2020

वार्षिक प्रतिवेदन
ANNUAL REPORT

भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़

ICAR- Central Plantation Crops Research Institute, Kasaragod

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भा.कृ.अ.प.-केन्द्रीय रोपण फसल अनुसंधान संस्थान
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आमुख

मैं अत्यंत खुशी के साथ भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान की वर्ष 2020 की अनुसंधान उपलब्धियॉं और विस्तार गतिविधियॉं प्रस्तुत कर रही हूँ। यह वर्ष भारत सरकार द्वारा किए गए कृषि परिष्कार जैसे नए पहल, निवेश और तात्पर्य बर्हिवर्तन का वर्ष है। लॉकडाउन अवधि में यथावत आर्थिक स्थिती से कृषि क्षेत्र उल्लेखनीय वृद्धि दर **3%** से ऊपर के साथ रीबांउड किया है। नारियल, सुपारी और कोको का पण्य मूल्य लॉकडाउन अवधि के बाद बढ़ने की अवस्था तक पहुँच गया है। तथापि, लॉकडाउन अवधि में इन फसलों में 6,00,000 लाख रुपए से अधिक आर्थिक नाश आंकलित किया गया है।

वर्ष **2020** की अत्यंत महत्वपूर्ण उपलब्धी यह रही कि लॉकडाउन की अवधि में कम स्टाफ के साथ प्रक्षेत्र जीन बैंक और परीक्षणी प्रक्षेत्रों का अनुरक्षण किया गया। इन कोविड योद्धाओं का प्रयास प्रशंसनीय है। डॉ त्रिलोचन महापात्र, सचिव (डेयर), महानिदेशक भाकृअनुप और डॉ आनन्द कुमार सिंह, उप महानिदेशक (बागवानी विज्ञान) उनके लगाव और मार्गदर्शन के लिए अत्यंत कृतघ्न हैं कि उन्होंने बार बार परिस्थिति के बारे में और विशेष रूप से स्टाफ सदस्यों के स्वास्थ्य पर पूछताछ की।

हमारे सहयोगियों में डॉ. एम. सेंथिल अमुथन को दिनांक 24 जुलाई 2020 को कोविड-19 संक्रमण से दिवंगत हुए। गहरी संवेदना के साथ उनकी आत्मा की शांती के लिए प्रार्थना करते हैं।

यात्रा प्रतिबंधों के बावजूद वीडियो सम्मेलन से पंचवर्षीय पुनरीक्षण समिति बैठक, अनुसंधान सलाहकार समिति बैठक, संस्थान परिषद बैठक आदि का आयोजन पूरा किया जा सका। सभी समिति के सदस्यों को इस संबंध में सहयोग के लिए धन्यवाद।

वर्ष 2020 में अनुसंधान क्षेत्र में संस्थान द्वारा अनेक महत्वपूर्ण उपलब्धियॉं अर्जित की गई। नारियल का पूर्ण जीनोम अनुक्रमण (प्रजाति चौघाट हरा बौना) का टिप्पण लिखा गया और प्रकाशन किया गया। नारियल पुष्प ऊत संवर्द्धन पौध का प्रक्षेत्र रोपण अनुसंधान केंद्र, कायम्कुलम में किया गया। रोपाई सामग्रियों का वितरण बिना रोक संस्थान द्वारा किया गया; इस वर्ष संस्थान द्वारा 145,459 नारियल, 655,795 सुपारी और 62,626 कोको का वितरण किया गया। लाल ताड़ घुन को पहले ही पहचानने के लिए ध्वनिक-आधारित एक साधन विकसित किया गया जो कीट प्रबंधन में एक मुख्य सुविधा युक्त साधन है।

संस्थान की प्रौद्योगिकियों पर जागरूकता पैदा करने के लिए अनेक नूतन कार्यक्रमों का आयोजन किया गया। एक बृहत कार्यक्रम 'ग्रामीण भारत व्यवसाय कॉनक्लेव' दिनांक 27 फरवरी से 3 मार्च 2020 तक आयोजित किया गया। इस कार्यक्रम के भाग के रूप में आयोजित 'अग्रिटेक हैकेथोन' अपूर्व था।

'आत्मनिर्भर भारत' और कृषि परिष्कारों की घोषणा के बाद, संस्थान द्वारा कृषक समुदाय को संवेदनशील बनाने के लिए अनेक कार्यक्रम आयोजित किए गए। इस वर्ष प्रौद्योगिकियों के हस्तांतरण के लिए 17 समझौतों पर हस्ताक्षर हुए।

सहायक महानिदेशक (बागवानी विज्ञान), डॉ बी के पाण्डे और डॉ.वी. एस पाण्डे तथा अन्य एस एम डी के स्टाफ द्वारा प्राप्त मदद के लिए आभार प्रकट करते हैं। इस वार्षिक रिपोर्ट की तैयारी के लिए संपादकीय बोर्ड का प्रयास सराहनीय है।

अनिता करुण

कासरगोड़
25.01.2021

Preface

I am extremely happy to present research achievements and extension activities of ICAR-Central Plantation Crops Research Institute for the year 2020. The year will be referred for the agriculture reforms rolled out by the Government of India that brought many new initiatives, investments and implications. From a stand still economy in the lockdown period, the agriculture sector has rebound with an impressive growth rate of over 3%. The commodity prices of coconut, arecanut and cocoa have shown an increasing trend in the post lockdown period. However, during the lockdown period, these sectors suffered with an economic loss of over 60,000 million rupees.

The most notable achievement of the Institute in the year 2020 was that it could maintain its field gene banks and experimental fields during the lockdown period by deploying only limited number of staff. The efforts of these Covid-warriors are praise worthy. It is my duty to place on record the concern of by Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR and Dr. Anand Kumar Singh, Deputy Director General (Horticultural Science) on Institute activities, health of staff in particular during these difficult days. They interacted very frequently on these issues and guided us.

It is with great sadness let me mentioned here the untimely demise of our colleague Dr. M. Senthil Amudhan (50 years) who succumbed to Covid-19 on 24 July 2020. His contribution in the field of arecanut biochemistry will be remembered forever.

Despite the travel restrictions, we could complete our Quinquennial Review, Research Advisory Committee meeting and Institute Research Committee meeting through videoconferencing. I thank all committee members for their cooperation in this regard, especially to Dr. B.M.C. Reddy, Former Vice Chancellor, Dr. YSR Horticultural University and Chairman, QRT and Dr. S.P. Ghosh, Former Deputy Director General (Horticultural Science), ICAR and Chairman, RAC.

The Institute has made several breakthroughs in the research front during 2020. The whole-genome sequencing of coconut (*var*. Chowghat Green Dwarf) was annotated and published. The coconut inflorescence tissue culture plants were field planted in the Research Station, Kayamkulam. In this year too, distribution of planting material from the Institute was done uninterruptedly; the number of units distributed in coconut, arecanut and cocoa in the year were respectively 145,459; 655,795; and 62,626 units. The development of an acoustic-based device for early detection of red palm weevil will be an important milestone in pest management.

Several innovative programmes were conducted for bringing awareness about Institute technologies. A mega event 'Rural India Business Conclave' was organized during 27 February to 3 March 2020. The Agri-Tech Hackathon held as part of this programme was unique. Following the announcement of 'Atmanirbhar Bharat' and agriculture reforms, the Institute conducted several programmes for sensitizing the farming communities. During the year 19 MoAs were signed for technology transfer.

The support we received from Assistant Director Generals (Horticultural Science) Dr. B. K. Pandey and Dr. V. S. Pandey and other staff of SMD is acknowledged here with thanks. The efforts of the editorial board for the preparation of this annual report are being appreciated.

Kasaragod
25-01-2021

Anitha Karun

कार्य सारांश

कोविड़-19 महामारी के कठिन समय में, अनुसंधान गतिविधियॉं, संस्थान फार्म कार्य आगे ले जाने में अत्यन्त चुनौतीपूर्ण रहा और किसानों ने रोग आशंकाओं को पार करने के प्रति निष्ठा रखी। यह एक कड़ा वर्ष था कि हितधारियों के कल्याण के लिए और उस कठिन समय को पार करने के लिए अधिक कुशलता, ध्यान और परानुभूति की आवश्यकता थी। संस्थान की कुल उपलब्धियों को कुल मिलाकर समझने के लिए समस्त गतिविधियॉं और रोपण क्षेत्र पर आश्रित कृषक समुदाय की आवश्यकताओं को चुकाने का अथक प्रयत्न संक्षेप में यहाँ प्रस्तुत है। बाहरी निधि प्रदत्त 31 परियोजनाओं सहित कुल 51 परियोजनाएँ इस अवधि में चालू रहीं।

पादप आनुवंशिक संसाधन

भाकृअनुप - केंरोफअसं नारियल, सुपारी और कोको जननद्रव्यों के संग्रहण पर अधिदेशित है। यहॉं मुख्य फसलों का सबसे बड़ा प्रक्षेत्र जीन बैंक, जिसमें 455 नारियल, 181 सुपारी और 515 कोको प्रजातियों का अनुरक्षण किया जाता है। इस वर्ष सुपारी के तीन जननद्रव्य संग्रहण भी शामिल किए गए हैं।

आनुवंशिक संसाधनों के अनुरक्षण के लिए 29, 15 और 13 जातियों के अण्ड भ्रूणों का प्रशीत परिरक्षण, पराग और से डी एन ए नमूने संग्रहण भाकृअनुप- एन बी पी जी आर, नई दिल्ली के सहयोग किया गया है।

फसल सुधार, उपज और अन्य विशेषताएँ

संस्थान के संगठित दीर्घ कालिक प्रजनन प्रयास नारियल, सुपारी और कोको प्रजातियों की उच्च उपज प्रदान करने वाली अनेक जातियों के विमोचन में परिणित हुआ।नारियल प्रजातियों में 15 मूल्यांकन परीक्षण, सुपारी जातियों के साथ 9 परीक्षण और कोको में 7 परीक्षण किया गया। उपज और अन्य विशेषताओं के साथ अन्य मूल्यांकन के लिए 9 विदेशी प्रजाति, 17 देशी प्रजातियों को पहचान लिया गया। उत्तर हिमालयी तराई क्षेत्रों में नारियल मूल्यांकन से बारी नारिकेल 1 से वार्षिक उच्चतम गुठली उपज 110 गुठली प्रति ताड़ प्राप्त की गयी। असम में केरा संकरा (डब्ल्यु सी टी x सी ओ डी) से अधिक गुठली उपज (96 गुठली/ताड़/वर्ष) प्राप्त की गयी। तेल मात्रा के लिए परीक्षित 28 प्रजातियों में पश्चिम तट लंबी से उच्चतम तेल मात्रा 70.9 प्रतिशत और साम्बवा ग्रीन लंबी से 69.4 प्रतिशत प्राप्त किया गया।

हाल ही में विमोचित नारियल प्रजाति कल्पा हरिता में एरियोफिड कीट का लक्षण कम (7%) पाया गया लेकिन एफ एम एस टी और एफजेटी सुभूद्य (88%) पायी गयी।

नारियल के लिए परिशोधित तल परागण विधि का परीक्षण किया गया और कुल उत्पादित मादा फूलों के 11.5-14.7 प्रतिशत परागण में सफलता पायी गयी। कुल 1,45,459 नारियल रोपाई सामग्री 6,55,795 सुपारी, 62,626 कोको रोपाई सामग्री का उत्पादन किया गया और वितरण किया गया और 2.75 करोड़ रुपए की आमदनी प्राप्त हुई। इसके अतिरिक्त केरल के 12 जिलों में नारियल की खेती के लिए कुल 32 सामुदायिक नर्सरियों से 19,488 नारियल बौनी पौधों का उत्पादन किया गया।

जैव प्रौद्योगिकीय अन्वेषण

जैव प्रौद्योगिकी के क्षेत्र में दो प्रमुख उपलब्धियॉं इस वर्ष रिपोर्ट की गई है। नारियल के अप्रौढ़ फूल से उत्पादित ऊत संवर्द्धित पौध, जिसकी प्रक्षेत्र रोपाई श्री मुरलिधरन, माननीय राज्य मंत्री, संसदीय और विदेशी मामला, भारत सरकार ने की। दूसरा चौघाट हरा बौनी जाति का जीनोम अनुक्रमण है। जीनोम डाटा का एनोटेशन का परिणाम 13707 जीन 11,181 प्रोटिन के लिए कॉड कॉड करवी हैं। इनमें आर एन ए अनुक्रम डाटा पर आधारित अनुलेखन स्तर गवाह 6828 प्रेडिक्ठड जीन के लिए एकत्र किया गया। न्यूक्लिटोइड बैंडिंग और ल्यूसिने रिच रिपीट लोसी 112 था जो छह वर्ग का है। सुपारी का

कांच में पुनरुत्पादन नयाचार के प्रयोग में वीटीएलएएच 2 प्रजाति के एकल अप्रौढ़ फूल से लगभग1000 समजातिय भ्रूण प्राप्त किए गए

फसलन पद्धति और संसाधन प्रबंधन

फसलन पद्धति मॉडल में निवेश इष्टतमीकरण पर प्रक्षेत्र परीक्षण से यह देखा गया कि जैविक पुन:चक्रमण से महत्वपूर्ण रूप से लगातार उत्पादन प्राप्त किया जा सकता है । फसल उत्पादन के विषय में नारियल, नारियल ताड़ारोही काली मिर्च, नारियल के अंतर स्थलों में प्लोट की सीमाओं में केला, चारा घास (संकर बाजरा नैपियर सी ओ 5) डेयरी एकक और मुर्गी पालन से कुल 6,53,385/-रुपए प्रति वर्ष सकल आय प्राप्त किया जा सकता है। कुछ नए फसल, मूंगफली और चीकू का परीक्षण इस पद्धति के अधीन किया गया कि उसका निष्पादन अच्छा पाया गया।

मोहितनगर में सुपारी के अधीन के फसलन पद्धति में तरकारी, आर्किड और पान पत्ता भी सम्मिलित किया गया। सुपारी के अधीन सघन रोपाई (3712 पौध / हेक्टर) के लिए भाकृअनुप-केरोफअसं से विमोचित कोको प्रजाति नेत्रा सेंटुरा उचित पायी गयी।

काहिकुची में सुपारी में समीकृत कीट प्रबंधन में वर्मीकंपोस्ट 2/3 उर्वरक 1/3 के प्रयोग से उच्चतम चाली उपज 2.34 कि. ग्रा प्रति ताड़ प्रति वर्ष प्राप्त की गयी। कर्नाटक में श्रृंगेरी, (सुल्लिया) में सुपारी के पीला पत्ता रोग पर प्रबंधन परीक्षण में सुपारी छिल्के के साथ प्लास्टिक मल्चिंग करने से रोग तीव्रता कम करने में सहायक देखा गया।

कोको फली छिल्के के पाईरोलिसिस और इसके बाद बायोचार बनाना प्रक्रिया पर प्रयास किया गया। परिणामी कोको बायोचार मिश्रित कम्पोस्ट का प्रयोग तरकारियों मे किया गया और उपज निर्धारण किया जा रहा है।

बेसिलस मूल एन्टोफाइटिक पौध वृद्धि सुधारक राईज़ोबैक्टीरिया नारियल पौध के बायोप्राइमिंग के लिए उचित है जो नर्सरी प्रयोग के लिए उचित पाया गया और वह प्रक्षेत्र मूल्यांकन के अधीन है।

दो फिल्लोप्लेन एक्टिनो जीवाणुवीय एकलन सीपी1ए1 और सीपी1ए4 जिसमे पत्ता सड़न रोग कारक विरोधी क्षमता है, जिसे नारियल में रोग प्रबंधन के लिए विचारित।

रोग का समीकृत प्रबंधन

समीकृत रोग प्रबंधन के अनुसार *लासियोडिप्लोडिया* जाति एक उभड़ता रोगजनक है जो नारियल का पत्ता चित्ती रोग और चारकॉल फली सड़न और कोको शीर्षारंभीक्षय चित्ती रोग के समान नारियल एवं कोको में तीक्ष्ण रोग कारक है। नारियल के कवक रोग के विरुद्ध प्रतिकूल कवकानी का मूल्यांकन किया गया और उचित सूक्षमाणुओं का प्रक्षेत्र परीक्षण किया गया। निश्चित फफूंदनाशियों की आपेक्षा सुपारी के फूल शीर्षारंभीक्षय के लिए 25% ईसी प्रापिकोनज़ोल सिफारिश किया जाता है।

अरिका ट्रायन्ड्रा में *फाईटोफ्थोरा पाल्मिवोरा* का संक्रमण पहली बार रिपोर्ट किया गया।

बहुकोशक अनुक्रमण और ट्रान्सलेशन इलोंगेशन फाक्टर, राइबोज़ोमल प्रोटिन, Sec Y और ऐंटिजेनिक मेम्बरेन प्रोटिन जीन्स द्वारा नारियल का घातक मुर्झा रोग के साथ फाइटोप्लाज़्मा का गुणावगुणन विस्तार रूप से सूक्ष्माणुवीय गुणावगुणन अध्ययन किया गया।

कीट एवं सूत्रकृमियों का समीकृत प्रबंधन

कीटों के उत्तम प्रबंधन के लिए निगरानी के अलावा प्रौद्योगिकी परिष्कार किया गया।

ओरिक्टस राईनोसेरस नुड़िवाइरस प्रतिरोध हाप्लोटाइप की अनुपस्थिति दर्शाते विभिन्न भागों से संग्रहित नारियल राईनोसेरस भृंग का साइटोक्रोम ऑक्सिडेस जीन का आम्प्लिफाइड क्षेत्र में *MseI* प्रतिबंध स्थल का विश्लेषण किया गया।

आर्टिफिशल इंटेलिजेंस का उपयोग कर लाल ताड़ घुन का पता लगाने की विधि का विकास किया गया जिसमें नारियल बाग के इस कीट को पहचानने में 80% सटीकता है।

प्रक्षेत्र परीक्षण में रुगोस सर्पिल सफेद मच्छर के जैव धमन पर जैवयौक्तिक की प्रभाविकता का परीक्षण किया गया। तथापि सबूत के साथ यह सिद्ध किया गया कि जैविक नियंत्रण संरक्षण अधिक सफल है कि प्राकृतिक जीवसंख्या की वृद्धि कर और युहें पुनस्थापित कर कीट जीवसंख्या को कम किया जा सकता है।

सुपारी में विदेशीगत सफेद मच्छर कांप्लेक्स *पारालेयरोड्स बोन्डारी* पेराच्छी और *पारालेयरोडूस्मिनेइ लासियारिनो* आक्रमणकारी रुगोस सर्पिल सफेद मच्छर *अल्यूरोडिकस रूजियोपरक्यूलेटस* मार्टिन और देशी सुपारी मच्छर *अल्यूरोकेन्थस अरीकि* डेविड और मंजुनाथा ने कर्नाटक में किया। कोको में काष्ठ वेधक राफिपोडुस्सुबोपकस का निरीक्षण गहन 1890 (*कोलियोपेटरा: सेरमबैसिडे: प्रियोनिनेइ*) कर्नाटक में पहली बार रिपोर्ट की गई।

'कल्पा इपीएन' (सीपीसीआरआई –एससी1) का जल संरूप, 2500 आईजेएस निहित 50 मि.ली दर में *स्टेनेरनेमा कारपोकाप्से* घोल पत्ता नाली में और 4 और 8 दिन वय सूत्रकृमि संक्रमित गल्लेरिया कडवेर्स *स्टेनेरनेमा कारपोकाप्से* और *हेटेरोराब्टिडिस इंडिका*

सीपीसीआर आई- एच11 1 कडवेर प्रति पत्ता झुर्री में दो हफ्ते के अंतराल में प्रयोग से 4 महीने का केला स्यूडोस्टेम भृंग को धमन करने में प्रभावी पायी गयी। पूर्व कीट संक्रमण पहचान और ईपीएन विमोचन कीट धमन में महत्वपूर्ण है।

कीटरोग जनक सूत्रकृमि *स्टेनेरनेमा* जाति सीपीसीआरआई एस 0804 का काप्स्यूल रूप का विकास किया गया जो नारियल बाग में लाल ताड़ घुन के नियंत्रण के लिए पहचान लिया गया है, मानकीकरण किया गया ।

पादप शरीर क्रिया विज्ञान, जैव रसायन और मूल्य श्रृंखला प्रबंधन

माक्स एंटमोडल का उपयोग कर आरसीपी 8.5 के साथ 2070 में नारियल और सुपारी की सुभेद्यता निर्धारण किया गया। आवश्यक सिंचाई सुविधा लभ्यता नहीं प्रदान करने से वर्तमान के नारियल और सुपारी वर्द्धित क्षेत्रों के बडे विस्तृत सीमा अनुपयुक्त हो जाएगा।

हाइड्रोपोनिक से वर्द्धित मलयन हरा बौनी नारियल पौध 10 प्रतिशत तक समुद्र जल प्रतिस्थापन के लिए सहनशील है।

पानी की कमी तनाव के अधीन (मृदा आद्रता की लभ्यता की 25%) और नियंत्रण के अधीन नारियल पौध का विश्लेषण दो प्रजातियों में (प्रजाति कल्पश्री और कल्पतरु) किया गया।

स्ट्रेप्टोज़ोटोसिन पाडित प्रेरित मधुमेह विस्तार राट मॉडल में नारियल शक्कर का मौखिक प्रयोग पर अन्वेषण किया गया। मधुमेह पाडित चूहे में नारियल ताड़ शक्कर के प्रयोग से शरीर भार में कमी देखी गयी।

निम्नलिखत के लिए वर्ष 2020 में प्रक्रमण/ पैकेजिंग नयाचार का मानकीकरण किया गया।

1. लघु संसाधित नारियल चूरा 2. नारियल दूघ पेडा 3. शक्कर निस्सारित, रसाकर्षक निर्जलीकृत नारियल चिप्स 4. सूखा नारियल दूध चूर्ण फॉममाट तैयार किया गया। सूखा नारियल में वसा मात्रा खोजने के लिए ताप विसरण विधि उपयोग किया गया।

विकसित गेजेट्स और यंत्र 1. स्वचालित नारियल कटाई यंत्र 2. बेदाग इस्पात पात्र के साथ संशोधित कल्परस संग्रहण 3. ट्राक्टर यंत्र चालित एयर ब्लास्ट फुहारक 4. स्वयं नोदित एयर ब्लास्ट फुहारक।

प्रौद्योगिकी हस्तांतरण, आर्थिकी और सॉख्यिकीय विधि

देशव्यापी लॉकडाऊन के पहले 58 प्रशिक्षण कार्यक्रम आयोजित किया गया, इसका लाभ 2197 किसानों ने उठाया। लगभग 15 विभिन्न ऑनलाइन प्रशिक्षण कार्यक्रमों का लाभ पंजीकरण द्वारा और अन्य दर्शकों के रूप में 3300 से अधिक किसानों को प्राप्त हुआ। आत्मनिर्भर कृषि के अधीन जब भारत सरकार ने कृषि परिष्कार का उल्लेखन किया, उच्चतम प्रतिभागिता उस कार्यक्रम में देखी गयी। दिनांक 14-17 सितंबर को आयोजित बहु भाषी कार्यक्रम में एक ही समय 2500 से अधिक किसानों ने भाग लिया था।

संस्थान की ओर से आयोजित मुख्य प्रदर्शनी कार्यक्रमों में 1. नारियल की मृदा संबंधित समस्याओं को कम करने के लिए उत्तम प्रबंधन पद्धति 2.पालघाट जिला जेल में पॉच विमोचित प्रजातियों की बीज बाग की स्थापना 3.सुपारी बौनी संकर (दो प्लॉट) और सुपारी आधारित बहुजातिय फसलन पद्धति (4 प्लॉट)।

जनजातिय विशेष कार्यक्रम (एससीएसपी) के अधीन पॉच राज्य के छह जिलों के 329 किसानों को रोपाई सामग्री जैसे नारियल कोको सुपारी काली मिर्च फल फसल मधुमक्खी पालन, मुर्गीखाना और सुअर, और ताड़ारोहण सामग्री प्रदान किया गया। कासरगोड़ के 22 अनुसूचित जनजाति युवकों के लिए नारियल मूल्य वर्द्धन पर दो औद्योगिक प्रशिक्षण कार्यक्रम आयोजित किए गए।

समीकृत जनजाति विकास एजेंसी, पदेरु,आन्ध्रप्रदेश के सहयोग से अनुसूचित जनजाति समिति गतिविधियॉ आयोजित की गई। नारियल पौध, काजू ग्राफ्ट, बुश काली मिर्च और मधुमक्खीपालन बॉक्स का 335 परिवारों को वितरण किया गया। 'कोको खेती और संसाधन' पर एक इडीपी और काजू खेती पर एक दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया गया।

किसानों की आय सुधारने के लक्ष्य से प्रौद्योगिकी अपनाने का एक सामाजिक प्रक्रिया सम्मिलित 'फार्मर फस्ट' कार्यक्रम के अधीन 1000 किसान परिवारों से स्वयं सहायक समूह की 64 महिलाएँ,15 नारियल उत्पादक सोसाईटी, जनप्रतिनिधियों का 19 वार्ड समिति, एक नारियल उत्पादन कम्पनी लिमिटेड, और कृषि विभाग और भाकृअनुप संस्थान/राज्य कृषि विश्वविद्यालय और गैरसरकारी संगठन के साथ प्रभावी संपर्क के साथ 10 माईक्रो उद्यमकर्ता एकक ने भाग लिया। कंदमूल, तिल, बाजरा, हल्दी, चाराघास, दाल आदि की खेती 378 हेक्टर क्षेत्रफल में किया गया और 512 प्रतिशत उत्पादन बढाया गया। माईक्रो उद्यमकर्ता एकक की ओर से 6.8 टन केरा प्रोबायो, 3 टन कल्पा वर्द्धिनी और नारियल और हल्दी मूल्य वर्द्धन के अतिरिक्त 6000 नारियल पौधों का उत्पादन किया गया।इन सामग्रियों के विपणन की सुविधा प्रदान करने के लिए 'वोकल फॉर लोकल' पहल एफएफपी मार्ट शुरु किया गया।इसमें एफ एफ पी के अधीन एफपीओ 'आडनाडु फार्मरउत्पादक कम्पनी लि.' का उत्पादन भी है। वर्ष 2019 के अध्ययन के नमूना अध्ययन के आधार पर मध्यवर्ती की स्वीकार्यता से 24 प्रतिशत भगीदारी

किसानों ने अपनी आय दुगुनी कि। 37.5 प्रतिशत ने अपनी आय एफ एफ पी के पूर्व की तुलना में 1.5 से 2 गुना के बीच बढ़ाई।

आलप्पुषा जिला में जलवायु परिवर्तन के संबंध में स्वीकार्यता कमी के बहुआयामी विश्लेषण से यह देखा गया कि नारियल के अधीन अंतरफसलों का साल भर की खेती में निम्नलिखित दबाव है। बीच बीच में जल प्लावन, लघु अवधि के लिए आवधिक बाढ़, मानसून के समय नमक पानी जलमग्नता और जल न्यूनता और गर्मी के दिनों में लवणता।

डि-मल्टिप्लेक्स मेटाजिनॉम डाटा से फंकशनल मेटाजिनॉमिक कन्टेंट अनुमान के लिए R में अलगोरिदम विकसित किया गया। यह डोनट डायग्रम जैसे उच्च गुण ग्राफ उत्पन्न करने में, बॉक्स प्लॉट के लिए दण्ड आरेख, समर्थ है। फंकशनल मेटाबॉलिक पाथवेयपैंकिंग और फंकशनल मेटाबॉलिक एनजाइम सर्कल सनबरस्ट डायग्रम के लिए समर्थ है। नारियल उत्पादन क्षमता में जियोस्पेशियल भू-स्थानिक परिवर्तन चार जिले से संग्रहित प्राइमरी डाटा पर आधारित विश्लेषण केरल में किया गया। परिणाम से यह देखा गया कि उचित प्रौद्योगिकी अपनाने से उच्च उपज प्राप्ति, मृदा पोषण कमी सुधार किया जा सकता है।

रोपण फसल पर कोविड़-19 महामारी और फलस्वरूप लॉकडाउन के प्रभाव पर एक अन्वेषणात्मक विश्लेषण से घरेलू और वैश्विक मूल्य श्रृंखला में भंग देखा गया। नारियल उत्पादन में आकलित नाश 231900 लाख रुपए और संसाधन क्षेत्रमें 25,7700 लाख रुपए था। कायर क्षेत्र में 43540 लाख रुपए का नाश भी होगा। सुपारी उत्पादन में 18000 लाख और कोको में 290 लाख आकलित किया गया। नारियल, सुपारी और कोको निर्यात राजस्व में 54070 लाख आकलित किया गया।

केरल में नीरा उत्पादन और विपणन में कार्यरत 95 नारियल उत्पादन फेडरेशन की भागीदारी के साथ आयोजित अध्ययन से नीरा क्षेत्र चुस्त बनाने के लिए रुपरेखा का परिष्कार किया गया। नीरा मूल्य श्रृंखला विकसन अवस्था में और नारियल विकास बोर्ड के संस्थानीय सहारे की वापसी उद्यम में सम्मिलित सीपीएफ का आत्मधैर्य अहितकारक ढंग से प्रभावित देखा गया।

'एक कोम्पोसिशन डिवाइज या एक ट्राप और उसकी तरीका' खोज के लिए उन्नत वैज्ञानिक अनुसंधान के लिए जवाहरलाल नेहुरू केंद्र, बैंगलूर और भारतीय कृषि अनुसंधान परिषद (केंरोफअस) ने राष्ट्रीय पेटेंट प्राप्त किया गया। इस वर्ष दो पेटेंट फाइल किया गया है। 1. फाम मेट सूखा नारियल दूध चूर्ण के लिए संसाधन नयाचार 2. डाब के लिए लघुतम संसाधन आधारित लंबीय यांत्रिक भुजाधारक यंत्र (30543/2020–CHE) खारह प्रौद्योगिकियों की जानकारी के लिए प्रौद्योगिकी हस्तांतरण के लिए 17 समझौता ज्ञापन पर हस्ताक्षर हुए और 2,87,000 रुपए राजस्व लाभ प्राप्त हुआ।

मांग आधार पर गुणी प्रौद्योगिकी उत्पाद के वितरण द्वारा 207.47 लाख रुपए राजस्व प्राप्त किया गया।

कल्पा कृषि व्यापार इन्क्युबेटर के अधीन 10 नई इन्क्युबेटीस ने प्रवेश किया और वर्ष 2020 में 8 स्नातक हुआ। 12 उद्यमकर्ताओं ने उनका व्यपार शुरु किया गया। नौ ईडीपी आयोजित किया गया जिसमें कोको संसाधन पर दो और नारियल मूल्यवर्द्धन पर दो सम्मिलित थे।

केरल स्टार्ट अप मिशन के साथ 27फरवरी से 3 मार्च 2020 तक पहला ग्रामीण भारत व्यापार कॉनक्लेव संगठित कल्पकृषि व्यापार इन्क्युबेटर आयोजित किया गया। इसमें बृहत प्रदर्शनी (एसआईटीआई विज्ञान, खोज, प्रौद्योगिकी नूतन प्रदर्शनी) 2. सम्मेलन, ग्रामीण आर्थिक प्रभावन क्षमता के लिए स्टार्ट अप 3.नेटवर्किंग डिनर 4. ड्रीम बिग कल्प-कार्यशाला भाकृअनुप के विभिन्न संस्थानों से कृषि प्रौद्योगिकी स्रोत आछरित 5.विशेषज्ञा भाषण और 6. अग्रि-टेक हाकेथॉन।

जून से सितंबर, 2020 तक कल्पा ग्रीन चाट ऑनलाइन कार्यक्रम विभिन्न प्रौद्योगिकियों पर 19 व्याख्यान के साथ आयोजित किया गया। नारियल के लिए प्रौद्योगिकी वित्त एवं नीति सहाय एमएसएमइ विकास संस्थान के साथ सहयोग से दिनांक 6 अगस्त 2020 को आयोजित किया गया।रोपण फसल में प्रक्षेत्र स्तर समस्याओं को पता कराने के लिए कृषि/बागवानी स्नातक छात्रों को तैयार करने के लिए 17 सितंबर को ऑनलाइन व्याखान श्रृंखला का शुभारंभ किया गया।

संस्थान की वेबसाइट ऑनलाइन समुदाय की सेवा करते हुए अब भाकृअनुप के डोमेन पर है और नया युआरएल cpcri.icar.gov.in है। इसके अलावा केरोफअसं का यू ट्यूब चैनल में 70 से अधिक वीडियो सूचनाओं के साथ अपलोड किया गया है। सूचनाओं के हस्तांतरण के लिए सामाजिक अंतराफलक पर फेसबुक हितधारकों को जोड़ता है।

कृषि औज़ार और यंत्र का रोज़गार केंद्र के रूप में किसानों को तकनीकी सहारे के भाग के रूप में कृषि विज्ञान केंद्र, कासरगोड़ में स्तापित किया गया। कृषि पद्धति के लिए इसकी उपयोग सक्षम किसानों द्वारा किया जा रहा है।

कृषि विज्ञान केंद्र, आलप्पुषा ने प्रशिक्षण की विस्तार गतिविधियों के अतिरिक्त एफ एल डी, ओ एफ टी, संदर्शन, अभिमुख एवं संगोष्ठियॉ, एफ पी ओ आधारित स्टार्टअप के रूप में उद्यमकर्ताओं के विकास

में प्रमुख भूमिका निभाया है। राज्य सरकार के सहाय और निधि के साथ कृषि विज्ञान केंद्र, आलप्पुषा द्वारा सस्य - संसाधन प्रशिक्षण एवं उद्भवन केंद्र प्रारंभ किया गया।

मानव संसाधन विकास के विषय में 40 वैज्ञानिक, 15 तकनीकी, 9 प्रशासनिक और 10 कुशल सहायक स्टाफ सदस्यों को प्रासंगिक विशेष क्षेत्र मे प्रशिक्षण दिया गया। इसी प्रकार 52 वैज्ञानिक और 10 तकनीकी स्टाफ द्वारा अनुसंधान उपलब्धियॉं बुद्धिजीबी श्रोताओं को प्रस्तुत की गई। कुल 215 जिनमें 46 शोध लेख थे, समकालीन समीक्षित पत्रिकाओं में प्रकाशित हुए।

बागवानी विज्ञान प्रभाग के सहाय और प्रोत्साहन के साथ भाकृअनुप पद्धति में पहली बार वीडियो सम्मेलन फ्लाटफार्म पर भाकृअनुप-केंरोफअसं आंतरिक अनुसंधान समिति और अनुसंधान सलाहकार समिति बैठक का आयोजन किया गया है।

III. EXECUTIVE SUMMARY

During the testing times of the Covid-19 pandemic, it was extremely a challenging task to take forward the research activities, farm operations of the Institute and also to stand by the farmers to tide over the apprehensions of the disease. It was indeed an exacting year which required a great amount of skill, attention and empathy to navigate this unprecedented period of pandemic and to deliver for the welfare of the stakeholders. A brief account of the overall activities of the Institute, including the salient achievements and untiring efforts to meet the demands of the farming community predominantly depends on the plantation sector are summarized here. A total of 51 research projects including 31 externally funded were in operation during the period.

Plant genetic resources

ICAR-CPCRI has the mandate to conserve the germplasm of coconut, arecanut and cocoa. It has the world's largest germplasm collection for coconut (455 accessions), arecanut (181 accessions) and cocoa (515 accessions) that include three arecanut germplasm accessions added during this year. Besides field gene bank, cryopreservation of coconut germplasm is made with zygotic embryos, pollen and DNA of 29, 15 and 13 accessions were carried out in collaboration with ICAR-NBPGR, New Delhi,.

Crop improvement for yield and other attributes

Concerted long-term breeding efforts of the Institute have resulted in the release of several high yielding coconut, arecanut and cocoa varieties. There are 15 evaluation trials with coconut accessions, 9 trials with arecanut accessions and 7 with cocoa accession. Based on yield and other attributes, 9 exotic accessions and 17 indigenous coconut accessions were identified for further evaluation. From the evaluation trial in the North Himalayan Terai region, Bari Narikel 1 has given the highest annual yield of 110 nuts per palm. Kera Sankara (WCT x COD) recorded a higher yield (96 nuts/palm/year) in a trial in Assam. Among the 28 accessions of coconut investigated for their nut oil content, West Coast Tall exhibited the highest oil content of 70.9% followed by Sambava Green Tall (69.4%).

The recently released coconut variety, Kalpa Haritha recorded a low incidence of eriophyid mite (7%) in the field conditions whereas the established varieties such as FMST and FJT were found to be vulnerable (88%) to the mite infestation.

Modified ground pollinator for coconut has been tested and the device had yielded a significantly high success rate of 11.5-14.7 % of pollination of the total female flowers produced. In the realm of planting material production and distribution, a total of 1,45,459 coconut, 6,55,795 arecanut and 62,626 cocoa planting materials were produced and distributed leading to the generation of Rs. 2.75 crores earnings. Besides, a total of 32 community nurseries across the 12 districts of Kerala produced about 19,488 dwarf seedlings of coconut for cultivation.

Biotechnological investigations

In the biotechnology front, two important achievements were reported this year. First, the field planting of tissue culture derived plant from immature-inflorescence of coconut at the Regional Station, Kayamkulam; it was done by Shri. Muralidharan V, Hon'ble Minister of State for Parliamentary and External Affairs, Government of India. And the second is the whole genome sequencing of Chowghat Green Dwarf (CGD). Annotation of the genome data resulted in 13,707 genes, which are coded for 11,181 proteins. Among these, transcript level evidence was gathered for 6828 predicted genes based on the RNA-Seq data. The number of nucleotide-binding and leucine-rich repeat loci was 112 that are belonging to six classes. Successful application of *in vitro* regeneration protocols in arecanut yielded approximately 1000 somatic embryos from a single immature inflorescence of variety VTLAH2.

Cropping systems and resources management

Field trials on input optimization in cropping system models

indicated that organic recycling contributes significantly for sustainable production. The coconut based integrated farming system with components as pepper, banana (on the border), fodder grass (hybrid Napier Co 5), dairy unit and poultry, proved a net return of Rs.653,385 per year. Few crops were newly tested under the system such as groundnut and sapota that were observed to be performing well.

Under arecanut based coconut systems at Mohitnagar, vegetables, orchids and beetle vine were introduced. Cocoa variety Netra Centura released from ICAR-CPCRI is found to be suitable for high density planting under arecanut (3712 plants/ha).

At Kahikuchi, INM with the application of vermicompost (2/3rd) + fertilizers (1/3rd) in arecanut indicated the highest chali yield of 2.34 kg per palm per year. In the management trials on yellow leaf disease of arecanut (Sringeri, Sullia in Karanataka), mulching with arecanut husk and plastic was found to reduce the disease index.

Cocoa pod pyrolysis and subsequent biochar making process were attempted. The resultant cocoa biochar composite compost is applied to vegetables and yield assessments are being done.

Bacillus root endophytic plant growth-promoting Rhizobacteria (PGPR) for biopriming of coconut seedlings was found to be promising for nursery application and are under field evaluation.

The two phylloplane actinobacterial isolates CP1A1 and CP1A4, having antagonistic potential against leaf rot pathogen was considered for disease management in coconut.

Integrated management of diseases

It was observed that *Lasiodiplodia* spp. is an emerging pathogen of both the coconut and cocoa causing severe diseases similar to leaf blight of coconut and charcoal pod rot and die-back of cocoa. The field trial on the management of stem bleeding disease of coconut indicated that Propiconazole 25 EC is as effective as Hexaconazole 5EC and *Trichoderma harzianum* (CPTD28). Propiconazole 25 EC is also found effective for the management of inflorescence dieback disease of arecanut.

For the first time infection of *Phytophthora palmivora* in *Areca triandra* was reported.

Multilocus sequencing and characterization of phytoplasma associated with lethal wilt disease (LWD) of coconut was studied in detail by the molecular characterization of translation elongation factor (*tuf*), ribosomal protein (*rp*), Sec Y and antigenic membrane protein (*amp*) genes.

Integrated management of pests and nematodes

For better management of pests, technology refinements were made besides surveillance. Analysis of *Mse*I restriction site polymorphism in amplified region of cytochrome oxidase gene (*COI*) of coconut rhinoceros beetle collected from different parts indicated absence of *Oryctes rhinoceros* nudivirus (OrNV) resistant haplotype (Guam strain).

For early detection of red palm weevil detection, an acoustic based device was developed using Artificial Intelligence, which has more than 80% accuracy.

Efficacy of bio-rationals on the bio-suppression of rugose spiralling whitefly was tested in a field trial: However, it was proved with evidence that conservation biological control is very successful as it could restore the population build-up of natural enemies leading to reduction of the pest population.

In arecanut, the incidence of exotic whitefly complex (*Paraleyrodes bondari* Peracchi and *Paraleyrodes minei* Iaccarino) in association with invasive rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin and native areca whitefly, *Aleurocanthus arecae* David & Manjunatha was observed in Karnataka. In cocoa, infestation by the wood borer, *Rhaphipodus subopacus* Gahan, 1890 (Coleoptera: Cerambycidae: Prioninae) was reported for the first time from Karnataka.

Prophylactic application of aqua formulation of 'Kalpa EPN (CPCRI - SC1), *S. carpocapsae* @ 50 ml solution containing 2500 IJs and delivered on leaf axis and whorls as well as placement of nematode infested *Galleria* cadavers of about 4 and 8 days old *S. carpocapsae* and *Heterorhabditis indica* (CPCRI - HI1) @ 1 cadaver/leaf whorl at fortnightly intervals on four months old banana was found effective in the suppression of banana pseudostem weevil. Early detection of pest infestation and EPN delivery is crucial for the suppression of the pest.

A capsule formulation of EPN *Steinernema* sp. CPCRIS0804 which is identified for control of red palm weevil infestation in coconut was standardized.

Physiology, biochemistry and value chain management

Vulnerability assessment of coconut and arecanut

production in 2070 with RCP 8.5 was made using MaxEnt model. The model projects that a large extent of coconut and arecanut growing areas at present may become unsuitable if adequate irrigation facilities are not made available.

Hydroponically grown coconut seedlings of Malayan green dwarf (MGD) shown tolerance up to 10% seawater substitution.

Leaf transcriptome profiles of coconut seedlings (var. Kalpasree and Kalpatharu) under water-deficit stress (25% of available soil moisture) and control were analysed: Significantly expressed genes (*i.e.*, highly up and downregulated genes) in the two varieties were observed to be different.

The effects of oral administration of coconut palm sugar (CPS) in a streptozotocin-induced diabetic Wistar rat model were investigated. Administration of CPS to diabetic rats reduced the body weight loss, and fasting blood glucose levels in a dose-dependent manner.

Processing/packaging protocols for the following products were standardized in the year 2020: (i) minimally processed grated coconut; and (ii) Coconut milk peda; (iii) Jaggery infused osmo-dehydrated coconut chips. Quality standards of foam mat dried coconut milk powder could be achieved. It was found that the heat dissipation pattern can be used for detection of fat content in desiccated coconut (by adulteration with low fat coconut mil residue).

Gadgets and machinery developed were: (i) Automatic tender coconut cutting machine; (ii) Modified Kalparasa® collection device with stainless steel container; (iii) Tractor driven air blast sprayer; and (iv) Self-propelled air blast sprayer.

Technology transfer, economics and statistical methods

Before the nationwide lockdown, the Institute had conducted 58 training programmes to benefit 2197 farmers. In the post Covid-19 pandemic, the Institute resolved to use online platforms to reach out to its stakeholders. It has conducted fifteen online training programmes with a total registration of 3300 farmers. Highest participation was for the programme organized when the Government of India rolled out agriculture reforms under Atmanirbhar Krishi. This multi-lingual programme conducted during 14-17 September had live participation of over 2500 farmers at a time.

Important FLDs conducted by the Institute are (i) Best Management Practices (BMP) to alleviate the soil-related constraints for coconut (60 holdings); (ii) Establishment of seed garden of five released varieties in Palakkad district jail; (iii) Arecanut dwarf hybrids (2 plots); and (iv) Arecanut based multispecies cropping system (4 plots).

Under SCSP, critical inputs such as planting material (coconut, cocoa, arecanut, black pepper fruit crops, beehives, poultry, and pig) and climbing devices were provided to 329 farmers belonging to six districts spread across five states. Besides two industrial training programme on coconut value addition were conducted at Kasaragod for 22 SC youths.

STC activities were conducted in collaboration with the Integrated Tribal Development Agency, Paderu, Andhra Pradesh. Coconut seedlings, cashew grafts, bush pepper and hive boxes were provided to 335 families. One EDP on 'cocoa cultivation and processing' and a one-day training programme on cashew cultivation were also conducted.

Under the Farmer FIRST programme, evolved an inclusive social process model for improving farmers income through technology adoption among 1000 farm families, 64 women SHG, 15 coconut producers societies, 19 ward committees led by peoples representatives, one Farmer Producer Company Ltd., and 10 microenterprise units with effective linkage with line Departments and ICAR institutes/SAU and NGOs. Released varieties of tubers, sesamum, finger millet, turmeric, fodder grass, pulses were cultivated in an area of 378 ha thereby increasing the production by 512%. The microenterprise units produced 6.8t Kera Probio®, 3t Kalpa Vardhini, and 6000 coconut seedlings; besides coconut and turmeric value addition. For facilitating the marketing of these items, a 'vocal for local initiative – FFPmart' was started. It also has the products of the FPO 'Odanadu Farmer Producer Company Ltd' formed under FFP. It was found that 24.5% of the participating farmers doubled their income through the adoption of interventions, 37.5% increased income between 1.5 to 2 times and 1 to 1.5 times compared to pre FFP, based on the sample study during 2019.

Multi-dimensional analysis of adaptation deficit in relation to climate change in Alappuzha district indicated the following constraints for year round cultivation of intercrops under coconut: Intermittent water logging/ periodical flooding for short periods, saltwater inundation during monsoon, and water scarcity and salinity during summer.

An algorithm in R for predicting functional metagenomic content from de-multiplex meta-genome data was developed. It is capable of generating high-quality graphs

such as the Doughnut diagram; bar diagram for abundance box plots; functional metabolic pathways-circle packing, and functional metabolic enzymes-sunburst diagram.

Geospatial variability in coconut productivity in Kerala was analysed based on primary data collected from four districts. Results indicated that that proper technology adoption has significantly contributed to higher yield. Soil nutrients deficiency is also contributing to yield variation.

An exploratory analysis on the impact of Covid-19 pandemic and subsequent lockdown on plantation crops reflected disruptions in domestic and global value chains. The estimated loss in coconut production sector was estimated to be Rs. 23,190 million and in processing sector, it would be Rs. 25,770 million. Additionally, Rs. 4,354 million would be the loss in the coir sector. The economic loss in areca production was estimated to be Rs.1800 million and Rs. 29 million in case of cocoa. Deficit in export revenue from coconut, arecanut and cocoa was worked out to be Rs. 5407 million.

A refined framework for revamping the 'neera' sector was evolved from the study conducted with the participation of 95 coconut producing federations in Kerala engaged in neera production and marketing. It was observed that the 'neera' value chain is in the evolving stage and the withdrawal of the institutional support of Coconut Development Board had detrimentally affected the confidence of the CPFs ventured into it. The dearth of technical competence and lack of marketing skills were very much evident in the sector.

A national patent was granted for the invention entitled 'a composition, device or a trap and the methods thereof' jointly for Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore and Indian Council of Agriculture Research (CPCRI). Institute has filed two patent applications this year: Process protocol for foam mat dried coconut milk powder and linear actuator based minimal processing machine for tender coconut (TEMP/E-1/30543/2020-CHE). Seventeen MoAs were signed for transfer of technology know-how of 11 technologies and realised revenue of Rs. 2,87,000. Towards the distribution of quality technology products on a demand basis, a revenue of Rs. 207.47 lakhs was also generated.

Under Kalpa Agr-Business Incubator, 10 new incubatees admitted, and eight graduated during 2020. Twelve entrepreneurs initiated their business. Nine EDPs were conducted that include two on cocoa processing and two on coconut value addition.

The Kalpa Agri-Business Incubator, jointly with Kerala Startup Mission organised the first Rural India Business Conclave from 27 February to 3 March 2020 at Kasaragod with the following events: (i) Mega exhibition (SITI - Science, Invention, Technology and Innovation Expo) (ii) Conference: Startups to leverage rural economy (iii) Networking dinner (iv) Dream Big Kalpa – Workshop' on sourcing agriculture technologies from different ICAR institutes (v) Expert talks and (vi) Agri-tech hackathon.

During June to September 2020 Kalpa Green Chat was conducted as an online programme with 19 lectures on various technologies. A webinar on 'technology, finance and policy support for coconut MSME' was organised in collaboration with MSME Development Institute, Thrissur on 6 August 2020. To equip the final year agriculture/ horticulture graduate students to address field level problems in plantation crops, an online lecture series was started on 17 September 2020.

The Institute website is now on the ICAR domain with a new URL cpcri.icar.gov.in, serving the online community. Besides, the CPCRI YouTube channel has more than 70 videos loaded with information. Facebook connects stakeholders on the social interface for the exchange of information.

KVK Kasaragod, as a part of its technical support to farmers, established a custom hiring centre of agricultural implements and machinery. These are being utilized by farmers for efficient farming practices.

KVK Alappuzha, besides usual extension activities of training, FLD, OFT, visits, interfaces and seminars, has taken leading roles in hand holding entrepreneurship development in terms of FPO based start-up. The KVK has also initiated the Agro-Processing Training cum Incubation Centre with state government support and funding.

Publications and awards

As part of human resources development, 40 scientists, 15 technical, 9 administrative and 10 skilled support staff were trained in specific fields of relevance. Similarly, the research findings were presented before the intellectual audience by 52 scientists and 10 technical staff. A total of 215 of which 46 were research articles in peer-reviewed journals.

ICAR-CPCRI is proud to place on record the conduct of IRC and RAC meetings over the video conferencing platform for the first time in the ICAR system with the encouragement and support from the Division of Horticultural Science.

IV. VISION, MISSION AND MANDATE

Vision

To develop 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.

Mission

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

Mandate

- 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), the premier research institution in the National Agricultural Research System of India, is presently mandated to research plantations crops (coconut, arecanut and cocoa). It had a modest beginning as Coconut Research Station in 1916 under the erstwhile Madras presidency. Since its inception, it has served the farming community with a distinction through exemplary research, generation of appropriate technologies and development of the skilled human resource.

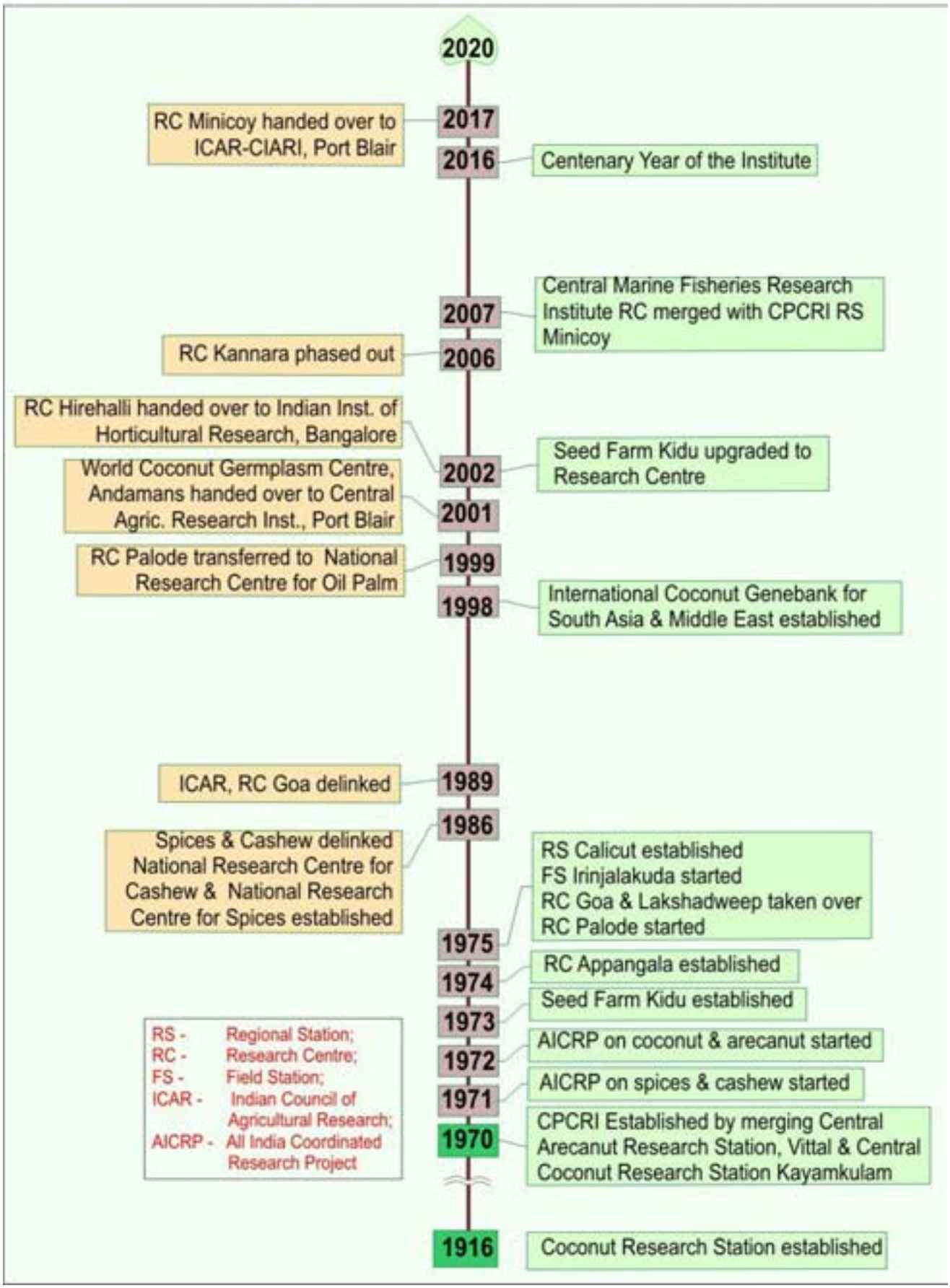
Historical perspective

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 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.

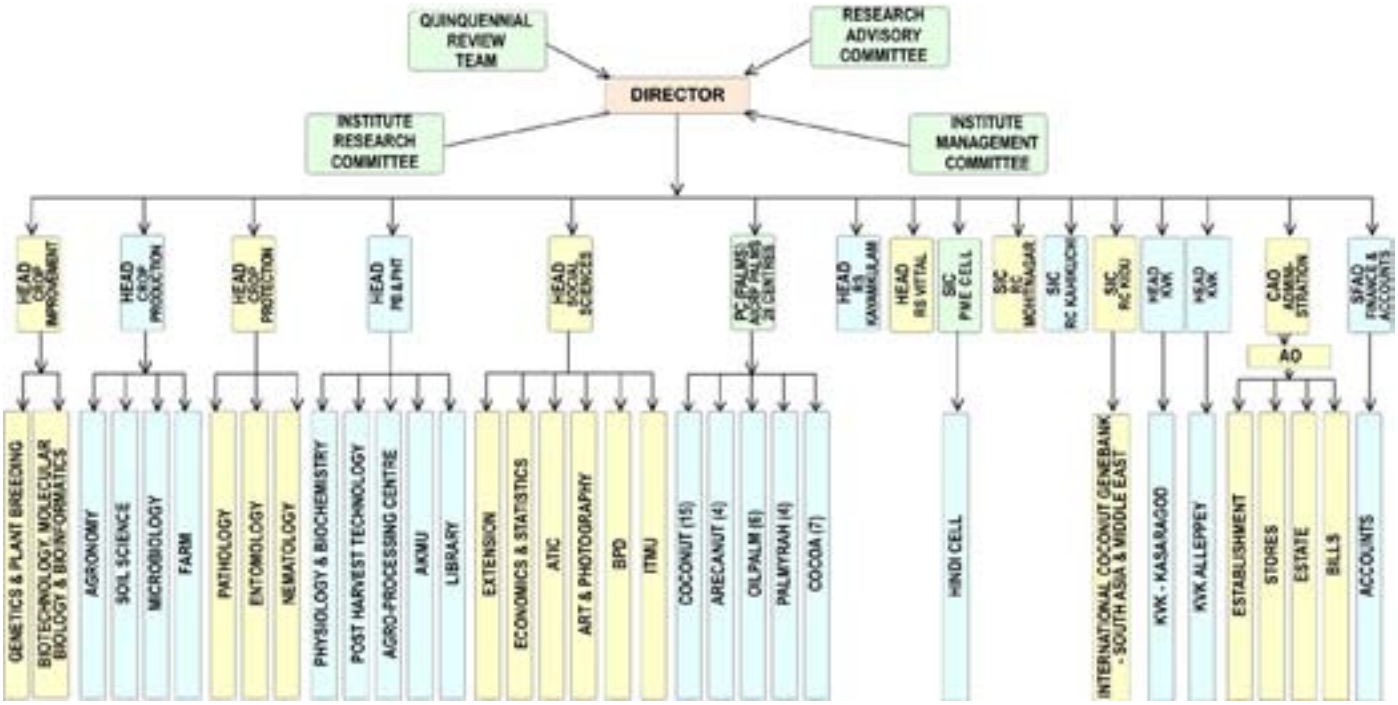
Since 1986, crops like spices, cashew, and oil palm were taken out of the purview of the institute with the formation of dedicated research institutions like Indian Institute of Spices Research, Kozhikode, Directorate of Cashew Research, Puttur and Indian Institute of Oil Palm Research, Pedvegi. Some 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 undertaken under five divisions *viz.,* Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post-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 National/ 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.

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 AICRPP has 15 centres working on coconut, four on arecanut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa.

MILESTONES IN THE TIMELINE OF ICAR-CPCRI



Organogram



Achievements at a Glance

Plant genetic resources

ICAR-CPCRI maintains the world's largest repository in coconut with 478 accessions (346 indigenous and 132 exotic genotypes) from 28 countries, 178 germplasm collections in arecanut of which 23 are exotic and 143 indigenous and 515 cocoa germplasm collections. International Coconut Genebank for South Asia (ICG-SA) was established under a tripartite agreement among ICAR-FAO-ITPGRFA. The Institute also hosts the national coconut genebank (NCGB) and serves as the National Active Germplasm Site (NAGS) for coconut, arecanut and cocoa.

Through intensive breeding and evaluation, 21 improved coconut varieties including six hybrids involving talls and dwarfs as parents have been released for commercial cultivation. The high yielding varieties are capable of yielding 3.12 to 6.28 tonnes of copra ha^{-1} annually, as compared to 2.96 t copra ha^{-1} in West Coast Tall local. During 2018, Kalpa Ratna, with a yield of 148 nuts/palm/year, suitable for copra, tender nut and inflorescence sap production was released for cultivation in Western Ghats and coastal plains and semi-arid region of Tamil Nadu. Eleven improved varieties of arecanut, including nine selections and two dwarf hybrids, have been released. The improved varieties with annual average yield of 2.54 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 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 fieldsto 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 National Horticultural Board

Biotechnology and bioinformatics

Achievements under biotechnology include standardization of embryo culture protocol for germplasm exchange, standardization of regeneration protocol for inflorescence tissues of arecanut and cryopreservation of coconut DNA, 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. The safe movement of coconut germplasm through embryo cultures, instead of seed nuts, is recommended by FAO/ IPGRI.

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 using RNA-Seq and transcripts up/ down-regulated have been identified. Many of transcripts down-regulated in root (wilt) diseased palms were primarily involved in defense responses, signaling pathways, cellular transport and other metabolic processes. Transcriptome analysis of coconut embryogenic calli, derived from plumular explants of West Coast Tall, resulted in the identification of 14 genes with important roles in somatic embryogenesis. Work on deciphering the genome sequence of Chowghat Green Dwarf has been initiated.

ICAR-CPCRI hosts 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's 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-storied multi-species cropping as well as mixed farming systems have been developed by integrating livestock to increase total productivity. Compared to coconut mono-cropping, the cropping system can provide more than three times farm income. In the case of arecanut, the income enhancement through intercropping would be 75% to 130%.

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 35-40 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 helps 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}).

The productivity of coconut in coastal sandy soil, which is made of 99% sand, is very low (30 nuts $palm^{-1}$ yr^{-1}) due to the porous nature and low fertility. Incorporation of coconut husk in the interspaces of the coconut garden and growing various intercrops like vegetables, flowers, grasses and pineapple and fertigation along with mulching to coconut has increased the yield of coconut to 140 nuts $palm^{-1}$ yr^{-1}. The intercrops generated an additional income of Rs. 2.5 to 3.5 lakh ha^{-1} of coconut garden.

Bioresources utilization

Recycling crop wastes in coconut, arecanut and cocoa through vermicomposting and mushroom production helps in disposing of wastes, improving soil fertility, reduction in use of chemical fertilizers and sustaining the yield besides enhancing nutritional security. Coconut gardens of one hectare area can generate up to eight tonnes of leaf biomass residues every year. Technology has been developed to utilize these wastes for production of vermicompost, vermiwash, compost and mushrooms. From about eight tonnes of leaf residues, 3-4 tonnes of vermicompost could be produced annually using the local isolate of *Eudrilus* sp. or 1,660 kg of fresh mushroom. The coconut leaf vermicompost can also meet 50% of the nitrogen requirement of coconut palms grown in one hectare area saving expenditure on inorganic fertilizer. 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. 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 as well as use as soil-less medium for production of quality planting material. Efforts are on to standardize composting of immature coconut husk, which otherwise accumulates in heaps outside tender nut parlours along the roadside.

Arecanut and cocoa gardens generate biomass of 4-5 and 0.7-0.8 million tonnes ha^{-1} respectively and these wastes 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} that has the potential to meet nitrogen and phosphorus requirements of arecanut, which can save the cultivation cost to the extent of Rs. 5,200 ha^{-1}. Arecanut leaf sheath and bunch waste can result in production of 643 kg fresh mushroom.

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 and vigourous coconut and cocoa seedlings. The genes involved in the plant growth promoting properties and other important metabolic functions of three PGPRs, one each from coconut, arecanut and cocoa, have been identified through whole genome sequencing. An efficient zinc solubilizer has been identified from alkaline soil which could not only increase availability of soluble zinc in soil, but also its electrical conductivity. This bioresource could prove to be useful in regions where zinc availability is a problem.

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 has resulted in saving of thousands of coconut and arecanut palms and reduced the loss due to black pod diseases in cocoa. Most importantly, the disease management strategies are being continuously refined based on the change in pathogen population, soil and climatic factors and screening of new and native bioagents or fungicides or host plant resistance.

The role of slug *Deroceros* sp. in spreading of bud rot has been confirmed by observing the presence of sporangia of *P. palmivora* in faecal matter of the slugs collected from bud rot affected garden and proving its pathogenicity on coconut. Prophylactic treatments of Bordeaux mixture (1%) or placement of two perforated sachets containing mancozeb (5g) 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 and efforts were made to improve the PCR-based diagnostic techniques for reliable early detection of phytoplasma. A package of practice for the disease affected regions had been recommended.

Spraying of Bordeaux mixture (1%) or mandipropamid (0.5%) was found to be effective in reducing the fruit rot disease of arecanut. Among the foliar fungal diseases, inflorescence die back of arecanut caused by *Colletotrichum* spp. and leaf blight of coconut caused by *Lasiodiplodia* spp. were the major diseases observed.

Phytoplasmal etiology of YLD has been established and observed and INM strategies and improved drainage system can sustain yield.

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. 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 @ 250g mixed with equal volume of sand) and aggregation pheromone embedded nanomatrix trap @ 1trap ha^{-1} has been developed. Area-wide (1575 ha) farmer-participatory experiments undertaken at Krishnapuram (Kerala), Semanampathy (Tamil Nadu), Voodimudi (Andhra Pradesh) and Doddenhally (Karnataka) significantly reduced the spear leaf and inflorescence damage to an extent of 81.2%. Recently, an agro-ecosystem based pest regression strategy through ecological bio-engineering has been designed for managing Rhinoceros beetle, exploiting the interplay of mixed-volatile cues of crop plurality of coconut with spices and fruit trees.

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. Community level technology convergence and large-area adoption of IPM technologies conducted in 2150 ha in Bharanikavu (Kerala), Palladam (Tamil Nadu), Ambajipet (Andhra Pradesh) and Bidramamandi (Karnataka) could reduce the pest incidence to 56.8%.

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% in a period of 12-15 months. Area-wide field validation and demonstration experiments conducted at Kasaragod (Kerala), Sethumada (Tamil Nadu), Matlapalem (Andhra Pradesh) and Arsikere (Karnataka) in an area of 550 ha recorded a minimal pest incidence of 2.4% from an initial damage level of about 73.4% indicating the success of the technology.

IPM technologies for the suppression of eriophyid mite developed by ICAR-CPCRI involving 2% 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%. From an initial pest incidence of 58.6% observed in Krishnapuram (Kerala), Kottur (Tamil Nadu), Ambajipet (Andhra Pradesh) and Boranakoppalu (Karnataka), the pest incidence was reduced to 16.3% in a period of two years indicating the success of the technology at national level.

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 arecanut white grub population significantly. Placement of the neonicotinoid, thiamethoxam (2g) 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.

Climate resilient technologies

Coconut, arecanut and cocoa are highly sensitive to climate change variables like high temperature and water deficit stress. The impact, adaptive strategies and the mitigation potential of the above crops were studied to develop climate resilient technologies. The impact of climate change variables, 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% Field capacity (FC), tall genotypes exhibited high WUE (3.5 g biomass L^{-1} water), while at 25% FC, dwarf genotypes had high WUE (3.8). Tall genotypes had highly sensitive stomata while, dwarfs exhibited better root growth under stress. Furthermore, studies on leaf epicuticular wax content revealed that 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% at 30°C and got drastically reduced to 14% at 45°C. A clear contrast was observed between 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 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

Value addition and product diversification can ensure the sustainable livelihood of plantation farmers and entrepreneurs. In this context, the recently developed 'coco-sap chiller' technology for collecting fresh, hygienic and unfermented coconut inflorescence sap (Kalparasa) is very promising. Other value added products like virgin coconut oil, coconut chips could improve the profitability and employment generation in coconut sector. 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. For effective utilization of by-products, the process of vinegar production from mature coconut water and fermented neera, jelly and squash production from mature and tender coconut water, muffins cake production from virgin coconut oil cake, and low fat desiccated coconut flour production from coconut milk residue have been standardized.

Farm mechanization and various processing machineries developed at the institute could contribute substantially in reducing the production cost, increased labour efficiency and enhanced product output and quality. 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. So far the institute could obtain national patents for seven of its technology devices.

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, participation in exhibitions and conducting Kisan Melas, 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. Mega Expo and Kisans Mela were organized in addition to release of various publications and documentation farmers' experiences and felicitation of the innovative farmers across the country.

Applications of ICT tools like videoconferencing to conduct trainings, conferences and interaction workshops with various stakeholders were utilised. Statistical Databases 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 interfaces. The Institute website (https://cpcri.icar.gov.in) is being updated regularly with latest information. 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

The impact of changing trade policy environment (domestic / international) on mandate crops in terms of prices (cointegration also) and demand-supply equations was studied and continuously monitored. Consultancy briefs (yearly basis) on production and trade aspects of the coconut sector were submitted to CACP as inputs to facilitate the fixation of minimum support prices of copra. Policy brief on minimum support price for arecanut was also submitted. Policy note on raw coconut procurement was prepared and submitted to the CACP. In view of the efficient raw coconut procurement, it was suggested to establish level/panchayat level hubs with forward and backward integration along with unit level collection centers under the supervision of CPS networks.

The theoretical concept of sectoral system of innovation approach was empirically adopted in the coconut sector of India and put forth a restructured sectoral innovation system for the vibrant and sustainable coconut economy. Innovation system analysis of Neera was also carried out.

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 the semi parametric 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.

Technology commercialization

The Institute Technology Management Committee is responsible for protection of IP assets and commercialization. Till 31 December 2020, the Institute has commercialized more than 50 technologies, signed 248 MoAs for transfer of technology know-how and realized a revenue of Rs.69,22,500.

Crops, Area, Altitude and Research Undertaken at Different Locations

Headquarters

KASARAGOD (Estd.: 1916), Crops: 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), Crops: Coconut, Area 24.17ha, 3 m MSL

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

VITTAL (Estd.: 1956), Crops: 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), Crops: Arecanut and Cocoa, Area 15.76 ha; 48 m MSL

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

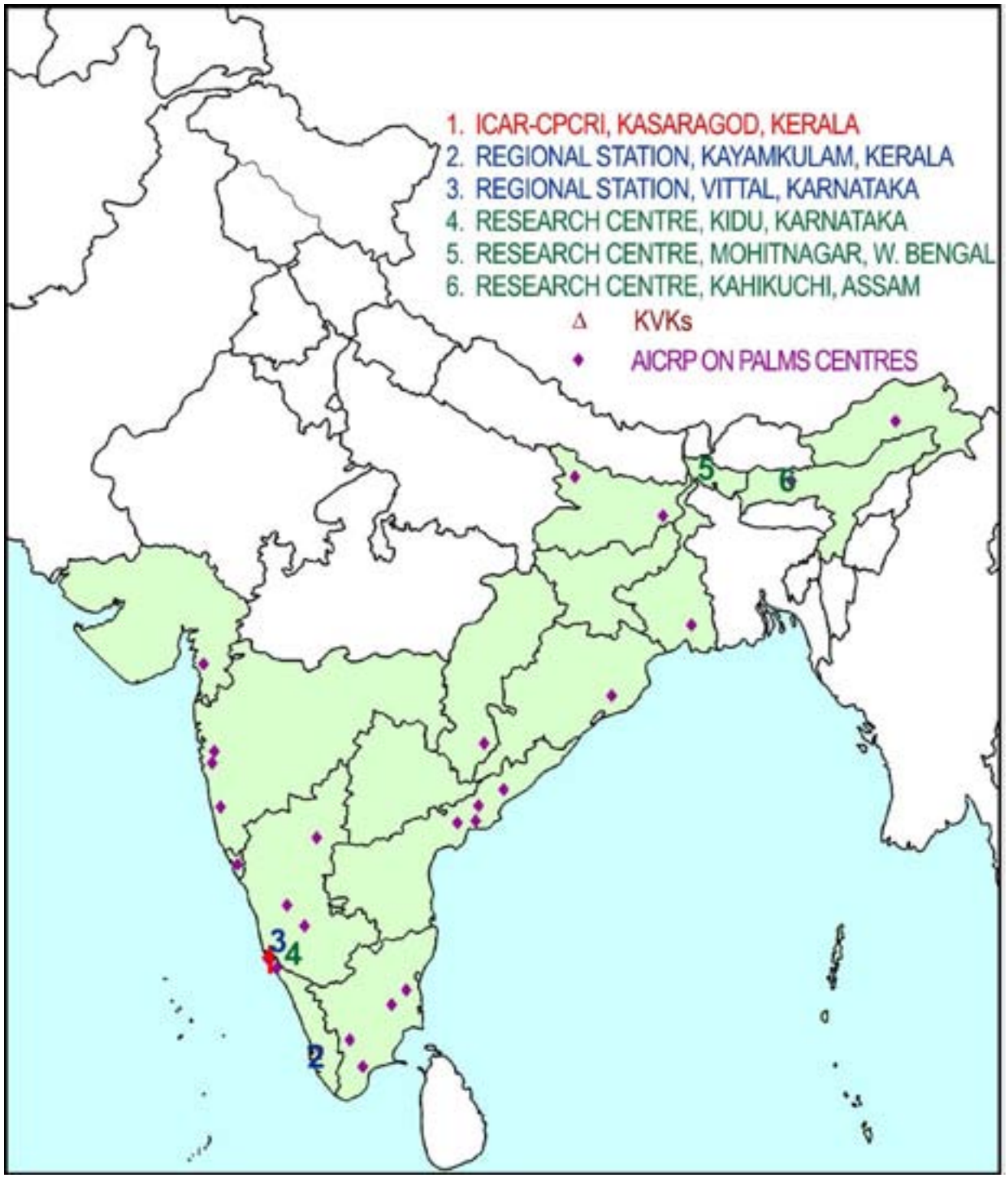
KIDU (Estd.: 1972), Crops: Coconut, Arecanut and Cocoa, Area 120 ha; 281 m MSL

Priority areas of research: National coconut gene bank, International Coconut Gene bank for South Asia (ICGSA), 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



Staff Strength as on 31-12-2020

ICAR-CPCRI			
Category	**Sanctioned**	**In position**	**Vacant**
Scientific	65	67	+02
Technical	113	70	-43
Administrative	89	55	-34
Supporting	131	95	-36
Total	**398**	**287**	**-111**
ICAR-KVK, KASARAGOD			
Category	**Sanctioned**	**In position**	**Vacant**
Scientific	1	1	-
Technical	11	6	-5
Administrative	2	-	-2
Supporting	2	-	-2
Total	**16**	**7**	**-9**
ICAR-KVK, ALAPPUZHA			
Category	**Sanctioned**	**In position**	**Vacant**
Scientific	1	1	-
Technical	11	10	-1
Administrative	2	-	-2
Supporting	2	-	-2
Total	**16**	**11**	**-5**
Grand Total	**430**	**305**	**-125**

Details in chapter XVII - Personnel

Budget and Expenditure (Rs. in crores)

Head	Allocation	Expenditure
Budget	73.5942	73.4266
Revenue generation	6.53	

VI. Research Achievements

01. GENETIC RESOURCES MANAGEMENT

Germplasm Enrichment and Conservation

Field gene banks

In active germplasm sites for coconut, arecanut and cocoa maintained by the Institute, 455 coconut accessions, 178 arecanut accessions and 515 cocoa accessions are maintained. The coconut gene banks are located at Kasaragod and Kidu, while the arecanut and cocoa gene banks are located at Vittal, along with alternate conservation sites for coconut and arecanut at Mohitnagar and Kahikuchi and cocoa at Kidu. The institute also hosts the International Coconut Genebank for South Asia and the Middle East (ICG-SAME) at Kidu.

Cryopreservation of germplasm

The zygotic embryosof 29 coconut accessions, pollen from 15 accessions and DNA from 13 accessions are maintained at ICAR-NBPGR, New Delhi.

Germplasm collection

Threearecanut germplasm accessions were collected which include two from the district and one from Kodagu district of Karnataka. Details are provided in Table 1 and fruit characteristics are shown in Fig. 1.

Germplasm Characterization and Evaluation

Coconut

Growth and reproductive characters of dwarf accessions planted in the two evaluation trials during 2011 (17) and 2013 (12) were analyzed.A significant difference among accessions was observed for the characters shown in Table 2. Higher initial nut yield was recorded in NGOD (50 nuts/palm), followed by AGD01 (43 nuts/palm) and AOD (42 nuts/palm).

Significant variation in growth characters, initiation of flowering and yield parameters were observed among the 33 indigenous accessions conserved at Kasaragod (year of planting: 2012). Significant variation in growth characters was observed in the trial with 31 accessions planted at Kasaragod during 2014 and 2015. Except for Agatti Green Dwarf, flowering is yet to initiate in other accessions.

Among the 32 palms of sweet kernel coconut planted in the field gene bank at Kasaragod during 2008 (*Mohacho*

(a) (b) (c)

Fig. 1. Fruits of arecanut germplasm collected in 2020 from (a) Irde, (b) Ishwaramangala and (c) Hakathu.

Table 1. Brief description of arecanut germplasm collected in the year 2020

District	Location	Average fresh weight (g)	Nut length (cm)	Nut breadth (cm)	Distinct features
Dakshina Kannada	Irde in Puttur Taluk*	60.94	6.22	4.78	Semi-tall palm showing tolerance to fruit rot disease
	Ishwaramangala, Puttur Taluk	49.53	7.39	4.30	longer fruits
Kodagu	Hakathu in Madikeri Taluk		5.42	3.40	High yielder

*It is a single palm of semi-tall nature out of 330 progenies of the local variety planted in 1982.

Table 2. Variation for reproductive characters among dwarf accessions

Character	Range among accessions	
	Lowest	Highest
Inflorescence length (cm)	ANYD01 (65.75)	RTB04 (126.5)
Length of the spikelet bearing portion (cm)	SYD (18.6)	MGD (36.6)
Number of female flowers	INGR13061 (11)	SUBD (90)

Narel, collected from Guhagar, Maharastra), production of sweet kernel fruits were recorded in eight lines. The percentage of sweet kernel fruits varied from 4 to 53. The embryos from sweet kernel fruits were extracted and used for tissue culture propagation – the study is in progress. Observations were also recorded from 48 palms of sweet kernel coconut planted in 2008 at Kasaragod.

Morphological growth characters and yield attributes were recorded for different accessions conserved in the gene bank at Kidu. Among 10 accessions planted in 1989, KPDT and NLAD, higher yield (76 nuts) was recorded over control; *i.e.*, WCT (65 nuts). Significant variation for average bunch, flower and nut yield was observed among 20 accessions planted in 1990. Yield varied from 45 nuts (SLYD) to 143 nuts (CALT). Among the 10 accessions planted in 1990, FJT showed significantly higher yield over WCT; respectively 76 and 50 nuts. In the 1992 planting, among the nine accessions, significant difference for yield was observed over WCT. Highest yield was for GPT (145 nuts).Significant difference in yield attributes were observed among the 9 accessions planted in 1993. Accessions NUGT and SUT recorded higher yield (respectively 151 and 130 nuts) in the 1994 planting. Evaluation of the yield attributes of the Pacific Ocean tall accessions planted in 1997indicated significant differences between these accessions for annual bunch, female flower and nut production. No significant variation observed among the four collections from Odisha planted in 2000. From other trials, higher nut yield potential was observed in the following exotic tall accession: Borneo Tall, West African Tall, Jamaican Sanblas, Guam Tall, Panama Tall, Federated Malayan States Tall, Niu Hako, Straits Settlement Apricot Tall, and Standard Kudat Tall. Among indigenous accessions, BARI Narikel-II, Bagharpara Tall, Rupidia Tall, Uzirpur Tall, Laccadive Micro Tall II, Ponnani Tall Yellow, Kodiaghat Big Round Tall, Kodiaghat Tall, Tutiala Tall, Katchal Micro Tall, Nicobar Beak Tall, Achamthuruthy Tall-I, Aliyar Nagar Tall, Kakkadipuram Tall, Tinisera Tall, Chandan Nagar Tall, and Barajaguli Tall showed high yield potential.

Evaluation trial at Mohitnagar (21 tall accessions, five dwarfs and five hybrids), indicated significant difference for yield. The higher yield was observed for BARI Narikel 1), Chinnasukhania, and Agailjhara Tall (respectively 110, 105 and 95 nuts). Observation on juvenile growth characters were recorded in fifteen lines (local collection) planted for studying tolerance to cold. Cold injury symptoms on leaf were not noticed in the local lines, during the last winter season.Fruit component traits were studied in 18 accessions, including 16 talls and two dwarfs. Higher fruit weight was recorded in Jamaica Tall (1565 g) followed by BARI Narikel 1 (1523 g) and Agailjhara Tall (1481 g).

Evaluation trial with 15 coconut cultivars at Kahikuchi indicated higher nut yield for Kera Sankara (96 nuts) followed by Chandra Sankara (75 nuts). Among the dwarfs, COD showed higher yield (49 nuts). Fruit component studies undertaken in these genotypes indicated higher fruit weight (1160.99 g) in Assam Green Tall.

Other characters: Oil content in selected exotic/indigenous germplasm conserved in at Kasaragod was estimated and found that it varied between 58 and 75%. Among 28 accessions at Kidu, the oil content varied between 50.5 to 70.9%.

Physico-chemical properties of testa and oil extracted from testa were studied in six coconut genotypes. The proportion of testa as a percentage of whole fruit weight varied from 1.29±0.30% in COD to 3.42±0.54% in MYD. Oil content in testa varied from 50.56±0.66% (CRD x GBGD) to 40.97±0.81% (MYD).

Biochemical characterization of pink husked types revealed significantly higher total phenol content in the tender nut water of pink husked types as compared to normal husked types. Significantly higher protein content of 86 mg/100ml was noted in pink husked as compared to normal husked type with 58.7 mg/100ml. Higher free radical scavenging activity based on DPPH assay with pink husked type was recorded with IC_{50} value of 266.7 as compared to normal type with IC_{50} value of 358. Similarly, phosphomolybdate assay also revealed higher scavenging activity of pink husked type based on IC_{50} value of 415.2 compared to 637.9 observed in normal husked type. Anthocyanin content of 25.972 mg/100g fresh weight was noted in the exocarp of pink husked types and it was negligible in normal husked type.

Pollen morphological characterization with different aspects of the pollens including the shape, length, width, length and width ratio, aperture and exine sculpturing in the polar and equatorial view were studied in eight coconut accessions. The pollen of the different accessions showed diversity in their size, the mean values of length (equatorial diameter) of the pollen ranged between 52.09 µm for WCT

and 71.25 µm for CGD. The mean values for width (polar diameter) of the pollen ranged from 24.38 µm for JVT to 36.27 µm for CGD. The mean values of length to width ratio ranged from 1.75 for NT to 2.64 for MOD. The pollen shape for all studied cultivars was elliptical or ellipsoidal and trichotornocolpate grain was also observed in WCT.

Twenty accessions were observed for eriophyid mite damage during January 2020 to March 2020; infestation varied between 7.02% and 88.02%. FJT and FMST showed higher mite damage (88%) whereas, low mite incidence was recorded in Kalpa Haritha (7.02%), followed by GPT (23.56%), JAMT (26.31%) and ECT (28.11%).

Arecanut

Evaluation of arecanut germplasm planted in different trials is in progress at ICAR-CPCRI, Vittal, Mohitnagar and Kahikuchi. At Vittal among the North Eastern collections At Vittal, highest chali (dry kernel) yield (per palm per year) was recorded in Thargira (2.42kg) followed by Nalbari (2.34kg). At Mohitnagar also Nalbari recorded the highest yield (3.74kg). In another batch of North Eastern-III collections, arecanut germplasm Bokul showed high yield of 4.53kg followed by Rangoon (3.35kg). Among the collections from Andaman Islands, highest chali yield of 3.53kg was observed in the arecanut germplasm SCRDTC-18, followed by Cal-1 (2.40kg). Among the indigenous collections,Rathnagiri recorded the highest chali yield (2.85kg) followed by Mohitnagar (2.45kg) and Kamrup (2.44kg).

Among the palms planted in the year 1988 (14 accessions) at Mohitnagar, a higher yield (3.81kg) was recorded in variety Mohitnagar followed by VTLC 17(C) (2.163kg). In 1991 batch planting (12 accessions), VTL-27 was recorded higher yield of 3.89kg followed by VTL 29 (b) (2.12kg). Higher yield of 2.44kg was observed in VTL18 (c) among the accessions planted in 1992. Among the NE collection planted during 1994, higher yield of 3.74kg obtained from Nalbari followed by K & J Hills (2.76kg). In 1997 planting, Calicut-27 and Calicut-20 were recorded high yielders respectively 3.42 and 3.30kg.

Other characters: Morphological traits were recorded from arecanut wild species and related genera *viz*., *Areca triandra, Areca microcalyx, Actinorhytis calapparia* and *Normanbya normanbyii* in YLD screening trial and disease indexing was also done. So far no symptoms of YLD were observed in wild species and related genera of arecanut.

Twenty two arecanut genotypes including five dwarf hybrids characterized for biochemical parameters like total phenol content and antioxidant activity. Total phenol content was ranged from 25.61 percent to 32.95 percent. Highest and lowest phenol content was observed in the germplasm Thargira and Aunihati respectively. Arecanut germplasm, Shrivardhana showed highest antioxidant activity with 83.45% and the arecanut hybrid HD x Mohitnagar recorded lowest antioxidant activity (72.685%).

Cocoa

Evaluation of cocoa germplasm collections of different age groups from 11 years to 25 years was continued. Accessions showing higher yield are shown in Table 3.

In top-worked and rejuvenated cocoa collections at Kahikuchi, canopy area ranged from 4.18 to 39.82 m^2 and the accession KHIC-35 yielded highest number of pods (76) per tree.

Other observations: Fourteen cocoa clones belong to Upper Amazon/Trinidad collections were assessed for fat content which ranged from 33 to 57% and the highest fat content of 57% was recorded in VTLC-58. In another set of 9 cocoa clones planted under coconut recorded 34.3 to 57.9% fat and the highest of 57.9% was recorded in VTLCC-2. Beans from farmers' gardens of Sullia were assessed for fat content, which ranged from 35-50%.

Table 3. Promising accessions in the cocoa germplasm

Collection	Age of stand (years)	Promising accessions	Canopy area (m^2)	Pods/tree (No.)	Dry bean yield (kg/tree)
Peru	11	VTLC-205 ; VTLC-229	15-20	78-85	1.5
Amazon	13	VTLC-177; VTLC-181	16-19	89-99.5	2
Ghana	13	VTLC-129; VTLC-134	12-13	46-58	1
Wayanad	23	VTLC-108	20	83	2.5
Nigeria	25	VTLC-18; VTLC-24; VTLC-33	18-22	63-81	2.5-2.8
Malaysia	25	VTLC-3	20	61	2.5
Upper Amazon/ Trinidad	29	VTLC-75	18	45	2.5

Black pepper

Thirteen black pepper accessions collected from farmers' field of Kamrup district of Assam were evaluated for growthand yield along with Panniyur 1 was a standard check variety at Kahikuchi. The accession IC-0599150 showed 43.62% higher dry pepper yield than Panniyur 1 followed by IC-0599145 (34.89%).

Utilization of Genetic Resources

Coconut

In hybrid evaluation trials at Kasaragod (planted during 2013 & 2014), comprising 28 Dwarf x Tall hybrid combinations, flowering and fruiting characteristic features were observed in 22 combinations. In Dwarf x Dwarf trial planted at Kasaragod in 2016, with 14 cross combinations involving seven dwarf parents, significant variation was observed for juvenile growth characters; early flowering was recorded in almost all the hybrids (27 to 48 months).

In the hybrid evaluation trial planted at Kidu during the year 1996, WAT (West African Tall) x NAT (Natava Tall) and PHOT (Philippines Ordinary Tall) x GBGD (Ganga Bondum Green Dwarf) continued to perform better in bunch and nut yield. In the 1998 planted trial, WCT x CRD and CGD x LCT showed better performance as was in the past. In Dwarf x Dwarf trial planted at Kidu in 2003, CGD x CRD, MYD x NLGD, MYD x GBGD were recorded higher showed better performance in terms of bunch and tender nut production.

Pollination for production of experimental hybrids in 11 cross combinations was undertaken at Kasaragod and around 325 seed nuts were sown for raising seedlings. At Kidu, pollination have been initiated for eight new cross combinations (Cocobelu x FMST, Cocobelu x ADOT, SUBD x Renell Tall, SUBD x FMST, COD x Renell Tall, MYD x ADOT, MYD x Renell Tall, GBGD x Renell Tall)

Varieties proposed to release: Fruit component studies were initiated for characterization of identified hybrids for release *viz.,* COD x LCT and COD x WAT.

Developing 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 were observed in S_3 seedlings. Palms of three families have started flowering this year.

Trials in farmers' field: Performance assessment of D x D hybrids in farmers' garden in Karnataka and Andhra Pradesh; and of newly released hybrids Kalpa Samrudhi and Kalpa Sreshta in Karnataka, Kerala, Andhra Pradesh and Tamil Nadu were in progress. Two evaluations trials with D x T hybrids were initiated at Dakshina Kannada district in Karnataka and Erode district in Tamil Nadu.

Mapping populations: To decipher the genetic basis inheritance of fruit colour, reciprocal crossing between dwarfs varying for fruit colour, *viz.* COD, CGD, MYD, SUBD, has been initiated. Self-pollination was carried out in MYD x NLGD and MYD x CGD hybrid palms and crossing of LMT x COD was also continued for developing mapping population for linkage studies.

Pollen and nectar compatibility studies*:* Pollen and nectar compatibility studies in ten coconut varieties were in progress. Seasonal variation was found in the concentration of nectar for all the varieties. Nectar diluted with water to 1:50 and 1:20 was used for pollen germination. Pollen germination showed differences according to season. Varietal differences in nectar-pollen compatibility were also observed.

Unique Dwarf Character: A unique dwarf palm without any fruit set since flowering was observed among progenies of Lakshadweep population planted at Kasaragod. However, on pollinated pollen from COD, fruit set achieved and raised 54 seedlings which are planted at Kasaragod in 2018.

Arecanut

Evaluation of eight dwarf hybrids of arecanut including Hirehalli Dwarf and released varieties *viz.*, Mangala, Sumangala, Sreemangala, and Mohitnagar is in progress at Vittal, Mohitnagar and Kahikuchi centers. At Vittal, Mohitnagar x HD and HD x Mohitnagar yielded higher yield (dry kernel weight per palm) of 1.60 and 1.47kg. Among the eight arecanut dwarf hybrids evaluatedat Mohitnagar, Sumangala x HD and HD x Mohitnagar performed better (3.1 and 2.9 kg dry kernel).

Cocoa

Vegetative vigour of 8 cocoa varieties (three years old) grown under different shade levels was assessed: At 50% and 75% shade levels, VTLCH-3 showed appreciable plant vigour with thick stem, canopy spread, number of branches and prunes weight, whereas at 90% shade, VTLCS-1 showed profuse vegetative growth.

Exotic cocoa populations of 25-30 year old seedling progenies grown without any shade were assessed for their bearing behavior. Number of pods ranged between 43 to 135 among the 25 year old trees, and 132 to 196 among 30 year old trees (canopy area 25-30 m^2).

Table 4. Production planting material

Crop/type	Kasaragod	Vittal	Kayam-kulam	Kidu	Mohit-nagar	Kahi-kuchi	Total
Coconut							
Varieties	39256	--	--	61171	--	--	
Hybrids	18338	--	--	16267	212	--	
Total	57594		10215	77438	212	--	
Arecanut							
Seednuts	--	--	--	408030		37200	
Seedlings	--	9620	--	39965	50000	24400	
Total	--	96200	--	447995	50000	61600	
Cocoa							
Pods	--	29220	--	2031	--	--	
Seedlings	--	30748	--	627	--	--	
Total	--	**59968**	--	**2658**	--	--	

Black pod rot (BPR) infection was severe in the year because of the delayed harvests and intense monsoon rains. In the severely infected garden with Nigerian collections, VTLC-20, VTLC-13 and VTLC-35 were free of infection with more pods during July 2020. Among the hybrids, VTLCH-1, VTLCH-2, VTLCP-8 and VTLCP-9 were free of pod rot during post-monsoon season.

Selective red genotypes of multiple collections were assessed for the percentage of tea mosquito bug (TMB) damage in pods during post-monsoon season. In general, the level of infestation was less in germplasm plots due to continuous rains, delayed pruning and limited number of off-season pods. Red Amelonado, Ghana Red, Jerangau Red Axil, and 1Wayanad clone with smooth surfaced pods were free of damage. Among the hybrids, VTLCP-8, 3 trees each of Malaysian and Philippines hybrids were free of TMB infestation.

Planting Material Production

Planting material of mandate crops produced at different centres is shown in Table 4.

At Kasaragod, for monitoring and scheduling artificial pollination in coconut, a database was put on use. Observations on characters of polybag and nursery seedlings were recorded to develop seedling standards for six, nine and twelve month old seedlings.

For polybag seedlings of arecanut, an experiment with soil less media was conducted: Vigorous growth was observed in the medium of vermicompost and vermicompost + coir pith compost.

The modified ground pollination technique was evaluated at different centres of ICAR-CPCRI (Kasaragod, Kayamkulam and Kidu) and three AICRP on Palms centres (RCRS-Bhatye, CRS-Aliyarnagar and HRS-Ambajipeta). An average fruit setting of 25.10% was recorded which is comparable to the setting observed under natural pollination. Training on 'Modified ground pollination technique in coconut' was conducted during December 2020 for members nominated by Coconut Producers Company, Thrissur and efforts are being made to carry out pollination on 100 mother palms (Tall and Dwarfs) in Thrissur District.

At the pollen cryo-preservatory at Kayamkulam, a total of 400 vials of coconut pollen collected from healthy and high yielding WCT palms were stored.

Decentralized planting material production

Production and distribution of quality planting material of dwarf /semi tall varieties and hybrids were undertaken in farmer participatory mode in 12 districts of Kerala. Parental palms utilized in this regard are: WCT (2383), COD (4374), CGD (1633), MYD (49), MOD (25), GBGD (12) and MGD (5). These palms were labelled and geo-tagged. A total of 63394 seed nuts were sown in the community nurseries managed by Farmer Federations/ Societies.

In root (wilt) affected area, 500 Chowghat Green Dwarf (CGD) mother palms and 100 WCT pollen-parents were used for hybridization and seed nut collection. 100 West Coast Tall (WCT) palms used as male parents for pollen collection were also selected. These parental palms are located in four districts (Alappuzha, Kottayam, Pathanamthitta and Kollam).

Aforesaid programmes were conducted with financial assistance from Kerala State Department of Agriculture and Farmers Welfare.

To increase the production of 'Kalpa Sankara' hybrid in root (wilt) affected area, 35 CGD mother palms from Regional Station, Kayamkulam and 175 CGD palms selected from farmers' plots spread across over 22 panchayats were also used.

Demonstration plots of arecanut dwarf hybrids

With financial assistance from DASD, Kozhikode, two demonstration plots were established in Dakshina Kannada district of Karnataka.

DUS centre for coconut

Juvenile growth characters were recorded in candidate variety planted for DUS testing, along with three reference varieties. Higher palm height, total length of leaf and collar girth was recorded in candidate variety as compared to the reference varieties, whereas longer and broader leaflets were observed in WCT (reference variety). In all the planted varieties, significantly longer internodes and trunk length were recorded under 4m x 4m (DUS test spacing) as compared to the 6m x 6m spacing. Flowering initiation was recorded 21 months after planting in two reference varieties (CGD, GBGD). Seed nuts of five dwarfs and 12 tall reference varieties were sown in polybags for generating planting material of reference varieties and also documenting the seedling characteristics.

DUS centre for arecanut

Sixteen arecanut DUS reference varieties were characterized for their biochemical components. The fat content was ranged from 8.80% (Sagar) to 15.80% (Sumangala). Highest and the lowest phenol content was recorded from VTLAH-1 (30.69%) and Mangala (25.73%) respectively. The antioxidant activity was varied from 47.44% (South Kanara Local) to 86.12% (Sumangala).

02. BIOTECHNOLOGICAL INVESTIGATIONS

Coconut Tissue Culture

Field planting of tissue culture derived coconut seedlings

Shri. P. Muraleedharan, Minister of State for External Affairs, Govt. of India, planted the tissue culture raised coconut seedlings at ICAR-CPCRI, Regional Station, Kayamkulam. The tissue culture coconut seedling was produced from immature inflorescence explant collected from WCT variety. The rachilla segments were cultured on Y3 medium supplemented with 4.54 µM 2,4-dichlorophenoxyacetic acid. After eight months dark incubation, the cultures were transferred to 1/2 Murashige and Skoog (MS) with 5.37 µM naphthalene acetic acid (NAA) and 4.44 µM 6-benzylaminopurine (BAP) for multiple shoot formation. The individual shoots after development of 3-4 leaves were transferred to 1/2 Y3 medium supplemented with 5.37 µM NAA and 24.6 µM indole-3-butyric acid (IBA), and root initiation was observed in 39.3% plantlets. It took three years from explant inoculation to field planting.

Fig. 2. Shri V. Muraleedharan, Min. State for External Affairs, planting a tissue culture derived coconut seedling

Regeneration of plantlets from immature inflorescence-explants of coconut

A repeatable protocol was developed for culturing explants from immature inflorescences with outer spathe length ranging from 3.5 cm to 18.5 cm (*var*. WCT and Kalpasree). The rachillae bits were incubated in dark condition for eight months with monthly sub-culturing in Y3 medium supplemented with 2,4-D (1 mg l^{-1}). Cultures were then transferred to ½ MS medium 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 cultures gradually turned green in light condition and formed multiple shoots. These multiple shoots were separated and the individual shoots were cultured in shoot regeneration medium containing Y3 with 5µM 2IP and 5µM BAP. Well-developed shoots having 3-4 leaves were obtained for WCR and were transferred to various combinations of rooting media. Maximum rooting (25%) was observed in medium containing ½ Y3+ NAA (2mg l^{-1})+ IBA (5mg l^{-1})+ activated charcoal (1g l^{-1}) + sucrose (20 g l^{-1}). Plantlets having well developed roots were washed in tap water and treated in 1% Bavistin followed by 1000 mg l^{-1} 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 klin wrapping film so as to develop high humidity. New leaves emerged out from plantlets after 2-3months of hardening in sterile conditions. These plantlets were transferred to polybags containing soil: sand :Coco-peat in 1:1:1 and kept in green house (Fig. 3).

Media optimization for somatic embryogenesis and plantlet regeneration

Growth media optimization using novel plant growth regulators to induce shoots from the embryogenic calli identified that the aromatic cytokinin, metatopolin at 0.25µM and flurprimidol at 5µM along with picloram 5 µM and charcoal 0.5g/l in M72 medium induced higher number of shoots (13) per explant.

In vitro response of embryonic shoot meristem explant of coconutin inducing somatic embryogenesis following different stresses was investigated. Different concentrations of Abscisic acid - ABA (9, 10, 11, 12 and 13 mgl^{-1}) in two media Y3 and M72 with 16.5 mg l^{-1} 2,4 D as the auxin, resulted in initiation of ear shaped embryogenic callus in M72 medium supplemented with ABA 13mg $l^{-1}$and Y3 at 11 mg l^{-1}.

To reduce the biological contaminants in coconut *in vitro* culture operations, the effect of Plant Preservative Mixture

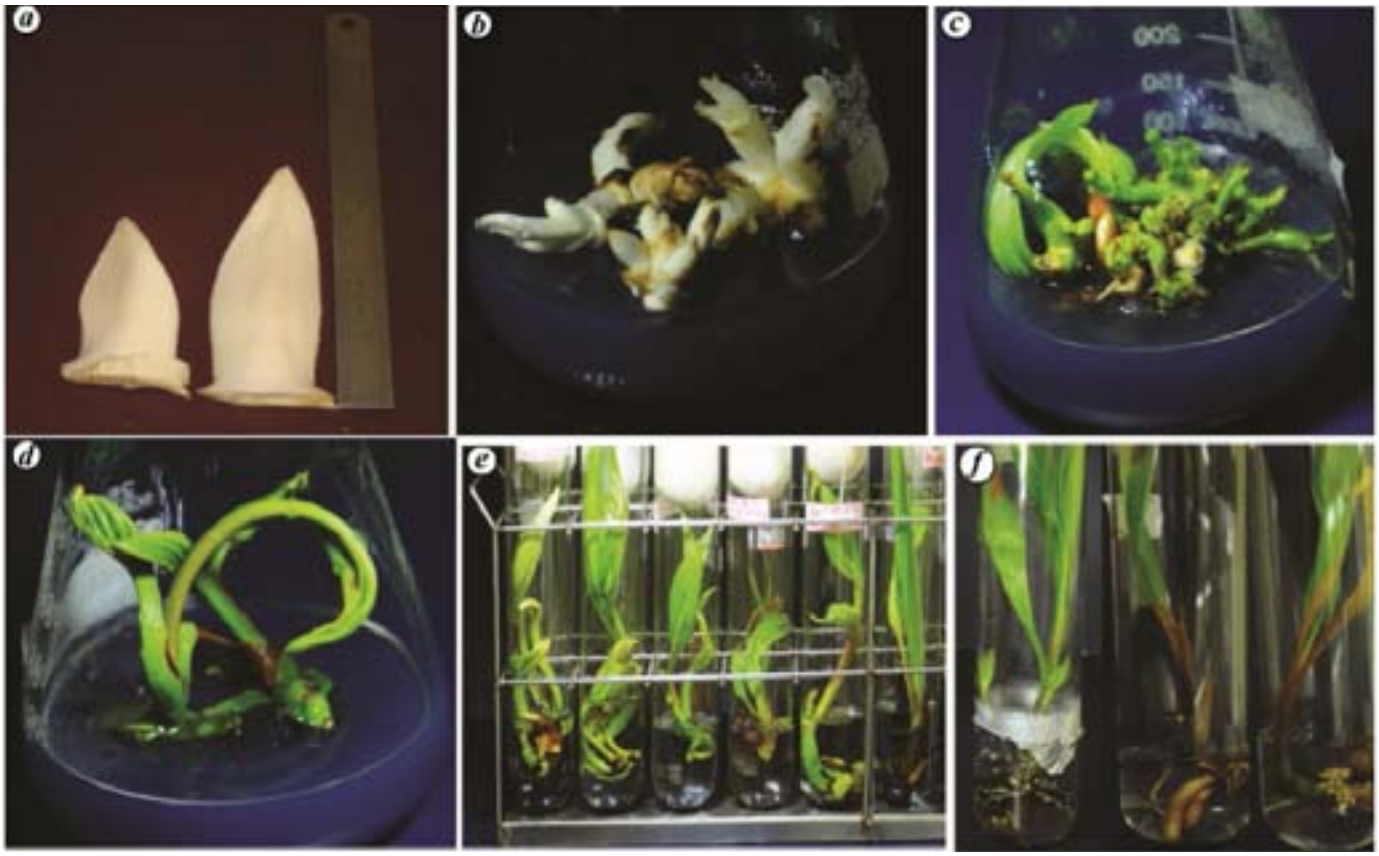


Fig. 3. Steps involved in plant regeneration and hardening of *in vitro*-derived plantlets from immature inflorescence culture in coconut.

(PPM) in tissue culture mediawas explored. Three treatments*viz*., (a) surface sterilization of endosperm plug with 0.1g l^{-1} $HgCl_2$ (3 min) and surface sterilization of embryo 20% NaOCl (20 min) (b) surface sterilization of endosperm plug with 0.05g l^{-1} $HgCl_2$ (3 min), surface sterilization of embryo with 10% NaOCl (10 min) and surface sterilization of embryo with 0.1% PPM (10 min) and (c) surface sterilization of endosperm plug with 0.1% PPM (10 min), surface sterilization of embryo with 0.1% PPM (10 min) was performed in M72 medium with picloram 100 µM. The results revealed that among the various concentrations of PPM (0.25, 0.5, 1, 1.5,2, 2.5 and 5 mg l^{-1}), 1.00mg l^{-1} of PPM additive reduced the contamination to 75%.

Effect of novel growth regulators 4-CPA (4- Chloro Phenoxy Acetic acid) on *in vitro* growth of plumular and seedling shoot meristem derived explants of coconut showed higher callusing in M72 medium supplemented with Picloram 10 µM, 4-CPA 10µM and charcoal 0.25 gl^{-1}.

Endosperm explants

Calli derived from immature endosperm explants of Gangabondam Green Dwarf (GBGD) maintained under dark and different light emitting diode (LED) conditions shown higher growth rate of callus multiplication in cultures maintained under a combination of blue and red LED.

Arecanut Tissue Culture

Tissue culture for rapid multiplication of elite genotypes

Five arecanut plantlets derived from the immature inflorescence culture initiated from VTLAH1 (HD x Sumangala) were field planted at ICAR-CPCRI on 23 October 2020.

Somatic embryos (1000) were produced from a single immature inflorescence culture initiated from VTLAH2 (HD x Mohitnagar). Embryogenic calli were multiplied in Y3 medium supplemented with picloram (2.5 µM). Plantlets derived from these cultures were in different stages of growth.

Ten immature inflorescences from dwarf hybrids (VTLAH1 and VTLAH2) from ICAR-CPCRI, RS Vittal and six from apparently healthy palms of YLD hotspot area in Sringeri, Karnataka were handed over to M/S SPIC ABC, Coimbatore as per the mass multiplication programme.

Meristemoids along with embryogenic calli were transferred to temporary immersion system and nourished with Y3 medium supplemented with BAP (5 mg l^{-1}) and sucrose (30 g l^{-1}) and maintained under 16h photoperiod for two weeks to improve the shoot regeneration. A relative growth rate of 0.02 g^{-1} day^{-1} was recorded. Somatic embryos were cultured in Y3 medium supplemented with sucrose (30 g l^{-1}) abscisic acid (2,4 and 8 mg l^{-1}), and charcoal 2 g l^{-1} for initiating secondary somatic embryos. Cultures were initiated for callus and somatic embryogenesis using immature inflorescence as explant from Shatamangala cultivar (Fig. 5).

Embryo rescue and cryopreservation studies in coconut and arecanut

Till date zygotic embryo from 29 accessions, genomic DNA from 13 accessions and desiccated pollen from 15 accessions of coconut were cryostored at National Cryo Gene Bank, ICAR-NBPGR, and New Delhi.

Embryo Rescue of Ratnagiri sweet kernel genotype was attempted. Of the 64 numbers of embryo from Ratnagiri sweet kernel genotype which was inoculated into embryo culture media (Y3+Sucrose 60gl^{-1}+2.5gl^{-1} charcoal), 62 embryos germinated and roots were developed in 12 embryos.

Arecanut somatic embryo derived from immature inflorescence explants of VTLAH 2 (HD x Mohitnagar) were pre-cultured in Y3 medium supplemented with 0.3M sucrose and different concentrations of green synthesized silver nanoparticles (AgNP) @ 2.5, 5 and 10 mg l^{-1} for six days.

Pre-grown somatic embryos were vitrified for 60 and 120 minutes in PVS3 supplemented with AgNP (2.5, 5 and 10 mg l^{-1}) after affixing in aluminium cryomesh and encapsulated with sodium alginate. Cryopreserved explants were cultured in recovery medium for regeneration.

Coconut Genome Sequencing

Characterization of repeats and Simple Sequence Repeats (SSRs)

A survey of repetitive elements in the genome assembly, using RepeatModeler and RepeatMasker softwares, revealed that the genome sequence of Chowghat Green Dwarf (CGD) cultivar has a relatively large proportion of (~77.29 %) repetitive DNA. The long-terminal repeat

Fig. 4. Field planting of inflorescence culture derived plantlets of dwarf hybrid arecanut (HD x Sumangala)

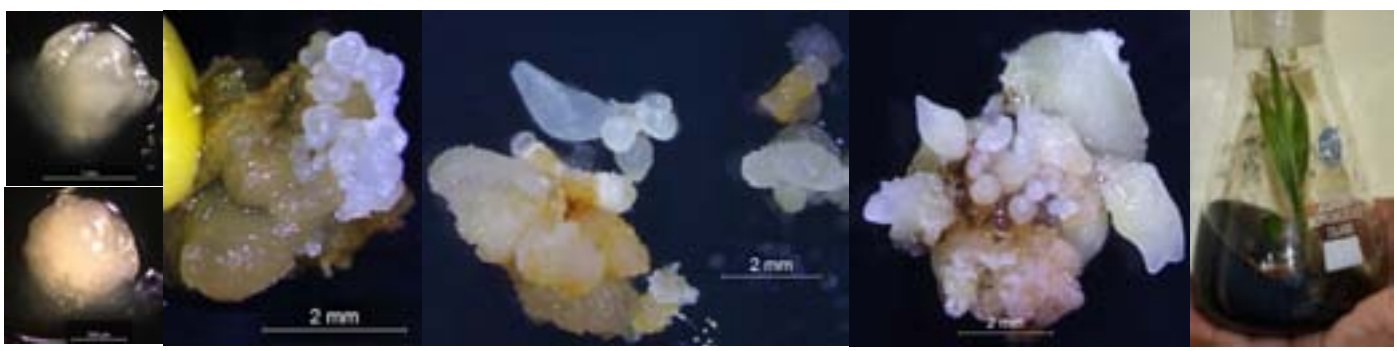


Fig. 5. Callus initiation somatic embryogenesis and plantlet regeneration in embryonic shoot meristem explants of arecanut var. Shatamangala.

(LTR) retrotransposons comprised the most abundant class of repetitive DNA (58.85%), with *copia* (36.80%) and *gypsy* (21.44%) being the most abundant elements. A total of 281,666 SSR or microsatellite loci were also identified in the assembly, including di- (80,469), tri- (35,686), tetra- (19,549), penta- (8,235) and hexanucleotide (1,026) repeats.

Identification of non-coding RNAs in dwarf coconut genome

A total of 1,214 non-protein coding genes were identified from the draft genome sequence of Chowghat Green Dwarf cultivar. Among these, 470, 463, 126, and 155 were categorized as tRNAs, rRNAs, snRNA, and miRNAs respectively.

Nucleotide binding sites-leucine-rich repeat (NLR) gene family in the CGD genome

A total of 112 *NLR* loci were identified in CGD genome, which accounts for approximately 0.8% of the 13,707 annotated genes. These *NLR*s could be classified into *NBS–LRR* (Nucleotide Binding Site-Leucine Rich Repeats) (40 loci), *CC–NBS–LRR* (coiled-coiled NBS-LRR) (20 loci), *NBS* (29 loci), *CC–NBS* (20 loci), *RPW8-NBS-LRR* (RNL) (two loci) and *TIR-NBS* (TN) (one locus), on the basis of arrangement of the domains of the translated proteins. MEME analysis, undertaken on amino acid sequences of NBS domains of coconut NLRs, revealed highly conserved domains like 'GKTTLA' at P-loop, 'GLPLA' at GLPLA, and 'LLVLDDW' at Kinase 2.

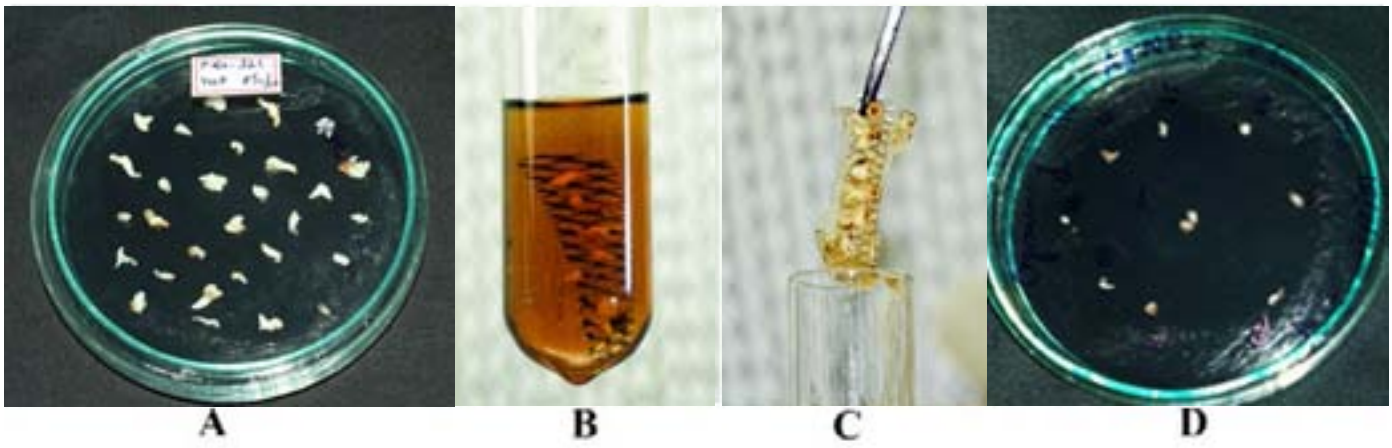


Fig. 6. Use of aluminum cryomeshes for the cryostorage of arecanut somatic embryos: A. Somatic embryo in pre-culture media; B. PVS3 vitrification; C. unloading post cryopreservation; D. explants in recovery medium

03 CROPPING SYSTEMS AND MANAGEMENT OF RESOURCES

Cropping / Farming System

Coconut based integrated farming systems (CBIFS)

Coconut based farming system comprising coconut, pepper trailing on the coconut trunk, banana in the border of the plots, fodder grass (hybrid Bajra Napier Co 5) in the interspaces of coconut, and animal components (dairy, goat and poultry)generated a net returns of Rs. 653,853/ha: The INM of the system was consisting of 50% organics recycled and 50% inorganics. Output from the components of the system include 23800 coconuts, 14940 litres of cow milk, 372.7 kg live weight of goat, 252.9 kg of live weight of poultry birds, 2632.5 kg of banana and 625 kg of pepper.

Coconut based high density multi species cropping system

Three nutrient management regimes were compared with coconut based high density multi species cropping system in a 42 year old garden (var. WCT; spacing 8x8m). They are T1: 2/3rd of recommended fertilizer NPK (333:213:800 g/palm) + recycling biomass (as vermicompost @ 30 kg/palm); T2: 1/3rd of recommended fertilizer NPK (167:107:400 g/palm) + recycling biomass (as vermicompost @ 30 kg/palm)+ biofertilizer application (*Azospirillum* and *Phosphobacterium* @ 200 g/plant)+ green manuring (*in situ*) + vermiwash application (10 l/palm); and T3: recycling biomass (as vermicomost @ 30kg/palm)+ biofertilizer application (*Azospirillum*and *Phosphobacterium* @ 200 g/plant)+ green manuring (*in situ*) + vermiwash application (10 l/palm) + husk burial + mulching with coconut leaves are replicated seven times in a randomized block design.

While yield of coconut was not significantly different among the treatments (Table 5), pepper performed better with fully organic treatment (T3) and banana (*var*. Kadali) in T1. Effect of different nutrient management practices on economics for the year 2020 revealed that the treatment T3 recorded higher net returns compared to other treatments. The increase in net income was 3.45 times over monocropping of coconut. Compared to the net return from monocrop (Rs.98147), the HDMCS provided over three-fold more; Rs. 329129, Rs. 363486 and Rs.3 38265 respectively for the treatments T1, T2 and T3. The B:C ratio was worked out to be 2.42, 2.52 and 2.42 in order.

Soil nutrient status: The soil nutrient status in the samples collected from rhizosphere of banana and coconut revealed that, significant difference among the treatments for total nitrogen, available phosphorus and available potassium at 0-30 cm and 30-60 cm depths. The treatment T3 recorded significantly higher organic carbon and total nitrogen whereas the treatment T1 recorded higher P and K content and it was significantly different from other treatments. Similar trend was observed for the samples collected from banana.

Performance of groundnut genotypes as intercrop in coconut garden

A field experiment on intercropping of groundnut (*var*. Girnar 2 and Girnar 3) was conducted in a 53 year old a coconut garden (var. WCT, spacing 7.5x7.5m) with the following three nutrient management practicesin a randomized block design. T1: Integrated nutrient management (50% of recommended chemical fertilizer, FYM (15 t/ha), poultry manure (10 t/ha), goat manure (10 t/ha) and vermicompost (9 t/ha), T2: Fully organics; and T3: Fully inorganic. Higher pod yield was recorded in T1 (respectively 2189, 1932 kg forGirnar 2 and Girnar 3 from the interspace available in 1 ha of coconut garden – 67%) followed by T2 (1632 and 1634kg in order). In T3 it was 1515 and 1209 kg.

Coconut based fruit intercropping system in coastal sandy soil

Sapota (*var*. DHS 2A) was grown under coconut (*var*. WCT; age 41 years; spacing 7.5x7.5m) in coastal sandy soil under three different nutrient management practices: Green manuring + biofertilizers + organic recycling + FYM @10t/ha+ 50% RDF (T1), Green manuring + biofertilizers + organic

Table 5. Effect of nutrient management on intercrops yield in coconut based HDMSCS

Treatment	Coconut (nuts/ palm)	Copra yield (Kg/ ha)	Dry Black pepper (kg/ha)	Banana Kadali (kg/bunch)	Banana Robusta (kg/ bunch)
T1	133.19	3609.02	567.84	9.22	16.53
T2	150.51	4222.10	631.57	8.06	15.76
T3	135.75	3580.70	641.55	8.09	15.60
CD (P=0.05)	NS	NS	60.74	0.78	NS

Fig. 7. Groundnut grown as intercrop in coconut garden

Fig. 8. Sapota grown under coconut in littoral sandy soil

recycling + FYM@10t/ha+ 100 % RDF (T2) and Green manuring + biofertilizers + organic recycling + FYM@10t/ha + 150 % RDF (T3). The fifth year fruit yield data of sapota revealed that the treatment T3 recorded significantly higher yield (47 kg per tree and 7.3 t/ha) than others.

Arecanut based high density multispecies cropping system (HDMSCS) at Kahikuchi

The trial on Arecanut based high density multispecies cropping system (HDMSCS) with different crop components: arecanut (Kahikuchi) + banana (Malbogh) + citrus (Assam lemon) + pineapple (Kew type) + turmeric (Lakadong) and with organic and integrated nutrient management at Kahikuchi indicated that application of 2/3rd RDF + recycling of biomass exhibited higher yield in banana (2534.2 kg/ha) and Assam lemon (33,810 fruits/ha) and 1/3rd RDF + recycling of biomass + biofertilizer + green manure recorded higher yield in Pineapple (2,731 fruits/ha) and turmeric (1256.98 kg fresh rhizome/ha). The main crop arecanut is 4 years old and observation on vegetative growth were recorded.

Intercropping of seasonal horticultural crops under arecanut at Kahikuchi

Cultivation of vegetables Cabbage (*var*. Veloce 5561), Cauliflower (Fujiyama hybrid), tomato (S-22) and Brinjal (local type) were included as intercrop in arecanut garden (Fig. 9.) and produced yield 6.60, 3.80, 13.20 and 7.73 t/h respectively.

Intercropping of orchids and betel vine in arecanut garden at Mohitnagar

Four orchids of Dendrobium type were collected locally and planted on the trunk of arecanut (Fig. 10) and coconut.

Fig. 9. Vegetable intercopping under arecanut

Fig. 10. Growing of orchid on the trunk of arecanut

Orchids under arecanut plantation exhibited flowering phase within one year of planting. The flowering duration was recorded for 17 days. Six numbers of local betel vine has been planted in arecanut plantation for evaluation. Observations on vegetative growth and leaf characters are being recorded.

Nutrient and Water Management

Site specific soil management

Six hundred soil and leaf samples from the palms of three yield levels from the Dindigal district of Tamil Nadu were analyzed and results summarized in the following Table 6.

Table 6. Leaf nutrient status in coconut palms of different yield categories

Nutrient	<60 nuts/ palm	60-100 nuts/ palm	>100 nuts/ palm
Potassium (%)	0.882	1.03	1.05
Magnesium (%)	0.34	0.26	0.38
Calcium (%)	0.45	0.47	0.57

Comparison of yield on harvesting tender nut and mature nut

Comparison of yield was made on different proportion of tender nut harvesting in palms grown in red sandy loam soil. Harvesting of tender nut throughout the year recorded significantly higheryield (187 tender nuts/ palm) with 14 number of bunches/palm 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 mature nuts throughout the year. Harvesting of mature nuts throughout the year recorded the lowest yield (97 mature nuts/ palm) with 12 bunches/ palm. Continuous harvesting of tender nuts improved the income offering a higher net return of Rs. 2,64,768/-than the other interventions due to the high prices the tender nuts command in the market.

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

Effect of higher doses of fertilizers on yield of hybrid coconut (Kalpa Sankara) was studied. Five levels of nutrients ranging from 50 to 200% ofsoil test based nutrient values were applied through drip fertigation; basin application of nutrients along with drip irrigation was the control. Plant height was significantly higher in all fertigation treatments (585-630cm) than the control (498 cm). Collar girth ranged from 119 to131.85cm in fertigation treatments compared to 110cm in control (as on January 2020). Number of buttons produced and retained was highest (231.25 and 137 respectively) in treatment with highest dose of nutrients; i.e., 200% (Fig. 12).

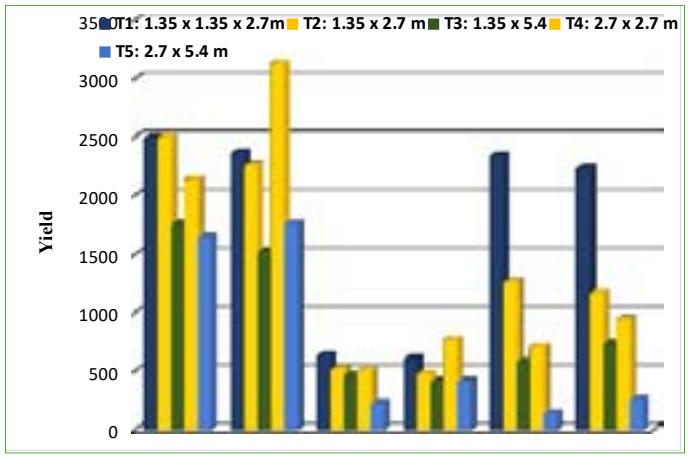


Fig. 11. Yield of cocoa grafts in different spacing

Integrated nutrient management in arecanut at Kahikuchi

Among the different treatment combinations, application of vermicompost (2/3rd) + fertilizers (1/3rd) recorded the highest number of nuts (243 nuts per palm per year) and maximum chali yield of 2.34 kg/ palm/ year.

High density planting of cocoa in arecanut

Grafts of cocoa variety Nethra Centura were planted as a mixed crop with arecanut (*var*. Nalbari) in 5 different spacing with planting density ranging from 650 to 3712 plants per ha. During 4th year after planting, the wet bean yield per hectare was significantly higher in closed planted grafts (738 – 2233 kg ha^{-1}) than the grafts under normal spacing (257 kg ha^{-1}). Other yield attributes are shown in Fig. 11.

Management of Yellow Leaf Disease in Arecanut

Field trial on management of YLD was initiated in 2 farmer's gardens in Sringeri and 3 gardens in Sullia taluk in 2015 and 2016, respectively. In 2020, the disease index (DI) ranged from 0.6 to 28.7% in different gardens. Mulching with plastic sheet (Fig. 13) was found to reduce the DI in all three management trial plots in Sullia during the experimental period (2017-2020) and also obtained higher yield of 1680 – 2628 kg ha^{-1}in these plots. Whereas, it was 1419-2159 kg ha^{-1} in control plots during 2020. In Sringeri, DI in mulched plot was 26.8% in 2020 compared to 19.8% in 2015. However, the increase in DI was much less compared to the plot without plastic mulching which

increased from 12.5% in 2015 to 28.7% in 2020.

Areca husk mulching followed by plastic mulching lowered the bulk density of soil when compared to farmer's practice. Compared to the farmer practice, reduction in bulk density of the soil was by 27.74 - 38.93 % in Sullia and 10.85 - 27.1 % in Sringeri. Moreover, arecanut husk mulching + plastic mulching enhanced the water holding capacity (WHC) and the porosity of the soil by 49.6 % and 54.83 %, respectively.

Deciphering rhizosphere bacterial diversity in Yellow Leaf Disease endemic areas

The rhizosphere bacterial microbiome of arecanut palms in Yellow Leaf Disease endemic was characterized through Illumina Miseq sequencing of the V3-V4r egions of the 16SrRNA gene. *Proteobacteria, Bacteroidetes, Firmicutes, Acidobacteria, Planctomycetes, Patescibacteria, Chloroflexi, Actinobacteria, Fusobacteria* and *Verrucomicrobia* were the dominant phyla in the rhizosphere. Bacterial community composition was found to be distinct between the YLD endemic apparently healthy rhizosphere soil (YLD-AHR), YLD endemic disease intensive rhizosphere soil (YLD-DIR), and YLD endemic disease non rhizosphere soil (YLD-NR).The core arecanut rhizosphere microbiome in YLD endemic Sullia, Karnataka composed of *Rhizobiales*, *Xanthobacteriaceae, Enterobacteriaceae, Pseudomonadales, Nitrosomonadaceae, Burkholderiaceae, Myxococcales, Desulforolales, Chitnophagales, Firmicutes, Acidobacteria* – Subgroup 6, 7, 17, Planctomycetes - WD2101, OM190, Thepidispherales, Gemmataceae, Pirellulaceae; Patescibacteria – Parcubacteria, Candidatus Moranbacteria, ABY1 - Candidatus Magasanikbacteria, Saccharimonadaceae, Chloroflexi - KD4-96, Actinobacteria – Acidimicrobiia, Verrucomicrobia - Candidatus Xiphinematobacter; Chlamydiae - cvE6; Rokubacteria; Latescibacteria; Dependentiae – Vermiphilaceae and Nitrospirae – Nitrospira. The multiple members of these core bacterial taxa are known as plant beneficial microbes, and these microbes help maintain the plant hormone balance, control root development, facilitate nutrition acquisition, and prevent the disease in the plant host.

Soil health management for sustainable production in coconut based land use system

Field experiments were conducted in Agro Ecological Unit, AEU-3 (Onattukara Sandy Plain) and AEU-9 (South Central Laterite soil) with the following five treatments: T1-application of NPK @ 500:0:1200g palm^{-1} year^{-1}, zinc, copper and boron through 100g $ZnSO_4$, 150 gram borax and 50 gram copper sulphate, lime and dolomite each @ 1 kg per palm, common salt and gypsum@ 2 kg per palm, along with *in situ* recycling of crop residues; T2-except common salt same as T1; T3-except Gypsum same as T1; T4-same as T1 + biological agents; and T5-farmer's management practice for coconut (chiefly farmyard manure @ 20kg per palm). This was conducted in a RBD with 4 replications (plot size 6). The treatments were imposed in June-July and September-October on each year during the period 2014-2020. Soil properties in AEU-9 and AEU-3 were significantly improved after the application of treatments. The improvement in soil pH was two units rise in AEU-9 and one unit in AEU-3. The per cent increase in organic carbon at the different depth in T1 over the control is 43.85, 35.78 and 64.5% respectively.

Fig. 12. Early and profuse bearing in the treatment imposing 200% nutrients dose

Fig. 13. Mulching with black plastic sheets

Bioresource Management in Coconut, Arecanut and Cocoa

Pyrolytic reprocessing of cocoa pod husk

Attempt was made to make effective use of cocoa leaves, cocoa pod husk, and cocoa bean shell by converting them into biochar by their pyrolysis under oxygen-limiting conditions using ICAR-CIAE developed simple charring kiln. Cocoa pod husk was found to be the most suitable for biochar conversion with a turnover of 38-42% on weight-by-weight basis. For each ton of cocoa dry beans produced, approximately ten tons of potassium-rich cocoa pod husks are generated which, if left in cocoa gardens, may act as a source of inoculum for *Phytophthora*. So upgrading them into biochar can not only prevent this but also return mobile K, Ca and Mg to soil and aid carbon sequestration and fertility quality of soil.

Effect of cocoa pod husk biochar on soil properties

A soil incubation experiment was initiated to assess the impact of cocoa pod husk biochar on its addition to soil along with or without in-house prepared organic amendments. The experiment was conducted in pots containing mixtures of soil and cocoa pod husk biochar and/or coconut leaf vermicompost/ cocoa waste compost/ coir pith compost. Two doses of cocoa pod husk biochar @ 2.5 and 5 tonnes ha^{-1} were evaluated. The samples drawn after definite time intervals are being evaluated.

Effect of cocoa pod husk biochar on field performance of selected vegetables

A field trial was laid down to study the effect of cocoa pod husk biochar in combination with cocoa waste compost on the performance of chillies. Seedlings of 'Sierra' var., which is a chilli hybrid with rejuvenation capacity and medium pungency from Mahyco, were procured from KVK, Kasaragod and planted in the field. Another field trial was started to study the effect of cocoa pod husk biochar in combination with cocoa waste compost and coconut leaf vermicompost on the performance of brinjal. Seedlings of 'KAU Selection' which yields inwardly-curved purple long fruits were procured from KVK, Kasaragod and planted in the field. The yield and other parameters are being recorded for both these crops.

Effect of PGPR isolates and consortia on coconut seedlings

PGPR strains possessing multiple phytobeneficial traits isolated from healthy coconut rhizosphere in RWD tract and the consortia of above PGPR are being evaluated in coconut seedlings in polybag nursery. The experimental design is CRD with 6 treatments: T1-*Pseudomonas* sp.-KH3PSB2 (multiple nutrient solubilizing rhizobacteria); T2-*Bacillus* sp.- CRE-9 (Root endophyte); T3-*Bacillus* sp.-CRE-15 (Root endophyte); T4-*Azospirillum* sp.-AZOL8; T5-Consortium (of above 4 strains) and T6-Control. Treatments were imposed two times; one at the day of transferring sprouted seedlings to polybags (and the second at 3-month interval @ 50 ml of diluted bacterial culture (approximately 1×10^6 CFU/ml). T3 recorded highest shoot height (212.33 cm) followed by T2 and T1 after 12 months. Seedling collar girth was highest for T3 (18.71 cm) that was on par with T1. Growth rate with respect to shoot height and collar girth expansion rate was 0.47 cm/day and 0.26 mm/day respectively during the initial treatment phase up to 3 months. T3 recorded maximum shoot growth rate (0.517 cm/day) in the second phase after treatment (3 to 12 months) followed by T2 and T1, where as T1 recorded maximum collar girth expansion rate of 0.39 mm/day followed by T3. Further, evaluation of these field transplanted bioprimed seedlings will be continued by analyzing biometric and RWD tolerance traits.

Bioprospecting of actinobacteria for bioactive metabolites

The two phylloplane actinobacterial isolates CP1A1 and CP1A4, belonging to *Streptomyces* spp. with antagonistic potential against leaf rot pathogen, were further characterized for its cultural properties in different ISP (International Streptomyces Project) media (ISP 1-7 media) (Fig. 14). Their antagonistic potential was further evaluated against *Colletotrichum* sp. *in vitro* on four different media. CP1A4 recorded maximum activity of more than 50 percent inhibition of mycelial growth with highest inhibitory zone radius (2.4 cm) on Basal Salts agar (BS agar) (Fig. 15). Both the isolates were incompatible with fungicide Hexaconazole (recommended for leaf rot management) at concentrations of 1000 to 10000 ppm under *in vitro* plate assay.

Further as part of this experiment, more than 30 actinobacteria isolated from coconut rhizosphere and phylloplane are being maintained for screening for bioactive metabolites including PGP traits for selection and bioinoculant applications for palm health management.

Composting process for areca crop wastes

An effort was made to standardize a process for recycling of areca crop wastes such as arecanut husk, bunch waste and areca leaves and leaf sheath. Areca husk with total carbon

of 92.6% and moisture content of 0.9 % is recalcitrant for microbial manipulation into simpler forms. To start with, areca husk and areca leaf sheath were taken as biomass residues. Several treatment combinations were made with amendments such as rock phosphate, lime, glyricidia and urea. The moisture was maintained at 60% with turning every 15 days. Daily recording of temperature showed an increased from 26°C to 33°C in treatments that were amended with rock phosphate and lime. In treatments where glyricidia was included, the temperature reached 48°C by 5th day and then gradually decreased. However, temperature lowered down to 28°C to 30°C by 10-15 days of the start of the process, across the treatments, after which *Eudrilus* sp. earthworms were introduced @100 per 100 kg. After 65-75 days of treatment application, areca husk amended with rock phosphate showed significant decomposition.

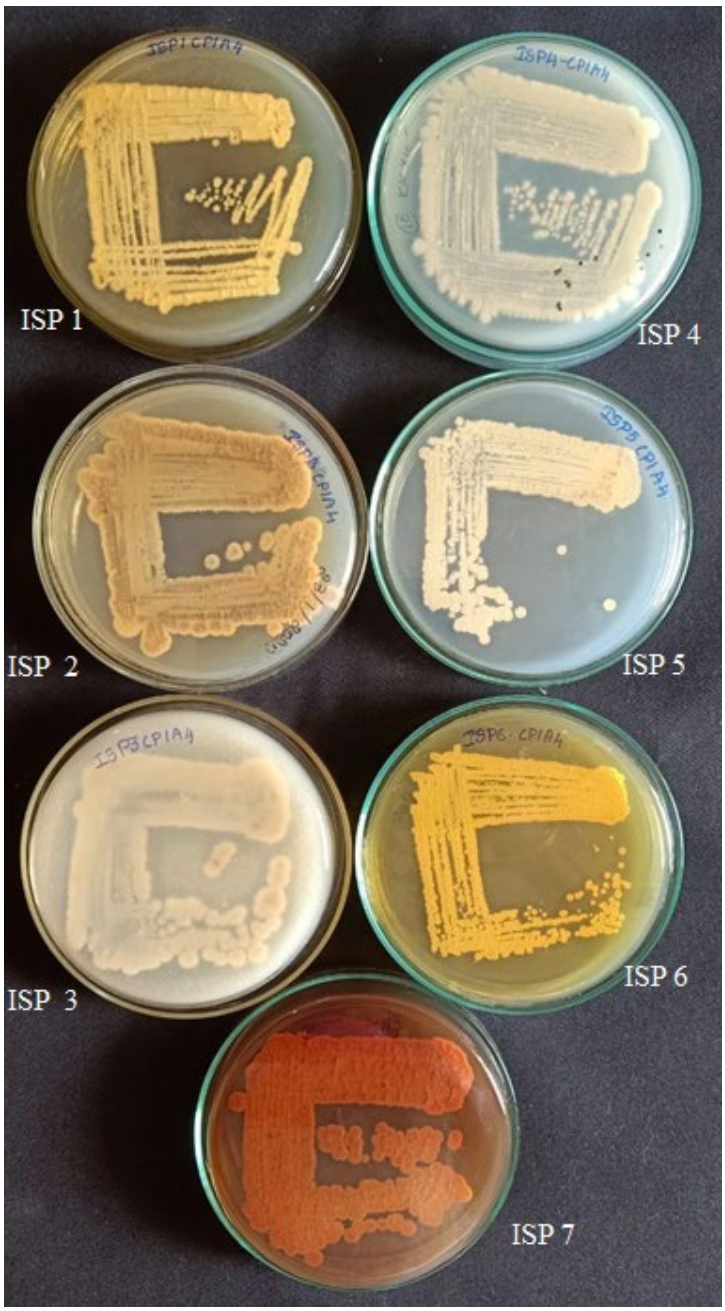
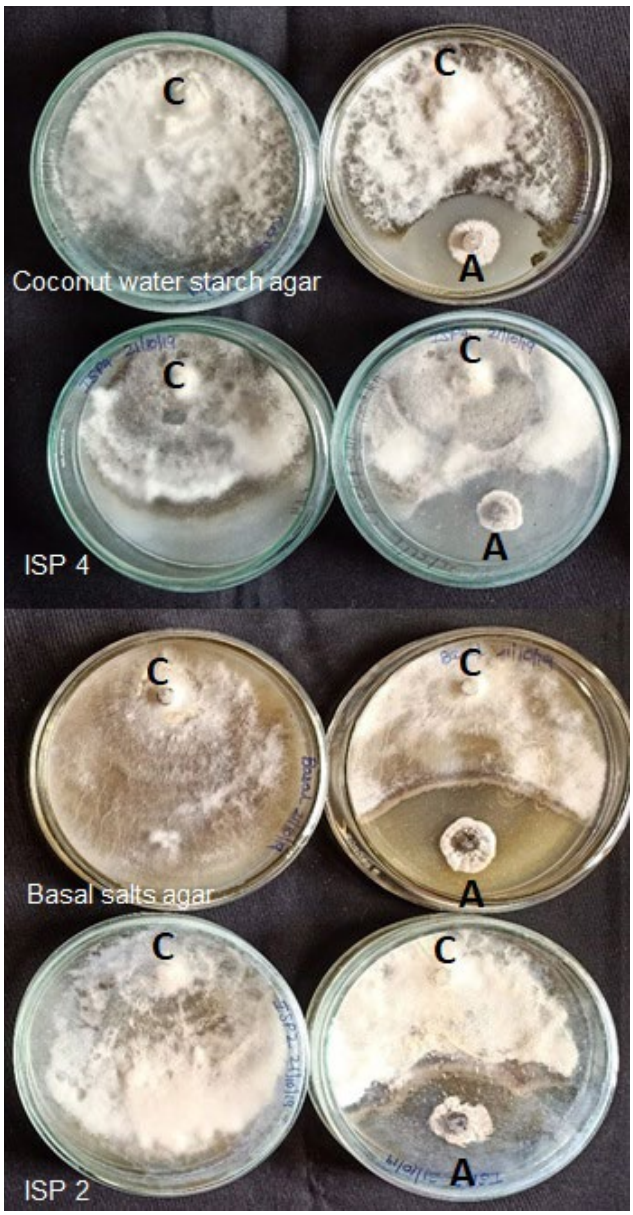


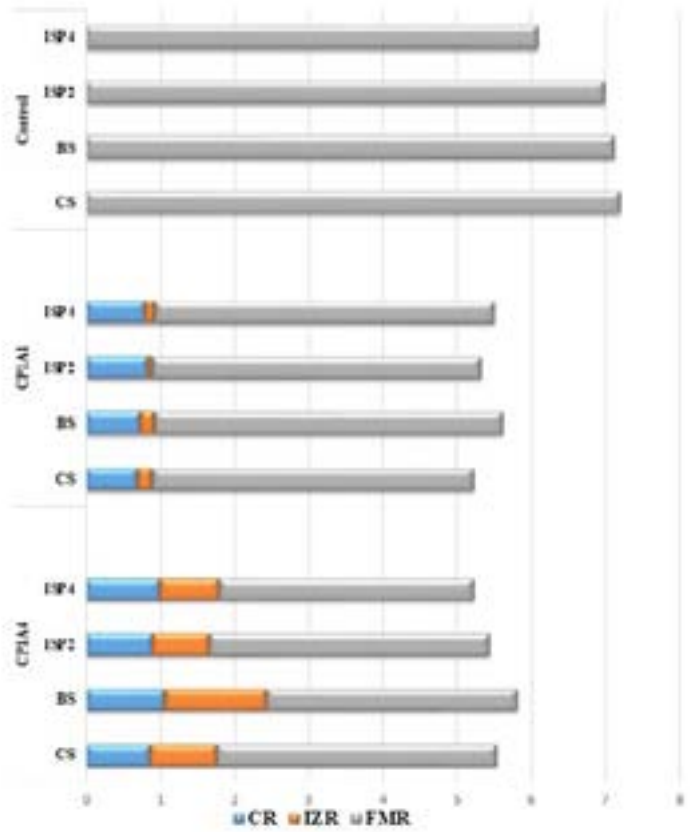
Fig. 14. Growth characteristiscs of CP1A4 in different ISP media



C-*Colletotrichum* sp.

A-Actinobacteria-*Streptomyces* sp. CP1A4C

Fig. 15. Dual culture antagonistic assay of CP1A4 against



CR-colony radius (cm);
IZR- Inhibition zone radius (cm);
FMR-Fungal mycelial radius (cm)
ISP-International Streptomyces Project
BS-Basal salts agar
CS-Coconut water starch agar

Fig. 16. Antagonistic potential of CP1A4 against *Colletotrichum* sp. in different media

04. Integrated Management of Diseases in Palms and Cocoa

Diseases are one of the major constraints in realizing the production potential of plantation crops. Though integrated disease management packages have been developed for the major diseases of coconut, arecanut and cocoa over the years, managing the diseases in these crops is a challenge due to various reasons. Regular monitoring of the pathogen population to find out the emergence of any new strains/new species, accurate identification, early diagnosis and refining the IDM to the changing climatic conditions or cropping pattern are necessary for the development of management strategies.

Fungal Diseases of Palms and cocoa

Diversity analysis of the pathogens

***Lasiodiplodia* spp.:** It is an emerging pathogen both in coconut and cocoa causing severe leaf blight in coconut and charcoal pod rot and dieback in cocoa. Recently observed dry bud rot/seedling rot in many coconut gardens in Coimbatore, Erode, and Tanjavore districts of Tamil Nadu is caused by *Lasiodiplodia theobromae*. Thirty *Lasiodiplodia* isolates associated with coconut and 10 isolates from cocoa were purified from infected samples collected from Andhra Pradesh, Kerala and Tamil Nadu states. Out of thirty *Lasiodiplodia* isolates of coconut, twenty nine were identified as *Lasiodiplodia theobromae* and one as *Lasidiplodia iranensis*. All the cocoa isolates were identified as *L. theobromae*. These strains are characterized by grey colour 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. Where as in *L. Iranensis* has grey color colonies with less aerial mycelium, oval-shaped conidia, initially hyaline and then brown (18-22×9-14 µm in size) with a single septum and longitudinal striations. Molecular identification of the pathogen was performed by sequencing the internal transcribed spacer (ITS) region. Phylogenetic analysis of ITS sequences of all the isolates and reference sequences retrieved from NCBI, GenBank revealed that only one isolate could be assigned to *L. iranensis* and remaining 29 to *L. theobromae.* (Fig. 17). Pathogenicity tests demonstrated that *L. theobromae* was pathogenic to both coconut and cocoa and further confirmed their cross infectivity on both the crops.

Disease Management

Screening of fungicides against major fungal pathogens infecting coconut: The systemic triozole fungicide, Hexaconazole 5EC, is currently recommended for the management of basal stem rot caused by *Ganoderma lucidum* and stem bleeding of coconut caused *Theilaviopsis paradoxa*by following the method of soil drenching and root feeding. An *in vitro* screening of selected combination fungicide (Captan 70% + Hexaconazole 5% EP) was carried out against both the pathogens as an alternative to the existing recommendation and same was compared with other fungicides (copper sulphate 47.15 % + mancozeb 30 % DWG, Hexaconazole 2% SC, Propiconazole 25% EC and Chlorothalonil 75% WP) at different concentrations *viz.*, 0.1%, 0.2% , 0.3% and 0.4%. Hexaconzole 5EC was taken as positive control treatment. Among the fungicides tested *in vitro*, combination of Captan 70% + Hexaconazole 5% EP (Taquat) gave 100% inhibition of fungal growth in the selected lowest concentration (0.1%). This may be due to the fact that combination fungicides due to presence of more than one active ingredient can disrupt more than one target site thereby increasing the potency of the fungicide. Propiconazole 25% EC (100%) and Hexaconazole 2% SC (90-100%) gave higher inhibition percentage at 0.2, 0.3 and 0.4 % respectively in comparison with the recommended Hexaconazole 5EC (80-95%) against both the pathogens. The performances of these fungicides were on par with combination fungicide Captan 70% + Hexaconazole 5% EP (100% mycelial growth inhibition at all concentrations) at higher concentration but not at 0.1%. Another combination fungicide, Copper sulphate 47.15 % + Mancozeb 30 % DWG didn't have any inhibitory effect on both fungi *in vitro* (0-10%). The study revealed that the potential of combination fungicide Captan 70% + Hexaconazole 5% EP in inhibiting the growth of both *G. Lucidum* and *T. paradoxa*. Field testing of this combination fungicide for the management of basal stem rot and stem bleeding disease has to be carried out.

Management of stem bleeding in coconut: Field trial on the management of stem bleeding disease of coconut with different fungicides (Hexaconazole 5EC and Propiconazole 25 EC) and *Trichoderma harzianum* (CPTD28)was conducted from 2016 at Maicha, Kasaragod district of Kerala. There were five treatments: T1 - Smearing of Hexaconazole 5EC on bleeding patches + drenching @ 0.1%; T2 - Smearing of Propiconazole 25EC on bleeding patches + drenching @ 0.01%; T3 - Placement of *T. harzianum* (CPTD28) enriched arecanut leaf sheath into bark + application of Trichoderma enriched neem cake @5kg/palm; T4 - Smearing with *T. harzianum* (CPTD28) talc powder +application of *Trichoderma* enriched neem

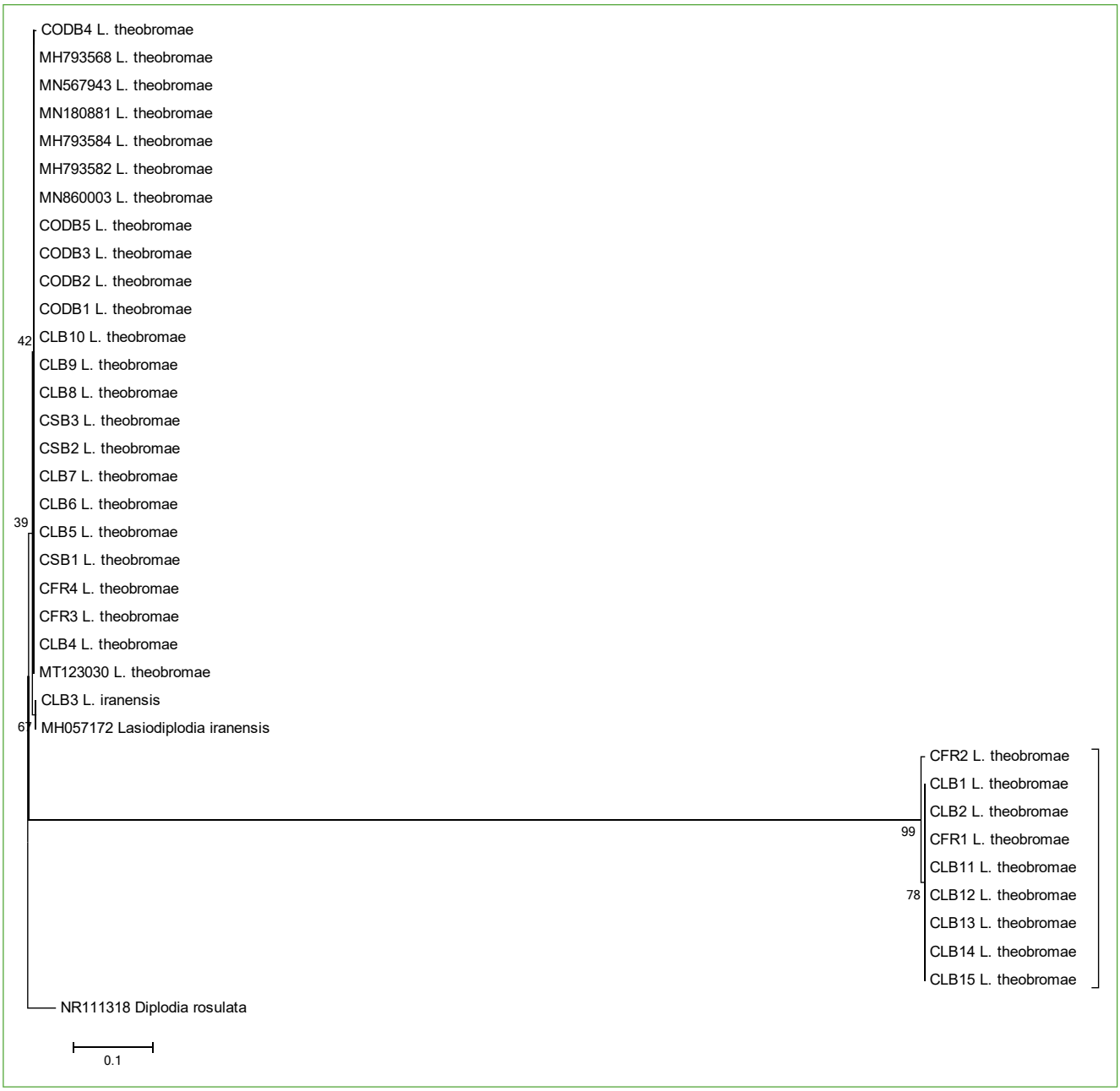


Fig. 17. Phylogenetic tree based on ITS region sequences of *Lasiodiplodia* isolates collected from coconut and cocoa

cake @5kg/palm; and T5 – Control. Test treatments were imposed at quarterly intervals. Significant reduction in disease index (23.1 to 0%) was observed with test treatments; complete recovery of palms observed with three treatments with Propiconazole 25 EC, Hexaconazole 5 EC and *T. harzianum*. Disease index in control palms increased from 21 to 66.5%.

Alternative fungicide for management of inflorescence dieback in arecanut

Inflorescence die-back disease is incited by an anamorphic fungus, *Colletotrichum gloeosporioides* Penz, and Sacc, and accountable for up to 60% yield loss in India. Seven fungicides (consists of contact, systemic and combinations) have been evaluated under *in-vitro* and *in-vivo* condition. Poisoned food technique against the virulent *C. gloeosporioides* revealed 100% mycelial inhibition in Propiconazole 25% EC; Carbendazim 25% EC + Flusilazole 12.5%SC; Chlorothalonil 78.12% WP; Zineb 68% WP + Hexaconazole 4% WP and Carbendazim 12% EC + Mancozeb 63%WP: Mancozeb 75% WP was the control. Significantly more mycelial growth was recorded in copper oxychloride 50% WP and Mancozeb 75% WP treatments. In the field trial, treatments were imposed after opening of female flowers and second spray was given at

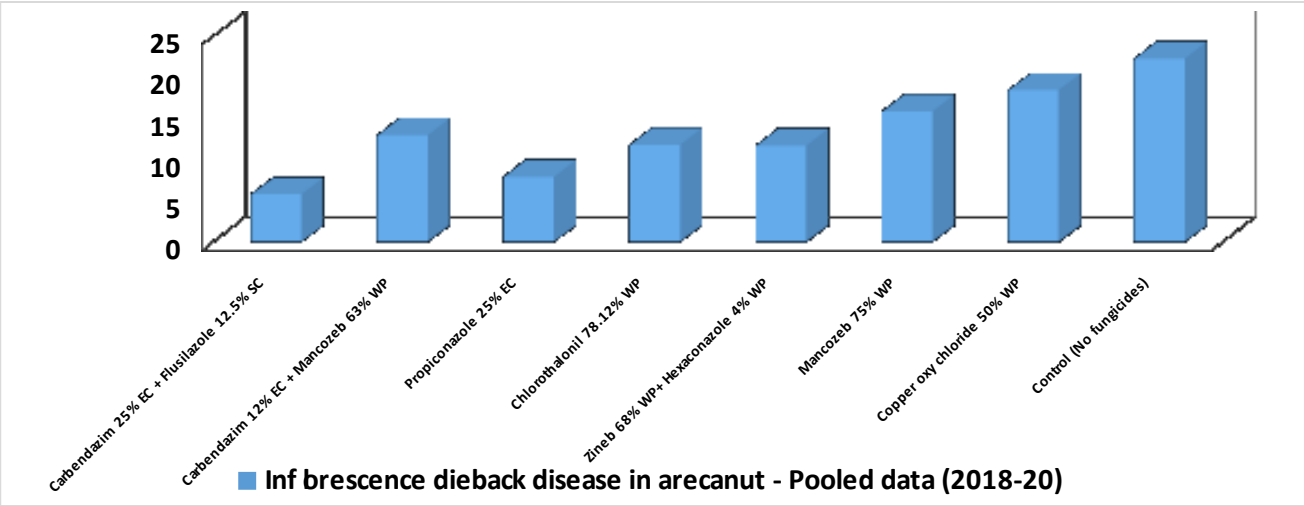


Fig. 18. Percentage incidence of inflorescence die-back disease in arecanut sprayed with different fungicides

30 days interval. Periodical observations on the percent disease incidence were recorded up to May. Pooled analysis of the field data collected during three consecutive years (2018-2020) recorded significantly lower disease incidence of 5.79% and 7.94% respectively with the treatments 0.2% Carbendazim 25% EC + Flusilazole 12.5% SC and 0.3% Propiconazole 25% EC. Incidence in other treatments can be seen in Fig. 18. Recently, the Government of India has listed 27 fungicides to be banned for use in India which included the commonly used fungicides like carbendazim, mancozeb and zineb. In this context, Propiconazole 25% EC (0.3%) could be used as an alternative fungicide in the IDB disease management programme.

Isolation of *Phytophthora palmivora* from fruit rot infected wild arecanut (*Areca triandra*)

Areca triandra is a wild arecanut species characterized with small size arecanuts which are very hard. The observation on these palms for many years at ICAR-CPCRI farm has shown that they were free from fruit rot disease. However, a recent diagnostic visit conducted during August, 2020 reported the fruit rot infection in *A. triandra* fruits in Sullia, Karnataka. Pale to dark green water soaked lesions were observed near perianth end and gradually spread over the entire fruit surface which finally shed off (Fig. 19). Severely infected fruits remain mummified without shedding. Subsequently, morphological (colony growth, texture of colony, sporangial shape, and branching of sporangiophore) (Fig. 20) and molecular characterization (PCR amplification of ITSregion of ribosomal DNA origin) confirmed the identity of the causal organism as *Phytophthora palmivora* Butler. Koch postulate was confirmed on healthy *A. triandra* fruits by re-isolation of the inoculated pathogen. Cross-inoculation studies of *P. palmivora* isolated from *A. Triandra* against coconut and cocoa resulted in the development of water soaked lesions and rotting of fruits. Further, Koch postulate was also confirmed by re-isolation of the pathogen and confirmed as *P. palmivora*.

Farmer friendly technology for *Trichoderma* multiplication and supply of nucleus culture

T. harzianum (CPTD28) is a potential native isolate found very effective in the management of major fungal diseases of coconut and cocoa and also possesses growth promotion property. Presently talc-based formulation of *T. harzianum*

Fig. 19. Fruit rot symptoms on *Areca triandra*

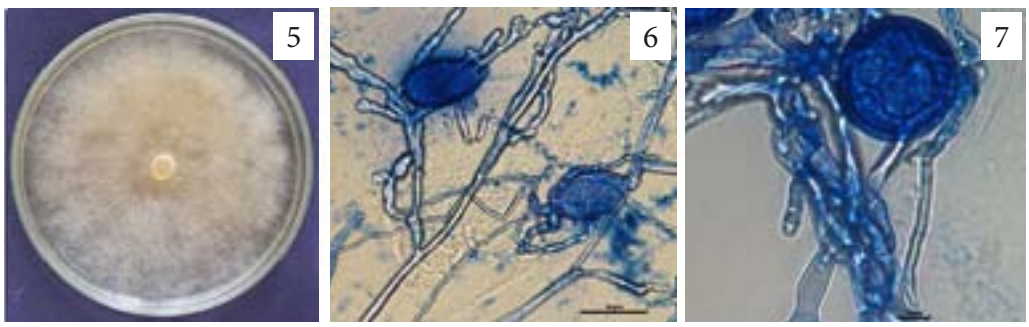


Fig. 20. Morphological characteristics of *Phytophthora palmivora*; Mycelial growth (5); Sporangial characteristics (6); and Chlamydospore characteristics (7).

has been produced and being used in the management of coconut and cocoa diseases. One of the limitations of talc based formulation is the short shelf life and difficulty to maintain and multiply the formulation at farm level. Hence, four types of farmer friendly and cost effective bio substrates *viz*, coconut leaves, arecanut leaf sheath, sorghum grains and sorghum grain powder were tested for multiplication. Significant increase in colony forming units (cfu/g) was recorded in all the formulations (200 X $10^8$to 433X 10^8cfu/g) but highest cfu/g was recorded in areca based formulation (433x10^8) and this could be used for regular multiplication of *Trichoderma* and also for maintenance and supply of nucleus culture to farmers.

Sodium alginate based bead formulation of fungal conidia for long term storage.

Dry mycelial and conidial bead formulations of *Colletotrichum gloeosporioides*, *Lasidiplodia theobromae* and *Trichoderma harzianum* were prepared using sodium alginate solution. The mycelia and conidial mass of fungal cultures were impregnated in sodium alginate by soaking the powdered dry mycelia and conidia in sodium alginate solution (2% w/v) for 30 minutes and made into bead form by gently pouring the solution in calcium chloride solution (3% w/v) with the help of burette at a flow rate of 1 ml/ minute. The beads were washed twice with deionized water and kept for drying in room temperature. Another set was freeze dried to smaller pellets. The beads were later kept at 4°C and room temperature (25°C) desperately for studying the shelf life and conidial viability. The colony forming units (cfu) for the fungal cultures were 27×10^8 cfu/gm for *C. gloeosporioides*, 26 × 10^7 cfu/gm for *L. theobromae* and 35 × 10^8 cfu/gm of bead for *T. harzianum* in the initial. Further conidial viability will be calculated at weekly interval for maximum period until the viability deteriorates.

Phytoplasma diseases

Multilocus sequencing and characterization of phytoplasma associated with lethal wilt disease (LWD) of coconut

The identity of the LWD phytoplasma (*Candidatus* Phytoplasma asteris, 16Sr IB subgroup) isolates from Tamil Nadu was studied in detail by the molecular characterization of translation elongation factor (*tuf*), ribosomal protein (*rp*), Sec Y and antigenic membrane protein (*amp*) genes. The partial *tuf* gene sequences of LWD phytoplasmas (GenBank accessions: MK614890, MT108188) showed more than 99% identity with aster yellows group (AY) phytoplasma (GenBank accessions: MG744259, MH061368, KP219000). In the phylogenetic tree constructed using *tuf* sequences of AY group phytoplasmas, LWD phytoplasma formed a subclade in *tufI*-B subgroup (Fig. 21). Phylogenetic analysis using partial sequences of ribosomal protein showed LWD phytoplasma isolates asa separate cluster along with the *rpI*-L subgroup phytoplasma isolates *viz*., Maize bushy stunt phytoplasma MBS and the Iranian isolates affecting carrot (CADI), niger seed (NiG2) and onion (SOZ1). The preprotein translocase subunit (*SecY*) sequences of LWD phytoplasma showed more than 99% nucleotide sequence identity with Carrot yellows phytoplasma (GenBank accession: KC354611). In the phylogenetic tree based onSecY sequences the LWD phytoplasmal isolates grouped together into a separate subclade.The fragment containing partial sequences of the molecular chaperonin subunit groEL and antigenic membrane protein (*amp*) showed 100% similarity with Maize bushy stunt phytoplasma strain M3 (GenBank accession: CP015149).

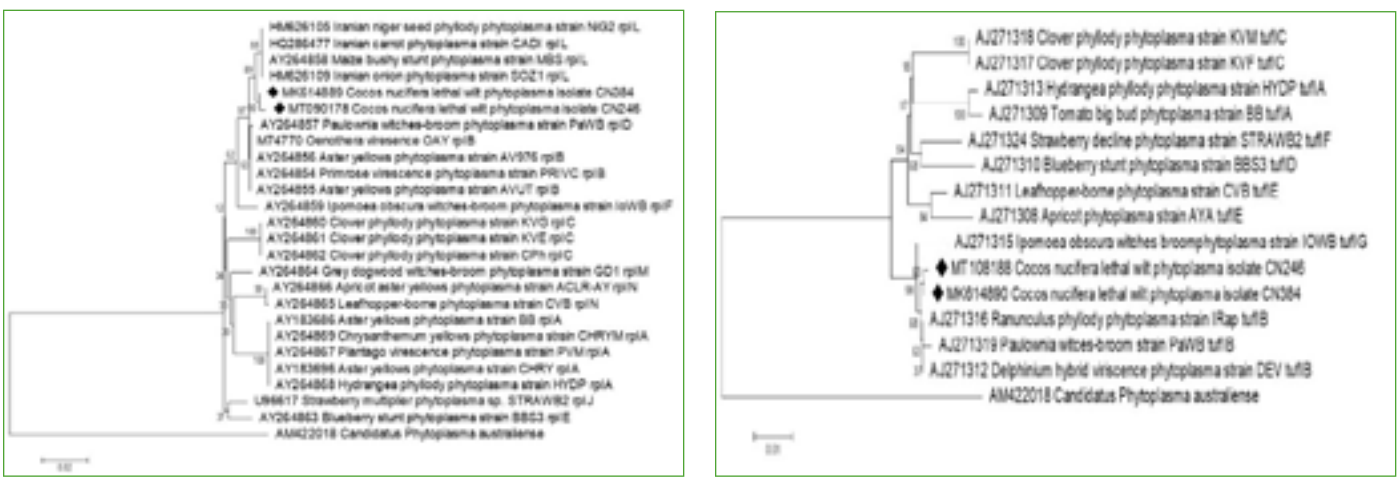


Fig. 21. Ribosomal protein gene (*rp*) and tuf gene based phylogeny of the LWD phytoplasma

05. Integrated Management of Pests and Nematodes in Palms and Cocoa

Coconut rhinoceros beetle (*Oryctes rhinoceros*)

The emergence of *Oryctes rhinoceros* nudivirus (OrNV) resistant haplotype (Guam strain) of coconut rhinoceros beetle (CRB)in coconut plantations in south-east Asia led to a systematic surveillance for this Guam haplotype of CRB in India. Indian OrNV has been characterized and was found in similarity with identified OrNV genome. OrNV is being maintained *in vivo* in the grubs of *O. rhinoceros* whereas it is maintained in cell lines of *Heteronychus arator* (F.) in all Pacific Island Countries.

In the surveillance programme, more than 1.3% of grubs of *O.rhinoceros* collected from natural breeding zone in the country have been virosed exhibitingcharacteristic gut clearing and prolapsed symptoms. In addition, more than 90% infection was realized in the grubs of *O. rhinoceros* upon artificial *per os* feeding of OrNV suspension suggestingthe absence of Guam haplotype. It was reported that *Mse*I restriction site polymorphism in amplified region of cytochrome oxidase gene (*COI*) of coconut rhinoceros beetle allowed A to G transition at nucleotide position 288 in the identification of CRB-Guam haplotype. However, molecular characterization of *COI* gene of coconut rhinoceros beetle collected from Kayamkulam, India had no A to G transition (Fig. 22) indicating the absence of CRB-Guam haplotype in the country.

Area-wide evaluation of botanical cake and paste in AICRP on palms centres as well as at Kayamkulam subdued the pest damage to more than 80% and shielded the juvenile palms from fresh attack by rhinoceros beetle to more than three months.

Ecological engineering for *Atmanirbhar Krishi*

Crop pluralism in Kalpa Sankara coconut garden suppressed the incidence of rhinoceros beetle (7.7%), rugose spiralling whitefly (5.1%) and Bondar's nesting whitefly (10.3%) whereas it exceeded 20% in mono-cropped garden. Parasitism by the aphelinid parasitoid, *Encarsia guadeloupae* on rugose spiralling whitefly was found to be higher (>65%) due to habitat diversification in the system favouring the sustenance of natural enemies as well as pollinators. Colony build up of honey bee in crop divergence encouraged effective bifurcation of two bee colonies due to good inflow of pollen by foragers, however, the nectar sources are limiting. Continuous outflow of banana bunches, Annona, Jack and West Indian cherry fruits as well as fishes make the system holistic and self-reliant delivering continuous income and employment (*Nariyal dwara aatmanirbhar krishi*). Small millets were the new addition and the nut yield for the past five years exceeded 165 nuts/palm/year. While the soil temperature was 5°C lower, the organic carbon content and vermicasts were significantly higher with abundant beneficial microbes due to effective recycling

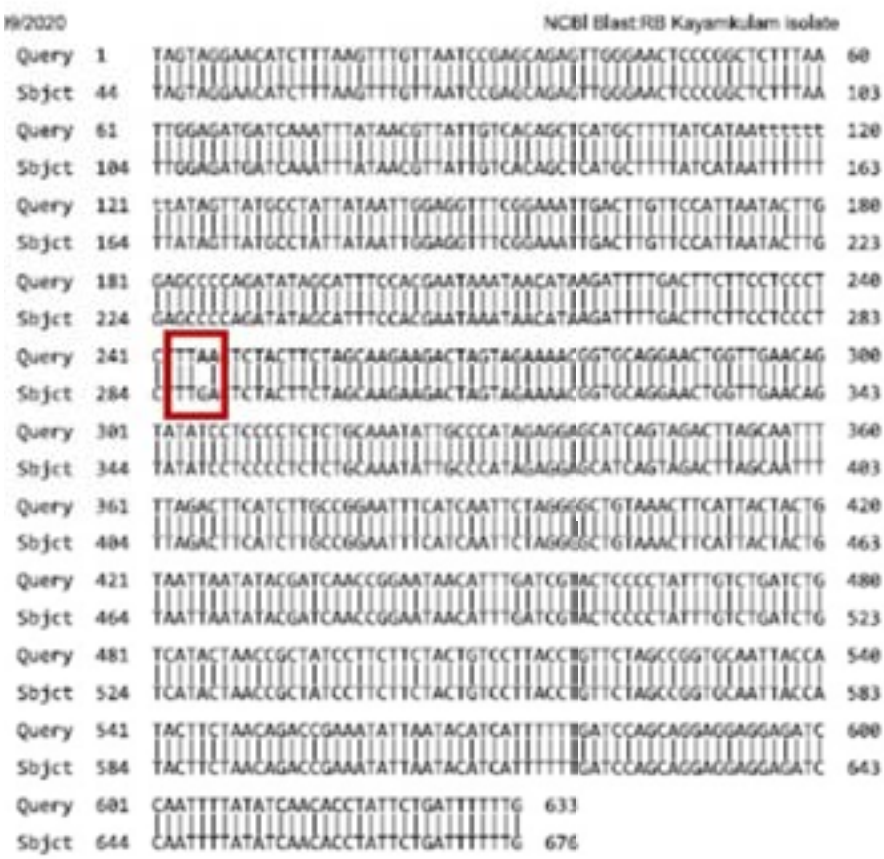


Fig. 22. Molecular characterization of cytochrome oxidase gene (*COI*)of Indian CRB showing no A to G transition at 288 nucleotide position.

of organic residues making soil-health resilient as well as climate smart.

Red Palm Weevil (*Rhynchophorus ferrugineus*)

The field data collection phase of the detection system was completed. The collected data was analysed and utilized for training and developing AI models. More than 25 different models were developed and tested with field data and chosen the AI model that resulted in 80% accuracy. The battery powered portable acoustics based detector scans the palm for two minutes and displays the detection feedback on the screen. This would be the first prototype gadget (Fig. 23) in the country for early detection of red palm weevil infestation using machine learning and artificial intelligence.

Fig. 23. Acoustics-based detection system of red palm weevil infestation on palms

Black headed caterpillar (*Opisina arenosella*)

Moderate incidence of black headed caterpillar was noticed at Karsaragod. In a total 120 tall infested palms, frond damage was found to be 10.75 %. On juvenile palms (4 year old), 20.93% fronds were infested with a range of 8.4% to 27. 45% infested leaflets. The pest outbreak was successfully contained by sequential release of larval parasitoids *Goniozus nephantidis* and *Bracon brevicornis*.

Exotic whiteflies in coconut system

Woolly whitefly (*Aleurothrixus floccosus*): A non-native woolly whitefly, *Aleurothrixus floccosus* from Neotropical region was observed on guava (*Psidium guajava*) prevalent in coconut based homesteads in Kerala (Azheekal, Kollam district) and Tamil Nadu (Marthandam, Kanyakumari district).

Damage symptoms: Adult whitefly and immature stages are confined on the under surface of guava leaves. At severe level of infestation, entire underside of leaf was covered with flocculent white mass with nymphs and adult whitefly. By the exhaustive de-sapping by nymphs and adult whitefly, a good amount of honey dews are deposited which subsequently attracted growth of black sooty mould (Fig. 24A) subduing the photosynthetic efficiency of the plants. When damage intensity increased, leaves get scorched and become necrotic and turn the plant sick. This whitefly was not observed on other host plants including some *Citrus* sp. noticed in the immediate vicinity.

Pest stages: Eggs are saucer-shaped (Fig. 24B), light brownish, laid in small congregation in an irregular manner. Early instar nymphs are oval with strong whitish borders with eight conspicuous white puff on the dorsum; two at the anterior end, two posterior and four in the mid region (Fig. 24C).With advancement into next stage, the nymphs secrete enormous flocculent mass (Fig. 24D) and cover the entire body with dense coverage on the leaf. Adults are pure white with no visible markings on wings and upon rest, the wings are held roof-like (Fig. 10E), typical to that of *Aleurothrixus* group.

Pupal diagnosis

Puparia dark brown to black; margin with coarse teeth or crenulations (Fig. 25C), a gland is present at the base of each tooth, which gives margin the appearance of having a double row of teeth. Vasiform orifice elevated, heart-shaped, transverse, wider than long, small lingula obscured by operculum.Operculum large covering the entire vasiform orifice with a pectinate process (mushroom-shaped) on the posterior margin (Fig. 25D) Caudal furrow absent. Puparia often in dense groups which are covered by secreted flocculent wax. Sub-marginal fold continuous (Fig. 25A), A8 (pair of setae on either side of vasiform orifice) and caudal setae very long and extending beyond the pupal margin (Fig. 25B) with small but conspicuous sub-marginal setae (Fig. 25E).

Structural characterization of cement gland in *Aleurodicus rugioperculatus* and *Paraleyrodes bondari* as an identification marker

Cement gland is anaccessory reproductive gland in adult female whiteflies producing secretions for effective adherence of eggs in to the epidermis on the underside of leaves. Cement glands of the two exotic whiteflies infesting coconut *viz.,* rugose spiralling whitefly *Aleurodicus rugioperculatus* and the Bondar's Nesting

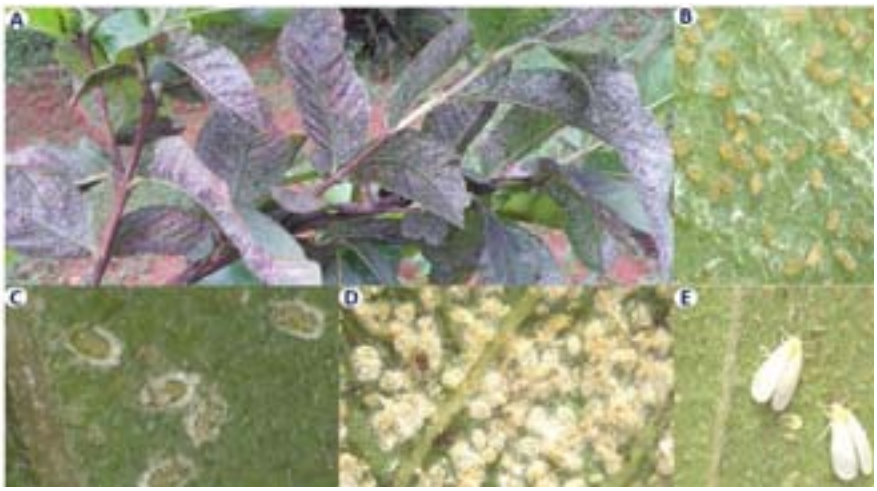


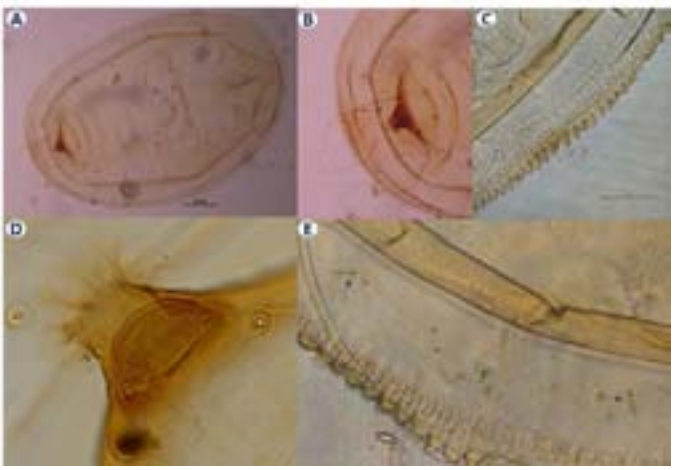
Fig. 24. Damage symptoms and pest stages of Woolly whitefly (*Aleurothrixus floccosus*) on guava

whitefly, *Paraleyrodes bondari*were characterized as part of taxonomic studies. The shape and structural alignment of bulb body of these glands are recently used as one of the identification features of adult whiteflies. Upon examination of these two non-native whiteflies, the bulb body of cement gland was found to have a wavy margin in case of *P. Bondari* (Fig. 26B)whereas *A. Rugioperculatus* showed a smooth margin having bulged middle end (Fig. 26 A). Considering the significant structural modification of bulb body in each of the whitefly species, cement glands could probably emerge as an identification marker for adult whiteflies. Unique structural modifications of these cement glands in *A. rugioperculatus* and *P. bondari* are reported for the first time.

Co-existence and competitive regulation

Co-existence of rugose spiralling whitefly (*A. rugioperculatus*) and Bondar's nesting whitefly (*P. bondari*) and modulation in their population was studied at Kayamkulam on Kalparaksha coconut variety during the year 2020. Live colonies were counted on five randomly selected leaflets and the population dynamics was presented in Fig. 27. Influence of the aphelinid parasitoid, *E. guadeloupae* on the population of *A. rugioperculatus* was also observed and presented in Fig. 28.

RSW colony was found to be highest (4.5) during February



v Fig. 25. Puparial features of *A. floccosus*

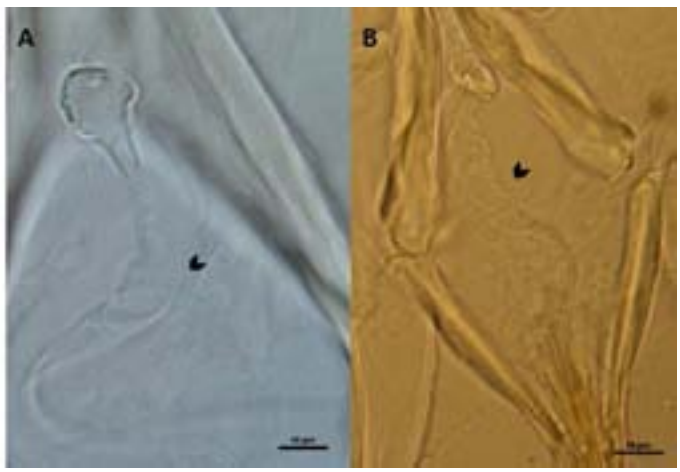


Fig. 26. Cement glands of *P. bondari* and *A. rugioperculatus* a potential identification marker

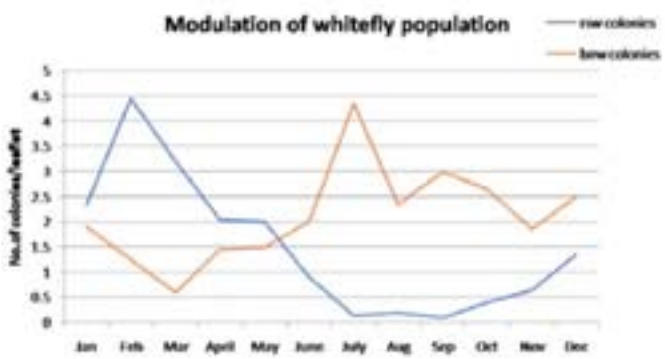


Fig. 27. Modulation of co-existing whitefly population

Fig. 28. Parasitism by *E. guadeloupae* on *A. rugioperculatus*

2020 and lowest (0.3) during July to September 2020. Likewise BNW colony was found to be highest (4.5) during July 2020 and lowest during March 2020 (0.5). This clearly indicates the competitive regulation of whitefly population when RSW colony rose to highest, BNW was always found to be least and *vice-versa*. Increased population of RSW is definitely subduing the population of BNW. The transition phase happened during May 2020 when the population synchronised (1.7). This ecological significance also coincided with the enhanced parasitism of *E. guadeloupae* on *A. rugioperculatus*. Parasitism of *E. guadeloupae* was found to be highest during August to October 2020 when population of *A. Rugioperculatus* was found the least. Congenial weather factors, parasitism by *E. guadeloupae* as well as inter-specific competition regulate the population of *A. rugioperculatus* in coconut system.

At Kasaragod, monthly observation on population dynamics of whitefly complex on COD palms indicated that, *Paraleyrodes bondari* dominated over other whitefly species, which was maximum during December 2019 (6 adults/leaflet) and least on September 2020 (0.6 adults/leaflet). RSW population was found to be highest during December 2019 (1.4 adults/leaflet) and least during September 2020(0.3 adults/leaflet). The population of *P. Minei* was found to be negligible throughout the period of observation. Per cent parasitism by *E. Guadeloupae* on RSW pupae was found the highest during the month of August 2020 (63. 32%) and least during October (36.05 %).

Conservation biological control of rugose spiralling whitefly

The experiment was initiated during January 2020 on juvenile Kalpasankara palms to evaluate the efficacy of biorationals on the bio-suppression of rugose spiralling whitefly mainly coinciding the rising phase of the pest. Four treatments were imposed with ten palms per treatment and sampling made on four leaflets per palm. Two sprays were undertaken at fortnightly intervals and observations were recorded one-month and two-months after superimposition of treatments. The results are presented in Table 6.

Under good nutrition management, it was found that palms treated with neem oil (5%) and water spray could reduce the RSW population significantly. In a period of five months, RSW population could be effectively suppressed to the tune of 83% to 87% in all treatments and parasitism by *E. guadeloupae* ranged from 52% to 56%. It was therefore evidently proved that conservation biological control was very successful in the bio-suppression of RSW as pesticide holiday approach could restore the population build up of natural enemies which subsequently reduced the pest population in a period of five months.

Classical bio-scavenging programme

Sooty mould scavenger beetle, *Leiochrinus nilgirianus* re-emerged after aestivation in RSW-infested Kalparaksha coconut garden at Kayamkulam during May-June and sustained till December 2020. The beetle was introduced in two RSW-prone regions through Aliyarnagar and Ambajipet centres of AICRP on Palms. The establishment of sooty mould scavenger beetles was not very successful in dry summer period in many areas.

Botanical soap for the management of exotic whiteflies

Aqueous extract of three botanicals *viz.,* garlic, neem and *Vitex negundo* was formulated as botanical soap and evaluated against exotic whiteflies on coconut. Application of 0.5% to 1.0% of soap solution reduced 52%-74% of different stages of whiteflies under field condition whereas water spray could reduce 35% of pest population. These

Table 6. Efficacy of biorationals on the bio-suppression of rugose spiralling whitefly

Treatments	RSW live colonies per leaflet (no.)					
	Pre-treatment	After two months	Reduction (%)	After 5 months	Reduction (%)	Parasitism (%)
Conservation biological control	4.05 (1.93)^{b}	2.58 (1.68)^{b}	36.30^{b}	0.65 (0.81)	86.1	55.7
Isaria fumosorosea	7.16 (2.54)^{a}	3.10 (1.72)^{b}	56.70^{ab}	1.10 (1.04)	87.2	52.6
Neem oil 0.5%	4.78 (2.17)^{ab}	1.35 (1.12)^{a}	75.76^{a}	0.75 (0.87)	82.9	52.2
Water spray	6.40 (2.46)^{ab}	1.88 (1.29)^{a}	70.63^{s}	0.90 (0.95)	85.5	52.6
CD (P=0.05)	0.53	0.33	23.2	ns	ns	ns

Fig. 29. a) Caterpillar b) Obtect pupa and c) Adult moth

botanical soaps readily dissolved in water, were found to be less persistent and were relatively safe to non-target organisms. The *p*H of spray fluid was found to be neutral (7.0).

Sporadic outbreak of microlepidopteran, *Coconympha iriarcha* Meyrick on coconut

A sporadic outbreak of microlepidopteran, *Coconympha iriarcha* (Gelechidae: Lepidoptera) was noticed in association with black headed caterpillar, *Opisina arenosella* infested coconut palms at Kasaragod, Kerala during Jan-Feb 2020. Caterpillars scrape and feed on the green matter in between the veins and in severe cases, leaf skeletonization and abundant frass material was observed. On an average, 3 to 20 larvae per leaflet were recorded. Larvae were pale yellowish with two red dorsal lines running from head to rear end with cream-coloured head (Fig. 29a). Larval period ranged from 7 -12 days, with pupal period for about 6 – 7 days (Fig. 29b). Adult moths have olive green forewings with silvery white median transverse line and with dark hind wings having wingspan of 10-13 mm (Fig. 29c).

Phyto and entomopathogenic nematodes

EPN for the bio-suppression of banana pseudostem weevil in coconut system: Prophylactic application of aqua formulation of 'Kalpa EPN (CPCRI - SC1), *S. carpocapsae* @ 50 ml solution containing 2500 IJs and delivered on leaf axis and whorls as well as placement of nematode infested *Galleria* cadavers of about 4 and 8 days old *S. carpocapsae* and *Heterorhabditis indica* (CPCRI - HI1) @ 1 cadaver / leaf whorl at fortnightly intervals on four months old banana were found effective in the suppression of banana pseudostem weevil. Curative treatment of the aforesaid treatment reduced pest damage to 6.2% from about 10% and to 27.5% from about 35% during 2019-20 and 2020 -21 crop seasons, respectively. Field collected grubs caused 100% mortality @ 30 IJs / grub within 48 - 72 hours of release of *S. carpocapsae* (CPCRI - SC1), *S. abbasi* (CPCRI - SA1) and *Heterorhabditis indica* (CPCRI - HI1) in the laboratory (Fig. 30). Early detection of pest infestation and EPN delivery is crucial for the suppression of the pest.

EPN- A success story in pest suppression: EPN has been a successful bio-agent in the bio-suppression of soil pests (white grubs), cryptic pests (internal borers) as well as foliage vegetable pests. Area-wide demonstration in the management of arecanut root grubs, banana pseudostem weevil as well as caterpillar foliage pests on okra, cabbage and cauliflower had made this technology highly popular among farmer groups and other stakeholders. The demand of EPN has been on the rise and the mass production technology is being procured by various farmer groups to realize clean and green farming, promoting *Atmanirbhar Krishi*. More than 2000 units of EPN liquid and cadaver formulation were distributed to the farmers on demand basis from the ICAR-CPCRI sale point and generated revenue of Rs. 18,500/- during 2020-21 crop season. About 4000 EPN units were freely distributed to the farmers who had visited CPCRI during COVID- 19 pandemic. Conducive weather conditions in Western Ghat region cultivated

Fig. 30. Healthy grubs, EPN infected grubs, and emerging nematodes from grubs.

with plantation crops realized better efficacy of EPN against crop pests and became an integral part in environmentally responsible farming.

Area-wide demonstration of EPN in white grub management: An eco-friendly technology for root grub (*Leucopholis* sp.) management using EPN was demonstrated in arecanut gardens at Dakshina Kannada and Udupi district of Karnataka having 40% to 50% pest incidence. Soil drenching of Kalpa EPN (CPCRI - SC1), an aqua suspension of *Steinernema carpocapsae* @ 1.5 billion IJs / ha during June - July and September - October followed by neem cake application @ 2 kg/palm during December - January for three years, reduced 90% to 100% root grub incidence with dry nuts yield of 1.7 – 2.2 kg/plant. The incidence of root grub infested palms was below 1% in treated gardens compared to the farmer practice.

Survival of EPN (CPCRIS0804) in water suspension under ambient temperature: The superiority of the EPN isolate *Steinernema* sp. CPCRIS0804 over the other species was confirmed for the third year in a row (Fig. 31). More than 96% survival of infective juveniles (IJs) of the isolate was observed after seven months of storage indicating its superior virulence.A new entomopathogenic nematode belonging to *Steinernema* sp. was isolated from the Thekkekara village of Alappuzha district. The mean body length of infective juveniles (IJs) was observed to be 450 to 500 µ and the morphology of the new isolate indicated it as a member of 'carpocapsae' group of steinernematids.

Survival of EPN in sand medium for developing formulation against RPW: When EPN infested cadavers were kept inside 100 ml plastic bottles filled with moist soil, the IJs readily emerged from the cadavers into the sand medium. As the moisture within the bottle gradually depleted the IJs were observed to concentrate on a particular point and converted into anhydrobiotic state, which was observed as white patches within the bottles. These bottles were rehydrated in monthly intervals and observed the live IJs by washing the soil. The presence of live IJs (27855 IJs/ bottle) was observed in 75% of bottles (4 cadavers/bottle) up to three months of storage.

Cadaver based EPN capsule formulation: The capsule formulation of entomopathogenic nematode *Steinernema* sp. CPCRIS0804 (Fig. 32a) was developed for the prophylactic application of EPN against red palm weevil infesting coconut. Dry sand particles used within the capsules will not allow emergence of IJs from the cadaver placed inside the capsule attaining anhydrobiotic condition. When the capsule gets in contact with water, it dissolves slowly and sand particles within the capsule absorb moisture. As the moisture get in to the capsule, the anhydrobiotic IJs within the cadaver slowly rehydrate and get out from the capsule (Fig. 32b). The field evaluation of the capsule formulation as a prophylactic treatment for the management of red palm weevil is in progress.

Phytoparasitic nematodes: Infestation by root-knot nematode, *Meloidogyne incognita* was recorded on fenugreek and cow pea grown in coconut-based cropping system. The incidence was recorded to the tune of 18% - 20 % with maximum gall index as 3.5 and 2.0 in fenugreek and cow pea plant roots, respectively.

Management of root knot nematodes infestation in coconut intercrops: Field survey in five villages in Alappuzha district revealed severe infestation of root knot nematodes in intecrops such as tuber crops, spices, vegetables and fruit crops. Demonstration of integrated nematode management was made in 10 plots.

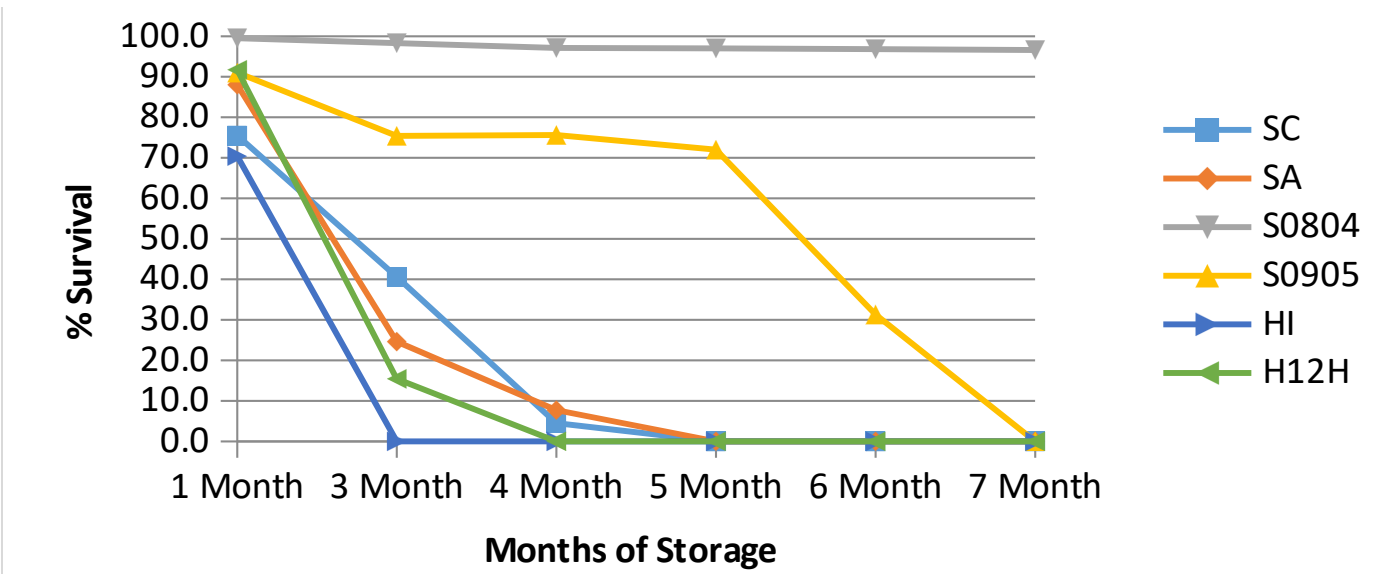


Fig. 31. Survival of different EPN isolates under ambient temperature

Fig 32a. Capsule formulation of EPN

Fig. 32b. Emergence of IJs from the capsule.

Community analysis of plant parasitic nematodes in the coconut rhizosphere: Soil samples were collected from the basins of coconut palms and the samples were processed for the isolation of plant parasitic nematodes. The presence of important genera viz. Radopholus, Rotylenchulus, Hoplolaimus, Helicotylenchus, Pratylenchus, Tylenchorhinchus, Criconema, Meloidogyne, Xiphinema and Longidorus was observed with varying population densities.

Concurrent Emergence of Exotic Whitefly Incursions on Arecanut

Field incidence of exotic whitefly complex comprising two Neotropical nesting whiteflies *viz., Paraleyrodes bondari* Peracchi and *Paraleyrodes minei* Iaccarino in association with invasive rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin and native areca whitefly, *Aleurocanthus arecae* David & Manjunatha on arecanut is reported from Karnataka, India during 2020 (Fig. 33).

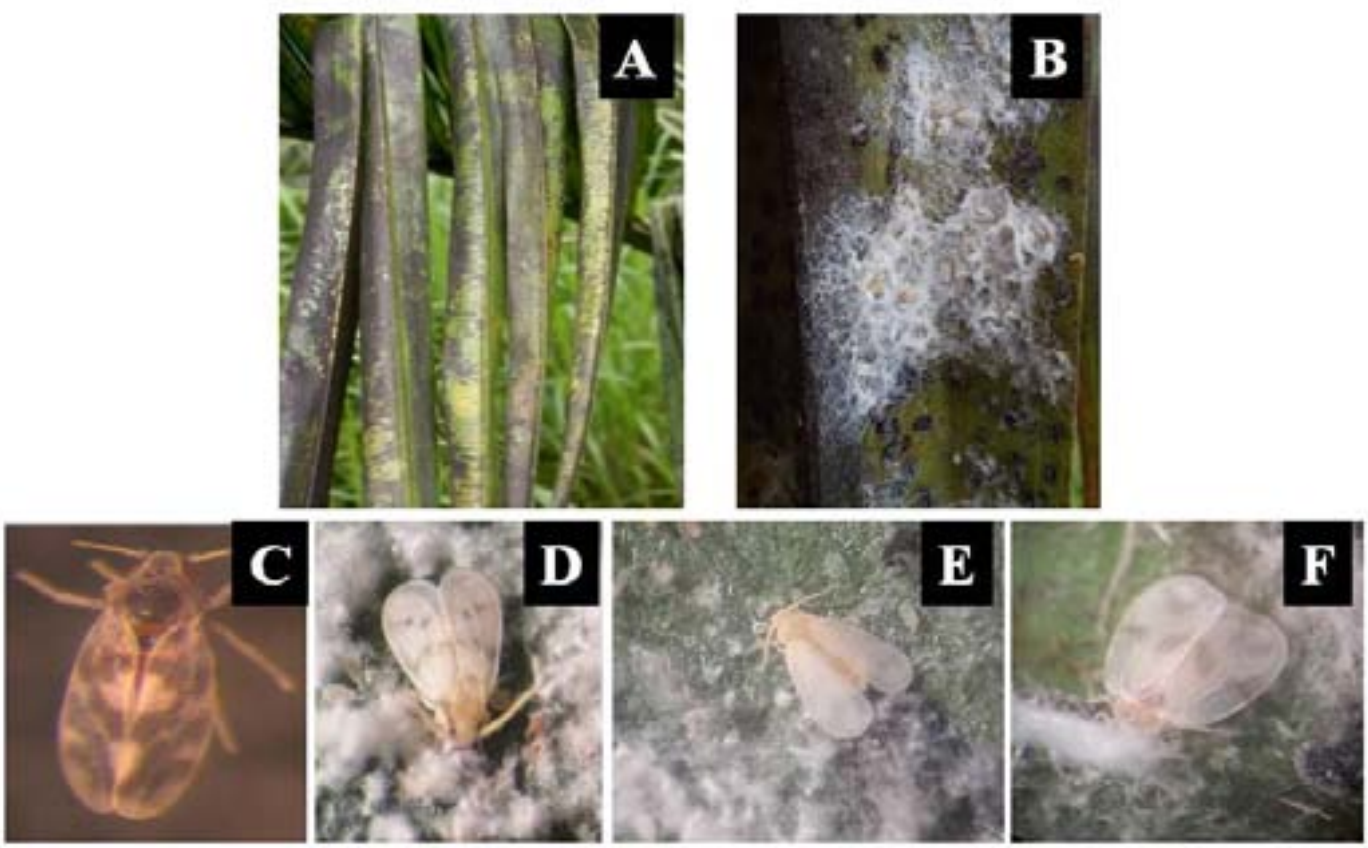


Fig . 33. Whiteflies on arecanut:(C) *Aleurocanthus arecae*; (D) *Paraleyrodes bondari*; (E) *Paraleyrodes minei*; and (F) *Aleurodicus rugioperculatus*

These arecanut palms were previously infested by *A. arecae* which was earlier reported from Karnataka during 2003. To our knowledge this is the first report on the infestation of *P. bondari* and *P. minei* on arecanut. Morphological identification based on pupal taxonomy and male genitalia as well as molecular characterization of the mitochondrial cytochrome oxidase I (*COI)* gene confirmed the identity of nesting whiteflies. The Bondar's nesting whitefly, *P. bondari* is the most predominant whitefly species with 87.5 % active colonies followed by the nesting whitefly, *P minei* (13.64 %) and the rugose spiralling whitefly, *A. rugioperculatus* (6.25 %). Co-occurrence of these three non-native whitefly species on arecanut in synergy with the native *A. arecae* indicates a kind of competitive regulation of one species over the other upsetting biodiversity.

Wood borer, *Rhaphipodus subopacus* Gahan, 1890 (Coleoptera: Cerambycidae: Prioninae), infesting Cocoa

Infestation by the wood borer, *Rhaphipodus subopacus* Gahan, 1890 (Coleoptera: Cerambycidae: Prioninae) on cocoa is reported for the first time from Karnataka state in Southwestern India (Fig. 34). The taxonomic identity of the species was confirmed by amplification of the mitochondrial cytochrome oxidase I gene (*COI* gene). The nucleotide sequences of the *COI* gene were submitted to GenBank with accession number, MT-773580 to MT-773583 (Fig. 35). No pervious information on the nucleotide sequences of *R. subopacus* is available in any of the taxonomic database. As far as the genus *Rhaphipodus* is considered, nucleotide sequences of *mtCOI gene* of only one species (*R. suturalis*) is available in the GenBank.

Cocoa trees of more than 15 years old were found highly susceptible to infestation of *R. subopacus.* The symptoms of infestation are (i) Yellowing of trees during initial stage of the infestation, (ii) presence of 20-40 mm round emergence holes with extrusion of chewed fibrous material (Fig. 36B), (iii) main stem becomes hollow due to extensive feeding of grubs inside (Fig. 36C), (iv) during the later stage of infestation, internal content of the stem turns into decomposed powdery matter (Fig. 36D), and (v) drying of infested trees during advanced stage of infestation.

Novel damage intensity index for tea mosquito bug (TMB), *Helopeltis* spp.

Based on thesymptoms and intensity of damage (number of feeding lesions(Xn), diameter of feeding lesions and infested area (Xa) on cocoa pods), a new damage intensity index for TMB infestation has been developed. Correlation coefficient of Xn and Xa with other easily observable variables (Tn=number of feeding lesions on top portion; Mn= number of feeding lesions on middle portion; Bn= number of feeding lesions on bottom portion) revealed that the highest correlation is between Xn and Mn. Hence, linear regression with Xn as response variable and Mn as independent variable was worked out to obtain the damage intensity index (DII) and the estimated regression equation is Xn=1.79+0.25Mn (R^2=0.989). The estimated value of Xn is taken as the pest severity index.

Fig. 34. Adult beetle of *Rhaphipodus subopacus*; 1. Dorsal view; 2. Ventral view

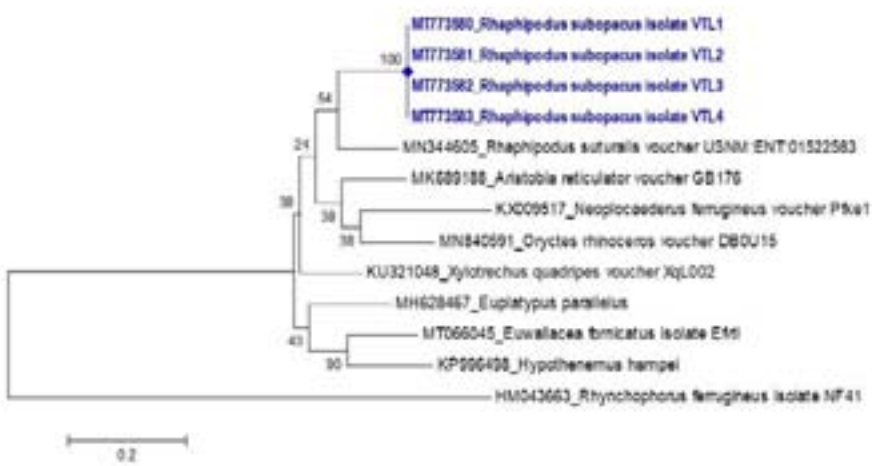


Fig. 35. Phylogenetic tree depicting evolution of the genus*Rhaphipodus* with other close coleopteran insects

Fig. 36. Damage by *Raphipodus subopacus*: (B) Presence of exit holes and chewed fibre; (C) Hollowed stem, and (D) Feeding grubs and powdery mass

06. PHYSIOLOGY, BIOCHEMISTRY AND VALUE ADDITION

Climate change, abiotic stress and biochemistry

Climate change impact: Vulnerability assessment and adaptation strategies

The rising temperature and the expected water deficit conditions are the major climate variables affecting production of plantation crops. The MaxEnt model projects that the current suitable climatic regions *viz*. some parts of south interior Karnataka (Tumkur, Bangalore rural, Ramnagaram), Tamil Nadu (Tanjavur, Vellore) and most parts of Andhra Pradesh are highly vulnerable to future climate. While other parts of south interior Karnataka and Tamil Nadu remain suitable, but only when the farmers adopt the agronomic practices to manage the high temperature and temperature-induced water deficit. West coast remains highly suitable (Fig. 37).

Arecanut is highly sensitive to the large day to night temperature variations, precipitation during the winter months. Hence, temperature seasonality and precipitation seasonality are the major climate variables determining the arecanut distributions (contributes >75% variation). Karnataka has more than 50% area and production of arecanut in India. However, in future climate conditions, large area currently suitable in the state will become unsuitable up to 30% in all the scenarios except RCP 8.5 2070 wherein nearly 62% area will be contracted. Some parts of DK, Hasana and Chikkamagaluru are only suitable for arecanut (Fig. 38).

Effect of high temperature on the progamic phase of coconut

The progamic phase, which elapses from pollination to fertilization, is one of the most critical phases during the sexual reproduction processes and is extremely vulnerable to high temperature. The progamic phase of the tall coconut cultivar West Coast Tall (WCT) in the event of

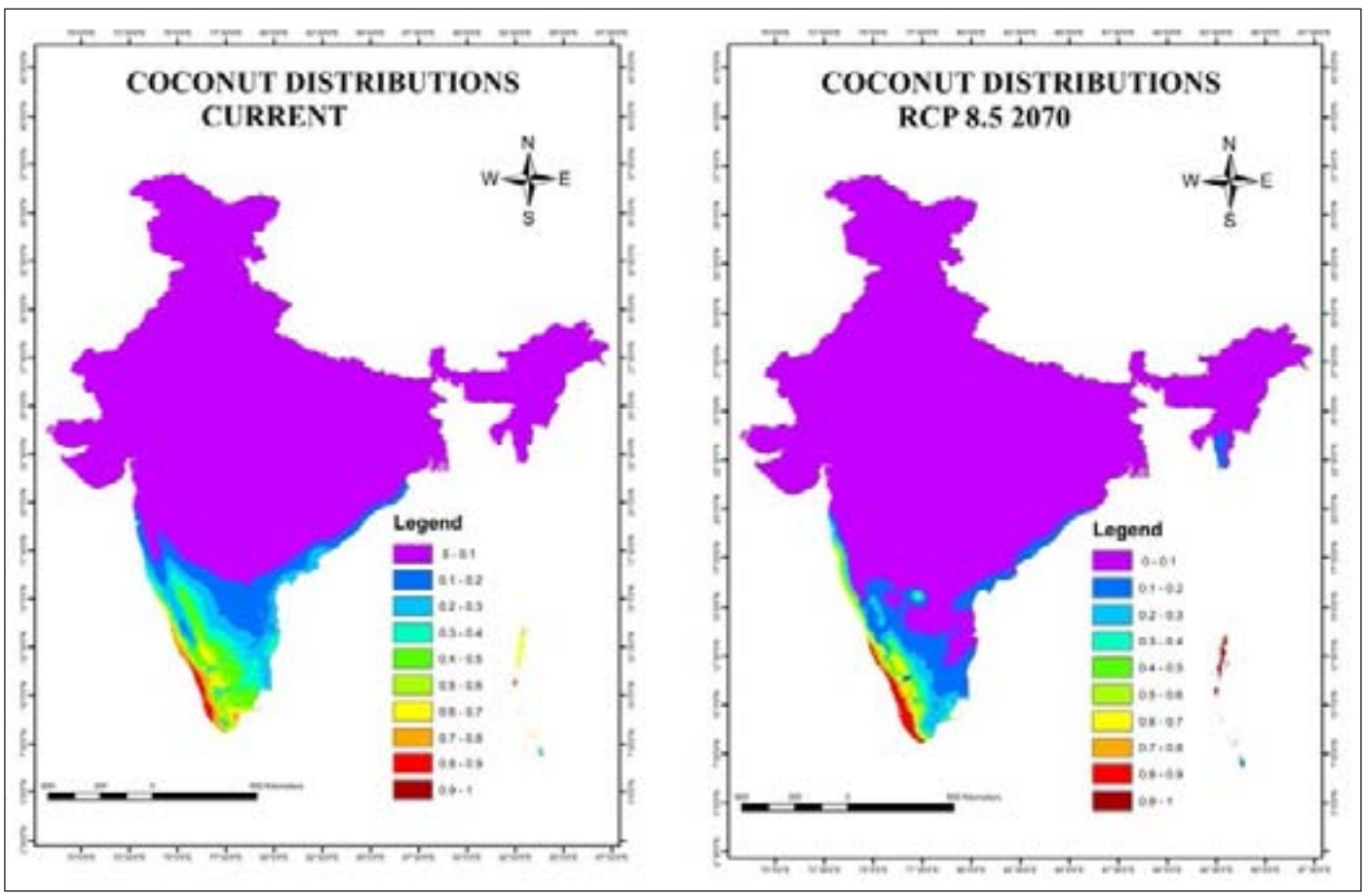


Fig. 37. Model prediction of current suitability of coconut production and future coconut distribution for 2070 under RCP 8.5 within coconut growing regions of India.

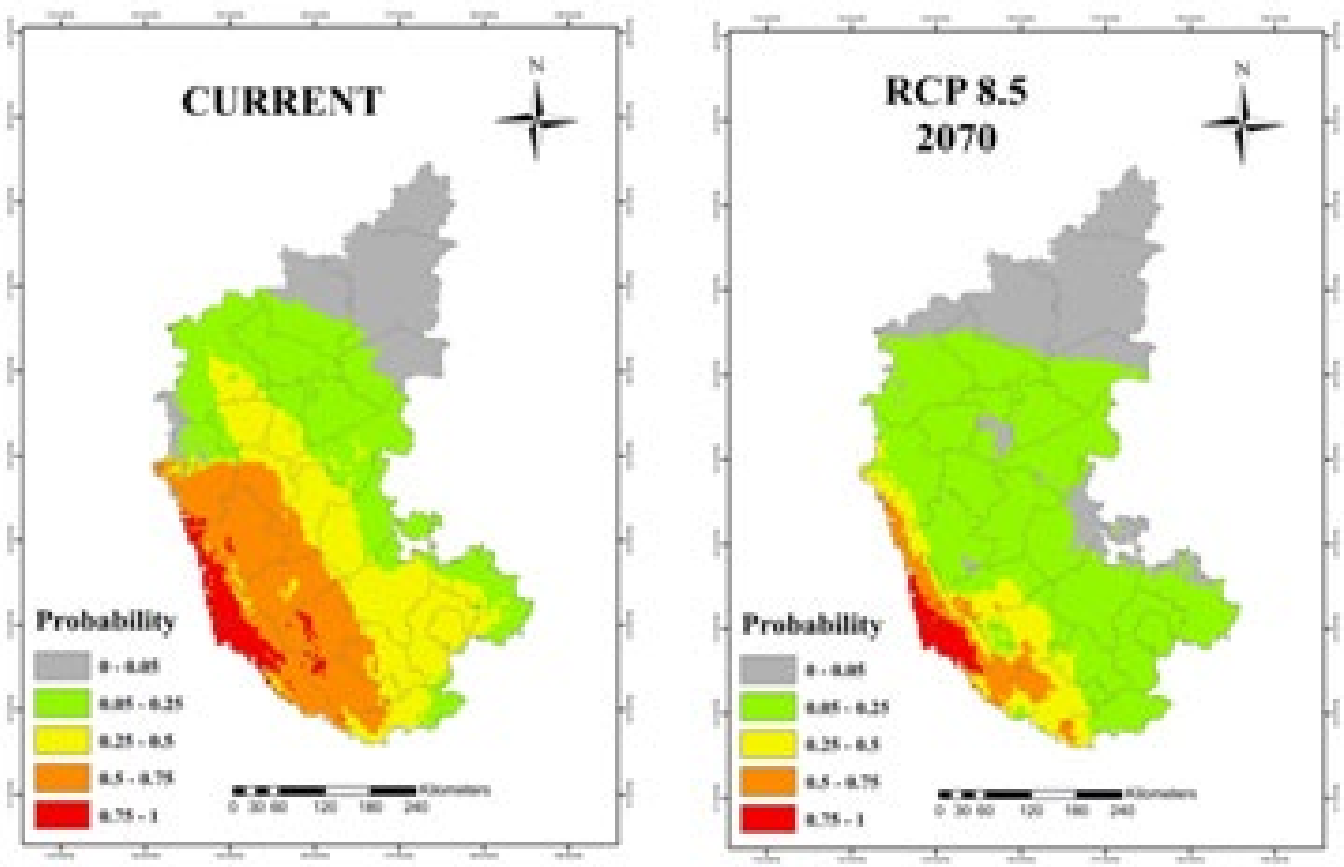


Fig. 38. Climate suitability map of Karnataka for arecanut cultivation under current and future climate 2070 with RCP 8.5

high temperature was studied under both *in vivo* and *in vitro* conditions (Fig. 39). Coconut has a long pistil and its length was found to be 18.2 ± 4.9 mm in WCT. Pollen germination on stigma occurred one day after pollinationand the pollen tube traversed through the pistil and reached micropyle of ovule four days after pollination at 29ºC. However, high temperature (T_{max}> 33ºC), both under *in vivo* and *in vitro* conditions, significantly reduced pollen tube growth through the pistil was observed. High temperature also altered the phenology of nectar secretion and stigma receptivity. Nectar secretion occurred early and at the time of receptivity, stigma was dry that make it unattractive to the pollinators and may lead to poor nut set.

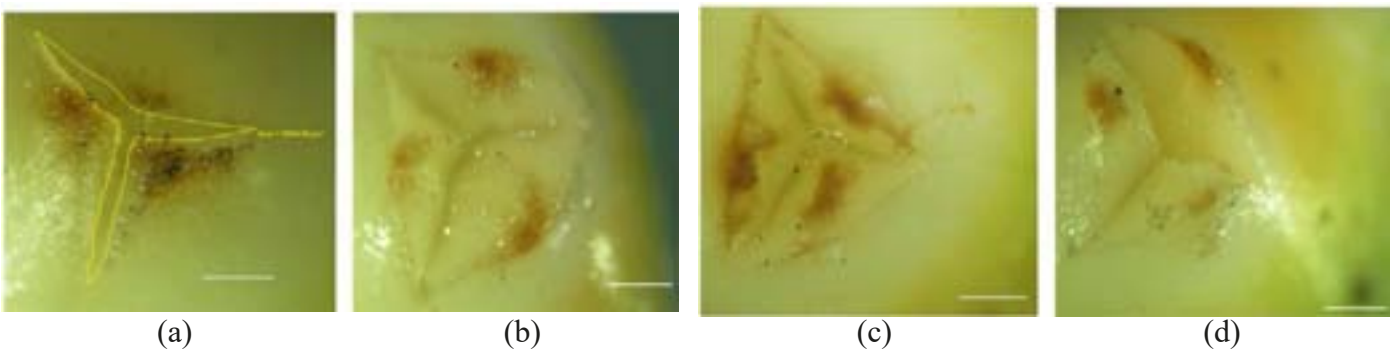


Fig. 39. Visualization (2X) of receptive stigma of the coconut variety WCT under different conditions: (a) ambient,(b) chamber control, (c) chamber with 3°C rise in temperature and 55+5% RH and (d) chamber with 3°C rise in temperature and 65 + 5% RH. The area in-between the opening of perianth lobes was measured as shown in (a) using a stereo microscope. Scale bar =100 µm.

Studies on abiotic stress

Molecular studies on water-deficit stress: Two-year-old coconut seedlings of the varieties Kalpasree and Kalpatharu were subjected to soil water-deficit regimes (25% of available of soil moisture and control). The leaf transcriptome profiles of the control and water-deficit stressed seedlings were examined utilizing paired-end RNA-Seq. In total, ~7300 differentially expressed genes have been identified between the seedlings under water-deficit stress and control. Four cDNA libraries yielded approximately 158.96 million bp reads with an average transcript length of 829bp and transcript N50 value of 1225. Analysis of transcript length distribution revealed that a maximum of 68482 transcripts belonged to class 300-400bp. Transcripts were further processed for unigene prediction using CD-HIT package v 4.6.1 which predicted a total of 162483 unigenes with a mean unigene length of 786 bp. Also, significantly expressed genes (*i.e.,* highly up and downregulated genes) are represented in form of a heatmap using Pheatmap package of R, following the hierarchical clustering approach (Fig. 40).The results are summarized in Table 7.

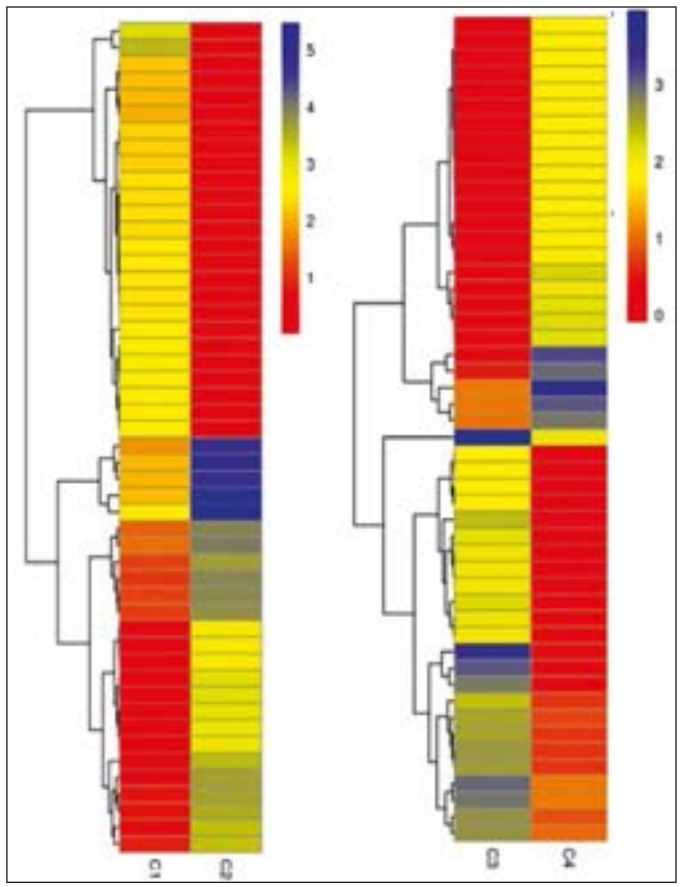


Fig. 40. Unsupervised hierarchical clustering analysis of differentially expressed transcripts. Heat Map showing clusters of differentially expressed genes in (a) Kalpa Sree (C1:control, C2:stressed) (b) Kalpatharu (KT) (C3:control, C4:stressed). The codes of colour bars are also presented.

Level of tolerance of coconut to seawater substitution: Hydroponically grown coconut seedlings of Malayan green dwarf (MGD) variety when subjected to 0, 10, 25, 50, 75 and 100% of seawater substitution (SWS), equivalent to respectively 2.17, 8.32, 16.32, 30.03, 42.14 and 53.69 dSm^{-1} EC, indicated that >50% SWS significantly affected the normal physiological processes (Fig. 41). The maximum quantum yield of Photo System II (Fv/Fm) decreased and stomatal resistance increased as early as 7 and 18 days after imposition of treatment (DAT), respectively, which led to a significant decline in leaf area and root length expansion as early as 24 DAT. At 25% SWS, root system (root length and root biomass) was stable but the aerial part biomass showed a decline of 47%. Nevertheless, plant height, leaf area, collar girth and biomass accumulation of seedlings under 10% SWS was on par with the control plants suggesting coconut seedlings could tolerate up to 10% SWS.

Table 7. Summary results of transcriptome profiles

Feature characterized	Kalpasree	Kalpatharu
RNA transcripts		
(a) Significantly upregulated	2388	2868
(b) Significantly downregulated	1278	778
Significantly expressed (i.e, highly upregulated) genes	PHLOEM PROTEIN 2-LIKE A1-like (Log2 FC 11.19); WRKY transcription factor 40 isoform X1 (Log2 FC 9.59)	polyamine oxidase (Log2 FC 9.78); Arabinose 5-phosphate isomerase (Log2 FC 6.52): WRKY transcription factor 40 isoform X1 (Log2 FC 5.57)
Highly downregulated genes	Glycerol-3-phosphate acyltransferase 3	Aquaporin PIP1-2 (Log2 FC -1.8); Ethylene-responsive transcription factor ERF105 (Log2 FC -1.9)
Differentially regulated InccRNAs	32	59

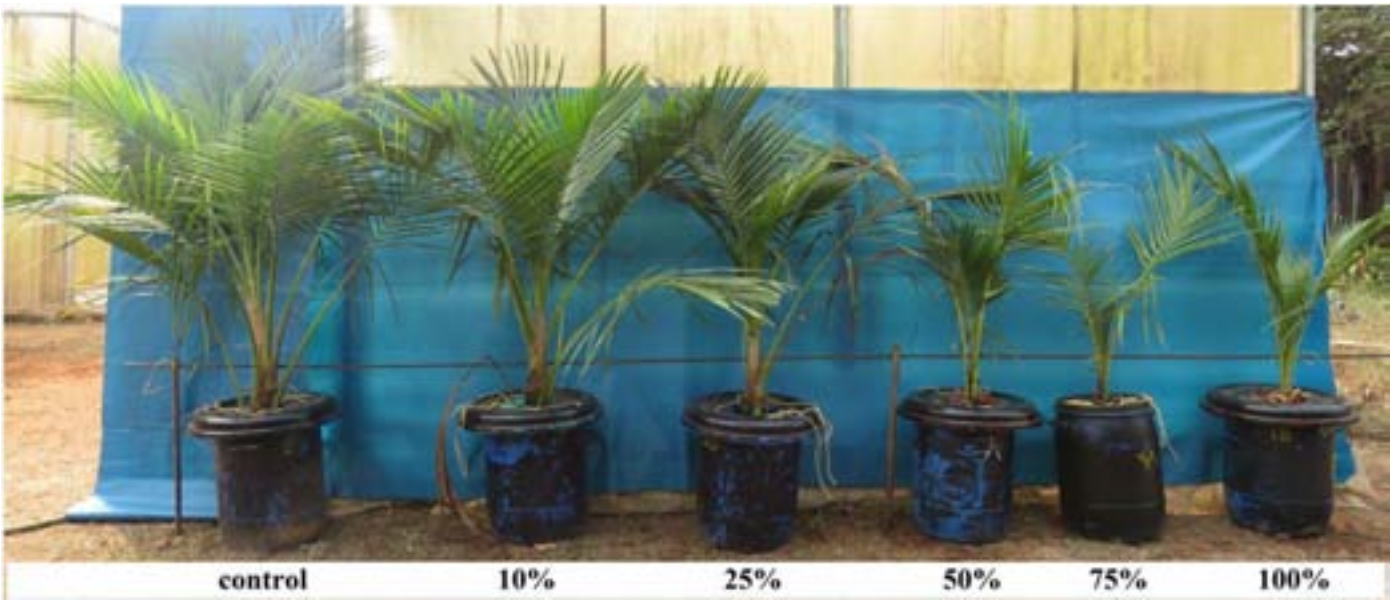


Fig. 41. Photograph showing the growth of thirteen month old hydroponically grown coconut seedlings. Three months after substitution of Hoagland solution by increasing substitution of seawater at 10, 25, 50, 75 and 100 % stunted the plant growth remarkably

Biochemical features and antioxidant potential of coconut testa oil: Coconut testa, the brown skin covering the endosperm, is one of the by-products of the coconut processing industries and remains currently underutilized. This study was formulated to extract coconut testa oils from the select coconut genotypes (*viz*., MYD-Malayan yellow dwarf, COD-Chowghat Orange Dwarf, FMST-Federated Malay States Tall, WCT-West Coast Tall, CRD x GBGD and MYD x CGD) and to characterize the oils for biochemical characteristics. The total phenolic content (TPC) of the testa oils of the coconut genotypes varied from 6.84±0.09to 8.67±0.22(expressed as mg GAE/100g of oil). The testa oil of the genotypes FMST and CRD x GBGD exhibited highest TPC of 8.67±0.22and 8.47±0.41mg GAE/100g, respectively whereas the least TPC content was found in genotype MYD x CGD. The total flavonoid content (TFC) of the testa oilranged from 17.45±0.60 (WCT) to 20.58±0.42 (FMST) mg QE/100g. Analysis of reducing power of the testa oil as measured by FRAP showed that highest ferric reducing ability of 26.93±0.42 (µmol TE/g) in CRD x GBGD followed by FMST (21.94±1.10). Similarly, the measure of antioxidant potential of testa oil, CUPRAC was highest inCRD x GBGD (23.61±0.157 µmol TE/g) followed by FMST (20.34±0.29). The radical scavenging activity of the testa oil as quantified in DPPH assay varied from 15.89±0.46 (MYD x CGD) to 31.95±2.43 (FMST).

Hypoglycemic effect of coconut palm sugar (CPS) on streptozotocin-induced diabetic rats: The effects of oral administration of CPSin a streptozotocin-induced diabetic Wistar rat model were investigated. Diabetic Wistar rats were treated with CPS200, CPS400 and CPS800 representing 200,400 and 800mg/Kg body weight (b.w) of CPS, respectively along with the standard drug gliclazide (5mg/Kg b.w) during a period of 28 days. Biochemical features underlying glucose, lipid balance andpancreatic anti-oxidant status of all the animal groups were monitored.Administration of CPS to diabetic rats reduced the bodyweight loss, and fasting blood glucose levels in a dose-dependent manner. CPS treatment showed a highly significant ($P \leq 0.005$) reduction in plasma glucose levels 120 min after glucose load, reduction in serum blood glucose, hepatic enzymes *viz*., aspartate transaminase (AST), alanine transaminase (ALT), alkaline phosphatase (AP); serum lipid profile of total triglycerides, total cholesterol, and low-density lipoprotein fraction. However, it significantly increased the serum total protein and high-density lipoprotein. CPS restored the levels of pancreatic enzymatic antioxidants and decreased lipid peroxidation. CPS exhibited multiple healthbenefits in diabetic rats byrestoring the glucose and lipid homeostasis and accords beneficial effects against oxidative stress. CPS could be a promising food for diabetics.

Influence of Water Activity on the Shelf-life of Arecanut: It is imperative to devise suitable quality standards for appropriate storage of arecanut samples under the extant FSSAI guidelines and to suggest suitable modifications. Arecanut samples sourced from different places during dry and rainy seasons, processed (red) and *chali* and their sub-types had a mean water activity (a_w) of < 0.71 (corresponding MC of <11.3%). It is safe for storage and would prevent nut deterioration by fungal contamination that includes discolouration, musty odours, dry matter loss, tissue disintegration, nutritional and processing quality losses, and mycotoxin accumulation.

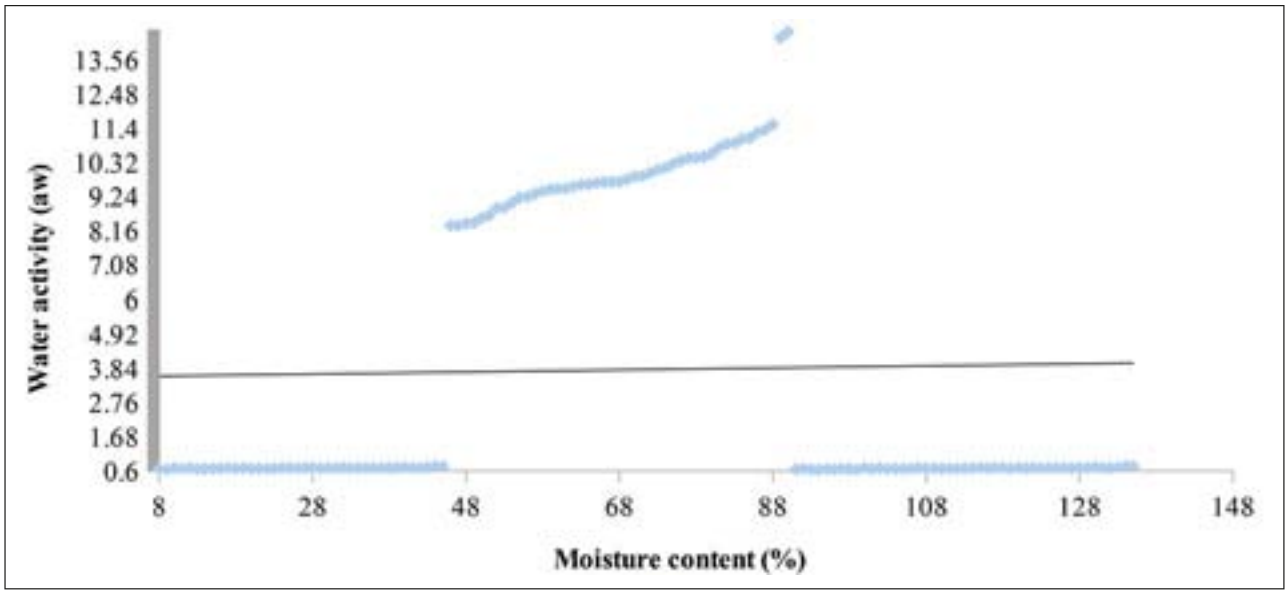


Fig. 42. Relationship between water activity (a_w) and moisture content (MC) and its influence on shelf-life of arecanut

Value Addition

Foam mat drying of coconut milk: Foam mat drying process is preferred due to its simplicity, cost-effectiveness and rapid drying rate.Foam mat drying protocol consists of two stages drying, which was simplified to a single-stage drying by incorporating foaming agent, foam stabilizer and encapsulating agent to coconut milk during the initial whipping. Foam expansion of 147±2.5% was observed while whipping. Single-stage dried milk powder had a loose bulk density, packed bulk density and angle of repose of 0.37g/cm, 0.49 g/cm, 42.32°, respectively. Quantity of encapsulating material (less than 6% of the weight of coconut milk which otherwise is added at more than 20% during spray drying) and drying time (2 h for complete drying unlike 3.5 h in the two-stage process) could be saved in this simplified method. The resultant powder also had a Hausner ratio of 1.13±0.01 which falls under the category of powder with good flow character. The cost economics calculated for the upscaled production revealed that this venture is profitable with a BC ratio of 1.13, IRR of 33% and a break-even period of 206 days. The qualitative evaluation of foam mat dried coconut powder is given below (Table 8).

Preservation protocol for coconut gratings: Studies were conducted to standardize the processing protocol for minimally processed grated coconuts and to evaluate the effect of different hurdles such as humectants (common salt), acidulant (citric acid- E 330), buffering agent (sodium citrate), antioxidant (4-hexyl resorcinol), permitted class II preservative (sodium benzoate-E211), packaging materials (LDPE and laminated pouches), packaging methods (vacuum and normal sealing) and storage conditions (ambient and refrigerated conditions) on the physicochemical, sensorial and microbial qualities of grated coconuts. The standardized protocol consists of dehusking the fully matured coconuts, dipping in boiling water for 15 sec, cutting the nuts into two halves, blanching at 90°C for 6-7 min, grating using an electric grater, steam blanching of gratings for 3 min, incorporation of additives. The result of the biochemical, and sensorial evaluation showed the efficacy of two additive combinations such as i) salt (3%), citric acid (0.05%), sodium citrate (0.05%)and

Table 8. Qualitative evaluation of foam mat dried coconut powder

Parameter	Value	Parameter	Value
Moisture (%)	2. 18±0.3	Ash (%)	7.47±0.58
Total solids (%)	97.82±0.3	Carr's index	6
Crude fat (%)	52.07±2.3	Hausner ratio	1.16
Solid non fat (%)	42.87±1.5	Colour values:	
Crude protein (%)	8.24±0.62	*L*	79.60±0.01
Carbohydrates (%)	27.29±0.6	*a*	-0.05±0.01
		b	11.31±0.01

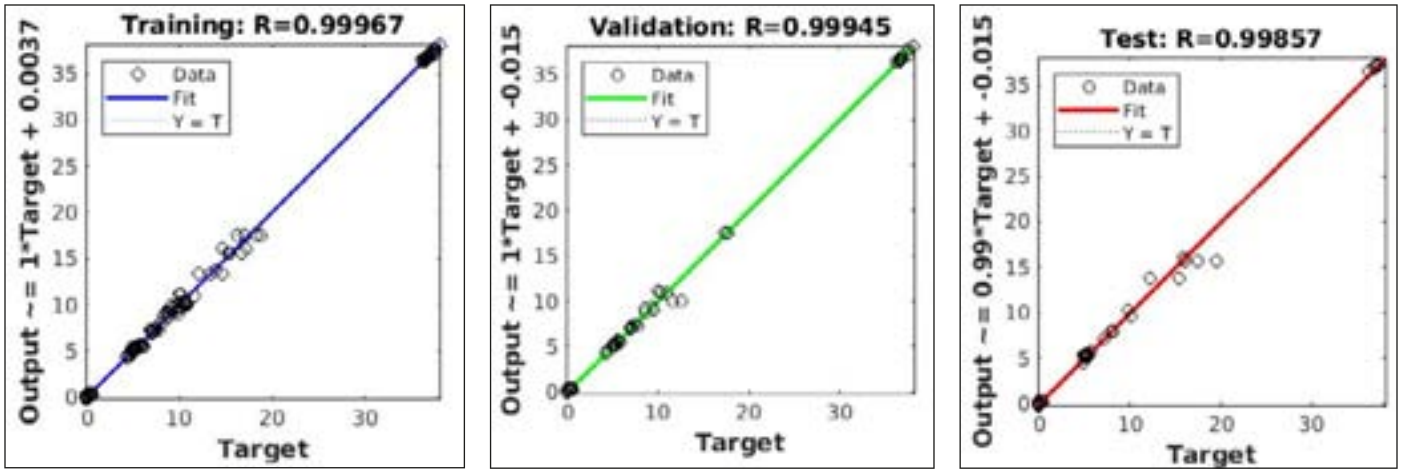
sodium benzoate (0.05%) ii) 4-hexyl resorcinol (0.05%) and citric acid (0.05%) which had a water activity of 0.74 and 0.72 respectively. However, the microbiological evaluation revealed the former as the most effective treatment combination for gratings. It is concluded that pre-processed coconut gratings treated with additives (with 3% salt, 0.05% citric acid, 0.05% sodium citrate, 0.05% sodium benzoate), packaged with laminated pouched and sealed under vacuum had a shelf life of 7 days under ambient and 24 days under refrigerated conditions. The result of the microbiological evaluation is furnished below.

Phenolic content and antioxidant potential of Kalpa dark chocolate: Kalpa dark chocolate comprises 45% cocoa liquor, 30% coconut sugar and 25% cocoa butter wherein, the fermented dried beans were roasted at 130 °C with a holding time of 20 min in an open ball roaster, followed by breaking of beans and winnowing of shell using a cocoa pod breaker and winnower, grinding (nibs, cocoa butter and coconut sugar), tempering at three different temperatures (43, 27 and 33 °C), moulding, cooling, de-moulding, packaging and storage at 10-15 °C.A protocol for estimation of total phenolic content (TPC), flavonoids and antioxidant properties of chocolate was standardized. Four different organic solvents were used to extract the phenolic fractions from the defatted dark chocolate samples. Among the solvents, 70% acetone, acidified acetone (70%, 1.2M HCL), 80% ethanol and acidified ethanol (80%, 1.2M HCl) yielded TPC (determined using Folin-Ciocalteu assay) of 448±0.04, 480±0.07, 341±0.06 and 367±0.04 mg GAE/100g dark chocolate, respectively ($p<0.001$) suggesting the efficacy of acidified acetone in extracting maximum phenolic content. Similarly, the antioxidant potential was determined using DPPH and FRAP assays, wherein 70% acetone extract showed high percentage inhibition (91.8%) than the acidified extracts (89.4%) in DPPH assay.

Coconut milk peda: The process protocol for the preparation of peda from coconut milk and coconut sugarwas standardized. Light coconut milk obtained from the pooled extraction (2nd and 3rd extract of coconut kernel) consisted of 74.7±1.52% moisture, 25.26±1.52% total solids and 23.5±3.3% crude fat. It had a total soluble solids content of 5.35±0.5°Brix and an acidity of 0.23%. It was concentrated to form *khoa* stage through indirect heating using VCO cooker. Changes in TSS while concentrating coconut milk were also noted. It took 60 min to reach the desirable TSS of 75- 80 °Brix at 85-100°C. Sugar levels varied from 20-50%. Sensory evaluation of the resultant products revealed that incorporation of 30% sugar to the weight of coconut milk is optimum for peda making. The comparison of coconut milk peda prepared with refined sugar and coconut sugar revealed the acceptability of coconut sugar over refined sugar. The yield of peda ranged from 50-53%. Peda made with coconut sugar was superior ($p<0.001$) in mineral (ash) and protein contents than those made with refined sugar. It had moisture, carbohydrate, crude fat, crude protein and ash content of 23.5± 2.4%, 42.5±1.1%, 23.75±0.7%, 5.6±0.3% and 3.01±0.2% respectively.

Jaggery infused osmo-dehydrated coconut chips: Protocol for mineral-rich coconut chips using jaggery infused osmo-dehydrated solution was standardized. The process parameters involved for the production of coconut chips were convective drying temperature (50-70 °C), osmotic-solution concentration (45–55 °Brix), and slice thickness (0.50-1.00 mm). A Box-Behnken design was employed to optimize the process parameters. The product responses such as final moisture content, drying rate, rehydration ratio, water loss, solute gain, and overall acceptability were investigated. The optimized conditions for the development of coconut chips were found to be convective drying temperature 69.31 °C, slice thickness 0.67 mm and jaggery solution concentration 54.61 °Brix. Moisture, carbohydrate, fat, protein and ash content of the jaggery treated (optimized sample) coconut chips (per 100g) were 2.16±0.14g, 45.83±0.33g, 42.79±2.11g, 6.17±0.20g and 1.16±0.03g, respectively. The proximate analysis of the optimized sample suggested that the incorporation of jaggery infused osmotic agent has improved the nutritional quality of the chips with high consumer acceptability.

Microwave processing of tender coconut water - artificial neural network based parameter optimization: Polyphenol oxidase (PPO) and peroxidase (POD) are the major enzymes that affect the quality of tender coconut water. The advanced thermal treatment such as microwave treatment has the potential for inactivation of food enzymes. Therefore, the effect of microwave processing parameters on the physico-chemical changes and enzyme inactivation rate in tender coconut water was investigated. The experiments were conducted at three different microwave power level (450, 600 and 900 W) and five different exposure time (70, 80, 90, 100, 110, and 120 s). The modeling and optimization of process parameters were performed using central composite design (CCD) and artificial neural network (ANN). Microwave power level of 600 W for 120 s exposure time was found suitable for complete enzyme inactivation with minimal quality loss. Optimized treatment has pH=5.02, total soluble solids (TSS)=5.68 °Brix, turbidity=12.51 NTU, titratable acid (TA)=0.07% malic acid, PPO=0, POD=0, phenolic content=37.238 mg GAE/L and overall acceptability



a b c

Fig. 43. Regression plots for training (a), validation (b) and testing (c) of ANN model

(OA)=7.5. The data modelled using supervised learning with ANN was found to be a better fit than CCD model. A higher R^2 value in the range of 0.99 for all the factors in ANN model (Fig. 43) depicts the best fit compared to the CCD models, which varied from 0.54 to 0.98. These results confirmed that microwave treatment could be the potential alternative to conventional thermal treatment for processing of tender coconut water.

Automatic tender coconut cutting machine: Tender coconuts are widely used as fresh beverages and in the production of frozen delicacy. The conventional unit operations involved in the processing of tender coconuts such as punching and cutting are time-consuming and cumbersome. Hence, the study was designed to develop an automatic type cutting machine for tender coconut. The designed machineconsists of a stainless steel knife, linear actuator and electrical panel. The machine was designed on the principle of conversion of straight forward action of rotary motion into a linear motion by using a linear actuator. Two relays were fixed for the forward and backward action of cutting knife. The power required to operate this machine is 12 V and the capacity of the machine is 90-110 nuts/h. The capacity of the machine can be increased to 180-220 nuts/h by adjusting the specification of the linear actuator to 6000 N cutting force and 5 mm/s operating speed.

Detection of adulteration in desiccated coconut (DC): Coconut milk residue (CMR) is the major co-product in virgin coconut oil and coconut milk processing industries. The fat content of CMR is less than DC powder. The dehydrated CMR is available in the market as low-fat desiccated coconut powder. DC is adulterated with low-value CMR. In this context, the present study was taken to detect adulteration in desiccated coconut powder using an IR thermal camera. The DC was adulterated with different proportion (10-100%) of CMR. Then, the adulterated samples were heated at 63°C for 30 min in a convective air oven. Heat dissipation pattern of samples was observed at the time interval of 7 minutes in different phases (total 9 phase). It was observed that the images recorded during the 5th and 8th phase provided a good result (Fig. 44). It was observed that the dissipation temperature got reduceddepending on the percentage of an adulterant. The pure DC sample dissipates more temperature than the adulterated samples (Fig. 44). The difference in the thermal behavior could be due to differences in their fat content. Developing a proper setup to record the thermal image may yield better accuracy for the detection of adulteration in DC.

Design, fabrication and field demonstration of a Neera (Kalparasa®) collection device: A mould was developed for the industrial level production of coco-sap chiller and a collection container. The cost of the chiller is approx. Rs. 850 which is far less than earlier chillers developed manually. A stainless steel collection container was fabricated for the collection of fresh neera inside the chiller instead of disposable polythene bags at an initial cost of Rs 200/piece. Ice (0.75 kg) in this chiller lasts for two tappings, (24hrs) thus markedly reducing the operational costs of *Kalparasa*® collection.

Design, Development and Field Demonstration of Air Blast Sprayers for Coconut

Airblast sprayers for coconut: Timely application of plant protection measures, especially spraying is an important problem among coconut farmers. Traditionally spraying is done manually by climbing the tree. However, coconut tree climbers are becoming rare. Prototypes of two air blast sprayer were developed to spray coconut from the ground itself.

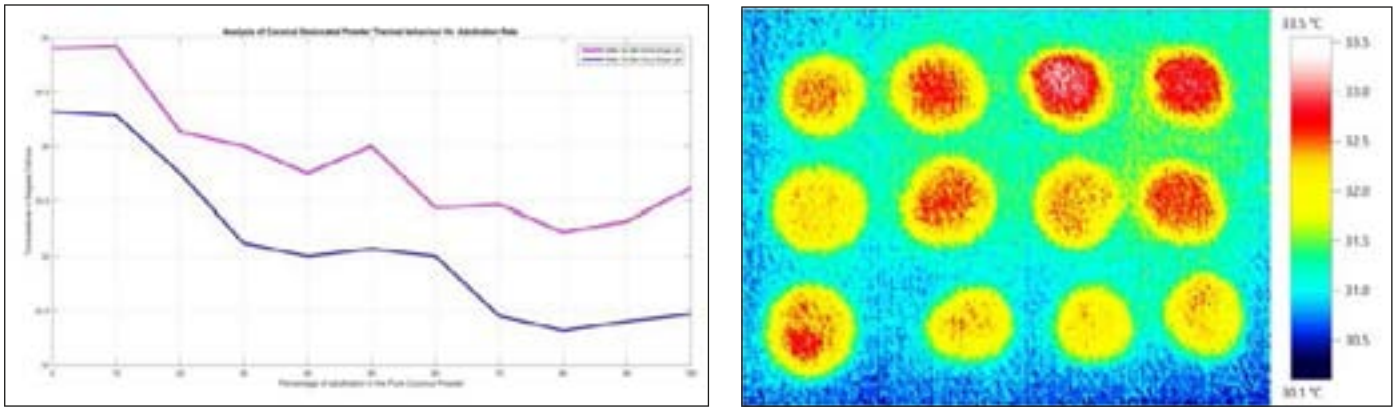


Fig. 44. Thermal images of the DC powder adulterated with different proportion of CMR

Tractor driven sprayer: Prime mover of this sprayer is a tractor. The sprayer (Fig. 45) is mounted on the tractor using the three-point linkage. Power to operate the sprayer is taken from the tractor PTO. An air blast blower blows a power full stream of air and an injection pump injects liquid using the tractor power. A centrifugal atomiser atomises the liquid and is carried away by the power full air stream. With this machine, spraying could be done from the ground and the spray could reach a height of 30m.

Self-propelled Sprayer: Prime mover of the self-propelled sprayer is an IC engine. The sprayer (Fig. 46) could either be carried manually by two people or using a trolley. Alternatively, it could be mounted on a tractor. Working principle of both the sprayers is the same. However, the self-propelled sprayer can reach a height of 20 m only.

Fig. 45. Tractor driven air blast sprayer

Fig. 46. Self propelled air blast sprayer

07. Technology Transfer and Economics and Statistical Methods

The Covid-19 pandemic placed new norms for social living – restrictions were imposed for meetings, and social distancing has become a new order. The Institute thus resolved for innovative methods to reach out to the stakeholders through online platforms.

Transfer of technology and co-learning action research approaches

Training programmes

Before the nationwide lockdown, 12 training programmes were conducted at Kasaragod during January-March 2020, benefiting 242 participants. At Kayamkulam, 20 training programmes were conducted for 982 participants; these include three training programmes for extension personnel and one on 'Friends of Coconut Tree' (sponsored by Coconut Development Board). The number of training programmes conducted at Vittal is 11, and the total number of participants was 276.A total of 13 programmes were conducted at Kahikuchi with a participation of 637 farmers that include nine programmes under the Consortium Research Platform-Farm Mechanization and Precision Farming (FM & PF) project. At Mohitnagar, two training programme has been conducted benefiting 60 farmers.

The research station attachment phase of the RAWE Programme was conducted for two students of B.Sc (Agri), Navsari Agricultural University at Kasaragod from 23 November to 22 December 2020.

Reaching out through online means

Several online lectures, webinars, interface programmes and trainings were conducted during the year. The first online training programme of ICAR-CPCRI was conducted on May 14, 2020 on 'Virgin Coconut Oil production for village entrepreneurship' for farmers of Munrothuruthu panchayath, Kollam district and Pathiyoor panchayath, Alappuzha district. A total of 38 rural youths and coconut farmers attended the training programme.

Online Interface programme on 'Enhancing productivity and income from coconut-based farming systems' was conducted on 16 June 2020 in collaboration with Haritha Kerala Mission, Government of Kerala, which was streamed through Facebook Live.

To sensitize the coconut communities to make the best use of the reforms in the agriculture sector announced by the Central Government towards Atmanirbhar Krishi, a three-day multilingual farmers training programme on 'Enterprise diversification in coconut sector' was conducted online during 14 – 17 September 2020. The programme was conducted in three languages (Malayalam, Tamil and Kannada) concurrently with the participation of 1400, 600 and 400 farmers, respectively.

Online training programme for farmers on 'Coconut Production Technologies - Seed to Market' was organised by ICAR-CPCRI Kasaragod in collaboration with Farmers Training Centre (FTC), State Dept. of Agriculture, Vengeri, Kozhikode during 4-27 August 2020.

Five days webinar series on 'Coconut based integrated farming system' was organised by the Regional Station, Kayamkulam in collaboration with Mavelikkara block and Cherthala South block 7-25August, 2020 in which over 400 farmers, extension workers and students participated.

In addition to the above, five training programmes through videoconferencing were organized by Regional Station, Kayamkulam; three programme by Vittal, and two programmes by Mohitnagar. These programmes had the participation of over 500 farmers/extension personnel. Besides, scientists of the Institute delivered lectures in over 70 online programmes organised by other agencies. Training programmes conducted under externally funded projects are not reported here.

Fig. 47. Training on "Budding and grafting techniques of Fruit crops" for Forest personnel, Govt. of West Bengal

Fig. 48. Multi-lingual training programme on 'Atmanirbhar Krishi' through video conferencing

The interface on post-flood management of coconut gardens

A scientist-extension personnel interface programme on coconut gardens management in flood-affected areas in Tamil Nadu was conducted through videoconferencing on 3 July 2020. Dr Anitha Karun, Director, ICAR-CPCRI, Kasaragod, inaugurated the interface programme, which was chaired by Mr. A. Justin, Joint Director of Agriculture, Thanjavur.

Frontline Demonstrations

Best Management Practices (BMP) to alleviate the soil-related constraints for coconut

Under the multi-institutional collaborative project sponsored by Kerala State Planning Board, Government of Kerala, 60 technology demonstrations were conducted in six locations *viz*., Mayyanad, Chettikulangara, Pathanamthitta, Mookannoor, Naduvannur and Cheruthazham during the period 2015-19.

The average increase in nut yield realised at successful demonstration sites was 49%. Improvement in general palm health was noticed with a reduction in pest and disease incidence, increased number of leaves, reduced button shedding and increased size of nuts and kernel thickness. The total cost of the intervention was 41% lower than the standard package of practice for coconut. The enhanced yield and significant cost reduction make the adoption of technology a superior option for the coconut farmers.

Various extension programmes including training and field demonstration of scientific crop management technologies for coconut were organised in all the localities under the project to benefit the coconut growers.

Fig. 49. Shri K. V. Vijayadas, M.L.A., Kongad, planting a coconut seedling during the inaugural function

Coconut seed garden in district jail campus, Palakkad

A coconut seed garden was established in district jail campus, Palakkad, Kerala, with 20 seedlings each of five released coconut varieties (Kera Chandra, Kalpatharu, Kalpa Prathibha, Kalpa Mithra and Kera Keralam). Sri V.S.Sunilkumar, Hon'ble Minister for Agriculture & Farmers' Welfare, Government of Kerala, inaugurated the seed garden through videoconferencing on 16 July 2020 in the presence of Shri K. V. Vijayadas, M.L.A., Kongad, Dr Anitha Karun director, ICAR-CPCRI, and Smt K. Santhakumari, president, Palakkad district panchayat. Dr. C. Thamban, Principal Scientist, coordinated the programme.

Demonstration of arecanut dwarf hybrids (Funded by DASD, Calicut)

Two demonstration plots one each in Puttur and Sullia taluks (Dakshina Kannada district) were established

Arecanut based multispecies cropping system (Funded by DASD, Calicut)

There were six demonstrations conducted in this regard: In four plots, Arecanut + Cocoa + Black Pepper + Banana cropping system and in two plots, Arecanut + Nutmeg + Black Pepper + Banana cropping system. Out of these, four were in Bantwal taluk and one each in Puttur and Belthangady taluks.

Fig. 50. Handing over of dwarf arecanut hybrid to the farmer as part of technology demonstration

Agricultural Technology Information Centre (ATIC)

Farm advisory services, diagnostic services and supply of technology products such as planting material of coconut were provided to farmers and other stakeholders through ATIC. The majority of the queries were through phone calls (3154) followed postal (733) and e-mail (186). Total revenue of Rs. 37,72,613 was generated at ATIC Kasaragod during 2020-21 through sales of planting material, vermicompost, earthworms, publications etc.

SCSP Activities

At Thonnakkal village, Thiruvananthapuram district, critical inputs like poultry (40 families); planting material of coconut and fruit crops (103 families); bee hives and related gadgets (10 families), and fertilisers including 'Kera Priobio' (85 families) were provided. Four training programmes were conducted in the village to benefit 118 SC-farmers.

In Assam, pig and poultry were distributed to 100 SC-families in Barsimanuwa village of Nalbari district.

Cocoa cultivation was demonstrated in nine farmer plots in Bantwal and Puttur taluks of Dakshin a Kannada district.

Planting material of arecanut, black pepper and acid lime were distributed to 52 SC-farmers of Jalpaiguri district.

At Kasaragod, two industrial training programmes on coconut value addition (food processing) were conducted for 22 SC-youths.

STC Activities

One EDP on 'cocoa cultivation and processing' was conducted for 20 tribal farmers and two officials of Integrated Tribal Development Agency, Paderu at Kasaragod and Vittal. A one-day training programme on cashew cultivation was conducted in Koyyuru with the participation of 100 farmers. Critical inputs distributed to tribal farmers in the Paderu area are (i) 50 hive boxes (25 families in Chintapalle); (ii) 6000 cashew grafts (60 families of Koyyuru and Munjincut); and (iii) 2000 bush pepper (50 families in Chintapalle and GKVD).

Other extension activities

Exhibitions: The Institute participated in eight exhibitions at various cities and organized four.

Fig. 51. Training programme on apiculture conducted for youths from SC communities

Fig. 52. Industrial training programme on coconut value addition (under SCSP component)

Fig. 53. EDP on cocoa production and processing conducted for ST youths from Paderu, Andhra Pardesh

Fig. 54. ST farmers in Paderu receiving bee hives

Radio programs: Scientists participated in 13 radio programmes. A radio series on coconut farming entitled '*Thengum thanalum*' started on 15th August 2020 as acollaborative initiative of All India Radio, Kannur and ICAR-CPCRI Kasaragod. Apart from talk/discussions by scientists, experience sharing by award-winning coconut farmers, FPO representatives and entrepreneurs were also included; 20 sessions were completed during the year 2020.

Extension literature: Published 50 popular articles, and three manuals.

Farmer FIRST Programme (FFP)

Farmer FIRST programme with an objective of participatory technology integration to empower and ensure farmers' livelihood security is being implemented at Pathiyoor panchayath among 1000 farm families in 1657 ha area in participatory mode. The interventions are in six modules; crop, horticulture, livestock, natural resource management, value addition and entrepreneurship and integrated farming system (IFS).

Integrated management of coconut root (wilt) disease: Adoption of recommended practices including nutrient mixtures (Kalpa vardhini and Kalpa Poshak) is being implemented in 92.1 ha area of 237 farmers gardens. It was observed that coconut yield (the number of nuts/ha) increased from 4305 in 2017-18 to 6186 in 2019-20 (*i.e.*, 43.69% increase).

Crop intensification: Participatory assessment of varieties of new intercrops introduced in the crop cafeteria in coconut gardens enabled the conversion of 371 ha of fallow land under cultivation of assessed varieties of ICAR-CTCRI, ICAR-IISR, ICAR-IIHR, TNAU, KAU, and UAS-Bangalore. Pathiyoor panchayath was declared as fallow free by Dr. T.N. Seema, Chairperson, Haritha Kerala Mission, Kerala state, on 25 September 2020. The varieties tested include Gajendra (amorphophallus); Payur-2 and KMR (finger millet); CO-5 (fodder); Kayamkulam-1, Thilak, Thilathara, Thilarani, Thilathara, Thilothama and SVPR-1 (sesamum); and Pragathi and Prathibha (turmeric).

The revival of sesamum cultivation in the area resulted in an expansion of the area to 54 ha (from a meagre 1.61 ha at the start of the project: Farmers realised and income of Rs.25 lakhs from the cultivation of sesamum. The varieties Kayamkulam -1 and Thilak performed better in oil recovery (38-49%), tolerance to phyllody disease and yield.

In turmeric, variety 'pragathi' was rated better than 'prathibha' by 81.3% of the farmers in terms of yield, low duration and for its ability to withstand waterlogging.

Value addition and formation of FPO: Two virgin coconut oil (VCO) units, two coconut oil units, and two coconut food products units were established that resulted in the realization of value addition to Rs. 70 per nut. Turmeric powder unit, 'Thripthi processing unit', has processed 1.8 tonnes of turmeric. The Odanadu Farmer Producer Company Ltd was strengthened with the production of 'Kalpakam Kera Probio' (6.2tonnes) and nutrient mixture Kalpa Vardhini (0.5 tonnes).

Natural resource management: Five soil testing campaigns in 19 wards (5 ha grid based soil sampling) organised in convergence with Coconut Producers Federation (CPF). The results indicated moderate to strongly acidic reactions of acidic level (5.2-6.5), very low to medium (0.18% to 0.65%) organic carbon, high level of available phosphorus content ((>45 kg/ha), low level of available potash (< 60 ppm), low to moderate level of available calcium (180.2-360 ppm), very low (21.2-46.5) available magnesium, very low (<0.5 ppm) available boron and sufficient level of copper and zinc. The application of phosphorus was skipped this year based on the results, thus saving Rs. 4.8 lakhs per year.

Water harvesting through renovation and rejuvenation of 88 homestead ponds were integrated with fish farming: Quality fingerlings of anabas and nile tilapia (67500 nos per year) with 40 % of the cost shared by farmers were made available.

Livestock: Good management practices introduced through linkages with veterinary hospital and PRA results leading to adoption of cow-mat by 35 livestock farmers with 25 % cost sharing. Farmers opined 12 % increase in milk yield, reduced drudgery in cleaning, less fatigue of animals and reduction in hoof diseases.

Pathiyoor brand egg production and marketing as income units among selected 72 poultry farmers units targeting and achieving 1500 eggs per day @ Rs. 6 per egg, earning Rs. 2.7 lakhs per month. Five egg incubators are in operation by rural youths that enable the sustainability of these poultry units.

IFS: The major output is delineating of location-specific integrated farming systems models that can increase income two-fold ore even more. Besides the principal crop coconut, these models have one or more components like poultry, livestock, pond fisheries, and inter/mixed crops. The IFS combination of coconut (33.55%) and animal husbandry (66.44%) indicating the income role of livestock in realising income for the marginal land holders.

Recognition: Shri. Gopalakrishna Pillai, a farmer participant of FFP, was selected as 'Innovative Farmer'

of ATARI XI. He is a practitioner of livestock-based IFS system in an area of one ha. The farmer tripled his income to pre-FFP through various innovations, technology adoption, value addition and marketing strategies.

Extension strategies and social process evolved:

Group and community based Participatory assessment of technologies to derive location suitable technologies for continued adoption was an important change in the FFP interventions. Women SHG members were the social strata with least access or ownership to land for cultivation, which was addressed successfully through social consensus in land availability in all the wards facilitated by peoples representatives of local self government. Linkage with 32 agencies/social institutions/ formal and informal lead to the success of FFP in creating demand to technology and extension avisories for improving income and production.

Bottom line: It was found that 24.5% of the participating farmers doubled their income through the adoption of interventions, 37.5% increased income between 1.5 to 2 times and 1 to 1.5 times compared to pre FFP, based on the sample study during 2019.

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

Multi-dimensional analysis of adaptation deficit was done through a one day workshop and exposure visit to a climate-resilient model farm for analysis and prioritization of climate vagaries in the four AEUs. Intermittent water logging/periodical flooding for short periods, salt water inundation during monsoon, water scarcity and salinity during summer were reported as major concerns in the year round cultivation of intercrops under coconut-based farming systems. As part of adaptation deficit analysis and strategies for climate resilience, identified, prioritised and introduced adaptation strategies in 13 demonstration plots to establish climate-resilient model farms. Based on the climate vulnerabilities and soil characteristics in each area, 12 strategies were introduced in the demonstration gardens to evaluate their efficacy under varied stress conditions. Diverting excess water in waterlogged areas to micro-watersheds through central and peripheral drainage channels and low-cost vertical gardens proved successful technologies during monsoon season. But in extreme low lying areas of Kuttandu, intense rainfall for a continuous period of 8-10 days resulted in 60% crop loss, for which further refinements are being undertaken. Low-cost vertical gardens using bamboo poles in waterlogged areas in seven farmer gardens under four AEUs of Alappuzha District were developed. Modified husk burial technique was undertaken in in waterlogged areas for banana and fruit crops in 13 farmers' gardens in Alappuzha District. Enrichment of locally available organic substrates using *T. harzianum* in 13 farmer garden could control disease incidence by 80% and enhanced plant growth and yield by 75%. Even though the adaptive measures are in the initial stage of implementation, the farmers could harvest 3500 kg vegetables and 5200 kg tuber crops. Usually, the farmers of the Panavally block of Kuttanad could cultivate in garden lands only up to the middle of March due to water scarcity. However, these farmers are still cultivating vegetables during April with adaptation measures.

Technology support for plant protection campaign against pests and diseases of coconut

This programme with financial support from Government of Kerala was implemented in 12 districts of Kerala(Wayand and Idukki districts not included). In coconut health management, eight training programmes were conducted for 346 extension officials; 21 programmes for 1515 farmers and 10 programmes exclusively for farm women (571 participants). Two awareness programmes were also conducted that include technology demonstrations exhibits benefitting 130 farmers. Farmer field schools activities empowered 532 coconut farmers.

Mass production of *Trichoderma* cakes was successfully implemented in various districts for tackling bud rot disease. Bio-priming of coconut seedlings using *Trichoderma* improved the seedling quality and growth standards. Area-wide implementation of crown cleaning and prophylactic application of neem cake and sand could significantly reduce rhinoceros beetle incidence.

Twenty satellite model farms were developed for showcasing an integrated farming system approach for doubling farmers' income, giving importance to plant protection aspects. Moisture conservation technologies with better irrigation facilities as well as bioresource management including vermicomposting were practised in these farms. In satellite demonstration plots, the ubiquitous pest, rhinoceros beetle damage was reduced by 58%. Coreid bug attack was observed in six districts with a reduction in damage by 46% due to technology intervention. Attack by coconut eriophyid mite was reduced by 56% (four districts). Leaf rot disease was observed in all districts, which had subsequently reduced by 79% after the targeted intervention. Stem bleeding was observed in Palakkad district, which was significantly reduced by 94%. Overall the yield enhancement in coconut was realised up to 0.1 fold.

Development of statistical and computational techniques for improving research methodology

Analysis of spatio-temporal changes in production statistics of mandate crops: Changes in area and production of mandate crops were analysed. Logistic growth model was used to study the relative growth rate of area and coconut production with respect to the carrying capacity in the major coconut growing states viz., Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. The present share of coconut area and production is highest in Kerala (35 and 36%, respectively). But over the past ten years, the area under coconut declined in Kerala (ACGR of -0.27%), whereas in Karnataka, there was a 3.24% annual increase in area. Changes in yield over the years show that Tamil Nadu (TN) has experienced a marginal decline in productivity (ACGR of -0.36%). Nevertheless, productivity remained high in TN. Kerala, a less productive state, has witnessed an increase in productivity over the years (@ 3.73% ACGR), whereas Karnataka is the state with the highest growth rate in productivity (@ 8.27% ACGR), which is also reflected in production (11.58%). Overall there was a growth in the area, production and yield in the country with respective ACGRs of 1.19%, 4.02% and 2.81%.

In the case of arecanut, Karnataka, Kerala and Assam are the major states with a respective share of 54%, 18% and 16% in area and 68%, 11% and 9% in production. The growth rate in area and production indicates no significant change in the area in Kerala. However, in Karnataka and Assam, the area increased at an ACGR of 4.26% and 2.14%. Mizoram witnessed a higher annual compound growth rate in area (10.28%) among the minor states. Area and production of arecanut in the country increased by 2.8% and 5.8%, respectively over the last ten years.

Cocoa is mainly produced by AP (41%) and Kerala (38%). However, in recent years, there is an increase in newly planted gardens in TN, reflecting in its share of 33% in area and 9% share in production. Respective Annual compound growth rates of 13.6%, 6%, 4.6% in TN, AP and Kerala has contributed to an overall increase in the area @ 7.8 % in the country. However, production has witnessed a slower growth @ 4.9%, as new plantations are yet to attain stabilised yield.

STDAPR –Statistical Software for data analysis in R: User interface- based statistical software STDAPR based on R and Java graphical was updated. It is in standalone mode. Users can perform descriptive analysis, Analysis of Variance of designed experiments, group data analysis, and regression analysis. Provision for generation of high quality graphs is also provided. In windows platform, the results can be saved in word format.

Computer program for micro biome analysis: It was developed using the open-source software package, DADA2 (Ver. 1.10.1) for analysing the ampliconmicrobiome data like Illumina sequences. The program is available as R-script executable in R environment. Operational taxonomic unit (OTU) may be picked from the de-multiplexed and quality filtered sequences using close reference protocol against the Green Gene/ RDP/ SILVA Database Consortium at 97% or, 99% sequence similarity cutoff for further downstream analysis. The program can generate reports, like alpha, beta diversity and other indices along with graphs of microbial relative abundance.

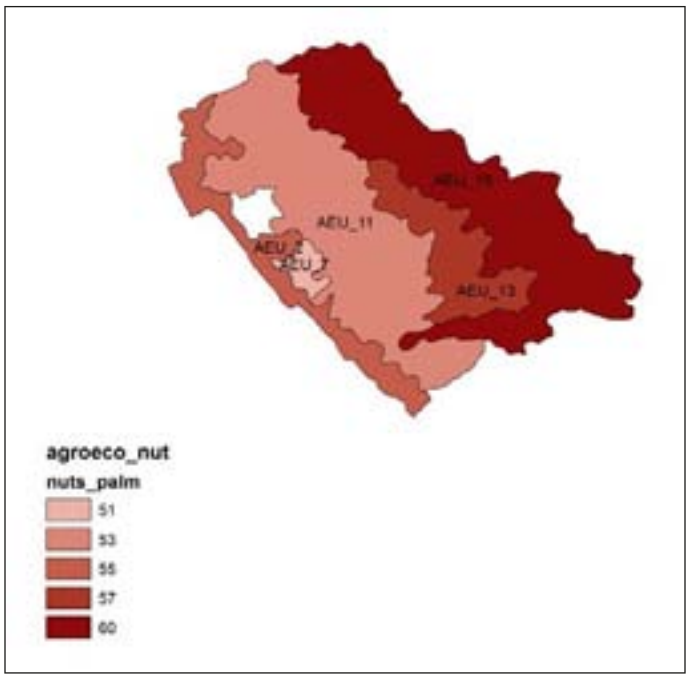
Nonparametric regression analysis in R: The R scripts have been generated to produce the regression models, and estimates using nonparametric regression approaches like moving average, running line smoother, Nadaraya-Watson estimator, local linear regression and kernel regression, along with high-quality graphs.

Prediction of functional metagenomic content from de-multiplex meta-genome data: To predict functional metagenomic content of bacterial community, an algorithm has been developed and implemented in R script. The feature and pathway tables containing predicted KEGG orthologues (KO) occurrence at a 99% threshold were computed from amplicon sequence variants using the Piphillin server.The KOs was also annotated using the Kyoto Encyclopedia of Genes and Genomes (KEGG) database. The script comprises of programs for generating high-quality graphs such as: i) Donut diagram for abundance classes of KEGG pathway maps, ii) Bar diagram for abundance box plots for functional hierarchies of KEGG pathway maps, iii) KEGG functional metabolic pathways-circle packing, and iv) KEGG functional metabolic enzymes- sunburst diagram.

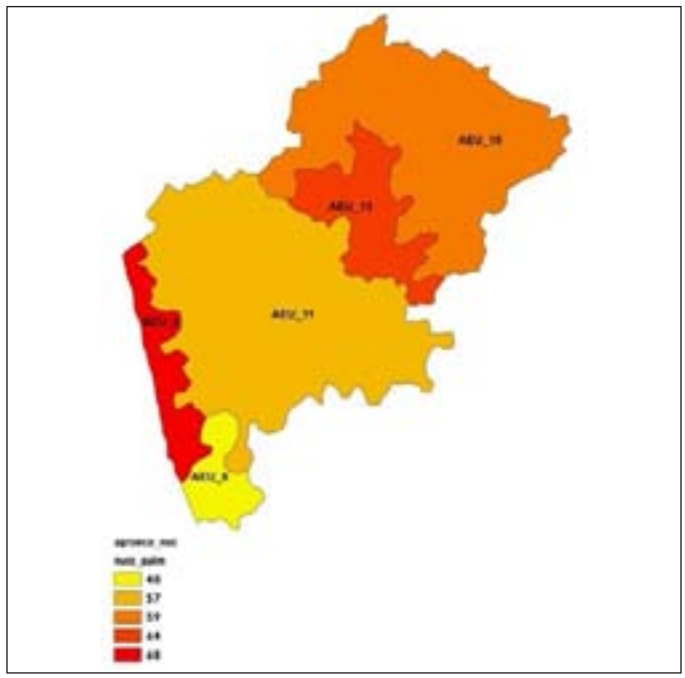
Geospatial variability in coconut productivity in Kerala: Analysis of extent and determinants

Four districts were selected for the study. From northern Kerala Malappuram and Kannur were selected to represent high and low productive districts respectively (based on published statistics). From southern Kerala Thiruvananthapuram and Alappuzha were selected in order. Field survey was conducted to collect information at household level. Stratified random sampling design was followed. Each district was stratified into agro-ecological units and a minimum of 50 gardens with a minimum of 30 coconut palms were selected for field survey form each stratum. Data on crop management (nutrients, crop protection), cultivation practices (spacing, intercropping), irrigation, crop characteristics (age, variety), etc., were collected employing a structured questionnaire. Besides,

secondary information on soil and climatic variables were also collected. Variations in coconut productivity among AEUs in the selected districts are shown in Fig. 55. Among the four selected districts, Malappuram has the highest annual yield of 59 nuts/palm, whereas Thiruvananthapuram is having the lowest (38 nuts/palm). Productivity among the AEUs varied from 48 to 68 nuts in Malappuram whereas the range is 33-44 nuts in Thiruvananthapuram district. Kannur has an average per palm annual yield of 55 nuts with yield level among AEUs ranging from 51 to 60 nuts. The average productivity of Alappuzha district is 44 nuts ranging from 41 to 46 nuts among the AEUs.



a Kannur



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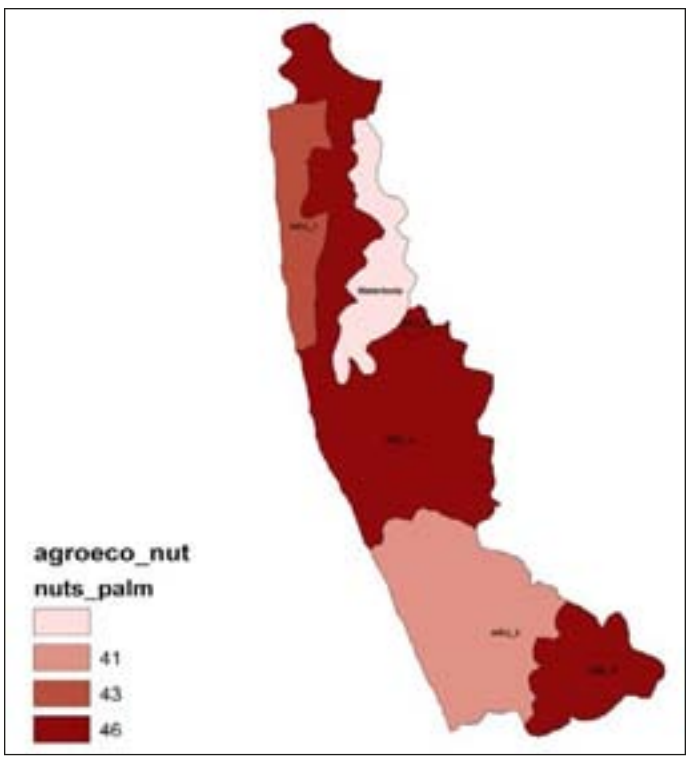
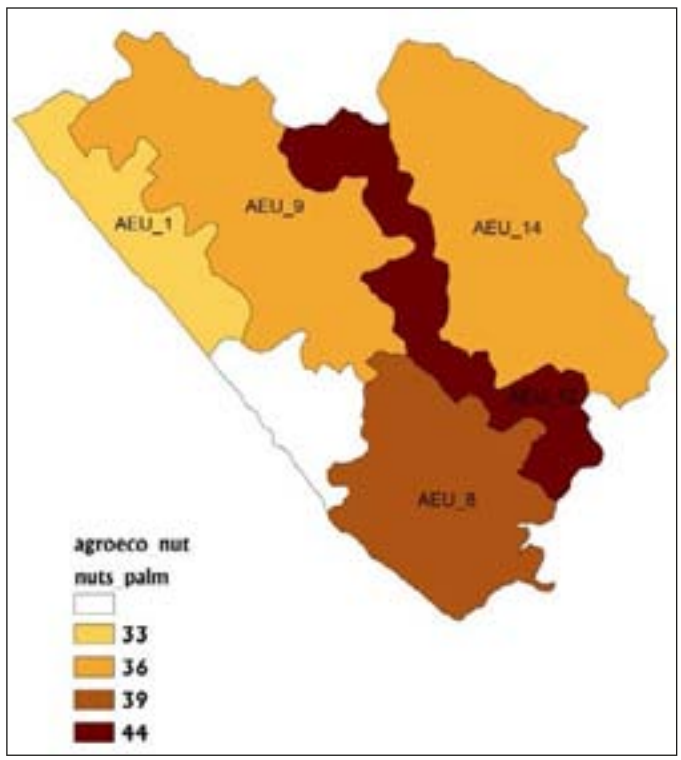


c Alappuzha



d Thiruvananthapuram

Fig. 55. AEU wise thematic maps of coconut productivity in selected districts

To capture the impact of changes in the adoption of technologies on coconut productivity, the variability in factors among the various yield categories were studied. A major issue to be tackled in the study was accounting for the errors in data recording of yield based on the recollection and observation. To reduce the impact of measurement error in coconut productivity, yield data was converted into two non-overlapping categories, *viz*. High yield (≥90th percentile) and low yield (≤10th percentile). Accordingly, yield below 25 nuts/palm/year was grouped as low yield category and yield above 79 nuts/palm/year as high yield category. Differences in technology adoption in these two categories are shown in Table 8. It is evident that technology adoption, as per recommendation, has resulted in increased yield.

Soil fertility-related factors: One of the major factors affecting crop productivity is the level of soil nutrients. The deficiency of organic carbon (OC) and Potassium (K) are more prominent in southern districts as compared to northern districts, on average. Among the micronutrients, Boron deficiency is very prominent in all the districts, with even the lowest deficiency (holding %) is more than 20% (in Malappuram district). Soils of major coconut growing areas in Kannur and Malappuram are strongly acidic. Organic carbon status is in the Medium-high range, whereas P is in the High level. In contrast, the majority of the soils in Kannur district are deficient in K (73%). Soils of Kannur district are deficient in Ca, S, and B. Majority of soils in Malappuram is at medium level in OC and K and are sufficient in micronutrients. All the soils are deficient in Mg. Soils of Alappuzha and Thiruvananthapuram districts are deficient in K, Mg, S and B.

Impact of deficiency of nutrients on yield level was studied critically. Yield level was significantly lower in soils deficient in OC in Alappuzha, Malappuram and Thiruvananthapuram districts. Similarly, yield in K deficient soils was lower in Malappuram and Thiruvananthapuram districts. Ca deficiency in Alappuzha and Mg deficiency in Kannur and Malappuram have resulted in reduced yield. Results of logistic regression are also in conformity to these findings.

Socioeconomic dimensions and value chain dynamics in policy perspective

Sectoral impact of COVID 19-pandemic on mandate crops: An exploratory analysis on the impact of COVID-19 pandemic and subsequent lockdown on plantation crops, reflected disruptions in domestic and global value chains. The repercussions in the production front are, inadequate irrigation especially in large plantations; break in production of planting material; delay in harvests; difficulties in on-farm preliminary processing that resulted in post-harvest loss; problems in nursery management; and not taking up plant protection measures in time. The shutdown of large scale industries resulted in piling up the stock of raw material which in turn had a short-term effect in the supply chain.

A reduction in the coconut oil price (up to 20%) was noticed during the lockdown period. However, on the relaxation of lockdown restrictions, the price of copra and coconut had shown an upward movement. It is estimated that there will be a reduction of 30% in hybrid seed production and 10% in the collection of open-pollinated seed nuts due to restrictions. There will be a deficit in export revenue to the tune of Rs. 3348

Table 8. Level of adoption of technologies between yield categories (Low: <25 nuts/palm/year; High: ≥80 nuts/palm/year)

Technology	Farmers (%)	
	Low yield	High yield
Optimum plant density	24.04	42.45
Soil and water conservation	26.92	38.68
Irrigation	61.54	67.92
Fully organic	53.41	40.38
Organics + inorganic manure	35.23	56.73
Fully inorganic	11.36	2.88
No cultivation practices followed	15.38	1.92
Improved varieties/ hybrids (≥25%)	8.65	9.43
Existence of pest attack	91.35	35.85
Integrated pest management practices	25.00	26.32
Existence of disease infection	89.42	37.79
Integrated disease management practices	2.88	15.38

million in the coconut sector, which is a direct impact of ceasing the overseas trade (i.e. 16.2% of annual export earningsfrom coconuts and coconut products). The restrictions on public/ vehicle movement, labour utilization, and closure of processing units, mandis and markets resulted in an estimated loss of Rs. 25,770 million in the coconut processing sector and Rs. 23,190 million in the production sector. Altogether the estimated loss in value of trade would be Rs. 4,354 million. Additionally, in the coir sector, an amount of Rs. 4500 million would be the loss.

In case of arecanut, the estimated export loss is worked out to be Rs. 153 million (16.5% reduction in annual exports), and the import deficits would be to the tune of Rs. 712 million. Further, the lack of crop management practices due to labour scarcity would result in an economic loss of 1800 million rupees.

The cocoa sector in the country will have an export loss up to Rs. 1906 million, but the real impact on the sector would be the scarcity of cocoa beans in the domestic processing companies, as 51% of the bean requirement in the sector is met by the imports. There will be a reduction of 7590 MT cocoa dry beans in the industry. As the international cocoa prices were soaring high (up to 20% higher on year on year comparison), the small scale industry players found it challenging to make procurement in the domestic front. There will be a reduction of 10602 MT cocoa dry beans worth Rs. 2458 million in the industry. The estimated production loss in cocoa will result in a loss of Rs. 29 million.

Price analysis of coconut oil and comparison *vis a' vis* major edible oils: The price movements of coconut oil, soybean oil and palm oil for the period 2008-20 are depicted in Fig. 56. It is striking that, excluding a few years, mostly coconut oil prices were much higher than the other two edible oils, and this price wedge was especially ruled at the highest levels during 2013-18. The higher international prices than the substitutable edible oils will certainly debilitate the competitiveness of coconut oil in the international market. This is a matter of grave concern

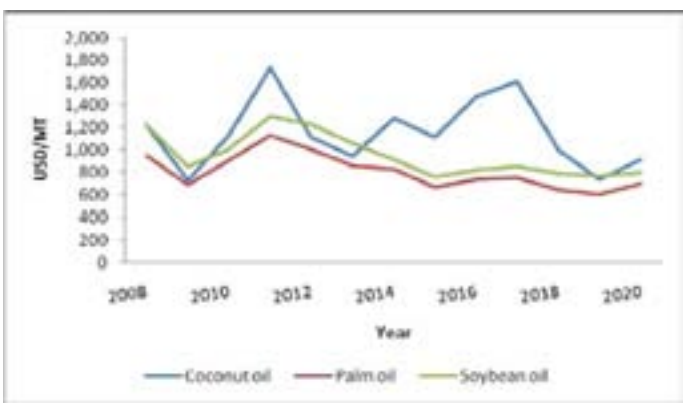


Fig. 56. Price movements of major edible oils (2008-20)

regarding the sustainability of the coconut sector in the long term perspective.

Price difference of coconut oil compared to palm oil and soybean oil for the period 2008 to 2020 was 44.6% and 23.4%, respectively. While examining the price instability over the last 15 years, it was observed that in the initial five years (2006-10), the price instability indices of coconut oil (0.035), palm oil (0.040) and soybean oil (0.031) have not shown much of difference. Still, in the subsequent period, coconut oil prices at the international level were comparatively volatile than the other two major edible oils.

Refined framework for revamping the 'neera' sector: A study was conducted to trace the reasons for setbacks experienced in the 'neera' sector in Kerala to provide a refined framework for revamping the sector. The details of licenses granted to the CPFs were sourced from the department of excise, Kerala. The size of the respondents was 95 (including the discontinued ventures). It was observed that the 'neera' value chain is in the evolving stage and the withdrawal of the institutional support of Coconut Development Board had detrimentally affected the confidence of the CPFs ventured into it. The dearth of technical competence and lack of marketing skills were very much evident in the sector. The availability of 'neera' technicians (tappers) and the high wage rates have evoked concerns on profitability and the assurance of the continuous supply of the product. The study categorically highlights the need for a restructured innovation system of 'neera' with specific roles assigned to the stakeholders by creating functional linkages. Based on the study results, a framework for the same is suggested as in the Fig. 57. The beneficial impact of the restructured support mechanisms on the sustainability of activities of coconut FPOs in Kerala, the pioneer in institutionalising interventions on 'neera' for improving livelihoods of coconut growers, would be useful for the FPOs in neighbouring states of Karnataka, Tamil Nadu, and Andhra Pradesh to streamline their activities were similar 'neera' based enterprises are coming up with an enabling policy environment and incentive mechanisms.

Institute Technology Management Unit

National patent has been granted for the invention entitled 'a composition, device or a trap and the methods thereof' to Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore and Indian Council of Agriculture Research (CPCRI). Institute has filed two patent applications this year: Process protocol for foam mat dried coconut milk powder using sodium caseinate, maltodextrin and carboxy methyl cellulose (TEMP/E-1/29398/2020) and Linear

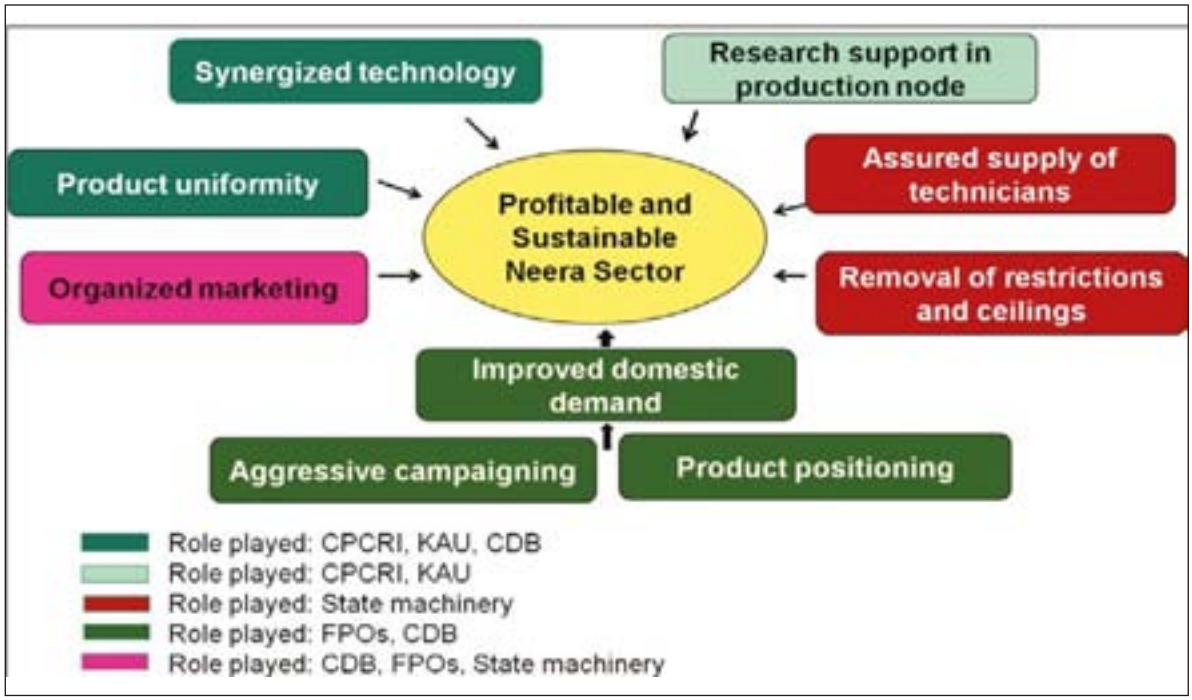


Fig. 57. Desired sectoral innovation system for neera

actuator based Minimal Processing Machine for Tender coconut (TEMP/E- 1/30543/2020-CHE).

Seventeen MoAs were signed for transfer of technology know-how of 11 technologies: VCO, coconut chips, Kalparasa, mature coconut water based products, tender coconut trimming machine, Kalpa Organic Gold (2), Kalap soil care, EPN (2), Kalpavardhini, and trichoderma coir pith cake. Revenue realised from technology transfer was Rs. 2,87,000.

Kalpa Agri-Business Incubator

Ten incubatees registered, and eight graduated during 2020. Twelve entrepreneurs initiated their business. Nine EDPs were conducted that include two on cocoa processing and two on coconut value addition.

The Kalpa Agri-Business Incubator, jointly with Kerala Startup Mission organised the first Rural India Business Conclave from 27 February to 3 March 2020 at Kasaragod. Report of the event is provided in another chapter of this Annual Report.

Owing to Covid-19 restrictions, the Kalpa Green Chat was rescheduled as an online-programme by which it received better coverage and participation. During June to September 2020, 19 online lectures on various technologies were conducted.

A webinar on 'technology, finance and policy support for coconut MSME' was organised in collaboration with MSME Development Institute, Thrissur on 6 August 2020.

To equip the final year agriculture/horticulture graduate students to address field level problems in plantation crops, an online lecture series was started on 17 September 2020. Dr Laxman Singh Rathore, Formerly Director, IMD and Vice President, VIBHA inaugurated the programme. Dr B. K. Pandey, ADG (Hort. Sci.), ICAR presided over the function. Dr Manjunatha K. Naik, Vice Chancellor, UAHS, Shivamogga delivered the keynote address. Sri Sajl Ghose, Vice Chancellor, Bidhan Chandra Krishi Viswa Vidyalay, Kalyani and Dr. Janakiram Tolety, Vice-Chancellor, Dr. YSR Horticultural University, Venkataramannagudem, Andhra Pradesh were guests of honour. Nearly 1500 students from all over India registered for the programme. Dr. S. Jayasekhar coordinated the programme.

08. ICAR-Krishi Vigyan Kendra-Kasaragod

Frontline Demonstration (FLD)

The ICAR- Krishi Vigyan Kendra, Kasaragod carried out 10 FLDs during 2020.

High yielding rice variety - Shreyas: Demonstrated in 5 ha area of 20 farmers' plots in Bombrana village during the Kharif sason. Against an average yield of 5.2t/h in the control, yield of Shreyas was 7.2t/ha and realized a net return of Rs. 92750 per ha.

High yielding rice variety – Manuratna: This short duration paddy variety released by KAU was demonstrated in 5ha area in Bombrana village.

Turmeric variety - Pragathi: In 10 farmers' plots covering 1 acre area in Enmakaje village.

Coconut based farming system: Inter crops like banana, fodder grass, vegetables, ginger, turmeric and fruit crops were introduced in 10 farmers' plots in Panayal village.

High yielding Okra variety - Salkeerthi: Introduced in 20 farmers' plots covering an area of one acre in Bombrana village.

Raising Leguminous green manure crops in coconut basins: Cowpea (*Vigna unguiculata)* was successfully raised in coconut basins in 10 farmers' plots in Kudlu village. On an average 10.3 kg biomass was added to the basins of 250 palms.

Hybrid cashew: The demonstration was carried out in 5 farmers plots in Enmakaje village during 2019 and is continuing. Method demonstration on soil and water conservation practices in cashew was carried out during 2020.

Mechanized in rice cultivation: It was carried out in Kolayavayal village in an area of 4 ha belonging to 14 farmers in Ajanur panchayat that include use of tractor operated rotavator, mat nursery preparation, and transplanting with riding type transplanter.

Introduction of grain cowpea in rice fallows: It yielded 10 quintal grain cowpea per ha with a net return of Rs. 37,400 per ha.

Coconut value added products: Process demonstration of coconut vinegar (5 units), coconut milk based peda and paneer (3 units) and VCO based protein rich muffins (3 units) were carried out.

Arka CoorgExcel variety of black pepper variety released by ICAR-IIHR: Introduced in 10 farmers' plots in Parappa and Enmakaje panchayats.

On Farm Trials

Assessment of ITKs on indigenous functional foods for addressing anemia was initiated.

Assessment of functional food supplements for differently-abled children in Kasaragod district: The product is pre cooked, easily digestable, palatable and have shelf life of six months which is consumed in porridge form. Twenty children of age group 2-10 years from two Buds schools in Bedadka and Enmakaje were selected and five Kudumbasree units were trained for the production.

Training Programmes

KVK Kasaragod carried out 36 on campus training programmes for 422 farmers (147 male; 275 female) and 19 off campus training programmes for 334 famers (187 male; 147 female). KVK also conducted training programmes for rural youths with participation of 67 trainees (33M, 34F). Training programme on mushroom production which was sponsored by Agriculture Skill Council of India (ASCI) with a participation of 18 rural youths (9 M, 9F) was organized at KVK. Six training programmes on formation of Farmer Producer Companies and value addition of agricultural produce were conducted in four blocks in Kasaragod district with a participation of 158 farmers (142M and 16 F). One online training on FPO formation also carried out in which more than 200 farmers participated. EDP programme on preparation of dried vegetable and fruit products was conducted for 5 batches (30 participants) and two groups have started production.

Extension Activities

Conducted 4 farmers group meetings, 27 field visits, 12 method demonstrations, 4 agricultural seminars and attended 2850 help line services. During the lockdown period, farmers were provided advisories through telephone to 300 farmers. Assisted four FPOs for registration and receiving assistance from SFAC.

Technology Week celebration: The technology week of KVK Kasaragod was celebrated from 27th February 2020 to 3rd March 2020 with six seminars (hydroponics, IPDM in coconut, commercial fish farming, value added honey

products, commercial goat rearing, energy management, urban horticulture) benefitting 736 farmers.

World Soil Day: A class on soil health was taken by Dr. Ravi Bhat, Heat, Crop Production, ICAR-CPCRI on 5 December at Bombrana village with a participation of 19 farmers.

International Women's day: Exhibition and display on Nutri Thali was conducted on 8 March 2020. Two farm women Ms. Lakshmi Bhat and Ms. Khadeja Mohammed were honoured on this occasion.

Poshan maah abhiyan: In connection with the nationwide campaign on Poshan Maah a seminar on nutrigraden was organized for 64 Anganwady staff and farmers on 17 September 2020.

Field day on HYV Shreyas: It was conducted on 30 October 2020 with a participation of 30 farmers and elected representatives of LSG.

Custom Hiring Centre: The custom hiring centre of KVK Kasaragod was inaugurated on 4 January 2020 by Dr. DNS Murthy, Horticulture Commissioner, GoI. Twenty six farmers had availed the facility with a total cumulative utilization of 288.5 hrs for tractor, 21 days for transplanter by 3 farmers and 12 days for power tiller.

NFSM programme on Demonstration on pulses: Green gram was cultivated in 20 ha rice fallows in Bambrana village as part of National Food Security Mission programme.

Product launch: ICAR-KVK, CPCRI Kasaragod formulated a nutri-bar to provide a healthy snack food for school children. The main ingredients are cashewnut, coconut, dates, sesame seeds, jaggery and cocoa powder. Thirty women were trained on preparation of nutri-bar and two SHGs - Indiraj Kudumbasree Kayangad and Sara kudumbasree Koliadukam in Kasaragod have stated production and marketing. According to AIphonsa Paul of Kanyangad SHG, she has started providing to five schools and later on as the product got wide acceptance among children, she is now getting orders from 10 schools from Kanhangad. As the first order, she provided 3000 Nutri-bars in the month of Febraruy 2020. Now she has a demand for 3000 Nutri-bars every day.

09. ICAR-Krishi Vigyan Kendra-Alappuzha

On Farm Testing

Five OFTs are being taken up in the operational villages of Thazhakkara, Chettikulangara, and Chennithala during 2020 -21 as listed below:

- Assessing the performance of pulses in rice fallows of Onattukara during summer season
- Assessment of organic liquid nutrient – NOVEL on the yield of vegetable cowpea
- Assessment of the quality and acceptability of Garcinia paste and powder Management of repeat breeders in dairy cows
- Assessing the performance of Namakkal Chicken 1

Frontline Demonstrations

Twelve front line demonstrations are being taken up in the operational villages of Thazhakkara, Chettikulangara, and Chennithala during the year as listed below:

- Demonstration of High yielding short duration Paddy variety Manuratna
- Demonstration of high yielding short duration turmeric variety Pragati in coconut gardens
- Secondary and micronutrient management in paddy for enhancing farmer's income
- Demonstration of nutrient efficient variety of Cassava (Sree Pavithra) in Onattukara
- Eco friendly disease management in betelvine
- Integrated management of dry rot in turmeric
- Integrated disease and nematode management in banana
- Demonstration of turmeric rhizome maggot management using var.Pragati
- Demonstration of IPM packages in chilly for better yield and income
- Demonstration of IPM packages in bitter gourd for better yield and income
- Specific mineral mixture for goat for enhancing productivity
- Demonstration of Opheocephalus (Varaal) fish in homestead ponds

Training Programmes

76 training programmes were organized during 2020 (January – November) for a total of 1780 participantsas detailed below.

Other Extension Activities

Advisories to farmers during the COVID 19 lockdown period: The KVK provided timely advisories for farmers on various activities in crop production, value addition, mushroom cultivation and animal husbandry during the period of lockdown from 25 March to 19 April, 2020. 1565 farmers were given messages through mKISAN portal on various farm activities.

Table 9. Details of training programmes conducted by KVK, Alappuzha

Training	No. of Programmes	Participants		
		Men	Women	Total
On campus	4	21	34	55
On campus (online)	40	892	263	1155
Off campus	21	194	144	338
Vocational	1	9	4	13
Sponsored	4	36	82	118
Training to extension official	4	15	51	66
ASCI Training	2	19	16	35
Total	**76**	**1186**	**594**	**1780**

Cluster FLD on Sesamum at Chettikulangara: Sowing of Cluster FLD on Oil Seeds - Sesamum was conducted at Chettikulangara was inaugurated by Adv. U Prathibha, MLA on 27 January 2020 in a meeting chaired by Smt. C Krishnamma, President Chettikulnagara Gramapanchayath. The demonstration aimed at increasing the productivity of the crop by proving sprinkler irrigation in its critical stages of growth and preparation of value added products from sesamum to increase the farmers' income.

Seminar on Scientific cultivation and value addition of coconut: In collaboration with Coconut Development Board, Kochi organized a District level seminar on 'Scientific cultivation and value addition of coconut' on 19February 2020 at CPCRI Regional Station. Dr. Anitha Karun, Director, ICAR-CPCRI inaugurated the programme. Over 150 farmers participated.

Fertilizer Application Awareness Programme: A district level Fertilizer Application Awareness Programme funded by the Dept. of Agriculture and Farmers' Welfare, Govt. of India was organized on 20 Feb 2020. Dr. S. Kalavathi, Acting Head, ICAR CPCRI, RS, made keynote address: 105 farmers participated.

International Women's day Celebration: Five woman farmers - Smt. R. Jagadhamma (Crop production), Smt. Viji Gopan (Value addition), Smt. P. Sathi (Mushroom Cultivation), Smt. Anitha kumari (CBIFS) and Smt. Sheeba Sadique (Animal Husbandry) were honoured by Smt. Babitha Jayan, Member Muthukulam Division, District Panchayath, Alappuzha in a function chaired by Kum. Aritha Babu, Member Krishnapuram Division, District Panchayath 7 March 2020 as part of Women's day celebrations.

Animal Disease Control Programme Campaign: A campaign on Animal Disease Control Programme of the Govt. of India was conducted at Vallikunnam APCOS on 10 March 2020. Bharanikkavu Block Panchayath President Smt. Rajani Jayadev inaugurated the campaign which was attended by Smt. Biji Prasad, Vice President, Vallikunnam Grama panchayath. Essential medicines were distributed to 120 farmers.

Farmer Producer Organizations: Vegetable kits were distributed to the shareholders of Onattukara Spices Farmer producer Company Limited, promoted by ICAR-KVK-Alappuzha on the occasion of Onam festival. It was inaugurated by Smt. Rajini Jaydev, Block Panchayath President, Bharanikkavu and Managing Director, OSFPCL on 27 August 2020.

Poshan Abhiyan campaign: Poshan Abhiyan campaign was organized on 17 September, 2020 on the occasion of the 70th birthday of the Hon. Prime Minister Sri Narendra Modi at Thekkekkara Gramapanchayath meeting hall. SriR.Unnikrishnan, Chairman, Welfare Standing Committee inaugurated the programme and handed over the vegetable seed packets to the Anganwadi teachers. Teachers representing 40 Anganwadies and farm women from Thekkekkara and Chettikulangara panchayaths attended the programme. Seed packets received from IFFCO and arranged by KVK were distributed to the participants.

150thBirth Anniversary of Mahatma Gandhi celebrated: The following programmeswere organized during 26.09.20 - 02.10.20: (i) Swachhta activities were carried out in the Office and farm of KVK; (ii) Online training on 'Empowerment of rural women through small scale agri enterprises'; (iii) Photography competition on 'My role in Swachh Bharath' and Essay competition on 'Gandhiji's concept of grama swaraj - Present day realities' for vocational higher secondary (Agri.) students of Alappuzha district.

Mahila Kisan Diwas: It was celebrated on 15 October 2020 and inputs for establishing nutrition gardens at Anganwadies and homesteads was distributed by Smt. Shyla Lakshmanan, President, Thekkekkara Grama panchayath in the presence of Smt. Eby Baby, Agrl. Officer.

World Soil day: The message of 'Keep soil alive, protect soil biodiversity' by following good agricultural practices and maintaining natural resources in healthy condition for a healthy society was conveyed in an online interactive session with farmers as part of the 'World Soil Day' celebrations organized by the KVK on 5 December, 2020. Marking the occasion, soil health cards were distributed to 35 farmers of Thalavady and Chennithala villages.

Revolving fund activities of KVK: Different inputs were made available to the farmers of the district (as resource centre) through revolving fund activities *viz.,* Methyl Euginol, cue lure and yellow sticky traps, seeds and seedlings, layer chicks, mushroom spawn, mother spawn, multi nutrient mixture for banana and vegetables, azolla, worms for composting, bio agents, myccorrhizae,

organic manure, processed products, publications etc. The progressive closing balance of revolving fund as on 30.11.20 is Rs. 21,24,237.

Field day of the FLD on 'Integrated disease management in cowpea': It was conducted at Parankulangara in Thazhakkara on 10 March 2020. Sri S. Anirudhan, Vice president, Thazhakkara grama panchayath presided over the function.

Rural Agricultural Work Experience (RAWE): Conducted the programme for 13 final year B. Sc. (Ag.) students of five SAUs.

Externally Funded Projects

National Innovations in Climate Resilient Agriculture (NICRA)

The project is funded by ICAR and coordinated by ICAR-CRIDA, Hyderabad and ICAR-ATARI, Bengaluru. Technology Demonstrationson climate resilient practices relevant to the production systems in Kuttanad region were taken up, that include:

- Large scale composting of aquatic weeds using EM solution
- Vegetable cultivation in grow bags
- Soil health card for better nutrient management
- Demonstration of short duration rice variety Manu Ratna
- Strengthening of mushroom cultivation with spawn production
- Housing of poultry in slatted floor, feeding and disease control programme
- Fabrication of goat shed with raised platform
- Rice-fish-duck-vegetable model
- Prevention of diseases and Mastitis control programme in livestock

Onattukara Spices Farmer Producer Company Ltd. (OSFPCL)

At present it has 269 share holders and share capital of 2.90 lakhs. The company facilitates cultivation, procurement, processing, and marketing of the major spices viz., Turmeric, Ginger, Pepper and Garcinea in six panchayaths of Bharanikkavu block so as to enhance the net income of the shareholder farmers.

Agro Processing Training cum Incubation Centre (APTIC)

It was established with financial support from Department of Agriculture Development and Farmers Welfare, Govt. of Kerala. The incubation centre facilitates the development of technology based and knowledge driven agri business ventures by providing an integrated package of technology, work space, access to specialized equipments and pilot plant to entrepreneurs in processing and value addition of coconut, jackfruit, and seasonal fruits and vegetables..

Capacity building in value addition of coconut

A Virgin Coconut Oil production-cum-training unitequipped with VCO Cooker, Coconut milk extractor, Manual filter press and Band sealer has been set up at the KVK for capacity building of entrepreneurs on value addition of coconut under the'Innovation-Science and Technology based Entrepreneurship Development (i-STED) project of Department of Science and Technology, Govt. of India, implemented by the Swadeshi Science Movement in Kerala. A total of 250 entrepreneurs, identified by the project, are trained in this unit on VCO production and value addition of coconut.

Value chain in turmeric

This new project sanctioned under the FSPF of NABARD with a funding of Rs. 18.0 lakh has been initiated with the objective of promoting the value chain activities of turmeric from production to processing and marketing, by involving 250 partner farmers from 10 panchayaths of Mavelikkara and Chengannur Blocks of Alappuzha district.

10. ICAR- All India Coordinated Research Project (AICRP) on Palms and Cocoa

The AICRP on Palms and Cocoa has five mandate crops: Coconut, oil palm, arecanut, palmyrah and cocoa. Its headquarters is at ICAR-CPCRI, Kasaragod and has 28 centres spread across and it is implemented in 28 centres spread across 15 states (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Telengana, Chattisgarh, Odisha, Jharkhand, West Bengal, Bihar, Assam and Arunachal Pradesh) and one UT (Andaman and Nicobar Is.), of which 15 centres are conducting research on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa. These centres are attached to 13 SAUs/SHUs, one CAU and four ICAR institutes. The budget for the year 2020 (January-December) was Rs. 351.75 lakhs and the scheme is implemented through the respective state Agricultural/ Horticultural Universities on 75:25 basis, with 75% ICAR share, 25% share from State Agricultural Universities and with 100% ICAR funding in the case of Central Agricultural Universities and ICAR Institutes.

Research Achievements

Coconut

Crop Improvement

At Aliyarnagar centre, the combination MGD x ALR was observed to be the earliest to start flowering (34 months). The maximum nut yield was recorded in the hybrid COD x ALR (89.0 nuts/palm/year) at the age of eight year. Regarding the nut characters, the cross combination COD x WCT recorded higher whole nut weight (2421.0g), de-husked nut weight (1086.0g), kernel thickness (1.4 cm) and copra weight (247.5g).

At Ambajipeta centre, among the varieties/hybrids evaluated, Godavari Ganga recorded significantly highest yield /palm/year (138.6 nuts) followed by VHC-1 (121.6 nuts) and VHC-2 (119.5 nuts). Highest fruit weight was recorded in Double century (1450.5 g) followed by Chandra Sankara (1328.3g) and Godavari Ganga (1316.3g). Significant differences were observed for tender nut water content and the highest quantity was recorded in VHC-2 (386.8ml), followed by Godavari Ganga (382.51ml) and Double century (375.4ml).

Kerasankara recorded significantly highest yield/palm/year (97.4 nuts) followed by Keraganga (95.5 nuts) and Chandra Sankara (93.9 nuts) in the trial started in 2004 at Bhubaneswar centre.

Crop production

In coconut+cocoa+banana+pineapple cropping system, integrated nutrient managementwith 75% of recommended NPK through fertilizer coupled with 25% NPK through organic recycling with vermicompost recorded higher nut yield and intercrops yield, along with higher net income (Rs. 3.28 lakhs per ha) followed by 50% of recommended NPK+50% through organic (Rs. 3.07 lakhs per ha) and fully organic treatment (Rs. 2.96 lakhs per ha) at Aliyarnagar centre.

Under coconut based farming system at Aliyarnagar, a total of 17,200 nuts/ ha/year and 10,700kg of fodder was produced from one ha. From 26 lambs, 6600 kg goat manure obtained. Integration of coconut with pasture crops (Cumbu Napier hybrid + Desmanthus) + Fodder trees (*Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia*) + Tellichery goats accrued gross income of Rs. 3,18,400 per ha as compared to Rs. 2,03,400 per ha in the monocrop of coconut. Thus inclusion of goat is highly remunerative in coconut based farming system.

At Kahikuchi and Mondouri centres, among the black pepper varieties/hybrids screened, Panniyur-1 recorded significantly higher number of spikes (112.0 in one meter column height), spike length (14.4 cm), number of berries per spike (67.8) and dry yield (1.50kg/vine). This variety can be recommended forgrowing with coconut in Assam and West Bengal.

Crop protection

Root(wilt) disease: Integrated management practices involving addition of organic manure @ 25 kg/palm +*Trichoderma viride* @ 50 g/palm + sowing of dhaincha seeds @ 100 g/palm basin and incorporation with the initiation of flowering + recommended dose of fertilizers + zinc sulphate @ 50g/palm reduced the average root (wilt) disease index of coconut in farmers field, from 15.86 (2016) to 9.95(2019) in Coimbatore district and 16.34 (2016) to 11.94 (2019) in Tirunelveli district: Coconut yield was respectively 83 and 95 nuts/palm.

Rhinoceros beetle: A field study was carried out in Tamil Nadu (Aliyarnagar), Andhra Pradesh (Ambajipeta), Karnataka (Arsikere) and Maharashtra (Ratnagiri) to evaluate the CPCRI Botanical cake + paste@ 15g each/ palm against rhinoceros beetle infestation in juvenile palms and it was found effective in reducing spindle damage and

Table 10. Efficacy of integrated management package on coconut eriophyid mite at Ambajipeta during 2019- 20

Treatment	Nut damage (%)			Mite Population /16 mm²			Mean Grade Index		
	March 2019*	Sept 2019**	March 2020**	March 2019*	Sept 2019**	March 2020**	March 2019*	Sept 2019*	March 2020*
IPM	88.3±1.5	82.1±0.6	84.2±0.8	56.9±5.9	46.7±1.3	52.8±1.4	2.0	1.3±0.1	1.75±0.2
Control	93.3±0.8	92.8±0.7	93.8±1.0	86.7±4.8	69.1±1.8	72.2±2.0	2.5	2.3±0.1	2.5±0.1

*Significant at 5%; **Significant at 1%

leaf damage in coconutwith enhanced nut yield. Hence, botanical cake and paste can be recommended and used as prophylactic management strategy for combating rhinoceros beetle damage.

Eriophyid mite: Combination of Integrated nutrient management and integrated pest management package was found effective against eriophyid mite with increased coconut yield. Besides application of macro and micro nutrients, organics like 20kg FYM and 20kg vermicompost 5kg neem cake and green manuring through raising leguminous crops in coconut basins, husk incorporation in the inter rows), and bioagent Kera Probio (100g/palm) were applied as part of the treatment. Root feeding with fenpyroximate 5%EC @ 10 ml and 20 ml water during March and spraying palm oil – sulphur emulsion during December were also carried out and in summer, irrigation was provided. The results of the trial is provided in Table 10.

Spiralling whitefly: The Integrated Pest Management strategies effectively reduced the incidence and intensity of rugose spiralling whitefly (RSW). In the IPM strategies adapted plot the incidence and intensity of RSW was significantly reduced from 56.6% to 28.3% and 64.3 % to 32.2% respectively when compared to the natural control were the percent incidence and pest intensity was increased from 48.2% to 60.2% and 60.4% to 71.6% respectively. Pesticide holiday approach successfully proved for conservation of natural enemies like *Encarsia* in all localities which was effectively managing rugose spiraling whitefly infestation. Five coloured plastic sheets viz., Red, Yellow, Green, Black and White with dimensions of 100 x 50cm were installed in the coconut garden and grease was applied to them and observations on mean number of RSW trapped was recorded.The observations revealed that the maximum catch of the whitefly was on yellow colour trap with a mean number of 21.3 (No. of RSW trapped at points of dimensions 5 cm^2), respectively.

Oil palm

Based on long term hybrid evaluation, the oil palm hybrids were recommended for release in respective regions *viz.*, NRCOP-4 with FFB yield of 30.11t/ha as Godavari Swarna for Andhra Pradesh; NRCOP-17 with FFB yield of 28.37 t/ha as Godavari Gold for Tamil Nadu; and NRCOP-2 with FFB yield of 22.69 t/ha as Godavari Ratna for Maharashtra states.

Arecanut

Technology demonstration on crown chokemanagement in Shivamogga indicated that, management practices influenced better rootdevelopment as well as better uptake ofnutrients by the plant resulting in reduction ofthe infected leaves in the affected palms. After one year of imposition of treatments, healthy plants produced 5.8 bunches/ plant and infected plants produced 2.9 bunches/ plant compared to pre-treatment yield (5.1 and 2.6 bunches/ plant, respectively)

Cocoa

Multilocation trials of cocoa clonesunder palms is in progress at different AICRP centres *viz.*, Aliyarnagar,

Fig. 58. Godavari Swarna

Fig. 59. Godavari Gold

Fig. 60. Godavari Ratna

Arsikere, Kahikuchi, Ratnagiri and Vijayarai. At Ambajipeta, VTLCH-2 recorded higher dry beans/ plant (2.1kg) and was at par with VTLCC-1 and VTLCH-4 (1.8kg/tree). At Navsari, VTLCH-4 registeredthe highest pod weight, single dry beanweight, numbers of beans/pod and drybean yield/tree/year.

Palmyrah

Fresh Neera collected through CPCRImethod was further processed by pasteurizationfollowed by PET bottle sterilization gave maximumshelf life of 30 days for neera under refrigeratedconditions. Palmyrah syrup/honey of 65 °Brixmade from sap collected through cooling box method stored in glass bottle recorded shelf lifeup to 6 months under ambient condition; it canbe extended more than one year underrefrigerated conditions. Dehydrated tuber andtuber flour is ready for commercialization andcurrently an NGO 'ASHA' is using the technologyfor tribal employment

29th Annual Group meeting of AICRP on Palms

The ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala organizedthe "Virtual 29th Annual Group Meeting of All India Coordinated Research Project on Palms" from 10- 11 August 2020. Dr. A. K. Singh, Deputy Director General (Hort. Sci.)was the chief guest of the function and Dr. B. K. Pandey, Assistant Director General (Hort. Sci- II), ICAR, New Delhi was the guest of honour of the event. Dr. Anitha Karun, Director, ICAR-CPCRI, Kasaragod welcomed the dignitaries and delegates in which she applauded the positive concern of the Deputy Director General over the health of the palm scientists, across the nation. Dr. H. P. Maheswarappa, Project Co-ordinator, AICRP (Palms), briefed about activities of the project and mentioned that the total budget outflow during last yearwas 543.60 lakhs. He enlisted that Impact assessment of cyclonehit areas in the Western Ghats of the country, Management of the debilitating pests of coconut -rugose spiraling whitefly employing the parasitoid *Encarsia guadeloupe*and Development ofMulti-tier and Integrated Farming System models are the noteworthy contributions of AICRP(Palms). Effective Transfer of Technology from lab to land through diverse tools and modes remainthe major strength of this AICRP programme.

The Assistant Director General highlighted that all the research a programme of AICRP (Palms) needs to be tailored to go in tandem with the present extra–ordinary situation. In his inauguraladdress, the honorable Deputy Director General gave a bird's eye view of the overall growth ofhorticultural sector and its significant contribution to GDP and nutritional security of the nation withspecial emphasis on oil palm. He hinted that carbon sequestration potential of palms may beexplored, to take over research forward in the era of climatic vagaries. He underlined the need fordeveloping high yielding varieties, user friendly technologies for the betterment of the farm frontand to connect ourselves with the farmers with benefitting technological outputs. He portrayedthat adoption of remunerative location specific intercrops and integration of animal enterprises incoconut ecosystem through IFS approaches can help farmers to realize better income than monocropping. Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi suggested that high yielding traditional varieties of oil palm be conserved for scaling up its production.

VIII. Publications

Research Articles

Alagar, M., Rajamanikam, K., Chinnadurai, S., Yasmin, A. and Maheswarappa, H.P. 2020. Surveillance, assessment of infestation, biology, host range of an invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin and status of its natural enemies in Tamil Nadu. *Journal of Entomology and Zoology Studies*,**8**(3):2041-2047 (NAAS Score 5.53).

Anes K.M., Babu, M., Sivadasan, J. and Josephrajkumar A. 2020. Discovery of a new *Steinernema* sp. (Rhabditida: Steinernematidae) with higher shelf life and better efficacy against red palm weevil under laboratory conditions. *Journal of Plantation Crops*, **48**(3): 184-191. (NAAS Score 5.54)

Anithakumari, P. and Jayasekhar, S. 2019. Leadership and social intelligence of coconut farmer leaders and implications in extension services.*Journal of Plantation Crops*, **47**(3): 158-166. (NAAS Score 5.54)

Arvind, K., Rajesh, M.K., Josephrajkumar, A. and Grace, T. 2020. Dataset of *de novo* assembly and functional annotation of the transcriptome of certain developmental stages of coconut rhinoceros beetle, *Oryctes rhinoceros* L. *Data in Brief*, *28*, p.105036. (NAAS Score --)

Babu, M., Thangeswari, S., Josephrajkumar, A., Krishnakumar V., Selvamani V., Daliyamol, Hegde Vinayaka, Maheswarappa H.P. and Anitha Karun 2021. First report on the association of '*Candidatus* Phytoplasma asteris' with lethal wilt disease of coconut (*Cocos nucifera* L.) in India. *Journal of General Plant Pathology,* **87,** 16–23. https://doi.org/10.1007/s10327-020-00970-y (NAAS Score 6.89)

Bandyopadhyay, A., Ghosh, D.K., Biswas, B., Parameswarappa, M.H. and Timsina, J., 2020. Fertigation effects on nutrient use efficiency, energy productivity, and economics of Coconut (*Cocos nucifera* L.) cultivation in the Eastern Indo-Gangetic Plains of South Asia. *International Journal of Fruit Science*, *20*(sup3), S1483-S1494. https://doi.org/10.1080/15538362.2020.1812016. (NAAS Score --)

Chaithra, M., Vanitha, S., Ramanathan, A., Jegadeeshwari, V., Rajesh, V., Hegde, V. and Apshara, E. 2020. Profiling secondary metabolites of cocoa (*Theobroma cacao* L.) endophytic fungi *Lasiodiplodia pseudotheobromae* PAK-7 and *Lasiodiplodia theobromae* TN-R-3 and theirantimicrobial activities.*Current Journal of Applied Science and Technology,* **39**(2): 47-56. (NAAS Score 5.32)

Chaithra, M., Vanitha, S., Ramanathan, A., Jegadeeshwari, V., Rajesh, V., Hegde, V. and Apshara, E. 2019. Morphological and molecular characterization of endophytic fungi associated with cocoa (*Theobroma cacao* L.) in India. *Current Journal of Applied Science and Technology*, **38**(6):1-8. (NAAS Score 5.32)

Daliyamol, Merin Babu, Josephrajkumar, A. and Vinayaka Hegde. 2020. Identification of *Leptoxyphium sp.* causing sooty mold on coconut. *Indian Phytopathology.* https://doi.org/10.1007/s42360-020-00298-9 (NAAS Score 5.90).

Deo, M.M., Mathew, A.C., Manikantan, M.R. and Hebbar, K.B. 2020. Performance evaluation of power operated coconut de-shelling machine for different varieties of coconut, *Journal of AgriSearch*, **7**(3): 154-157 (NAAS Score 4.41).

Deo, M.M., Mathew, A.C., Manikantan, M.R. and Hebbar, K.B. 2020. Performance evaluation of semi-automatic coconut de-husking machine for West Coast Tall variety of coconut, *International Journal of Current Microbiology and Applied Sciences*, **9**(6): 3187-3194 (NAAS Score 7.60).

Devakumar, K., Thomas, R.J. and Karun, A. 2020.A durable pollination rain coat for coconut hybridization during monsoon.*Journal of Plantation Crops,***48**(3): 269-272 (NAAS Score 5.54).

Gangaraj, K.P. and Rajesh, M.K. 2020.Dataset of dual RNA-sequencing of *Phytophthora palmivora* infecting coconut (*Cocos nucifera* L.). *Data in Brief*, p.105455. (NAAS Score --)

Ghavale, S.L., Shinde, V.V., Wankhede, S.M., Maheswarappa, H.P. and Haldankar, P.M. 2020.Carbon sequestration and productivity potential of coconut (*Cocos nucifera* L.) hybrids and varieties under coastal eco-system of Maharashtra.*Current Journal of Applied Science and Technology,* **39**(22): 30-37(NAAS Score 5.32).

Hebbar K.B., Apshara E., Chandran K.P. and Prasad P.V.V. 2020.Effect of elevated CO_2, high temperature, and water deficit on growth, photosynthesis, and whole

plant water use efficiency of cocoa (*Theobromacacao* L.). *International Journal of Biometeorology,* **64**(1): 47-57. *https://doi.org/10.1007/s00484-019-01792-0* (NAAS Score 8.38).

Hebbar K.B., Neethu P., Abhin Sukumar P., Sujithra M., Arya Santhosh, Ramesh S.V., Niral V., Hareesh G.S, Nameer P.O. and Prasad P.V.V. 2020. Understanding physiology and impacts of high temperature stress on the progamic phase of coconut (*Cocos nucifera* L.). *Plants,* **9**(12)**:** 1651. *https://doi.org/10.3390/plants9121651* (NAAS Score: 8.76)

Hebbar, K.B., Arivalagan, M., Pavithra, K.C., Roy T. K., Gopal, M., Shivashankara K. S., and Chowdappa, P.2020. Nutritional profiling of coconut (*Cocos nucifera* L.) inflorescence sap collected using novel coco-sap chiller method and its value added products. *Journal of Food Measurement and Characterization,* **14:** 2703–2712. *https://doi.org/10.1007/s11694-020-00516-y* (NAAS Score 7.42)

Josephrajkumar, A., Mohan, C., Babu, M., Prathibha, P.S., Hegde, V. and Krishnakumar, A. 2020.Diagnosis of invasive whitefly species co-occurring on coconut. *Current Science,***119**(7): 1101-1105(NAAS Score 6.76).

Kalavathi, S., Jeena Mathew, Indhuja, S., Merin Babu and Muralidharan, K. 2020. Community-level management of bio-resources for augmenting income from coconut-based farming systems in Kerala State, India.*Journal of Plantation Crops*, **48**(3): 252-258(NAAS Score 5.54).

Murali Gopal, Alka Gupta, Shahul Hameed, K, NeenuSathyan, KhadeejathRajeela, T.H. and George V. Thomas. 2020. Biochars produced from coconut palm biomass residues can aid regenerative agriculture by improving soil properties and plant yield in humid tropics. *Biochar,* **2**: 211–226. (doi.org/10.1007/s42773-020-00043-5) (NAAS Score -).

Pandiselvam, R., Hebbar, K.B., Manikantan, M.R., Prasanth, B.K., Shameena Beegum P.P., and Ramesh, S.V. 2020. Microwave treatment of coconut inflorescence sap (Kalparasa): A panacea to preserve quality attributes. *Sugar Tech,* **22** (4): 718-726.https://doi.org/10.1007/s12355-020-00828-9 (NAAS Score 7.02).

Pandiselvam, R., Manikantan, M.R., Balasubramanian, D., ShameenaBeegum, P.P., Mathew, A.C., Ramesh, S.V., Hebbar, K.B. and Niral,V. 2020. Mechanical properties of tender coconut (*Cocosnucifera* L.): Implications for the design of processing machineries. *Journal of Food Process Engineering*, **43**(2):e13349. DOI: 10.1111/jfpe.13349. (NAAS Score 7.45)

Pandiselvam, R., Manikantan, M.R., Kothakota, A., Rajesh, G.K., Beegum, S., Ramesh, S.V., Niral, V. and Hebbar, K.B. 2020.Engineering properties of five varieties of coconuts (*Cocosnucifera* L.) for efficient husk separation.*Journal of Natural Fibers*, **17**(4): 589-597. https://doi.org/10.1080/ 15440478. 2018. 1507863 (NAAS Score 7.25).

Paul, S.C., Acharya, G.C., Chakraborty, R., Maheswarappa, H.P., Hussain, M. and Ray, A.K. 2020. Sustainability of soil health and system productivity through arecanut based cropping system in the NE region of India. *Journal of Plantation Crops*, **48**(2): 111-119.(NAAS Score 5.54).

Prathibha, V.H., Hegde, V., Monisha, M. and Vipin K. 2020. Management strategies for *Ganoderma* wilt disease of Coconut. *International Journal of Agriculture Sciences*,**12**(11):9890-9893 (NAAS Score 4.82).

Prathibha, V.H., Hegde Vinayaka and Gangaraj K.P. 2020. Morphological and molecular diversity among *Phytophthora* spp. infecting arecanut.*Research Journal of Biotechnology*, 15 (1): 25-34 (NAAS Score 5.00).

Preethi, P., Rahman, S., Naganeeswaran, S., Sabana, A.A., Gangaraj, K.P., Jerard, B.A., Niral, V. and Rajesh, M.K. 2020.Development of EST-SSR markers for genetic diversity analysis in coconut (*Cocos nucifera* L.). *Molecular Biology Reports*, ***47***(12): 9385-9397. (NAAS Score 8.11)

Rajesh, M.K., Chowdappa, P., Behera, S.K., Kasaragod, S., Gangaraj, K.P., Kotimoole, C.N., Nekrakalaya, B., Mohanty, V., Sampgod, R.B., Banerjee, G. and Das, A.J. 2020. Assembly and annotation of the nuclear and organellar genomes of a dwarf coconut (Chowghat Green Dwarf) possessing enhanced disease resistance. *OMICS: A Journal of Integrative Biology*, **24**(12): 726-742. (NAAS Score 8.61).

Rajesh, M.K., Gangaraj, K.P., Prabhudas, S.K. and Prasad, T.K. 2020.The complete chloroplast genome data of *Areca catechu* (Arecaceae). *Data in Brief*, ***33***, p.106444. (NAAS Score --)

Rajesh, M.K., Muralikrishna, K.S., Nair, S.S., Kumar, B.K., Subrahmanya, T.M., Sonu, K.P., Subaharan, K., Sweta, H., Prasad, T.K., Chandran, N. and Karunasagar, I. 2020. Facile coconut inflorescence sap mediated synthesis of silver nanoparticles and its diverse antimicrobial and cytotoxic properties. *Materials*

Science and Engineering: C, p.110834. (NAAS Score 10.96)

Rajkumar, Jagadeesh Patil, Pervez Rashidand Subhaharan Kesavan. 2019. Management of white grub (*Leucopholis burmesterie*) infesting arecanut through entomopathogenic nematodes under field conditions. *Annals of Plant Protection Sciences (An international Journal of Crop Protection),***27**(1):112-116.(NAAS Score 4.82)

Rajkumar, Rashid Pervez, Surekha and Ravi Bhat. 2019. Weed as alternate host of root knot nematode, *Meloidogyne incognita* in coconut garden. *Annals of Plant Protection Sciences (An international Journal of Crop Protection),* **27**(2):285-288. (NAAS Score 4.82)

Ramesh S.V., Pandiselvam R, Hebbar K. B., Manikantan M.R., Shameena Beegum P.P., Shelly Praveen S., and Sruthi N.U. 2020. Antiviral potential of coconut (*Cocosnucifera* L.) oil and COVID-19.*Coronaviruses. https://doi.org/10.2174/2666796701999201*(NAAS Score--)

Ramesh S.V., Yogindran S., Gnanasekaran P., Chakraborty S., Winter S.and Pappu H.R. 2020. Virus and viroid-derived small RNAs as modulators of host gene expression: molecular insights into pathogenesis. *Frontiers in Microbiology* .**11**:614231 https://doi.org/10.3389/fmicb.2020.614231(NAAS Score 10.26).

Ramesh, S.V., Pandiselvam, R., Thushara, R., Manikantan, M.R., Hebbar, K.B., Beegum, S., Mathew, A.C., Neenu, S. and Shil, S. 2020. Engineering intervention for production of virgin coconut oil by hot process and multivariate analysis of quality attributes of virgin coconut oil extracted by various methods. *Journal of Food Process Engineering*,**43**(6): p.e13395. DOI: https://doi.org/10.1111/jfpe.13395. (NAAS Score 7.45)

Sabana, A.A., Rajesh, M.K. and Antony, G. 2020. Dynamic changes in the expression pattern of miRNAs and associated target genes during coconut somatic embryogenesis. *Planta*, **251**(4), pp.1-18(NAAS Score 9.06).

Shinde, V.V., Maheswarappa, H.P., Ghavale, S.L., Sumitha, S., Wankhede, S.M. and Haldankar, P.M. 2020. Productivity and carbon sequestration potential of coconut-based cropping system as influenced by integrated nutrient management practices. *Journal of Plantation Crops*, **48**(2): 103-110 (NAAS Score 5.54).

Singh, L.S., AnokUchoi, Rizal, S.K., Alpana Das and Ganesh Das. 2020. Evaluation of training with reference to socio personal attributes affecting knowledge and skills of cocoa farmers of North East region. *Journal of Agri Search*, **7**(3): 163-167. (NAAS Score 4.41)

Sivakumar, V., Subramanian, A., Geethanjali, S., Praneetha, S. and Maheswarappa, H.P. 2020.Assessment of genetic variability for growth, floral, yield and its component traits in coconut (*Cocos nucifera* L.).*Electronic Journal of Plant Breeding*, **11**(3):809-813.(NAAS Score 4.97).

Srikanth, V., Rajesh, G.K., Kothakota, A., Pandiselvam, R., Sagarika, N., Manikantan, M.R., and Sudheer, K.P. 2020. Modeling and optimization of developed cocoa beans extractor parameters using box behnken design and artificial neural network. *Computers and Electronics in Agriculture*, **177**: 105715. (NAAS Score 9.17)

Sujithra, M, Rajkumar, Prathibha, V.H.,VinayakaHegde and Poorani, J. 2019. Occurrence of nesting whitefly *Paraleyrodesmineii*accarino (Hemiptera: Aleyrodidae) in India. *Indian Journal of Entomology*, **81**(3): 507-510. (NAAS Score 5.89)

Sumitha, S., Maheswarappa, H.P., Basavaraju,T.B., Prashanth, M. and Swetha. 2020. Potential coconut (*Cocos nucifera*) hybrids developed using Gangabondam (GBGD) as maternal parent for yield and quality for southern dry tract of Karnataka (India). *Indian Journal of Agricultural Sciences,***90**(8): 1467–73(NAAS Score 6.25).

Sunilkumar, K., Murugesan, P., Mathur, R.K. and Rajesh, M.K. 2020. Genetic diversity in oil palm (*Elaeis guineensis* and *Elaeis oleifera*) germplasm as revealed by microsatellite (SSR) markers. *Indian Journal of Agricultural Sciences*, **90**(4): 741-745 (NAAS Score 6.25).

Thamban, C., Jayasekhar, S., Chandran, K.P. and Rajesh, M.K. 2020. Sustainability of Farmer Producer Organisations - The case of producer organisations involved in the production and marketing of 'neera' in the coconut sector in Kerala, India. *Journal of Plantation Crops.***48**(2): 150-159 (NAAS Score 5.54).

Wankhede, S.M., Shinde, V.V., Maheswarappa, H.P. and Ghavale, S.L. 2020. Impact of integrated management package on eriophyid mite, *Aceria guerreronis* (Keifer) and yield of Coconut.*Journal of Entomology and Zoology Studies,***8**(5): 1967-1971 (NAAS Score 5.53).

Papers presented in seminar/ symposia/ conference/ workshops

Alka Gupta, MuraliGopal, Priya George and George V. Thomas. 2020. KeraProbio™: a bioinoculant developed specifically for coconut seedlings. ***In***: 29thSwadeshi Science Congress: National Conference on 'Science and Technology for Sustainable Development'. CPCRI, Kasaragod, Feb. 27-29, 2020. Abstract Book pp. 25 -26.

Aparna, V., Bhat, K.V., Janakiram, T., Prasad, K.V., Raju, D.V.S., Namita and Panwar, S. 2020. Assessment of genetic diversity and population structure of fragrant rose genotypes using microsatellite markers. ***In:*** Proceedings of National conference on Science and Technology for sustainable development (29th Swadeshi Science Congress).27th-29th February, 2020 at ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. p. 19-20.

Aparna, V., Bhat, K.V., Janakiram, T., Prasad, K.V., Raju, D.V.S., Amitha Mithra, S.V., Bharadwaj, C., Namita, Panwar, S. and Singh, K.P. 2020. Studying population structure, diversity and genetic relationship of 21 wild rose species grown in India based on SSRs and morphological markers. ***In:*** Proceedings of a conference on Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity, 24-27th November 2020 at Bengaluru, India. P. 9-10.

Bhat Ravi, Bhavishya and Sujatha, S. 2020. Spices in arecanut based cropping systems. Lead talk delivered in National Seminar on Spices: Emerging Trends in Production, Processing and Marketing held at ICAR-CCARI, Goa from 21-01-2020 to 22-01-2020.

Chandrika Mohan, Josephrajkumar, A. and Anes, K.M. 2020. Advances in red palm weevil IPM in coconut ***In***: Proc. International webinar 'Advances in Red palm weevil Research and Management' (Eds: Rajan Shelke and J.R. Faleiro), Don Bosco College of Agriculture, Goa, India. 8th September 2020, pp 14-27.

Daliyamol, Merin Babu, A Josephrajkumar and Vinayaka Hegde. 2020. First report on the association of *Leptoxyphium* sp. with Rugose Spiraling Whitefly infesting Coconut. ***In***: 29th Swadeshi Science Congress on 27- 29 February 2020, ICAR-CPCRI, Kasaragod. pp 32.

Daliyamol, Prathibha, V.H., Panchavarnam, G. and Vinayaka Hegde. 2020. First report of *Curvularia eragrostidis* causing flower and fruit rot of dragon fruit in India. ***In***: 7th International conference-Phytopathology in achieving UN sustainable development goals 16-20 January 2020 at ICAR-IARI, New Delhi. pp 45.

Daliyamol, Prathibha V.H., Mahendran, B. and Vinayaka Hegde. 2020. Evaluations of fungicides on *Colletotrichum gloeosporioides*, *Fusarium solani* as incitant of leaf rot disease in coconut under in vitro. ***In:*** InternationalE-Conference on "Multidisciplinary approaches for plant disease management inachieving sustainability in agriculture" organised by Department of Plant Pathology, College of Horticulture, Bengaluru, University of Horticultural Sciences, Bagalkot, India 6-9th October, 2020, pp 104.

ElainApshara, S. and Subramanian, P. 2020. Performance of selected genotypes of cocoa as clones and seedlings under coconut in Kasaragod condition. ***In:***International E-Conference on "Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity" University of Horticultural Sciences, Bagalkot, 24-27 Nov 2020, pp.34.

Elain Apshara, S., Chaithra, M., SenthilAmudhan, M., Suchithra, M., Rajesh, M.K. and Murali Gopal. 2019. Cocoa improvement programs and achievements of CPCRI. ***In:***Proceedings of International Meeting on Asia Pacific Cocoa Breeders Working Group (APCBWG). (Eds.) Elain Apshara, S., Sudha, R., Anitha Karun and Muralidharan, K. pp. 4.

Gangaraj, K.P., Santhi, C.K.V., Ginny Antony and Rajesh, M.K. 2020. Temporal gene expression patterns of coconut upon challenge by the oomycete pathogen *Phytophthora palmivora*: ***In:***Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B17, p. 40.

Geethu Venugopal., Muralikrishna, K.S. and Rajesh, M.K. 2020. Callus initiation and basic biochemical analysis of coconut endosperm: ***In:***Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B33, p. 49.

Jayasekhar, S., Thamban, C. and Chandran, K.P. 2020. Whether a revamped value chain is inevitable? The case of producer organizations involved in the production and marketing of *'neera'* in the coconut sector Agricultural Economics Research Review 2020, 33 (Conference Number), 147.

Josephrajkumar, A., Chandrika Mohan, MerinBabu, Anes, K.M., Regi J. Thomas and VinayakaHegde. 2020. Strengthening quarantine and incursion management of invasive pests on coconut. ***In***: International Seminar on Transboundary Pest Management, Souvenir cum Abstracts, 4-5 March, 2020, pp 137-138.

Kavyashree, Sowmyashree Sharma, Nagaraja, N.R., Ranjini, T.N., Niral, V. and Rajesh, B. 2020. Estimation of genome size in arecanut (*Areca catechu* L.) varieties using flow cytometry. ***In***: Abstracts- 29thSwadeshi Science Congress- National Conference on Science and Technology for Sustainable Development, Ramanan, R., Prasad, E., Aneesh., Jasmine, M.S. et. al. (Eds.). ICAR-CPCRI, Kasaragod, Kerala, India, 27th to 29th February 2020. pp.44 45.

Kiran Kumar, D.G., Lakshmana, D., Nagaraja, N.R., SadashivNadukeri and Ganapathi, M. 2020. Molecular diversity analysis in arecanut (*Areca catechu* L.) germplasm by employing SSR markers. ***In***: 29thSwadeshi Science Congress- National Conference on Science and Technology for Sustainable Development, Ramanan, R., Prasad, E., Aneesh., Jasmine, M.S. *et. al.* (Eds.). ICAR-CPCRI, Kasaragod, Kerala, India, 27th to 29th February 2020. Pp.43.

Krishna Prakash, Namitha, M.S., Muralikrishna, K.S., Rajesh, M.K. and Anitha Karun. 2020. Exploring novel plant growth regulators as callogenic agents in coconut. ***In:*** Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B32, p. 49.

Kumar Arvind, Rajesh, M.K., Josephrajkumar, A. and Tony Grace.2020. Differential gene expression analysis (DGE) of certain developmental stages of Oryctes rhinoceros's transcriptome reveals candidate genes for pest management. ***In:*** Book of Abstracts-29thSwadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B18, p. 41.

Maheswarappa, H.P., Sumitha, S. and Elain Apshara, S. 2019.Performance of cocoa varieties/ hybrids as intercrop in coconut/ oil palm gardens in different regions of India. ***In***: Proceedings of International Meeting on Asia Pacific Cocoa Breeders Working Group (APCBWG). (Eds.) Elain Apshara, S., Sudha, R., Anitha Karun and Muralidharan, K. pp. 24.

Manikantan, M.R., Pandiselvam, R., Arumuganathan, T., Indurani, S. and Krishnakumar. 2020. Investigation on the production of osmo dehydrated coconut chips. ***In:*** 5th Online National conference on Agricultural Scientific Tamil organized by TNAU and Agricultural Scientific Tamil Society, New Delhi during 9-10 October 2020.

Manikantan, M.R., Pandiselvam, R., Ramesh, S.V. and Krishnakumar. 2020. Investigation on the production and nutritional evaluation of hot and fermentation process virgin coconut oil. ***In:*** 5th Online National conference on Agricultural Scientific Tamil organized by TNAU and Agricultural Scientific Tamil Society, New Delhi during 9-10 October 2020.

Manikantan, M.R., Pandiselvam, R., Shameena Beegum, P.P. and Sreejith, S. 2020. Selected engineering properties of ready-to-eat extrudates from the blends of coconut milk residue-corn-rice clour. ***In:*** 54th Annual Convention of Indian Society of Agricultural Engineers (ISAE) and International Symposium on Artificial Intelligence Based Future Technologies in Agriculture: organized by Indian Society of Agricultural Engineers during 7-9, January, 2020 at Hotel Hyatt Regency, Vimannagar, Pune.

Murali Gopal, Nihad, K., Alka Gupta, Krishnakumar, V. and Narayanan, S. 2020. Microbial differences in coconut leaf vermicompost produced from palms growing in healthy and root (wilt) diseased tracts. ***In***: 29th Swadeshi Science Congress: National Conference on 'Science and Technology for Sustainable Development'. CPCRI, Kasaragod, Feb. 27-29, 2020. Abstract Book pp.23-24.

Muralikrishna, K.S., Sajini, K.K. and Anitha Karun.2020. Cryopreservation of coconut (*Cocos nucifera* L.) zygotic embryo by air desiccation method ***In:*** Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B36, p. 51.

Nagaraja, N.R., Dhanyashree, Shaili, M.S. and ElainApshara, S. 2020. Compatibility reactions of cocoa germplasm. ***In***: 29thSwadeshi Science Congress-National Conference on Science and Technology for Sustainable Development, Ramanan, R., Prasad, E., Aneesh., Jasmine, M.S. *et. al.* (Eds.). ICAR-CPCRI, Kasaragod, Kerala, India, 27th to 29th February 2020. pp.20.

Nagaraja, N.R., Ranjini, T.N., Neenu, S., Niral, V. and Ravi Bhat. 2020. Occurrence and frequency of chlorophyll deficient seedlings in arecanut. ***In:*** International

E-Conference on Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity organized by College of Horticulture, Bengaluru, University of Horticultural Sciences, Bagalkot, India during 24th to 27th November 2020.

Neema, M., Alka Gupta, MuraliGopal and Anitha Karun. 2020. Preliminary report of basidiomycete *Pseudolagarobasidium acaciicola* contamination in *in vitro* culture of coconut plumule. ***In***: 29thSwadeshi Science Congress: National Conference on 'Science and Technology for Sustainable Development'. CPCRI, Kasaragod, Feb. 27-29, 2020. Abstract Book pp. 48-49.

Pandiselvam, R., Manikantan, M.R., Mathew, A.C. and Krishnakumar. 2020. Tender coconut trimming machine. ***In:*** 5th Online National conference on Agricultural Scientific Tamil organized by TNAU and Agricultural Scientific Tamil Society, New Delhi during 9-10 October 2020, Page 11-14.

Pandiselvam, R., Manikantan, M.R., Shameena Beegum and Krishnakumar. 2020. Kalpa krunch – An extrudate product from coconut milk residue. ***In:*** 5th Online National conference on Agricultural Scientific Tamil organized by TNAU and Agricultural Scientific Tamil Society, New Delhi during 9-10 October 2020, Page 15-18.

Pandiselvam, R., Manikantan, M.R., Mathew, A.C. and Krishnakumar. 2020. Tender coconut trimming machine. ***In:*** 5th Online National conference on Agricultural Scientific Tamil organized by TNAU and Agricultural Scientific Tamil Society, New Delhi during 9-10 October 2020.

Praveen S., Vinutha T. and Ramesh S.V. 2020. Prospects of oilseeds in secondary agriculture. ***In***: Proceedings of National Oilseed Brainstorming Meet, Sep, 24th, 2020, ICAR-Indian Institute of Soybean Research (ICAR-IISR), Indore.(page number not mentioned??)

Rajkumar, Nihad K., Krishnakumar V., Ravi Bhat and Vinayaka Hegde 2020. Influence of combined use of organic and inorganic nutrients on *Meloidogyne incognita* disease incidence in papaya intercropped in coconut based cropping system. ***In*:** 29thSwadeshi Science Congress, National Symposium on Science and Technology for Sustainable Development held at ICAR-CPCRI, Kasaragod, and Kerala. p74.

Rajkumar, Rashid Pervez, Pratibha V. H., Surekha R., Vinayaka Hegde and Ravi Bhat. 2019. Eco-friendly management of Root-knot nematode infesting Okra and Brinjal intercropped with coconut. ***In:*** National Symposium: A threat to food security and farmers livelihood held at Manipur University, Imphal, Manipur, India from 11- 13 December. p92.

Rajkumar, Sujithra M., Surekha R., Subramanian P., Ravi Bhat and Vinyaka Hegde 2020. Entomopathogenic nematodes (EPNs): A safer alternative for managing *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in fodder maize in coconut cropping system. ***In:***International Seminar on Transboundary Pest Management held at TNAU, Coimbatore from March 4-5. p169.

Ramesh S.V.and Hebbar K.B. 2020. Untapped nutraceutical potential of *Cocos nucifera* L. - the *Kalpavriksha* on earth. ***In***: National Virtual Conference on Current Trends and Challenges in Plant Biochemistry and Biotechnology (CTCPBB 2020). BITS Pilani, K. K. Birla Goa Campus and The Society for Plant Biochemistry and Biotechnology. Nov. 20-21, 2020. pp.27

Ramesh S.V., Hebbar K.B., Rajesh M.K., Abhin S.P., Gangaraj K.P.and Athul Bobby. 2020. Transcriptome analysis of *Cocos nucifera* L., seedlings having contrasting water use efficiency (WUE) under water-deficit stress: molecular insights and genetic markers for drought tolerance. ***In***: International Electronic Conference on Plant Sciences (IECPS) Basel, Switzerland, Dec. 1-15, 2020. *Proceedings*. doi: 10.3390/IECPS2020-08853.

Ramesh S.V., Rose Mary, Shameena Beegum P.P, Pandiselvam R., Sugatha P., Manikantan M.R., Niral V.and Hebbar K.B. 2020. Coconut testa-derived biocolourant and oil: a treasure trove of antioxidants. ***In***: International Webinar on Phytochemistry-2020; Proceedings and Abstracts of Papers (Eds. Rameshkumar K. B., Priya Rani M. and Lekshmi N Menon), 28-29 September 2020, Kerala Academy of Sciences, IUCGGT, University of Kerala, Karyavattom, Thiruvananthapuram, Kerala, India (www.kas.org.in) p20. ISBN No.: 978-81-940888-2-0

Sabana, A.A., Gangaraj, K.P., Rajesh, M.K. and Ginny Antony. 2020. Genome-wide development of microRNA-based SSR markers in coconut (*Cocos nucifera* L.): A case study with 'Kera Sankara' hybrid: ***In:*** Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B30, p. 48.

Santhi, C.K.V., Aishwarya Sujanan, Gangaraj, K.P., Muralikrishna, K.S., Ramesh, S.V. and Rajesh, M.K. 2020.Effects of induced abiotic stresses on the expression of lipoxygenases (*LOX*) in zygotic embryos of coconut.***In:***Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B37, p. 52.

Santhi, C.K.V., Muralikrishna, K.S., Gangaraj, K.P., Ramesh, S.V. and Rajesh M.K. 2020. Genome-wide exploration of auxin response factors (ARF) in coconut: Expression dynamics in response to growth regulators and abiotic stresses. ***In:*** Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B14, p. 38.

Sharath, B.C., Krishna Prakash, Muralikrishna, K.S., Rajesh, M.K. and Anitha Karun. 2020. Embryogenesis in Cocoa (*Theobroma cacao*): Explant development for cryopreservation. ***In:*** Book of Abstracts-29th Swadeshi Science Congress, Ramanan, R., Prasad, E., et al. (Eds.). ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala. B35, p. 50.

Shivaji, H.T., ThavaPrakasaPandian, R., Rajkumar, MerinBabu and Josephrajkumar, A. 2020. Non-native Ambrosia beetle, *Euwallacea fornicates*: A potential vector of *Fusariumsolani* species complex in cocoa, (*Theobroma cacao* L.). ***In***: International Seminar on Transboundary Pest Management, Souvenir cum Abstracts, 4-5 March, 2020, pp 375.

Subramanian, P., Ravi Bhat, Maheswarappa, H.P., Selvamani, V. and MuraliGopal. 2020. Water management in coconut. ***In***: 29th Swadeshi Science Congress: National Conference on 'Science and Technology for Sustainable Development'. CPCRI, Kasaragod, Feb. 27-29, 2020. Abstract Book pp.5.

Sujithra, M., Prathibha, V. H., Rajkumar, Hegde, V. and Ramanujam, B. 2020. Characterization and entomopathogenecity of *Simplicium cylindrosporum* isolated from Rugose spiraling whitefly, *Aleurodicusrugioperculatus* Martin. ***In***: International seminar on Transboundary pest managment, 4-5 March 2020. p 346.

Sujithra, M., Prathibha, V. H., Rajkumar, Rangeshwaran, R. and VinayakaHegde. 2020. Characterization of *Bacillus* sp. isolated from grubs of rhinoceros beetle, *Oryctesrhinoceros* (Coleoptera: *Scarabaeidae*) causing natural septicemia. ***In*:** 29thSwadeshi Science Congress, National Symposium on Science and Technology for Sustainable Development. p73.

Sujithra,M.,Subramanian,P.,Samsudeen,K.,Muralidharan, K., Paulraj, S. and Anitha Karun. 2020. Rejuvenating coconut plantations in gaja cyclone affected areas of Tamil Nadu under SCSP through Central - State aided partnership programmes. ***In***: 29thSwadeshi Science Congress, National Symposium on Science and Technology for Sustainable Development. p65.

Thube, S.H., Saneera, E.K., Pandian, R.T.P., Nagaraja, N.R. and Rajkumar. 2020. Occurrence of pentatomid bug, *Halyomorphapicus* in southern part of Karnataka. ***In***: Abstracts- National Web Conference: Vegetable Farmers Forum 2020 (Natwebcon VVF-2020), Mahapatro, G.K. (Eds.). Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi-110012, India, 25th to 26th June 2020. pp.26.

Popular Articles

Alka Gupta, Murali Gopal, Krishna Prakash and Maheswarappa, H.P. 2020. *Nariyal baag ki antarfasal makke ke bhuse se banayen kenchua khaad* (Produce vermicompost from stovers of baby corn grown in coconut garden). *Bharatiya Nariyal Patrika*. **31(2)**: 6-10 (Hindi).

Alka Gupta, Murali Gopal, Neema, M. and Maheswarappa, H.P. 2020.*Thenginthoppilthannae compost nirmanam*. *Indian Nalikera Journal.*July, pp. 9-12 (Malayalam).

Alka Gupta, Neema,M. and Murali Gopal. 2020. *Mikachavilavinu 'Kalpa Vermiwash'.Indian Nalikera Journal.*August, pp. 19-22 (Malayalam).

Alka Gupta, Panjavarnam, G., Murali Gopal and Maheswarappa, H.P. 2020.*Thennanthoppel payiridapattu babycorn kaleevukalai manpulu uramaga matruthal.Indhia Thennai Idhazh*. **20**(1) : 26-30. (Tamil).

Alka Gupta, Murali Gopal, Krishna Prakash and Maheswarappa,H.P. 2020.*Nariyal baag ki antarfasal makke ke bhuse se banayen kenchua khaad.Bharatiya Nariyal Patrika*,**31**(2): 6-10. (Hindi).

Ananda, K.S. and Nagaraja, N.R. 2020. Shatamangala: Hecchuiluvariko duva kempadikemattuchalie radakkusooktavaa daadikethali (Kannada). *KrishibimbaPatrike*. **18**(10): 3-8.

Anes, K.M., Josephrajkumar, A., Chandrika Mohan

and Merin Babu. 2020. Thengile velleecha, virunninethhunna shathru (In Malayalam). *Karshakasree,* **26**(4): 36-38.

Anithakumari, P. and Shaju, J. 2020. Marketing tender nuts, gaining more income (*InMalayalam*).*Indian Nalikera Journal,* **11** (2): 12-14.

Anithakumari, P. and Jithin Shaju. 2020. Satisfaction and income from family farming (*In Malayalam*).*Indian Nalikera Journal*,**11**(8): 21-24.

Anithakumari, P., ShameenaBeegum. P. P. and Shaju, J. 2020. Building success of coconut products by an educated youth from Pathiyoor (*In Malayalam*). *Indian Nalikera Journal.* **11** (1): 9-12.

Anithakumari, P.2020. Going digital: Integrating experiential innovations in coconut farming. *LEISA India*. **22**(2): 14-17.

Aparna, V., Shameena Begum, P., Manikantan M.R. and Mathew, A.C. 2020. Coconut chips- a value added product from ICAR-CPCRI. *Annadata Telugu Magazine* Issue: September 2020; pp.20-21.

Bhalerao, P. P. and Maheswarappa, H. P. 2020. Doubling the farmers income through coconut farming by intercropping of turmeric: a profitable spice crop under coconut garden. *Bharatiya Nariyal Patrika,* **30** (4):12 -15 (In Hindi).

Bhalerao, P. P. and Maheswarappa, H. P. 2020.Organic farming in coconut - a success story from Gujarat. *Indian Coconut Journal*, **13**(2): 18-19.

Bharath Mohan, Jefri, J.R., Shareefa, M. and Thomas, R.J. 2020. Convergence model for establishing decentralized coconut nursery: The Kallara Experience. *Indian Coconut Journal,* **63**(7): 5-7.

Chalapathi Rao, N.B.V., Chakkani Priya, K., Ramanandam, G., Bhagavan, B.V.K. and Maheswarappa, H.P. 2020.Successful management of slug caterpillar outbreak in Andhra Pradesh through IPM. *Indian CoconutJournal*, **13**(2): 24-26.

Chandrashekar, G.S., Maheswarappa, H.P., Jilu V. Sajan and Siddappa, R. 2020. Biological control of coconut black headed caterpillar. *Indian Coconut Journal,* **13**(4): 14-16.

Daliyamol and Prathibha, P.S. 2020. Mazhakkalavum thengukalude koombucheeyalum (*In Malayalam*). *Indian coconut Journal*, **11**(8):12-13.

Daliyamol, Prathibha, P.S., Prathibha, V.H. and Jilu V Sajan.2020. Thengurogangalkku *Trichoderma* (*In Malayalam*). *Karshakasree,* **26**(3):32-34.

Janakiram, T., Aparna, V. and Pavan Kumar, P. 2020. Tabernae montana at a glance. *Nursery Today*, **7**(7): 44-45.

Jissy George, Anju. K.A. and Muralidharan, P. 2019. Value added products of Pepper. *Spice India*, **32**(9): 17 - 21.

Jissy George. 2020. The opportunities opened in lockdown, *Karshakasree,* **26** (7):24-25.

Jissy George**.** 2020. Value addition. *In*: Twenty five successful enterprises, *Karshakasree*,**26** (9): 36-38.

Jissy George. 2020. Enterprises without licenses - farmers can be benefitted. *Karshakasree*, **26**(2): 67.

Jissy George. 2020. Juices made from fruits. *Karshakasree*, **26**(5): 47.

Jissy George. 2020. Market for dried leaves, flowers and fruits. *Karshakasree*, **26**(3): 67-68.

Josephrajkumar, A., Anes, K.M., Merin Babu, Prathibha, P.S. and Chandrika Mohan. 2020. Holistic package to mitigate exotic whiteflies on Coconut. *Indian Coconut Journal.* **63**(5): 9-12.

Maheswarappa, H. P., Sumitha S. and Vijaya Selvaraj, K.S. 2020.High-yielding coconut hybrid : VHC 4 (LCOT x CCNT) for Tamil Nadu. *Indian Coconut Journal*, **63** (6): 11-12.

Murali Gopal, Alka Gupta and Anitha Karun. 2020. Mooting 1 per 1000 policy initiative to rejuvenate coconut soils. *Indian Coconut Journal,* **63**(8): 18-20.

Murali Gopal, Alka Gupta, Muralidharan, K. and Chowdappa, P. 2020. Turning waste to wealth – Success story of 'Samruthy' coir-pith composting unit.*Indian Coconut Journal,* **63**(4): 28-30.

Murali Gopal, Alka Gupta, Aparna, V.and Subramanian, P. 2019. Kobbari aakulanundi vermicompostu tayaari (Preparation of vermicompost from coconut leaf wastes).*Annadata*, Dec. 2019: 42-43 (In Telugu).

Murali Gopal, Panjavarnam, G. and Alka Gupta. 2019. Thennai kalivugal moolam unavkalaanurpathi (Edible mushrooms can be cultivated on coconut wastes). *Indhia Thennai Idhazh*. **19**(4): 24- 28 (*In Tamil*).

Murali Gopal, M. Neema, P. Subramanian and Alka Gupta. 2020. *Composting eluppamaakkaan pulverizing. Indian Nalikera Journal.* August, pp. 16-18 (*In Malayalam*).

Murali Gopal, Panjavarnam, G. and Alka Gupta. 2019. Thennaielai manpulu uram thaiyarikum tholilnatpam (Technology for coconut leaf vermicompost production). *Indhia Thennai Idhazh*. **19**(4): 32-36 (In Tamil).

Nagaraja, N. R., Anithakumari, P., Geetha Shetty, S., Dhanyashree, Shahala, M. I., Krishna Kumar, V. and Chowdappa, P. 2020. e-Kalpa: Thengina mahithi nimma berala tudiyalli (Kannada). *Krishibimba Patrike*. **18**(12): 7 11.

Nagaraja, N.R., Thava Prakash Pandian, R., Chaithra, M. and Shivaji Hausrao Thube. 2020. Adike mattu kokko bele samrakshane (*In Kannada*). *Krishi Bimba Pathrike*. **19**(2): 3-7.

Neema, M. 2020. Coco de mer palm athava irattathengu, *Indian Coconut Journal*, **11**(11): 15-17.

Nihad K., Krishnakumar K., Rajkumar M**.,** Abdul Haris A. and Ravi Bhat. 2019. Papaya intercropping in coconut gardens. *Indian Nalikera Journal* (In Malayalam), **10**(9): 25-26.

Nihad K., Krishnakumar V., Rajkumar M**.,** Abdul Haris A. and Ravi Bhat. 2019. Papaya intercropping- an income source for newly planted coconut gardens. *Indian Coconut Journal*, **62**(4): 27-29.

Nihad, K.2020. Commercial floriculture in coconut garden. *Karshakan,* December 2020: 64-66.

Nihad, K. 2020. Garden lay-out techniques. *Krishiankanam,* **2**(6): 32 33.

Nihad, K. 2020. Kokedama - 'moss ball' plants. *MathrubhoomiK arshikarangam,* Mathrubhoomi Daily dated 05.02.2020.

Nihad, K., Haris, A.A. and Kalavathi, S. 2020. Nariyalbagom me pushpa krishi ki sambhavanayem (*In Hindi*). *Bharathiya Nariyal Pathrika*. June Issue: 33-36.

Nihad, K., Haris, A.A. and Kalavathy, S. 2020. Scope of floriculture in coconut garden. *Indian Coconut Journal,* **63** (1): 5-8.

Nihad, K., Krishnakumar, V. Rajkumar, M. Abdul Haris A. and Ravi Bhat. 2019. Papaya intercropping- an income source for newly planted coconut gardens. *Baharthiya Nariyal Pathrika* (*In Hindi*), **30** (3):30-33.

Pandiselvam, R., Manikantan, M.R., Beegum, S., Mathew, A.C., Ramesh, S.V., Gopal, M. and Hebbar, K.B. 2020. Preservation protocol for trimmed tender coconut. *Indian Coconut Journal*, **63**(8), 25-27.

Rajeev, G., Shareefa, M. and Thomas, R.J.2020. Coconut varieties suited to Kerala condition, its availability and when to plant coconut seedlings (*In Malayalam*). *Indian Nalikera Journal,* **11**(9): 13-14.

Ramesh S.V.and Praveen, S. 2020. SARS-CoV-2 infection dynamics and the candidate therapeutic agents and protease inhibitors for COVID-19. *Scientific India,***8** (4):7-9. https://www.scind.org/

Sahoo, S.C. and Maheswarappa, H.P. 2020. Plant Health Management in Coconut grown in littoral sandy soil of Odisha. *Bharatiya Nariyal patrika*, **30** (4): 22 -26 *(In Hindi).*

Sajnanath, K. and Muralidharan, P. 2020. Enhancing income through soil moisture conservation in coconut gardens. *Indian Nalikera Journal*, **11**(6):14-16.

Sajnanath, K. and Muralidharan, P. 2020. Sampoorna for complete nutrition. *Karshakasree*, **26** (7):49.

Sajnanath, K. and Muralidharan,P. 2020. Soil health for human life. *Karshakan,* **28**(12): 58-59.

Sajnanath, K. And Muralidharan, P. 2020. Enhancing income from coconut gardens through soil moisture conservation. *Indian Nalikera Journal*, **11**(8):14-16.

Sajnanath, K. and Muralidharan, P. 2020. Vegetable mix for yield enhancement Onattukara region, *Kerala Karshakan,* **65**(11): 60-61.

Shameena Beegum, P.P., Manikantan, M.R., Pandiselvam, R. and Hebbar, K.B. 2020. Dairy udhyog mein naariyal. *Bharathiya Naariyal Pathrika*, **31**(2): 3-5.

Shameena Beegum, P.P. and Masood. 2020. Naalikerathintesu varnanaaru kalilaabharanathilakkam. *Indian Nalikera Journal*,**11**(1). 13-14.

Shameena Beegum, P.P., Mnaikantan, M.R., Pandiselvam, R. and Hebbar, K.B. 2020. Coconut in Dairy industry. *Indian Coconut Journal*, **63**(1).9-11.

Shameena Beegum, P.P., Shamsudden, K. and Thamban, C. 2020. 'Lakshadweepinte swantham nalikera naatarivukal' *Indian Nalikera Journal*, **11**(1).18-21.

Shareefa, M. and Thomas R.J. 2020. Production of quality coconut seedlings through scientific nursery management (*In Malayalam*). *Krishianganam,* **2**(6): 21-24.

Shareefa, M., Ganesh, N.K. and Thomas, R.J. 2020. Occurrence of bizarre / freakish inflorescence in coconut palm. *Indian Coconut Journal,* **63**(5): 19-21.

Shareefa, M., Rajesh, K.S., Nazrin, N. and Thomas, R.J. 2020. Farmers also can produce hybrid seedlings of coconut (*In Malayalam*). *KrishiJagaran,* May Issue.

Shinde, V.V., Maheswarappa, H.P., Ghavale, S.L. and Wankhede, S.M. 2020. Coconut in Maharashtra. *Indian Coconut Journal*, **13**(2): 5-10.

Shinde, V.V., Maheswarappa, H.P., Ghavale, S.L., Khandekar, R.G. and Mahaldar, S.R. 2020. Nisarga: The strongest tropical cyclone striked the coconut ecosystem of Maharashtra state. *Indian Coconut Journal,* **13**(3): 23-26.

Singh, L.S., Anok Uchoi. and Alpana Das. 2020. Coconut cultivation in Assam: prospects and constraints. *Indian Coconut Journal*, **30**(3): 3-7.

Sivakumar, T. 2020. Moris Sir and the crying coconut palm. *Karshakan*, **28**(1): 62-63.

Sivakumar, T. 2020. The story of Bordeaux mixture. *Indian Nalikera Journal*, **11**(1): 15-16.

Sivakumar, T.2020. Tea Mosquito bug on betel wine, *Karshakasree,* **26** (7): 32

Sivakumar, T. 2020. Fertilizer application in Coconut. *Indian Coconut Journal*, **11**(9): 18-19.

Sivakumar, T. and Ranikrishna, K. 2020. Farm field school at Sabarmathi, Vallikunnam. *Indian Coconut Journal*, **11**(10): 9-10.

Sudhalakshmi, C., Rani, S. and Maheswarappa H.P. 2020. Goat farming in Coconut gardens: A pivot of confidences for rural unemployed during COVID era. *Indian Coconut Journal*, **13**(5):13-17.

Sumitha, S. and Maheswarappa, H.P. 2020. Coconut based cropping systems developed for different agro-climatic regions. *Indian Coconut Journal,* **63**(6): 25-27.

Sunayana, S., Thomas, R. J. and Shareefa, M. 2020. Bharanikavu model for decentralized coconut nursery (*In Malayalam*). *Indian Nalikera Journal,* **11**(6): 17-18.

Thamban,C.2020.Susthirakeravikasanathinukarshakakoot taymakal (*In Malayalam*). *Indian Nalikera Journal*, **11**(9): 5-8.

Thamban, C. and Byju, G. 2020. Food security through intercropping of tuber crops in coconut gardens - Opportunities under *Subhiksha Keralam* initiative. *Indian Coconut Journal,* **63**(5): 5-8.

Thamban, C., Nair, K.M., Anilkumar, K.S., Lijo Thomas, Chandran, K.P., Subramanian, P., Muralidharan, P., Robert, C.P., Shinoj Subramanian., Rathakrishnan, P. and Nagesh, S.S. 2020. Kerasamrudhikkumannintearo gyaparipalanam-Sameepanangalumsadhyathakalum (*In Malayalam*). *Indian Nalikera Journal*, **11**(8): 5-11.

Thamban, C., Samsudeen, K., Niral, V. and Thomas, R.J. 2020. Coconut Producer Societies' decentralized coconut nurseries (*In Malayalam*). *Kerala Karshakan,* March 2020: 44-46.

Thamban, C., Samsudeen, K., Niral, V. and Thomas, R.J. 2020. Decentralized nurseries for ensuring availability of quality coconut seedlings locally (*In Malayalam*). *Indian Nalikera Journal,* **11**(1): 5-8.

Thamban, C., Samsudeen, K. and Thomas, R.J. 2020. Enhancing planting material production in coconut through decentralized community nurseries. *Indian Coconut Journal,* **63**(6): 5-11.

Thamban, C., Subramanian, P. and Joseph Rajkumar. 2020. Cultivation practices for coconut –August. *Indian Coconut Journal,* **63**(3): 31-36.

Thamban, C., Subramanian, P. and Joseph Rajkumar. 2020. Cultivation practices for coconut –September. *Indian Coconut Journal,* **63**(4): 31-36.

Thamban, C., Subramanian, P. and Joseph Rajkumar. 2020. Cultivation practices for coconut –October. *Indian Coconut Journal,* **63**(5): 34-36.

Thamban, C., Subramanian, P. and Joseph Rajkumar. 2020. Thenginthoppil August masathekrishippanikal (*in Malayalam*). *Indian Nalikera Journal*, **11**(7): 31-34.

Thamban, C., Subramanian, P. and Joseph Rajkumar. 2020. Thenginthoppil September masathekrishippanikal (in Malayalam). *Indian Nalikera Journal*, **11**(8): 33-34.

Thamban, C., Subramanian, P. and Joseph Rajkumar. 2020. Thenginthoppil October masathekrishippanikal (*in*

Malayalam). *Indian Nalikera Journal*, **11**(9): 32-34.

Thomas, R.J. 2020. Coconut management strategies for doubling production (*In Malayalam*). *Sabdamillathavarude Sabdam,* **2**(1): 32-34.

Thomas, R.J. 2020. Coconut revolution from Prisons (*In Malayalam*). *Indian Nalikera Journal,* **11**(3,4,5): 13-14.

Thomas, R.J. 2020. QR technology for coconut seedlings (*In Tamil*). *Pasumai Vikatan,* 25 May 2020.

Thomas, R.J. 2020. QR technology for coconut seedlings (*In Tamil*). *Dinamalar,* 28 May 2020.

Technical Bulletins

Elain Apshara, S., Shivaji Hausrao Thube and Thava Prakasa Pandian, R. 2019.Cocoa Notebook.Technical bulletin no. 144, ICAR- CPCRI, Kasaragod and DCCD, Kochi, p. 70.(*In English*).

Elain Apshara, S., Chaithra, M., Venkatesh N. Hubballi, Purandhara, C., Meenakshi Patil, Deepashri and Nitin. 2019. Cocoa Notebook- Cocoa Kaippidi. Technical bulletin no.145, ICAR- CPCRI, Kasaragod and DCCD, Kochi, p. 70. (*In Kannada*).

Thamban, C., Samsudeen, K. and Shameena Beegum, P.P. 2020. Coconut farming in Lakshadweep Islands - Strategies for enhancing sustainability. Technical Bulletin No. 149. ICAR- Central Plantation Crops Research Institute, Kasaragod. p 28.

Thomas, R.J., Shareefa, M., Sunayana, S. And Josephrajkumar, A. 2020. Guidelines for production of coconut seedlings (In Malayalam). ICAR-CPCRI, Kasaragod, Kerala. Technical Bulletin No. 147.42 p.

Vaibhav V. Shinde, Sunil S. Ghawale, Santosh, M. Wankhede, Khandekar, R.G. Salavi, B.R. Maheswarappa, H.P. and Haldankar, P.M. 2020. Integrated nutrient management in coconut based cropping system under Konkan region of Maharashtra. Technical Bulletin No. 5/2020. ICAR-AICRP on Palms, RCRS, Bhatye, Maharashtra. 24p.

Book Chapters

Jayasekhar, S. 2020. Reviving coconut sector in Kerala: Problems & Prospects. ***In*:** Sunil Mani (Ed.) Kerala and World Economy, Centre for Development Studies, Thiruvananthapuram, Kerala. pp.161-179.

Kalavathy, S. 2020. Social responsibilities for entrepreneurship development. ***In:*** Compendium of Lectures of Model Training Programme on 'Pluralistic extension for upscaling secondary fisheries', 17-24 January 2020. ICAR-CIFT, Cochin. pp. 45-50.

Kalavathy, S. 2020. Streamlining community based organizations for climate smart agriculture. ***In:*** Compendium of Lectures of ITEC Training course on 'Improving fishery based livelihood: Policies, technologies and extension strategies' 13-26 February 2020. ICAR-CIFT, Cochin. pp. 273-278.

Nagaraja, N.R. and Khadke, G.N. 2020. Adike thaligalu mattu adikeyalli utthama gunamattada beeja athava sasigala uthpadane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 8-12.

Nagaraja, N.R., Bhavishya and Khadke, G.N. 2020. Adikeyalli hecchina iluvarige besaya sambanditha tanthrikathegalu.***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 27-35.

Prathibha, V.H., Rajkumar, Surekha, Nagaraja, N.R., Sujithra, M., and Vinayaka Hegde. 2020. Kokkodalli samagra rogagala nirvahane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 71-73.

Prathibha, V.H., Surekha, Rajkumar, Sujithra, M., Nagaraja, N.R. and Vinayaka Hegde. 2020. Thenginalli samagra rogagala nirvahane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala.pp. 50-53.

Prathibha, V.H., Surekha, Rajkumar, Sujithra, M., Nagaraja, N.R. and Vinayaka Hegde. 2020. Adikeyalli samagra rogagala nirvahane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 61-65.

Rajkumar, Surekha, R., Pratibha, V. H., Sujithra, M., Nagraj, N. R. and Vinayaka Hegde. 2020. Thenginalli samagra kitagala nirvahane. Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu ICAR - CPCRI, Kasaragod. p 50-53.

Rajkumar, Surekha, Nagaraja, N.R., Prathibha, V.H., Sujithra, M. and Vinayaka Hegde. 2020. Kokkodalli

samagrakeetagalanirvahane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 66-70.

Rajkumar, Surekha, Prathibha, V.H., Sujithra, M., Nagaraja, N.R. and Vinayaka Hegde. 2020. Thenginalli samagrakeetagalanirvahane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 38-49.

Rajkumar, Surekha, Sujithra, M., Prathibha, V.H., Nagaraja, N.R. and Vinayaka Hegde. 2020. Adikeyalli samagrakeetagalanirvahane. ***In:*** training manual on Thotadabelegalalli sasimadi thanthrikate mattu uthpadana thantrajnanagalu (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala. pp. 54-60.

Ramesh S.V., Arivalagan M. and Hebbar, K.B. 2020. The nutritional benefits of coconut: the tree of heaven. ***In***: Omics tools and techniques for nutritional evaluation and enhancement. World Bank – ICAR sponsored National Agricultural Higher Education Project Centres for Advanced Agricultural Science and Technology (CAAST) (Eds. Praveen S., Kumar R.R.) pp. 63-69.

Ramesh, S.V., Arunachalam, V. and Rajesh, M.K., 2020. Genomic designing of climate-smart coconut. ***In:*** Genomic designing of climate-smart fruit crops (pp. 135-156). Springer, Cham. DOI: https://doi.org/10.1007/978-3-319-97946-5_6.

Ramesh, S.V., Kumar, R.R. and Praveen, S., 2020. Plant transcriptional regulation in modulating cross-tolerance to stress. ***In:***Priming-mediated stress and cross-stress tolerance in crop plants (pp. 231-245). *Academic Press*. DOI: https://doi.org/10.1016/B978-0-12-817892-8.00015-5.

Books

AICRP on Palms, 2020. Annual Report for 2019 of ICAR- All India Co-ordinated Research Project on Palms. (Eds. Maheswarappa, H.P., Jilu V. Sajan and Balanagouda Patil). ICAR-CPCRI, Kasaragod. 140p.

Merin Babu, Josephrajkumar, A., Anes, K.M., Rajeev, G. and Kalavathi, S. 2020. Science Connect with New Age Students. Proceedings of workshop on 'Inculcating Spirit of Science and Plant Health Management (ISSPHM)' ICAR-CPCRI, Regional Station, Kayamkulam 43p.

Extension Folders

Anithakumari, P., Anju, K., Kalpanamol, K., Steffin, S. and Jithin, S. 2020. Bush pepper for home needs and income. Extension folder in Malayalam (FFP).

Anithakumari, P., Anju, K., Kalpanamol, K., Steffin, S. and Jithin, S. 2020. Scientific cultivation practices of Ginger. Extension folder in Malayalam (FFP).

Anithakumari, P., Anju, K., Kalpanamol, K., Steffin, S. and Jithin, S. 2020. Fodder grass cultivation for quality milk production and income. Extension folder in Malayalam (FFP).

Anithakumari, P., Anju, K., Kalpanamol, K., Steffin, S. and Jithin, S. 2020. Amorphophallus cultivation for health and income. Extension folder in Malayalam (FFP).

Lekha, G. and Rani Krishna, K. 2020. Mycorrhiza. ICAR-KVK-Alappuzha.(In Malayalam).

Prathibha, V.H., Daliyamol, Surekha, Rajkumar, Sujithra M. Vinayaka Hegde and Thamban, C., 2020. Thegina sulikoleyuva roga Extension publication No. 287. Central Plantation Crops Research Institute, Kasaragod (in Kannada).

Prathibha, V.H., Daliyamol, Surekha, Rajkumar, Sujithra M. Vinayaka Hegde and Thamban, C., 2020. Bordeaux dravana thayarike vidhana. Extension publication No. 288. Central Plantation Crops Research Institute, Kasaragod (in Kannada).

Prathibha, V.H., Daliyamol, Surekha, Rajkumar, Sujithra M. Vinayaka Hegde and Thamban, C., 2020.Thengina kaandasoruva roga. Extension publication No. 289. Central Plantation Crops Research Institute, Kasaragod (in Kannada).

Prathibha, V.H., Daliyamol, Surekha, Rajkumar, Sujithra, M. Vinayaka Hegde and Thamban, C., 2020.Thengina anabe roga. Extension publication No. 290. Central Plantation Crops Research Institute, Kasaragod (in Kannada).

Sajnanath, K. and Arathy, J. 2020. Integrated nutrient management in Banana. ICAR-KVK-Alappuzha. (In Malayalam).

Sajnanath K. and Rani Krishna, K. 2020. EM solution for manure production from biowastes', ICAR-KVK-Alappuzha.(In Malayalam).

Shameena Beegum, P P., Pandiselvam, R., Manikantan, M.R., Mathew, A.C., Hebbar, K.B. and Muralidharan,

K. 2020. Technologies for value added coconut products. AICRP on PHET, ICAR-CPCRI, Kasaragod.

Training Manuals

Khadke, G.N., Nagaraja, N.R., Niral, V., Samsudeen, K., Dhathri, N.R. and Latha, H.K. 2020. Thotadabelegalall isasimadithanthr ikatemattuuthpadanathant rajnanagalu – Tharabethikaipidi (Kannada). ICAR-CPCRI, Kasaragod – 671 124, Kerala.78 pp.

Nihad, K., Anes, K.M. and Kalavathi, S. 2020. Agricultural Sciences: Scope and Opportunities, ICAR-CPCRI, Regional Station, Kayamkulam, 68 p.

Surender Singh and Shameena Beegum, P.P. 2020. Spoilage of Canned Foods, In: Food Microbiology and Food Safety (Open Online Course), Central University of Haryana, hosted on SWAYAM portal of MHRD, Govt. of India (http//: swayam.gov.in/ courses/5147 -food microbiology-and-food safety)

Thomas, R.J., Shareefa, M. and Anes, K.M. 2020. Manual for 'Friends of Coconut Tree' programme (In Malayalam). ICAR-CPCRI, Regional Station, Kayamkulam, Kerala. 30 p.

Sujithra, M. and Daliyamol, 2019.Training Manual on "Thennaiyil Orunginaintha Payir Melaanmai (in Tamil)". ICAR- CPCRI, Kasaragod, Kerala. 79p.

Vinayaka Hegde, Prathibha, V. H. and Daliyamol 2020. Training manual on Hands on training on Production of biocontrol agent: *Trichoderma*,training programme on Production of *Trichoderma* for group of farmers from Shivamogga, ICAR-CPCRI Kasaragod, 27p.

Electronic Books

CPCRI. 2020. Videos on cocoa nursery and pruning techniques (English) made with DCCD funding.

IX. Technology Assessed and Transferred

Groundnut as intercrop in coconut gardens

The groundnut varieties Girnar 2 and Girnar 3 (released by ICAR-DGR, Junagadh) can be cultivated in coconut gardens as intercrop. Highest yield is obtained under the INM practice consisting of 50% of recommended chemical fertilizer, FYM (15 t/ha), poultry manure (10 t/ha), goat manure (10 t/ha) and vermicompost (9 t/ha).

High density planting of cocoa in arecanut

Cocoa varielty Netra Centura released from ICAR-CPCRI is found to be suitable for high density planting under arecanut (3712 plants/ha). The bean yield per plant was on par with regular spacing, but unit area yield was double that of regular spacing.

Pyrolytic reprocessing of cocoa pod husk

Process of pyrolysis of cocoa pod husk using the ICAR-CIAE kiln was standarized. The turnover was 38 to 42% on weight-by-weight basis. Convertion of cocoa waste into biochar will prevent building of *Phytophthora* inoculum in the garden besides its positive impact on carbon sequestration and providing mobile K, Ca and Mg to soil.

New fungicide for management of stem bleeding in coconut

The field trial on the management of stem bleeding disease of coconut indicated that Propiconazole 25 EC is as effective as Hexaconazole 5EC and *Trichoderma harzianum* (CPTD28).

Control of rugose spiralling whitefly

Based on a field trial it was found that palms treated with neem oil (5%) and water spray could reduce the RSW population significantly. However the interesting observation is lthat parasitism by *E. guadeloupae* increased in all treatments indicating that conservation biological control would be successful in the bio-suppression of RSW.

EPN for the bio-suppression of banana pseudostem weevil in coconut system

Prophylactic application of aqua formulation of 'Kalpa EPN (CPCRI - SC1), *S. carpocapsae* @ 50 ml solution containing 2500 IJs and delivered on leaf axis and whorls as well as placement of nematode infested *Galleria* cadavers of about 4 and 8 days old *S. carpocapsae* and *Heterorhabditis indica* (CPCRI - HI1) @ 1 cadaver / leaf whorl at fortnightly intervals on four months old banana were found effective in the suppression of banana pseudostem weevil. Early detection of pest infestation and EPN delivery is crucial for the suppression of the pest.

Kalparasa® collection device:

The mould developed with financial assistance from Coconut Development Board was commercialized to a manufacturing firm at Mangalore. The new device is priced lesser than 50% of the old model. Further modification made in this device is replacement of polythene bags with stainless steel collection container thereby reducing the operational cost. Feedback from users indicated very good to excellent level of satisfaction. Demand for the device showing increasing trend in the past one year.

A new cost saving device for collection of Kalparasa

X. Awards and Recognitions

ICAR-CPCRI, Kasaragod Centre of AICRP on PHET attained first position for Best Centre of the year 2019-20 Award during 35th Annual Workshop at JNKVV, Jabalpur during 23-25 January 2020.

Dr. T. Sivakumar, SMS (Agricultural Entomology) bagged the ICAR Cash Award for technical category for the year 2019 during the Foundation Day celebrations of ICAR on 16th July, 2020.

Dr. M.R. Manikantan, Principal Scientist (AS&PE) received "ISAE Commendation Medal 2019" award by Indian Society of Agricultural Engineers (ISAE), New Delhi during 54th Annual Convention of ISAE and International Symposium on "Artificial Intelligence Based Future Technologies in Agriculture" at Hotel Hyatt Regency, Pune during 7-9 January 2020.

The research paper authored by Josephrajkumar, A., Chandrika Mohan, Merin Babu, Anes, K.M., Regi J. Thomas and Vinayaka Hegde entitled 'Strengthening quarantine and incursion management of invasive pests on coconut' authored was adjudged as the best oral presentation during the International Seminar on Transboundary Pest Management, held during 4-5 March, 2020 at TNAU, Coimbatore.

Research paper authored by Dr. Sujithra M., Prathibha, V.H., Rajkumar and Vinayaka Hegde entitled" Characterization and entomopathogenecity of *Simplicium cylindrosporum* isolated from rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin" was awarded as best oral presentation during the International Seminar on Transboundary Pest Management" held at TNAU, Coimbatore organized by Entomological Society of India, New Delhi during 4 -5 March 2020.

Dr. L. S. Singh, Scientist (Sr. Scale), has got the best oral presentation award in the International webinar on urban and peri-urban agriculture for livelihood organized by Dr. Ram Avatar Shiksha Samiti and ICAR-CAZRI, RRS, Pali, Marwad, Raj during 29-30 July, 2020.

Dr. G. Panjavarnam, Scientist (Fruit Science), Crop production, ICAR-CPCRI, Kasaragod received Appreciation Award for Ph. D. Dissertation on International Conference on Banana-2020 held during 22-25 Feb, 2020.

Dr. Ramesh S.V., was awarded Best Oral Presentation Award for the research paper entitled 'Coconut testa-derived biocolourant and oil: a treasure trove of antioxidants' authored by Ramesh S.V., Rose Mary, Shameena Beegum P.P, Pandiselvam R., Sugatha P., Manikantan M.R., Niral V.and Hebbar K.B. during the International Webinar on Phytochemistry-2020; held during 28-29 September 2020, Kerala Academy of Sciences, IUCGGT, University of Kerala, Karyavattom, Thiruvananthapuram, Kerala.

XI. Training and Capacity Building

e-Office training being conducted at ICAR-CPCRI, Kasaragod

Training attended

Scientists

Name & designation	Title	Place and date
Dr. Nihad K., Sr. Scientist, CPCRI, RS, Kayamkulam	Integrated Nutrient Management and Nutrient Budgeting through advanced models to Improve Crop Productivity	ICAR-IISWC (RC), Ooty 3 - 7thFebruary, 2020.
Dr. V. Selvamani, Sr. Scientist, Soil Science, CPCRI, Kasaragod	Workshop cum training programme on "Airborn Hyperspectral Remote Sensing	ICAR – IARI, New Delhi 10 - 20th February, 2020.
Dr. M.K. Rajesh, Principal Scientist	Basics of flow cytometry and its applications in Plant Biology. (Online)	Flowcytometry Solutions, Jaipur 5 - 8th May, 2020
	SciCom for Smart Scholars (Online)	ICAR-CIFE, Mumbai 27t May - 8th June, 2020
	Bacterial Whole Genome Sequencing. (Online)	Bionivid Technology Pvt. Ltd., Bengaluru 18t- 19th July, 2020
Dr. Ravi Bhat, Principal Scientist Dr. Alka Gupta, Dr. Murali Gopal and Dr. Subramanian, Principal Scientists, Dr. V. Selvamani and Dr. Neenu S., Scientists	Online Training on 'Field Book v4.3'	ICAR- IIMR, Hyderabad 16th June 2020
Dr. S. Jayasekhar, Sr. Scientist, Dr. Neema M., Scientist Dr.M. Anes, Scientist Dr. Sandip Shil, Scientist Dr. Khadke Ganesh Navanath, Scientist	Online Training session on e-Office training	ICAR-IASRI, New Delhi 26thJune, 2020
Dr. Arun Kumar Sit, Principal Scientist and Dr. SandipShil, Scientist	Online Training session on e-Office training	ICAR-IASRI, New Delhi July-2020.
Dr. S. Kalavathi, Head I/C Dr. Chandrika Mohan, Dr. Regi J. Thomas, Dr. A. Joseph Rajkumar., Pr. Scientists and Dr. Merin Babu, Dr. K.M. Anes, Scientists	Virtual zoom meeting on e-Office training for scientists by	ICAR-CIFT, Kochi 7th July, 2020

Name & designation	Title	Place and date
Dr. S. Kalavathi, Head I/C Dr. Chandrika Mohan Dr. A. Joseph Rajkumar., Pr. Scientists and Dr.MerinBabu, Dr. K.M. Anes,Scientists	Virtual zoom meeting on e-office training for scientists	ICAR-CPCRI, Kasaragod 8th July, 2020
Dr. S. Kalavathi, Head I/C Dr. Chandrika Mohan and Dr. A. Joseph Rajkumar., Pr. Scientists Dr. MerinBabu, Scientist	Hands on e-office training for scientists	ICAR-CPCRI, RS, Kayamkulam 4th August, 2020
Dr. K.B. Hebbar, Principal Scientist Dr. Ravi Bhat, Principal Scientist Dr. Niral V., Principal Scientist Dr. K.P. Chandran, Principal Scientist	Data analysis using R (Online)	ICAR- NAARM Hyderabad 6-11th August, 2020
Dr. SandipShil, Scientist	Online Training Programme, Analysis of Experimental Data using R	Organized by ICAR- NAARM, Hyderabad–5- 11th August, 2020
Dr. R. Sudha,Sr. Scientist and Dr. Shameena Beegum P.P., Scientists	Application of Statistics in Science and Technology using SPSS (Online)	World Food Preservation Center, USA 8 - 10th, August 2020.
Dr. M.R. Manikantan, Principal Scientist	IP valuation and technology management (Online)	ICAR-NAARM, Hyderabad 1-5th September 2020
Dr. Shameena Beegum P.P., Scientist	Intellectual Property rights in agricultural Research & Education in India (Online)	NAHEP & IP&TM 12 -28th September, 2020
Dr. C. T. Jose, Head I/C, Dr. S. Kalavathi, Head I/C, Dr. Chandrika Mohan, Dr. A. Joseph Rajkumar, Dr. A. Abdul Haris, Dr. Regi J. Thomas, Dr. S. Elain Apshara, Dr. Arun Kumar Sit, Principal Scientists, Dr. M. Shareefa, Dr. K. Nihad, Dr. Jeena Mathew, Dr.Merin Babu, Dr. K.M. Anes, Dr. Alpana Das, Dr. Anok Uchoi, Dr. L. S. Singh Sujithra M., Dr. Sandip Shil, Dr. N.R. Nagaraja, Mr. Bhavishya, Dr. Chaithra, M., Dr.Neema and Dr. Daliyamol, Scientists	Workshop cum training programme on digital field data book	IIMR, Hyderabad 18th September, 2020
Dr. R. Pandiselvam, and Dr. Shameena Beegum, P.P., Scientists	14 days virtual workshop cum Training Programme on "Intellectual Property Rights in Agricultural Research & Education in India"	IP&TM Unit of ICAR, New Delhi 12-28th September, 2020
Dr. Elain Apshara, Principal Scientist	Leadership and Organization Development for Women scientist Technologists	DST sponsored online programme conducted by Centre for Organization Development (COD), Hyderabad. 12t-16thOctober 2020
Dr. S.V. Ramesh, Sr. Scientist	Training Processing & Marketing of Coconut Sugar (Online)	International Coconut Community & NAM CSSTC 6th October, 2020
Dr. R. Sudha, Sr. Scientist	Management Development Program for women in development sector (Online)	MANAGE, Hyderabad 14-18th December, 2020
Dr. Shameena Beegum P.P., Scientist	Response surface and mixture experiment methodologies for Agricultural and Fisheries experimentation (Online)	ICAR-CMFRI 16th December, 2020

Technical Staff

Name & designation	Title	Place and date
Sri Suvith P.S., Technician	Workshop on e-Office Implementation	ICAR-IASRI, New Delhi 30th April, 2020
	Online workshop on TMIS (Training Management Information System	HRM Division, ICAR 8th May, 2020
	Training on e-Office EMD & e-File	ICAR-IASRI, New Delhi 22nd June, 2020
	Training on framework of TSA system through PFMS for Autonomous Body	ICAR HQ
Dr. Ravindran P.	Online Training on 'Field Book v4.3'	ICAR- IIMR, Hyderabad 16th June 2020
Sri Hareesh G.S., TO	Familiarization on eoffice – efile module	ICAR-IASRI, New Delhi 26thJune,-2020
Sri Hareesh G.S., TO Sri K.M. Ansari, TO Sri Arunji G., TA Sri Nirmal Kumar, TA Sri Suvith P S, Technician	Online Training session on e-Office training	ICAR-IASRI, New Delhi 26th June,-2020
Dr. Saran Kumar Rizal, CTO, Dr. Avrajyoti Ghosh, ACTO, Sri Pratap Kumar Sarkar, STA, and Sri Jagadish Roy, STA	Online Training session on e-Office training	ICAR-IASRI, New Delhi July-2020.
Sri H. Muralikrishna, CTO, Dr. B. Chowdhury, CTO Sri Avrajyoti Ghosh, ACTO, Sri Pratap Kumar Sarkar, STA Sri Nirmal Kumar, TA Sri Bisun Bhaskar, TA Sri Suvith P.S., Technician	Workshop cum training programme on digital field data book	IIMR, Hyderabad 18th September, 2020
Sri Hareesh G.S., TO	VAIBHAV-Sensors and Sensing for Precision Agriculture (V16H1S1) Sessions Attended: 1. IoTs for Precision Agriculture 2. Sensors and Sensing of Soil and Crop Health for Precision Agriculture (Online)	VAIBHAV, ICAR-IARI 5th October, 2020
	Generic Online Training Course on Cyber Security	C-DAC, MeitY 16th December, 2020

Administrative Staff

Name & designation	Title	Place and date
Smt. K. Narayani, PS Smt. Sulochana Nair, PS Smt. Prasanna Sarngan, PA	Enhancing Efficiency and Behavioural Skills for Stenographers Grade III, PA, PS and Sr. PPs of ICAR	ICAR – NAARM, Hyderabad. 24-29th, February, 2020
Sri Hareesh Nair G.S., CAO Sri T.E. Janardhanan, AO, Sri A.K. Sasi, AFAO Sri M. Raveendran, AAO Sri Umesh Kumar, LDC	Online Training session on e-Office training	ICAR-IASRI, New Delhi 26thJune,2020
Sri Subhash Paul, Asst.	Online Training session on e-Office training	ICAR-IASRI, New Delhi July-2020

Skilled Support Staff

Name & designation	Title	Place and date
Sri S. Dasappa Gowda, Sri B. Bhavani, Sri V. Chennapa, Sri V. Jathappa Gowda, Smt. T. Susheela, Sri S. Chenappa, S, Smt. Lolakshi, Sri Bhojappa Gowda S., Sri Sheenappa Gowda S., and Smt. Meenakshi B., Skilled Support Staffs, CPCRI, RC, Kidu	Production of technologies and nursery management in plantation crops (In house training)	ICAR-CPCRI, Research Center, Kidu 23- 25th, January,2020

XII. Workshops, Seminars, Summer Institutes, Farmers Days organized

Swadeshi Science Congress

The 29th Swadeshi Science Congress was held during 27-29th February 2020 at ICAR-CPCRI, Kasaragod, Kerala under the focal theme 'Science and Technology for Sustainable Development'. It was jointly organized by ICAR-CPCRI, Central University of Kerala and Swadeshi Science Movement-Kerala. Sri V. Muralidharan, Hon'ble Minister of State for External Affairs and Parliamentary Affairs inaugurated the Congress on 27th February 2020. He highlighted the achievements of the nation in various advanced sectors including space science. Dr. G. Gopa Kumar, Vice-Chancellor, Central University of Kerala, Kasaragod and Prof. (Dr). A. Ramachandran, Vice-Chancellor, Kerala University of Fisheries and Ocean Studies, Kochi were the guest of honours. Dr. K. Muralidharan, Vice President, Swadeshi Science Movement Kerala presided over the function. Dr. Anitha Karun, Director, ICAR-CPCRI welcomed the gathering. Dr. Vivekananda Pai, Vijnana Bharati offered felicitations. Dr. P. Rajendran, Central University of Kerala briefed about the programmes and Dr. A. R. S. Menon, Secretry SSMK proposed vote of thanks.

A publication on 'Farmer participatory technology transfer' brought out by the Institute was released by the Hon'ble Minister during the occasion. He also distributed the i-STED project awards to Shri AM Subrahmanyan Nair, Kalichanadukkam, Kasaragod (best Papaya Farmer) and to The Papain Society, Vandum, Malappuram (Best Papaya Enterprise). Memorandum of Understanding (MoU) between CPCRI and KUFOS, Kochi was exchanged during the occasion.

The Conference was held simultaneously in three different hallstracks. Over 200 research papers were presented in the 10 technical sessions. Technical Sessions started with the Padma Vibhushan Parameswarji Memorial Lecture delivered by Prof V. P. N. Nampoori, Emeritus Professor, CUSAT on the topic 'Panini, Euclid and Mendeleev'. More than 300 delegates participated in the conference.

A Student-Scientist Interface Programme was conductedas a part of the 29th Swadeshi Science Congress on 29 February 2020. The programme was inaugurated by Prof. K. Jayaprasad, Pro-Vice Chancellor, CUK, Kasaragod followed that by C.V. Raman Memorial Lecture which was delivered by Prof. Reji Philip, Raman Research Institute, Bangalore. The following scientists interacted with the students: Prof. G.M. Nair, Kerala Biotechnology Commission, Dr. V.P. Balagangadharan, Former ISRO Scientist, Dr. K. Ganesh Raj, NRSC, ISRO, Bangalore, Prof. V.P.N. Nampoori, Prof. Reji Philip, , Dr. P.V. Mohan, Scientist-G, Sree Chithra Thirunal Institute of Medical Sciences & Technology, Dr. Suresh C.H., NIIST, Thiruvananthapuram, and Dr. Anitha Karun. More than 500 students participated in the interactions.

A Kathakkali performance on life of Bharat Ratna C.V. Raman was staged by Dr. C.G.N. Namboothiri, Technical Officer and his team.

Valedictory session was held on 29th February 2020, chaired by Dr. Anitha Karun, Director (Acting), ICAR-CPCRI. Dr. N.G.K. Pillai, former Director, CMFRI, Kochi, Dr. K. Muralidharan, Vice President, SSMK, and Dr. M.K. Rajesh, Chairman Programme Committee and Principal Scientists, ICAR-CPCRI were the dignitaries on the dais.

Rural India Business Conclave (RIBC)

The Kalpa Agri-Business Incubator, ICAR-CPCRI and Kerala Startup Mission jointly organized Rural India Business Conclave during 27 February to 3 March 2020 at ICAR-CPCRI, Kasaragod. The LBS Engineering College, Kasaragod and Central University of Kerala were the knowledge partners. This mega event had the following programmes: (i) Mega exhibition (SITI - Science, Invention, Technology and Innovation Expo) (ii) Conference: Startups to leverage rural economy (iii) Networking dinner (iv) Dream Big Kalpa – Workshop' on sourcing agriculture technologies from different ICAR institutes (v) Expert talks and (vi) Agri-tech hackathon.

Sri V. Muraleedharan, Honourable Union Minister of State for External Affairs and Home Affairs inaugurated the SITI exhibition on 27 February 2020. The conferences were held during 1-2 March 2020 and inaugurated by Sri N.A. Nellikunnu MLA Kasaragod inaugurated the Conference. Mr. A.G.C. Basheer, District Panchayath President presided over the function. Dr. Saji Gopinath, CEO, Kerala Startup Mission flagged the focal theme of the conclave that the inclusive growth of rural economy has a decisive role in achieving nation's aspiration to become a five trillion dollar economy by 2024. Dr. Anitha Karun, Director (Acting), ICAR-CPCRI welcomed the gathering. Founders of six highly successful start-up ventures shared their experience and vision; they included Sri Mathew Joseph, Co-Founder,

'Fresh to Home' (a retail supply chain of fresh fish and meat operating in different cities); Sri Senthil Kumar, Founder, 'Savemom' (provides connected maternal care using a smart device and telemedicine); Sri Mohamed Jamsheer, CFO, 'Green Worms' (involved in solid waste management); Sri Sikkendar Meeranaik, CEO, Sankalpa Rural Development Society (a Society that works for recharging dried bore wells); Sri Pradeep Punarka, CEO, 'FarmersFZ' (linking production from farmer-clusters to consumers, and Dr. Saji Vargese, CEO, 'Coconut Leaf Straw' (manufacture of drinking straws from coconut leaflets).

In the networking dinner-talk, Sri P. K. Gopalakrishnan, Indian Angel Network on investment presented the investment opportunities with startups.

In the 'Dream Big Kalpa Workshop', commercialized technologies from the following institutes were presented in the session chaired by Dr. C. Thamban, Principal Scientist (Agrl Extn.); ICAR-CIAE (Dr. Ravindra Naik); ICAR-IIMR (Dr. Dayakar Rao) ICAR-CIFT (Dr. George Ninan); ICAR-IISR (Dr. T.E. Sheeja); ICAR-CPCRI (Dr. K. Muralidharan); ICAR-SBI (Dr. P. Muralidharan); ICAR-CTCRI (Dr. D. Jaganathan); ICAR-NRCB (Dr. K. N. Shiva); and ICAR-IIHR (Dr. R.H. Laxman).

There were two expert-talks in the second day: Sri Nagaraja Prakasam, Angel Investor & Startup Mentor delivered a talk on 'Focus on India's strength -People, Problem and Technology'. He cited examples where rural youths provided solutions matching with global standard and converging resources including sourcing of technologies from ICAR institutes. Sri Harikrishnan C.A., dwelt upon the legal, financial and policy issues in his expert talk.

The Agri-tech hackathon, probably the first of its kind, was conducted to find solutions under five themes: Robotic assisted grafting of plants; Technology for identification of maturity of coconut without human interface; Computer/mobile – based monitoring and controlling of drip irrigation system for multiple cropping systems; Virtual Santhai - To enable seamless marketing of Rural India commodities and products; and Mobile App for connecting waste aggregators. Out of 75 teams registered, 24 were shortlisted and 15 teams participated in the 30 hours hackathon started at 9.30 am on 29 February 2020. Team DTi from Sahyadri College of Engineering and Management, Mangaluru (comprising of Pushparaj A., Ramkishor K., Harshith Kumar and Dhanush M.) was adjudged as winners and awarded a cash prize of Rs.50,000.

Task force committee meeting on DUS testing in cocoa

First meeting of the task force committee to finalize distinctness, uniformity and stability (DUS) testing guidelines for Cocoa was conducted on 11 November 2020 online. Dr. V.A. Parthasarathy, Former Director and Emeritus Scientist, ICAR-IISR, Kozhikode chaired the meeting. Dr. Anitha Karun, Director, ICAR-CPCRI, Dr. K.V. Prabhu, Chairperson, PPV & FRA, Dr. D. Balasimha, Former Head, CPCRI, RS, Vittal, Dr. Prasannakumariamma, Former Professor KAU, were present. Dr. Nagarathna, Registrar, Dr. Dipal Roy, Deputy Registrar, PPV & FRA, New Delhi conducted the task force meet. Chairman, briefed the importance of DUS guidelines in horticultural crops specifically fruits/ plantation crops considering their perenniality and cross pollinating nature. Dr. S. Elain Apshara, Principal Scientist (Hort.) & PI of the project presented the draft guidelines before the committee. Based on important inputs, the committee shall be finalising the DUS test guidelines for cocoa.

Sri V. Muralidharan, Hon'ble Union Minister of State for Parliamentary and External Affairs visiting the SITI exhibition

Agri-Tech hackathon in progress as part of Rural India Business Conclave

XIII. Participation of Scientists in Conferences, Meetings, Workshops, Symposia and Webinars

Deputation Abroad

Dr. Murali Gopal, Principal Scientist (Agril. Micro.) was deputed to University of Delaware, Newark, DE, USA. He had attended the IUSSTF funded Indo-US Bilateral Workshop on 'Transnational Research needs and Applications of Plant Microbiomes' from 25-27th February, 2020. He made a presentation on recycling of coconut residues and their impact on soil and plant health and sustaining coconut ecosystem services.

Participation within India

Name and designation	Programme	Place & Date
Dr. Shameena Beegum, P.P. Scientist	International workshop on value addition in Agriculture	Kerala Agricultural University, Vellanikkara, Thrissur 4-7th January 2020
Dr. M.R. Manikantan, Principal Scientist	54th Annual Convention of Indian Society of Agricultural Engineers and International Symposium on Artificial intelligence based future technologies in agriculture	Hotel Hyatt Regency, Vimannagar, Pune 7-9th January 2020
Dr. M.R. Manikantan, Principal Scientist, Dr. R. Pandiselvam, Scientist	35th Annual Workshop of AICRP on PHET	Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur 23 – 25th January 2020
Dr. Anitha Karun, Director (Actg.), Dr. K. Muralidharan, Dr. K.B. Hebbar, Dr. Vinayaka Hegde, Acting Heads, Dr. H.P. Maheswarappa, Project Coordinator, Dr. A.C. Mathew, Dr. P. Subramanian, Dr. C. Thamban, Dr. M.K. Rajesh, Dr. K.P. Chandran, Dr. M. R. Manikantan, Principal Scientists, Dr. S. Jayasekhar, Senior Scientist, Dr. M. Sujithra, Dr. Rajkumar, Dr. Nagaraja, N. R., Dr. Sudha R., Dr. Neema M., Dr. Daliyamol, scientists, Dr. K.S. Muralikrishna, Tech. Asst.	29th Swadeshi Science Congress-National Conference on Science and Technology for Sustainable Development	ICAR-CPCRI, Kasaragod 27-29th February 2020
Dr. M.R. Manikantan, Principal Scientist	National Conference on "Sustainable Natural Resources Management: An Engineering Perspective"	College of Forestry, Ponnampet, Kodagu, Karnataka 28-29th January 2020
Dr. A. Joseph Rajkumar, Principal Scientist and Dr. M. Sujithra, Scientist	RSW workshop and Farmer's Conclave	TNAU, Coimbatore 3rd February 2020
Dr. S. Kalavathi, Acting Head	SAC Meeting of KVK	KVK, Kumarakom 12th February 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Coconut Workshop for students and farmers	VIT, Vellore 19th February 2020
Dr. Arun Kumar Sit, Principal Scientist	District Level Seminar on Horticulture development for Darjeeling district	25th February 2020
Dr. P. Muralidharan, Principal Scientist & Head	XI National KVK Conference - 2020	NASC Complex, New Delhi 28February to 1March 2020
Dr. A. Joseph Rajkumar, Principal Scientist Dr. Rajkumar, Dr. M. Sujithra and Shivaji Husarao Thube, Scientists	International Seminar on Transboundary Pest Management	TNAU, Coimbatore 4-5th March 2020

Name and designation	Programme	Place & Date
Dr. Arun Kumar Sit, Principal Scientist	SAC Meeting of KVK	Jalpaiguri 6th March 2020

Participation in webinars

Name & designation	Title	Organizer & Date
Dr. P. Muralidharan, Head, KVK, Sri M.S.Rajeev, Smt. Jissy George, Dr. T. Sivakumar, Smt. G. Lekha, Dr. S. Ravi and Dr. K. Sajnanath (SMSs)	Action plan meeting of KVKs of Zone XI Online	14th May, 2020
Dr. Chandrika Mohan and Dr. A. Joseph Rajkumar, Principal Scientists, Dr. K.M. Anes, Scientist	Virtual meet on 'AICRP on Biological Control workshop'	ICAR-NBAIR, Bengaluru 21-22nd May, 2020
Smt. Jissy Geroge, SMS	Online interface with entrepreneurs organized by Agropark, Piravom	22nd May, 2020
Dr. Chandrika Mohan and Dr. A. Joseph Rajkumar, Principal Scientists	Virtual meet 'Outbreak of Desert Locust in North India'	ICAR-NBAIR, Bengaluru 5th June, 2020
Dr. Jeena Mathew, Scientist	Webinar on 'An environmental agenda for the future'	Centre for Science and Environment, New Delhi 5thJune, 2020
Mr. Arunji G. Technical Assistant (Library)	National webinar on 'INFLIBNET as a Digital Platform: Support for Academicians from Teaching Learning process to Academic advancement'	Sheth N.K.T.T. College of Commerce & Sheth J.T.T. College of Arts, Thane in association with Library & Inf. Science Research Scholars' Forum (LISRF) 7th June, 2020
Dr. Chandrika Mohan and Dr. A. Joseph Rajkumar, Principal Scientists	Virtual meet on 'Impact and implications of COVID-10 on Agrochemicals industry and banning of 27 molecules'	FICCI, New Delhi 11th June, 2020
Dr. S. Kalavathy, Acting Head Dr. Chandrika Mohan, Dr. Regi J. Thomas, Dr. A. Joseph Rajkumar, Principal Scientists Dr. M. Shareefa, Senior Scientist Dr. Merin Babu, Dr. K.M. Anes, Scientists	Webinar on 'Way Forward for the Global Coconut Industry'	International Coconut Community (ICC), Jakarta 11th June, 2020
Dr. Shameena Beegum, Scientist	Webinar on 'Efficient Tools for Effective Research Communication and Publications'	World Food Preservation, Center, USA 12 -14th June 2020.
Mr. Arunji G. Technical Assistant (Library)	International webinar on' New directions for Library & Information Service and Education' Webinar on 'Digitisation and Copyright: Issues and Challenges'	Karnataka State Library Association, Bengaluru (R) 13th June 2020 Brainware University, Kolkata. 15th June, 2020
Dr. K. Sajnanath, SMS	Finalization of 'Jaivagruhum (Integrated farming Systems)' project as part of Rebuild Kerala Initiative	Mavelikkara Block on 15th June, 2020.

Name & designation	Title	Organizer & Date
Dr. S. Ravi, SMS	Resource Persons meeting to prepare Block level plan for Subhiksha Keralam	Harippad Block on 17thJune, 2020
Mr. Arunji G. Technical Assistant (Library)	National webinar on 'From Artificial Intelligence to IOT: Changing Landscape of Libraries'	Learning Resource Centre, Jain (Deemed to be University), Bangalore 22nd June, 2020
Dr. Chandrika Mohan Principal Scientist	Kalpa green chat /YAWA web chat series "Business build on technologies"	ICAR-CPCRI, Kasaragod 9th July, 2020
Dr. L. S. Singh	'International web conference on Climate Smart Agriculture for sustainable food and nutritional security'	Beni Singh College Chenari, Rohtas, Bihar and Society for Upliftment of Rural Economy, Varanasi, UP 10 – 11thJuly, 2020
Dr. L. S. Singh	'International webinar on environment in 2020: vision and Mission' organized in collaboration with Faculty of Science, Lincoln University College, Malaysia.	NSS Unit, Bidhan Chandra Krishi ViswaVidyalaya, Mohanpur, Nadia, West Bengal 12thJuly, 2020
Dr. P. Muralidharan	Annual Review Meeting of KVKs of Zone XI (online)	ATARI, Bengaluru on 14 – 15thJuly, 2020.
Dr. P. Anithakumari Principal Scientist	Webinar on 'Programme on accounting, reporting and compliance for FPOs'	Banking Institute of Rural Development (BIRD) and NABARD 15-16th July 2020
Dr. K. Sajnanath	Webinar on "Protected cultivation: Promising technology to boost crop production during pandemic period	CWRDM, Kozhikode on 17th July, 2020
Dr. P. Anithakumari, Principal Scientist	Virtual Dialogue webinar 'Online methodologies and training for gender equality	UN Women Centre on 22nd July, 2020
Smt. Jissy George	Webinar on "Prospects of Agro-Processing"	Kerala Start Up Mission 22nd July, 2020
Dr. S. Kalavathi Acting Head	Sensitization workshop on Standardized Scheme Process	IASRI, New Delhi 23rd July 2020
Dr. A. Abdul HarisPrincipal Scientist	Webinar on 'Precision Farming in Banana"	ICAR-NRC Banana on 25th July, 2020.
Dr. Nagaraja, N. R., Scientist-Sr. Scale (Plant Breeding)	Attended online Annual Review Meeting of the MIDH (Mission for Integrated Development of Horticulture)/ NHM (National Horticulture Mission) programmes implemented through DASD	DASD, Calicut 28–29th July 2020
Dr. Anok Uchoi, Dr. L. S. Singh	'International webinar on urban and peri-urban agriculture for livelihood' organized by	Dr. Ram Avatar Shiksha Samiti and ICAR-CAZRI, RRS, Pali, Marwad, Rajasthan 29 –30th July, 2020.
Dr. Nagaraja N.R. Scientist (Plant Breeding)	Panelist - YAWA web chat series 'Business built on technologies'	ICAR-CPCRI, Kasaragod 1st August 2020
Dr Chandrika Mohan Dr. A. Joseph Rajkumar, Principal Scientists	Online meet on Evolving Protocol for Whitefly management in coconut	CDB, Kochi, 3rd August, 020
Dr. A. Joseph Rajkumar, Pr. Scientist	Online discourse on Integrated Management of Insect Pests & Nematodes in Banana	ICAR-NRCB, Tiruchirapalli, 4th August, 2020
Dr. T. Sivakumar, SMS	Webinar on "Integrated pests and nematode management in banana"	ICAR-NRCB, Trichi on 4th August, 2020

Name & designation	Title	Organizer & Date
Dr. Regi Jacob Thomas Principal Scientist	Coconut varieties suitable for Kerala's agro-ecological zones and management of young coconut palms FB Live 'Krishi Pathasala'	SAMETHI, Thiruvananthapuram 5th August, 2020
Dr. R. Thava Prakasa Pandian and Dr. Shivaji Hausrao Thube, Scientists	International Web Conference on 'Ensuring the Food Safety, Security and Sustainability through Crop Protection'	BAU, Bihar 5 – 6th August, 2020
Dr Chandrika Mohan Principal Scientist	International web conference on 'Ensuring food safety, security and sustainability through crop protection'	Bihar Agricultural University, Sabour 5-6th August, 2020
Sri M.S. Rajeev, SMS	Webinar on "Planting material in banana: Present and next generation technologies"	ICAR-NRCB, Thiruchirappilly 7th August, 2020
Dr. Shameena Beegum, P.P., Scientist	Online Workshop on "Application of Statistics in Science and Technology using SPSS"	World Food Preservation Center, USA 08-10th August, 2020
Dr. A. Abdul Haris, Principal Scientist and Dr. K. Nihad, Scientist	Coconut Webinar Series No.2	ICAR-CPCRI, RS, Kayamkulam 10th August, 2020
Dr. S. Kalavathi Dr Chandrika Mohan Dr. A. Joseph Rajkumar, Principal Scientists	Online Workshop on the AICRP (Palms) Annual Group Meeting	ICAR-CPCRI, Kasaragod 10-11th August, 2020
Dr. S. Kalavathi Dr. Chandrika Mohan Dr. A. Joseph Rajkumar,Principal Scientists Dr. Anes K.M., Scientist	Orientation to training Pest Management in coconut Invasive pests on coconut and ecological engineering. Nematodes: the hidden enemies	Mavelikkara 11th August, 2020
Dr. Murali Gopal, Principal Scientist (Agri. Microbiology) and Dr. Sandip Shil, Scientist (Agril. Stat)	Webinar on Bioinformatics Analysis on Soil Microbial Community Sequence Data	ICAR- IARI, New Delhi 12 –13th August, 2020.
Dr. K. Sajnanath, SMS	Webinar on "Advances in Rice research for food security and environmental sustainability"	TNAU, Aduthurai campus 13th August, 2020
Dr. Priya, U.K., Scientist (Soil Science)	National webinar on 'nature extent and management of problematic soils for sustainable agriculture' by Directorate of research services, RVSKV, Gwalior.	13thAugust 2020
Dr. Thamban, C., Principal Scientist (Agrl. Extension)	Webinar on 'Building farm resilience during COVID-19 pandemic'	Purogamana Kala Sahithya Sangham 17th August, 2020
Dr. Anes K.M., Scientist	Endowment lecture on Advances in Nematode Management	TNAU, Coimbatore 17th August, 2020
Sri M.S. Rajeev Dr. T. Sivakumar Smt. G. Lekha Dr. K. Sajnanath, SMSs	Online workshop on "ABC of Scientific writing"	KVK-Cuttack & ICAR-NRRI, Cuttack from 18 August to 2nd September, 2020
Dr. Shivaji Hausrao Thube and Dr. R. Thava Prakasa Pandian Scientist	'CRISPR/ Cas9: Basics and application'	ICAR-IISR, Calicut 19th August 2020
Sri M.S. Rajeev, SMS	E-learning programme on "Strengthening of FPOs-Linking with e NAM, Commodity exchanges, Opportunities and Challenges"	BIRDS (NABARD), Mangaluru 18 – 20th August, 2020
Dr. S. Elain Apshara, Principal Scientist (Hort.)	Resource person- Kalpa Green Chat- 'You too can make chocolate from cocoa beans'- Technology driven agri business interaction with incubators	ICAR- CPCRI, Kasaragod 22nd August, 2020

Name & designation	Title	Organizer & Date
Dr. P. Anithakumari, Principal Scientist	'Practical tips in coconut management by small and marginal farmers'	RATTC, Kazhakoottam 23rd August, 2020
Dr. M. Shareefa Senior Scientist	Coconut varieties and its scientific management 'Krishi Padasala' by Farmers Training Centre	Pandalam 24th August, 2020
Dr. A. Abdul Haris Principal Scientist, Dr. K. Nihad and Dr. Jeena Mathew, Scientists	Coconut Webinar Series	ICAR-CPCRI, RS, Kayamkulam 24th August, 2020
Dr. Alka Gupta, Principal Scientist (Microbiology)	Webinar on "Agriculture and the Microbiome"	Council for Agricultural Science &Technology (CAST), IOWA, USA 25thAugust,2020
Dr. S. Kalavathi Dr. Chandrika Mohan Dr. A. Joseph Rajkumar., Principal Scientists and Dr. Anes K.M., Scientist	Orientation to trainingIPM in Coconut Incursion management of invasive pests & Ecological Engineering Nematodes: the friend & enemy	Cherthala 25th August, 2020
Dr. A. Joseph Rajkumar., Pr. Scientist	Virtual workshop on Mitigation and Adaptation Strategies for Alleviating Impact of Climate Change on Food Security	BSNVPG, College Lucknow 25th August, 2020
Dr. P. Muralidharan	Governing Body meeting of ATMA, Alappuzha chaired by the District Collector (Online)	ATMA, Alappuzha 25th August, 2020
Dr. Anok Uchoi, Dr. L. S. Singh	'International webinar on Horticulture Industry Under Covid-19 Pandemic' jointly organized by Department of Horticulture and College of Horticulture, Assam Agricultural University, Jorhat in association with NAHEP.	27 -28th August, 2020
Mr Hareesh G.S., Technical Officer (Instrumentation Engineering)	Webinar on IoT Security (WISE)	ISEA, CDAC, Hyderabad 28-29th August, 2020
Dr. T. Sivakumar	Webinar on "Plant biosecurity strategies for sustainable plant health: protect domestic plant health, promote exports"	NIPHM, Hyderabad 29th August, 2020
Dr. A. Josephrajkumar, Principal Scientist (Entomology)	Pest and disease management	Karshakashree 1st September, 2020
Dr. Thamban, C., Principal Scientist (Agrl. Extension)	Webinar on 'Enhancing productivity and income from coconut farming' on World Coconut Day	Karshakasree (Farm journal) 2nd September, 2020
Dr. Anitha Karun, Director (Acting), Dr. Jayasekhar, Senior Scientist (Agri. Economics)	Webinar on the theme "Invest in coconut to save the world"	CCDO, CDB, Kochi 2nd September, 2020
Dr. V. Niral, Principal Scientist (Genetics)	Virtual webinar on "Application of Rapid breeding techniques in plantation crops"	ICAR-IIOPR 2nd September, 2020
Dr. Nagaraja, N.R., Dr. Chaithra, M., Dr. Shivaji Hausrao Thube, Dr. Priya, U.K., Dr. R. Thava Prakasa Pandian, Scientists	World Coconut Day 2020 'Invest in Coconut to save the world'	2nd September, 2020
Dr. R. Thava Prakasa Pandian, Scientist	'Coconut for nourishing mankind and nurturing ecology'.	2nd September, 2020
Dr. Shivaji Hausrao Thube and Dr. R. Thava Prakasa Pandian, Scientists	'Plant Health Management for Sustainable Agriculture'.	4th September, 2020
Dr. Shivaji Hausrao Thube, Dr. R. Thava Prakasa Pandian, Scientists	YAWA series talk on 'Protection of Intellectual properties'.	5th September, 2020

Name & designation	Title	Organizer & Date
Dr. P. Anithakumari, Pr. Scientist	'The wonder world of coconut'	Agri -Horti Society, Alappuzha 5th September, 2020
Dr. R. Thava Prakasa Pandian, Dr. Shivaji Hausrao Thube, Scientists	Teachers day lecture on 'Future Perspectives in Agricultural Education' delivered by Dr. T. Mohapatra, DG ICAR, New Delhi.	5th September, 2020
Dr. Chaithra, M.	Training/ Webinar on cocoa production and processing technology.	5th September, 2020
Dr. Arun Kumar Sit, Principal Scientist	Protection of Intellectual Property Rights	Organized by ICAR-CPCRI, Kasaragod-on 5th September, 2020
Dr. A. Joseph Rajkumar Principal Scientist, Dr. Shivaji Hausrao Thube, Dr. R. Thava Prakasa Pandian, Scientist	'Advances in Red Palm Weevil research and Management'.	8th September, 2020
Dr. A. Abdul Haris Dr. K. Nihad	Webinar and Report Release: Organic and Natural Farming in India	Centre for Science and Environment 8th September, 2020
Dr. Chandrika Mohan, Principal Scientist (Agri. Entomology), Kayamkulam, R. Thava Prakash Pandian & Shivaji Hausrao Thube, Scientists, Vittal	Advances in red palm weevil research and management	Don Bosco College of Agriculture, Goa 8th September, 2020
Dr. Vinayaka Hegde, AHD, Crop Protection and Dr. Rajkumar, Scientist (Nematology)	Webinar on "Drone remote sensing in agriculture"	Indian Society of Agrophysics, IARI, New Delhi 9th September, 2020
Dr. Vinayaka Hegde, AHD, Crop Protection	Meeting on international research programme on comparative mycoplasmaology (IRPCM) plant and arthropod mycoplasma (PAM) team on phytoplasma diseases.	IRPCM 9th September, 2020
Dr. A. Joseph Rajkumar, Dr. A. Abdul Haris, Principal Scientists Dr. K.Nihad and Dr. K.M. Anes, Scientists	Virtual International workshop on Drone Remote Sensing in Agriculture	Division of Agro-physics, ICAR-IARI, New Delhi, 9th September, 2020
Dr. A. Joseph Rajkumar, Principal Scientist Dr. Merin Babu, Scientist	Online International Research Programme on Comparative Mycoplasmology (IRPCM)-Plant and Arthropod Mycoplasma (PAM) meeting	IRPCM 9th September, 2020
Dr. T. Sivakumar, SMS	Webinar on " Programmes and Policies of Govt. of India and Kerala for Agri-Entrepreneurs"	MSME, Thrissur 9th September, 2020
Dr. A. Abdul Haris Dr. A. Joseph Rajkumar, Principal Scientists	Online Dr. B.P. Ghildyal memorial lecture delivered by Dr T. Mohapatra, DG, ICAR	Division of Agricultural Physics, IARI, New Delhi 10th September, 2020
Dr. Chaithra, M. Scientist	'Soil survey and Land use planning for realizing sustainable development goals of the united nations'	ICAR-NBSS&LUP, Nagpur 11th September, 2020
Dr. Thamban, C., Principal Scientist (Agrl. Extension)	Handled a session on 'Reorganisation of technology transfer programmes and new approaches' in the online training programme for input dealers of Kozhikode district under the DAESI programme	F.T.C., Kozhikode 14th September, 2020
Dr. A. Abdul Haris, Pr. Scientist	Coconut production technology'Enterprise diversification in coconut sector'	ICAR-CPCRI 14th September, 2020

Name & designation	Title	Organizer & Date
Dr. K. Nihad, Sr. Scientist (Hort.), RS, Kayamkulam	Webinar on"Scientific practices for improving coconut production"	KAU 14th September, 2020
Dr.P.Muralidharan, Head, KVK	Annual Review Meeting of DAMUs of Zone XI (online)	ATARI, Bengaluru on 15th September, 2020
Dr. C. T. Jose, Head I/C	Birth Centenary symposium on contributions of Prof. C. R. Rao in Statistics at ICAR- IASRI, New Delhi	15th September, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Webinar on 'Ozone for Life-35 years of Ozone layer protection'	KSCSTE 16th September, 2020
Dr. Daliyamol, Dr. R. Thava Prakasa Pandian, Scientist	'Advances in Plant Pathology with special reference to diagnosis and management'.	Dr. YSRHU, Andhra Pradesh 16th September, 2020
Dr. S. Kalavathi, Dr. Chandrika Mohan., Principal Scientists	Inaugural function of 'Kalpa Graduate Readiness' program	ICAR-CPCRI, Kasaragod, 17th September, 2020
Dr. Regi J. Thomas Dr. A. Joseph Rajkumar Pr. Scientist Dr. M. Shareefa, Sr. Scientist	Webinar on 'Seedling production of dwarf coconut varieties' for officials from Agriculture Department(Alappuzha)	17th September, 2020
Dr. K.Nihad, Scientist	Coconut based cropping systems	KAU 18 September, 2020
Dr. Anok Uchoi and Dr. L. S. Singh, Scientists	'International Symposium (online) on Food security and the stand of civilization: Agri-Hort-Livestock dynamics in changing global Ecology'	BCKV, India 20 – 21st September, 2020
Dr. R. Thava Prakasa Pandian and Dr. Shivaji Hausrao Thube, Scientists	'Management of Biotic and abiotic stresses in protected Agriculture'	CSKHPKV, Palampur 22 - 24th September, 2020
Dr. Ramesh S.V., Sr. Scientist	Attended the National Oilseed Brainstorming Meet	ICAR-IISR, Indore24th September, 2020
Dr. Alka Gupta, Principal Scientist (Microbiology)	Workshop/Webmeeting on "Commercialization of microbe based technologies"	NBAIM 23rd September, 2020
Dr. Ramesh S.V., Sr. Scientist (Biotechnology.)	Two day " Oilseed Brainstorming Meet " on research, industry and developmental challenges	ICAR - IISR, Indore 23 – 25th September, 2020
Dr. S. Kalavathi, Acting Head, Dr. Chandrika Mohan, Pr. Scientist and Dr. Merin Babu, Scientist	Webinar on Advances in Coconut Health Management	ADA-Idukki 24th September, 2020
Dr. A. Abdul Haris, Pr. Scientist	Scientific management practices in coconut cultivation to enhance productivity	CPCRI, RS, Kayamkulam 24 September, 2020
Dr. S. Elain Apshara, Principal Scientist, Dr. Priya, U.K. and Dr. Chaithra, M., Scientists	Farm Bills 2020: Understanding the Implications	ICAR-IARI 26th September, 2020
Dr. P. Muralidharan, Head, KVK and Sri M.S. Rajeev, SMS	Meeting of the "District Monitoring Committee (D-MC) of FPOs" chaired by the District Collector (Online)	NABARD, Alappuzha 26th September, 2020
Dr. S. Indhuja, Scientist	'Sasyangalude Poshaka labhyathakku Mithrasookshmaanukkal' Webinar Series 'Krishiyum Sookshmaanukkalum'	Dept. of Microbiology, College of Agriculture, Vellayani 25th September, 2020
Dr. A. Abdul Haris, Pr. Scientist	Scientific management in coconut for improving productivity Online training by Kerala (Krishi Padashala-26) as FB live programme	SAMETI, 28th September, 2020

Name & designation	Title	Organizer & Date
Dr. K. Sajnanath, SMS	2nd National (web) Conference on "Advances in Sustainable Agriculture"	Society of Krishi Vigyan, Kolkata 26 – 28th September, 2020
Dr. Ramesh S.V., Sr. Scientist	International Webinar on Phytochemistry-2020	University of Kerala, Karyavattom, Thiruvananthapuram 28-29th September, 2020
Dr. Chandrika Mohan, Pr. Scientist	Pest Management in Coconut Online Face book live webinar for Krishi padasala	SAMETI 29th September, 2020
Dr. K.Nihad, Scientist	Commercial floriculture in coconut gardens FB live; (Krishi Padashala-38)	RATTC, Kazhakkoottam 30th September, 2020
Dr. S. Ravi, SMS	International e-workshop on "Reproductive diagnostic techniques for bovine infertility"	TANUVAS, Chennai 29 – 30th September, 2020
Dr. Anok Uchoi, and Dr. L. S. Singh, Scientists	International Webinar on Soil Spectroscopy: An emerging technique for rapid soil health assessment	ICAR-Indian Institute of Soil Science, Bhopal and World Agroforestry (ICRAF), Nairobi 1st October, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Dragonflies and Damselflies : Ace acrobats and wafting damsels on stamps	Indian Dragonfly Society 02nd October, 2020
Dr. S. Jayasekhar, Sr. Scientist	Webinar series on Transforming Indian agriculture-Role of policies and reforms	Department of Agri. Economics, College of Agriculture, Vellayani 5th October 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Biopesticides - Registration and Quality Control Issues-Way forward	ICAR-NBAIR, Bengaluru 06th October, 2020
Dr. Arun Kumar Sit, Principal Scientist	ICAR Regional Committee II Meeting	Organized by ICAR- NRRI, 08th October, 2020
Dr. L. S. Singh, Scientist	International Webinar on Food Insecurity under Mountain Specificities	North-Eastern Hill University, Tura campus 9th October, 2020
Dr. Vinayaka Hegde, AHD, Crop Protection, Dr. Rajkumar, Dr. Prathibha V.H, Dr. Daliyamol, Scientist	International E - Conference on " Multidisciplinary approaches for plant disease management for achieving sustainability in agriculture	Department of Plant Pathology, College of Horticulture (UHS, Bagalakot), 6 – 9th October, 2020
Dr. M.R. Manikantan, Principal Scientist, Dr. R. Pandiselvam, Scientist,	"National conference on Agricultual Scientific Tamil" (Virtual)	TNAU 9 – 10th October, 2020
Dr. Ravi Bhat, Pr. Scientist Act. Head, Crop Production	Climate-Smart Agriculture:Opportunities and challenges	NIT, Karnataka jointly with Hiroshima University, Japan and Tata Institute of Social Science, Hyderabad 23 – 27th October, 2020
Dr. K. Nihad and Dr. A. Abdul Haris	International Workshop on Climate Smart Agriculture	NIT Suratkal 23-27th October, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	International Zoobinar on 'Recent Trends in Biodiversity Conservation'	Mary Matha College of Arts & Sciences, Mannathavady 26-28th October, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	International Webinar on on 'Harnessing the Potential of Tropical Tuber Crops under Changing Climate (HPTTC 2020)	ICAR-CTCRI, Thiruvananthapuram 27th October, 2020

Name & designation	Title	Organizer & Date
Dr. A. Josephrajkumar, Principal Scientist	three days International Webinar on "Recent Trends in Biodiversity Conservation"	Mary Matha Arts & Science College, Mananthavady, Wayanad 28th October, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Webinar on Agrochemicals sponsored by FICCI	FICCI, New Delhi, 05th November, 2020
Dr. A. Joseph Rajkumar and Dr. Regi J. Thomas, Principal Scientist	Foundation Day lecture by Dr. T. Mohapatra, Director General, ICAR	IAHS, New Delhi 06th November, 2020
Smt. Shobha K., CTO (Library)	Webinar on J-gate@CeRa user orientation programme	ICAR-DKMA 09th November, 2020
Dr. Ramesh S.V., Sr. Scientist	National Virtual Conference on 'Current Trends and Challenges in Plant Biochemistry and Biotechnology'	Society for Plant Biochemistry and Biotechnology (SPBB), New Delhi & BITS, Pilani 20-21st November 2020
Dr. M. Shareefa, Scientist (Hort. Science), RS Kayamkulam Dr. S. Elain Apshara , Pr. Scientist (Horticulture) & Dr. N R Nagaraja, Scientist	International E-Conference on "Advances and Future Outlook in Biotechnology and Crop Improvement for Sustainable Productivity"	UHS, Bagalkot 24 – 27th, November 2020
Dr. Ramesh S.V., Sr. Scientist	International Electronic Conference on Plant Sciences (IECPS-2020)	Multidisciplinary Digital Publishing Institute (MDPI), Basel, Switzerland 01-15th December, 2020
Dr. Shivaji Hausrao Thube, Scientist (Entamology), CPCRI, RS, Vittal	International Virtual conference on "Biodiversity and Ecosystem Services in a Climate Change Perspective (IVCBES)2020	Environmental Management and Policy Research Institute (EMPRI),Bengaluru, Karnataka 10 – 11th December, 2020
Dr. Arun Kumar Sit, Principal Scientist	Buyer Seller Meet for Spices of Sikkim and North Bengal region	Organized by Spice Board, Regional Station, Gangtok 11th December, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Recent Advances in Agricultural Forestry and Medical Entomology in India	ERI, Chennai, 15th December, 2020
Dr. S. Jayasekhar, Principal Scientist	28th AERA Annual Conference	16-17th December, 2020
Dr. Daliyamol, Scientist	National webinar on 'Recent Molecular Approaches for plant disease diagnosis'	Acharya NG Ranga Agricultural University, Andhra Pradesh 17th December 2020
Dr. Alpana Das, Senior Scientist	Webinar on Prospect of Genetic Improvement of Groundnut in the Genomic Era	ICAR-Directorate of Groundnut Research, Gujarat
Dr. A. Joseph Rajkumar, Principal Scientist	Co-chaired the Pest management technical session of AGM-AICRP on cashew on 19-12-2020	ICAR-DCR, Puttur 19th December, 2020
Dr. S. Indhuja, Scientist	Webinar on 'Arbuscular Mycorrhiza-Nutritional and health benefits in plants'	College of Agriculture, Vellayani 21st December, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	Farmer-interaction meet and distribution of PM-KISAN Samman Nidhi by Hon'ble Prime Minister	New Delhi, 25th December, 2020
Dr. A. Joseph Rajkumar, Principal Scientist	National workshop on 'Modern Interventions in Environmental Management'	ICAR-IIAB, Ranchi, 30th December, 2020

XIV. Linkage and Collaborations

International

International Coconut Community (ICC), Jakarta, Indonesia	Cooperation between coconut growing countries, Coconut genetic resources network, International Coconut Gene Bank for South Asia& Middle East and socio-economic collaboration
Coconut Research Institute, Sri Lanka	Resistance breeding programme against Coconut Weligama Wilt disease in Sri Lanka

National

ICAR Institutes

ICAR-CIARI, Port Blair	Coconut genetic resources collection, conservation and utilization
ICAR- Central Institute of Fisheries Technologies (CIFT), Kochi	Food processing R&D collaboration
ICAR- Directorate of Cashew Research, Puttur, Karnataka	Nematological and entomological programmes
ICAR- Indian Institute of Horticultural Research, Bengaluru	Phytoplasma disease related studies, varietal screening, cropping systems, agricultural tools and machinery and horticultural IP related activities
ICAR- Indian Institute Spices Research, Kozhikode	Cropping system studies, Phytophthora diseases in plantation crops
ICAR-Central Tuber Crop Research Institute, Thiruvananthapuram	Cassava and coconut based value added products, intercropping of tuber crops in coconut gardens
ICAR-CIPHET, Ludhiana	Agricultural pre- and post-harvest machinery
ICAR-CRIDA, Hyderabad	Climate change network and NICRA
ICAR-DMR, Solan	Agricultural pre- and post-harvest technology development
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, Cryo-preservation of germplasm
ICAR-NBAII, Bengaluru	Biological control R&D
ICAR-NBAIM, Mau	Microbial research network R&D
ICAR-NRC for Orchids, Pakyong	Technology Mission for the development of North Eastern states, Intercropping of orchids in coconut/ arecanut multispecies based cropping system
ICAR-Sugarcane Breeding Institute (SBI), Coimbatore	Food processing R&D

Others

Agricultural Technology Management Agency (ATMA)	ToT activities
All India Radio (AIR), Kannur, All India Radio (AIR), Thiruvananthapuram, Doordarshan (Prasar Bharati)	Transfer of technology programme through media
Bannari Institute of Technology, Sathyamangalam, Tamil Nadu	Food technology R & D collaboration
Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia, West Bengal	Collaborating centre under AICRP

CAMPCO, Mangalore	Arecanut/ cocoa research and development
Central University of Kerala, Kasaragod, Kerala	R & D collaboration in Biotechnology
Coconut Development Board, Kochi	Research and development in coconut
CSIR-NIIST, Trivandrum	Technology programmes
DBT, New Delhi	Advancements in Biotechnology and Bioinformatics
Department of Agricultural Development and Farmers Welfare, Govt. of Kerala	ToT activities, Plating material production
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	ToT activities
District Panchayath, Kasaragod	ICAR-CPCRI, Kasaragod & KVK, Kasaragod ToT activities
DIT, New Delhi	Bioinformatics programmes
DST, New Delhi	Molecular biology research and women empowerment programmes
General Aeronautics Ltd., Bangaluru	Unmanned Aerial Vehicle (UAV- Drone) for palm spraying
IIFPT, Thanjavur, Tamil Nadu	R & D collaboration in PHT
IIPM, Bengaluru	Technology programmes in plantations management
KCAET, KAU, Tavanur	Technology programmes
Kerala State Council for Science, Technology and Environment, Thiruvananthapuram	R & D collaboration
Kerala State Planning Board	R & D collaboration
KSCSTE, Thiruvananthapuram	Research in biotechnology and bioinformatics
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
PPV & FRA, New Delhi	DUS Centre on coconut, arecanut and cocoa
M/s 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

XV. Research Projects

Institute Funded Projects

Proj. No.	Proj. Title	Project Leader	Associate (s)
1000761028	Genetic resources management in coconut, arecanut and cocoa	V. Niral	S. Elain Apshara, N.R. Nagaraja, K. Samsudeen, A. K. Sit, L.S. Singh, Alpana Das, Sudha R., Ganesh Khadke, Regi Jacob Thomas, M. Sujithra, K.B. Hebbar, S.V. Ramesh, P. Subramanian, Shameena Begum, C. Thamban, Shivaji Hausrao Thube, Chaithra M., Anok Uchoi and B.A. Jerard ICAR-CIARI, Andamans
1000761029	Genetic investigations and breeding in coconut, arecanut and cocoa	Regi Jacob Thomas	K. Samsudeen, V. Niral, S. Elain Apshara, M. Shareefa, A.K. Sit, N.R. Nagaraja, Merin Babu, A. Josephrajkumar, L.S. Singh, Ganesh Khadke, Sudha R., Alpana Das, Sumitha S. S. Sendur Kumaran anda scientist from CIARI
1000761031	Development of tissue culture techniques in coconut	Anitha Karun	M. K. Rajesh, Neema M., Aparna V., Regi Jacob Thomas, Shareefa M., Krishna Prakash
1000761030	Biotechnological applications in palms and cocoa	M.K. Rajesh	Anitha Karun, Neema M., Aparna V., Murali Gopal, Alpana Das and Krishna Prakash
1000761032	Development of double-stranded RNA based food bait for the suppression of red palm weevil	M.K. Rajesh	Josephrajkumar A., Ramesh S.V. and M. Sujithra
1000763057	Cropping/ farming approaches for improving soil health and system productivity in coconut, arecanut and cocoa	P. Subramanian	Ravi Bhat, H. P. Maheshwarappa, V. Selvamani, Alka Gupta, Bhavishya, A. Abdul Haris, K. Nihad, Arun Kumar Sit, S. Neenu, G. Panjavarnam, U. K. Priya and Anok Uchoi
1000763058	Enhancing nutrient and water use efficiency for sustained productivity in coconut, arecanut and cocoa	V. Selvamani	P. Subramanian, H. P. Maheshwarappa, K. Nihad, Ravi Bhat, Neenu S., A. Abdul Haris, Jeena Mathew, U.K. Priya, Alka Gupta, G. Panjavarnam, Indhuja S., A.K. Sit, S. Paul Raj, Anok Uchoi, Merin Babu and P. Anitha Kumari
1000763055	Bioresources management in coconut, arecanut and cocoa	Alka Gupta	Murali Gopal, P. Subramanian, H.P Maheswarappa, Ravi Bhat, Abdul Harris, Elain Apshara, S. Neenu, Selvamani, U.K. Priya, Sandip Shil, S. Indhuja, K. Nihad, Jeena Mathew, Merin Babu, V.H. Prathibha, M. Sujithra and Bhavishya
1000765039	Integrated approaches for management of fungal diseases of palms and cocoa	Vinayaka Hegde	Prathibha V.H. and Thava Prakash Pandian, Chaithra M., Daliyamol, Rajesh M.K., Rajkumar, Ajeet Singh and Dr. L.S. Singh
1000765040	Diagnostics and management of root (wilt) disease (RWD) in coconut and yellow leaf disease (YLD) in arecanut	Vinayaka Hegde	K.B. Hebbar, A. Josephrajkumar, Murali Gopal, Merin Babu, R. Thava Prakash Pandian, S. Indhuja, Daliyamol, M. Chaithra and M.K. Rajesh
1000765041	Integrated management of pests and nematodes in palms and cocoa	Chandrika Mohan	A. Joseph Rajkumar, P.S. Prathibha, Rajkumar, M. Sujithra, Sivaji H. Thube, Jilu V. Sajan, Merin Babu, Anes, K. M, Thava Prakasa Pandian R., Daliyamol, Prathibha V.H. and Ramesh S.V.
1000766014	Phenotyping for climate resilient adaptation and mitigation strategies	K.B. Hebbar	S.V. Ramesh, Ajeet Singh, Elain Apshara, S. Neenu, A.K. Sit, B. Sravanthi and V. Selvaman
1000767018	Mechanization, processing, product diversification and nutraceutical properties	M.R. Manikantan	Shameena Beegum, R. Pandiselvam, Ajeet Singh, Murali Gopal, S. Paul Raj, S.V. Ramesh and K.B. Hebbar
1000767022	Development of continuous type coconut testa removing machine	R. Pandiselvam	M.R. Manikantan, A.C. Mathew and Shameena Beegum

Proj. No.	Proj. Title	Project Leader	Associate (s)
1000767023	Development of process technology for minimal processing of mature coconut kernel and its value added products	Shameena Beegum	M.R. Manikantan and R. Pandiselvam
1000769020	Technology transfer and co-learning action research approaches	C. Thamban	S. Kalavathi, P. Anithakumari, C.T. Jose, K. Muralidharan, Chandran, K.P., S. Jayasekhar, Alpana Das, N.R. Nagaraja, Abdul Haris, A.K. Sit, P. Subramanian, Sujihtra M. , Rajkumar, S. Paulraj, K. Nihad, Chaitra, M., Elain Apshara, Sandip Shil
1000769013	Socio-economic dimensions and value chain dynamics in policy perspective	S. Jayasekhar	Chandran K.P., Thamban C., Muralidharan K., Jose C.T, Sandip Shil
1000769019	Development of Statistical and Computational Techniques for Improving Research Methodology	Jose C.T.	Muralidharan. K., Chandran .K.P, Sandip Shil, Shivaji H. Thube, Thavaprakash Pandian and Jayasekhar S.
1000769022	Crop – weather modelling and methodological evaluation of crop insurance in plantation crops	Chandran. K. P.	Jose C.T., Muralidharan K., Sandip Shil and Jayasekhar S.
1000769023	Adaptation deficit analysis and resilience strategies to climate change in coastal coconut agro-ecosystems	Kalavathi S.	A.Abdul Haris, Chandrika Mohan, C.Thamban, Murali Gopal, Regi Jacob Thomas, Chandran. K.P., Anes, K.M. and Jeena Mathew

Externally Funded Projects

Proj. No.	Proj. Title	Project Leader	Associate (s)
1050761086	DUS Centre for coconut	V. Niral	K. Samsudeen
1050761114	Development of DUS testing criteria and establishment of genebank for arecanut	Nagaraja N.R.	A.K. Sit and L.S. Singh
1050761115	Development of DUS testing criteria and establishment of genebank for cocoa	S. Elain Apshara	-
2010760004	Seed Production in Coconut, Arecanut, Cocoa (Under ICAR Project on Seed Production in Agricultural Crops)	K. Samsudeen	V. Niral, S. Elain Apshara, N.R. Nagaraja, Regi Jacob Thomas, M. Shareefa, Anes K.M., Ganesh N. Khadke, Sudha R., A K Sit and L.S. Singh
1050761107	Large-scale production of elite and hybrid seedlings of coconut for the root (wilt) disease prevalent tract	Regi Jacob Thomas	M. Shareefa, V. Niral, Ganesh N. Khadke, V.V. Shinde (ARS, Ratnagiri), V. Sivakumar (CRS, Aliyarnagar) and B. V. K. Bhagawan, (HRS, Ambajipeta)
1050761121	Production and distribution of Dwarf/ semi tall varieties of quality planting materials	V. Niral	C. Thamban, K. Samsudeen and Regi Jacob Thomas
1050761122	Technology support for coconut hybridization/production of semi tall varieties	K. Samsudeen/ Regi Jacob Thomas	C. Thamban, M.K. Rajesh
1050231012	Development of a database for plantation crops for biologists	M.K. Rajesh	Anitha Karun, K. Muralidharan and K.P. Chandran
1050761127	Commercial production of arecanut – tissue culture of planting material of yellow leaf disease resistant palms and dwarf hybrids	Anitha Karun	M.K. Rajesh, R. Thava Prakasa Pandian, Neema M. and Krishna Prakash
1050761138	Participatory Demonstration Plots of Cinnamon intercropping in coconut	Ravi Bhat	P. Subramanian

Proj. No.	Proj. Title	Project Leader	Associate (s)
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.,Daliyamol and Prathibha P.S.
1050761128	Pest and disease surveillance on coconut palms by unmanned aerial vehicle	Vinayaka Hegde	A. Josephrajkumar Chandrika Mohan, Prathibha P.S., Prathibha V.H., Rajkumar, Merin Babu, Daliyamol, Anes K.M., Abhishek Burman
1050761139	Establishment of FLDs on arecanut root diseases management using mandipropamid fungicide	Prathibha V.H.	
1050761126	Detection system for red palm weevil infesting coconut	A. Joseph Rajkumar	Chandrika Mohan
1050761105	Demonstration of EPN in arecanut for the management of root grub	Rajkumar	Nagaraja N.R. and Shivaji Hausrao Thube
1050761120	Design, development and field demonstration of an airblast sprayer for coconut	Mathew A.C.	R. Pandiselvam
1050761108	Consortium Research Platform (CRP) on farm mechanization and precision farming	L.S. Singh	-
1050761117	Participatory technology integration to empower and ensure livelihood security of farmers in Alappuzha district	Anitha Karun (PI), P. Anithakumari	Joseph Rajkumar, Nihad .K, Shareefa M, Jeena Mathew, Indhuja S., Merin Babu, Anes K.M. and S. Jayasekhar
1050761123	Technology support for plant protection campaign against pest and diseases of coconut	Chandrika Mohan/ S. Kalavathy	A. Josephrajkumar, Thamban C., A. Abdul Haris andAnes K.M.
2010760007	Intellectual property management and transfer/ commercialization of agricultural technology scheme	K. Muralidharan	M.R. Manikantan and A.C. Mathew
1050761110	Establishment of Agri-Business Incubation (ABI) Center at ICAR-CPCRI, Kasaragod	Muralidharan K.	Mathew A.C., Manikantan M.R., Pandiselvam R., S. Jayasekhar, Murali Gopal, Shameena Beegum
1050761124	Geo-spatial variability in Kerala- an analysis of extent and determinants	C. Thamban	K.P. Chandran, S. Kalavathi and S. Jayasekhar
1050761129	Demonstration of Effective and Eco-friendly management of white grubs using Entomopathogenic nematodes in arecanut	Rajkumar	
1050761130	Participatory rejuvenation and refinement of coconut based homestead system models for food security and income	Anithakumari P.	Joseph Rajkumar A., Indhuja S., and Shareefa M.
1050761133	Design, Fabrication and Field Demonstration of a Neera (Kalparasa®) Collection Device	K.B. Hebbar	Mathew A.C.
1050761134	Design, Fabrication and Standardizing The Process Parameters of a Portable Biochar Unit for Tender Coconut Husk	A.C. Mathew	Murali Gopal, M.R. Manikantan, R. Pandiselvam
1050761132	High Pressure Processing to improve the shelf life of Neera (Kalparasa®), tender nut water and coconut milk	K.B. Hebbar	

Proj. No.	Proj. Title	Project Leader	Associate (s)
1050761131	Entrepreneurship Development Through Farmer Led Innovations – Study in Plantation Crops	T.S. Manojkumar	S. Jayasekhar and Sandip Shil
1050761135	Establishing Demonstration Plots on Arecanut Based Multispecies Cropping System	N.R. Nagaraja	C. T. Jose, Rajkumar and U.K. Priya
1050761136	Establishing Demonstration Plots on Arecanut Dwarf Hybrids	N.R. Nagaraja	C. T. Jose
1050761137	Farmer Producer Organization with ICAR-CPCRI as Producer Organization Promoting Institution (POPI)	P. Anithakumari	-

XVI. Research and Organisational Management

Quinquennial Review Team (QRT) visits

A meeting of the QRT for the period 2014-20 was held on online and offline mode. Prof. Dr. B.M.C. Reddy, Former Director, IIHR & Former VC, Dr. YSRHU. Other honourable members of QRT as below were present:

1. Dr. M.G. Bhat, Former Director, DCR, Puttur,
2. Dr. H. Hameed Khan, Former PC, AICRP on Palms,
3. Dr. S. Lingaraju, Emeritus Professor, Former Director, Institute of Organic Farming
4. Dr. John Zachariah, Former Head, ICAR-IISR, Kozhikode
5. Dr. S. Arulraj, Former Director, ICAR-IIOPR, Pedavegi, and
6. Dr. H. P. Maheshwarappa, Project Coordinator, AICRP Palms (Member Secretary).

The members visited ICAR-CPCRI, Kasaragod, Regional Station, Vittal and ICAR-CPCRI, Research Centre, Kidu during 27th December, 2020 to 31st December 2020.On 21-12-2020, Dr. John Zachariah, and Dr. H.P. Maheswarappa, visited ICAR-CPCRI, Regional Station, Kayamkulam.

Research Advisory Committee Meeting

The 22nd Research Advisory Committee (RAC) meeting of ICAR-CPCRI was held on 5th May 2020 through videoconferencing under the chairmanship of Dr. S.P. Ghosh, former DDG (Hort.). Dr. Abraham Verghese, Former Director, NBAIR, Bengaluru, Dr. B.S. Hansra, Former ADG (Extension), Noida, Uttara Pradesh, Dr. K.V. Bhat, Former Principal Scientist, ICAR-NBPGR, New Delhi and Dr. B.K. Pandey, Principal Scientist, ICAR (Nominee of ADG (HS-II)), were present during the online RAC meeting.

Dr. Anitha Karun, Director (Acting), ICAR-CPCRI hosted the meeting from ICAR-CPCRI, Kasaragod and. The Director has presented various R&D activities and achievements made by the Institute in the R&D sector. Dr. Ravi Bhat, Principal Scientist, Member Secretary, RAC and Dr. H.P. Maheswarappa, Project Coordinator (Palms), Heads of Divisions, programme leaders and other scientists of ICAR-CPCRI attended the meeting over online. These also include ICAR-CPCRI Kasaragod, ICAR-CPCRI, Regional Station, Kayamkulam, Kerala, ICAR-CPCRI, Regional Station, Vittal, Karnataka, ICAR-CPCRI, Research Centre, Kahikuchi, Assam, ICAR-CPCRI, Research Centre, Mohitnagar, West Bengal and ICAR-CPCRI, Research Centre, Kidu, Karnataka. Heads of ICAR-KVK, Kasaragod and Alappuzha also attended the meeting.The meeting came to an end with the vote of thanks by Member Secretary, RAC. The deliberations during the meeting have led to the emergence of RAC recommendations which was later approved by the Council.

Institute Research Committee Meeting

The 48th Institute Research Committee (IRC) meeting of ICAR-CPCRI was held from 27th April to 2nd May 2020 for the first time through videoconferencing under the chairmanship of Dr. Anitha Karun, Acting Director, ICAR-CPCRI, Kasaragod at ICAR-CPCRI, Kasaragod. She inaugurated the meeting with her opening remarks on 27th April 2020. Project Coordinator (Palms), Heads of Divisions, programme leaders and other scientists of ICAR-CPCRI attended the meeting from different locations including ICAR-CPCRI Kasaragod, ICAR-CPCRI, Regional Station, Kayamkulam, Kerala, ICAR-CPCRI, Regional Station, Vittal, Karnataka, ICAR-CPCRI, Research Centre, Kahikuchi, Assam, ICAR-CPCRI, Research Centre, Mohitnagar, West Bengal, ICAR-CPCRI, Research Centre, Kidu, Karnataka. Heads of ICAR-KVK, Kasaragod and Alleppey also attended the meeting.

Presentation of work done report on various projects under ICAR-CPCRI including externally funded projects was made by the scientists. The Plenary Session was held on 2nd May 2020, was attended by Dr. Abraham Verghese, Former Director, NBAIR, Bengaluru, Dr. B.S. Hansra, Former ADG (Extension), Noida, Uttara Pradesh, Members of RAC, Dr. B.K. Pandey, ADG (HS-II), Dr. C.N. Ravishankar, Director, ICAR-CIFT, Kochi, Dr. Nirmal Babu, IISR, Kozhikode, Dr. V. Ravi, Director ICAR-CTCRI, Thiruvananthapuram, Dr. Uma S., Director, ICAR-NRCB, Trichy, Dr. Homey Cheriyan, Director, DASD, Kozhikode, Dr. Sujatha, Director, Coconut Mission, KAU, Padannakkad and about twelve farmers from Kerala, Karnataka, Tamil Nadu and Telangana. During the meeting, project-wise reports, action taken on previous RAC recommendations, the proposed technical programmes were presented. The Technical Programmes for 2020-21was finalised by incorporating the 22nd RAC recommendations.

XVII. Intellectual Property and Technology Management

Patent Granted

A patent (Indian patent number 354729) has been granted to ICAR-CPCRI and JNCASR, Bengaluru for 'A composition, device or a trap and method thereof', concerned with controlled pheromone delivery nanomatrix for protection of crops from insect pests.

Patent Applications Filed

Two patent applications were filed from the institute at Patent Office online. One application on 'Process protocol for foam mat dried coconut milk powder using sodium caseinate, maltodextrin and carboxymethylcellulose' was filed on 26th June 2020 (TEMP/E-1/29398/2020) by ShameenaBeegum, P.P., Manikantan, M.R., Pandiselvam, R., Paulraj,S. Another was on 'Linear Actuator based Minimal Processing Machine for Tender Coconut' (TEMP/E-1/30543/2020-CHE on 30 June 2020) by Pandiselvam, R., Manikantan, M.R. Mathew, A.C., ShameenaBeegum, P.P.

Consultancy services

Various consultancy services and contract research projects were taken up as part of the Professional Service Functions of the institute during 2020-21 as per the following details.

Sl.No.	Date	Consultancy service	Client	Amount (Rs)
1	09.07.2020	Analysis of organic manure	Rajapuram Agri. Improvement Co-op. Society Ltd, Rajapuram 671532	3600.00
2.	28.10.2020	Analysis of bone meal sample	Agri. Officer , Krishi Bhavan, Muliyar-671542	1250.00
3.	13.12.2020	Analysis of soil and compost samples.	Dr. Ajith Waman, Scientist, Div. Hort. & Forestry, ICAR-CIARI, Port Blair-744101	20000.00
4.	21.11.2020	Analysis of organic manure from organic waste converter	Canopu Apartments, Urwa, Mangalore	2750.00
5	21.11.2020	Analysis of organic manure from organic waste converter	The City Centre Mall, KS Rao Road, Hampankatta, Mangalore 575001	2750.00
6.	08.01.2021	Analysis of organic manure from organic waste converter	Fernhill Apartments, Nanthoor, Mangalore	2750.00
7.	08.02.2021	Analytical charges- NPK average Carbone pH, EC	The City Centre Mall Owners Association, KS Rao Road, Mangalore	2750.00
		Total		**35850.00**

Sale of planting materials and other technology products

During the year, planting materials and other items worth Rs. 2,07,46,608 were sold through ATIC as per the following details.

Sl.No.	Item	Qty/No.	Amount (Rs.)
1	Publications	5	170
2.	Coconut seedlings (Hybrid)	15,664	39,16,000
3.	Coconut seedlings (Dwarf)	20,864	40,37,460
4.	Coconut seedlings (WCT)	19,038	20,94,180
5.	OP/varieties Coconut seedlings	4,606	5,06,660
6.	Polybag coconut seedlings	1,119	2,16,880
7.	Coconut seed nuts (Dwarf)	2,430	2,91,600
8.	Coconut seed nuts (Tall)	5,673	3,97,110
9.	Arecanut seed nuts	3,71,757	37,17,570
10.	Arecanut seedlings	1,48,665	47,40,145
11.	Arecanut seedlings (Hybrids)	2,083	3,33,280
12.	Cocoa seedlings	14,516	1,45,160
13.	Cocoa seed pods	8,643	2,59,290

Sl.No.	Item	Qty/No.	Amount (Rs.)
14.	Earthworms	6200	4,464
15.	Vermicompost	3189	54,935
16.	Vermiwash	3	300
17.	*Trichoderma*	52	5,200
18.	Kera Probio	107	2,675
19.	EPN (Aqua/cadaver) formulations	1011	32840
		Total	**2,07,55,919**

Commercialization of Technology

Sl. No.	Name of Technology Commercialized	Date of Signing MOU	Value (In INR)	Licensee
1	Tender Coconut Trimming Machine	05-01-2020	10,000	M/s Stonehat Technologies, No.62C-1, Siruvani Main Road (East), Vadavalli, Coimbatore – 41, Tamil Nadu, India.
2	Operation of the marketing incubation facility	05-01-2020	-	District Mission Co-Ordinator, Kudumbashree, Civil Station, Vidyanagar Post, Kasaragod – 671123.
3	Incubation facility of VCO	05-01-2020	-	M/s Panchamala Agro & Horticulture Farmers Producer Company Ltd., No VII/214, Chandrabavan, Padimarud P.O Anandashram, Kasaragod, Kerala - 671531
4	Kalpa Soil Care	10-03-2020	25,000	Mr. Anantharao M, Banana Biotech Pvt Ltd., H. No 10_96, Bommakal village, Karimnagar District, Telangana State.
5	Virgin Coconut Oil – Incubation facility	09-06-2020	2,000	Mr. Jayaraj P, Gokulam, Near O V Gardens, Trichambaram, Taliparamba, Kannur – 670141, Kerala.
6	Collection of fresh and hygienic Palm Neera / Kalparasa and production of PalmNeera / Kalparasa based value added products	23-07-2020	1,00,000	J. Harikishan, Asst. Secretary (Hqrs), Office of Commissioner, on behalf of Prohibition & Excise Department, Govt. of Telangana, Prohibition & Excise Complex (AbkariBhavan), Opp: Exhibition Grounds, Besides Gandhi Bhavan Metro Station, Nampally, Hyderabad – 500001, India.
7	Kalpavardhini	23-07-2020	10,000	Odanadu Farmer Producer Company Ltd (Reg. No. U01110KL2019PTC060976) represented by Representative of Board of Directors (OFPC Ltd), FPO
8	Aqua formulation of EPN Kalpa EPN (CPCRI- SC1) Technology.	27-07-2020	5,000	Mr. Sandeep Bhat, Kanchigadde village, SirsiTaluk, Uttarakannada District of Karnataka.
9	Matured coconut water based value added products	14-08-2020	15,000	JK farms, Near milk society, Bela village, Nirchal post, PIN - 671321, Kasaragod – Dist
10	Coconut Chips	15-09-2020	25,000	Mrs. KavithaPandiyammal B, No.1, Golden Nagar, TelungupalayamPudur, Coimbatore – 641039, Tamil Nadu, India.
11	Aqua formulation of EPN Kalpa EPN (CPCRI-SC1)	30-09-2020	5,000	Mr. Manjunatha K.S., Hadonahalli village, ShivamogaTaluk, Karnataka, PIN – 577216, India.
12	Kalpa Organic Gold (coconut leaf vermicomposting)	30-09-2020	20,000	Mr. M.T. Pradeep Kumar, Deepthi Eco Store, J T Road, Vadakara, Kozhikode – 673101, Kerala,
13	Matured coconut water based value added products	03-11-2020	15,000	Secretary, Chemperi Regional Coconut Growers Co-operative Society Ltd. No. C 1901 (CHECOPS), Chemperi P.O., Kannur District, PIN – 670632.
14	Trichoderma Coir Pith Cake	05-11-2020	5,000	Mr. Manjunatha K.S., Hadonahalli village, ShivamogaTaluk, Karnataka District, PIN – 577216, India.

Sl. No.	Name of Technology Commercialized	Date of Signing MOU	Value (In INR)	Licensee
15	Know-How on utilization of *Metarhiziumanisopliae* culture	31-12-2020	5,000	Dr. Mallikarjuna BG, CEO & Scientist, PromagicellLifetech (OPC) Private Limited, RakshamAgri Solutions, #10, 5th Phase, KHB Colony, CMC ward, Near ZP, Opposite to Pavitravana, KM Road, Chikmagalur- 577102, Karnataka
16	*Trichodermaharzianum* (CPTD – 28) culture	31-12-2020	5,000	-do-
17	Technical knowhow of production of virgin coconut oil	31-12-2020	40,000	K. Ramesh Kamath, Proprietor, Sri Vinayaka Virgin Coconut Oil and Other Products Industries, Yedthadi, Barkur, Udupidist, Karnataka, 576210
Total			**2,87,000**	

Exchange of MoAs for transfer of technology know-how

Business Incubation

Virgin Coconut Oil – Incubation facility has been lent to Mr. Jayaraj P., Trichambaram, Taliparamba, Kannur, Kerala, with effect from 9 June 2020 for one year. An amount of Rs. 2,000 has been collected as fees.

XVIII. Managerial Personnel

Dr. (Smt.) Anitha Karun	Director (Acting)
Dr. K. Muralidharan	HoD (Social Science)(Acting)
Dr. K.B. Hebbar	HoD (PB & PHT) (Acting)
Dr. H.P. Maheswarappa	Project Coordinator (Palms) (Acting)
Dr. Ravi Bhat	HoD (Crop Production) (Acting)
Dr. Vinayaka Hegde	HoD (Crop Protection) (Acting)
Dr. C.T. Jose	Head RS, Vittal (Acting) (Agril. Stati.)
Dr. (Smt.) S. Kalavathy	Head RS, Kayamkulam (Acting) (Ag.Extension)
Dr. Manojkumar T.S.	Principal Scientist & Head, KVK
Dr. Muralidharan P.	Principal Scientist &Head, KVK
Sri G.S. Hareesh Nair	Chief Administrative Officer
Sri Ram Avtar Parashar	Senior Finance and Accounts Officer
Sri T.E. Janardhanan	Administrative Officer

LIST OF PERSONNEL

SCIENTIFIC STAFF

Sl. No.	Name	Designation
KASARAGOD		
1	Dr. (Mrs.) Anitha Karun	Director (Acting)
2	Dr. K. Muralidharan	HoD, (Social Science)(Acting)
3	Dr. K.B. Hebbar	HoD (PB & PHT) (Acting)
4	Dr. H.P. Maheswarappa	Project Coordinator (Palms) (Acting)
5	Dr. Ravi Bhat	HoD (Crop Production) (Acting)
6	Dr. Vinayaka Hegde	HoD (Crop Protection) (Acting)
7	Dr. (Mrs.) Alka Gupta	Principal Scientist(Agril. Microbiology)
8	Dr. P. Subramanian	Principal Scientist (Agronomy)
9	Dr. C. Thamban	Principal Scientist (Agril. Extension)
10	Dr. Murali Gopal	Principal Scientist(Agril. Microbiology)
11	Dr. A.C. Mathew	Principal Scientist (Soil&Water Conservation Engg.)
12	Dr. (Mrs.) V. Niral	Principal Scientist (Genetics)
13	Dr. K. Samsudeen	Principal Scientist (Economic Botany)
14	Dr. M.K. Rajesh	Principal Scientist (Agril. Biotechnology)
15	Dr. M.R. Manikantan	Principal Scientist (Agril. Process Engg.)
16	Dr. K.P. Chandran	Principal Scientist (Agril. Statistics)
17	Dr. S. Jayasekhar	Senior Scientist (Agril. Economics)
18	Dr. Selvamani V.	Senior Scientist (Soil Science)
19	Dr. S. Paulraj	Senior Scientist (Agril. Microbiology)
20	Dr. (Mrs.) R. Sudha	Senior Scientist (Fruit Science)
21	Dr. (Mrs.) Neenu S.	Senior Scientist (Soil Science)
22	Dr. Ramesh S.V.	Senior Scientist (Agril. Biotechnology)
23	Dr. (Mrs.) V.H. Prathibha	Scientist (Plant Pathology)
24	Dr. (Mrs.) Pratibha P.S.	Scientist (Agril. Entomology)
25	Dr. Rajkumar	Scientist (Nematology)
26	Mrs. Surekha	Scientist (Agronomy)
27	Dr. (Mrs.) M. Sujithra	Scientist (Agril. Entomology)
28	Dr.(Mrs.) Neema M.	Scientist (SPM&AP)
29	Dr. (Mrs.) Shameena Begum P.P.	Scientist (SPM&AP)
30	Dr. (Mrs.). Sumitha S.	Scientist (SPM & AP)
31	Dr. (Mrs.) Aparna Veluru	Scientist (SPM&AP)
32	Dr. (Mrs) G. Panjavarnam	Scientist (Fruit Science)
33	Dr. (Mrs) Jilu V. Sajan	Scientist (Agril. Entomology)
34	Dr. R. Pandiselvam	Scientist (Agril. Process Engg.)
35	Mrs. Bandela Sravanthi	Scientist (SPM&AP)
36	Mrs. Ranjini T.N.	Scientist (SPM&AP)

Sl. No.	Name	Designation
37	Dr. (Mrs.) Daliyamol	Scientist (Plant Pathology)
38	Dr. Krishna Prakash	Scientist (SPM & AP) (up to 16.06.2020)
39	Dr. Ajeet Singh	Scientist (Biochemistry) (up to 10.08.2020)
KVK, CPCRI, KASARAGOD		
1	Dr. Manojkumar T.S.	Principal Scientist &Head, KVK
Kayamkulam		
1	Dr. (Mrs.) S. Kalavathy	Head (Acting) (Ag. Extension)
2	Dr. (Mrs.) Chandrika Mohan	Principal Scientist (Ag. Entomology)
3	Dr. (Mrs.). P. Anitha Kumari	Principal Scientist (Ag. Extension)
4	Dr. Regi Jacob Thomas	Principal Scientist (Hort.)
5	Dr. Abdul Haris	Principal Scientist (Agronomy)
6	Dr. Joseph Rajkumar A.	Principal Scientist (Ag. Entomology)
7	Dr. (Mrs.) Nihad K.	Senior Scientist (Hort.)
8	Dr. (Mrs.) Shareefa M.	Senior Scientist (Hort.)
9	Dr. (Mrs.) Jeena Mathew	Scientist (Soil Science)
10	Dr. (Mrs.) Merin Babu	Scientist (Plant Pathology)
11	Dr. (Mrs.) Indhuja S.	Scientist (Agril. Microbiology)
12	Dr. Anes K.M.	Scientist (Agril. Nematology)
KVK, CPCRI, RS, Kayamkulam		
	Dr. Muralidharan P.	Principal Scientist &Head, KVK
Vittal		
1	Dr. C.T. Jose	Head (Acting) (Agril. Stati.)
2	Dr. S. Elain Apshara	Principal Scientist(Hort-Fruit Science)
3	Dr. M. Senthil Amudhan	Senior Scientist (Biochemistry) (expired on 24.07.2020)
4	Dr. N.R. Nagaraja	Scientist (Plant Breeding)
5	Dr. Chaithra M.	Scientist (Plant Pathology)
6	Dr. (Mrs.) Priya U.K.	Scientist (Soil Science)
7	Sri Bhavishya	Scientist (SPM&AP)
8	Dr. Shivaji Hausrao Thube	Scientist (Agril. Entomology)
9	Ms. Suchithra M.	Scientist (SP M&AP)
10	Mrs. Saneera E.K.	Scientist (Agril. Entomology)
11	Dr. Thava Prakash Pandian R.	Scientist (Plant Pathology)
Kidu		
1	Dr. Khadke Ganesh Navanath	Scientist (SPM & AP)
2	Sri Diwakar Y.	Scientist (SPM & AP)
Mohitnagar		
1	Dr. Arunkumar Sit	Principal Scientist (Hort.)& Scientist In-charge
2	Dr. SandipShil	Scientist (Agril. Statistics)

Sl. No.	Name	Designation
Kahikuchi		
1	Dr. (Mrs.) Alpana Das	Principal Scientist (Agril. Biotechnology) & Scientist In-charge
2	Dr. Anok Uchoi	Scientist (SPM&AP)
3	Dr. Leichombam Singhajit Singh	Scientist (SPM&AP)

TECHNICAL STAFF

Sl. No.	Name	Designation
KASARAGOD		
1	Sri H. Muralikrishna	Chief Technical Officer (Technical Information)
2	Sri John George	Chief Technical Officer (Lab) (up to 30.09.2020)
3	Sri A. Sebastian George	Chief Technical Officer (Lab)
4	Smt. K. Shobha	Chief Technical Officer (Library)
5	Sri. K. Devadas	Assistant ChiefTechnical Officer (F/F) (up to 31.10.2020)
6	Sri K. Shyama Prasad	Assistant ChiefTechnical Officer (F/F)
7	Smt. Sugatha Padmanabhan	Assistant ChiefTechnical Officer (Lab)
8	Sri P. Ravindran	Assistant Chief Technical Officer (F/F)
9	Smt. K. Sreelatha	Assistant Chief Technical Officer (Official Language)
10	Sri G.S. Hareesh	Technical Officer (Instrumentation Engineering)
11	Sri M.P. Rajendran Nair	Technical Officer (Mechanical Engineering)
12	Sri K. Ajith Kumar	Technical Officer (Civil Engineering)
13	Sri V.K. Gopalakrishnan	Technical Officer (Civil Engineering)
14	Sri S. Manohara	Technical Officer (Vehicles)
15	Sri K. Krishnan Nair	Technical Officer (F/F)
16	Sri K.N. Radhakrishnan Nambiar	Technical Officer (F/F)
17	Sri V. Balakrishnan	Technical Officer (F/F)
18	Sri V. Suresh Kumar	Technical Officer (F/F) (up to 31.05.2020)
19	Sri Devaraj K.	Senior Technical Assistant (Junior Engineer)
20	Sri K.N. Pankajakshan	Senior Technical Assistant (Vehicles)
21	Dr. Muralikrishna K.S.	Senior Technical Assistant
22	Smt. Jesmi Vijayan	Senior Technical Assistant (up to 03.07.2020)
23	Sri A. Sanjeeva	Technical Assistant (up to 30.11.2020)
24	Sri M.V. Sreedharan	Senior Technical Assistant
25	Sri K. Panduranga	Technical Assistant (F/F)
26	Sri K. Raghavan	Technical Assistant (F/F)
27	Sri Arunji G.	Technical Assistant (Library)
28	Sri A.V. Satheesh Kumar	Technical Assistant (Vehicles)
29	Sri Bhavani Sankar Naik	Senior Technician (F/F)
30	Sri A.O. Varghese	Senior Technician (F/F)
31	Sri A. Divakaran	Senior Technician (F/F)
32	Sri A.R. Padmanabha Naik	Senior Technician(F/F)
33	Sri K.J. Sebastian	Senior Technician (F/F)

Sl. No.	Name	Designation
34	Sri Sunil S.	Senior Technician (Electrical Engineering)
35	Smt. M. Vimala	Senior Technician (F/F)
36	Sri N. Dinesh Kumar	Senior Technician (F/F)
37	Smt. Ashamol E.P.	Technical Trainee (F/F)
38	Sri Suvith P.S.	Technical Trainee (F/F)
39	Sri Ajith Kumar R.	Technical Trainee (F/F)
40	Sri Premjith Antony	Technical Trainee (F/F)
KVK, Kasaragod		
1	Dr. (Mrs.) Saritha Hegde	Chief Technical Officer (SMS-Home Science)
2	Dr. (Mrs.) Neelofar Illias Kutty	Chief Technical Officer (Programme Assistant) (Home Science)
3	Mrs. Jayasree M.P.	Assistant Chief Technical Officer (SMS - Agrl. Extn.)
4	Sri K. Manikandan	Senior Technical Officer (Programme Assistant) (Agronomy)
5	Sri A.K. Ramadas	Senior Technical Assistant (Vehicle)
6	Sri Lagesh K.P.	Technical Trainee (Vehicle)
Kayamkulam		
1	Dr. C. Keshavan Nampoothiri	Asst. Chief Technical Officer (Statistics)
2	Sri S. Thajuddin	Asst. Chief Technical Officer (Library) (up to 31.05.2020)
3	Dr. M. Shanavas	Chief Technical Officer (Lab.) (up to 31.05.2020)
4	Dr. C.G Narayanan Namboothiri	Asst. Chief Technical Officer (F/F)
5	Dr. G. Rajeev	Asst. Chief Technical Officer (F/F)
6	Sri Jacob Kurian	Asst. Chief Technical Officer (F/F) (up to 31.05.2020)
7	Sri K.K Sudhanandan	Senior Technical Officer (F/F)
8	Sri B.Anilkumar	Senior Technical Officer (F/F)
9	Sri K. Rajendran	Technical Officer (F/F)
10	Sri K.P. Udayabhanu	Technical Officer (F/F)
11	Sri Sunny Thomas	Technical Officer (F/F)
12	Sri P.K. Sunil Kumar	Senior Technical Assistant (up to 31.01.2020)
13	Sri Jinu Sivadasan	Senior Technical Assistant (F/F)
14	Sri V.P. Joy	Technical Assistant(F/F)
15	Smt. Asha K. Chandran	Technical Assistant (F/F)
KVK, Kayamkulam		
1	Sri M. S. Rajeev	Assistant Chief Technical Officer (SMS-Agronomy)
2	Smt. Jissy George	Assistant Chief Technical Officer (SMS- Home Science)
3	Dr. T. Sivakumar	Assistant Chief Technical Officer(SMS- Agricultural Entomology)
4	Smt. Lekha G.	Assistant Chief Technical Officer (SMS-Plant Pathology)
5	Dr. S. Ravi	Assistant Chief Technical Officer (SMS- Animal Husbandry)
6	Sri Sajnanath K	Assistant Chief Technical Officer (SMS-Soil Science)
7	Sri Ansary K.M.	Technical Officer(Computer)
8	Smt. Bijila P.V.	Technical Officer (Horticulture)
9	Sri Dayanandan Unnithan	Senior Technical Assistant (Vehicles)
10	Sri Sajin B.J.	Technical Trainee (Vehicle)

Sl. No.	Name	Designation
Vittal		
1	Dr. H. Moosa	Chief Technical Officer(F/F) (up to 30.04.2020)
2	Smt. Meenakshi Patil	Assistant Chief Technical Officer (Library)
3	Sri C. Purandhara	Technical Officer(F/F)
4	Sri Adolphus Francis Mascarenhas	Technical Officer (Electrician)
5	Sri Abdul Aziz	Technical Officer(F/F)
6	Sri Y. Srinvasa Bhat	Technical Officer(F/F) (up to 29.02.2020)
7	Sri B. Ananda Gowda	Senior Technical Assistant (F/F) (up to 31.12.2020)
8	Sri V. Chandrasekhara Shetty	Senior Technical Assistant (Vehicles)
9	Sri Ramanna Gowda	Senior Technical Assistant (Vehicles)
10	Sri Santhosh Kumar P.	Senior Technical Assistant (F/F)
11	Sri Tharanath Naik B.	Technical Assistant (Vehicle)
12	Sri Bisun Bhaskar	Tech. Asst. (Laboratory)
13	Sri Nirmal Kumar B. J.	Tech. Asst. (Field/Farm)
14	Sri Vineeth V. S.	Technical Trainee (FF) (upto 13.11.2020)
Kidu		
1	Sri Chandra Nairy	Technical Officer (FF) (up to 30.06.2020)
2	Sri M. Manamohan	Technical Officer (Mechanical Engineering)
3	Sri A.S. Gopalakrishna	Technical Officer (FF)
4	Sri M. Narayana Naika	Technical Officer (FF)
5	Sri Kamal Kumar V.	Technical Assistant(FF)
6	Sri Anoop Kumar P.P.	Technical Assistant (FF)
Mohitnagar		
1	Dr. Saran Kumar Rizal	Chief Technical Officer (Farm Superintendent) (up to 31.12.2020)
2	Sri Avrajyothi Ghosh	Assistant Chief Technical Officer (FF)
3	Sri Pratap Kumar Sarkar	Senior Technical Assistant (FF)
4	Sri Jagadish Roy	Senior Technical Assistant (Vehicles)
5	Sri Prakash Burman	Senior Technician (F/F)
Kahikuchi		
1	Dr. Bikash Chowdhury	Chief Technical Officer (FF)
2	Sri Gopinath Malakar	Senior Technical Assistant (Vehicles)

ADMINISTRATIVE STAFF

Sl. No.	Name	Designation
KASARAGOD		
1	Sri G.S. Hareesh Nair	Chief Administrative Officer
2	Sri Ram Avtar Parashar	Senior Finance and Accounts Officer
3	Sri T.E. Janardhanan	Administrative Officer
4	Sri Pradeep Kumar Vasu	Assistant Administrative Officer
5	Sri K.R. Nithianandan	Assistant Administrative Officer
6	Smt. M. Reetha	Assistant Administrative Officer
7	Sri A. Neil Vincer	Assistant Administrative Officer

Sl. No.	Name	Designation
8	Smt. K. Narayani	Private Secretary
9	Smt. Girija Chandran	Private Secretary
10	Smt. Sulochana Nair	Private Secretary
11	Sri K. Kunhiraman Nair	Private Secretary
12	Sri T.N. Vidhyadharan	Assistant
13	Smt. K.S. Vishalakshi	Assistant
14	Sri P.M. Thomas	Assistant
15	Smt. K.T.K. Sheenakumari	Assistant
16	Sri P. Narayana Naik	Assistant
17	Smt. Rupa Manikandan	Assistant
18	Smt. Jayashree K.	Assistant (w.e.f.07.08.2020)
19	Sri Paulson Sam George	Assistant (w.e.f. 30.07.2020)
20	Smt. K. Preethi	Assistant (w.e.f. 30.07.2020)
21	Smt. Arathi A.R.	Stenographer Gr.III
22	Sri T.K. Gangadharan	Upper Division Clerk
23	Smt. Remya T.R.	Upper Division Clerk (on deputation)
24	Sri Aswin Reghunath	Upper Division Clerk
25	Sri N. Udayakumar	Upper Division Clerk
26	Smt. A.J. Mary	Upper Division Clerk
27	Sri P.K. Pramodkumar	Lower Division Clerk
28	Sri Jayarajan V.	Lower Division Clerk
29	Sri Dinesh	Lower Division Clerk
30	SriRatan Singh	Lower Division Clerk
31	Sri Satyabrata Moharana	Lower Division Clerk
KVK, Kasaragod		
1	Sri Anurag Meena	Stenographer Grade-III (up to 10.02.2020)
Kayamkulam		
1	Sri K.G. Bhageerath	Assistant Administrative Officer
2	Sri K. Haridas	Assistant
3	Sri K. Venugopal	Assistant
4	Smt. K. Sreelatha	Assistant
5	Smt. V. Madhavikutty	Assistant
6	Sri C. Ramesh Babu	Personal Assistant
7	Smt. Prasanna Sarngan	Personal Assistant
8	Sri Arun N.K. Raj	Lower Division Clerk
9	Sri K.N. Sajeev	Lower Division Clerk
10	Sri C.R. Babu	Lower Division Clerk (w.e.f. 12.03.2020)
KVK, Kayamkulam		
1	Smt. Rejitha K.R.	Stenographer Gr.III
Vittal		
1	Sri P. Krishna Naik	Assistant Administrative Officer
2	Sri Sasi K.K.	Assistant Finance and Accounts Officer
3	Sri Mohammed Haneefa P.K.	Upper Division Clerk
4	Sri T.J. Saji	Upper Division Clerk
5	Sri Vivek Singh	Stenographer Gr.III
6	Sri Fawaz C.M.O.	Lower Division Clerk

Sl. No.	Name	Designation
7	Sri Chandu Naika	Lower Division Clerk (w.e.f. 12.03.2020)
8	Sri B. Choma	Lower Division Clerk (w.e.f. 12.03.2020)
Kidu		
1	Sri M. Ravindran	Assistant Administrative Officer
2	Sri Lakshmi Narayana	Lower Division Clerk
3	Sri M. Durgesha	Lower Division Clerk (w.e.f. 12.03.2020)
Mohitnagar		
1	Sri Subash Paul	Assistant
Kahikuchi		
1	Sri Deepak Meena	Lower Division Clerk
2	Sri Umesh Kumar	Lower Division Clerk

SKILLED SUPPORT STAFF

Sl. No.	Name
KASARAGOD	
1	Sri M. Shankara
2	Smt. K. Baby
3	Sri A. Mohana
4	Sri K. Kesava (up to 31.05.2020)
5	Sri K. Sukumaran
6	Sri K.V. Krishnan(up to 29.02.2020)
7	Sri P.A. Chaniya Naik (KVK)
8	Sri P. Kumaran
9	Sri V.S. Pakeeran
10	Smt. V. Thambai
11	Smt. G. Kamala
12	Sri K.G. Sureshbabu
13	Sri T.J. Ninan
14	Smt. Chithralekha Kodoth
15	Sri B. Chandrahasa
16	Sri V.T. Rameshan
17	Sri K. Krishnankunhi (expired on 16.06.2020)
18	Smt. K. Shobhana
19	Sri M. Krishnan
20	Smt. V.A. Leela
21	Smt. U. Sarojini
22	Sri V. Krishnankutty
23	Sri P.P. Prabhakaran
24	Sri B. Ramachandran
25	Sri B. Sanjeeva Patali
26	Smt. N.V. Sasikala
27	Sri Lakshmana Naik
28	Smt. Lalitha Bai
29	Sri M. Velayudhan

Sl. No.	Name
30	Sri N. Bhaskaran
31	Sri B. Sundara
32	Sri K. Sureshan
33	Sri A. Madhu
34	Sri K.A. Madhavan
35	Sri Aneesh E.M.
36	Smt. Vanamalini
37	Sri N.B. Mahesan(up to 31.05.2020)
38	Sri Sarath Kumar
39	Sri Ashok Kumar R.
40	Sri Praveen Raj P.R.
41	Sri Jayaprakash K. (Canteen)
42	Kripesh Kumar (w.e.f. 02.11.2020)
Kayamkulam	
1	Sri M.E. Sivan
2	Sri K.B. Thankachan
3	Sri R. Ravindran
4	Sri K. Soman
5	Sri K. Omanakuttan
6	Sri K.C. Damodaran (up to 31.03.2020)
7	Sri V.T. Unnikrishnan
8	Sri T.K. Mani
9	Sri K. Ravi
10	Sri K.K. Sreedharan
11	Sri C. Sukumaran
12	Sri K.V. Vijayan
13	Smt. K. Valsala
14	Sri C. Sundaran
15	Sri K.P. Ibrahim
16	Smt. N. Suma

Sl. No.	Name
17	Sri A.T. Harikuttan
18	Sri K. Saseendra
19	Sri Ajith Mattappadan (KVK)
20	Sri R. Rajesh (KVK)
21	Smt. L. Leena
22	Sri Ancil Pereira
23	Sri S. Rajesh
24	Sri N. Reghu
Vittal	
1	Sri Sudhakara
2	Sri A. Gopala
3	Sri D. Isubu
4	Sri B. Dharmapala
5	Sri Vinod K.
6	Sri Ibrahim
7	Sri Mohana
8	Sri Somappa K.
9	Sri M. Ananda
Kidu	
1	Sri S. Chennappa
2	Smt. N. Bhavani
3	Smt. Susheela S.(up to 31.05.2020)
4	Smt. Lolakshi (up to 31.12.2020)
5	Sri S. Janardhana
6	Sri Dasappa Gowda

Sl. No.	Name
7	Smt. T. Susheela
8	Sri Padmayya Gowda
9	Smt. B.Bhavani
10	Smt. S. Rukmini
11	Sri S. Bhojappa
12	Smt. Komalangi
13	Sri V. Chennappa
14	Sri V. Jathappa Gowda
15	Sri S. Sheenappa Gowda
16	Sri S. Neelappa
17	Sri S. Regappa
18	Smt. S. Chandravathi
19	Smt. Meenakshi K.
Mohitangar	
1	Sri Sailen Seal
2	Sri Krishna Kumar Mandal
3	Sri Nripendra Chandra Roy
4	Sri Kartick Chandra Biswas
5	Sri Sushanta Burman
6	Sri Mahadev Misra
Kahikuchi	
1	Sri Sathish Baishya
2	Sri Pankaj Das
3	Sri Tanka Bahadur Thapa (w.e.f. 20.07.2020)

XIX. DISTINGUISHED VISITORS

Dignitary visited	Centre	Date
Dr. B.N.S. Murthy, Horticultural Commissioner, Govt. of India, New Delhi	Kasaragod	5th Jan 2020
Dr. A. K. Singh, DDG (Hort. Science), ICAR; Dr. K. V. Prabhu, Chairperson, PPVFRA, Govt. of India, New Delhi	Kahikuchi	11th Jan 2020
Prof. T.M. Thomas Issac, Hon'ble Finance Minister, Kerala	Kasaragod	30th Jan 2020
Sri V. Muralidharan, Hon'ble Minister of State for External Affairs and Parliamentary Affairs, Govt. of India, Dr. G. Gopa Kumar, Vice-Chancellor, Central University of Kerala, Periya, Kasaragod, Kerala Prof. (Dr). A. Ramachandran, Vice-Chancellor, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala Prof. G.M. Nair, Chairman, Kerala Biotechnology Commission, Thiurvananthapuram	Kasaragod	27th Feb 2020 ICAR-CPCRI, Kasaragod
Sri N.A. Nelikunnu MLA Kasaragod Dr. Saji Gopinath, CEO, Kerala Startup Mission Sri Nagaraja Prakasam, Angel Investor & Startup Mentor	Kasaragod	1st Mar 2020

Professor Thomas Issac, Finance Minister, Government of Kerala interacting with the scientists at Agro Processing Lab at ICAR-CPCRI, Kasaragod

Dr. A.K. Singh, ICAR-DDG (Hort.) visiting the cocoa plantation at ICAR-CPCRI, RC, Kahikuchi

XX. Mera Gaon – Mera Gaurav Programme

Activities under "Mera Gaon Mera Gaurav", the village adoption programme to promote the direct interface of agricultural scientists with the farmers to hasten the lab to land process, were implemented in collaboration with other stakeholders viz., Department of Agriculture, Krishi Vigyan Kendra, grama panchayat, input dealers, progressive farmers, and SHGs. Training programmes, demonstration on improved practices, farm advisory visits, and advisory services through mobile were organised in the selected villages. Some of the important programmes were (i) field demonstration of the release of parasitoids to control coconut leaf-eating caterpillar in Mogral Puttur panchayat, Kasaragod; (ii) field demonstration and distribution of Metarhizium majus to dairy farmers in Vallikunnam village, Alappuzha district; (iii) Farmers Field School on ecological engineering and system approaches in doubling farmers' income at Chettigulankara Panchayat, Alappuzha district.

Visiting a dwarf coconut plot in MGMG village

Release of parasitioides for controlling coconut leaf eating caterpillar in a MGMG village

Diagnostic field visit in MGMG village

XXI. Swachh Bharat Mission

Besides weekly session of cleaning office premises, the following special programmes were conducted as part of Swachh Bharat Mission at headquarters and other units of the Institute.

Swachhta Hi Sewa campaign: It was conducted during 25 September to 2 October 2020 to commemorate 150th Birth Anniversary of Mahatma Gandhi. At Kasaragod, a webinar was organized in which Dr. V. Rajagopal, Former Director, ICAR-CPCRI, Kasaragod delivered a lecture on "Poverty and Hunger through the prism of Gandhian Principles". For staff and students, different contests were conducted (stay safe video contest, quiz competition and elocution competition). A sanitization drive was organized at the entrance of the ATIC building and Centenary Building premise of the Institute. Programmes were conducted in other units of the Institute as well. A digital workshop on the theme "Cleanliness and rural development through Gandhian ideologies" was organized at Kayamkulam on 1 October 2020. Sri. K.G. Jagadeesan, National Committee Member, Gandhi Smaraka Nidhi was invited to deliver a lecture on "Gandhian principles for rural development". Besides staff of ICAR-CPCRI, staff of ICAR-DCR and ICA-CTCRI was participated in this programme.

Swachhta Pakhwada and Kisan Diwas celebrations: It was conducted during 16-31 December 2020. During this fortnight various activities such as digitization of office records, sanitation drives at Institute premises, MGMG villages, laboratory waste management, method demonstration on converting kitchen waste to wealth through composting, Cleaning the premises of local areas (Lalitha Kala Academy), Selecting Model Residential Quarters with regard to waste management, webinar on organic vegetable production, Visit to community waste disposal sites/compost pits and application of *Metarhizium* in compost pits, establishment of nutri gardens, Campaign on cleaning of sewerage & water lines, Awareness Campaign at Madhur village were organized. Two webinar-lectures were organized: Aeerobic composting by Dr. Dr.D.Girija, Professor (Retired), Department of Microbiology, College of Horticulture, Vellanikkara and Scientific waste management by Dr. Rishiram Ramanan, Assistant Professor (Environmental Science), Central University of Kerala. An online farmers' seminar in connection with the farmers day/Kisan Diwascelebration was organized on 23.12.2020.

Activities as part of Swachh Bharat Mission conducted at different places

XXII. Women Welfare Committee Activities

International Women's Day

The International Women's Day was organized on 9th March 2020 at ICAR-CPCRI, Kasaragod. Advocate (Mrs.) S.N. Saritha, a practicing member of the Kasaragod Bar Council, Working Legal Counselor of Women and Children's Home under Nirbhaya Project and also serving as Legal Counselor of Women Protection Officer of Kasaragod was the chief guest. She addressed the gathering regardingthe various social issues faced by the women and enlightened the audience about the legal provisions available to handle those issues and also expressed her views on conquering the personal and professional challenges of women to achieve their goals. Dr. Anitha Karun, Director (Acting) presided over the formal function conducted during this occasion and in her presidential address emphasized on the importance of gender equality and the influence of women in the nation building and importance of women's education in realizing the same. Dr. V. Niral, Principal Scientist & Chairperson, Women's Welfare Committee welcomed the gathering and Dr. V. Selvamani, Sr. Scientist & member of the Committee proposed the vote of thanks. All staff members of the institute actively participated in these programme.

ICAR-CPCRI, Regional Station, Kayamkulam celebrated International Women's Day under the chairmanship of Dr. S. Kalavathi, Acting Head and the chief guest of the event was Smt. TN. Vijayalekshmi, the woman who climbed Mount Kanjunjunga in 1984 and a teacher who is very active in NCC activities, led camps all over India including Leh-Ladakh for NCC girl cadets.

District level seminar on cocoa sponsored by Directorate of Cashewnut and Cocoa Development (DCCD) was organized at ICAR- CPCRI Regional Station Vittal on 7 March 2020 in commemoration of International Womens' Day. Class room lectures, demonstration on mother tree/ seed pod selection, soft wood grafting, farm level primary processing and visit to cocoa nursery and experimental plots were arranged and 35 women participants comprising farmers and ladies club members benefitted from the program.

ICAR- KVK, Kasaragod celebrated the International Women's Day 2020 with a participation of more than 70 women from different walks of life. Ethnic foods and their health benefits were displayed and elaborated by women groups who were experts in ITK. Two eminent women entrepreneurs Smt. Khadeeja who bagged the Karshaka Tilak award of Kerala State Government recently and Smt. Lakshmi Bhat, an expert in ITK were honoured during the event.

KVK, Alappuzha organized International Women's Day celebrations on 7 March 2020 at ICAR-CPCRI campus, Krishnapuram. Five woman farmers *i.e*; Smt. R. Jagadhamma (Crop production), Smt. Viji Gopan (Value addition), Smt.P.Sathi (Mushroom Cultivation), Smt. Anitha Kumari (CBIFS) and Smt. Sheeba Sadique (Animal Husbandry) were honoured by Smt. Babitha Jayan, Member Muthukulam Division, District Panchayath, Alappuzha in a function chaired by Kum. Aritha Babu, Member Krishnapuram Division, District Panchayath. Dr. S. Kalavathi, Acting Head, ICAR CPCRI, RS and Dr. P. Muralidharan, PS & Head, KVK addressed the gathering. An awareness programme on 'Rights of women' by Smt. T. Geetha (President, Centre for Social Studies, Alappuzha) was conducted. Technological input kits for nutrition garden were provided to 60 selected women farmers attended the programme.

Adv. S.N. Saritha addressing the gathering at ICAR-CPCRI, Kasaragod

Honouring of women during the International Women's Day at KVK, Alappuzha

XXIII. Major Events and Other Information

ICAR CPCRI Lined-Up in the COVID-19 War front

In compliance of withthe ICAR guidelines, the Institute has extended its untiringsupport to the district administration incombating the spread of coronavirus in Kasaragod. Dr. Anitha Karun, Director (Acting) interacted with Dr. D. Sajith Babu IAS, District Collector and provided two real-time PCR machines for the use of testing suspected samples. With this, the testing facilities created in the Central University of Kerala could be enhanced to 87 samples per day.

The Institute also prepared a very potent hand sanitizer using the in-house produced virgin coconut oil andethyl alcohol. Initially, 500 liters of sanitizer was made and supplied for general use. Besides, the Chandragiri Guest House of the Institute was dedicated for the stay of state level monitoring officials and the other guest houses werekept available for use as isolation rooms whenever district administration requires it.

ICAR-CPCRI, Regional Station, Kayamkulam also has joined hands with district and local administration to fight against COVID-19 and also supported the farmers for self-sustenance by raising food and nutritional crops. RS has prepared and supplied 28 litres of hand sanitizer. The Institute has also offered farm advisory services. The farmers could harvest vegetables locally during lockdown period and provide it to community kitchens and neighbours.

Contributions to the Covid-19 management fund

In accordance with the appeal made by the District Collector, Kasaragod, staff of ICAR-CPCRI, have shown thesolidarity with the efforts made by the Kerala State Government, contributed collectively from the Centres located in the state. Dr. Anitha Karun, Director (Acting) handed over the collective contributions to the Chief Mnister's Distress Relief Fund to Shri E. Chandrasekharan, Hon'ble Minister for Revenue and Housing handling the district responsibility of Kasaragod in presence of Dr. Sajith Babu, IAS, District Collector on 3rd August 2020.

Other activities during the lockdown period

The Institute supported farmers to sustain themselves by raising food and nutritional crops during the Covid-19 lockdown period. Advisory services were provided through mass media and social media. The office was completely sanitized after the two lockdown periods and facilities for hand sanitization have been arranged at office entrance and office buildings.

Dr. Anitha Karun, Director (Acting) handing over contributions

Advisory Services to farmers

Advisory service is being provided through the Whatsapp group 'Climate change adaptation' on various queries related to drainage during waterlogging, pests and disease problems, irrigation and moisture conservation strategies. Usually, the farmers from problematic areas do not produce vegetables during extreme stress conditions like severe summer and rainy months. However, the farmers covered under the project in remote problem affected areas could harvest around 1700 Kg vegetables and tubers during the lockdown period. This bumper harvest was achieved through the adoption of strategies *viz*., low cost vertical gardening practice of vegetables under coconut based cropping system, potting mixtures containing microbial enriched organic substrate combinations with low weight, optimum drainage capacity and low nutrient leaching for filling grow bags in areas of water logging during rainy season. The farmers could overcome the difficulty in accessing the fresh vegetables. In addition they could effectively utilize their time during the lockdown period. The farmers could supply vegetables to community kitchens and also to their neighbours. One farmer along with a group of members could run a community kitchen of their own during the entire lockdown period and served daily food to around 70 old people. In addition, the farmers planted different varieties of banana, elephant foot yam, tapioca, colocasia, ginger and turmeric in 16.5 acres of land during the period. Our station supported the

farmers by distributing coir geo-textile mats to prevent soil erosion, botanicals for plant protection, supplied planting materials of fruit crops, tuber crops, pepper, ginger and turmeric along with manures.

Advisory service / Technological information through Dailies during Lockdown period

- ICAR-CPCRI empowering farmers through innovative adaptations to meet climatic challenges in Deshabhimani dated 12 May 2020.
- Be ready to receive the monsoon: Advisory service by ICAR-CPCRI to the coconut farmers in Malayala Manorama dated 16 May 2020.
- Coconut seedlings should be planted before heavy monsoon: Pre-monsoon advisory for coconut growers in Mathrubhoomi dated 19 May 2020.
- Pre-monsoon advisory services for coconut farmers in Mangalam dated 21 May 2020.

Infrastructure Development

Agro Processing Training cum Incubation Centre (APTIC)

The Agro-Processing Training cum Incubation Centre (APTIC) sanctioned by the Department of Agriculture Development and Farmers Welfare, Govt. of Kerala to KVK, Alappuzha with a budget of Rs. 73 lakhs has been established. The centre envisages strengthening the capacity of entrepreneurs in processing and value addition of coconut, jackfruit, and seasonal fruits and vegetables. The incubation centre will facilitate the development of technology-based and knowledge-driven agri business ventures during the start-up period by providing an integrated package of technology, work space, access to specialized equipments and pilot plant.

Important events

Republic Day

71st Republic day was celebrated on 26th January, 2020by officials and staff of ICAR-CPCRI at Kasaragod, Regional Station, Kayamkulam, Regional Station, Vittal, RC, Kahikuchi, Kidu and Mohitnagar.

National Science Day

National Science Day 2020 was celebrated at ICAR-CPCRI, Regional Station, Kayamkulam on 26 February 2020.As part of the National Science Day-2020 celebrations, a one-day workshop on 'Inculcating Spirit of Science and Plant Health Management' was organized at ICAR-CPCRI, Regional Station, Kayamkulam on 26th February 2020. The workshop, under the theme Women in Science, supported by KSCSTE, Thiruvananthapuram was hosted with the patronage of Department of Science and Technology, New Delhi. Around 100 students from nine different colleges participated in the workshop. Dr. C.N. Ravisankhar, Director, ICAR-CIFT, Kochi inaugurated the programme under the chairmanship of Dr. S. Kalavathi, Acting Head. On this occasion, two e-publications viz., E-compendium on 'Coconut Root (Wilt) Disease Research (1908-2019)' and the e-compilation of the proceedings of the workshop entitled 'Science Connect with New Age Students' comprising lecture notes of scientists were also released. Technical sessions on Women in Science, Knocking pest suppression through endophytes, Spirit of Science and Plant Health, Fundamentals in biochemical sciences and Laboratory instrumentation techniques were handled by scientists of the Regional Station, Kayamkulam imparting science with basic and applied techniques. An agricultural quiz and an elocution competition with the underlying theme of "Women in Science" were conducted for the benefit of students.

World Environment Day

World Environment Day was observed at ICAR-CPCRI, Kasaragod by planting trees in the campus. The programme was inaugurated by Dr. Anitha Karun, Director (Acting) on 5th June 2020.

As part of World Environment Day (WED) celebration on June 05, 2020 at ICAR-CPCRI, Regional Station, Kayamkulam, Dr. Chandrika Mohan, Acting Head planted a sapling of soursop (*Annona muricata*) in the Ecological Engineering garden. This coconut based crop-habitat diversification is a self-reliant model of inclusiveness (Nariyal Dhuvara Aatmanirbhar Krishi), providing continuous income, employment and pest regression. In addition, she harvested a jack fruit from Vietnam Super Early, planted two years ago in the same garden. As environment and economy follow two sides of the same coin, a symbolic planting of tree sapling (Environment) and harvesting a jack fruit (Economy) assumes significance on this day.

Independence Day

The Institute has celebrated 74thIndependence Day of our nation. Dr. Anitha Karun, Director (Acting), hoisted the National Flag and delivered Independence Day address at Kasaragod on 15th August, 2020. Independence Day was

also celebrated in the Regional Stations at Kayamkulam, Vittal and Research Centres at Kahikuchi, Kidu and Mohitnagar with patriotic furore.

Hindi Day

Hindi Saptah was celebrated from 14 - 17th September, 2020 at KVK, Alappuzha with a spectrum of activities starting with Hindi Diwas celebrations on 14th September, 2020. Dr. P. Muralidharan, PS and Head, KVK gave the inaugural address. He emphasized the importance of Hindi in day to day life and appealed all KVK staff to improve the use of National language in official correspondences. Various Hindi competitions like memory test, reading, translation, handwriting etc. were conducted for the staff and all the staff members actively participated in these contests. Winners were awarded prizes, items which were specifically required to prevent Covid-19, in the valedictory function on 17 September, 2020.

Officials and staffs of ICAR-CPCRI, RC, Kahikuchi celebrated Hindi week from 14th- 19th September, 2020 at the Centre. The competition was held during the week and Sri Badari Yadav, Research Officer, Regional Implementation Office (North-East), Department of Official Language, Govt. of India, graced the occasion through online on 17th

Dr. V. Balakrishnan, DySP (Vigilance) addressing the gathering

September, 2020.

Vigilance Awareness Week-2020

Vigilance Awareness Week was observed at this Institute and its regional stations and research centres from 27th October to 2nd November 2020. Dr. Anitha Karun, Director inaugurated the Vigilance Awareness Week. Staff members took the 'Integrity Pledge' on the day. Director briefed the gathering the need of transparency in office dealings. Various programmes including competitions were conducted to create awareness among institute staff and students of nearby schools. A special programme was arranged by the institute Farm Section to sensitize the contractual and other temporary staff working within the institute. An Awareness Grama Sabha was also organised at Mogral Puthur Grama Panchayath. The week long programme was concluded with a valedictory function on the 2nd November 2020. Dr. Anitha Karun, Director chaired the function. Dr. V. Balakrishnan, Deputy Superintendent of Police, Vigilance and Anti-Corruption Bureau, Kasaragod was the chief guest. Over exploitation of natural resources like granite, laterite and river sand, especially in Kasaragod District, is a major corruption according to him.

World Soil Day 2020

As part of the World Soil Day celebrations 2020, a virtual interactive workshop on the theme: "Conserving soil biodiversity for sustainable agriculture" was conducted at ICAR-CPCRI, Regional Station, Kayamkulam on 05th December, 2020. The programme was aimed at creating awareness about the necessity of preserving the pristine nature of soil to the graduate and post graduate student community represented from eight colleges. One hundred and twenty students registered for the workshop which was conducted through zoom platform as well as through the YouTube live sessions. Dr. S. Kalavathi, Acting Head, ICAR-CPCRI, RS in her welcome address stressed importance of World Soil Day commemoration, the duties of the younger generation to carry forward the message to protect the soil wealth for the future sustainment in the planet. The workshop was inaugurated by Dr. S. K. Ray, Head, ICAR-NBSSLUP, RS, Jorhat. In the inaugural address, he highlighted the importance of soil organic matter, the different types of soils in India, the role of soil on sustaining plant health and thereby the human health was emphasized. More than 300 BSc and M.Sc. students from 17 colleges were participated the programme through Zoom meeting and YouTube live.

Farmers Day celebrations

A webinar for the farmers in connection with thefarmers day celebration was organized on 23rd December 2020. The programme was inaugurated by Dr. S. Kalavathi, Acting head, emphasizing the need for ecological balancing of plant, animal, insect and microbial species, conservation of natural resources and recycling of wastes for making farming sustainable. The technical sessions included the topics: (1) Crop habitat diversification for plant health management handled by Dr. A. Joseph Rajkumar and (2) Residue recycling for sustainable crop yield handled by Dr. A. Abdul Haris. In the session on crop habitat diversification, Dr. Joseph Rajkumar, Principal Scientist, Agricultural Entomology emphasized the importance of diversification in farming systems with the inclusion of crops such as medicinal plants, flowering plants, fruit

crops, spices along with coconut in a wholistic manner which will reduce the risk of crop loss or price fluctuation in he market. The system should also include, apiary and fisheries component so that the income per unit inch of land can be multiplied. The volatile hues emerging out of these crop components will ward off the pests and thereby the palm health can be sustained. In the session of crop residue recycling for sustainable palm productivity, Dr. A. Abdul Haris, Principal scientist (Agronomy), explained the nutrient components in the palm wastes, the methods for *in situ* recycling of palm residues, the added benefit of palm residue recycling on crop health and productivity. The programme was coordinated by Dr. K.M. Anes, Dr. Jeena Mathew, Dr. A. Abdul Haris and Dr. S. Kalavathi.

Implementation of e-office in ICAR-CPCRI

Inaugurated the e-office system in ICAR-CPCRI on 4th July 2020 by the Director (Acting) by Approval of a circular on implementation of e-office in ICAR-CPCRI. Subsequently, different demonstration cum training programmes were arranged from 6th to 10th July 2020.

Inauguration of e-Office by Director at Kasaragod

Reconstitution of Institutional Biosafety Committee (IBSC)

Department of Biotechnology (DBT)-Review Committee on Genetic Manipulation (RCGM) has reconstituted the Institutional Biosafety Committee (IBSC) at ICAR-CPCRI on, 4th August, 2020. The reconstituted committee comprises the following members: Dr. Anitha Karun, Director, ICAR-CPCRI (Chairman), Dr. A. Ishwara Bhat, ICAR Indian Institute of Spices Research, Kozhikode (DBT Nominee) and Dr. Rajendra Pilankatta, Central University of Kerala, Periya, Kasaragod, Kerala (Outside Expert) among others.

Field planting of first tissue culture raised coconut seedling

Shri V.Muraleedharan, Minister of State for External Affairs, Govt. of India visited ICAR-CPCRI, Regional Station, Kayamkulam on 27th October, 2020. Hon'ble Minister planted the first tissue culture raised coconut seedlings in front of the main building of ICAR-CPCRI in the presence of Dr. S. Kalavathi, Acting Head. Minister also discussed with Dr. M. Shareefa, Sr. Scientist about the advantages of tissue culture coconut seedlings and interacted with other scientist staff about achievements of this Regional Station.

Career orientation programme

Career Oriented Webinar Series on 'Agriculture and Allied Sciences: Challenging Career Options for Students' was organized at ICAR-CPCRI, Regional Station, Kayamkulam during 6-12th October, 2020 for the Higher Secondary students. More than 1000 students from 14 districts of Kerala and Lakshadweep had actively participated in the programme which was conducted online through Zoom platform and simultaneously broadcasted live through ICAR-CPCRI YouTube channel. The programme was inaugurated by Dr. Rajasree M.S., Vice Chancellor, Dr. A.P.J. Abdul Kalam Technological University, Thriruvananthapuram and Mr. P.B. Nooh, IAS, was the guest of honour during the programme. The webinar consisted of a talk and seven technical sessions by eminent speakers including Dr. Anitha Karun (Acting Director, ICAR-CPCRI), Dr. Jiju P. Alex (Director of Extension, KAU), Dr. K. Muralidharan (Acting Head, Division of Social sciences, ICAR-CPCRI), Dr. S. Kalavathi (Acting Head, ICAR-CPCRI, RS, Kayamkulam), Dr. C. George Thomas (former Associate Dean, COH, KAU), Dr. Manoj P. Samuel (Head, Division of Engineering, ICAR-CIFT), Dr. P.J. Cherian (Executive Director, PAMA Research Institute), Dr. Chandrika Mohan (Principa Scientist), Dr. Anithakumari (Principal Scientist), Dr. A. Joseph Rajkumar (Prinicipal Scientist), Mr. Nagesh S.S. (Chief - Agriculture, Kerala state planning board), Dr. Sudheesh Manalil (Honorary Associate Professor, University of Queensland, Australia). The programme was coordinated by Dr. K. Nihad (Senior Scientist), Dr. Anes K.M. (Scientist) and Dr. S. Kalavathi (Acting Head).

Task force committee meeting on DUS testing in cocoa

First meeting of the task force committee to finalize distinctness, uniformity and stability (DUS) testing guidelines for Cocoa was conducted on 11th November 2020 online. Dr. V.A. Parthasarathy, Former Director and Emeritus Scientist, ICAR-IISR, Kozhikode chaired the meeting. Dr. Anitha Karun, Director, ICAR- CPCRI, Dr. K.V. Prabhu, Chairperson, PPV & FRA, Dr. D. Balasimha, Former Head, CPCRI, RS, Vittal, Dr. Prasanna Kumari Amma, Former Professor KAU, were present. Dr. Nagarathna, Registrar, Dr. Dipal Roy, Deputy Registrar, PPV & FRA, New Delhi conducted the task force meet. Chairman, briefed the importance of DUS guidelines in horticultural crops specifically fruits/ plantation crops considering their perennial habit and cross pollinating nature. Dr. S. Elain Apshara, Principal Scientist (Hort.) presented the draft guidelines before the committee. Based on important inputs, the committee shall be finalising the DUS test guidelines for cocoa.

Establishment of EPN mass production laboratory

A mass production laboratory unit for entomopathogenic nematode (EPN) and its host insect *Galleria mellonella* at ICAR – CPCRI, Kasaragod was established. About 13,800 units including EPN aqua formulation and nematode infected *Galleria* cadavers were produced and distributed to farmers for eco-friendly management of white grubs and lepidopteron caterpillars in coconut, arecanut and intercrops.

EPN production unit at CPCRI, Kasaragod

Distribution of EPN formulations to farmers

'Kalpa' EPN aqua formulation units ready to transport to the field

XXIV. Budget and Expenditure

Budget Head	Plan	
	Budget	Expenditure
Revenue		
Estt. Charges	295178000	295164396
OTA	0	0
Pension	299217000	298430857
TA	2000000	1908634
Research & Operational expenses	49296000	49023407
Works: Repair & Maintenance		
Office Buildings	6695000	6694919
Residential Buildings	3677000	3676659
Minor works	2787000	2786606
Other Administrative Charges	49800000	49727810
Total		
Miscellaneous Expenses (Including HRD)	745000	683713
Tribal Sub Plan -General	3100000	3098932
Scheduled Cast/Scheduled Tribe-General	6800000	6799543
NEH	11500000	11499944
Total	**730795000**	**729495420**
Capital		
Equipments	898000	884726
Information Technology	1067000	1066144
Library	0	0
Furniture and fixtures	135000	134400
Livestock	0	0
Works	0	0
Minor work	0	0
Tribal Sub Plan -Capital	47000	47000
NEH	2800000	2448616
SCSP	200000	189200
Total	5147000	4770086
Grant total	735942000	734265506

Other Projects

	Opening Balance	Receipts	Expenditure	Refund
Other Plan Schemes	3915991	65453318	64933957	2168033
Deposit Schemes(Externaly funded)	3895378	1698831	214879	
KVK,Kasaragod	1430949	11876337	12033467	
KVK,Alappuzha	2587564	19637011	21091058	

Revenue Receipts

Head	Target	Achievement
Income from sales/services(schedule-8)	439.5	34627733
Fee/subscription(schedule-10)		755156
Income from royalty,publication etc.(schedule-12)		420
Other Income(schedule-14)		27778683
STD Interest		559799
Recoveries on Loans & Advances		1579213
Total		65301004

XXV. Weather Data 2020

ICAR-CPCRI, Kasaragod

Month	Temp. (°C)		RH %		Wind velocity	Sunshine	Evapo ration	Rainfall	Rainy days
	Max	Min	FN	AN	(km/h)	(h)	(litre)	(mm)	
January 2020	32.4	20.6	72	59	2.1	9.1	3.5	0.0	0
February 2020	32.5	21.1	73	58	2.1	8.9	3.8	3.2	1
March 2020	33.2	23.0	70	60	2.3	8.7	4.6	3.2	1
April 2020	34.4	24.4	66	61	2.6	8.9	5.1	0003.2	1
May 2020	34.0	24.3	69	70	2.3	7.0	4.1	0150.4	10
June 2020	29.7	23.2	80	82	2.7	2.0	2.7	0881.0	27
July 2020	29.2	23.3	83	84	2.4	2.4	2.5	1127.9	26
August 2020	29.4	23.4	81	81	2.4	2.1	2.7	0729.4	25
September 2020	29.0	23.1	80	79	2.3	3.0	2.3	0939.2	17
October 2020	30.0	23.2	78	77	1.6	5.7	3.2	0386.0	14
November 2020	32.9	22.0	70	64	1.4	7.8	3.1	0040.6	3
December 2020	33.6	22.1	77	55	1.6	8.6	3.5	0008.6	1

ICAR-CPCRI, Regional Station, Kayamkulam

Month	Temp. (°C)		RH %		Wind velocity	Sunshine	Evapo ration	Rainfall	Rainy days
	Max	Min	FN	AN	(km/h)	(h)	(litre)	(mm)	
January 2020	33.9	21.7	93	56	1.5	9.6	4.0	00.0	0
February 2020	34.5	22.5	93	54	1.8	9.8	4.1	00.0	0
March 2020	34.2	24.9	92	62	1.9	9.1	4.0	67.8	3
April 2020	34.4	25.2	93	63	1.9	8.8	4.1	72.8	4
May 2020	32.3	24.9	95	74	1.5	5.4	3.6	423.8	17
June 2020	31.3	24.4	95	71	1.5	5.4	3.5	462.8	20
July 2020	30.8	24.0	95	74	1.5	5.2	3.4	267.4	16
August 2020	30.7	24.0	95	75	1.6	7.0	3.7	371.4	13
September 2020	29.9	23.7	95	80	1.0	3.7	3.3	543.6	19
October 2020	31.3	23.7	93	71	1.1	6.9	3.7	159.2	11
November 2020	32.6	23.5	94	66	0.8	8.1	3.8	128.3	7
December 2020	32.3	22.7	93	63	0.6	6.3	3.6	51.2	3

ICAR-CPCRI, Regional Station, Vittal

Month	Temp.		RH %		Wind velocity (Km/h)	Sunshine (h)	Evaporation (lit)	Rainfall (mm)	Rainy days
	Max (*C)	Min (*C)	FN	AN					
January 2020	34.12	20.17	92.55	48.03	2.31	7.90	3.54	0	0
February 2020	34.82	20.64	92.76	46.34	2.54	7.55	4.32	1.60	0
March 2020	35.48	22.69	91.32	54.13	2.93	7.78	5.01	14.60	2
April 2020	36.24	24.71	88.70	56.63	3.20	7.51	5.14	24.40	2
May 2020	35.05	25.03	90.45	63.26	3.20	5.67	3.94	107.20	7
June 2020	30.52	23.05	96.33	81.80	2.16	1.92	2.17	484.40	22
July 2020	29.18	22.88	96.68	85.16	2.18	1.99	2.16	960.30	23
August 2020	29.04	22.53	96.90	88.35	2.94	1.88	2.17	883.20	25
September 2020	29.51	22.43	96.87	83.37	2.13	2.89	2.18	742.70	22
October 2020	30.79	22.03	94.48	73.42	1.88	4.49	2.32	258.80	11
November 2020	34.07	20.97	90.43	56.90	1.79	6.66	3.13	22.50	2
December 2020	33.87	19.73	90.94	54.06	1.83	7.27	2.97	54.60	3

ICAR-CPCRI, Research Centre, Kidu

Month	Temp.		RH %		Wind velocity (Km/h)	Sunshine (h)	Evaporation (lit)	Rainfall (mm)	Rainy days
	Max (*C)	Min (*C)	FN	AN					
January 2020	34.9	19.3	81.1	38.0	1.4	9.2	4.1	0.0	0.0
February 2020	35.8	19.9	69.4	29.2	1.7	9.0	4.8	0.0	0.0
March 2020	35.6	22.0	87.3	42.3	1.0	8.2	6.1	15.2	2.0
April 2020	32.4	23.6	89.4	19.5	1.3	7.5	5.5	137.0	10
May 2020	34.0	24.0	92.0	56.0	1.1	6.0	4.6	255.8	15
June 2020	30.8	23.7	95.8	79.5	0.7	2.4	1.9	637.0	29
July 2020	29.0	22.9	96.6	81.3	0.6	1.5	1.5	957.8	26
August 2020	29.5	23.0	94.9	88.6	0.8	1.3	1.4	1448.8	23
September 2020	29.4	23.1	95.9	85.6	0.5	1.2	1.9	571.9	24
October 2020	31.0	22.7	82.1	58.1	0.5	3.8	2.1	605.7	17
November 2020	34.8	21.6	83.5	38.2	0.5	6.2	2.8	129.0	5
December 2020	35.3	20.7	83.5	36.6	0.7	7.3	2.7	3.0	1

XXVI. राजभाषा कार्यान्वयनरिपोर्ट

राजभाषा कार्यान्वयन कार्य

भारतसरकार कीराजभाषा नीति के अनुपालन केसंबंधमेंराजभाषाविभाग द्वारानिर्धारितवार्षिक कार्यक्रममें उल्लिखितलक्ष्यों की पूर्ति औरभारतीय कृषि अनुसंधान परिषद की ओर से जारी किए जा रहे राजभाषा कार्यान्वयन संबंधी दिशानिर्देश के अनुसार राजभाषा हिंदी के प्रयोग की उत्तरोत्तर प्रगति हेतु मुख्यालय के साथ इसके अधीनस्थ क्षेत्रीय केसभी पहलुओं पर भरपूर प्रयास किया जा रहा है।

निदेशक महोदय की अध्यक्षता में गठित राजभाषा कार्यान्वयन समिति की बैठक में राजभाषा अधिनियम 1963 धारा 3(3) एवं राजभाषा नियम 1976 के अनुपालन की अनिवार्यता परबल देकर नियमों का अनुपालन शत प्रतिशत सुनिश्चित किया जाता है। अधीनस्थ स्टेशनों/केंद्रों की ओर से जारी किए जा रहे संविदा एवं निविदा प्रपत्रों, नोट एवं परिपत्रों को द्विभाषीकरण कर राजभाषा अधिनियम 1963 धारा 3(3) के अनुपालन का अधिकाधिक प्रयास किया जाता है और लक्ष्यों की पूर्ति हेतु सहयोग दिया जाता है। राजभाषा नियम 1976 नियम 11 का अनुपालन हमेशा सुनिश्चित किया जाता है कि आवश्यक सामग्रियों का द्विभाषीकरणकर समय-समय पर मार्गनिर्देश दिया जाता है। क्षेत्रीय केंद्रों/अनुसंधान केंद्रों को इसके अनुपालन पर सख्त आदेश दिया जाता है और आवश्यक सामग्रियों की तैयारी की मदद दी जाती है। संस्थान की ओर सेआयोजित समारोह/बैठकों के बैनर, प्रदर्शनी बोर्ड एवं संगोष्ठी का निमंत्रण पत्र समय- समय पर द्विभाषा में तैयार किया जाता है और प्रदर्शित किया जाता है।

हिंदी समारोह

कोविड -19 महामारी के परिप्रेक्ष्य में केंद्र सरकार द्वारा जारी दिशा-निर्देशों एवं मानक प्रचालन प्रक्रिया एसओपी का अनुपालन करते हुए इस संस्थान में 14 सितंबर 2020 को निदेशक महोदया की अध्यक्षता मेंहिंदी दिवस समारोह का आयोजन किया गया। जिसमें संस्थान के कर्मचारियों ने उत्साहपूर्वक प्रत्यक्ष और परोक्ष रूप से इस कार्यक्रम में भाग लिया।अध्यक्ष महोदया ने हिंदी भाषा के महत्व एवं प्रतिवर्ष 14 सितंबर को हिंदी दिवस मनाने की आवश्यकता व्यक्त की और सभी अधिकारियों एवं कर्मचारियों से एकसाथ सहायोग की भावना से अधिकाधिक हिंदी शब्दों का प्रयोग करने की अपील की। श्री गिरिश भट्ट, उपसचिव,सामान्य प्रशासन समन्वयन, भाकृअनुप, नई दिल्ली ने हिंदी दिवस मनाने की आवश्यकता व्यक्त की। साथ-साथ भाषा की सरलता और सरकारी काम काज में प्रयोग करने की आवश्यकता पर विवरण दिया । सरकारी काम काज मेप्रयोग करने की आवश्यकता पर विवरण दिया । सरकारी काम काज में हिंदी का अधिकाधि प्रयोग करने की विधियों पर सुझाव और प्रेरणा संदेश भी दिया।

इस अवसर पर कार्यालय के स्टाफ सदस्यों के लिए और कुशल सहायक कर्मचारियों के लिए प्रत्येक रूप से प्रतियोगिताएँ आयोजित की गई और विजेताओं को पुरस्कार वितरित किए गए। सरकारी काम काज में हिंदी का अधिकाधिकप्रयोग करने वाले 4 अधिकारियों एवं कर्मचारियों को प्रोत्साहन योजना के अधीन नकद पुरस्कार वितरित किए गए ।

द्विभाषिक यांत्रिक सुविधा

- राजभाषानियम के अनुपालनहेतु कार्यालयमें उपलब्धसभी कंप्यूटरोंमेंयूनिकोड कीसुविधा प्रदान की गई। मुख्यालय और अधीनस्थ केंद्रोंमेंई- आफिस का कार्यान्वयन करतेसमयहिंदीमें काम काज करने कीव्यवस्था की गई है।

प्रबोध, प्रवीण एवं प्राज्ञ औरहिंदी टंकण प्रशिक्षण कार्यक्रम

कोविड- 19 महामारी के कारण लंबित प्रशिक्षण कार्यक्रम और परीक्षा में अनुपस्थित सभी अधिकारियों और कर्मचारियों कोप्रशिक्षण के लिए पुनः नामिति किया गया ।

संस्थान में ई-ऑफिस का कार्यान्वयन करते समय हिंदी में भी कार्य करने की सुविधा प्रदान कर ई- ऑफसि का प्रशिक्षण के साथ साथ हिंदी में मूल पत्राचार कानिर्धारित लक्ष्य (55%) को प्राप्त करने के लिए नेमी पत्र जैसे अग्रेषण पत्र, आवरण पत्र, पावती आदि का नमूना अपने अपने कंप्यूटर में अपलोड कर हिंदी में भी भेजने का प्रशिक्षण भी दिया गया और ई-ऑफसिमें टिप्पण लेखन में हिंदी का अधिकाधिक प्रयोग करने का मार्गदर्शन दिया गया।

वेबसाइट प्रदर्शन: संस्थान वेबसाइटका अद्यतन किया गया है। वेबसाइट का मानक रूप द्विभाषा में प्रदर्शित की जाती है। अद्यतन के बाद अंग्रेज़ी में प्रदर्शित विवरणों को हिंदी में भी प्रदर्शित की जाएगी।

नगरराजभाषा कार्यान्वयनसमिति, कासरगोड़

कासरगोड़ नगरमेंस्थित केंद्रीयसरकार के कार्यालय, उपक्रम, बैंकसहित३८सदस्य कार्यालयसम्मिलित नगरराजभाषा कार्यान्वयनसमिति, कासरगोड़ काराजभाषा कार्यान्वयनकार्य इस संस्थान के हिंदी अनुभाग द्वारा ही संभालता जा रहा है। इस संस्थान के निदेशक महोदय इस समिति के अध्यक्ष और सहायक मुख्य तकनीकी अधिकारी, राजभाषा सदस्य सचिव के रूप में कार्यरत है ।

डॉ अनिताकरुण, कार्यकारी निदेशक, केंद्रीय रोपण फसल अनुसंधान संस्थान की अध्यक्षता में दिनांक 21 अगस्त, 2019 को केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड में आयोजित नगर राजभाषा कार्यान्वयन समिति,कासरगोड़ की तैंतीसवीं अर्धवार्षिक बैठक के निर्णयानुसार केंद्रीय विद्यालय नं 1 सीपीसीआर आई , कासरगोड़ और केंद्रीय विद्यालय, विद्यानगर,कासरगोड़ के छात्रों के लिए प्रतियोगिताएँ आयोजित की गई। कोविड-19 महामारी के कारणनिर्णय के अनुसार केरल केंद्रीय विश्वविद्यालय की ओर से संयुक्त हिंदी कार्यशाला के आयोजन में विलंब हुआ।

संस्थान के निम्नलिखित प्रकाशनों का सारांश हिंदी में प्रकाशित किया गया:

1. केंद्रीय रोपणफसल अनुसंधान संस्थान, वार्षिक रिपोर्ट- सारांश (वर्ष 2018 -2019 एवं वर्ष 2019)

2. अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना, वार्षिक रिपोर्ट - सारांश एवं प्रस्तावना (वर्ष 2018 -2019 एवं वर्ष 19).

भाकृअनुप
ICAR

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