Assembly of high quality reads was carried out using the reference cocoa genome (https://www.cacaogenomedb.org/). In total, 92.5-94.5% of reads were mapped to the reference genome. A total of 13,751 genes were identified and 13,341 genes among them were annotated. A total of 4002 genes contributed to the activity of signal transduction followed by 3396 genes in carbohydrate metabolism pathway respectively. Differential expression analysis of cocoa genes identified 156 significantly up-regulated and 155 significantly down-regulated genes in VTLC 22 whereas, in VTLC 15, 312 upregulated genes and 505 downregulated genes were documented upon induction of water-deficit stress. Gene ontology (GO) mapping was performed for 13,751 genes expressed during water-deficit stress using Blast2GO, and the category distribution is as follows: Biological Process-6140, Molecular Function-7179 and Cellular Component-4972. Long non-coding RNAs (lncRNAs) were identified from the transcriptome profile of cocoa genotypes under water-deficit stress. Among the conserved lncRNA families, four families (tRNA, snoR71 and LSU_rRNA) accounted for more than 10 members. Moreover, several small nucleolar RNA families (SNORD14, SNORD18, SNORD25, SNOR71, SNOR116) constituted the major categories of lncRNAs with more than five members in all the samples. The key genes and non coding RNAs repertoire identified in this study would serve as a useful genomic resource for for breeding drought tolerance in cocoa (Fig. 6.3).

Anti-obesity, lipid lowering and anti-inflammatory effects of virgin coconut oil

Studies on the beneficial properties of VCO were undertaken in collaboration with KSHEMA, NITTE University, Mangaluru using Male Wistar rat models. Supplementation of high fat diet (HFD) rats with VCO significantly decreased the body mass index (BMI) in comparison to the control HFD group. The levels of high density lipoprotein-cholesterol (HDL-C) were significantly increased in the HFD-VCO treated groups as compared to the HFD fed rats whereas the levels of low density lipoprotein-cholesterol (LDL-C) level

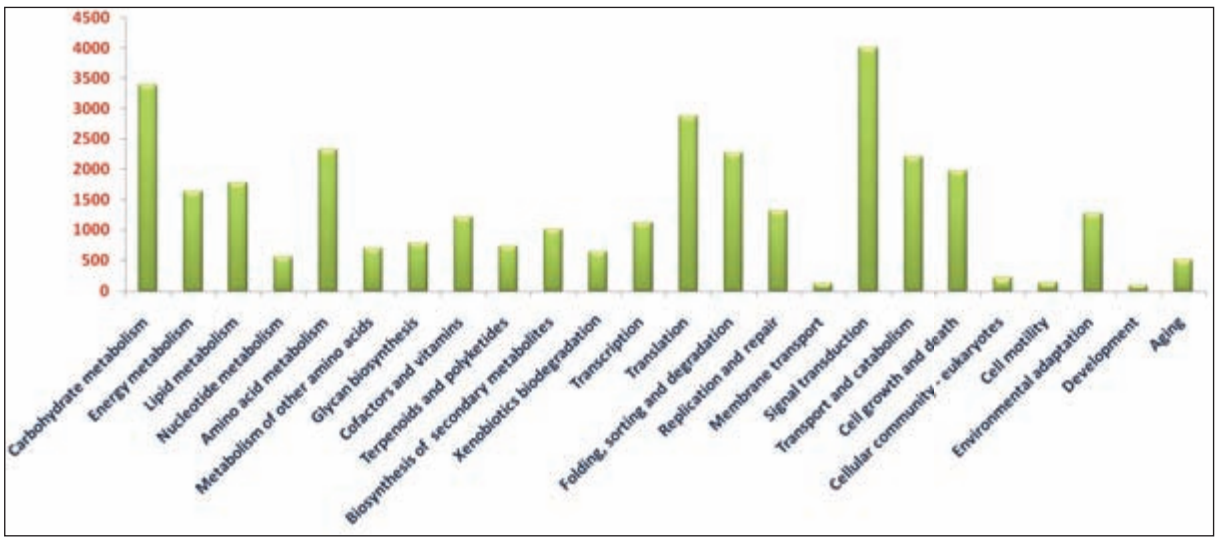


Fig. 6.3. KEGG metabolic pathways enriched in cocoa leaves during water-deficit stress

significantly decreased in the HFD-VCO treated groups. VCO significantly decreased the atherogenic index (AI), considered as a marker for various cardiovascular disorders, indicating the cardioprotectant effects of VCO. VCO treated rats exhibited significant reduction in edema formation induced by carrageenan suggesting that VCO possesses anti-inflammatory activity by inhibiting release of various inflammatory mediators such as histamine etc.

Antidiabetic and Antiobesity properties of arecanut extract

The aqueous, ethanol, butanol and 80% ethanol extracts of arecanut were assayed *in vitro* for alpha-amylase inhibitory activity. The aqueous extract of arecanut exhibited 34.50 ± 1.3% alpha-amylase inhibition. Ethanol extract showed highest (44.72 ±1.6%) inhibition followed by 80% ethanol extract (41.23±1.4% inhibition) whereas butanol extract showed least amylase inhibition (18.21±1.1%). The total phenol content of different arecanut extracts was determined: aqueous extract - 80.21±1.2 mg GAE g^{-1}, ethanol extract - 110±.1.3 mg GAE g^{-1}, butanol extract -45.62±1.5 mg GAE g^{-1} and 80% ethanol extract - 120.21±1.2 mg GAE g^{-1}. Thus, ethanol extract has great potential for anti-diabetic effect and could be exploited in ethnomedicines.

Value-Chain Management in Palms and Cocoa:

Homemade Bean to Bar Chocolate using coconut sugar

A complete processing protocol (consisting of fermentation, drying, roasting and winnowing of cocoa beans, refining of nibs with coconut sugar and cocoa butter, tempering, moulding, refrigeration, demoulding, packaging and storage) for the preparation of bean to bar chocolate using coconut sugar was standardized. Besides, the effect of varying levels of coconut sugar, cocoa liquor and cocoa butter on sensory, textural characteristics of dark chocolate were also studied using response surface methodology. The optimized combination of dark chocolate is shown in Fig.6.4 with a maximum desirability of 0.96 (Fig. 6.5) for which the predicted sensory score for appearance, mouth feel, texture & taste and textural hardness were 8.14, 7.98, 8.05, 7.55 and 52.14N, respectively.

Fig. 6.4. Bean to Bar chocolate

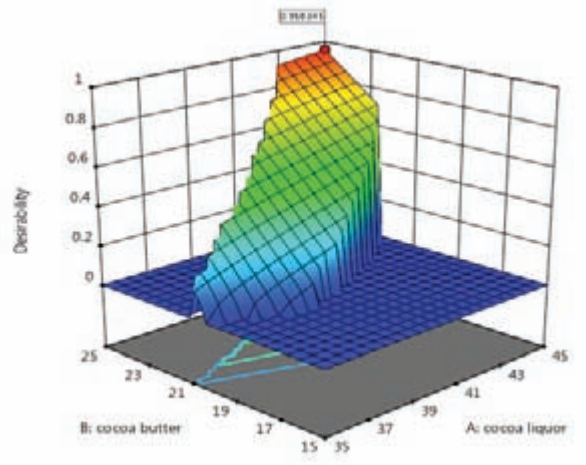


Fig. 6.5. Response surface graph showing the optimized combination of cocoa liquor and cocoa butter at 30% coconut sugar

Process protocol for coconut milk-based *paneer*

Protocol for coconut milk-based *paneer* was standardized using second and third extractions of coconut milk followed by blending with different protein sources such as soy milk, dairy milk, egg albumin and skim milk powder in varying concentrations. Lime juice (at 2.5% concentration) was added as coagulating agent. The resultant *paneer* was evaluated for yield, moisture, total solids, crude fat, crude protein, textual characteristics such as springiness, resilience and cohesiveness and overall sensory attributes.

Kalparasa®-based Nutribar

Kalparasa®-based Nutribars were developed using coconut inflorescence sap and other ingredients such as peanut, green gram and cocoa powder in fourteen different combinations. Kalparasa® was concentrated to the level of 75-80º Brix to obtain thick consistency and the ingredients were mixed and moulded into a Nutribar. Total solids, crude fat, crude protein, hardness were analyzed and the sensory evaluation was conducted among two different age groups (kids and adults).

Coconut milk powder using foam mat drying and ready to cook *kheer* mix

Refinement was made in the coconut milk powder technology by replacing egg albumin with sodium caseinate as a foam stabilizer. Central composite design was selected for the optimization of levels of sodium caseinate and maltodextrin (encapsulant). The responses selected were foam expansion, foam stability, foam density, moisture, loose bulk density, packed bulk density, solubility, flowability, overall sensory acceptability of coconut milk powder and rehydrated coconut milk powder. The optimized combination had coconut milk with 4% sodium caseinate and 17.5% maltodextrin with a desirability factor of 0.82. Average recovery of milk powder using this foam mat drying technology was 33%. The resultant milk powder was used for the preparation of ready to cook *kheer* mix along with vermicelli and coconut sugar (1.5:1.5:1). The amount of water for reconstituting the *kheer* was standardized as 6:1.The *kheer* mix developed was found to be safe under refrigerated storage for three months with respect to moisture content, flowability, bulk density, particle density, interstitial air content, pH, titratable acidity and free fatty acids.

Frozen coconut delicacy

The effect of coconut derived ingredients such as coconut milk, tender coconut pulp, tender coconut water, coconut sugar etc. on the quality of frozen coconut delicacy was studied. In general, the overrun was found to be significantly reduced after the addition of coconut ingredients. Total solids and the fat content of different formulations varied from 31.10 to 38.53% and 9.99 to 12.03%, respectively. Non-significant differences ($p>0.05$) were observed for total sugars and total phenolic content. The result of sensory evaluation (with different age group) revealed the positive influence of coconut ingredients on taste and flavour of frozen coconut delicacy. Refinement in the exclusive vegetarian delicacy was made to improve the physical qualities by adding soy protein and maltodextrin along with coconut milk, tender coconut pulp, tender coconut water and sugar (Fig. 6.6).

Fig. 6.6 Vegan Coconut Delicacy

Artificial Neural Network and Multiple Linear Regression Modeling of Extrusion Processing Parameters for the Extrudates Containing Coconut Milk Residue-Rice-Corn Flour

The prediction models using multiple linear regression (MLR) and artificial neural network (ANN) were developed to predict the extrudates characteristics like expansion ratio, bulk density, water solubility and water absorption index, compression force and cutting strength. The significant variables that influence the response variables were selected from the mixture process design output and used for developing MLR equations using MATLAB's 'fitlm' function. A feed forward single layer ANN was developed to train a model for predicting the extrudates properties (Fig. 6.7). The model performances were evaluated based on coefficient of determination (R^2) and sum of squared error (SSE). The R^2 of MLR ranged between 0.34 and 0.84, and SSE ranged between 0.0009 and 292.51. Whereas, the R^2 of ANN ranged between 0.41 and 0.94, and SSE ranged between 0.0001 and 214.81. Both models (MLR and ANN) were found to be appropriate for the prediction of water absorption index, and were least suited for predicting the cutting strength. The performance of ANN was superior to MLR and can be used for future predictions of extrudates properties.

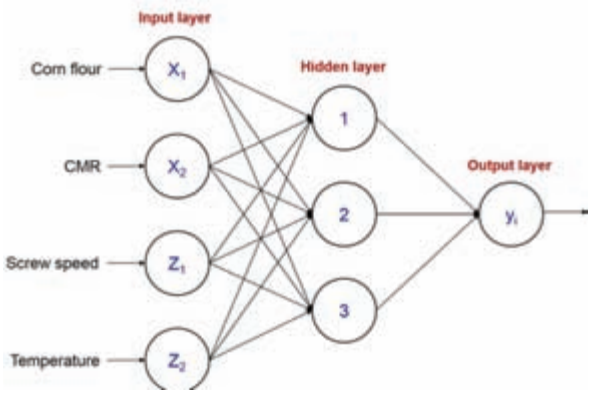


Fig. 6.7 The scheme of artificial neural network with 4 input neurons, 3 hidden neurons, and 1 output neuron

Preservation protocol for trimmed tender coconut

The effect of different combinations of 12 anti-browning agents including acidulants (citric acid), reducing agents (ascorbic acid, isoascorbic acid, L-cysteine), complexing agents (maltodextrin, dextrose), chelating agents (organic acids such as oxalic acid, phytic acid), aromatic carboxylic acids (cinnamic acid and ferulic acid,) inorganic salts (calcium chloride), substituted resorcinol [4-hexylresorcinol (4HR)]) and blanching (100 °C for 5 min and 98 °C for 5 min) on the inhibition of browning in minimally processed tender coconut during cold storage (5±1°C) was studied. The physicochemical parameters *viz.,* pH, total soluble solids, turbidity, total sugar, reducing sugar, acidity, polyphenol oxidase activity, and peroxidase activity were evaluated during the storage. Application of combination of acidulants, chelating agents and resorcinols were found to be more effective than blanching in preventing the browning of minimally processed tender coconuts. With shrink wrapping and low temperature storage (5±1°C), browning-free storage life of the minimally processed tender coconut was extended beyond 21 days with 10 min dipping in anti-browning solution.

Physical properties of tender coconut (*Cocos nucifera* L.) in relation to the development of trimming machine

The physical properties of tender coconuts such as coconut size, weight, husk thickness, and husk moisture content play a vital role in the development of an efficient and ergonomically superior trimming machine. A sample of 50 tender coconuts of each variety *viz*., Kalpa Haritha, Andaman Giant Tall (AGT), Gangabondam (GBGD), Malayan Orange Dwarf (MOD), and Chowghat Orange Dwarf (COD) were selected and salient physical properties were determined. The properties including fruit weight, diameter, length, husk thickness, husk moisture content, husked fruit diameter, husked fruit length, and shell thickness were high for AGT and low for COD. The average bulk density, true density, and porosity of AGT was 332.47 $kg.m^{-3}$, 1196.67 $kg.m^{-3}$, and 72.21%, respectively. The husk weight and volume of water in AGT was 87.77% and 12.39% more, respectively, than COD. The intact coconut weight correlated positively (r = 0.791) with the husked fruit diameter and vertical distance between the shell and the fruit base (r = 0.813). Principal component analysis suggested that the varieties GBGD, Kalpa Haritha, and MOD have similar physical properties than COD and AGT. The present investigation provides the necessary basic information to design an efficient tender coconut trimming machine.

Determination of punching strength of tender coconut of different varieties

A study was carried out to determine the effect of coconut genotype (variety) and probe type on punching strength of intact tender coconuts. The peak punching force, distance at which peak force is obtained, and the punching energy was measured using Texture Analyzer (TA-Stable micro systems). The settings used in the

Fig. 6.8. Estimation of punching strength of tender coconut at different orientations

texture analyzer for measuring punching strength were: Pre-test speed, 2 mm s^{-1}; Test speed, 1 mm s^{-1}; Post-test speed, 10 mm s^{-1}; Test distance, 4 mm; Trigger type, Auto; Trigger force, 0.50 N; Load cell; 750 kg. Intact tender coconuts of four cultivars (AGT, Kalpa Haritha, GBGD, COD) with similar maturity were evaluated for punching strength at six different orientations (ridge top, ridge middle, ridge bottom, flat top, flat middle, and flat bottom) as depicted in Fig 6.8. The graph was plotted to study the relationship between the force resisted by the husk and penetration distance. The peak force experienced by the husk from zero to the test distance is considered as maximum punching strength and the area under this curve is known as punching energy. Significant variation in punching strength characteristic was observed among tender coconut cultivars. The results showed that cultivars having higher fiber density had higher punching strength. It was observed that bottom orientation of tender coconut required more punching strength followed by middle and top orientation.

Development and performance evaluation of tender coconut trimming machine

A tender coconut trimming machine is fabricated to perform three different operations including top cutting, side cutting, and bottom cutting. Three linear actuators are fixed for automatic movement of three cutting blades. The mechanism of linear actuators is to move in forward direction on direct polarity circuit connection and to move in backward direction on reverse polarity circuit connection. Each linear actuator is fitted with appropriate blades for removing the peel of tender coconut and it is connected with power source of 12V DC. After the initial performance evaluation, the optimized setting parameters for smooth finishing of tender coconut are 53 degree for top cutting knife, 85 degree for side cutting knife, and 90 degree for bottom cutting knife at a rotational speed of 480 rpm

Design and development of an air blast sprayer for arecanut

Fruit rot infection, caused by *Phytophthora meadii*, is a serious disease in arecanut, if timely plant protection measures are not applied yield loss could be as high as 90%. ICAR-CPCRI in collaboration with ASPEE, Mumbai has developed a tractor mounted air blast sprayer prototype, which delivers the fungicide solution to a height of 30 m. This sprayer has been found effective in well laid out gardens under arecanut mono-cropping system. Spraying could be done from the ground thereby avoiding the drudgery of climbing the palm, which is cumbersome during rainy season. The sprayer can help in much easier and faster delivery of agro-chemicals even during monsoon when fruit rot disease occurs. The field efficiency and sprayer performance are: Speed of Tractor (3 km/hr); Coverage (1 ha/3hr); Fungicide consumption (180 l/ha or 250 ml/palm).

7. Technology Transfer, Economics and Statistical Methods

Technology transfer and co-learning action research approaches

Dissemination of knowledge on Institute technologies has been carried out through systematic training programmes. The Institute has conducted 142 training programmes with participation 6514 farmers/ extension personnel/students spread across seven states. These programmes include one international training programme (delegates from Republic of Bhutan) and three National Institute of Agricultural Extension Management (MANAGE) off campus training programmes.

Diploma in Agricultural Extension Services for Input Dealers (DAESI) Programme

A one year diploma programme in agricultural extension services for input dealers (DAESI) programme of Alappuzha district wsa initiated with ICAR-CPCRI, Regional Station, Kayamkulam as the nodal training institute in collaboration with Agriculture Technology Management Agency (ATMA), Alappuzha, State Agricultural Management and Extension Training Institute (SAMETI) and National Institute of Agricultural Extension Management (MANAGE). The programme was envisaged to enable them to serve the farmers through the delivery of right information and quality inputs for sustainable development in agriculture (Fig. 7.1). The programme was inaugurated by Shri K. K. Anilkumar, Municipal Councillor, Kayamkulam on 23rd October, 2018 at ICAI-CPCRI, Regional Station, Kayamkulam and Dr. V. Krishnakumar, Acting Head presided over the function. A total of 40 input dealers from Alappuzha district enrolled under the programme.

Fig. 7.1. Students and coordinators of diploma programme in agricultural extension services at ICAR-CPCRI, Regional Station, Kayamkulam

Training programmes

Training programme on technologies pertaining to crop improvement, crop production, crop protection and value addition of mandate crops were conducted for the benefit of farmers and other stakeholders (Fig. 7.2), as listed in Table 7.1.

Frontline Demonstrations

Demonstration of integrated management of root (wilt) disease was implemented in 218 coconut gardens covering 95 hectares and 15839 coconut palms for improving income, resource efficiency and productivity. The farmer participatory demonstrations on best management practices for soil health management for

Table 7.1. Exposure Visit / Training programmes conducted

Farmers		Extn. Personnel		Students		Others		Total	
No. of batches	No. of visitors	No. of batches	No. of visitors	No. of batches	No. of visitors	No. of batches	No. of visitors	No. of batches	No. of visitors
68	**2128**	**09**	**271**	**34**	**1310**	**31**	**2805**	**142**	**6514**

RAWE students from College of Agriculture, Padannakkad with scientists of ICAR-CPCRI, Kasaragod

Refresher course on coconut health management at ICAR-CPCRI, RS, Kayamkulam

Trainees of participatory mass production of Entomopathogenic Nematodes (EPN)

Method demonstration on Trichoderma + coir pith cake preparation at ICAR-CPCRI, Kayamkulam

Sri. R.Vimalasenan Nair, Director, All India Radio (AIR) inaugurating AIR-farmers interface programme at ICAR-CPCRI, Kayamkulam

Skill upgradation training for Skilled Support Staff, organized at ICAR-CPCRI, Kyamkulam

Fig. 7.2. Glimpse of training/interface programmes organized at the Institute

enhancing productivity in coconut were conducted in 60 farmers' gardens spread over six agro-ecological units in Kerala. A demonstration on 'bioresource management under coconut based farming systems' was also conducted. Farmer participatory demonstration plots on arecanut based multispecies cropping system were implemented in eight gardens.

Soil health cards

Farmers' training programme on soil health management and scientist-farmer interface programme on pest and disease management in different crops were organized on 5th December, 2018 at ICAR-CPCRI, Kasaragod. As a part of the event, a workshop on "Be the solution to soil pollution" and a sensitization programme for college students on the importance of soil health management and an awareness amongst farmers of Mera Gaon-Mera Gaurav (MGMG), were organized at Kasaragod. Besides, a seminar on 'post flood soil health management and good agricultural practices for sustainable crop production in paddy and coconut' was conducted. A total of 170 soil health cards were distributed from the institute.

Impact of ICAR-CPCRI technologies

Based on data available from Kozhikode district, the methodology for computing the yield and economic advantage was developed and illustrated. To account for variation in adoption, productivity and share of production among holdings of different sizes, it is suggested to post-stratify the sample to small, medium and large holdings. The production technologies considered along with percentage adoption in the category of small holdings were: (i) HYV (5.7%); (ii) application of organics (65.68%); (iii) application of chemical fertilizers (30.29%); (iv) inter/mixed cropping (38.75%); (v) irrigation (24.65%); (vi) intercultivation (44.70%); (vi) plant protection (7.19%); (vii) soil and water conservation-including mulching (13.37%); and (viii) raising green manure crops (0.57%).

The estimates of density of bearing palms, average yield per palm and percentage area under the category were worked out. Yield advantage is determined as the difference of per palm yield of holdings where the technology adopted and that of the rest in the holding-category. Weighted average of these differences multiplied by density of bearing palms and area of the category is the yield advantage on adoption of technologies in that category. Accordingly, the yield advantage from the technologies with regard to small holding category was worked out to be 40.07 million nuts. This on multiplying with average price (*i.e.*, Rs.13.00) gives the contribution towards GDP and is obtained as Rs. 572.88 million. On similar lines, the contributions from medium and large holding categories were worked out. The economic impact of technologies in the Kozhikode district was then obtained as Rs. 2962.46 million. Extrapolating this result to national level would give Rs. 51802.80 million as the economic impact. This estimate can however be improved on obtaining economic impact in all the major coconut growing districts. On similar lines the economic impact for arecanut and cocoa are also to be worked out. A different approach is required to add the contribution from value addition protocols of coconut, tender coconut, and Kalparasa®.

Tribal Sub-Plan

The Institute had signed MoU with Integrated Tribal Development Agency (ITDA), Paderu, Visakhapatnam, which is a notified region for implementing the Tribal Sub Plan (TSP) by Government of India. Under TSP, 5400 coconut seedlings were planted in holdings of 90 farmers spread across 14 villages. Training was conducted for the farmers on planting of coconut and juvenile care and in four villages, planting of seedling was demonstrated. In Chintepalli area, 110 honey bee boxes and colonies were provided to farmers followed by training programme on bee keeping. Following inputs for the crop year 2019-20 was procured: chemical fertilizers for the planted coconut seedlings; cashew grafts (6250); cocoa seedling (10,000); honey bee boxes and colonies (50); coconut seedlings (3000); and coconut seed nuts for raising nursery (4000). An exhibition showcasing coconut technologies in Telugu was arranged at Paderu on the occasion of World Adivasi Day, which was inaugurated by Hon'ble Chief Minister of Andhra Pradesh. Out of Rs. 15.00 lakhs allocation under TSP, an expenditure of Rs. 13.13 lakhs was accomplished.

Scheduled Caste Sub-Plan

Production of coconut planting material in Gaja affected areas of Andhra Pradesh was given high priority under Scheduled Cast Sub Plan (SCSP) and 65,600 seed nuts

were procured of which 25,600 were collected through Coconut Producer Federations in the five districts of northern Kerala. It is proposed to sow 50,000 seed nuts in Tanjavur and Pudukottai districts of Tamil Nadu and the remaining in selected villages in Karnataka and Andhra Pradesh. Poultry birds and cages were provided to SC community members belonging to the category of BPL in Thrissur, Ernakulam, Kottayam and Kollam districts in Kerala in collaboration with respective KVKs. Planting materials of arecanut, pepper and other crops available at ICAR-CPCRI Research Centers at Kahikuchi and Mohitnagar were also distributed to SC families locally. To empower SC community members in farm mechanization, the following implements were procured for distribution: tender coconut punch and cutter (12); coconut climbing device (90); sprayer (3); power tiller (1); mini-tiller (3); diesel engine (2); and electrical engine (1). Out of Rs. 95.00 lakhs allocated under SCSP, an expenditure of Rs. 89.3 lakhs has been made.

Farmer FIRST Programme: Participatory technology integration to empower and ensure livelihood security of farmers of Alappuzha district

The Farmer FIRST Program (FFP) is being implemented in multi-stakeholder participatory mode to achieve the goal of doubling farm income in the area. A blue print for the same is derived based on the experiences and input from the participants and stakeholders as a model.

Output of the FFP interventions

The FFP is being implemented in 1627 hectares in Pathiyoor panchayath, Alappuzha district of Kerala involving 1000 farm families in six modules consisting of crop, horticulture, livestock, entrepreneurship development, natural resource management and integrated farming systems. Forty-five training programmes were organized for knowledge and skill upgradation benefitting 2233 participants. The expansion of area in coconut gardens has been achieved with intercrops such as finger millet, cowpea, vegetables, tubers and spices to the tune of 680 acres. Demonstration of integrated management of root (wilt) disease and technologies implemented in 218 coconut gardens of 95 hectares covering 15839 coconut palms. Coconut based integrated farming systems was established through integrating 69 poultry units of high yielding breeds like gramapriya, gramasree and BV 380.

Outcome of the FFP interventions

Four farmer community based organizations were formed namely; Ramapuram Karshaka Sevana Sangham, Pathiyoor, Surabhi Desi Cow Farmers' Group, Pathiyoor Egg Producers' Group, and Kalpakam Kera Probio Unit. Interventions for commercial vegetable cultivation in all the 19 wards of the FFP panchayath resulted in realizing a total of Rs. 4.75 lakhs in the panchayath. Value addition enterprises on coconut oil, two virgin coconut oil units and coconut based food products utilizing ICAR-CPCRI technology started realizing revenue up to Rs.18 per nut.

Convergence of the FFP components with Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) could improve the farming outcome as well employment wages to the tune of Rs. 94.97 lakhs in the panchayath. Innovative extension approach named 'Responsible Extension Approach (REA)' was evolved for rapid technology spread. The farmers of FFP contributed 50 per cent of the seed materials of HYVs [(Gajendra, Sreekeerthy (tubers), Prathibha (turmeric), CO-5 (Maize-fodder) and Mahima (ginger)] resulted in spreading of varieties by eight-folds in the panchayath.

Impact of FFP interventions

The direct impact of the FFP interventions, as the total income from interventions, is depicted in Fig 7.3. Impact of the training programmes for women farmers are shown in Table 7.2.

The impact of the training programmes among women farmers indicated that the trainings imparted confidence, improvement in income, savings, knowledge and adoption. The impact of the training programme in

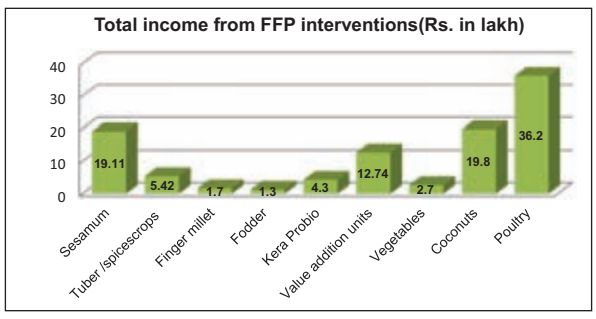


Fig. 7.3. Total income from FFP interventions

income and savings indicated improvement in all categories. However, the improvement in monthly savings in the category of Rs. 500-1000 exceeds the monthly net income indicating the sustainability as well as the long term economic empowerment.

Table 7.2. Economic impact of women farmers from FFP interventions (n=120)

Sl. No.	Category (income in rupees)	Percentage (%)	
		Increase in monthly income	Increase in monthly savings
1	500-1000	66.67	86.11
2	1000-1500	20.83	5.56
3	1500-2000	8.33	5.56
4	2000-2500	4.17	2.78

The adoption of technologies improved among the women farmers after FFP in terms of the number of technologies in various crops/farming and majority of them are adopting more than three technologies after FFP interventions, with more than 95 per cent improvement compared to pre FFP.

Leadership behavior and social intelligence of coconut farmer leaders

Leadership and social intelligence of both leaders and followers are important for the development of sustainable farming sector. Hence a pilot study was undertaken in Bharanikkavu and Muthukulam blocks of Alappuzha district of Kerala among the farmer leaders of coconut producers' societies (CPS). It was found that 80 per cent of CPS leaders fall in the medium to high level of leadership practices (Fig 7.4). The leadership experiences, in multiple organizations could be the contributing reason for the leadership scores (Fig. 7.5). The leadership practices were found to be positively and significantly correlated with occupational status of the farmer leaders and their social intelligence score.

The average social intelligence score of the sample respondents, under study was 30.11 which fall in the medium category. The overall scores showed that leaders were having appropriate and desirable social intelligence factors for being the leaders of farming communities.

This study brought out the need of identifying training areas of farmer leaders, evolving pathways for exercising power dynamics in grass root level farmer

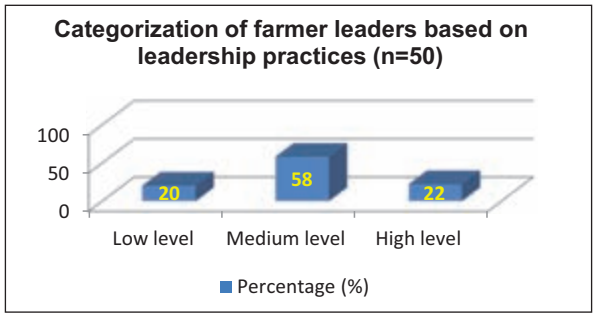


Fig. 7.4. Categorization of farmer leaders based on leadership practices

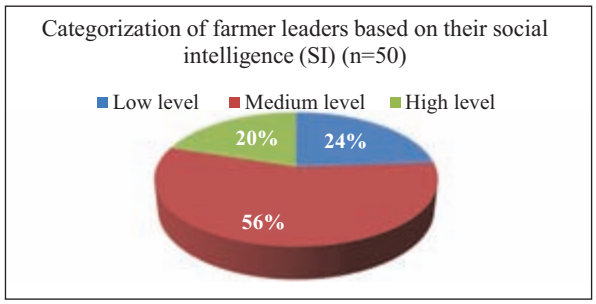


Fig. 7.5. Categorization of Farmer leaders based on social intelligence

organizations and policies to encourage gender and youth representations in leadership positions of farmer organizations.

Adaptation deficit analysis and resilience strategies to climate change in coastal coconut agro-ecosystems

Measurement techniques for deriving perception of various stakeholders on aspects related to clime change were developed and data were collected from 147 respondents through, participatory rural appraisal (PRA) & rapid rural appraisal (RRA). Regarding climate variability, the major concern expressed by majority of the respondents were shifting monsoon, erratic rainfall, reduction in the number of rainy days and distribution, increase in temperature and number of hot days (resulting in longer droughts and drying of water bodies and wells). Regarding the impact of climate variability on coconut and intercrops, majority of the respondents expressed that higher incidence of pests and weed growth, low germination of seeds, low setting percentage / higher nut/fruit fall and wilting/rotting of plants are the implications. Adaptation deficit analysis revealed that 82 per cent deficit with major gaps in areas viz., alternate cropping pattern, innovative strategies under IPM/IDM, stress tolerant varieties, crop rotation, improved cultivation / INM practices. Regarding the technological needs to cope with climate change, the

farmers considered plan for shifting of planting time, selection of ideal crops, soil and moisture conservation strategies, conservation of indigenous varieties, ideal methods for storage of seeds and indigenous practices / modified farmer practices as the most important ones.

Socioeconomic dimensions and value chain dynamics in policy perspective

Micro and macro level analysis of price volatility of coconuts

Quantitative analysis along with qualitative studies on the recent price movements and trade concerns were conducted. The influence of international prices on the domestic sector and the impact thereof were also studied. Beyond any degree of doubt, in the recent times, trade related issues, market access, and attractive prices are the major factors shaping up investment decisions in coconut farming enterprise. Analysis of coconut prices for over a decade (2004-16) depicts the increasing price volatility, especially in the recent years (Fig. 7.6). From 2004 till 2009, the prices were declining with comparatively low price fluctuations. On the other hand from the year 2010 onwards, the price fluctuations are quite apparent wherein the prices started rising reaching peak levels during the mid-2011 after which it plummeted to low levels. But again from the beginning of 2013, the prices started improving and the prices continued as attractive, and all over again, from 2015 onwards the sector has been experiencing a price crash regime, followed by a price rise regime in 2018. The bubbles of price rise regime is not helpful for the sectoral prosperity, as these sort of price boom periods are not long-lasting enough to instill confidence in the coconut farmers to have a serious reorientation towards scientific farming approaches.

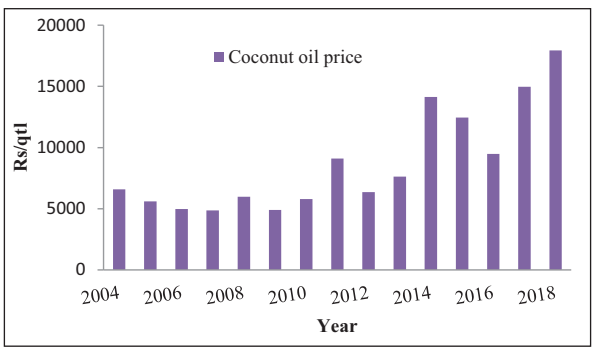


Fig. 7.6. Price movement of coconut (2004-2018)

Besides, the analysis of demand-supply scenario using stock-use ratio revealed that there is a declining demand for coconut oil from 2012-13 onwards and the wedge between demand and supply has been narrowed down. This, of late, has certainly reflected in realization of low prices for the commodity. It was observed that there is huge positive price wedge between domestic and international prices (Fig. 7.7). As the prices will tend to integrate, there is a possibility for a price crash in the near future.

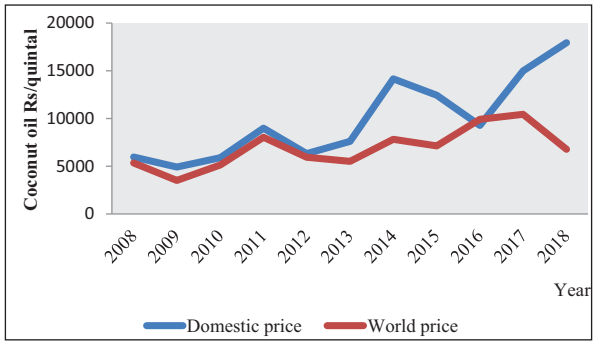


Fig. 7.7. Coconut oil: Movement of domestic prices and international prices

Analysis of production economics

Cost of production of coconut in Kerala State, India, based on data from a well-managed coconut garden, is Rs. 8.94 per nut. In this scenario, about 56 per cent of the total cost incurred is due to labour charges, which shows higher per unit labour charges, directly attributed to higher labour demand and higher cost of labour in the recent times. In addition, lack of availability of sufficient skilled labourers for harvesting of coconut leading to higher cost of cultivation of coconut in Kerala scenario. Currently, wage rate prevailing in Kerala is around Rs. 700 per day, which is one of the highest rates prevailing for agricultural labour in India (Fig 7.8). On the other hand, it is noteworthy that the annual growth rates (over the year 2017) in wages in other states are

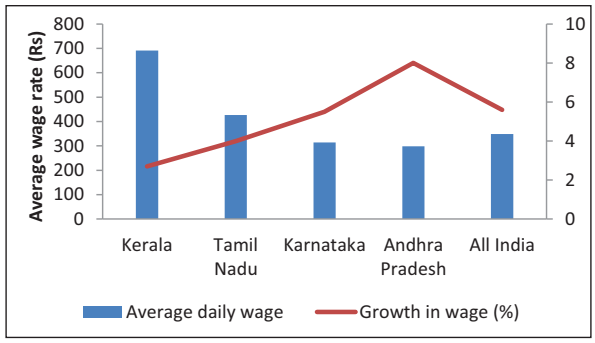


Fig. 7.8. Pattern of wage rates in major coconut growing states

much higher than that of Kerala. Twenty six per cent of the total cost is for applications of manures & fertilizers and plant protection chemicals. Total cost of cultivation per hectare is Rs. 1,40,800 with an average productivity of 90 nuts palm^{-1} year^{-1}. Processing cost for copra is around 24 per cent of total cost. Copra recovery per nut is @ 120 g and cost of production of copra is Rs. 83.25 per kg of copra.

Policy Research and consultancy

The institute has provided policy level inputs on mandate crops at different strata ranging from regional to international level (Fig. 7.9). The analysis has provided policy insights pertaining to plantation sector to the State Agricultural Prices Board and WTO Cell-Government of Kerala for shaping the International Free Trade Agreements towards livelihood security of farmers. It was extremely important in the present scenario wherein volatile international market prices and the lowering of import barriers under free trade agreements had affected the domestic production and export of plantation crops. In this connection, a policy write-up on price and non price aspects of coconut sector was prepared for the Commission for Agricultural Costs and Prices (CACP) and resulted in elevation of Minimum Support Price (MSP) of copra in tune with the suggestions/indications of the Institute. It is also pertinent that the Institute has provided key inputs and suggestions to International Labour Organization (ILO) on plantation crops focussing employment and skill aspects in post flood situation in Kerala. The inputs were crucial, keeping view of way forward and recovery/ reconstruction planning for the state.

Fig. 7.9. Providing policy inputs on mandate crops at different levels

Development of statistical and computational techniques for improving research methodology

Study of consumption pattern and health status of arecanut consumers

A field survey was undertaken in three districts of Karnataka to study the pattern of arecanut chewing, perceptions about health benefit, risks and socio economic factors. Arecanut chewing with tobacco was common than without tobacco in these regions. Majority of the respondents perceived that chewing had beneficial effects like increasing taste, digestion, pleasure and reducing tooth pain. The present study did not find any significant difference in health issues between arecanut chewers and non-chewers.

Field survey to assess the incidence of diseases/ pests in mandate crops

A field survey was conducted to estimate the yield loss due to *fruit rot* in Kasaragod district of Kerala and five major arecanut growing districts of Karnataka, *viz*, Dakshina Kannada, Udupi, Chikkamagalur, Shivamogga and Uttara Kannada. These districts received very high rainfall during monsoon season. To cover large number of gardens with limited time and resources, purposive sampling method has been adopted in the selected taluks of each district. To take observations, the gardens were selected systematically in each taluk. The district wise yield loss was estimated by using the previous year's production and the estimated percentage yield loss in each district (Table 7.3).

Assessment of crop loss due to floods in Kerala

The abnormally high rainfall of 2346.6 mm received in Kerala from 1 June 2018 to 19 August 2018, which is 42.3% more than the normal rainfall, resulted in severe floods in 13 out of 14 districts in the state. The design of the study was chalked out with an objective to gain a quick understanding of the ground level situation in the affected districts. The teams visited the respective offices of Principal Agricultural Officer (PAO) of the districts, and in consultation with them, the roadmap of the survey was finalized. The teams transected the villages to gain a perception on the extent of damage at the macro level while using a specially designed simplified schedule to elicit information on the nature of damage and other specific inputs from the selected farmers. In

Table 7.3. Yield loss in arecanut due to fruit rot in arecanut growing areas of Karnataka and Kerala

District	Area (Ha)	Production (tonnes)	No. of gardens surveyed	Yield loss (%)	Loss in production (MT)
Dakshina Kannada	39396	78792	141	44	34668
Shivamogga	48187	68721	151	34	23365
Chikkamagalur	36980	49015	93	52	25488
Uttara Kannada	17671	43260	62	59	25307
Kasaragod	19478	51807	54	45	23313

the case of plantation crops sector, the landslides had resulted in the loss of approximately 25,000 coconut palms, 20,000 arecanut palms and 80,000 cocoa trees in the state. The (life time) economic loss from the landslides would be Rs. 102.50 crores for the farming community. Flood related losses is of two types: One is crop loss and the other is yield loss. It was reported that around 3500 coconut palms and 40,000 arecanut palms were lost due to flood. The (life time) economic loss in this regard was worked out to be Rs. 35.25 crores. In coconut, immature nut fall was noticed in the hilly terrains of north central districts (Kozhikode, Wayanad, Malappuram and Palakkad). Number of affected palms varied between 10% and 40%. Loss of juvenile coconut palms in the flood affected areas is approximately 1,00,000 (including plants in the nursery). The yield loss is worked out to be 95.6 million nuts and in terms of economic loss it would be Rs. 143.40 crores. The expected yield loss in arecanut would be 63,577 tonnes and at prevailing market price, the economic loss would be Rs.1589.43 crores.

Development of sampling techniques for spatial data analysis and impact assessment

Spatial sampling procedure to study the impact assessment has been developed. The method is based on the spatially stratified double sampling procedure and this can be used to evaluate the impact of technologies.

Development of need based computer programs for data analysis

The R cum Java graphical user interface- based statistical software, STDAPR, has been designed to analyse the agricultural research data. This software has been designed by integrating the programming languages R (version 3.5.2) and Java (version 7). The software is standalone and platform independent. Currently, the users may perform data exploration, descriptive analysis and analysis of experimental designs. The powerful analysis and statistical graphs features may also be carried out with internet connectivity.

An efficient program has been developed for analysing the experimental data collected over years. A mixed effects model approach was used to carry out the repeated measures analysis. The program is available as R-script is capable to generate good statistical report along with graphical representations.

A program for simulated gel visualization has been implemented for making comparison of polymorphic microsatellite markers for polymorphism discovery. Codes were developed using R (v 3.0) software which gives the output as product sizes for the markers for the same primer pair. Main application is, if user enters the ladder results obtained from previous/multiple experiments, the program will generate a graphical gel view to identify suitable genotypes for designing further in-vitro experiments helping in exploring/ comparing previous or, multiple experiments results, in-vitro and without repeating lab- experiments. Further, this code may also easily be integrated with the other reporting language like Perl, Java, ASP.NET, etc. One of successful usage of this code is implemented in the web based tool (PolyMorphPredict) using Perl, R, Java and launched at Apache which is available at http://webtom.cabgrid.res.in/polypred/.

Agribusiness incubation

An innovators' meet was conducted on 6th October, 2018 in which 10 successful incubatees were honoured by the Hon'ble Governor of Kerala, Shri. Justice (Retd.) P. Sathasivam. The MoU signed with Kerala StartUp Mission (KSUM) for mutual cooperation in promoting entrepreneurship in agricultural sector was exchanged between Dr. P. Chowdappa, Director, ICAR-CPCRI and Dr. Saji Gopinath, CEO, KSUM.

One of the joint initiatives in this regard was 'Kalpa Green Chat' in which entrepreneurs will get an opportunity to interact with successful businessmen/faculty. Mr. Nagaraja Prakasam, Angel investor; Mr. Mahesh Bhat, incubatee; Mr. Jayaraj P Nair, coconut consultant and Mrs. Deepti Nair, Coconut Development Board were the invited speakers in different months.

Incubatees were provided with various platforms for networking: On an average three incubatees were invited to showcase their products in exhibitions at different locations (31); five inucbatees of CPCRI-ABI participated in the Agri Startup Conclave held during 16-18 October 2018 at NASC Complex, New Delhi.

Intellectual property and technology management

The Institute Intellectual Property and Technology Management Committee met 10 times in the year to take decisions on various issues pertaining to technology transfer. Technology transfer fee for three products were fixed: Kalpa Poshak; Kalpa Vardhini; and preservation protocol for trimmed tender coconut.The Institute made two trade mark registrations viz., Kera Probio (No. 2813921) and KeraAM (No. 2813918).

During the period, 10 technologies were commercialized by signing 21 Memorandum of Agreements and a sum of Rs. 7,00,000/- was realised as technology transfer fee. Technologies commercialized are virgin coconut oil (7); coconut chips (1); kalaparasa (2); matured coconut water based value added products (3), spraying technology using unmanned aerial vehicle (1); Kalpa Soil Care (1); preservation protocol for trimmed tender coconut (1); carbonated tendernut water (1); *Bacillus subtilis* culture (1); EPN (2) and frozen coconut delicacy (1).

8. ICAR-All India Coordinated Research Project on Palms

The All India Coordinated Research Project (AICRP) on Palms, with headquarters at ICAR-CPCRI, Kasaragod, started functioning from 1972 with the objective of conducting location-specific research in the mandate crops. At present, the project has coconut, oil palm, arecanut, palmyrah and cocoa as mandate crops and is being implemented in 30 centres, located in 14 states and one union territory, involving 13 SAUs/SHUs, two CAUs and four ICAR institutes (Fig. 8.1).

Fig.8.1. Map showing coordinating centres of ICAR-AICRP on Palms

The budget for the year 2018-19 was Rs. 535 lakhs and the scheme was implemented through the respective state agricultural/horticultural universities on 75:25 basis, with 75% ICAR share and with 100% ICAR funding in the case of Central Agricultural Universities and ICAR Institutes.

RESEARCH ACHIVEMENTS

Genetic Resources and Crop Improvement

At Aliyarnagar centre, among the five Tall x Tall cross combinations planted during 2011, Benaulim Green Round Tall (BGRT) x Andaman Ordinary Tall (ADOT) recorded the highest yield (81.4 nuts palm^{-1}), which was on par with West Coast Tall x Tiptur Tall (70.9 nuts palm^{-1}) (Fig. 8.2).

At Kahikuchi, evaluation of newly developed hybrids planted during 2009 revealed that Assam Green Tall (ASGT) x Philippines Ordinary Tall (PHOT) recorded a yield of 58.6 nuts palm^{-1} followed by ASGT x Malayan Yellow Dwarf (MYD) (55.0 nuts palm^{-1}) whereas, the lowest yield of 25.0 nuts palm^{-1} was found in check variety Assam Green Tall. The cross combination ASGT x PHOT also recorded the highest number of inflorescences palm^{-1} as well as the highest number of female flowers palm^{-1} compared to other hybrids (Fig. 8.3).

In the evaluation trial of five Dwarf x Dwarf cross combinations developed from ICAR-CPCRI, Kasaragod and planted during 2011 at Veppankulam centre for evaluation, the cross combination MYD x Chowghat Green Dwarf (CGD) commenced flowering at 22nd month after planting. The cross combinations Chowghat Orange Dwarf (COD) x MYD and Gangabondam Green Dwarf (GBGD) x Malayan Orange Dwarf (MOD) recorded higher yield (84 nuts palm^{-1}) with good quantity of tender nut water (430 – 510 ml nut^{-1}).

At Ratnagiri centre, among the five Dwarf x Dwarf hybrid combinations and one local check, under evaluation since 2011, earliest flowering was noticed in GBGD x MOD at 27th month after planting followed by COD x MGD (28th month). The hybrid COD x MYD (Fig. 8.4) recorded higher tender nut yield (54.3 nuts palm^{-1}), while the higher quantity of tender nut water was found in MYD x CGD (463.8 ml) and higher TSS in GBGD x MOD (5.7° Brix).

In the field evaluation of different hybrid combinations of oil palm viz.,. NRCOP 11 to 20, planted in 2006, indicated highest bunch weight of 198.4 kg palm^{-1} and fresh fruit bunch (FFB) yield of 28.4 t ha^{-1} in hybrid NRCOP 17 at Pattukkottai centre. Under the evaluation of new cross combinations, the hybrid NRCOP 10 recorded the highest FFB yield (9.9 t ha^{-1}) at Madhopur centre while at Pattukkottai, the highest FFB yield (21.0 t ha^{-1}) was recorded in the hybrid NRCOP 9 (Fig. 8.5). NRCOP 2 recorded the highest yield of 22.7 t ha^{-1} at Mulde centre (Fig. 8.6). Yield data at Vijayarai centre indicated that the FFB yield was the highest in NRCOP 4 (30.1 t ha^{-1}).

Fig. 8.2. High yielding coconut hybrid BGRT x ADOT

Fig. 8.3. High yielding coconut hybrid ASGT x PHOT

Fig. 8.4. High yielding coconut hybrid COD x MYD

Fig. 8.5. High yielding hybrid NRCOP 9

Fig. 8.6. High yielding hybrid NRCOP 2

Crop Production

At Kahikuchi centre, trial on evaluation of nutrient management under coconut based cropping systems showed that the highest yield ha^{-1} for all the intercrops, nut yield, net returns (Rs. 4,86,650/- ha^{-1}), benefit cost ratio (2.1), highest biomass production (9,086 kg ha^{-1}) were recorded in treatment comprising of 50% of recommended fertilizer dose + 50% N through organic recycling with vermicompost + vermiwash application + *in situ* green manuring + biofertilizer and the lowest yields were recorded in fully organic treatment.

At Aliyarnagar centre, the yield of coconut (18,600 nuts ha^{-1}), yield of intercrops and net returns (Rs. 3,30,800 ha^{-1}) were higher in treatment comprising of 75% of recommended fertilizer dose + 25% of N through organic recycling with vermicompost, followed by treatment comprising of application of 50% of recommended fertilizer dose + 50% through organic and treatment which was fully organic. The mono crop of coconut recorded the lowest net returns (Rs. 1,00,800 ha^{-1}).

Crop Protection

Basal stem rot

Roving survey was conducted in three southern coconut growing states *viz.*, Karnataka, Tamil Nadu and Andhra Pradesh. The incidence of basal stem rot was high in Arsikere taluk (5.8%) in Karnataka and Thovali block (4.08%) in Tamil Nadu.

Fixed plot survey of basal stem rot disease, indicated increase to the tune of 1.5 per cent in Arsikere, 2.3 per cent in Ambajipeta and 9.4 per cent in Veppankulam centre in comparison to the previous year. On the contrary, increase in the incidence of stem bleeding was meagre both at Arsikere and Ambajipeta.

Stem bleeding

The new fungicide molecule with combination product of Carbendazim 25% + Mancozeb 50% WS was tested against *Thielaviopsis paradoxa* under *in vitro* conditions. Complete inhibition of pathogen at lower concentration (100 ppm) was observed, indicating its strong action against the test pathogen.

Leaf blight

At Aliyarnagar centre, in the field evaluation trial, sequential root feeding of Carbendazim @ 5 g 100 ml^{-1} of water during January and July followed by Propiconazole @ 5 ml 100 ml^{-1} of water during April and October reduced the leaf blight incidence by 2.8 per cent after 18 months of application.

Rugose spiralling whitefly (RSW)

In Aliyarnagar, the RSW incidence was high (38.3%) during June 2018 after the commencement of the South West monsoon. The incidence declined to 20.5 per cent during December 2018. The increasing trend in pest incidence was observed from January 2019 and reached a peak of 47.5 per cent during Mach 2019. Parasitisation by *Encarsia guadeloupae* varied from 24.7 to 70.5 per cent and the highest parasitism was recorded in the month of December 2018. The centre distributed about 17,03,800 *E. guadeloupae* parasitoids for the management of RSW to farmers, covering an area of 2,726 ha in the major coconut growing districts of Tamil Nadu and East Godavari district of Andhra Pradesh. Under IPM package, yellow sticky traps attracted significantly higher number of RSW (31.6) followed by green and red sticky traps (11.5). The IPM strategies significantly reduced incidence and intensity of RSW from 75.5 to 37.7 per cent and 85.7 to 42.9 per cent, respectively compared to the natural control (64.2 to 80.2% and 80.5 to 95.5%, respectively).

Rhinoceros beetle

In a field trial at Ratnagiri centre, leaf axil filling of chlorantraniliprole recorded the least leaf damage (5.9%) at 18 months after treatment, which was significantly superior over control (10.7%) and on par with botanical cake and paste (7.4%), neem cake (8.6%) and naphthalene ball (8.8%) application. At 27 months after treatment, the minimum leaf damage was observed in chlorantraniliprole treatment (2.3%) and was at par with botanical cake and paste (3.3%). At 21 months after treatment, chlorantraniliprole registered the least spindle damage (5.0%) which was significantly superior over control (35.0%) and on par with botanical cake + paste and naphthalene ball application.

27th Annual Group meeting of ICAR-AICRP on Palms

The 27th Annual Group Meeting of ICAR-AICRP on Palms was conducted during 24-26 May, 2018 at ICAR-IIOPR, Pedavegi. Dr. J. Dilip Babu, Director of Research, Dr. YSRHU, Venkataramannagudem, Andhra Pradesh was the chief guest and Dr. W.S. Dhillon, ADG (Hort. I), ICAR, New Delhi delivered the presidential address. Dr. K. U. K. Nampoothiri, Former Director, ICAR-CPCRI, Kasaragod, Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod and Dr. D. Damodar Reddy, Director, ICAR-CTRI, Rajamahendravaram were the guests of honour. Dr. R. K. Mathur, Director, ICAR-IIOPR welcomed the gathering. Dr. H. P. Maheswarappa, Project Coordinator (Palms), ICAR-AICRP on Palms presented the Project Coordinator's report and achievements made during 2017-18. Based on performance grading, AICRPP Centre Bhubaneswar was adjudged as the best centre for the year. Dr. Dilip Babu emphasized on the need of strong farming system based technologies to help the farmers for survival and increasing profitability and also the need to make available quality planting material to the farmers at affordable price. During the presidential address, Dr. W. S. Dhillon emphasized on the need for increasing the productivity which is possible through quality planting material production and briefed about the role of processing and value addition in increasing the profitability.

During the inaugural function, eight extension folders were released from different AICRP on Palms centres in local languages on various aspects of the mandate crops. About 100 scientists from the 30 AICRPP centres, ICAR-CPCRI and ICAR-IIOPR attended the programme. Different technical sessions on crop improvement, crop production, crop protection, post harvest technology in palmyrah and transfer of technology were conducted during the subsequent days to assess the progress of research during 2017-18 and to formulate technical programme for 2018-19. Five technologies were recommended for the benefit the farming community. Dr. W. S. Dhillon presented Dr. S. Thangeswari, Asst. Professor Veppankulum centre, with the best presentation award based on the evaluation of project presentations made during the group meeting. Dr. H. P. Maheswarappa, PC (Palms), proposed vote of thanks.

The following technologies have been recommended during the meeting:

- Abhaya Ganga and Gauthami Ganga varieties recommended for cultivation in Andhra Pradesh state.
- The cocoa clone VTLCC-1 and hybrids VTLCH - 2 & 4 recommended for intercropping in coconut gardens of Gujarat state.
- Technology for composting of Palmyrah leaf base pith and production of organic manure in 100 to 105 days period with sufficient nutrient content. Palmyrah pith (100 kg) + poultry manure (10 kg) + urea (1 kg) + *Pleurotus* fungus (1 kg) + lingo-cellulolytic fungi (1 kg) + *Trichoderma viride* (1 kg): turning at 15 days interval up to 45 days and application of *Trichoderma viride* on 46th day and again turning at 15 days interval.
- For management of stem bleeding disease in coconut, application of cake formulation of *Trichoderma harzianum* (one cake/bleeding patch year^{-1}) recommended for Andhra Pradesh state.
- For management of bud rot disease in the coconut nursery, application of talc based formulation of *Trichoderma ressei* @ 5 g seedling^{-1} at spindle region is recommended for Andhra Pradesh state.

9. ICAR-Krishi Vigyan Kendra, Kasaragod

KVK, Kasaragod provided farm advisory services related to the pest, disease incidence and the other crop management issues encountered by farmers of the district. Further, KVK organized various extension programmes which include field visits to farmers' plots, advisories to farmers over phone, diagnostic visits, agricultural seminars, workshops etc. The major programmes conducted by the KVK are enlisted below:

***Grama Swaraj Abhiyan* Programme:** In association with ATMA *Grama Swaraj Abhiyan* Programme was conducted in all blocks of Kasaragod district on 2nd May, 2018. A total of 707 farmers attended this programme wherein technologies released by ICAR-CPCRI for doubling farmers' income were showcased. Many dignitaries including K. Kunhiraman, MLA of Uduma, Panchayath Presidents, Vice Presidents, Standing Committee Chairmen, Panchayath members and ATMA officials participated in the programme. Animal Health camps were organized in three blocks as part of the programme.

Hon'ble Prime Ministers' Farmer Interaction Programme: This programme was conducted on 20th June, 2018 wherein Prime Ministers' live interaction with farmers telecasted by Doordarshan was live streamed. On the sidelines, a training programme on Recent Advances in Rice Cultivation was also organized. Around 50 farmers attended this programme.

Live Webcasting of PM's interaction with farmers: A farmers' meeting was organized in connection with the webcasting of Prime Ministers interaction with women SHGs on 12th July, 2018 and 45 women farmers and women SHG group members of the district attended the programme.

Fig. 9.1. Farmer Interaction Programme at KVK, Kasaragod

Fig. 9.2. Members of women SHG attending interaction programme

World Honey Bee Day celebration: World Honey Bee Day was celebrated on 20th August, 2018 in collaboration with Horticorp, Thiruvananthapuram. Around 120 farmers of the district attended this programme, which

Fig. 9.3. Smt. Santhamma Philip inaugurating the World Honeybee Day

was inaugurated by Smt. Santhamma Philip, Vice President, Kasaragod District Panchayat.

Soil Health Day : The World Soil Health Day was celebrated on 5th December, 2018 with the theme, "Be the solution to Soil pollution", to create awareness among the farming community and public about the importance of soil health for maintaining the production, productivity and sustainability of agriculture. The programme was inaugurated by Sri. A.A. Jaleel, President, Mogral Puthur panchayath. Seminars on Soil Health Management and Crop Health Management in Coconut were conducted as part of the programme. Soil Health cards were distributed to 20 farmers and method demonstration on soil sampling was carried out.

Kisan Diwas: *Kisan Diwas* was celebrated on 23th December, 2018 by organizing an awareness programme on 'Wealth from Waste' in Kumbla panchayath. The focus of the programmes was on management and conversion of household waste and farm waste into high value compost. Around 50 farmers and farm women attended the programme.

Kisan Mela: KVK in collaboration with ATMA, Kasaragod and ICAR-CPCRI organized "Punarnava" a *Kisan Mela* and a Technology Week from 16th - 19th February, 2019. The Kisan Mela was inaugurated by Shri E. Chandrasekharan, Hon'ble Revenue Minister of Kerala and was attended by other dignitaries like Shri N.A. Nellikunnu, Hon'ble MLA, Kasaragod, Shri Rajasekharan, Hon'ble MLA, Thrikkarippur, Dr. Sajith Babu IAS, Hon'ble District Collector, and Smt. Santhamma Philip. Vice president of District Panchayat. 'An exhibition was organized with over 60 exhibition stalls. Eight seminars on various topics such as pest management in paddy and vegetables, eco friendly pest management in banana, Meliponiculture, medicinal uses of honey, hi-tech dairy farming, fodder grass cultivation, management of plantation crops, fruit crop cultivation and new methods of cashew cultivation and its processing was organized with various eminent speakers. A farmer Scientist Interface and a quiz programme were also organized.

Inauguration of PM-KISAN: A farmers meet and seminar was held in connection with the national level launch of the scheme PM-KISAN by Hon'ble Prime minister of India on 24th February, 2019. Around 200 farmers and officials participated in the event. The event was inaugurated by Shri N.A. Nellikkunnu, Hon'ble MLA, Kasaragod and was attended by Dr. Sajith Babu IAS, Kasaragod District.Collector

Scientific Advisory Committee meeting: The Scientific Advisory Committee (SAC) meeting was conducted on 17.12.2018 under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI. Dr. D.V.S. Reddy, Principal Scientist, ATARI and 21 members of the SAC representing various line departments and farmer representatives participated in the meeting.

Technology Assessed and Transferred

On -Farm Trials: Two on-farm trials were implemented as d etailed below (Table 9.1).

Frontline Demonstrations: Eleven frontline demonstrations were carried out as detailed below (Table 9.2).

Pulses cultivation under NFSM: Demonstration on green gram cultivation was carried out in 20 ha at

Table 9.1. On -Farm Trials implemented by KVK, Kasaragod

Sl. No.	Crop/ enterprise	Title of the intervention	Technology	Location
1	Plantation crops	Eco-friendly management of rhinoceros beetles in coconut	Botanical cakes and Ferterra - sand mixture	Mangalpadi and West Eleri - 5 farmers
2		Varietal evaluation of dwarf varieties of coconut	Kalpa Jyothi, Kalparaksha, Kalpasree and Kalpa Surya	Mangalpadi and West Eleri -3 farmers

Table 9.2. Frontline demonstrations conducted by KVK, Kasaragod

Sl. No.	Crop/ enterprise	Technology to be demonstrated	Location
1	Cereals	Introduction of high yielding variety of paddy-Shreyas	Chemnad
2	Spice crops	Introducing high yielding disease tolerant pepper variety Thevam released by ICAR-IISR	Ballal and Pullur Periye
3	Plantation crops	Management of yellowing and wilting in pepper gardens	Kunjar
4	Plantation crops	Management of Ganoderma wilt disease in coconut	Velutholi
5	Rice mechanization	Demonstration of mechanized cultivation in rice	Kolavayal
6	Floriculture	Demonstration of cultivation of marigold Pusa Narangi	Ajanur
7	Vegetables	Introduction of grafted vegetable crops	Vidyanagar
8	Dairy	Introducing HYV of fodder, Sampoorna- DHN6	Paivalike and Kuttikkol
9	Banana	Demonstration of micronutrient mixture spray in banana	Puthige
10	Paddy	Introduction of Pink-pigmented facultative methylotrophic bacteria for drought mitigation in paddy cultivation	Manjeshwar
11	Resource conservation	Demonstration of water recharging systems in open wells and tube wells	Kasaragod

Ajanur, Pallikkare and Pullur Periye panchayaths. The demonstration was highly successful and green gram yield of 1.12 t ha^{-1} was obtained from Kolavayal village of Ajanur panchayath.

Precision Farming: A precision farming unit was established in the KVK, comprising drip system with fertigation, sprinkler and micro sprinkler units for demonstration of open field precision farming practices to farmers.

Machinery for custom hiring centre: The machinery required for performing various agricultural operations were procured for establishment of a custom hiring centre in KVK. The machineries procured include tractor, rotavator, disc plough, reversible MB plough, cultivator, small tractor, trolley, cultivator, land leveler, power tiller, bund former, transplanter, power weeder, back pack power weeder, mulcher cum drip laying machine, brush cutter and zero till drill.

Production and supply of technology products

Production of different technology products like vegetable seeds, planting materials, bio agents and fingerlings/earthworms as listed below during the year.

Trainings organized

During this year, many trainings programmes were organized, as detailed below, for the benefit of varied participants comprising farmers, farm women, rural youth, self help groups (Table 9.3). Further, two RAWE programmes were organized for 25 B.Sc. (Agri.) students of College of Agriculture, Padannakkad and College of Horticulture, Vellanikkara, KAU. An on job training programme, in two batches, were given to 58 students from Government Vocational Higher Secondary School, Karadka.

ASCI Skill development training programme: Skill development training programme on 'Coconut grower' and 'Friends of coconut tree' were conducted during 21st

Table 9.3. Trainings programmes conducted by KVK, Kasaragod

Programme	No. of trainings	Participants		
		Male	Female	Total
Farmers	56	885	782	1666
Rural youth	22	441	325	766
Extension workers	8	48	65	113
Total	86	1374	1175	2545

Fig. 9.4. Skill development training programme at KVK, Kasaragod

Fig. 9.5. Value addition training programme at KVK, Kasaragod

January to 20th February, 2019. A total of 40 participants were trained in various aspects of coconut growing.

Field experience training programme for scientist probationers: A 21 day field experience training programme was organized for six scientist probationers (109th FOCARS) of NAARM, Hyderabad, from 19th February to 11th March, 2019.

Sponsored Training programme on value added products: A sponsored training programme on 'Value added product from Nutrimix as morning snacks' was conducted for the beneficiaries of Kudumbasree units. Five batches of the training prograame of two days duration were organized from 4th to 15th March, 2019 in which a total of 100 members of various Kudumbasree units from different districts of Kerala participated. As part of the programme, training on the process for preparation of different value added products such as cookies, biscuits, nutri-bars, cakes etc. were imparted.

Field day: A Field Day was organized at Chengala Panchayath on 24th October, 2018 in connection with a frontline demonstration on 'Introduction of high yielding variety of paddy, Shreyas'. The programme was inaugurated by Smt. Shahina Salim, President, Chengala panchayath and attended by local self government officials, Agriculture department officials and farmers of the locality.

Table 9.4. Planting material produced and distributed

Sl. No.	Crop	Variety	Produced (no.)	Sold (no.)	Farmers benefited (no.)
1	Chilli, Brinjal, cabbage, tomato, cauliflower, drumstick, curry leaf	-	5000	4145	438
2	Suppota, Papaya, Passion fruit, Annona	-	2500	2451	569
3	Marigold	Pusa Narangi	3000	2500	12
4	Vetivar		700	650	7
5	Arecanut	Mangala, Mohitnagar	25000	24672	493
6	Pepper	Panniyur-1, 5, 8	800	753	52
7	Fodder	DHN-6	1000	1000	5
8	Garcinia	Local	750	700	70
		Total	**38750**	**36871**	**1646**

Table 9.5. Bio products produced and distributed

Sl. No.	Products	Produced (q)	Sold (q)	Farmers benefited (no.)
1	Neem-based formulations	4	4	82
2	Organic manure	9	0	KVK use
3	Coir pith compost	25	16.29	130
Total		38	20.29	212

Table 9.6. Fish fingerlings/ earthworms produced and distributed

Sl. No.	Animal	Breed	Produced (no.)	Sold (no)	Farmers benefited (no.)
1	Fish fingerlings	Tilapia	1500	1000	5
2	Earthworm	*Eudrillus* sp.	9685	9685	38
Total			11185	10685	43

10. ICAR-Krishi Vigyan Kendra, Alappuzha

KVK, Alappuzha provided farm advisory services and organized various programmes and activities for the benefit of the farming community and related stakeholders in the district. The major activities undertaken by the KVK are enlisted below:

Mahila Kisan Diwas: *Mahila Kisan Diwas* was celebrated on 15th October 2018 with the participation of about 100 women farmers of Alappuzha district. Adv. U. Prathibha, Hon'ble MLA, Kayamkulam, graced the occasion as a chief guest. Five women farmers, with significant achievements in different fields of agriculture, were honored on the occasion. Highlights of the day long programme include a contest for preparation of snacks from raw/ripe banana in which 23 women participated.

Fig. 10.1. Hon. MLA Adv.U.Prathibha inaugurating Mahila kisan divas programme

World Soil Day: The World Soil Day celebration was organized in association with Department of Agricultural Development and Farmers' Welfare at Edathwa on 5th December 2018. Smt. Binu Issac Raju, Member, Alappuzha District Panchayath, inaugurated the programme and distributed soil health cards to 100 farmers.

Live Webcasting of PM's interaction with farmers: Live webcasting of Hon. Prime Minister's interaction with selected farmers from all over India was arranged in KVK. Farmers and farm women from different panchayaths of the district attended the programme.

Foundation stone-laying ceremony of Agro-Processing Training cum Incubation Centre: Agricultural Development and Farmers Welfare Department, Govt. of Kerala has sanctioned an Agro-Processing Training cum Incubation Centre (APTIC) at a cost of Rs.73 lakhs to the KVK. Foundation stone of the building for the centre was laid by Adv. V.S Sunil Kumar, Hon'ble Minister for Agriculture, Govt. of Kerala on 23rd November 2018. The meeting was presided over by Adv. U. Prathibha, Hon'ble MLA, Kayamkulam.

Webcasting of the inauguration of PM-KISAN: Inauguration of *Pradhan Mantri Kisan Samman Nidhi* (PM-KISAN) 2019 by Hon'ble Prime Minister Shri Narendra Modi at Gorakhpur, Uttar Pradesh on 24th February 2019 was webcasted live and about 50 farmers at this KVK witnessed the proceedings.

Scientific Advisory Committee (SAC) meeting: Seventeenth SAC meeting, which was presided over

by Dr. (Mrs.) Anitha Karun, Director, ICAR-CPCRI, Kasaragod, was conducted on 15th February, 2019. Twenty two members of the SAC and all staff members of the KVK participated in the meeting.

Fig. 10.2. Live webcasting of PM-KISAN inauguration

Fig. 10.3. 17th SAC meeting of KVK, Alappuzha

On farm testing:

Five new trials have been initiated and continued. The details are as follows:

Table 10.1. On farm testing conducted by KVK, Alappuzha

Sl. No.	Title	Location
1.	Assessment of ICAR-IISR released turmeric varieties in Alappuzha District	Vallikunnam Thamarakulam
2.	Assessment of customized fertilizer application in Cassava	Vallikunnam Thamarakulam
3.	Assessing safe and low cost methods for pseudostem weevil management in banana cv. Nendran	Vallikunnam Thamarakulam
4.	Assessment of feeding ratio management in dairy cows	Vallikunnam Thamarakulam
5.	Assessment of organoleptic qualities of solar dried banana figs of different varieties	Vallikunnam Thamarakulam

Frontline demonstrations: Thirteen new demonstrations were initiated and one from the previous year was continued during the year of report. The details are listed below:

Table 10.2. Frontline demonstrations conducted by KVK, Alappuzha

Sl. No.	Title	Location
1.	Upland paddy cultivation using modified drum seeder	Vallikunnam Thamarakulam
2.	Scientific sesamum cultivation under moisture stress	Vallikunnam Thamarakulam
3.	Utility of multi-nutrient mix for Onattukara soils in cowpea cropping system	Vallikunnam Thamarakulam
4.	Enhancing the productivity of banana by application of multi-nutrient mix 'Sampoorna'	Vallikunnam Thamarakulam
5.	Eco-friendly disease management in betelvine	Vallikunnam Thamarakulam
6.	Rhizome rot management in ginger using PGPR capsule	Vallikunnam Thamarakulam
7.	Introduction of mosaic resistant cowpea variety Geethika	Vallikunnam Thamarakulam
8.	Scientific apiculture technique in rubber plantations for doubling farmers' income	Vallikunnam Thamarakulam
9.	Cluster-based approach for mango fruit fly management through IPM practices	Vallikunnam Thamarakulam
10.	Integrated approach for enhancing the profitability of root wilt affected coconut palms (on-going)	Mararikulam
11.	Management of subclinical mastitis in dairy cows	Vallikunnam Thamarakulam
12.	Demonstration of 'Kadaknath' breed of poultry for high value meat and egg production	Vallikunnam Thamarakulam
13.	Male calf rearing for increased dairy farm income	Vallikunnam Thamarakulam
14.	Demonstration of nutrition farms for year-round nutrition security among the farm families	Thamarakulam

Training

During this year, 120 training programmes were organized benefitting a total of 3022 participants as detailed below.

Table 10.3. Training programmes conducted by KVK, Alappuzha

Training	No. of batches	Participants		
		Men	Women	Total
On campus	33	445	502	947
Off campus	72	937	770	1707
Sponsored	11	115	169	284
Vocational	2	11	25	36
Extension officials	2	14	34	48
Total	**120**	**1522**	**1500**	**3022**

Entrepreneurship development programme on food processing

Ten days long entrepreneurship development training programme on 'Food Processing' sponsored by District Industries Centre was conducted during 18th - 28th July, 2018 at KVK-Alappuzha. A total of 26 participants from different parts of the district including Kudumbasree members and small scale entrepreneurs attended the programme. The training focused mainly on value added products from fruits and vegetables, coconut, Jack fruit, and fish processing. FSSAI registration, packaging and labeling of foods, marketing etc. were also discussed in detail during the training.

KVK - ATMA Linkage: Head and SMSs of the KVK actively participated in the regular ATMA programmes like Management Committee and Governing Body meetings, monthly technology advisory meetings, MDDT visits, and handling sessions in Farm Schools. In addition, the following programmes were conducted.

a) **Technology Meet – *Bhoomika* 2019**: A district level technology meet was organized in collaboration with ATMA and Department of Agriculture, at Mavelikkara Town Hall on 31st January and 1st February, 2019. The programme was inaugurated by Hon'ble MP Shri Kodikunnil Suresh. A Seminar on 'Eco-friendly pest management practices' and a Farmer-Scientist interface on 'Doubling farmers' income' were conducted by the KVK. An Agricultural Exhibition with 25 stalls was arranged with the participation of Agriculture and allied departments, other agencies, and SHGs of the district. About 800 farmers and 100 students visited the exhibition stalls and showed interest and curiosity.

b) **Technical advice in flood affected areas:** Flood affected areas of Chengannur block was surveyed as a member of the expert team coordinated by ATMA, Alappuzha, along with interactions with farmers and peoples' representatives for providing scientific management inputs to flood affected areas.

External-funded projects

National Innovations in Climate Resilient Agriculture (NICRA)

Technology demonstration component of the NICRA has been implemented in Kuttanad region of Alappuzha District by the KVK at Muttarvillage, Veliyanad block from the year 2011-12 and extended to Thalavady village, Champakulam block from 2017-18. Technology demonstrations on climate resilient practices relevant to the production systems in the region were taken up in a cluster village approach.

Enhancing the economic viability of Coconut-based land use systems for land use planning in Kerala State

This project is funded by Kerala State Planning Board to conduct demonstrations on scientific and integrated crop management practices to enhance the profitability of coconut-based cropping system at Mayyanad Panchayath and Chettikulangara Panchayath.

Onattukara Spices Farmers Producers Company Ltd. (OSFPCL)

KVK promotes the Farmers Producers Company – Onattukara Spices Farmers Producers Company funded by NABARD. The company was registered in December 2016 under Companies Act. Major activities include cultivation, procurement, processing and marketing of major spices like ginger, turmeric, pepper and Garcinia.

Agro Processing Training cum Incubation Centre (APTIC)

To strengthen the capacity of entrepreneurs in processing and value addition of coconut, jackfruit, and

seasonal fruits and vegetables, Agriculture Development and Farmers Welfare Department, Govt. of Kerala has sanctioned an Agro-Processing Training cum Incubation Centre (APTIC) to ICAR-KVK, Alappuzha during 2017-18.

Fig. 10.4. Agro-processing training conducted at KVK, Alappuzha

Technology backstopping to Agro-clinics of the Dept. of Agriculture (Crop Health Management Scheme)

The project was sanctioned during 2018-19 to provide technological backstopping in pest surveillance and crop health management activities of the Dept. of Agriculture, Govt. of Kerala, Various activities are under progress in this scheme.

Revolving fund activities of KVK

Different inputs *viz.,* methyl eugenol cue lure, yellow sticky traps, seeds and seedlings, layer chicks, mushroom spawn, mother spawn, multi nutrient mixture for banana and vegetables, *Azolla*, worms for composting, processed products, publications etc. were made available to the farmers of the district (as resource centre) through revolving fund activities. The progressive closing balance of revolving fund as on 31st March 2019 is Rs.23,56,402/-

Field days: Field days of the Frontline Demonstrations were conducted during the period of report are as follows:

Table 10.4. Field days conducted

Sl. No.	Date	FLD	Location
1.	26.04.2018	Enhancing the productivity of coconut-based cropping system through moisture conservation in coastal sandy soils	Mararikulam
2.	04.05.2018	Production of organic manure from trash fish	Arattupuzha
3.	04.05.2018	Fish silage feeding for backyard poultry rearing	Arattupuzha
4.	04.05.2018	Multi-nutrient mix 'Sampoorna' in vegetable cowpea	Chingoli
5.	08.05.2018	Cultivation of milky mushroom *Calocybe gambosa*	Kayamkulam
6.	08.05.2018	Rhizome rot management in ginger using PGPR capsule	Bharanikkavu
7.	25.10.2018	Upland paddy cultivation using modified drum seeder	Vallikunnam
8.	01.12.2018	Cage culture of Pearl spot fish	Arattupuzha
9.	24.01.2019	Rhizome rot management in ginger using PGPR GRB 35 capsules	Thamarakkulam
10.	28.01.2019	Mosaic resistant cowpea variety Geethika	Thamarakkulam

VII. Publications

During the period, 39 research publications in peer reviewed journals, 59 paper presentations in national level seminars/ symposia/ conferences/ workshops, 82 papers in semi technical jounals/ magazines, six technical bulletins, eight extension pamphlets, five book chapters, six books, 20 training manuals, five e-publications and two interactive DVDs were published from the institute.

Research papers

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Thomas R.J. and Shareefa M. 2018. Manual on "Hybridization techniques and plant health management in coconut" (*In Malayalam*) ICAR-CPCRI, Regional Station, Kayamkulam, Kerala. 32 p.

E-publication

Haris A.A., Nihad K., Thomas R.J. and Krishnakumar V. 2018. *Orientation Training Programme for Skilled Support Staff (E-Manual)*.ICAR-CPCRI, Regional Station, Kayamkulam. 40 p.

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Josephrajkumar A., Chandrika Mohan, Asokan E.R. and Sajjan M. 2019. Bio-suppression of rugose spiralling whitefly. Video produced by Dr. Anitha Karun and Dr. V. Krishnakumar, ICAR-CPCRI 7 min.

VIII. Technologies Assessed and Transferred

Cryopreservation of coconut pollen for breeding programme

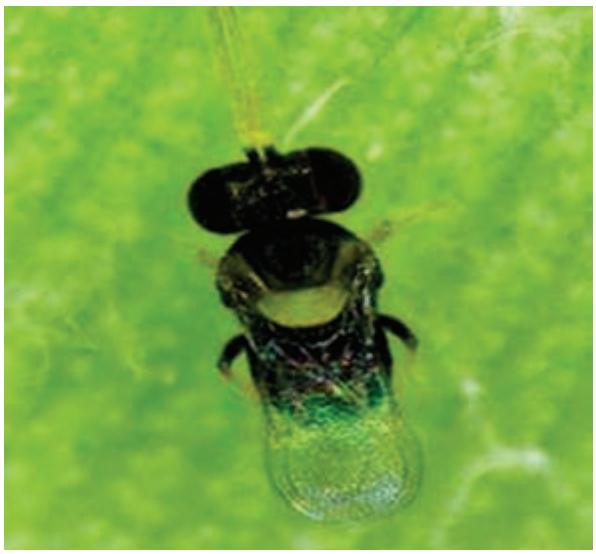
In order to enhance the hybrid seedling production, high yielding disease-free coconut mother palms are selected for artificial pollination to be carried out in a decentralized mode. The male flowers were selected from root (wilt) disease-free parental palms (based on ELISA test) and processed at ICAR-CPCRI, Regional Station, Kayamkulam and stored in deep freezer/ liquid nitrogen. The stored pollen will be transported to each *Panchayat* / *Krishi Bhavan* and will be kept in desiccators. Through this centralized mechanism of pollen processing, disease-free status of the male parental palms and quality of the pollen can be assured. From one inflorescence, approximately 6-8 g of pollen could be obtained, which can be transferred to 8-10 cryo vials (2.0 ml capacity). Cryo vials are then stored in liquid nitrogen cans; a can of 121 l capacity can store up to 6000 samples. One vial (filled with 1.5 g pollen) can be used for pollinating six palms for two days. This pilot programme is being taken up for the decentralized hybridization throughout Kerala state.

On-farm method of microbe production

A farmer-friendly method for mass-production of beneficial microbial bioinoculants utilizing a blend of mature coconut water, rice gruel and biochar, which are locally available, was developed. Using this method, contaminant-free bioinoculants can be mass-produced from starter cultures by farmers themselves, on their own farm, for immediate field application. The method is farmer friendly and does not require any costly instrument/equipment. The method was found suitable for mass-production of both bacterial and fungal inoculants, including 'Kera Probio®' and 'Cocoa Probio®' cultures.

Biological control of rugose spiralling whitefly on coconut

Rugose Spiralling Whitefly (RSW), *Aleurodicus rugioperculatus* Martin is an invasive pest on coconut. The pest could establish and successfully complete the



Coconut rugose spiraling whitefly larval parasitoid, Encarsia guadeloupae

life stages on coconut and to limited extent on banana, however, egg laying had been recorded on a wide array of hosts. Being a new invasive whitefly species, the initial spread will be quite rampant. It was observed that, more than 70 per cent of the whitefly colonies were parasitized by the aphelinid parasitoid, *Encarsia guadeloupae* Viggiani and controlled the buildup of the pest. A sooty mould develops on RSW affected leaves. A beetle, *Leiochrinus nilgirianus* Kaszab, was found feeding on sooty mould developed over the honey dew excreted by RSW.

Since the natural enemy buildup of *E. guadeloupae* has been initiated, RSW may not go beyond action threshold as expected. Farmer sensitization programmes focus on the natural buildup of the parasitoid, *E. guadeloupae* and habitat conservation of *L. nilgirianus* for effective bio-suppression of RSW. ICAR-CPCRI has conducted many pest-alert campaigns through mass media and sensitized the farmers regarding the invasive pest and the precautions to suppress the pest. These beneficial insects were released in the coconut plantations free of cost with the help of local Dept. of Agri./ Hort. Officials.

ICAR-CPCRI has initiated awareness campaign against the pest by resorting to pesticide holiday for the natural build-up of parasitoids and habitat conservation of scavenger beetles. The programmes were conducted in Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and Assam extensively. Mass production of these bioagents and scavenger beetles has been carried out. Advent of the parasitoid, *E. guadeloupae* and the scavenger beetle, *L. nilgirianus* considerably reduced the pestiferous potential of *A. rugioperculatus*.

Sooty mould feeding beetle, Leiochrinus nilgirianus

Arecanut palm spraying machines

Efficacy of the tractor mounted air blast sprayer, and the un-manned aerial vehicle/ drone (UAV) were demonstrated in the field. Spraying could be done from ground itself thereby avoiding a person climbing the tree, which would be difficult during rainy season. This makes the spraying more efficient and effective even during monsoon. This tractor mounted machine has been found suitable for well laid out garden of arecanut mono-cropping system.

Un-manned aerial vehicle spraying arecanut garden

Tractor mounted air-blast spraying machine

Frozen Coconut Delicacy

A “Frozen Coconut Delicacy” has been developed, which consists of coconut milk, coconut sugar/refined sugar, tender coconut water and pulp. It is a premium product which is completely natural and healthy. It is enriched with vitamins, minerals and healthy fatty acids. Richness of lauric acid in coconut milk and potassium mineral in tender coconut water makes it a functional as well as nutraceutical food.

IX. Awards and Recognition

Awards

Dr. H.P. Maheswarappa, Project Coordinator (Palms), ICAR-CPCRI, Kasaragod has been recognized as Fellow of Indian Society of Agronomy, New Delhi on the occasion of 21st Biennial National Symposium at MPUAT, Udaipur, Rajasthan on 24th October, 2018 for his outstanding contribution in the field of Agronomy in Plantation Crops. The certificate was presented by Dr. Ramesh Chand, Member, Niti Ayog, Govt. of India.

Dr. H.P. Maheswarappa, Project Coordinator (Palms) awarded ISA fellowship at Udaipur

Dr. Jayasekhar S. Sr. Scientist (Ag. Economics) received the 'Best Arecanut Scientist Award" instituted by All India Supari (Betelnut) Federation Trust through the Indian Society for Plantation Crops during the 23rd PLACROSYM held at Chikkamagaluru on 6th March, 2019 for his contributions towards the socio-economic and policy oriented research on arecanut sector in India.

Dr. S. Jayasekhar receiving Best Arecanut Scientist award from Dr. P. Chowdappa, President, ISPC at Chikkamagaluru

Dr. A. Joseph Rajkumar, Principal Scientist received a certificate of appreciation from Mr. V.S. Sunilkumar, Minster for Agricultural Development and Farmer's Welfare, Govt. of Kerala on 26th May, 2018 in recognition for the approval of two cardamom varieties (PV-3 and PV-5) by Kerala State Variety Release Committee. He was associated with the development of the varieties as Associate Breeder during his tenure (1999-2007) at Cardamom Research Station (under KAU), Pampadumpara, Idukki District.

Certificate of appreciation received by Dr. Joseph Rajkumar, Principal Scientist

The research paper entitled "Influence of crop combinations and soil factors on diversity and association of arbuscular mycorrhizal fungi in arecanut based cropping systems" by K. Ambili, George V. Thomas, Murali Gopal and Alka Gupta, published in the Journal of Plantation Crops, received Dr. C. S. Venkataram Memorial Award for the best research paper of the biennium 2016-2018 during the 23rd PLACROSYM held at Chikkamagaluru on March 6, 2019.

Dr. R.L. Narasimha Swamy Memorial Award for the best original research paper was awarded for the team of Jeena Mathew, A. Abdul Haris, Chinchu M. Raj, Krishnakumar, V., Ravi Bhat., Muralidharan, K. and Susan John for the paper entitled "Nutrient partitioning

Dr. Murali Gopal and Dr. Alka Gupta, receiving the award from Dr. P. Chowdappa, Former Director, ICAR-CPCRI and the President, ISPC at Chikkamagaluru

in root (wilt) disease affected *vis* a *vis* healthy coconut palms grown in an Entisol of humid tropics" presented at the 23rd PLACROSYM held at Chikkamagaluru during 6-8th March 2019.

Mr. Diwakar, Y., Scientist was conferred with Best Oral Presentation award in the National Conference on Conservation, Cultivation and Utilization of Medicinal and Aromatic Crops held at College of Horticulture, Mudigere during 25th – 26th April, 2018.

Dr. M.K. Rajesh (Principal Scientist), Ms.T.N. Ranjini (Scientist) and Dr. P.P. Shameena Beegum (Scientist) have received 'Best innovator award' from Central University of Kerala, Kasaragod in the 'Innovation Fest 19' organized during 18th-20th February 2019.

Dr. H.P. Maheswarappa, Project Coordinator (Palms) has been elected as the President, Indian Society for Plantation Crops for the biennium 2018-20.

Dr. S. Jayasekhar, Sr. Scientist (Ag. Econ.) has been elected as the Secretary, Indian Society for Plantation Crops for the biennium 2018-20.

Dr. K.P. Chandran, Principal Scientist (Ag. Stat.) has been elected as the Treasurer, Indian Society for Plantation Crops for the biennium 2018-20.

Ph.D. awarded

Jaysekhar. S, Scientist (Sr. Scale) was awarded Ph.D. from Centre for Development Studies, Jawaharlal Nehru University, New Delhi for his thesis on 'Impact of food safety standards on exports of agricultural products from India-The case of Kerala' under the guidance of Prof. K.N. Harilal and Prof. M. Parameswaran.

Jilu V. Sajan was awarded Ph.D. degree from ICAR-Indian Agricultural Research Institute (IARI), New Delhi for her thesis entitled 'Trapping activity of volatiles from symbiotic bacteria of melon fruit fly, *Bactrocera cucurbitae* (Coquillett)' under the guidance of Dr. Kirti Sharma, Principal Scientist, Division of Entomology, IARI, New Delhi.

Others

Dr. Nagaraja N. R., Scientist (Plant Breeding) received 'Young Scientist Travel Grant and Accommodation Fellowship' from AFITA (Asia-Pacific Federation for Information Technology)/WCCA (World Congress on Computers in Agriculture) for attending the International Conference AFITA/ WCCA 2018 on 'Research Frontiers in Precision Agriculture' at IIT Bombay, Mumbai during 24th to 26th October 2018.

X. Training and Capacity Building

Physical targets and achievements

S. No.	Category	Total No. of Employees	No. of trainings planned for each category during 2018-19 as per ATP	No. of employees undergone training during April-Sept 2018	No. of employees undergone training during Oct 2018-March 2019	Total No. of employees undergone training during April 2018 to March 2019	% realization of trainings planned during 2018-19
1	Scientist	77	30	2	13	15	50.00
2	Technical	84	15	6	23	29	193.33
3	Administrative & Finance	50	27	2	29	31	114.81
4	SSS	106	28	12	17	29	103.57
	Total	317	100	22	82	104	104.00

Financial targets and achievements

RE 2018-19 for HRD (Rs in lakhs)	Actual Expenditure up to 31 March, 2019 for HRD	% Utilization of allotted budget
9.2	9.16	99.57

Category-wise trainings attended by employees

Scientists		
S. No.	**Name of employee, Designation (Discipline/ Section)**	**Name of training programme attended**
1	Dr. C.T. Jose, Pr. Scientist (Agrl. Statistics), Dr. Thava Prakasa Pandian, Scientist (Plant Pathology), Mrs. Saneera E.K., Scientist (Agrl. Entomology), Mr. Najeeb N., Scientist (Fruit Science) and Mrs. Suchithra M., Mr. Ganesh N. Khadke, Mr. Diwakar Y., Scientists (Spices, Plantation and Medicinal and Aromatic Plants)	Orientation course on E- procurement on the CPP Portal and GeM at ICAR-CPCRI, RS, Vittal on 26th May, 2018
2	Dr. Ravi Bhat, Head (Div. Crop Production), Pr. Scientist (Agronomy)	National Dialogue on AI and IoT Applications in Agriculture at ICAR-NAARM, Hyderabad during 1st – 2nd June, 2018.
3	Ms. Ranjini T.N., Scientist (Spices, Plantation and Medicinal and Aromatic Plants)	Short course on Proteomics and its applications in agriculture held at Punjab Agricultural University, Ludhiana from 5th -14th September, 2018.

4	Dr. Anitha Karun, Head (Div. Crop Improvement), Pr. Scientist (Horticulture), Dr. K.B. Hebbar, Head (Div. PB & PHT), Pr. Scientist (Plant Physiology), Dr. Ravi Bhat, Head (Div. Crop Production), Pr. Scientist (Agronomy) Dr. Vinayaka Hegde, Head (Div. Crop Protection), Pr.Scientist (Plant Pathology)	Training in GeM at ICAR-CPCRI on 8th October, 2018
5	Dr. Jeena Mathew, Scientist (Soil Science)	Integrated Nutrient Management and Nutrient Budgeting through advanced models to improve crop productivity at ICAR-IISWC, Regional Centre, Udagamandalam during 22nd – 26th October, 2018
6	Dr. A.C. Mathew, Pr. Scientist (Soil & Water Conservation Engineering)	Training Workshop for Vigilance Officers of ICAR Institutes, at NAARM Hyderabad during 31st October, 2018 to 1st November, 2018
7	Dr. S. Paulraj, Scientist (Microbiology)	Recent Trends in Plant Microbe Interactions at TNAU, Coimbatore during 27th November – 17th December, 2018
8	Dr. Thava Prakasa Pandian, Scientist (Plant Pathology)	ICAR sponsored Winter School on Recent Advances in Diagnosis and Management of emerging diseases of field crops horticultural and medicinal plants at College of Agriculture, Dharward during 7th – 27th December, 2018
9	Mr. Ganesh N. Khadke, Scientist (Spices, Plantation and Medicinal and Aromatic Plants)	Training programme on Analysis of Experimental Data using R at ICAR-NAARM, Hyderabad during 21st – 26th February, 2019
Technical staff		
1	Mr. K. Devaraj, Senior Technical Assistant (Electrical)	Training on 'Basic Approaches to Transmission System (Operation and maintenance of Substation and Transmission Lines)' at Power Engineers and Research Centre, Idukki during 2nd – 6th April, 2018.
2	Dr. C.G.N. Namboothiri, ACTO and Mr. V.K. Gopalakrishna, Technical Officer (Civil Engg.)	Training on 'Motivation, Positive Thinking and Communication Skills for Technical Officers' at ICAR-NAARM, Hyderabad during 21st – 27th June, 2018.
3	Mr. S. Manohara, Technical Officer (Vehicle)	Competence Enhancement Programme on Automobile Maintenance, Road safety and Behavioural Skills' at ICAR-CIAE, Bhopal during 13th – 17th July, 2018.
4	Dr. Muralikrishna K.S., Technical Assistant	Motivation, Positive thinking and communication skills specific to T1-T4 category of technical staffs working in ICAR institutes at ICAR-CIAE, Bhopal from 1st-7th August 2018.
5	Dr. Saran Kumar Rizal, Chief Technical Officer	Farm Management' at ICAR-IIFSR, Modipuram during 14th – 20th September, 2018.
		Training on e-tender and GeM at ICAR-CRIJAF, Barrackpore during 23rd – 25th, September, 2018
6	Mr. Arunji G., Technical Assistant (Library)	Basic/Advanced Workshop on KOHA Software at C.H. Mohammed Koya Library, Department of Library and Information Science, University of Calicut. During 14th – 15th November, 2018

7	Mr. Pankajakshan K.N., Senior Technical Assistant (Vehicle)	Automobile Maintenance, Road Safety and Behavioural Skills CIAE, Bhopal during 16th – 22nd January, 2018
8	Mr. Chandra Nairy, Technical Officer	Farm Management' at ICAR-IIFSR, Modipuram during 14th – 20th September, 2018.
9	Mrs. Sreelatha K., ACTO (Hindi) Mr. Sebastian George, CTO	Training in GeM at ICAR-CPCRI on 8th October, 2018
10	Mr. Devadas K., Mr. Ramakrishnan N., Mr. Ravindran P., ACTOs, Mrs. Sugatha Padmanabhan, Senior Technical Officer, Mr. Balakrishna V., Technical officer, Mr. Krisahnan Nair K., Dr. Muralikrishna K.S., Mr. Sanjeeva A., Technical Assistant, Mr. Abdul Aziz C., Mr. Ananda Gowda B., Mr. Shrinivas Bhat Y., Mr. Sreedharan M.V., Sr. Technical Assistant, Mr. Sanjeeva A., Mr. Santhosh Kumar P., Technical assistant, Mr. Raghavan K., Mr. Dineshkumar N., Mr. Padmanabha Naik A.R., Mr. Radhakrishnan V., Mr. Sebastian K.J., Mrs. Vimala M., Senior Technician	Early detection and surveillance of pest and disease management in palms and cocoa" at CPCRI, Kasaragod held on 7th June, 2018
11	Mr. Devadas K., Mr. Ravindran P., ACTOs Mrs. Sugatha Padmanabhan, Senior Technical Officer, Mr. Abdul Aziz C., Mr. Ananda Gowda B., Mr. Raghavan K., Mr. Shrinivas Bhat Y., Mr. Sreedharan M.V., Sr. Technical Assistant, Mr. Sanjeeva A., Mr. Santhosh Kumar P., Technical assistant, Mr. Padmanabha Naik A.R., Mr. Radhakrishnan V., Mr. Sebastian K.J., Mrs. Vimala M., Senior Technician	Refresher course on coconut health management at CPCRI, RS, Kayamkulam during 6th - 7th July, 2018
Administrative staff		
1	Mr. K. Kunhiraman Nair and Mrs. Girija Chandran, Private Secretaries	Enhancing Efficiency and Behavioural Skills for Stenographers Grade III, PA, PS and Sr. PPs of ICAR at ICAR-NAARM, Hyderabad during 21st – 26th June, 2018
2	Mr. Ram Avtar Parashar, Sr. Fin. and Accounts Officer	MDP on Administrative & Financial Management for DS/CAO/CFAO/SAO/US/SFAO (Off-campus at ICAR-Hqrs, New Delhi) at ICAR-Hqrs, New Delhi 9th – 12th October, 2018
3	Mr. Neil Vincer, AAO	Refresher course on Administration and Finance Management for section officers/AAOs/AFAOs/ Assistants of ICAR HQ/Institute at ICAR-NIASM, Baramati during 10th – 14th December, 2018
4	Mr. Neil Vincer, Mr. Krishna Naik, Mr. T.E. Janardhanan, AO, Mr. Pradeep Kumar Vasu, Mrs. Reetha, AAOs, Mrs. Girija Chandran, Mrs. K. Narayani, Mrs. Sulochana Nair Private Secretaries, Mr. Thomas, P.M., Mrs. Rupa Manikandan, Mr. K. Haridasan, Mr. Narayana Naik P., Mr. T.N. Vidhyadharan, Mrs. Sheenakumari K.T.K., Assistants Mrs. Mary A.J., Mrs. Preethi, K., Mr. Paulson Sam George, Mr. N. Udayakumar, UDC, Mr. Ratan Singh, Mr. Umesh K.R., Mr. Dinesh, Mr. Jayarajan V., Mr. Lakshminarayan V., Mr. Pramod Kumar, Mr. Gangadharan, T.K., Mr.Pramod Kumar, LDCs	Training on GeM at ICAR-CPCRI on 8th October, 2018
5	Mr. Raveendran, AAO, Mrs. Jayasree J., UDC, Mr. Muhammed Haneefa, LDC	Orientation course on E- procurement on the CPP Portal and GeM at ICAR-CPCRI, RS, Vittal during 26th May, 2018

Skilled Support Staff		
1	Mr. Sivan M. E., Mr. K. B. Thankachen, Mr. R. Raveendran, Mr. K. Soman, Mr. K.C. Damodaran, Mr. V. T. Unnikrishnan, Mr. T. K. Mani, Mr. K. Ravi, Mr. K. V. Vijayan, Smt. K. Saseendra, Mr. C. Sukumaran, Smt. K. Valsala, SSSs	Orientation Training Programme for Skilled Support Staff at CPCRI, RS, Kayamkulam during 8th – 10th May, 2018.
2	Mr. K.K. Sreedharan, Mr. Omanakuttan, Mr. C. Sundaran, Mr. K. N. Sajeev, Mr. K.P. Ibrahim, Mr. A.T. Harikuttan, Mr. C.R. Babu, Mr. Justine Jayaraj Das, Mr. Ancil Parera, Mr.N. Reghu, Smt. N. Suma, Smt. Leena, Mr. Rajesh S., Mr. Rajesh R. and Mr. Ajith M., SSSs	Orientation Training Programme for Skilled Support Staff at CPCRI, RS, Kayamkulam during 29th – 31st October, 2018.
3	Mr. Pakkeera V.S. and Mr. Sundara B.	Early detection and surveillance of pest and disease management in palms and cocoa" at CPCRI, Kasaragod held on 7th June, 2018

Number of trainings organised for various categories of ICAR/Non-ICAR employees including winter/summer schools and short term trainings

S. No.	Category	No. of trainings organized during April 2018-March 2019	Participants (No.)			Institutes/office representation (No.)			States/UT representation (No.)
			ICAR	Non-ICAR	Total	ICAR	Non-ICAR	Total	
1	Scientist	-	-	-	-	-	-	-	-
2	Technical	1	32	0	32	1	0	1	2
3	Administrative & Finance	2	28	0	28	2	0	2	2
4	SSS	2	27	0	27	1	0	1	1
	Total	**5**	**87**	**0**	**87**	**4**	**0**	**4**	**5**

XI. Workshops, Seminars, Summer Institutes, Farmers' Days

Workshops organized

Breeding strategies in plantation crops

The workshop on 'Breeding Strategies in Plantation Crops' was organized at ICAR-CPCRI, Regional Station, Vittal on 27th April, 2018. The workshop was presided over by Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod and inaugurated by Dr. R. Chandrababu, Vice-Chancellor, Kerala Agricultural University. In the inaugural address, Dr. Chandrababu, highlighted the possibility of utilizing meta QTLS for MAS and mapping of genomic regions linked to phenology and plant production traits under drought conditions. Dr. R.K. Mathur, Director, ICAR-Indian Institute of Oil Palm Research, Pedavegi, Dr. M. Gangadhara Nayak, Acting Director, ICAR-Directorate of Cashew Research, Puttur, and Dr. A.K. Singh, Head, Department of Genetics, ICAR-Indian Agricultural Research Institute, New Delhi were present on the occasion. A total of 55 participants, including researchers and students from ICAR institutes, SAUs, Krishi Vigyan Kendras and other institutes participated in the workshop. Two publications from ICAR-CPCRI *viz*., a Technical Bulletin on `Arecanut cultivation practices (in Kannada)' and an Interactive DVD on `Hybridization techniques and production of hybrid seedlings in coconut (in Malayalam)' were released in the workshop.

Dr. K.S. Ananda, Acting Head, ICAR-CPCRI, Regional Station, Vittal, made a presentation on 'Six decades of arecanut breeding'. Dr. A.K. Singh, Head, Department of Genetics, ICAR-IARI, New Delhi, delivered a special lecture on 'Development and use of mapping populations in crops: Genetic considerations'. Dr Singh briefed about the strategies for developing mapping populations, types of mapping populations, and applications of mapping populations. Recommendations for breeding in plantation and perennial fruit crops were made based on the interactions and discussions held during the workshop.

Artificial Intelligence for plantation crops

A workshop on 'Artificial Intelligence (AI) for Plantation Crops' was organized at ICAR-Central Plantation Crops Research Institute during 28 to 29 September, 2018. Dr. Raju Narayana Swamy, IAS, Chairman, Coconut Development Board, Kochi, inaugurated the workshop. Dr. P. Chowdappa, Director, ICAR-CPCRI presided over the inaugural function.

Dr. Kota Harinarayana, Founder Chairman, General Aeronautics Pvt. Ltd., Bangalore presented the keynote lecture on 'Drones, deep learning and doubling farmers' income'. Dr. G. Dhanakumar, Director, Indian Institute of Plantation Management delivered a guest lecture on 'Disruptive Innovation (DI) and AIMDel Perspective'.

Inauguration of the Workshop on `Breeding Strategies in Plantation Crops' at ICAR-CPCRI, Regional Station, Vittal by Dr. R. Chandrababu, Vice-Chancellor of Kerala Agricultural University

Shri Raju Narayana Swamy, IAS, Chairman, Coconut Development Board, Kochi inaugurating the workshop

Arecanut and human health

An Interactive Workshop on 'Arecanut and Human Health' was conducted at ICAR-Central Plantation Crops Research Institute, Kasaragod during 24-25 July 2018. The meeting was inaugurated by Dr. P. Chowdappa, Director, ICAR-CPCRI. Shri V.V. Bhat, IAS (Rtd.), Former Secretary to the Govt. of India, Dr. Manjunatha K. Naik, Vice Chancellor, University of Agricultural and Horticultural Sciences, Shivamogga and Prof. Dr. Satheesh Kumar Bhandary, Vice Chancellor, NITTE University, Mangalore were the Chief Guests.

Twenty five medical practitioners, 30 scientists, 150 traders and growers, administrators, advocates and officials of developmental agencies participated in the Workshop.The majority of the medical practitioners were of the opinion that reports on the effects of arecanut consumption on human health are not based on any systematic scientific studies. The valedictory session was presided over by Dr. P. Chowdappa, Director, ICAR-CPCRI. Shri K.N. Bhat, Former Additional Solicitor General of India, delivered the valedictory address.

Inauguration of the interactive workshop 'Arecanut and Human Health' at ICAR-CPCRI, Kasaragod

Shri K.N. Bhat, Former Additional Solicitor General of India, delivering valedictory address during the interactive workshop at ICAR-CPCRI, Kasaragod

Seminars organized

Launching of 'Frozen Coconut Delicacy' developed by ICAR-CPCRI

Shri Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare and Shri Gajendra Singh Shekhawat, Union Minister of State for Agriculture and Farmers Welfare, launched a non-dairy vegan product "Frozen Coconut Delicacy" developed by ICAR-CPCRI, Kasaragod during the 90th ICAR foundation day celebration held on 16th July 2018. Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR), Shri Chhabilendra Roul, Special Secretary (DARE) & Secretary (ICAR) and Shri Bimbardhar Pradhan, Additional Secretary & Financial Advisor (DARE/ICAR) and Dr. P. Chowdappa, Director, ICAR-CPCRI were also present during the launching ceremony. The 'Frozen Coconut Delicacy', is a premium product which is completely natural and healthy. It is enriched with vitamins, minerals and healthy fatty acids. Due to lauric acid rich coconut milk and potassium rich tender coconut water, this will be a functional and nutraceutical food.

Shri Radha Mohan Singh, Hon'ble Minister of Agriculture and Farmers Welfare releasing the Frozen Coconut Delicacy during the ICAR Foundation Day at New Delhi

Introductory bio-scavenging programme for the suppression of rugose spiralling whitefly (*Aleurodicus rugioperculatus*) at Amalapuram, Andhra Pradesh

Introductory biological scavenging programme by importing the sooty mould feeding Leiochrinid beetle, *Leiochrinus nilgirianus* Kaszab from Kerala to Andhra Pradesh was launched on 10th August, 2018 by ICAR-CPCRI at Amalapuram, Andhra Pradesh. The launching ceremony was held during the inauguration of the Krushivala Coconut Farmers Producers Company, Amalapuram. In his key note address, Dr. P. Chowdappa highlighted the uniqueness of introducing the sooty mould feeding beetle into Andhra Pradesh which was not observed in the region so far. He further mentioned that this is the first time that a bio-scavenger beetle is being purposely introduced as part of classical bio-scavenging on whitefly-infested coconut palms.

Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod delivering the keynote address

Introductory bio-scavenging programme for the suppression of rugose spiralling whitefly (*Aleurodicus rugioperculatus*) at Pollachi, Tamil Nadu

ICAR-CPCRI has organized an introductory biological control through release of *Encarsia guadeloupae* parasitized pupae of rugose spiralling whitefly as well as classical bio-scavenging programme through liberation of the sooty mould scavenging beetle, *Leiochrinus nilgirianus* in synergy with Coconut Research Station (TNAU), Aliyarnagar for effective bio-suppression of the invasive rugose spiralling whitefly infested coconut palms at Pollachi, Tamil Nadu on 4th September, 2018. Farmers in Anamalai region of Pollachi, Tamil Nadu were formally educated on the unique area-wide bio-scavenging programme and releases of the beneficial insects were made in the coconut plantations infested by rugose spiralling whitefly with pronounced development of sooty mould (*Leptoxyphium* sp.).

Farmers' days organized

Demonstration of arecanut spraying machines

A field demonstration was conducted on 30th May, 2018 at ICAR- CPCRI, Regional Station, Vittal to demonstrate the efficacy of tractor mounted air blast sprayer and the un-manned aerial vehicle/ drone (UAV) developed by General Aeronautics Pvt. Ltd., Bengaluru. About 250 farmers and other major stakeholders attended the event. Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod addressed the farmers in the field and explained about the advantage of spraying using the machine. Spraying could be done from ground itself thereby avoiding a person climbing the tree, which would be difficult during rainy season. This will make spraying much easier and faster even during monsoon. This machine has been found suitable for well laid out garden of arecanut mono-cropping system.

Kisan Mela and Agri Expo-2018

A Mega Kisan Mela and Agri-Expo was organized during 10th – 11th November, 2018 at ICAR-CPCRI Research Centre, Kidu, Karnataka. Shri D.V. Sadananda Gowda, Hon'ble Union Minster of Statistics and Programme Implementation, inaugurated the event. Rajarshi Padmavibhooshana Dr. D. Veerendra Heggade, Dharmadhikari, Dharmasthala, was the chief guest. Smt. Meenakshi Shantigodu, President, Zilla Panchayat presided over the programme. Dr. P. Chowdappa, Director, ICAR-CPCRI, Kasaragod, welcomed the gathering. During the inaugural session, various technical publications were released namely ICAR-CPCRI Research Centre, Kidu, Arecanut (Kannada), Coconut (English), Coconut (Kannada) and Cocoa (Kannada). There were about 100 different exhibition stalls including a crop diversity fair arranged for the benefit of farmers.

Shri D.V. Sadananda Gowda, Hon'ble Union Minster of Statistics and Programme Implementation, inaugurating the Kisan Mela at Kidu

Innovators' Meet and Agri-Exhibition

Shri P. Sathasivam, Hon'ble Governor of Kerala inaugurated the 'Innovators' Meet' at ICAR-CPCRI (CPCRI), Kasaragod, Kerala on 6th October, 2018. He also inaugurated the exhibitions of innovators during the occasion. Hon'ble Governor released the publications 'Proceedings of the workshop on Arecanut and Human

Shri P. Sathasivam, Hon'ble Governor of Kerala, inaugurating 'Innovators Meet' at ICAR-CPCRI, Kasaragod

Health'. Shri N. A. Nellikunnu, MLA, Kasaragod presided over the programme. Dr. Raju Narayana Swamy, IAS, Chairman, CDB, Kochi has offered felicitation speech. Exchange of MoA was done between ICAR-CPCRI for Startup Green with Kerala Startup Mission, GoK, Thiruvananthapuram.

World Soil Day celebration and soil health card distribution

World Soil Day was celebrated on 5thDecember, 2018 at ICAR- CPCRI, Kasaragod with this year's theme "Be the Solution to Soil Pollution". The campaign aimed to raise awareness regarding soil pollution and call people to stop soil pollution.

Shri A.A. Jaleel, President, Mogral Puthur Grama Panchayat distributing soil health cards during the World Soil Day at ICAR-CPCRI, Kasaragod

Shri A.A. Jaleel, Mogral Puthur Grama Panchayat President, inaugurated the World Soil Day celebration at a function jointly organized by ICAR- CPCRI and KVK, Kasaragod. On this occasion Shri A.A. Jaleel distributed the soil health cards to selected farmers from Kasaragod district. Dr. Ravi Bhat, Director in-charge presided over the inaugural function.

'World Soil Day, has been celebrated by the ICAR Krishi Vigyan Kendra, Alappuzha in association with Department of Agricultural Development and Farmers' Welfare, Govt. of Kerala at Edathwa Co-op. Bank

Soil Health cards distribution on World Soil Day at Champakulam, Alappuzha

Auditorium in Champakulam Block on 5th December, 2018. Smt. Binu Issac Raju, Member, Alappuzha District Panchayath inaugurated the programme and distributed soil health cards to 100 farmers. A seminar on 'Post flood soil health management and good agricultural practices for sustainable crop production' and 'ICM in paddy and coconut' was conducted on the day.

Punarnava Kisan Mela - 2019

Shri E. Chandrasekharan, Hon'ble Minister for Revenue and Housing, Govt. of Kerala inaugurated Punarnava Kisan Mela - 2019, KVK-ATMA Technology Meet and Agricultural seminars at ICAR-CPCRI, Kasaragod on 16th February 2019. Sri N.A Nellikunnu, Hon'ble MLA, Kasaragod, Sri M. Rajagopalan, Hon'ble MLA, Thrikkaripur, Dr. Anitha Karun, Acting Director, ICAR-CPCRI, dignitaries from the ICAR-ATARI, Bangalore, LSGs and the Dept. of Agriculture, Govt. of Kerala and ATMA, Kerala, were present during the occasion. More than 40 exhibition stalls on agriculture were put up and about 300 stakeholders participated in the programme. The exhibitions and seminars related to agriculture, horticulture, pisciculture, animal husbandry, value addition and various schemes related to agriculture were organized.

XII. Participation in seminars/symposia/ conferences/workshops

a. Abroad

Dr. P. Chowdappa, Director and Dr. P. Subramanian, Principal Scientist (Agronomy) participated in the 48th APCC Cocotech Conference in Bangkok, Thailand held during 20th - 24th August, 2018. The conference and exhibition were held with the theme 'Sustainable coconut development through climate smart agriculture, product innovation and advancing technologies'.

Dr. P. Chowdappa, Director, ICAR-CPCRI along with dignitaries at the 48th APCC Cocotech Conference in Bangkok, Thailand

b. Within India

Name & designation	Title	Place and date
Mr. Diwakar, Y. Scientist	National conference on 'Conservation, cultivation and utilization of medicinal and aromatic crops'	College of Horticulture, Mudigere 25th – 26th April, 2018
Dr. V. Krishnakumar, Head, ICAR-CPCRI, RS, Kayamkulam	Annual Group Meeting of AICRP on Tuber Crops	ICAR-CTCRI, Thiruvananthapuram 26th April, 2018
Dr. P. Chowdappa, Director, Dr. Vinayaka Hegde, Dr. K.B. Hebbar, Dr. Anitha Karun (Heads of Divisions), Dr. V. Niral, Dr. M. K. Rajesh, Dr. Samsudeen K, Dr. C.T. Jose, Dr. S. Elain Apshara, Dr. Regi Jacob Thomas (Pr. scientists) Dr. Senthil Amudhan Dr. R. Sudha Dr. Neema M Ms. Ranjini T.N Dr. Nagaraja, N.R Dr. Thava Prakasa Pandian Mr. Najeeb N Ms. Suchithra, M. and Ms. Saneera E.K. (Scientists)	Workshop on 'Breeding strategies in Plantation Crops'	ICAR-CPCRI, Regional Station, Vittal 27th April, 2018
Dr. A. Joseph Rajkumar, Pr. Scientist	Technology awareness camp on 'Mechanization in coconut sector'	Dr. Ambedkar Auditorium, Amalapuram, Andhra Pradesh on 6th May, 2018

Dr. Vinayaka Hegde (Head, Crop Protection) Dr. A. Joseph Rajkumar and Dr. Bhanuprakash (Pr. Scientists)	Awareness workshop on 'rugose spiralling whitefly'	ICAR-CTRI, Rajmundhry 7th May, 2018
Dr. Chandrika Mohan, Pr. Scientist	Annual Group Meeting of AICRP on 'Biological control of crop pests'	Kerala Agricultural University, Thrissur 17th -18 th May 2018
Dr. P. Chowdappa, Director, Dr. Ravi Bhat, Dr. Vinayaka Hegde, Dr. K. Muralidharan, Heads of Divisions, Dr. V. Krishnakumar, Head, RS, Kayamkulam Dr. (Mrs.) Chandrika Mohan, Dr. (Mrs.) V. Niral, Dr. P. Subramanian, Dr. Elain Apshara, and Dr. Josephrajkumar, (Pr. Scientists), Dr. Merin Babu, Dr. Rajkumar (Scientists)	Annual Group Meeting of AICRP on Palms	ICAR-IIOPR, Pedavegi 24th - 27th May, 2018
Dr. Ravi Bhat, Head, Div. of Crop Production	National dialogue on 'Artificial intelligence and internet of things application in agriculture'	ICAR-NAARM, Hyderabad 1st – 2nd June, 2018
Dr. S. Elain Apshara, Principal Scientist	13th Steering committee meeting on cocoa	DCCD, Kochi 12th June, 2018
Dr. S. Jaysekhar, Sr. Scientist	National workshop on 'International agricultural trade and free trade agreements'	Thiruvananthapuram 26th – 27th June, 2018
Dr. Nagaraja, N. R., Scientist Dr Chandran, K.P, Pr. Scientist, Dr Jayasekhar S, Sr. Scientist Dr. V. Niral, Pr. Scientist	Interactive Workshop on 'Arecanut and Human Health'	ICAR-CPCRI, Kasaragod during 24th to 25th July 2018
Dr. Thamban C. and Dr. Regi J. Thomas, Pr. Scientists S Jayasekhar, Sr. Scientist	Kerala Karshaka Sangham-'Kerala Karshaka Sadas'	Nalanda Auditorium, Kozhikode on 25th July, 2018
Dr. Rajesh M.K., Pr. Scientist	Workshop on 'Biotechnology Ignition Grant (BIG)'	C-Camp, Bengaluru On 25th July, 2018
Dr. P. Chowdappa, Director	90th Foundation Day of ICAR	NASC Complex, New Delhi on 16th July, 2018
Dr. Nihad K, Scientist	20th conference of Heliconia Society International, USA	Kumarakom, Kerala during 4-6th August, 2018
Dr. Shameena Beagum P.P. , Scientist	International conference on 'Recent advance in food processing technology'	Indian Institute of Food Processing Technology, Thanjavur (TN) during 17th August, 2018
Dr. Ravi Bhat, Head of Div.	Workshop on 'Challenges of raising areca plantation in paddy field'	Bairumbe, Sirsi 25th August, 2018
Dr. P. Chowdappa, Director	World Coconut Day Celebration	IGKVV, Raipur, Chattisgarh 2nd September, 2018
Dr. Manikantan M.R., Pr. Scientist	Workshop on 'Mechanization of processing and value addition for agricultural and horticultural produce'	NASC, New Delhi 5th September, 2018.

Dr. Rajkumar and Dr. Sujithra M. , Scientists	International conference on 'Biological Control Approaches and Applications'	Society of Biological Control, Bengaluru 26th - 29th September, 2018
Dr. Chandrika Mohan, Pr. Scientist and Dr. K.M. Anes, Scientist	International Conference on Biological Control	Bengaluru 27th -29th September, 2018
Dr. V. Krishnakumar, Head, RS, Kayamkulam, Dr. A. Joseph Rajkumar, Dr. K. P. Chandran, Pr. Scientists, Dr. Jayasekhar S, Sr. Scientist, Dr. K. Nihad, Dr. Jeena Mathew, Dr. Nagaraja, N. R., Dr. Neenu, S. and Dr. S. Indhuja, Scientists Dr. V. Niral, Principal Scientist	Workshop on 'Artificial Intelligence for Plantation Crops'	ICAR-CPCRI, Kasaragod 28th - 29th September, 2018
Dr. Jayasekhar S., Sr. Scientist	National conference on 'Kerala Ecology and Society'	EKNM Government College, Elerithattu, Kasaragod 04-05 October 2018.
Dr. M.R. Manikantan, Pr. Scientist and Dr. R. Pandiselvam, Scientist	International conference on 'radiation biology'	Mangaluru 4th to 6thOctober, 2018
Dr. A. Josephrajkumar, Pr. Scientist	National seminar on 'climate change, habitat destruction and emergence of insect pests and vectors'	Department of Zoology, University College, Thiruvananthapuram 11th October, 2018
Dr. Jeena Mathew, Scientist	Workshop on 'Integrated Nutrient Management and nutrient budgeting through advanced models to improve crop productivity'	ICAR- Indian Institute of Soil and Water Conservation, Research Centre, Ooty 22nd to 26th October 2018
Dr. Nagaraja, N. R., Scientist	International conference AFITA/ WCCA 2018 on 'Research Frontiers in Precision Agriculture'	IIT Bombay, Mumbai 24th to 26th October 2018
Dr. Nagaraja, N. R., Scientist	International conference on 'Global Research Initiatives for Sustainable Agriculture and Allied Sciences' (GRISAAS-2018)	Rajasthan Agricultural Research Institute (RARI), Durgapura, Jaipur, Rajasthan 28th to 30th October 2018
Dr. Indhuja S., Scientist	International conference on 'Microbiome Research – 2018'	National Centre for Microbial Resources, Pune, Maharashtra 19th to 22nd November, 2018.
Dr. Jayasekhar S, Sr. Scientist	Workshop for nodal officers on 'ICAR-Research data repository'	NASC, New Delhi 4th to 5th December 2018.
Dr. Arun Kumar Sit, Pr. Scientist	3rd Regional science and technology congress, 2018 (Northern Region)	Govt. Engineering College, Jalpaiguri 12th December, 2018
Dr. V. Krishnakumar, Head, RS, Kayamkulam	XI SAC meeting	KVK, Kottayam 13thDecember, 2018
Dr. Ramesh S.V. , Scientist	National Conference for Virgin Coconut Oil manufacturers	CSIR-Central Food Technological Research Institute (CSIR-CFTRI), Mysuru 26thDecember, 2018

D. K. Muralidharan, Head (Div. of Social Sciences) Dr. A. Joseph Rajkumar, Dr. Regi J. Thomas, Pr. Scientists	International Conference on 'Agro-processing and Value Addition' (VAIGA) cum Krishi Unnati Mela	Thrissur 28th December, 2018
Dr. V. Krishnakumar, Head, RS, Kayamkulam Dr. A. Joseph Rajkumar, Pr. Scientist	Workshop on development of coconut sector	Gandhiji Study Centre, Thodupuzha 1st January 2019
Dr. L.S.Singh, Scientist	8th Indian Horticulture Congress: Shaping future of Indian horticulture	Indira Gandhi Krishi Viswavidyalaya, Raipur, Chhattisgarh 17th to 21st January, 2019
Dr. (Mrs) Alpana Das, Sr. Scientist	State level workshop on coconut	Panjabari, Guwahati 2nd February, 2019
Dr. Vinayaka Hegde, Dr. K.B. Hebbar (Heads of Divisions) Dr. V. Krishnakumar, Head, RS, Kayamkulam, Dr. M.K. Rajesh, Dr. A.C. Mathew, Dr. Murali Gopal, Dr. Alka Gupta, Dr. Chandran K.P., and Dr. P. Subramanian (Pr. Scientists) Dr. S. Jayasekhar S., Dr. M. Senthil Amudhan (Sr. Scientists), Dr. K. Nihad, Dr. Jeena Mathew, Dr. S. Indhuja, Dr. N.R. Nagaraja, Dr. Ganesh N. Khadke, Dr. M. Neema, Dr. S.V. Ramesh, Dr. Rajkumar, Dr. Krishna Prakash, Dr. R. Sudha (Scientists) and Dr. K.S. Muralikrishna, Tech. Assistant	23rd Plantation Crops Symposium	Chikkamagaluru, Coffee Board 6th to 8th March, 2019
Dr. A. Joseph Rajkumar, Principal Scientist, Dr. Jeena Mathew, Scientist	National workshop on 'Plant Health Management of coconut: Challenges and future opportunities'	NIPHM, Hyderabad 14-15th March, 2019
Dr. V. Krishnakumar, Head, RS, Kayamkulam Dr. P. Muralidharan, Pr. Scientist and Head, KVK Alappuzha, Dr. Rajeev M.S, Dr. S. Ravi, SMSs, KVK, Alappuzha	Workshop on 'Eco – friendly Kuttanad'	RRS, Moncompu 1st March, 2019

XIII. Linkages and Collaborations

International

APCC, Jakarta, Indonesia	Cooperation between coconut growing countries in the Asia – Pacific region
Bioversity International, Malaysia/ International Plant Genetic Resources Institute/ University of Reading, United Kingdom	Coconut genetic resources, International Coconut Gene Bank for South Asia& Middle East and socio-economic collaboration, Cocoa germplasm exchange
Coconut Research Institute, Sri Lanka	Resistance breeding programme against coconut Weligama Wilt disease in Sri Lanka
Kansas State University, Manhattan, KS, USA	R & D and value addition programmes
North Dakota State University, USA	R & D and value addition programmes

National

ICAR Institutes	
ICAR- Central Island Agricultural Research Institute (CIARI), Port Blair	Coconut genetic resources and breeding
ICAR- Central Institute of Fisheries Technologies (CIFT), Kochi	Food processing R&D collaboration
ICAR- Directorate of Cashew Research (DCR), Puttur, Karnataka	Nematological and entomological programmes
ICAR- Indian Institute of Horticultural Research (IIHR), Bengaluru	Phytoplasma disease related studies, varietal screening, cropping systems, agricultural tools and machinery and horticultural IP related activities
ICAR- Indian Institute Spices Research (IISR), Kozhikode	Cropping system studies, *Phytophthora* diseases in plantation crops
ICAR-Central Tuber Crop Research Institute (CTCRI), Thiruvananthapuram	Cassava and coconut based value added products, intercropping of tuber crops in coconut gardens
ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET), Ludhiana	Agricultural pre and post harvest machinery
ICAR-Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad	Climate change network and NICRA
ICAR-Directorate of Mushroom Research (DMR), Solan	Agricultural pre and post harvest machinery
ICAR-Indian Institute of Oil Palm Research (IIOPR), Pedavegi	Phytoplasma disease related studies and other common activities under plantation crops sector, tissue culture and biotechnological investigations
ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi	Germplasm registration and exchange of PGPR

ICAR-National Bureau of Agricultural Insect Resources (NBAIR), Bengaluru	Biological control programmes R&D collaboration
ICAR-National Bureau of Agriculturally Important Microorganisms (NBAIM), Mau	Microbial research network R&D collaboration
ICAR-National Research Centre for Orchids, Pakyong	Technology Mission for the development of North Eastern states
ICAR-Sugarcane Breeding Institute (SBI), Coimbatore	Food processing R&D collaboration
Others	
Academy of Climate Change Education and Research, Thrissur, Kerala, 680 656	Academic programmes
Agricultural Technology Management Agency	ToT activities
All India Radio (AIR), Kannur, All India Radio (AIR), Thiruvananthapuram, Doordarshan (Prasar Bharati)	Various transfer of technology mass media programmes
Bannari Institute of Technology, Sathyamangalam, Tamil Nadu	R & D collaboration
Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia, West Bengal	AICRP Centre collaboration
Central Arecanut and Cocoa Marketing and Processing Co-operative Limited (CAMPCO), Mangalore	Arecanut/ cocoa research and development
Central University of Kerala, Padannakad, Kerala	R & D collaboration
Coconut Development Board, Kochi	Research and development in coconut
CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Trivandrum	Technology programmes
Department of Biotechnology (DBT), New Delhi	Advancements in Biotechnology and Bioinformatics
Department of Agricultural Development and Farmers Welfare, Govt. of Kerala	R & D collaboration
Directorate of Arecanut and Spices Development, Kozhikode	Research and development in arecanut
Directorate of Cashew and Cocoa Research (DCCD), Kochi	Research and development in cocoa
District Panchayath, Alappuzha	ICAR-CPCRI, RS, Kayamkulam & KVK, Alappuzha ToT activities
District Panchayath, Kasaragod	ICAR-CPCRI, Kasaragod & KVK, Kasaragod ToT activities
Department of Information Technology (DIT), New Delhi	Bioinformatics programmes
Department of Science and Technology (DST), New Delhi	Molecular biology research and women empowerment programmes
General Aeronautics Ltd., Bengaluru	Unmanned Aerial Vehicle (UAV- Drone) for palm spraying
Govt. of Kerala/ Planning Board/ RKVY	Technology support programmes on coconut
Indian Institute of Food Processing Technology (IIFPT), Thanjavur, Tamil Nadu	R & D collaboration
Indian Institute of Plantation Management (IIPM), Bengaluru	Technology programmes

Kelappaji College of Agricultural Engineering and Technology (KCAET), Kerala Agricultural University, Tavanur	Technology programmes
Kerala State Council for Science, Technology and Environment (KSCSTE), Thiruvananthapuram	R & D collaboration
Kerala State Planning Board	R & D collaboration
Kerala Veterinary and animal Sciences University (KVASU), Wayanad	Technology programmes
National Bank for Agriculture and Rural Development (NABARD), Mumbai	Developing/ demonstrating model coconut clusters in root (wilt) affected areas
Onattukara Regional Agricultural Research Station (ORARS), Kerala Agricultural University	KVK, Alappuzha for NICRA activities
Protection of Plant Varieties & Farmers' Rights Authority (PPV & FRA), New Delhi	DUS Centre on coconut and arecanut
Resnova Ltd., Kochi	Red palm weevil detector development
Tamil Nadu Agricultural University, Coimbatore	AICRP Centre collaboration
Tamil Nadu Veterinary and Animal Sciences University, Chennai	AICRP Centre collaboration
University of Agricultural Sciences, Bangalore	AICRP Centre collaboration

XIV. Research Projects

Project No.	Project Title	Project Leader	Associate (s)
Institute Funded Projects			
1000761028	Genetic resources management in coconut, arecanut and cocoa	V. Niral	K.S. Ananda, S. Elain Apshara, K. Samsudeen, A. K. Sit, L.S. Singh, Alpana Das, N. R. Nagaraja, Ranjini T., Sudha R., Diwakar Y., Ganesh N. Khadke, P. Subramanian, M. Sujithra, Suchitha M., Najeeb N., Regi Jacob Thomas, M. Sujithra, K.B. Hebbar, S.V. Ramesh, Bhanu Prakash, R. Thava Prakasa Pandian, Saneera E.K., Shameena Begum P.P, C. Thamban, M. Senthil Amudhan and Scientists from ICAR-CIARI, Andamans
1000761029	Genetic investigations and breeding in coconut, arecanut and cocoa	Regi Jacob Thomas	K. Samsudeen, V. Niral, S. Elain Apshara, K.S. Ananda, M. Shareefa, A.K. Sit, N.R. Nagaraja, Merin Babu, A. Josephrajkumar, L.S. Singh, Ganesh N. Khadke, Diwakar Y., Sudha R., Ranjini T. N., Suchithra M., Najeeb N., M. Arivalagan, Scientists from ICAR-CIARI-Andaman, S. Sendur Kumaran (KVK, Kundrakudi)
1000761031	Development of tissue culture techniques in coconut	Anitha Karun	M. K. Rajesh, Neema M., Aparna V., Regi Jacob Thomas, Shareefa M. and Krishna Prakash
1000761030	Biotechnological applications in palms and cocoa	M.K. Rajesh	Anitha Karun, P. Chowdappa, N. R. Nagaraja, Neema M., Aparna V., Krishna Prakash and Murali Gopal
1000761032	Development of double-stranded RNA based food bait for the suppression of red palm weevil	M.K. Rajesh	A. Josephrajkumar and Ramesh S.V.
1000763057	Cropping/ farming approaches for improving soil health and system productivity in coconut, arecanut and cocoa	P. Subramanian	Ravi Bhat, H. P. Maheshwarappa, V. Krishnakumar, Selvamani V., Alka Gupta, A. Abdul Haris, K. Nihad, N. Najeeb, Arun Kumar Sit, Alpana Das, L. S. Singh and Neenu S.

1000763058	Enhancing nutrient and water use efficiency for sustained productivity in coconut, arecanut and cocoa	Ravi Bhat	P. Subramanian, V. Krishnakumar, H. P. Maheshwarappa, K. Nihad, V. Selvamani, Neenu, S. A. Abdul Haris, Jeena Mathew, N. Najeeb, Alka Gupta, Murali Gopal, S. Indhuja, Arun Kumar Sit, S. Paulraj, Merin Babu and P. Anitha Kumari
1000763055	Bioresources management in coconut, arecanut and cocoa	Alka Gupta	Murali Gopal, P. Subramanian, H.P Maheswarappa, V. Krishnakumar, A. Abdul Haris, S. Indhuja, K. Nihad, V. Selvamani, S. Neenu, S. Paulraj, Jeena Mathew, Regi J. Thomas, Merin Babu, V.H. Prathibha and M. Sujithra
1000765039	Integrated approaches for management of fungal diseases of palms and cocoa	Vinayaka Hegde	Prathibha V.H., R. Thava Prakasa Pandian, Daliyamol and M.K. Rajesh
1000765040	Diagnostics and management of root (wilt) disease (RWD) in coconut and yellow leaf disease (YLD) in arecanut	Vinayaka Hegde	K.B. Hebbar, K. Bhanu Prakash, A. Josephrajkumar, Murali Gopal, Merin Babu, R. Thava Prakasa Pandian, S. Indhuja and Daliyamol
1000765041	Integrated management of pests and nematodes in palms and cocoa	Chandrika Mohan	A. Josephrajkumar, P.S. Prathibha, Rajkumar, M. Sujithra, Saneera E.K., Anes, K. M, Jilu V. Sajan, Merin Babu, R. Thava Prakasa Pandian, Daliyamol and A.K. Sit
1000766014	Phenotyping for climate resilient adaptation and mitigation strategies	K.B. Hebbar	K. Bhanu Prakash, S.V. Ramesh, M. Arivalagan, S. Neenu, R. Surekha and A.K. Sit
1000767018	Mechanization, processing, product diversification and nutraceutical properties	M.R. Manikantan	K.B. Hebbar, M. Arivalagan, A.C. Mathew, Shameena Beegum, R. Pandiselvam, Murali Gopal, S. Paulraj, M. Senthil Amudhan and Sucheta Kumari from KSHEMA, Mangalore
1000767019	Development of coconut milk powder using low investment foam mat drying and ready to cook kheer mix	M.R. Manikantan	M. Arivalagan, A.C. Mathew, Shameena Beegum P.P, R. Pandiselvam and S. Paulraj
1000767021	Development of tender coconut trimming machine and preservation protocol for trimmed tender coconut	R. Pandiselvam	A.C. Mathew, M.R. Manikantan and Shameena Beegum P.P
1000769020	Technology transfer and co-learning action research approaches	C. Thamban	S. Kalavathy, P. Anithakumari, C.T. Jose, K. Muralidharan, K.P. Chandran, S. Jayasekhar, A.K. Sit, Sandip Shil, Alpana Das and N.R. Nagaraja

1000769013	Socio-economic dimensions and value chain dynamics in policy perspective	S. Jayasekhar	Chandran K.P., Thamban C., Muralidharan K., Jose C.T. and Sandip Shil
1000769019	Development of Statistical and Computational Techniques for Improving Research Methodology	Jose C.T.	Muralidharan. K., Chandran .K.P, Sandip Shil, Jayasekhar S, and R. Thava Prakasa Pandian
1000769022	Crop - weather modelling and methodological evaluation of crop insurance in plantation crops	Chandran K. P.	Jose C.T., Muralidharan K., Sandip Shil, Jayasekhar S. and Hebbar K.B.
1000769023	Adaptation Deficit Analysis and Resilience Strategies to Climate Change in Coastal Coconut Agro-ecosystems	S. Kalavathi	A. Abdul Haris, Chandrika Mohan, C. Thamban, Murali Gopal, Regi Jacob Thomas, Chandran. K.P. and Anes, K. M
Externally Funded Projects			
1050761086	DUS Centre for coconut	V. Niral	K. Samsudeen
1050761114	Development of DUS testing criteria and establishment of genebank for arecanut	K.S. Ananda/ N.R. Nagaraja	A.K. Sit
1050761115	Development of DUS testing criteria and establishment of genebank for cocoa	S. Elain Apshara	-
1050761107	Large-scale production of elite and hybrid seedlings of coconut for the root (wilt) disease prevalent tract	Regi Jacob Thomas	M. Shareefa, Merin Babu and S. Kalavathi
2010760004	Seed Production in Coconut, Arecanut, Cocoa (Under ICAR Project on Seed Production in Agricultural Crops)	K. Samsudeen	V. Niral, S. Elain Apshara, Regi Jacob Thomas, N. R. Nagaraja, M. Shareefa, Anes K.M., Murali Gopal, Diwakar. Y. and Ganesh N. Khadke
1050761121	Production and distribution of quality planting material of dwarf/semi tall varieties	V. Niral	K. Samsudeen, Regi Jacob Thomas, C. Thamban and Anes K.M.
1050761122	Technology support for coconut hybridization/ production of semi tall varieties	K. Samsudeen	Regi Jacob Thomas, C. Thamban, M.K. Rajesh, V. Niral and M. Shareefa
1050231012	Development of a database for plantation crops for biologists	M.K. Rajesh	P. Chowdappa and Anitha Karun
1050761127	Commercial production of arecanut – tissue culture of planting material of yellow leaf disease resistant palms and dwarf hybrids	Anitha Karun	M.K. Rajesh, N.R. Nagaraja, R. Thava Prakasa Pandian and Neema M.
1050761098	Enhancing economic viability of coconut based land use system for land use planning in Kerala	V. Krishna kumar	Jeena Mathew, Ravi Bhat, Selvamani V., C. Thamban, A. Abdul Haris, K.P. Chandran, S. Indhuja, S. Neenu and P. Subramanian

1050761109	Mass production of plant growth promoting microbes and bio-control agents for sustainability of coconut based farming system	Vinayaka Hegde	Prathibha V.H., Alka Gupta, Murali Gopal, Thamban C. and Chowdappa P.
1050761128	Pest and disease surveillance on coconut palms by unmanned aerial vehicle	Vinayaka Hegde	ICAR-CPCRI and M/s General Aeronautics Pvt. Ltd. Bengaluru
1050761105	Demonstration of EPN in arecanut for the management of root grub	Rajkumar	Nagaraja N.R.
1050761126	Detection system for red palm weevil infesting coconut	A. Joseph Rajkumar	Dr. Chandrika Mohan; Jijo Paul, Ajith Asok, Geet Rose Jose and Albin Joseph (M/sResnova)
1050761123	Technology support for plant protection campaign against pest and diseases of coconut	Chandrika Mohan	A. Josephrajkumar, Merin Babu, P.S. Prathibha, Rajkumar, M. Sujithra, Merin Babu, Vinayaka Hegde, S. Kalavathi, C. Thamban, A. Abdul Haris, K.M. Anes, V.H. Prathibha and P. Anitha Kumari
1050761119	Development of ready to eat extruded snacks from co-products of coconut processing	M.R. Manikantan	Shameena Beegum P.P and R. Pandiselvam
1050761112	Techno-socio-economic assessment of soil & water conservation and water harvesting structures	A. C. Mathew	C. Thamban, P. Muralidharan and Jayashekhar S.
1050761113	Design and development of an airblast sprayer for Arecanut	A.C. Mathew	R. Pandiselvam, R. Thava Prakas Pandian and D. Dhalin from KAU
1050761108	Consortium Research Platform (CRP) on farm mechanization and precision farming	L.S. Singh	-
1050761120	Design, development and field demonstration of an Airblast Sprayer for Coconut	Mathew A.C.	R. Pandiselvam
1050761125	Standardization of protocol for the preparation of frozen coconut delicacy	Shameena Begum P.P.	M.R. Manikantan, M. Arivalagan, and R. Pandiselvam
1050761117	Participatory technology integration to empower and ensure livelihood security of farmers in Alappuzha district	P. Anithakumari	A. Joseph Rajkumar, Jeena Mathew, Nihad K., Shareefa M., Jeena Mathew, Indhuja S., Merin Babu and Anes K.M.
1050761118	Participatory demonstration plots on arecanut based multispecies cropping system	Nagaraja N. R.	C. T. Jose and Rajkumar

2010760007	Intellectual property management and transfer/ commercialization of agricultural technology scheme	P. Chowdappa	K. Muralidharan, A.C. Mathew and M.R. Manikantan
1050761110	Establishment of Agri-Business Incubation (ABI) Centre at ICAR-CPCRI, Kasaragod	K. Muralidharan	Mathew A.C., Manikantan M.R., Pandiselvam R., S. Jayasekhar and Murali Gopal
1050761124	Geo-spatial variability in Kerala- an analysis of extent and determinants	C. Thamban	K.P. Chandran, K. Muralidharan. S. Jayasekhar and S. Kalavathi
1050761129	Demonstration of Effective and Eco-friendly management of white grubs using Entomopathogenic nematodes in arecanut	Rajkumar	Nagaraja N.R.
1050761130	Participatory rejuvenation and refinement of coconut based homestead system models for food security and income	Anithakumari P.	Indhuja. S, Shareefa.M, Josephrajkumar A. and V.Krishnakumar

XV. Research and Organisational Management

Research Advisory Committee meeting

The 21st Research Advisory Committee (RAC) Meeting was held during 27–28 February, 2019. The meeting was chaired by Dr. H.P. Singh, Former DDG (Hort. Sci), ICAR. The members present were: Dr. P. Das, Dr. D.M. Hegde, Dr. S.R. Bhat, Dr. Anitha Karun, Shri Suresh Kumar Shetty, Shri Shivakrishna Bhat and Dr. K.B. Hebbar (Member Secretary). Scientists of ICAR-CPCRI, KVK-Kasaragod, KVK-Alleppey also attended the meeting. The programme leaders presented activities and achievements of ICAR-CPCRI during the year 2018-19. After detailed deliberations, RAC has given the following recommendations:

- Design and validate trait-specific markers based on available sequence data and genotyping by sequencing (GBS) approaches in coconut and arecanut
- Initiate work on construction of molecular linkage maps of coconut and arecanut using selfed/ crossed populations
- Studies on rainwater management both in high and low rainfall regions with emphasis on better conservation of soil moisture and use of harvested runoff to overcome moisture deficit in dry season

Dr. H.P. Singh, Chairman, RAC releasing Cocoa Guide at Kasaragod

- Develop and promote integrated pest management module to contain and prevent the spread of invasive pest like spiralling whitefly
- Evolve strategies used to prolong the shelf life of neera, tender nut water and kernel based products
- Assess the socio-economic impact of the technologies developed and adopted across the agro-ecological regions.

Institute Research Committee meeting

The 47th Annual Institute Research Committee Meeting was held at ICAR-CPCRI Kasaragod during 18 – 22 March, 2019. Progress of research programmes and achievements under the ongoing projects under Crop

Release of DVD on bio-suppression of rugose spiraling whitefly of coconut during the plenary session of IRC meeting at Kasaragod

Improvement, Biotechnology, Crop Production, Integrated Disease Management, Integrated Pest Management, Physiology & Biochemistry, Value Chain Management, and Social Sciences including Transfer of Technologies from the two KVKs were presented in detail by the respective Principal Investigators. The progress of all the ongoing research projects was reviewed and the technical programme for the year 2019-20 was finalized.

The Plenary Session was held on 22nd March, 2019 under the chairmanship of Dr. Anitha Karun, Acting Director. The session was co-chaired by Dr. V. Krishnakumar, Head, ICAR-CPCRI, RS, Kayamkulam. Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Kozhikode and Dr. P.R. Suresh, Associate Dean, College of Horticulture, KAU, Padannakkad, Kerala, were the Guests of honour.

IMC meeting at ICAR-CPCRI, Kasaragod

Institute Management Committee meeting

A meeting of the Institute Management Committee (IMC) was held on 17th September, 2018 at ICAR-CPCRI, Kasaragod under the chairmanship of Dr. P. Chowdappa, Director, ICAR-CPCRI.

XVI. Intellectual Property and Technology Management

Trademarks Registered

Sl. No.	Trademark	Trademark Class	Registration No.
1	Kera Probio	1	2813921
2	KeraAM	1	2813918

Consultancy services

Consultancy services were taken up as part of the professional service functions of the Institute during 2018-19 as detailed below:

Consultancy service	Client	Amount (₹)
Nutrient analysis of organic manure	Agricultural Officer, Krishi Bhavan, Kumbdaje	12,500
	Green n Green Agro systems, Kacheripady, Ernakulam	
	Agricultural Officer, Krishi Bhavan, Kumbala	
	Shri Vishwanatha Bhat, Otepadup House, Uppala	
	Agricultural Officer, Krishi Bhavan, Puthige	
Nutrient analysis of compost	M/S Akshaya, Pith Fert, Mathil.P.O., Payyannur	3,750
	Mr. Vishnu Kiran Bhat, Neerabidire House, Duggaladka Post, Sullia, Dakshina Kannada	
Nutrient analysis of bone meal	Agricultural Officer, Krishi Bhavan, East Eleri, Chittarikkal	1,250
	Total	**17,500**

Technology commercialization

During the period, 21 technologies were commercialized through non-exclusive licensing with memorandum of agreement as per the details given below, an amount of ₹ 7,00,000 has been collected as technology transfer fee.

Technology Commercialized	Licensee	Fee (₹)
Technical knowhow of production of virgin coconut oil (VCO)	Mr. Earl Francis Gracias, Franpal Bungalow, Dandewado, Chinchinim, Salcete, South Goa	2,40,000
	M/s Delta Virgin Coconut Oil Plant Proprietor: Mr. Thomas Philip, Moolad Post, Naduvannur Via, Calicut Dist., Kerala	
	Mr. K.S.Hegde, Shantivana Estate, Kukkehalli Post, Udupi Taluk & District, Karnataka	
	Vadakara Coconut Farmers Producer Company Ltd., 2nd floor, 19/408 KM&L, Al-Diyafa Complex, Co-operative Hospital Road, Karimbanapalam, Vadakara, Kerala	
	M/s Epione Agro foods Private, Jananai, Renuka layout, Nonavinakere, Tiptur, Karnataka – 572201	
	A.V.P Uttara Kannada Coconut Farmers Producer Company Ltd., Aparna Building 1st Floor, Upparkeri 1st Cross, K.S.R.T.C New Bus Stand, Kumta, Uttara Kannada, Karnataka- 581343	

Matured coconut water based value added products	Aaral Exports, SF.No.341/B Suguna Foods Road, Anthiyur Village, Udumalpet, Tirupur District, Tamil Nadu - 642122	45,000
	Faizal M.A (FAABCO AGRO), M.B. House, R.S Road, Kottachery, Kanhangad, Kasaragod – 671124, Kerala	
	M/s Delta Virgin Coconut Oil Plant Proprietor: Mr. Thomas Philip, Moolad Post, Naduvannur Via, Calicut Dist., Kerala	
Spraying Technology using Unmanned Aerial Vehicle (UAV) for Arecanut, Coconut and Cocoa	M/s General Aeronautics, Entrepreneurship Centre, Indian Institute of Science, Bangalore, Karnataka	-
Coconut chips	Vadakara Coconut Farmers Producer Company Ltd., 2nd floor, 19/408 KM&L, Al-Diyafa Complex, Co-operative Hospital Road, Karimbanapalam, Vadakara, Kerala	25,000
Kalpa Soil Care	Mr. Younus Ali P.P., Akshaya, Post Pokkunnu, Kozhikode, Kerala	25,000
Collection of fresh and hygienic Kalparasa and production of natural coconut sugar	Pidilite Industries Ltd., Kondivita Village, Ram Krishna Mandir Road, Andheri East, Mumbai Maharashtra	2,00,000
	Dindigul Coconut Producer Company Ltd., H.O.1-16-25 H/45, Kalidasan Street, Gandhi Nagar, Batlagundu, Dindigul District, Tamil Nadu	
Preservation protocol for trimmed tender coconut	Meera & Meera Company, C/o Tanna Weighbridge, Majewadi Gate, Junagadh, India	50,000
Bacillus subtilis culture	Vimal Jyothi Engineering College, Chemberi, Kannur	-
Preservation of Carbonated Tender Coconut Water	Chairman, Andaman Pragati Coconut Producer Company Ltd., 7-Niketan Colony, Lamba Line, Janglighat Post, Port Blair, Andaman	25,000
Virgin Coconut Oil (for conducting research on curing mouth cancer)	Dr. Upasana Reddy, Department of Conservative Dentistry and Endodontics, A.B. Shetty Institute of Dental Sciences, Derlakatte, Mangalore, Karnataka	-
Frozen coconut delicacy formulation	M/s Dinesh Foods, Dinesh Bhavan, Payyambalam, Kannur, Kerala	40,000
Entomopathogenic nematode (EPN) aqua formulation	M/s Varanashi Organic Manures, 4-90(2), Kepu Village, Adyanadka, Dakshina Kannada, Karnataka	50,000
	Senior Agricultural Officer, State Seed Farm, Parasite Breeding Station, Kasaragod, Kerala	
	Total	**7,00,000**

Sale of technology products

Following is the list of product sales from the Institute during the period:

Item	Qty. / Nos.	Amount (₹)
Books	79	5,906
CD	3	330
Earthworms	800	583
Vermicompost	885	19,305
Coconut	11,359	1,40,952
Kera Probio®	314	7,983
Cocoa probio®	12	300
Trichoderma	125	12,500

KerAM®	10	250
Coconut seedlings (Hybrid)	45,286	1,07,84,990
Coconut seedlings (Dwarf)	24,389	43,95,690
Coconut seedlings (Tall)	20,703	16,81,216
Polybag coconut seedlings (Tall)	2,605	4,31,830
Polybag coconut seedlings (Dwarf)	217	52,080
Coconut seednuts	74,226	5,96,615
Arecanut seednuts	2,72,640	21,62,253
Arecanut seedlings	1,82,877	47,13,970
Black pepper cuttings	10,384	1,76,755
Acid lime	1,088	18,745
Cocoa seedlings	9,757	97,570
Cocoa seed pods	41,911	12,57,330
Cocoa graft	6,755	2,02,650
Heliconia stumps	50	500
Heliconia flowers	332	3,320
Bay leaf Air Layer	1,106	22,120
	Total	**2,67,85,743**

XVII. Personnel

Sl. No.	Name	Designation
Scientific Staff		
Kasaragod		
1.	Dr. P. Chowdappa	Director (resigned w.e.f. 10.1.2019)
2.	Dr. Anitha Karun	Acting Director (w.e.f. 11.1.2019)
3.	Dr. H.P. Maheswarappa	Acting Project Coordinator (Palms)
4.	Dr. Ravi Bhat	Acting HoD (Crop Production)
5.	Dr. K.B. Hebbar	Acting HoD (PB & PHT)
6.	Dr. Vinayaka Hegde	Acting HoD (Crop Protection)
7.	Dr. K. Muralidharan	Acting HoD (Social Sciences)
8.	Dr. C. Thamban	Principal Scientist (Agril. Extension)
9.	Dr. Murali Gopal	Principal Scientist (Agril. Microbiology)
10.	Dr. Alka Gupta	Principal Scientist (Agril. Microbiology)
11.	Dr. K. Bhanuprakash	Principal Scientist (Plant Biochemistry) up to 16.08.2018
12.	Dr. V. Niral	Principal Scientist (Genetics)
13.	Dr. P. Subramanian	Principal Scientist (Agronomy)
14.	Dr. A.C. Mathew	Principal Scientist (Soil &Water Conservation Engg.)
15.	Dr. K. Samsudeen	Principal Scientist (Economic Botany)
16.	Dr. M.K. Rajesh	Principal Scientist (Agril. Biotechnology)
17.	Dr. M.R. Manikantan	Principal Scientist (Agril. Process Engg.)
18.	Dr. K.P. Chandran	Principal Scientist (Agril. Statistics)
19.	Dr. S. Jayasekhar	Senior Scientist (Agril. Economics)
20.	Dr. V. Selvamani	Scientist (Soil Science)
21.	Dr. P.S. Pratibha	Scientist (Agril. Entomology)
22.	Dr. Rajkumar	Scientist (Nematology)
23.	Dr. V.H. Prathibha	Scientist (Plant Pathology)
24.	Mrs. Surekha	Scientist (Agronomy)
25.	Dr. M. Sujithra	Scientist (Agril. Entomology)
26.	Dr. S. Neenu	Scientist (Soil Science)
27.	Dr. M . Neema	Scientist (SPM&AP)
28.	Dr. S. Sumitha	Scientist (SPM&AP)
29.	Mr. Krishna Prakash	Scientist (SPM&AP)
30.	Mrs. Aparna Veluru	Scientist (SPM&AP)
31.	Dr. P.P. Shameena Begum	Scientist (SPM&AP)
32.	Mrs. G. Panjavarnam	Scientist (Fruit Science)
33.	Dr. S. Paulraj	Scientist (Microbiology)

34.	Dr. Jilu V. Sajan	Scientist (Agril. Entomology)
35.	Dr. R. Pandiselvam	Scientist (Agril. Process Engg.)
36.	Ms. T.N. Ranjini	Scientist (SPM&AP)
37.	Dr. Arivalagan	Scientist (Agril. Biotechnology) up to 30.06.2018
38.	Mrs. U. Keerthana	Scientist (Pl. Pathology) up to 30.06.2018
39.	Dr. S.V. Ramesh	Scientist (Agril. Biotechnology)
40.	Mr. Bhukya Narshima Swamy	Scientist (Veg. Science)
41.	Mrs. Bandela Sravanthi	Scientist (SPM&AP)
42.	Dr. R. Sudha	Scientist (Fruit Science)
43.	Dr. Ajeet Singh	Scientist (Biochemistry)
KVK, CPCRI, Kasaragod		
44.	Dr. T. S. Manojkumar	Principal Scientist & Head
Regional Station, Kayamkulam		
45.	Dr. V. Krishna Kumar	Acting Head
46.	Dr. S. Kalavathi	Principal Scientist (Ag. Extension)
47.	Dr. Chandrika Mohan	Principal Scientist (Ag. Entomology)
48.	Dr. P. Anitha Kumari	Principal Scientist (Ag. Extension)
49.	Dr. Regi Jacob Thomas	Principal Scientist (Hort.)
50.	Dr. A. Abdul Haris	Principal Scientist (Agronomy)
51.	Dr. A. Josephrajkumar	Principal Scientist (Ag. Entomology)
52.	Dr. K. Nihad	Scientist (Hort.)
53.	Dr. Jeena Mathew	Scientist (Soil Science)
54.	Dr. M. Shareefa	Scientist (Hort.)
55.	Dr. Merin Babu	Scientist (Plant Pathology)
56.	Dr. S. Indhuja	Scientist (Microbiology)
57.	Dr. Daliyamol	Scientist (Plant Pathology)
58.	Dr. K.M. Anes	Scientist (Nematology)
KVK, CPCRI, RS, Kayamkulam		
59.	Dr. P. Muralidharan	Principal Scientist & Head
Regional Station, Vittal		
60.	Dr. C.T. Jose	Acting Head
61.	Dr. S. Elain Apshara	Principal Scientist (Fruit Science)
62.	Dr. M. Senthil Amudhan	Senior Scientist (Biochemistry)
63.	Dr. N.R. Nagaraja	Scientist (Plant Breeding)
64.	Ms. M. Chaithra	Scientist (Plant Pathology)
65.	Dr. U.K. Priya	Scientist (Soil Science)
66.	Mr. Bhavishya	Scientist (SPM&AP)
67.	Dr. Shivaji Hausrao Thube	Scientist (Agril. Entomology)
68.	Ms. M. Suchithra	Scientist (SPM&AP)
69.	Mrs. E.K. Saneera	Scientist (Agril. Entomology)
70.	Dr. R. Thava Prakasa Pandian	Scientist (Plant Pathology)
71.	Mr. N. Najeeb	Scientist (Fruit Science)

Research Centre, Kidu		
72.	Mr. Y. Diwakar	Scientist (SPM&AP)
73.	Dr. Khadke Ganesh Navanath	Scientist (SPM&AP)
Research Centre, Mohitnagar		
74.	Dr. Arunkumar Sit	Principal Scientist (Hort.)
75.	Dr. Sandip Shil	Scientist (Agril. Statistics)
Research Centre, Kahikuchi		
76.	Dr. Alpana Das	Senior Scientist (Agril. Biotechnology)
77.	Mr. Anok Uchoi	Scientist (SPM&AP)
78.	Dr. Leichombam Singhajit Singh	Scientist (SPM&AP)
Technical Staff		
Kasaragod		
1.	Mr. H . Muralikrishna	Chief Technical Officer (TIO)
2.	Dr. K.K. Sajini	Chief Technical Officer (retired on 30.11.2018)
3.	Mr. John George	Chief Technical Officer
4.	Mr. Sebastian George	Chief Technical Officer
5.	Mrs. K. Shobha	Chief Technical Officer (Library)
6.	Dr. Bikash Chowdhury	Chief Technical Officer (up to 21.07.2018)
7.	Mr. K. Devadas	Asst. Chief Technical Officer
8.	Mrs. Sugatha Padmanabhan	Senior Technical Officer
9.	Mr. P. Ravindran	Asst. Chief Technical Officer
10.	Mr. N. Ramakrishnan	Asst. Chief Technical Officer
11.	Mrs. K. Sreelatha	Asst. Chief Technical Officer (Hindi)
12.	Mr. K. Shyama Prasad	Asst. Chief Technical Officer (Art-cum-Audio Visual aids)
13.	Mr. A. Sadanandan	Tech. Officer (Mech. Engg.)
14.	Mr. G.S. Hareesh	Tech. Officer (Instrumentation Engg.)
15.	Mr. M.P. Rajendran Nair	Tech.Officer (Mech. Engg.)
16.	Mr. K. Ajith Kumar	Tech. Officer (Civil Engg.)
17.	Mr. K. Balakrishna	Technical Officer
18.	Mr. K.N. Radhakrishnan Nambiar	Technical Officer
19.	Mr. V.K. Gopalakrishnan	Technical Officer (Civil Engg.)
20.	Mr. S. Manohara	Technical Officer (Vehicles)
21.	Mr. V. Balakrishnan	Technical Officer
22.	Mr. V. Suresh Kumar	Senior Technical Assistant
23.	Mr. K. Krishnan Nair	Senior Technical Assistant
24.	Mr. K.N. Pankajakshan	Senior Technical Assistant (Vehicles)
25.	Mr. Devaraj K.	Senior Technical Assistant (Junior Engineer)
26.	Mr. K. Raghavan	Technical Assistant
27.	Mr. A. Sanjeeva	Technical Assistant
28.	Mr. K. Panduranga	Senior Technician
29.	Mr. Bhavani Sankar Naik	Senior Technician
30.	Mr. A.V. Satheesh Kumar	Technical Assistant (Vehicles)

31.	Mr. A.O. Varghese	Senior Technician
32.	Mr. A. Divakaran	Senior Technician
33.	Mr. K.J. Sebastian	Senior Technician
34.	Mr. S. Sunil	Senior Technician (Electrical Engg.)
35.	Mr. V. Radhakrishnan	Senior Technician
36.	Mrs. M. Vimala	Senior Technician
37.	Dr. K.S. Muralikrishna.	Technical Assistant
38.	Mr. M.V. Madhavan	Sr. Technical Assistant (retired w.e.f. 10.03.2019)
39.	Mrs. Jesmi Vijayan	Technical Assistant
40.	Mrs. Niveditha M.S.	Technical Assistant (resigned w.e.f. 13.08.2018)
41.	Mr. P. K. Krishnan Kutty	Sr. Technical Assistant (retired on 30.11.2018)
42.	Mr. N. Dinesh Kumar	Senior Technician
43.	Mr. G. Arunji	Tech. Asst. (Library)
44.	Mr. M.V. Sreedharan	Senior Technical Assistant
45.	Mr. A.R. Padmanabha Naik	Senior Technicain (w.e.f. 05.01.2019)
KVK, Kasaragod		
46.	Dr. S. Leena	Chief Technical Officer (Entomology)
47.	Dr. Saritha Hegde	Chief Technical Officer (Home Science)
48.	Dr. R. Sanalkumar	Chief Technical Officer (Plant Pathology)
49.	Dr. Neelofar Illieskutty	Assistant Chief Technical Officer (Programme Assistant) (Home Science)
50.	Mrs. M. P. Jayasree	Assistant Chief Technical Officer (Agrl. Extn.)
51.	Mr. K. Manikandan	Technical Officer (Programme Assistant) (Hort.)
52.	Mr. A.K. Ramadas	Technical Assistant T-3 (Vehicle)
Regional Station, Kayamkulam		
53.	Dr. C. Keshavan Nampoothiri	Chief Technical Officer (Statistics)
54.	Dr. M. Shanavas	Chief Technical Officer
55.	Mr. S. Thajuddin	Asst. Chief Technical Officer (Library)
56.	Dr. G. Rajeev	Asst. Chief Technical Officer
57.	Mr. Jacob Kurian	Asst. Chief Technical Officer
58.	Dr. C.G. Narayanan Namboothiri	Asst. Chief Technical Officer
59.	Mr. K.K. Sudhanandan	Senior Technical Officer
60.	Mr. K. Rajendran	Technical Officer
61.	Mr. K.P. Udayabhanu	Technical Officer
62.	Mr. Sunny Thomas	Senior Technical Assistant
63.	Mr. P.K. Sunil Kumar	Senior Technical Assistant
64.	Mr. Jinu Sivadasan	Technical Assistant
65.	Mr. V.P. Joy	Technical Assistant
66.	Mr. B. Anilkumar	Technical Officer
67.	Mrs. Asha K. Chandran	Technical Assistant

KVK, Kayamkulam		
68.	Mr. M.S. Rajeev	Assistant Chief Technical Officer (Agronomy)
69.	Mrs. Jissy George	Assistant Chief Technical Officer (Home Science)
70.	Dr. T. Sivakumar	Assistant Chief Technical Officer (Agricultural Entomology)
71.	Mrs. G. Lekha	Assistant Chief Technical Officer (Plant Pathology)
72.	Dr. S. Ravi	Assistant Chief Technical Officer (Animal Husbandry)
73.	Dr. K. Sajnanath	Asst. Chief Technical Officer (Soil Science)
74.	Mr. E.R. Asokan	Technical Officer (retired on 31.12.2018)
75.	Mr. K.M. Ansary	Technical Assistant (Computer)
76.	Mrs. P.V. Bijila	Technical Assistant (Horticulture)
77.	Mr. Dayanandan Unnithan	Technical Assistant (Vehicles)
Regional Station, Vittal		
78.	Dr. H. Moosa	Chief Technical Officer
79.	Mrs. Meenakshi Patil	Asst. Chief Technical Officer (Library)
80.	Mr. C. Purandhara	Technical Officer
81.	Mr. Adolphus Francis Mascarenhas	Technical Officer (Electrical Engg.)
82.	Sri Ramanna Gowda	Senior Technical Assistant (Driver) (retired on 30.06.2018)
83.	Mr. Prakash Burman	Senior Technician (w.e.f. 04.10.2018)
84.	Mr.. A.R. Padmanabha Naik	Senior Technicain (up to 04.01.2019)
85.	Mr. Abdul Aziz	Senior Technical Assistant
86.	Mr. Y. Sreenivasa Bhat	Senior Technical Assistant
87.	Mr. B. Ananda Gowda	Senior Technical Assistant
88.	Mr. V. Chandrasekhara Shetty	Senior Technical Assistant (Vehicles)
89.	Mr. B. Tharanath Naik	Technical Assistant (Vehicles)
90.	Mr. P. Santhosh Kumar	Technical Assistant (Farm Assistant)
91.	Mr. Bisun Bhaskar	Technical Assistant (Laboratory)
92.	Mr. B.J. Nirmal Kumar	Technical Assistant (Field/Farm)
Research Centre, Kidu		
93.	Mr. N. Nagesh	Technical Officer (retired on 31.08.2018)
94.	Mr. Chandra Nairy	Technical Officer
95.	Mr. M. Manamohan	Technical Officer (Mech. Engg.)
96.	Mr. A.S. Gopalakrishna	Senior Technical Assistant
97.	Mr. M. Narayana Naik	Technical Assistant
98.	Mr. V. Kamal Kumar	Technical Assistant (w.e.f. 05.01.2019)
99.	Mr. P.P. Anoop Kumar	Technical Assistant (w.e.f. 05.01.2019)
Research Centre, Mohitnagar		
100.	Mr. Saran Kumar Rizal	Chief Technical Officer (Farm Superintendent)
101.	Mr. Avrajyothi Ghosh	Asst. Chief Technical Officer
102.	Mr. Jagadish Royburman	Sr. Technical Assistant (retired on 31.12.2018)
103.	Mr. Pratap Kumar Sarkar	Technical Assistant
104.	Mr. Jagadish Roy	Sr. Technical Assistant (Vehicles)

Research Centre, Kahikuchi		
105.	Dr. Bikash Chowdhury	Asst. Chief Technical Officer (w.e.f. 22.07.2018)
106.	Mr. N.C. Das	Technical Officer (expired on 07.04.2018)
107.	Mr. Prakash Burman	Senior Technician (up to 03.10.2018)
108.	Mr. Gopinath Malakar	Technical Assistant (Vehicles)
Administrative Staff		
Kasaragod		
1.	Mr. Hareesh Nair	CAO (w.e.f. 15.11.2018)
2.	Mr. Ram Avtar Parashar	SFAO
3.	Mr. T.E. Janardhanan	AO
4.	Mrs. Luisy D' Souza	AAO (retired on 31.12.2018)
5.	Mr. K.R. Nithianandan	AAO
6.	Mrs. M. Reetha	AAO
7.	Mr. K.G. Bhageerath	AAO
8.	Mr. Neil Vincer	AAO (w.e.f. 06.07.2018)
9.	Mr. K. Ramadasan	Assistant (resigned w.e.f. 13.08.2018)
10.	Mr. T.N. Vidhyadharan	Assistant
11.	Mrs. K.S. Vishalakshi	Assistant
12.	Mr. P.M. Thomas	Assistant
13.	Mrs. K.T.K. Sheenakumari	Assistant
14.	Mr. P. Narayana Naik	Assistant
15.	Mrs. Rupa Manikandan	Assistant
16.	Mrs. K. Preethi	UDC
17.	Mr. Paulson Sam George	UDC
18.	Mr. T.K. Gangadharan	UDC
19.	Mrs. T.R. Remya	UDC
20.	Mrs. A.J. Mary	UDC
21.	Mr. N. Udayakumar	UDC
22.	Mr. P.K. Pramodkumar	LDC
23.	Mr. V. Jayarajan	LDC
24.	Mr. Umesh Kumar	LDC
25.	Mr. Dinesh	LDC
26.	Mr. Ratan Singh	LDC
27.	Mr. K.T. Unni	Private Secretary (retired on 5.12.2018)
28.	Mrs. K. Narayani	Private Secretary
29.	Mrs. Girija Chandran	Private Secretary
30.	Mrs. Sulochana Nair	Private Secretary
31.	Mr. K. Kunhiraman Nair	Private Secretary
32.	Mrs. A.R. Arathi	Stenographer Gr.III

Regional Station, Kayamkulam		
33.	Mr. Pradeep Kumar Vasu	AAO
34.	Mr. S.B. Baburaj	AFAO
35.	Mrs. Annamma N. Topino	Assistant (retired on 31.01.2019)
36.	Mr. K. Haridas	Assistant
37.	Mr. K. Venugopal	Assistant
38.	Mrs. K. Sreelatha	Assistant
39.	Mrs. V. Madhavikutty	Assistant
40.	Mr. C. Ramesh Babu	Personal Assistant
41.	Mrs. Prasanna Sarngan	Personal Assistant
KVK, Kayamkulam		
42.	Mrs. K.R. Rejitha	Stenographer Gr.III
Regional Station, Vittal		
43.	Mr. P. Krishna Naik	AAO
44.	Mr. K.K. Sasi	AFAO
45.	Mrs. K. Jayashree	UDC
46.	Mr. Aswin Reghunath	UDC
47.	Mr. P.K. Mohammed Haneefa	UDC
48.	Mr. C.M.O. Fawaz	LDC (w.e.f. 05.01.2019)
Research Centre, Kidu		
49.	Mr. M. Ravindran	AAO
50.	Mr. Lakshmi Narayana	LDC
51.	Mr. Arun N.K. Raj	LDC
Research Centre, Mohitnagar		
52.	Mr. Subash Paul	Assistant
53.	Mr. Sathya Bratha Moharana	LDC
Research Centre, Kahikuchi		
54.	Mr. T.J. Saji	UDC
55.	Mr. Deepak Meena	LDC

Skilled Support Staff

Kasaragod	
Sl. No.	***Name***
1.	Mrs. K. Bhanu (retired on 31.08.2018)
2.	Mr. K. Kunhikannan (retired on 30.11.2018)
3.	Mr. M. Shankara
4.	Mr. P. Narayanan Nair
5.	Mr. K. Baby
6.	Mr. A. Mohana
7.	Mr. K. Keshava
8.	Mr. K. Sukumaran
9.	Mr. K.V. Krishnan
10.	Mr. P.A. Chaniya Naik
11.	Mr. P. Kumaran
12.	Mr. V.S. Pakeeran
13.	Mrs. V. Thambai
14.	Mrs. G. Kamala
15.	Mr. K.G. Sureshbabu
16.	Mr. T.J. Ninan
17.	Mrs. K. Chithralekha
18.	Mr. B. Chandrahasa

19.	Mr. V.T. Rameshan
20.	Mr. K. Krishnankunhi
21.	Mrs. K. Shobhana
22.	Mr. M. Krishnan
23.	Mrs. V.A. Leela
24.	Mrs. U. Sarojini
25.	Mr. V. Krishnankutty
26.	Mr. P.P. Prabhakaran
27.	Mr. B. Ramachandran
28.	Mr. B. Sanjeeva Patali
29.	Mrs. N.V. Sasikala
30.	Mr. Lakshmana Naik
31.	Mrs. Lalitha Bai
32.	Mr. M. Velayudhan
33.	Mr. N. Bhaskaran
34.	Mr. B. Sundara
35.	Mr. K. Suresan
36.	Mr. A. Madhu
37.	Mr. K.A. Madhavan
38.	Mr. Aneesh E.M.
39.	Mrs. Vanamalini
40.	Mr. N.B. Mahesan (w.e.f. 19.09.2018)
41.	Mr. Ashok Kumar R. (w.e.f. 02.06.2018)
42.	Mr. Praveen Raj P.R. (w.e.f. 02.06.2018)
43.	Mr. Sarath Kumar (w.e.f. 07.06.2018)
Canteen	
44.	Sri K. Vijayan (retired on 31.03.2019)
45.	Mr. B. Balakrishnan
46.	Mr. K. Jayaprakash
Regional Station, Kayamkulam	
47.	Mr. M.E. Sivan
48.	Mr. K.B. Thankachan
49.	Mr. R. Ravindran
50.	Mr. K. Soman
51.	Mr. K. Omanakuttan
52.	Mr. K.C. Damodaran
53.	Mr. V.T. Unnikrishnan
54.	Mr. T.K. Mani
55.	Mr. K. Ravi
56.	Mr. K.V. Vijayan
57.	Mr. K.K. Sreedharan
58.	Mr. C. Sukumaran
59.	Mrs. K. Valsala
60.	Mr. C. Sundaran
61.	Mr. K.N. Sajeev
62.	Mr. K.P. Ibrahim
63.	Mrs. N. Suma
64.	Mr. A.T. Harikuttan
65.	Mrs. K Saseendra
66.	Mr. C.R. Babu
67.	Mr. Ajith Mattappadan
68.	Mr. R. Rajesh
69.	Mrs. L. Leena
70.	Mr. Ancil Pereira
71.	Mr. S. Rajesh
72.	Mr. N. Reghu
Canteen	
73.	Mr. Justin Jayaraj Das
Regional Station, Vittal	
74.	Mr. Harischandra
75.	Mr. Chandu Naika
76.	Mr. Sudhakara
77.	Mr. A. Gopala
78.	Mr. D. Isbu
79.	Mr. B. Dharmapala
80.	Mr. K. Vinod
81.	Mr. Ibrahim
82.	Mr. B. Choma
83.	Mr. Mohana
84.	Mr. K. Somappa
85.	Mr. M. Ananda
86.	Mr. K. Monappa Gowda
87.	Mr. N.B. Mahesan (up to 18.09.2018)
Canteen	
88.	Mr. A. Shivarama Poojary
Research Centre, Kidu	
89.	Mr. Balappa Gowda
90.	Mr. S. Venkataramana
91.	Mr. S. Chennappa
92.	Mrs. N. Bhavani
93.	Mrs. S. Susheela
94.	Mrs. Lolakshi

95.	Mr. S. Janardhana
96.	Mr. Dasappa Gowda
97.	Mrs. T. Susheela
98.	Mr. Padmayya Gowda
99.	Mrs. B. Bhavani
100.	Mrs. S. Rukmini
101.	Mr. S. Bhojappa
102.	Mr. S. Narayana
103.	Mrs. Komalangi
104.	Mr. V. Chennappa
105.	Mr. V. Jathappa Gowda
106.	Mr. S. Sheenappa Gowda
107.	Mr. S. Neelappa
108.	Mr. S. Regappa
109.	Mrs. S. Chandravathi
110.	Mr. M. Durgesha
111.	Mrs. Meenakshi K. (w.e.f. 04.06.2018)
Research Centre, Mohitangar	
112.	Mr. Sailen Seal
113.	Mr. Krishna Kumar Mandal
114.	Mr. Nripendra Chandra Roy
115.	Mr. Kartick Chandra Biswas
116.	Mr. Sushanta Burman
117.	Mr. Mahadev Misra
Research Centre, Kahikuchi	
118.	Mr. Sathish Baishya
119.	Mr. Pankaj Das

XVIII. Distinguished Visitors

Sl. No.	Name and designation of official	Place and date of visit	Remarks
1	Dr. R. Chandrababu, Vice-Chancellor, KAU, Vellanikkara, Dr. R.K. Mathur, Director, ICAR-Indian Institute of Oil Palm Research, Pedavegi, Dr. M. Gangadhara Nayak, Acting Director, ICAR-Directorate of Cashew Research, Puttur	ICAR-CPCRI, Regional Station, Vittal 27th April, 2018	Workshop on 'Breeding Strategies in Plantation Crops'
2	Shri R.Vimalasenan Nair, Director, AIR, Thiruvananthapuram Shri R. Hali, Retired Director, Department of Agriculture, Kerala	ICAR- CPCRI, Regional Station, Kayamkulam 5thJune, 2018	Farmers Meet of the ICAR-CPCRI (FFP) and All India Radio
3	Dr. S.K. Bhandary, Vice Chancellor, NITTE University, Mangalore Dr. K. Satyamoorthy, Director, School of Life Sciences, Manipal University, Manipal Shri Anant Hegde Ashisar, Former Chairman, Western Ghats Task Force Dr. Homey Cheriyan, Director, Directorate of Arecanut and Spices Development, Kozhikode	ICAR-CPCRI Kasaragod 24thJuly, 2018	Interactive Workshop on 'Arecanut and Human Health', Inaugural session
4	Dr. P. Rajasekharan, Chairman, Kerala State Agricultural Prices Board	ICAR-CPCRI, Regional Station, Kayamkulam 24th July, 2018	Formulation of 'Coconut Mission' for Govt. of Kerala
5	Shri K.N. Bhat, Former Additional Solicitor General of India	ICAR-CPCRI Kasaragod 25thJuly, 2018	Interactive Workshop on 'Arecanut and Human Health', Valedictory session
6	Shri P. Sreeramakrishnan, Hon'ble Speaker, Kerala Legislative Assembly	ICAR-CPCRI, Regional Station, Kayamkulam 3rd September, 2018	Interactive discussion
7	Shri Raju Narayana Swamy, IAS, Chairman, Coconut Development Board, Kochi Padma Shri Dr. Kota Harinarayana, Chairman, General Aeronautics Pvt. Ltd., Bangalore Dr. G. Dhanakumar, Director, Indian Institute of Plantation Management, Bengaluru	ICAR-CPCRI Kasaragod 28thSeptember, 2018	Workshop on 'Artificial Intelligence (AI) for Plantation Crops'
8	Shri P. Sathasivam, Hon'ble Governor of Kerala Shri N. A. Nellikunnu, MLA, Kasaragod, Dr. RajuNarayanaSwamy, IAS, Chairman, CDB, Koch	ICAR-CPCRI, Kasaragod, Kerala 6th October, 2018	Innovators' Meet
9	Adv. U. Prathibha, Hon'ble MLA, Kayamkulam	ICAR-KVK, Alappuzha 15th October 2018	Mahila Kisan Divas

10	Shri D.V. Sadananda Gowda, Hon'ble Union Minster of Statistics and Programme Implementation, Govt. of India Dr. D. Veerendra Heggade, Dharmadhikari, Dharmasthala Shri Nalin Kumar Kateel, Hon'ble M.P., Dakshina Kannada Shri S. Angara, Hon'ble MLA Sullia, Shri Sanjeeva Matandoor, Hon'ble MLA Puttur Dr. Raju Narayana Swamy IAS, Chairman, Coconut Development Board, Kochi Dr. M. Ariz Ahmed IAS, MD, National Horticulture Board, New Delhi	CPCRI, Research Centre, Kidu, 10th November, 2018	Kisan Mela and Agri-Expo, inaugural session
11	Shri E. Chandrasekharan, Hon'ble Minister for Revenue and Housing, Govt. of Kerala Shri N.A.Nellikunnu, Hon'ble MLA, Kasaragod Shri M. Rajagopalan, Hon'ble MLA, Thrikkaripur	ICAR-CPCRI, Kasaragod 16th February, 2019	Punarnava - KVK-ATMA Technology Meet and Agricultural seminars
12	Dr. H.P. Singh, Former DDG (Hort.Sci.), ICAR, New Delhi	ICAR-CPCRI, Kasaragod 27th and 28th February, 2019	RAC meeting

Shri P. Sreeramakrishnan, Hon'ble Speaker of Kerala Legislative Assembly at ICAR-CPCRI, Regional Station, Kayamkulam

XIX. Mera Gaon – Mera Gaurav

ICAR-CPCRI has adopted 70 villages in various states, *viz*. Kerala, Karnataka, West Bengal and Assam as part of Mera Gaon - Mera Gaurav (MGMG) programme. Under the MGMG, training programmes, demonstration on improved practices, farm advisory visits and mobile advisory services were organized. A summary of activities undertaken for the overall development of the villages is given below:

Sl. No.	Activities	No. of activities conducted	No. of farmers participated & benefitted
1.	Visit to village by teams	208	1,295
2.	Interface meeting/ *Goshthies*	55	1,285
3.	Training organized	38	939
4.	Demonstrations conducted	42	353
5.	Mobile based advisories (No. of message)	7,844	8,130
6.	Literature support provided (Nos)	5,541	6,974
7.	Awareness created (Nos)	785	2,271
8.	Other, if any please specify	4	41
	Total	**13,542**	**20,095**

Meetings were organized on various subjects like, health benefits of mushroom, jack fruit processing, cocoa production and processing, planting of seedlings and maintenance of juvenile palms, pest surveillance, etc. mobile based advisory was given on the different topics.

In addition, facilitation for technology for making virgin coconut oil, technology for the management of red palm weevil and rhinoceros beetle in coconut, quality planting materials of coconut, cocoa and turmeric, mass multiplication of *Trichoderma*, and leaf rot management benefitting 1908 farmers were also carried out. Literature support was also provided for 6974 beneficiaries. Linkages with agencies, viz. Department of Agriculture and Horticulture in different states, ATMA and grama panchayaths were also carried out during the period benefitting 2662 farmers.

Demonstration on 'Management of rhinoceros beetle in coconut'

Demonstration on 'Management of spindle bug damage in arecanut juvenile palm'

Training programme on ICAR- CPCRI developed coconut varieties and coconut seedling production and nursery management

Interactive session during the demonstrations on value added products of coconut and cashew

Training on product diversification and value addition in coconut

Talk on 'Kera Probio', a PGPR based bioinoculant for coconut and vegetable seedlings In Punarjani program at Kundamkuzhy, Bedadka Krishi Bhavan

Recommendations for management of bud rot during the diagnostic field visit at Periya

Awareness pragramme on "organic way of disease management by effectively utilizing Trichoderma"

Training programme on "Production of Trichoderma coir pith cake preparation"

Technical help to Trichoderma production unit Punarjani JLG group at Kodom Bellur

Collection of soil samples from farmers' fields for nutrient analysis

Bud rot and nutrient deficiency in arecanut

Farmer's field day

Training on "Palm Health Management"

Training programme on 'Cocoa production and processing technologies' at Manchi, Karnataka

Field Diagnostic visit at South Berubari, West Bengal

Session on participatory pest and disease surveillance

Demo on ABMCS at Palthady, Karnataka

Experiential learning session on area wide plant protection of coconut

Diagnostic field visit

Harvesting of fish pond

XX. Swachh Bharat Abhiyan

Swachhata Hi Seva Campaign

In connection with the 150th birth anniversary celebrations of Mahatma Gandhi and 4th anniversary of Swachh Bharat Mission, a 'Swachhta Hi Seva' campaign was organised during 15th September, 2018 to 2nd October, 2018 which was inaugurated by Dr. P. Chowdappa, Director, ICAR-CPCRI. Various programmes such as awareness rally, door to door campaign on Swachhata, exhibition of mural painting and other cultural activities on the ideas of cleanliness were organised.

Swachhta Hi Seva campaign at ICAR-CPCRI, Kasaragod

This flagship campaign promulgated by Hon'ble Prime Minister aimed at showcasing "Clean and New India" as well as sanitation message to the young minds and to the rural masses. Different activities were also organized at ICAR-CPCRI, Regional Station, Kayamkulam, *viz*., Swachhtha Shapath, conduct door to door meeting in the neighbourhood, organize awareness campaign for school students, student rallies to create awareness on sanitation, making provisions for segregation of wastes, making compost pits, cleaning of roads inside campus. ICAR-CPCRI convened a village-level sensitization rally as well as awareness meeting with the school children from Government UPS, Krishnapuram on 25thSeptember, 2018. The rally was followed by an awareness meeting with the school kids at the Regional Station, Kayamkulam.

ICAR-CPCRI at its Regional Station organized all events as envisaged in the *Swachh Bharat Pakhwada* during December 16-31, 2018. A clean and green farming training session was handled by Dr. A. Abdul Haris, Pr. Scientist in Velanchira and Kopareth villages. A mega sanitation campaign was launched at Krishnapuram archaeological palace cum museum sensitizing the rural people as well as visiting tourists about the mission of cleanliness. As part of *Kisan Diwas*, farmers were empowered on the concept of "Waste to Wealth" by bio-composting and "Organic coconut production strategies" in Farmer FIRST project area. Door to door campaigning on plastic abuse was highlighted. Quarters inhabitants were provided with bins for efficient collection and recycling of solid and liquid wastes. An awareness quiz and elocution contest on *Swachh Bharat* was organized for the contract staff to take forward the message of *"Swacchata Hi Sewa*" to greater heights in their respective hamlets. A cloth bag with the message on reducing plastic use was released in the valedictory function and distributed to all staff.

Swacch Bharat campaign at Krishnapuram Palace

ICAR-CPCRI, Research Centre, Mohitnagar observed Swachhta Hi Sewa Campaign 2018 from 15th September to 2ndOctober, 2018 with various activities like cleaning at nearby school, public roads, public places, rally with villagers. Sachhwata Pakhawada was observed in the centre from 16 to 31 December, 2018. Awareness on Swacchata in nearby villages, digging of compost pits for disposal of wastes, inclusion of villagers for cleaning of roads and public places were some of the activities during this programme. School children were also participated in the programme.

XXI. Women's Cell Activities

A training programme on jack fruit based pappad making was conducted at ICAR-CPCRI, Kasaragod on 18th May, 2018. This year, members of the Women Cell of ICAR-CPCRI, Kasaragod bid farewell to three long serving colleagues on the occasion of their superannuation from ICAR service: Mrs. Bhanu K., SSS on 31st August, 2018, Mrs. Lucy D'Souza, Asst. Administrative Officer on 31st October, 2018 and Dr. K. K. Sajini, Chief Technical Officer on 30th November, 2018. A field-cum exposure visit was organized to the Home scale food products at Poinachi, Mushroom Production Unit and Food Production Units (Home scale initiative of an ICAR-CPCRI Kasaragod KVK trainee) at Nileshwar on 3rd June, 2018 for the benefit of Women Cell members.

An awareness programme on breast cancer was organized on 23rd June, 2018. Dr. M.S. Vijayalakshmi Deshmane, Former Professor and Head, Kidwai Memorial Institute of Oncology, Bangalore delivered a lecture and conducted an interactive session on Breast Cancer for the benefit of all the staff members.

Women's Cell of ICAR-CPCRI, RS, Kayamkulam organized a rejuvenation lecture for staff members of the station on 24th July, 2018. The lecture was delivered by Dr. R. Sreeni, Senior Medical Officer, Government Ayurveda Hospital, Kumarapuram, Alappuzha on the topic 'Importance of observing Ayurveda practice in *Karkkadaka* month for health rejuvenation'. The unique medicinal porridge, '*Karkkadaka Kanji',* traditionally popular in Kerala was prepared by women staff members and served to the participants on the day.

Lecture on 'Health rejuvenation' to women's cell members at ICAR-CPCRI, RS, Kayamkulam

International Women's Day

International Women's day was celebrated at ICAR – CPCRI, Kasaragod on 8th March, 2019 in a befitting manner. The celebration commenced with the Hon'ble Prime Minister's address on the occasion, which has been telecasted through livestreaming. Dr. Neetha Joseph, Lecturer (Psychology), Teachers Training Centre, Vidyanagar was the chief guest of the function. She addressed the gathering on the psychological aspects of balancing the women in personal and professional lives in order to achieve their goals. Dr. Anitha Karun, Acting Director presided over the function and emphasized the importance of the theme of this year, and on the role of women's education for nation building.

During the International Women's Day, a lecture was arranged at ICAR-CPCRI, Regional Station, Kayamkulam on 8th March, 2019, in which Dr. M. N. Girija, Gynaecologist, Parabrahma Hospital, Oachira was the chief guest. She delivered a talk on the topic "Women and health care" for the benefit of staff and family members.

International Women's Day celebration at ICAR-CPCRI, Kasaragod

XXII. Major Events

Impact of rainfall induced natural calamity on plantation sector of Kerala

Kerala was battered by unprecedented torrential rains, followed by flooding during August 2018. The agricultural sector has borne the brunt of the damage inflicted by the monsoon in the state. The field crops like paddy and vegetables are among the crop most severely affected by the calamity. The plantation crop sector has also been adversely affected by outright physical damage and indirect loss due to lower output resulting from adverse crop growing conditions and increased biotic stress. The Indian Council of Agricultural Research was in the forefront to assess the yield and crop loss due to the aforesaid natural calamities. It is highly gratifying for ICAR-CPCRI, being the nodal agency, has complete the task in time by effectively coordinating with respective ICAR institutes, State Agricultural Universities and other stakeholders. In the case of plantation crops sector, the landslides had resulted in the loss of approximately 25,000 coconut palms, 20,000 arecanut palms and 80,000 cocoa trees in the state. The (life time) economic loss from the landslides would be ₹ 1025 million for the farming community. Flood related loss is of two types: One is crop loss and the other is yield loss. It was reported that around 3500 coconut palms and 40000 arecanut palms were lost due to flood. Loss of juvenile coconut palms in the flood affected area was approximately 1,00,000 (including plants in the nursery). The yield loss was worked out to be 95.6 million nuts. The expected yield loss in arecanut would be 63,577 tonnes.

Dislodged coconut palms

Arecanut garden: Aftermath of land slide

Impact of the cyclone *Titli* in coastal Andhra Pradesh and Odisha

A scientific team from ICAR-CPCRI under the leadership of Dr. P. Chowdappa, Director, ICAR-CPCRI visited the cyclone *Titli* affected regions of Andhra Pradesh and Odisha during 22-26 October, 2018. The devastating cyclone *Titli* had taken heavy toll on coconut palms by means of uprooting and dislodging about 11.7 lakh palms in the state. More than 95% coconut palms in the affected villages were either uprooted, broken at the bole region, trunk twisted and broken off if damaged by disease or any mechanical injury, extensive twisting of crown with irrecoverable damage, crown congestion with arrest of emergence of spear leaf, partially uprooted slanting palms. Actionable strategies on need of planting materials, improved agro-techniques in palm health, crop pluralism approach in sustainable farming and innovative pest management solutions were evolved by the scientific team to combat such cyclonic storms in future.

Impact of the cyclone *Gaja* in coastal Tamil Nadu

The devastating cyclone *Gaja* had taken heavy toll on coconut palms in Tami Nadu by means of uprooting and dislodging about 31 lakh palms in the state. A team of


Dislodged coconut palms due to the cyclone Titli

scientists from ICAR-CPCRI visited the *Gaja* cyclone affected regions of Tamil Nadu during 20-22 November 2018 and surveyed the affected regions. Among the *Gaja* affected regions, coconut is predominantly cultivated in Thanjavur district and the loss incurred to the crop is also very high in the region. Juvenile palms were also twisted, became slanted by partial uprooting and crown twisted in many cases. Recommendations on removal of debris, caring of injured palms, raising of short duration pulses, vegetables, decentralized seedling production strategy, establishment of wind break system, scientific rejuvenation, wider spacing, crop insurance and pest management strategies were suggested by the team.

Scientists from ICAR-CPCRI interacting with cyclone affected farmers of Tamil Nadu

Cyclone affected tract in Thanjavur

Refresher course on 'Coconut Health Management'

ICAR-CPCRI, Regional Station, Kayamkulam organized a two days refresher course on 'Advances in Coconut Health Management' for the Technical Staff from Kasaragod, Kidu and Vittal during 6 – 7 July, 2018 as part of updating techniques in pest and disease management in coconut. Sixteen members participated in the training programme. Technical sessions on palm health management, laboratory and field visits were arranged for experiential learning. A special session exposing the trainees to e-kalpa was also conducted. A training and E-manual on '*Advances in Coconut Health Management'* was also released on the occasion.

Refresher course on coconut health management at ICAR-CPCRI, RS, Kayamkulam

Refresher course for the surveillance squad

A training cum refresher course on `Early detection and surveillance of pests and diseases in palms and cocoa with special emphasis on practical approaches for management' was conducted at ICAR-CPCRI, Kasaragod on 7th June 2018. Twenty five surveillance team members from ICAR-CPCRI, Kasaragod and ICAR-CPCRI, RS, Vittal attended the programme.

World Environment Day celebration

The World Environment Day was celebrated at ICAR-CPCRI on 6th June, 2018. Dr. P. Chowdappa, Director, ICAR-CPCRI, delivered a speech on the hazards caused by plastics, particularly single use plastics to the environment. Kokum and nutmeg seedlings were planted in the campus by the staff. An institute wide initiative was taken to make the campus a 'plastic free zone'. Kits with plantlets of curry leaf, annual moringa, tomato saplings, annona and ginger grass from the KVK, ICAR-CPCRI, Kasaragod were distributed to the staff.

Dr. P. Chowdappa, Director, ICAR-CPCRI planting seedlings in the campus

A seminar on 'Boost up coconut to beat out plastics' was held at ICAR-CPCRI, Regional Station, Kayamkulam on 20th June, 2018 with the aim of creating awareness among college students on the scope of utilizing coconut and its byproducts for replacing plastics. Thematic technical sessions on 'Safeguarding ecology for sustaining mankind', 'Replacing plastics through coconut byproducts', 'Boon and bane of plasticulture' and 'Motivation through social intelligence' were handled by experts. Competitions were conducted for college students on project presentation, quiz and exhibition.

Participants of World Environment Day programme at ICAR-CPCRI, RS, Kayamkulam

International Yoga Day

International Day of Yoga was observed in ICAR-Central Plantation Crops Research Institute on 21st June, 2018 at its headquarters (Kasaragod), Regional Stations (Kayamkulam and Vittal) and Research Centers (Kidu, Mohitnagar and Kahikuchi). At Kasaragod, demonstration-cum-practice of Yoga was organized for the staff. Dr. Ravi Bhat, Director i/c and Head (Crop Production) presided over the function. At Regional Station, Kayamkulam, a `Mass Demonstration Programme' was organized.

Staff at headquarters practicing Yoga

Independence Day

The Institute has celebrated 72nd Independence Day of our nation. Dr. P. Chowdappa, Director hoisted the National Flag and delivered the Independence Day address at Kasaragod. Independence Day was also celebrated in the Regional Stations at Kayamkulam and Vittal as well as Research Centres at Kahikuchi, Kidu and Mohitnagar.

Dr. P. Chowdappa, Director hoisting the national flag at ICAR-CPCRI, Kasaragod during Independence Day

World Soil Day celebrations

As part of the World Soil Day celebrations 2018, an interactive workshop on 'Be the solution to soil pollution' was conducted at ICAR-CPCRI, Regional Station, Kayamkulam on 5th December 2018. Soil health cards, indicating the soil nutrient status and nutritional management practices needed were distributed to farmers of Chettikulangara and Kandalloor panchayaths. A compilation of articles on 'Soil pollution management for sustainable crop production systems' was released on the occasion.

Science orientation training under 'Gifted Children Programme'

ICAR-CPCRI, Regional Station, Kayamkulam organized a science orientation cum training programme for students from Mavelikkara Education District under the 'Gifted Children Programme' of Government of Kerala on 3rdNovember, 2018. The programme included technical sessions followed by quiz competition as well as field and laboratory visits.

Tribute to Atal

A first monthly tribute to the former Prime Minister of India, Shri Atal Bihari Vajpayee was held on 15th September, 2018 at ICAR-CPCRI, Kasaragod. To mark the occasion, recital of poetries by the former Prime Minister was done by the staff of the institute.

Republic Day Celebration

Republic Day was observed in the headquarters, Regional Stations and Research Centres on

Atal Smaran programme held at ICAR-CPCRI, Kasaragod

26th January 2019. Dr. Anitha Karun, Acting Director, delivered the Republic Day speech at Kasaragod.

National Productivity Week

The National Productivity Week was inaugurated at ICAR-CPCRI, Kasaragod by Dr. Hari Kurup K.K, Head, Dept. of Economics, Govt. College, Kasaragod on 13th February, 2019. The programme was chaired by Dr. Anitha Karun, Acting Director, ICAR-CPCRI, who stressed the need for maintaining punctuality and dedication and thereby enhancing the work output.

Inaugural speech by Dr. Hari Kurup on 'Philosophy of Circular Economy'

Dr. Anitha Karun, Acting Director, ICAR-CPCRI, Kasaragod delivering Republic Day speech

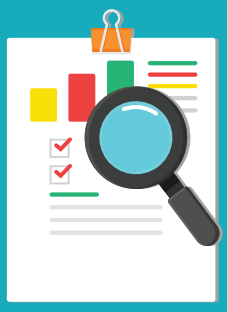
Dr. Hari Kurup delivered a lecture on 'Circular Economy for Productivity and Sustainability'. He explained how the topic is relevant in the Indian context, especially in the agricultural sector where the aspects of productivity, sustainability and circularity (cycles) play crucial roles. '

Infrastructure Development

A small dairy unit with a calf and an additional poultry unit have been established in the KVK Alappuzha farm, Kayamkulam. A new sales counter and a green house structure for storing planting materials have been established in the KVK farm.

Hi-tech green house with fan and pad cooling system was established with funding from the Directorate of Cashewnut and Cocoa Development (DCCD), Kochi at ICAR-CPCRI, RS, Vittal for production of quality planting material of cocoa.

Cocoa model nursery at Vittal



XXIII. Budget & Expenditure 2018-19

The Budget & Expenditure for the financial year 2018-19 in respect of ICAR-CPCRI, Kasaragod

(Figures in Rupees)

Budget Head	Plan	
	Budget	Expenditure
Revenue		
Estt. Charges	327295000	327214233
OTA		
Pension	287990000	287852620
TA	5775000	5729235
Research & Operational expenses	40145000	40129290
Works: Repair & Maintenance		
Office Buildings	7360000	7351530
Residential Buildings	6250000	6247120
Minor Works	6500000	6492888
Other Administrative Charges	49856000	49563927
Miscellaneous Expenses (including HRD)	3935000	3554032
Tribal Sub Plan - General		
Capital		
Equipments	1900000	1845439
Information Technology	230000	229839
Library	300000	299882
Furniture & Fixtures	136000	136500
Livestock		
Works	46000	45871
Minor Work	1959000	1959000
Tribal Sub Plan - Capital		
TOTAL	**739677000**	**738651406**

Other Projects	Opening Balance	Receipts	Expenditure	Refund
Other Plan Schemes	3793825	93581408	94487422	
Deposit Schemes (Externally funded)	57850523	38511931	39960162	3520686
KVK, Kasaragod	1059000	13929000	13248000	
KVK, Alappuzha	324000	18235000	17425000	
Revenue receipts -				
Head		**Target**	**Achievement**	
Income from sales/ services (schedule 8)		32766000	34148490	
Fee/Subscription (schedule 10)		595000	840000	
Income from Royalty, Publication etc. (schedule 12)		73000	6246	
Other Income			31389321	
STD Interest			3605806	
Recoveries on Loans & Advances			1279258	
TOTAL		**33434000**	**71269121**	

XXIV. Weather Data 2018-19

ICAR-CPCRI, Kasaragod

Month	Temp. (°C)		RH(%)		Wind velocity (km/h)	Sun shine (h)	Evapo ration (mm)	Rainfall (mm)	No.of rainy days
	Max.	Min.	FN	AN					
April 2018	33.4	24.0	73	64	2.4	7.5	4.2	105.2	5
May 2018	32.6	23.0	73	68	2.4	5.5	3.4	393.5	12
June 2018	28.8	22.5	76	80	3.2	1.5	1.8	1010.0	24
July 2018	29.2	22.4	78	78	2.6	1.8	2.0	703.2	30
Aug. 2018	29.8	22.1	69	76	1.8	2.2	2.1	597.8	26
Sept. 2018	30.7	21.5	66	72	1.7	7.8	3.3	034.0	3
Oct. 2018	32.2	21.6	67	64	1.8	6.9	3.2	130.4	5
Nov. 2018	33.0	21.5	68	60	1.7	7.9	3.3	38.4	3
Dec. 2018	32.3	20.5	69	60	1.5	6.2	2.8	2.4	1
Jan. 2019	32.4	17.5	59	57	2.0	9.0	3.6	0	0
Feb. 2019	32.6	20.0	67	56	2.3	9.4	4.0	0	0
Mar. 2019	32.9	21.7	68	60	2.5	8.6	4.4	0	0

ICAR-CPCRI, Regional Station, Kayamkulam

Month	Temp. (°C)		RH(%)		Wind velocity (km/h)	Sun shine (h)	Evapo ration (mm)	Rainfall (mm)	No.of rainy days
	Max	Min	FN	AN					
April 2018	33.7	24.9	92	62	1.7	8.1	3.9	105.9	6
May 2018	31.7	24.6	92	72	1.5	4.5	3.5	255.2	17
June 2018	30.0	24.0	94	79	1.6	3.5	3.2	591.3	27
July 2018	29.9	23.6	94	78	1.8	4.9	3.3	490.6	19
Aug. 2018	29.6	23.6	94	78	2.3	4.5	3.4	488.4	20
Sept. 2018	31.7	23.5	94	64	2.6	8.0	3.9	70.6	4
Oct. 2018	31.5	23.8	94	70	1.6	5.6	3.9	271.9	12
Nov. 2018	32.4	23.6	94	66	1.5	7.7	3.7	120.2	9
Dec. 2018	32.7	22.9	94	60	1.4	7.6	3.7	58.6	4
Jan. 2019	32.9	19.2	92	52	1.6	9.7	4.0	0	0
Feb. 2019	33.8	22.8	92	57	2.0	9.0	4.0	0	0
Mar. 2019	34.3	24.4	92	58	2.1	9.4	4.2	4.3	1

ICAR-CPCRI,
Regional Station, Vittal

Month	Temp. (°C)		RH (%)		Wind velocity (km/h)	Sun shine (h)	Evapo ration (mm)	Rainfall (mm)	No.of rainy days
	Max.	Min.	FN	AN					
April 2018	35.3	22.0	92.5	57.2	3.1	5.1	4.5	88.3	3
May 2018	33.6	22.7	93.9	62.6	3.3	3.2	3.7	334.1	9
June 2018	28.7	22.3	97.7	87.8	2.8	1.0	1.7	1216.3	24
July 2018	28.3	22.0	97.7	86.0	3.8	1.1	1.5	1149.4	28
Aug. 2018	28.3	20.9	97.7	84.5	4.0	1.5	1.7	858.5	29
Sept. 2018	32.0	21.5	95.1	63.7	2.5	6.5	3.4	51.8	5
Oct. 2018	33.4	21.9	93.8	59.6	2.0	6.4	3.1	258.4	10
Nov. 2018	34.3	21.4	92.0	49.5	2.1	6.8	3.5	84.6	2
Dec. 2018	33.4	20.4	94.2	50.2	1.8	6.0	2.9	0	0
Jan. 2019	33.6	16.1	93.8	36.3	2.2	7.6	3.3	0	0
Feb. 2019	35.2	19.5	93.8	38.9	2.6	7.9	4.2	0	0
Mar. 2019	35.6	21.2	92.5	46.8	3.2	7.1	4.8	0	0

ICAR-CPCRI,
Research Centre,
Kidu

Month	Temp. (°C)		RH (%)		Sun shine	Evapo ration	Rainfall	No.of rainy days
	Max.	Min.	FN	AN	(h)	(mm)	(mm)	
April 2018	36.1	23.9	97.0	49.0	7.4	2.9	150.8	12
May 2018	34.9	23.8	95.0	69.0	5.6	2.4	357.8	12
June 2018	29.2	23.1	97.9	90.4	1.3	1.2	1161.4	28
July 2018	28.2	22.9	98.3	93.3	0.7	0.9	1380.3	28
Aug. 2018	27.7	22.8	98.8	92.6	0.5	0.9	1707.2	31
Sept. 2018	33.1	22.6	95.0	60.5	6.6	2.4	165.3	8
Oct. 2018	34.2	21.9	94.2	58.6	6.9	2.1	284.8	14
Nov. 2018	34.8	20.7	92.8	50.6	7.8	2.2	17.8	2
Dec. 2018	34.0	19.9	90.5	45.5	7.5	1.9	6.6	2
Jan. 2019	34.5	15.2	90.8	34.2	9.3	2.2	0	0
Feb. 2019	36.5	19.6	93.2	31.6	9.0	2.8	8.4	1
Mar. 2019	37.5	22.2	91.5	38.2	8.2	3.5	0	0

XXV. राजभाषा कार्यान्वयन रिपोर्ट

भारत सरकार की राजभाषा नीति के अनुपालन के संबंध में राजभाषा विभाग द्वारा निर्धारित वार्षिक कार्यक्रम में उल्लिखित लक्ष्यों की पूर्ति और भारतीय कृषि अनुसंधान परिषद की ओर से जारी किए जा रहे राजभाषा कार्यान्वयन संबंधी दिशानिर्देशों के अनुसार राजभाषा कार्यान्वयन के सभी पहलुओं पर भरपूर प्रयास किया जाता है।

इस संस्थान में निदेशक महोदय की अध्यक्षता में गठित राजभाषा कार्यान्वयन समिति की बैठकें तिमाही की अवधि पर आयोजित की जाती है। इस समिति में राजभाषा विभाग के वार्षिक कार्यक्रम के अनुसार राजभाषा कार्यान्वयन प्रगति तथा भारतीय कृषि अनुसंधान परिषद के राजभाषा कार्यान्वयन से संबंधित सभी आदेशों के अनुपालन पर चर्चा एवं समीक्षा की जाती है। प्रत्येक बैठक के कार्यवृत्त की समीक्षा निदेशक (राजभाषा) भारतीय कृषि अनुसंधान परिषद की ओर से की जाती है और समीक्षा रिपोर्ट के अनुसार अगली बैठक में चर्चा कर निदेशक महोदय की अनुमति से पुष्टि की जाती है।

अधीनस्थ प्रादेशिक केंद्रों / अनुसंधान केंद्रों को समय-समय पर राजभाषा कार्यान्वयन समिति की बैठकों के आयोजन एवं राजभाषा कार्यान्वयन कार्य की ओर दिशा निर्देश दिया जाता है। और अधीनस्थ केंद्रों से प्राप्त राजभाषा कार्यान्वयन की प्रगति रिपोर्ट और बैठकों के कार्यवृत्तों की समीक्षा की जाती है। तदनुसार आवश्यक मार्ग निर्देश दिया जाता है।

राजभाषा अधिनियम 1963 धारा 3(3) का शत प्रतिशत किया जाता है कि मुख्यालय के विभिन्न अनुभागों द्वारा जारी किए जा रहे संविदा एवं निविदा प्रपत्रों, कार्यालय आदेश, नोट एवं परिपत्रों को द्विभाषीकरण कर अधिनियम का अनुपालन सुनिश्चित किया जाता है। प्रतिवेदनों का सारांश हिंदी में भी तैयार कर अधिनियम का अनुपालन शत प्रतिशत किया जाता है। तथा अधीनस्थ स्टेशनों/केंद्रों को इसपर मार्गदर्शन एवं सहायोग दिया जाता है।

राजभाषा नियम 1976 नियम 11 का अनुपालन हेतु संस्थान की ओर से आयोजित बैठकों के बैनर, प्रदर्शनी बोर्ड एवं संगोष्ठी का आमंत्रण पत्र द्विभाषा में प्रदर्शित कर शत प्रतिशत किया गया है।

राजभाषा नियम 1976 नियम 5 का अनुपालन शत प्रतिशत किया जाता है।

हिंदी में मूल पत्राचार बढ़ाने का प्रयास जारी है कि हिंदी आवरण पत्र के साथ सभी पत्र भेजा जा रहा है।

राजभाषा के प्रति जागरूकता पैदा कराने हेतु इस संस्थान में और अधीनस्थ प्रादेशिक केंद्रों और अनुसंधान केंद्रों में 14 सितंबर से हिंदी पखवाड़ा/चेतनामास समारोह विभिन्न प्रतियोगिताओ के साथ आयोजित की गई। उपर्युक्त अवधि में मुख्यालय में विभिन्न प्रतियोगिताएँ जैसे हिंदी टंकण, टिप्पणी एवं अनुवाद प्रतियोगिता, स्मरण परीक्षा, कविता‌पाठ, अन्ताक्षरी प्रतियोगिताएँ आयोजित कर हिंदी समारोह सफलतापूर्वक मनायी गई। हिंदी समारोह की अवधि पर आयोजित विभिन्न प्रतियोगिताएँ के विजेताओं का पुरस्कार वितरण किया।

सरकारी काम काज में हिंदी का अधिकाधिक प्रयोग किए गए 9 अधिकारियों एवं कर्मचारियों को राजभाषा विभाग द्वारा निर्धारित मानदण्डों के अनुसार प्रोत्साहन योजना के अधीन नकद पुरस्कार वितरित किए गए।

हिंदी चेतना मास समारोह की अवधि में केंद्रीय विद्यालय नं 1 सी पी सी आर आई के छात्रों के लिए निदेशक महोदय के निर्देशानुसार सातवीं कक्षा से दसवीं कक्षा के छात्रों के लिए दो समूहों में देशभक्ति गीत (एकल), कविता पाठ एवं कविता रचना प्रतियोगिताएँ आयोजित की गई। और छात्रों को पहला, दूसरा और तीसरा स्थान से पुरस्कृत किया गया।

संसदीय राजभाषा समिति की दूसरी उप समिति द्वारा प्रादेशिक केंद्र, कायम्कुलम का राजभाषा कार्यान्वयन संबंधी निरीक्षण पर दिए गए आश्वासनों पर अनुवर्ती कार्रवाई एवं पुष्टि उपर्युक्त अवधि पर की गई।

द्विभाषिक यांत्रिक सुविधा

राजभाषा नियम के अनुपालन हेतु कार्यालय में उपलब्ध सभी कंप्यूटरों में यूनिकोड की सुविधा प्रदान की गई है। समय-समय पर यूनिकोड की सक्रियता सुनिश्चित की जाती है। यूनिकोड का उपयोग बढ़ाने हेतु प्रशिक्षण कक्षाएँ आयोजित की जाती है।

वेबसाइट का प्रदर्शनः संस्थान वेबसाइट का प्रदर्शन अंशिक रूप से द्विभाषा में किया जाता है।

प्रशिक्षण कार्यक्रम

केंद्रीय हिंदी प्रशिक्षण संस्थान, राजभाषा विभाग, नई दिल्ली पत्राचार पाठ्यक्रम द्वारा प्रायोजित प्रबोध प्रशिक्षण के लिए नामित एक अधिकारी ने उत्तीर्ण की है।

विशेष कार्य

- अध्यक्ष, नगर राजभाषा कार्यान्वयन समिति, कण्णूर के अनुरोध पर कण्णूर समिति की 57 वीं अर्धवार्षिक बैठक (29.06.2018) का संचालन इस संस्थान का मुख्य तकनीकी अधिकारी (राजभाषा) एवं सदस्या सचिव, नराकास, कासरगोड़ द्वारा किया गया।
- भाकृअनुप केंरोफअसं, क्षेत्रीय केंद्र, विट्ल का राजभाषा कार्यान्वयन का निरीक्षण दिनांक 20.07.2018 में किया गया और केंद्र के प्रमुख की अध्यक्षता में राजभाषा कार्यान्वयन समिति बैठक बुलाकर निरीक्षण के दौरान पायी गयी कमियों पर चर्चा की/ विवरण दिया, और सुधारने का मार्गदर्शन दिया गया।

दिनांक 20.07.2018 अपराह्न में क्षेत्रीय केंद्र, विट्ल के प्रशासनिक एवं तकनीकी कर्मचारियों के लिए राजभाषा अधिनियम 1963 धारा 3(3) की अनिवार्यता और राजभाषा नियम 1976 का अनुपालन के दायित्व पर कक्षा आयोजित की गई।

नगर राजभाषा कार्यान्वयन समिति, कासरगोड़

कासरगोड़ नगर में स्थित केंद्रीय सरकार के कार्यालय, उपक्रम, बैंक सहित 36 सदस्य कार्यालय सम्मिलित नगर राजभाषा कार्यान्वयन समिति, कासरगोड़ की बत्तीससवीं अर्धवार्षिक बैठक दिनांक 08 अगस्त 2018 को इस संस्थान के कार्यकारी निदेशक महोदय की अध्यक्षता में आयोजित की गई। केरल केंद्रीय विश्वविद्यालय की ओर से मार्च 11-12, 2019 को छात्रों के लिए आयोजित 'साहित्य के विविध विमर्श' राष्ट्रीय संगोष्ठी में छात्रों द्वारा प्रस्तुत उत्तम शोध लेख के लिए नगर राजभाषा कार्यान्वयन समिति की ओर से शील्ड प्रदान किया गया।

हिंदी कार्यशाला

श्री अरविन्दाक्षन, वरिष्ठ हिंदी अधिकारी, कर्मचारी भविष्यि निधि संगठन, कण्णूर के मार्गदर्शन में दिनांक 08 अगस्त 2018 राजभाषा नीति, अधिनियम और नियम पर अभिमुखीकरण कार्यक्रम के रूप में संयुक्त हिंदी कार्यशाला आयोजित की गई। जिसमें नराकास, कासरगोड़ के सदस्य कार्यालयों के अधिकारीगण एवं केंरोफअसं के वरिष्ठ अधिकारियों ने भाग लिया। प्रत्येक तिमाही की अवधि में प्रशासनिक कर्मचारियों के लिए हिंदी टिप्पण लेखन /पत्राचार/ यूनिकोड के उपयोग पर कार्यशाला के रूप में डेस्क टू डेस्क मार्गदर्शन दिया जाता है।

संस्थान के निम्नलिखित प्रतिवेदनों का सारांश हिंदी में अनुवाद किया

1. केंद्रीय रोपण फसल अनुसंधान संस्थान, वार्षिक रिपोर्ट सारांश (वर्ष 2017-2018)
2. अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना, वार्षिक रिपोर्ट सारांश एवं प्रस्तावना (वर्ष 2017-2018)

मुख्यालय के और अधीनस्थ प्रादेशिक केंद्रों तथा अनुसंधान केंद्रों के सभी वैज्ञानिक, अधिकारी एवं कर्मचारी अपने सरकारी कामकाज में राजभाषा हिंदी के प्रयोग के लिए अपनी प्रतिबद्धता दोहराने का भरपूर प्रयास किया जाता है।

भाकृअनुप
ICAR

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

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