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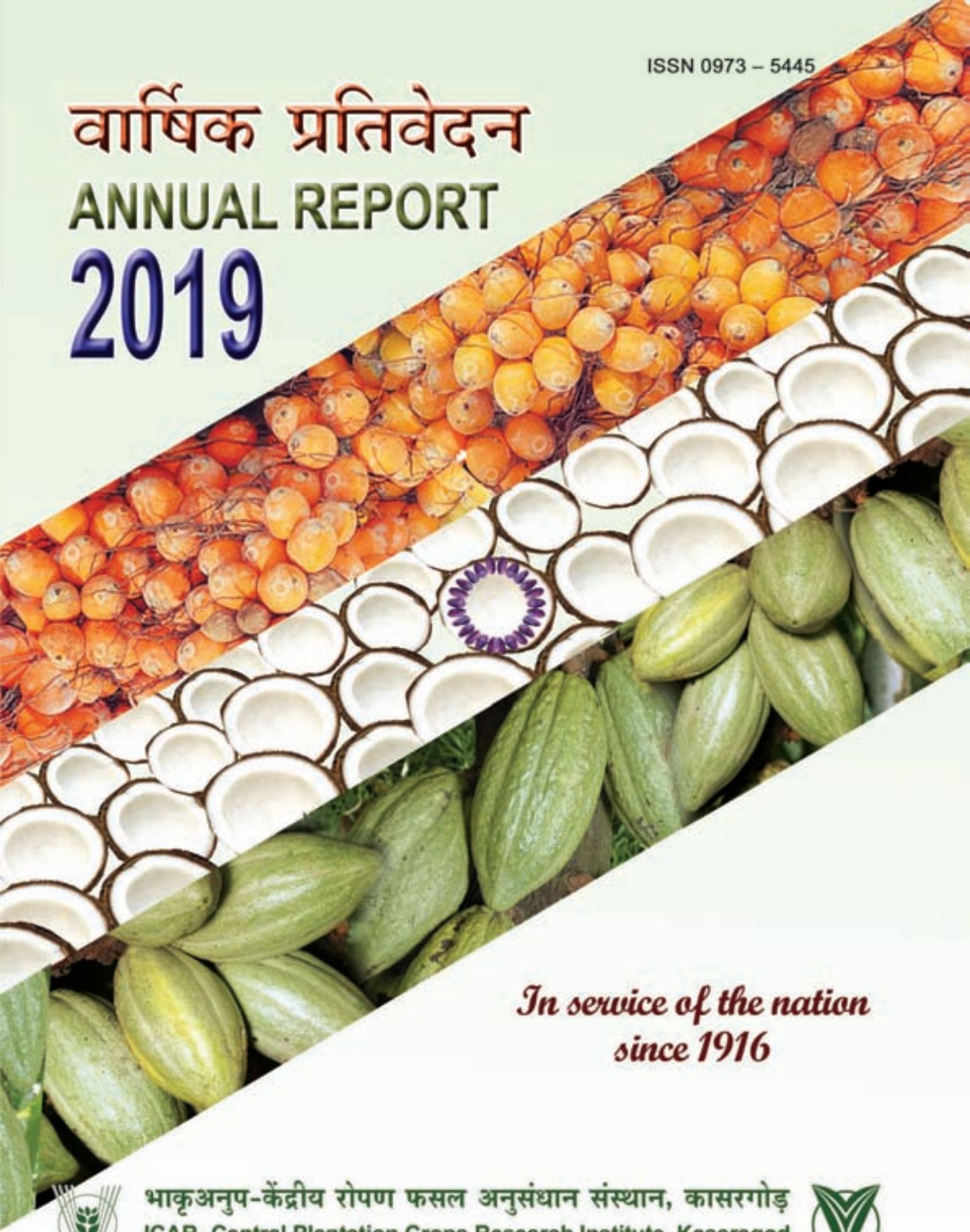

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भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़
ICAR- Central Plantation Crops Research Institute, Kasaragod
(An ISO 9001:2015 Certified Institution)

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कासरगोड, 671 124 केरल

ICAR-CENTRAL PLANTATION CROPS RESEARCH INSTITUTE
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Dr. K.V.A. Bavappa (1930 – 2019)

Founder Director of CPCRI, Kasaragod and a doyen in the research field of plantation crops

To his ideals we dedicate this Annual Report 2019

CONTENTS

प्रस्तावना

संस्थान द्वारा उसकी मुख्य फसलें नारियल, सुपारी और कोको पर किए गए मुख्य अनुसंधान और कृषक उन्मुख उपलब्धियों सम्मिलित भाकृअनुप-केंरोफअसं वार्षिक रिपोर्ट-2019 के प्रकाशन से खुश हूँ। विश्व में नारियल और सुपारी के उत्पादन में भारत का पहला स्थान है। 221.7 लाख हेक्टर के क्षेत्रफल से वर्ष 2018-19 की अवधि में देश में 213840 लाख नारियल गुठली का उत्पादन (अर्थात विश्व का 31.5 प्रतिशत अंश) प्राप्त हुआ। देश में नारियल की औसत उत्पादन क्षमता अन्य स्पर्धी देशों की तुलना में दुगुनी से अधिक लगभग 10000 गुठली/हेक्टर है। सुपारी के मामले में भारत का अंश 67 % (5 लाख हेक्टर क्षेत्रफल से 9 लाख टन) है। यद्यपि देश में कोको की उत्पादन क्षमता विश्व की औसतन से ऊपर है, 88515 हेक्टर क्षेत्रफल से 19866 टन की उत्पादन क्षमता के साथ विश्व में उभरती भूमिका है।

इस वर्ष संस्थान की ओर से एक नारियल प्रजाति 'कल्प रत्ना' का विमोचन किया गया और अत्यधिक प्रतीक्षित नारियल फूल ऊत संवर्द्धन नयाचार हासिल किया गया। नारियल पर जल-कमी तनाव पर जिनोमिक स्तर अध्ययन किया गया और नारियल का पत्ता चित्ती रोग और कवक *लासियोडिप्लोडिया थियोब्रोमे* द्वारा कोको का शीर्षारंभीक्षय के हेतुविज्ञान की पुष्टि की गई। कटाई उपरांत प्रौद्योगिकी के क्षेत्र में फोममैट सूखे नारियल दूध पाउडर के किफायती नयाचार और मृदुफल काट-छांट मशीन का विकास किया गया।

आन्ध्र प्रदेश, पदेरु बलॉक में एस टी सी का कार्यान्वयन, 14 जिले में (6 राज्यों के आर–पार फैले) और असम, कर्नाटक और केरल के बाढ़ से प्रभावित 19 जिलों में फसल नाश का निर्धारण किया गया। आलप्पुषा के पथियूर पंचायत के किसान फस्ट कार्यक्रम से यह देखा गया कि किसानों के संसाधनों के वैज्ञानिक प्रबंधन के साथ खेत की आय दुगुनी की जा सकती है।

मेसेर्स ला फेर्मे डि पीटर, तिरुनेलवेली, तमिलनाडु को नारियल नर्सरी की स्थापना के लिए 12 नारियल प्रजातियों के लाईसेंसीकरण सहित 25 अन्य प्रौद्योगिकी हस्तांतरण के सहमति ज्ञापन पर संस्थान द्वारा हस्ताक्षर अप्रैल-दिसंबर 2019 की अवधि में किए गए।

देश में कोको पर अनुसंधान प्रोत्साहित करने के रूप में एशिया-पेसेफिक को प्रजनक समूह पर अन्तर्राष्ट्रीय बैठक का मई 2019 में संस्थान द्वारा आतिथेय किया गया। कायम्कुलम में आयोजित जैविक कृषि पर कार्यशाला और कासरगोड़ और किडु में आयोजित किसान मेला और बागवानी प्रदर्शनी अन्य रोपण फसल गतिविधियों में मुख्य हैं। संस्थान प्रौद्योगिकियों के प्रमाणीकरण और फैलाव में अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना और दोनों कृषि विज्ञान केंद्रों की भूमिका अधिक संतोषजनक है।

डॉ त्रिलोचन महापात्रा, सचिव (डेयर) और महानिदेशक, भाकृअनुप, नई दिल्ली; डॉ आनन्द कुमार सिंह, उप महानिदेशक (बागवानी विज्ञान) द्वारा दिए गए प्रोत्साहन एवं मार्गदर्शन और बागवानी प्रभाग के सहयोगियों द्वारा प्रदान सहयोग के लिए आभार प्रकट करती हूँ।

सुचारु रुप से संस्थान के संचालन में प्राप्त की गई संस्थान प्रबंधन समिति और अनुसंधान सलाहकार समिति की निविष्टियों के लिए आभार प्रकट करती हूँ। किसान और अन्य हितधारकों के हित के लिए संस्थान को प्रोन्नत करने में स्टाफ सदस्यों का समर्पण और कोविड-19 अवपात के समय वार्षिक रिपोर्ट -2019 के प्रकाशन में संपादकीय टीम का प्रयास अधिक सराहनीय है।

अनिता करुण

अनिता करुण

कासरगोड़
01.07.2020

Preface

Am delighted to publish the ICAR-CPCRI Annual Report-2019 containing glimpses of important research and outreach accomplishments made by the Institute on its mandate crops coconut, arecanut and cocoa. India stands first in production of coconut and arecanut in the world. Coconut production in the country during 2018-19 was 21,384 million nuts (*i.e.*, 31.5% of world's share) from an area of 2.17 million ha. Average productivity of coconut in the country was around 10000 nuts/ha which was more than double the productivity of other competitive countries. In case of arecanut, India's share was 67% (0.9 million tonnes from an area of 0.5 million ha). Though productivity of cocoa in the country was above world average, it is seen as an emerging player in the world with a production of 19,866 tonnes of dry beans from an area of 88,515 ha.

This year, the Institute released a coconut variety 'Kalpa Ratna' and achieved a much awaited coconut inflorescence tissue culture protocol. It conducted genomic level studies on water-deficit stress on coconut and confirmed etiology of leaf blight disease of coconut and dieback disease of cocoa caused by the fungus *Lasiodiplodia theobromae*. In the area of post-harvest technology, a cost effective protocol of foam mat dried coconut milk powder and tender coconut trimming machine were developed.

Our objective of reaching the unreached attained new dimensions with the implementation of STC in Paderu block, Andhra Pradesh, SCSP in 14 districts (spread across 6 states) and crop loss assessment carried out in 19 flood ravaged districts of Assam, Karnataka and Kerala. The Farmer FIRST programme at Pathiyoor Panchayath, Alapuzha has clearly shown that farm income can be doubled with scientific management of farmers' resources.

The Institute has signed 25 MoAs for technology transfer during April-December 2019 including licensing of 12 coconut varieties to M/s La Ferme de Peter, Tirunelveli. Tamil Nadu to set up coconut nursery.

As a fillip to the research on cocoa in the country, the Institute hosted the International Meet on Asia-Pacific Cocoa Breeders Working Group during May 2019. Other important events organized were the Workshop on Organic Farming in Plantation Crops at Kayamkulam and Kisan Mela and Horti Fairs at Kasaragod and Kidu. The contribution of our AICRP-Palms and the two KVKs in validating and spreading of Institute technologies has been very heartening.

Before concluding, let me acknowledge with thanks for the support and guidance of Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR, Dr. Anand Kumar Singh, Deputy Director General (Horticultural Science) and all colleagues at the SMD. The inputs of Institute Management Committee and Research Advisory Committee are abundantly acknowledged for smooth running of the Institute. Last but not the least, the dedication of staff to promote the Institute's reach for benefit of farmers and other stakeholders, and the exercise of the editorial team for bringing out this Annual Report-2019 during the COVID-19 fallout is much appreciated.

Kasaragod
01-07-2020

Anitha Karun

III. कार्य सारांश

भाकृअनुप-केंरोफअसं के विभिन्न आंतरिक और बाह्य परियोजनाओं में अप्रैल से दिसंबर 2019 तक की अवधि में की गई मूल पहल और मुख्य अनुसंधान और कृषक उन्मुख उपलब्धियाँ इस कार्य सारांश में दर्शाई गई हैं।

आनुवंशिक संसाधन प्रबंधन एवं उपयोग

नारियल, सुपारी और कोको जननद्रव्यों के संग्रहण के लक्ष्य के अनुसार कुल 455 नारियल जननद्रव्य जातियाँ, 178 सुपारी और 515 कोको जातियाँ भाकृअनुप-केंरोफअसं के प्रक्षेत्र जीन बैंक में संग्रहण की गई हैं। युक्ता भ्रूण, जिनोमिक डी एन ए और राष्ट्रीय क्रायो जीन बैंक, भाकृअनुप-एन बी पी जी आर, नई दिल्ली में क्रमशः 14, 13, और 7 नारियल जातियों का शुष्क पराग बनाया गया है।

वर्ष 2019 में चार नारियल प्रजातियाँ जैसे कल्प सूर्या, कल्प ज्योति, कल्प हरिता और कल्प श्रेष्ठा के विमोचन और अधिसूचना के लिए सीवीआरसी ने सिफारिश की है। कल्प रत्ना जाति का डाब, खोपड़ा और पुष्परस की उच्च उपज को देखते हुए अखिल भारतीय समन्वित ताड़ अनुसंधान परियोजना की समूह बैठक में उसके विमोचन हेतु सिफारिश सीवीआरसी को प्रस्तुत किया गया है। उसको केरल, कर्नाटक और तमिलनाडु के अर्ध ऊसर क्षेत्र के तटीय मैदान में कृषि के लिए सिफारिश किया गया है।

कासरगोड, किडु, मोहितनगर और काहिकुची के नारियल जननद्रव्य संग्रहों की वृद्धि एवं उपज गुण का रिकार्ड किए गए। 15 प्यूटेटीव शीत सक्षम जो पश्चिम बंगाल से संग्रहित है, मोहितनगर में मूल्यांकनाधीन है। कासरगोड़ में नौ लंबी नारियल जातियों के लिए पुष्प रस उपज रिकार्ड किया गया और पश्चिम तट लंबी प्रजाति में उच्च कुल शक्कर, प्रोटिन और अमिनोअम्ल मात्रा पायी गयी।

आर्थिक उपज एवं फल संघटक तुलना पर तीन संकर, दो किडु में और एक कायम्कुलम में मूल्यांकन परीक्षण अध्ययन प्रगति पर है, जहाँ विभिन्न बौनी और संकर जड़ मुर्झा रोग प्रतिरोध के लिए तुलना की गई।

पैतृक लाइन्स और जननद्रव्य जाति का प्रजनन बीज के उत्पादन के लिए परागण कासरगोड़ में चुने गए जातियों में किया गया और लगभग 54 जातियों की 1236 बीज गुठलियाँ नर्सरी में बोयी गयी। चुने गए प्रजातियों/संकर और कुछ उचित संकरों के कृषक भागीदारी मूल्यांकन परीक्षण तीन स्थानों, तमिलनाडु में नागरकोविल और इरोड और कर्नाटक में दक्षिण कन्नड़ जिला में प्रगति पर है।

एसोसिएशन मैपिंग अध्ययन के भाग के रूप में 216 वासप्ररूपों के तर्कु पत्ता ऊत 14 एसएसआर मार्केर्स के साथ छानबीन किया गया। विट्टल, मोहितनगर और काहिकुची में सुपारी में उपज गुणावगुणन तीन प्रक्षेत्र परीक्षण प्रगति पर है। 25 जातियों के साथ एसएस मार्केर्स उपयोग कर सुपारी जननद्रव्य का गुणावगुणन का प्रयास किया गया।

विट्टल में उपज की तुलना में नारियल के अधीन कोको संकर 240 फली/ताड़/वर्ष के साथ वी टी एल सी पी-1 श्रेष्ठ पायी गयी। विट्टल, कासरगोड, काहिकुची, कायम्कुलम, मोहितनगर और अलियारनगर में कोको पर बहुस्थानीय परीक्षण प्रगति पर है। विट्टल में अनुरक्षित कोको जननद्रव्यों के बीच विशेष परीक्षण के साथ लक्षण विशिष्ट आनुवंशिक स्टॉक विकासन के लिए पहचान लिया गया। खुला सूर्यप्रकाश परिस्थिति में और 50%, 70% और 90% छाया में वर्द्धित कोको से उपज और वृद्धि मापदण्ड पर निरीक्षण किया गया। जून और अक्तूबर की अवधि में क्रियोलो, फोरास्टिरो और ट्रिनिटारियो कोको जाति पर किण्वन प्रक्रिया अध्ययन किया गया। क्रियोलो का बॉक्स किण्वन के लिए लगभग 4-5 दिन और फोरोस्टिरो और ट्रिनिटारियों के लिए 6-7 दिन लगे।

इस वर्ष की अवधि में कुल लगभग एक लाख नारियल, 3.34 लाख सुपारी और 0.43 लाख कोको रोपाई सामग्रियों का उत्पादन किया गया और रोपाई सामग्रियों की बिक्री से 222 लाख रुपए आय प्राप्त हुई।

कायम्कुलम में प्रशीत परिरक्षित पराग का उपयोग किया गया और तल से नियंत्रित पराग के तकनीकी के लिए परिष्कार किया गया। केरल के 12 जिले में बौनी/अर्ध लंबी प्रजातियों और संकरों के कृषक भागीदारी रोपाई सामग्री उत्पादन के लिए प्रयास किया गया। वर्ष की अवधि में बौनी नारियल से कुल 63,394 बीज गुठली की बुआई 31 विभिन्न सामुदायिक नर्सरियों में की गयी।

जैव प्रौद्योगिकीय अन्वेषण

नारियल फूल पौध के साथ ऊत संवर्द्धन परीक्षण से 2,4-डी और फ्लूरप्रिमिडोल के साथ अनुपूरित एम 72 मिडियम में प्रति पौध आठ समजातिय भ्रूण के साथ 80% कैलस प्राप्त किए गए।

भ्रूणीय प्ररोह मेरिस्टम पौध से अम्ल के निम्न स्तर में कैलस निकलने शुरु हुआ। मीडियम में 4-क्लोरोफेनॉक्सिएसेटिक एसिड की उच्च सांद्रण में एक वर्ष आयु पौध के प्ररोह मेरिस्टम के साथ कैलस प्रारंभ अधिक पाया गया। ग्रीन संश्लेषित AgNP (50 और 100 मि.ग्राम प्रति लीटर) नानोपार्टिकल्स के साथ परीक्षण से कम जीवाणु संदूषण के साथ नारियल भ्रूणीय प्ररोह मेरिस्टम से कैलस निकलने में अनुकूल प्रतिक्रिया पायी गयी।

सुपारी पुष्प ऊत संवर्द्धन नयाचार सुधार पर किए गए परीक्षण से (i) मीडियम में आल्फा और बीटा सैक्लोडेक्सट्रिन मात्रा 10 मि. ग्रा. प्रति लीटर से कम (ii) 0.25 से 0.5 ग्रा प्रति लीटर दर में कोयला (iii) IAA (6.58 uM) और IBA (4.9 uM) के साथ अनुपूरित मीडियम में ताज़ा मूल प्रारंभ प्राप्त किया गया। (iv) प्ररोह के लिए और पूर्ण रूप से वर्द्धित पौध के लिए 20-30 ग्रा प्रति लीटर माल्टोस।, नारियल में कुल 6,052 प्यूटेटिव IncRNAs (लॉंग कोडिंग क्षेत्र RNA) पहचान लिया गया ।

और नारियल कैली में संरक्षित और नोवल miRNAs पहचान लिया गया । छोटा RNA अनुक्रमणन से नारियल के भ्रूणीय प्ररोह मेरिस्टम से उपपत्ति (एम्ब्रियोजेनिक) भ्रूणोद्भवीय और नॉन भ्रूणोद्भवीय कैली संरक्षित और नॉवल miRNAs पहचान लिया गया।

पूरा जिनोम आंकडे पक्तिबद्ध करने से चौघाट नारंगी बौनी नारियल में इक्कीस ए आर एफ ऑक्सिन रसपोन्स फाक्टर पहचान लिया गया । MEGA7 संरेखण अध्ययन से आठ CnARFòs के बीच ग्लुटामिन, सेरैनठ, और ल्यूसिन समृद्ध ज़ोन की मौजूदगी व्यक्त हुई।

फसलन पद्धति और संसाधनों का प्रबंधन

काली मिर्च, केला, चारा घास, डायरी एकक, मुर्गीपालन और मत्स्यपालन के साथ एक हेक्टर क्षेत्रफल की नारियल आधारित फसलन पद्धति से 7,67,568 रुपए प्रति हेक्टर आय प्राप्त हुई।

डायरी एकक और मत्स्यपालन संघटक की सुपारी आधारित मिश्रित फसलन पद्धति से 10,15,168 रुपए प्रति हेक्टर प्राप्त किया गया।

मृदा गहराई, मृदा बनावट, मृदा जल निकासी और मृदा पी एच के लिए मृदा दबाव विषय मानचित्र पूरा तमिलाडु राज्य के लिए उत्तम नारियल खेती में मदद के लिए विकसित किया गया।

कल्पपोषक, नारियल का एक पोषण मिश्रण की क्षमता का प्रक्षेत्र मूल्यांकन से यह देखा गया कि कल्पपोषक से उपचारित ताड़ों में साठ प्रतिशत में फूलन शुरु किया गया और कल्प संकरा में रोपाई के 27 महीने के बाद, युवा अवस्था की अवधि कम कर फलन शुरु हुआ।

कोको प्रजाति नेट्रासेंचुरा का कलमन सुपारी के साथ अंतर फसल के रूप में 5 विभिन्न अंतरालन में 650 से 3712 पौध प्रति हेक्टर दर की रोपाई सघनता में की गई। प्रारंभिक वर्ष में निकट रोपित ग्राफ्ट (586-2335 कि.ग्रा प्रति हेक्टर) में प्रति हेक्टर बीन उपज सामान्य अंतराल 136 कि.ग्रा प्रति हेक्टर अधीन ग्राफ्ट की तुलना में महत्वपूर्ण तथा उच्च पायी गयी।

सुपारी का पीला पत्ता रोग प्रबंधन पर किया गया प्रक्षेत्र परीक्षण में मानसून (जून-अक्तूबर) अवधि में मल्च शीट के साथ मल्चिंग करने से रोग लक्षण कम करने में सहायक पाया गया (विशेषतः जब प्रारंभिक लक्षण कम होते हैं), उपज की वृद्धि होती है और गिर पडी गुठलियों के संग्रहण में सुविधा, कम घासपात, अलवाल में कॉप्पर जमा कम होना और मिट्टी से पोषण का निक्षालण हो जाता है।

कोको अवशेष का कंपोस्ट बनाना और कोको फली छिल्के और बीन अष्टी कचड़े से बायोचार उत्पादन का मानकीकरण किया गया। भरणिकाव पंचायत, आलप्पुषा जिला, केरल में किसानों के खेतों में जड़ मुर्झा रोग प्रभावित खेतों में नारियल का जैविक पोषण प्रबंधन किया जा रहा है।

यथावत् जैविक सामग्रियों का पुनचक्रमण + पीजीपीआर कंसोर्शिया + यथावत् हरा खाद डालना + छिल्का बिछाना + सल्फेट ऑफ पोटाश का प्रयोग कर 50 प्रतिशत शुपार्शित पोटाश और यथावत् जैविक सामग्री का पुनचक्रमण + पी जी पी आर कंसोर्शिया + यथावत् हरा खाद प्रयोग + छिल्का बिछाना + सल्फेट ऑफ पोटाश के प्रयोग से 50 प्रतिशत शुपार्शित पोटाश + स्वस्थाने जैविक सामग्री पुनचक्रमण + पीजीपीआर कंसोर्शिया + यथावत् हरा खाद प्रयोग + 25 कि. ग्रा. गोबर + सल्फेट ऑफ पोटाश के प्रयोग से शुपार्शित पोटाश का 50 प्रतिशत से अधिकतम गुठली भार (क्रमशः 1307 ग्रा और 1417 ग्रा) और क्रमश 187 ग्रा 182 ग्रा. खोपड़ा मात्रा प्राप्त किया गया। जड़ मुर्झा रोग का प्रक्षेत्र सक्षम नारियल ताड़ के जड़ ऊत से तीन अन्तारोही एकलित किया गया, 16S rDNA अनुक्रम विश्लेषण द्वारा बेसिलस सबिटलस (CREò2 & CREò9) और *बी षेक्लेटानीइ* के जैसे, पहचान लिया गया कि उसे प्रबल IAA उत्पादन और रोग प्रबंधन के लिए नाईट्रोजन यौगीकरण क्षमता का परीक्षण किया जा रहा है। इसी प्रकार 16S rDNA फिल्लोप्लेन एक्टिनोबाक्टीरिया स्वास्थ नारियल पत्ते से पहचान लिया गया जिसे पत्ता रोग सड़न प्रबंधन की क्षमता हो, *स्टेप्टोमैसेस आम्फोटेरिसिनिकस स्ट्रेइन* IH-SSA8 का निकट मिलान है।

ताड़ों और कोको में कीटों का समीकृत प्रबंधन

कवक *लासिडिप्लोडिया थियोब्रोमे* एक मुख्य रोगाणु के रूप में उभरा है, जो नारियल में तीक्ष्ण पत्ता चित्ती रोग और कोको में शीर्षारंभीक्षय रोग का कारक है। राइबोसोमल आर एन ए का आंतरिक ट्रान्स्क्राइब्ड स्पेसर क्षेत्र अनुक्रमण द्वारा रोगहेतु विज्ञान की पुष्टि की गई।

नारियल बाग में अंतर फसल के रूप में ड्रागन फल भी जल भीगा और मृदुल रूप से सड़ गला फूल और फल जैसे प्रभावित देखा गया । *करवुलेरिया इरग्रास्टिडिस* इस रोग के रोगाणु के रूप में पहचान लिया गया है। कर्नाटक के शिवमोगा जिला में सुपारी में पत्ता धारी/चित्ती रोग *पन्टोइया* जाति के रूप में पहचान लिया गया और जैवरासायनिक गुणवगुणन और 16S rRNA जीन अनुक्रम विश्लेषण द्वारा पुष्टि की गई।

कनार्टक के मूलपरिवेश सुपारी आधारित पारिस्थितिक तंत्र मूल परिवेश से कुल 186 ट्रैकोडेरमा एकलन प्राप्त किया गया। जो *ट्रैकोडेरमा एस्पेरेल्लम टी. हमाटम, टी. हरज़ियानम और टी.विरेंस* के साथ 99.5 प्रतिशत से अधिक समानता दिखाया । सुपारी के गेनोडेरमा लूसिडम रोगाणु के विरुद्ध विषाणु का परीक्षण प्रगति पर है।

केंरोफअसं, क्षेत्रीय केंद्र, विट्टल में सुपारी फूलों का शीर्षारंभक्षयी रोग के विरुद्ध चुने गए छह फफूंदनाशी का दो दौर रोग निरोधी फुहारण से 25% EC कारबन्डासिम + 12% SC *फ्लूसिलाज़ोल* के उपचार में बहुत कम रोग लक्षण (6.12%) और बाद में 25% EC प्रोपिकोनज़ोल से रोग लक्षण 9.62% कम पाया गया।

कीट एवं सूत्रकृमियों का समीकृत प्रबंधन

स्थानीय *ओरिक्टस राईनोसेरस* नुड़िवाईरस प्रति ओएस मोड के साथ संक्रामिकता अध्ययन से राईनोसेरस भृंग में 82%-85% प्रतिशत संवेदनशीलता पायी गयी कि यह देश में राईनोसेरस भृंग गुआम स्ट्रेन के अभाव को सूचित करता है। दक्षिण पेसफिक गुआम द्वीप से सी आर बी-जी हाप्लोटाइप का रिपोर्ट किया गया और *ओरिक्टस रोइनोसेरस नुडिवाइरस* का इस पर कोई प्रभाव नहीं है।

लाल ताड़ घुन, *रिंकोफोरस फेरुजिनियस* ओलिवर की ग्रब क्रियाशीलता का कंपन सिग्नल पर आधारित स्मार्ट डिटेक्शन सेंसर से कीट को पूर्व पहचानने का एक नया उपकरण हैं।

मान्ड्या, कर्नाटक से नारियल पर नया नवोष्णकटिबांधी ताड़ सफेद मच्छर *अल्यूरोट्राकेलुसट्रेटस* देखा गया । केरल के नारियल मे बोन्डार्स नेस्टिंग सफेद मच्छर *पी. बोन्डारी* को ग्लोस सर्पिल सफेद मच्छर *अल्यूरोडिकस रुजियोपरक्यूलेटस* द्वारा प्रतिस्पर्धा विस्थापन से पराजित किया जाता है।

कीट का पारिस्थितिक प्रबंधन के लिए सफेद मच्छर समूह के विरुद्ध वनस्पतीय फोरमुलेशन आधारित अज़ाडिराक्टिन फुहार का मूल्यांकन किया गया। उपचार के चौदह दिन के बाद नीमज़ाल (1%) से उच्चतम मृत्युदर (40-50%) पायी गयी और नियंत्रण और अन्य परीक्षित मात्राओं की तुलना में उपचारित पत्तों पर नई कॉलोनी नहीं पायी गयी।

नारियल में सर्पिल सफेद मच्छर के प्रबंधन के लिए *सिंप्लिसिल्लियम* जाति, एक कीटरोगजनक कवक का उत्पादन किया गया। पके नारियल के पानी से उच्चतम बीजाणु संख्या, मांड की अपेक्षा, पाई गई।

पोल्लाच्ची, तमिलनाडु में तना स्त्रवण प्रभावित नारियल ताड़ों में स्कोलिटिड

भृंग, *ज़ाइलेबोरस पेरफोरेन्स* और टेनेब्रियोनिड भृंग *कोरटिसेसिफल्म* फाइमाइर देखा गया । इस रोग के साथ इन भृंगों का परस्पर संबंध पर आधारित निरीक्षण प्रगति पर है ।

पैरा फिल्म का उपयोग कर ईपीएन संक्रमित *जी.मेल्लोनेल्ला काडावेर* की पैकिंग विकसित की गयी जिसको रोपण पद्धति में मृदा जन्म कीटों *(ल्यूकोफोलिस* जाति) को तितर-बितर करने और संक्रमण की क्षमता अधिक है। सूत्रकृमि का एन हैड्रोबायोटिक अनुजीवन तत्व पर आधारित न्यूनतम मूल्य ईपीएन संरूपण विकसित किया गया। कीटरोग जनक सूत्रकृमि, फोटोरेबडस H12H, का जीवाणुवीय सहजीवी नारियल पत्ता सड़न कवक *कालटोट्राइकम ग्लियोस्पोरीयोडिस* और फ्यॅसेरियम जाति का निरोध करता है।

कीटरोग जनक कवक, *मेटाराइज़ियम एनिसोप्लिए* के साथ प्राकृतिक संक्रामित प्रौढ़ चाय मच्छर कीड़ा का संग्रहण और एकलन कोको बाग से किया गया। इन एकलन प्रौढों की पूर्ण मृत्युदर की पुष्टि की गई।

जनवरी से नवंबर 2019 की अवधि में कोको पेड़ में मुर्झा लक्षण पाया गया और रिकार्ड किया गया। यह पुष्टि की गई है कि इस रोग का कारक एम्ब्रोसिया भृंग *यूवाल्लेसिया फोरनिकाटस* है।

शरीरक्रिया विज्ञान, जैव रसायन एवं ताड़ और कोको में मूल्य श्रृंखला प्रबंधन

नारियल पौध के साथ ओ टी सी परीक्षण में कारबनडायऑक्साइड सांद्रण वृद्धि से प्रकाश संश्लेषण 45% बढ़ जाती है जिससे उच्च जैव भार संचयन होता है और नारियल की पूर्ण पौध जल उपयोग क्षमता में सुधार आ जाता है। चैम्बर नियंत्रण में 36 डिग्री सेंटिग्रेड के विरुद्ध ई टी उपचार में उच्च ताप लगभग 39 डिग्री सेंटिग्रेड का प्रकाश संश्लेषण, पत्ता जल क्षमता और जैव भार संचयन पर प्रभाव पूर्ण-रूप से तीक्ष्ण है।

एम जी डी प्रजाति की बौनी नारियल पौधों को सागर पानी प्रतिस्थापन की सक्षमता स्तर का अध्ययन किया गया और 10% तक सागर पानी का प्रतिस्थापन का पौधों की शरीरक्रिया विज्ञान और जैवरसायन विज्ञान पर कोई प्रभाव नहीं पाया गया और भूमिगत जल सिंचाई के साथ समान पाया गया। नारियल का परागण जीवविज्ञान पर विभिन्न ताप और आर्द्रता का स्वस्थानी प्रभाव ताप और आद्रता मापक नियंत्रक उपयोग कर अध्ययन किया गया। यह निरीक्षण किया गया कि 29 डिग्री सेंटिग्रेड का व्यापक तापमान की तुलना में मादा फूल ग्रहणशीलता, पराग अंकुरण और पराग ट्यूब वृद्धि 33 और 35 डिग्री सेंटिग्रेड पर विशाल रूप से प्रभावित है।

झिल्ली स्थिरता सूचकांक के अध्ययन से जल-कमी तनाव का प्रोटाप्लाज्मिक सक्षमता और परासरणीय अनुकूलन से संबंधित जैवरसायनिक सूचनाएँ नारियल पौध में समझा जा रहा है। वासप्ररूप एफएमएसटी, जीबीजीडी, जे टी और के डी जल कमी तनाव के ऊपर एम एस आई में 48.2%, 26.47%, 17.19%, और 13.81% वृद्धि नियंत्रण की तुलना में दिखी।

फोम मैट सूखा नारियल दूध चूर्ण के लिए विकसित नयाचार का उन्नयन किया गया। माल्टोडेक्स्ट्रिन के मिलाव के बाद प्राप्त चूर्ण उपज 33±0.7% थी।

प्रौद्योगिकी हस्तांतरण, आर्थिकी और सॉख्यिकीय विधि

किसानों के बृहत दल ने इस वर्ष भर इस संस्थान और इसके क्षेत्रीय केंद्रों का संदर्शन किया। संस्थान द्वारा विकसित प्रौद्योगिकियों की जानकारी प्रदान करने के लिए नारियल विकास बोर्ड, कृषि/बागवानी विभाग, राज्य सरकार, आत्मा और अन्य एजेंसियों के सहयोग के साथ 90 प्रशिक्षण कार्यक्रमों का आयोजन किया गया। इन कार्यक्रमों से 3328 से अधिक कृषकों ने लाभ उठाया। विस्तार कार्मिकों के लिए 21 प्रशिक्षण कार्यक्रम आयोजित किया गया। लक्षद्वीप के चुने गए किसानों के लिए एन एच बी और ई डी पी से वित्तीय सहायता के साथ नारियल का जैविक उत्पादन और मूल्य वर्द्धन पर दो बैचों में विस्तार कार्मिकों के लिए 21 प्रशिक्षण कार्यक्रम आयोजित किया गया।

केरल के छह जिले में फैल गए 60 नारियल बागों में नारियल की उत्पादन क्षमता बढ़ाने के लिए स्वास्थ्य प्रबंधन पर और असम में सुपारी बाग में बहु जातिय फसलन पद्धति पर विशेष प्रदर्शनी आयोजित की गई।

वीडियो सम्मेलन सहित 27 किसान-वैज्ञानिक अभिमुख बैठक आयोजित की गयी जिसमें कुल 1120 किसानों ने भाग लिया। इस अवधि में दो किसान मेले, एक किडु में और एक कासरगोड़ में आयोजित किए गए। तकनीकी बुलेटिन, विस्तार फॉल्डर्स और ई-बुक सहित 7 प्रमुख प्रकाशनों का प्रकाशन संस्थान द्वारा किया गया। मेरा गॉव मेरा गौरव के अधीन कुल 68 गॉवों में पहल प्रारंभ किया गया। 141 प्रक्षेत्र संदर्शन में 1262 किसान, 29 अभिमुख कार्यक्रम 108 प्रौद्योगिकी प्रदर्शनियॉ और 35 प्रशिक्षण कार्यक्रम आयोजित किए गए। आई टी डी ए, पदेरु, आन्ध्र प्रदेश के सहयोग से अनुसूचित जाति संघटक गतिविधियॉ आयोजित की गई। कोको खेती पर एक ईडीपी कासरगोड/विट्टल में और तीन एक दिवसीय कार्यक्रम पदेरु क्षेत्र में आयोजित किया गया। 6250 काजू ग्राफ्ट्स, 10000 कोको पौध और उर्वरक सहित संकटकालीन निवेशों की पूर्ति की गई।

अनुसूचित जाति उप योजना के अधीन छह राज्यों में फैले 13 जिले में गतिविधियॉ आयोजित की गई। दो ई डी पी (कटाई पूर्व एवं उपरांत उपकरण और मधुमक्खी पालन एवं संभावना) और नौ प्रशिक्षण कार्यक्रम आयोजित किया गया। नर्सरी की स्थापना के लिए 58,000 नारियल बीज (चार जिले) मुर्गीपालन पक्षी और पिंजरे, मधुमक्खी बॉक्स, फार्म उपकरण, अन्य फसलों की रोपाई सामग्री आदि संकटकालीन निवेशों की पूर्ति की गई।

पथियूर पंचायत में 1000 किसान परिवारों के 1627 हेक्टर क्षेत्रफल में किसान फस्ट परियोजना का कार्यान्वयन किया गया। जिसमें वैज्ञानिक प्रौद्योगिकी पूर्ति के साथ संसाधन समीकरण द्वारा किसानों के आय दुगुना की साध्यता प्रकट की गयी। भागीदारी द्वारा 24.5% किसानों ने उनकी आय दुगुना कर ली, 37.5% किसानों ने आय 1 से 1.5 गुना बढ़ायी और 38% से अधिक लोगों ने बेसलाइन आंकड़े की तुलना में आय 1.5 गुना से ज्यादा बढ़ायी।

असम में जुलाई 2019 में 13 बाढ़ प्रभावित जिले में किए गए प्रक्षेत्र सर्वेक्षण से 21,277/- लाख रुपए सुपारी में और 19,793/- लाख रुपए की नारियल उपज नष्ट हुई है। फसल नाश के रूप में सुपारी में 109,471/- लाख रुपए की आर्थिक हानि और नारियल में 19,793/- लाख रुपए की आर्थिक हानि और नारियल में 19,793/- लाख रुपए की हानि हुई है।

IV. Executive Summary

The important research and outreach achievements obtained and key initiatives undertaken during the period April to December 2019 in the different projects of ICAR-CPCRI are highlighted in this executive summary.

Genetic Resources Management and Utilization

ICAR-CPCRI is presently conserving 455 germplasm accessions of coconut, 178 of arecanut and 515 of cocoa in the field gene banks. Cryo-conservation in the form of zygotic embryo, genomic DNA and desiccated pollen of respectively 14, 13 and 7 coconut accessions were made at National Cryo Gene Bank, ICAR-NBPGR, New Delhi.

During 2019, the CVRC has recommended the release of four coconut varieties proposed by ICAR-CPCRI, *viz*., Kalpa Surya, Kalpa Jyothi, Kalpa Haritha and Kalpa Shrestha. The release of variety Kalpa Ratna was recommended for submission to the CVRC considering its high yield of tender nuts, copra and inflorescence sap in the 28th Annual group meeting of AICRP on Palms at TNAU, Coimbatore during June 2019. It is recommended for cultivation in Kerala, Karnataka and semi-arid region of Tamil Nadu.

The growth and yield characters of the coconut germplasm accessions at Kasaragod, Kidu, Mohitnagar and Kahikuchi were recorded. The inflorescence sap yield was recorded for nine tall coconut accessions at Kasaragod. West Coast Tall (WCT) variety was found to possess high total sugar, protein and amino acid contents. At Mohitnagar 15 coconut lines from West Bengal are under evaluation for cold tolerance.

Assisted pollination for production of breeder seed of parental lines and germplasm accessions was undertaken in selected accessions at Kasaragod and about 1236 seed nuts of 54 accessions were sown in the nursery.

As part of association mapping studies, spindle leaf tissue DNA of 216 genotypes of coconut (distributed among 16 accessions) were subject to screening with 14 SSR markers. Characterization of using SSR markers arecanut 25 germplasm accessions.

Cocoa hybrid VTLCP-1 was found superior with 240 pods /tree /year under coconut and found promising in comparative yield trial at Vittal. Multi-location trial on cocoa is in progress at Vittal, Kasaragod, Kahikuchi, Kayamkulam, Mohitnagar and Aliyarnagar.

Fermentation studies on Criollo, Forastero and Trinitario cocoa types were carried out during June and October. Box fermentation of Criollo was found to take about 4-5 days, while for Forastero and Trinitario it is 6-7 days.

During the year, a total of about one lakh coconut, 3.34 lakh arecanut and 0.43 lakh cocoa planting materials were produced and distributed: Revenue generation from sale of planting material is Rs.222 lakhs.

At Kayamkulam, cryo-preserved pollen was being used for pollination and refinement was made for the technique of controlled-pollination from ground.

Farmer participatory planting material production of dwarf/semi tall varieties and hybrids was carried out in 12 districts of Kerala. During the year, a total of 63,394 seed nuts from dwarf coconuts were sown to raise seedlings in 31 different community nurseries.

Biotechnological Investigations

Tissue culture experiment with coconut inflorescence explants resulted 80% callusing with up to eight somatic embryos per explant in M72 medium supplemented with 2,4-D and flurprimidol. Experiment with embryonic shoot meristem explants provided callus initiation at lower levels of 4-Chlorophenoxyacetic acid (4-CPA); with shoot meristem of one year old seedling, callus initiation was more with higher concentration of 4-CPA in the medium.

The experiment with Green Synthesized AgNP (50 and 100 mg l^{-1}) nanoparticles indicated positive response on callus initiation from coconut embryonic shoot meristem with reduced bacterial contaminations.

Experiments on improving arecanut inflorescence tissue culture protocol indicated (i) and cyclodextrin content in the medium be < 10 mg l^{-1}; (ii) Charcoal @ 0.25 to 0.5 g l^{-1}; (iii) Initiation of fresh roots obtained in medium supplemented with IAA (6.58 µM) and IBA (4.9 µM); and (iv) Maltose at 20 to 30 g l^{-1} for shoot and root growth of fully grown plantlets.

In coconut, a total of 6,052 putative lncRNAs (long coding region RNA) were identified and a set of conserved and novel miRNAs were identified in coconut calli. A set of conserved and novel miRNAs were identified inembryogenic (EC) and non-embryogenic calli (NEC), derived from embryonic shoot meristem of coconut, through small RNA sequencing.

Twenty one *ARF* (Auxin Response Factor) genes were identified in Chowghat Green Dwarf coconut by aligning whole genome data. The MEGA7 alignment study revealed the presence of glutamine (Q), serine (S) and leucine (L) enriched zones among the eight *CnARF*s indicating their potentiality to serve as transcriptional activators.

Cropping Systems and Management of Resources

Coconut based farming system model with pepper, banana, fodder grass, dairy unit, poultry and aquaculture, gave an income of Rs. 7,67,568 per ha was obtained. In the arecanut based mixed farming system with dairy and fishery components, the income was Rs. 10,15,168 per ha.

Soil constraint thematic maps for soil depth, soil texture, and soil drainage and soil pH were developed for the entire Tamil Nadu state to aid in better coconut cultivation.

Field evaluation of the efficiency of 'Kalpa Poshak', a nutrient mix for coconut, indicated that 60% of the palms treated with Kalpa Poshak initiated flowering and nut bearing in Kalpa Sankara hybrids at 27th month after planting thus reducing the period of juvenile phase.

Grafts of cocoa variety Nethra Centura were planted as an intercrop with arecanut (var. Nalbari) in 5 different spacing with planting density ranging from 650 to 3712 plants per ha. During the initial years, the wet bean yield per hectare was significantly higher in closely planted grafts (586 – 2335 kg ha^{-1}) than grafts under normal spacing (136 kg ha^{1}) due to higher plant population and higher yield per plant.

In field trials on yellow leaf disease (YLD) management of arecanut, mulching with mulch sheets during monsoon (June-October) was found to reduce the disease symptoms (especially when the initial symptom is low), increase the yield and ease the collection of fallen nuts, and reduced the weed growth, deposition of copper in the basin and leaching of nutrients from the soil during monsoon.

Composting of cocoa residues and biochar production from cocoa pod husks and bean shell wastes were standardized.

In the organic nutrient management of coconut in root (wilt) disease tracts at farmers plot in Bharanikkav panchayath, Alappuzha district, Kerala, the treatments of *in situ* organic matter recycling, + PGPR consortia + *In situ* green manuring + Husk burial+ 50 % recommended K_20 through the application of sulphate of potash and *in situ* organic matter recycling, + PGPR consortia + *in situ* green manuring + 25 kg cow dung+ 50 % recommended K_20 through the application of sulphate of potash showed maximum nut weight (1307g and 1417g) respectively and copra content of 187g and 182g respectively.

Three endophytes isolated from root tissues of RWD field resistant coconut palms, identified by 16s rDNA analysis as *Bacillus subtilis* (CRE 2 & CRE 9) and B. *shackletonii* (CRE 15) having strong IAA production and N-fixing capacity are being tested for the disease management.

Similarly, phylloplane actinobacteria, identified by 16S rDNA closely matching to *Streptomyces amphotericinicus* strain 1H-SSA8 from healthy coconut leaves have potential for leaf-rot disease management in coconut palms.

Integrated Management of Diseases in Palms and Cocoa

The fungus *Lasiodiplodia theobromae* has emerged as a major pathogen, causing severe leaf blight disease in coconut and dieback disease in cocoa. Etiology was confirmed by sequencing the internal transcribed spacer region of ribosomal RNA.

Dragon fruit as intercrops in coconut gardens was affected by water-soaked, soft rot in both flowers and fruits. The pathogen of this disease was identified as *Curvularia eragrostidis*.

The pathogen of the emerging leaf stripe/blight diseases in arecanut in Shivamoga Distirict of Karnataka was identified as *Pantoea* spp. and confirmed by biochemical characterization and 16S rRNA gene sequence analyses.

A total of 186 *Trichoderma* isolates obtained from arecanut based ecosystem rhizosphere of Karnataka showed >99.5% similarity with *Trichoderma asperellum*, *T. hamatum*, *T. harzianum* and *T. virens*. Testing of virulence against *Ganoderma lucidum* pathogen of arecanut is under progress.

Two rounds of prophylactic spraying of six selected fungicides against arecanut inflorescence dieback disease showed that very less disease incidence (6.12%) in Carbendazim 25% EC + Flusilazole 12.5% SC treatment followed by Propiconazole 25% EC (9.62%), at CPCRI regional station, Vittal.

Integrated Management of Pests and Nematodes

Infectivity studies with local *Oryctes rhinoceros* nudivirus (OrNV) per os mode gave 82%-85% susceptibility in rhinoceros beetle grubs indicating the absence of coconut rhinoceros beetle -Guam (CRB-G) strain in the country. The CRB-G haplotype was reported from South-Pacific Guam Island and found insensitive to the *Oryctes rhinoceros* nudivirus.

Smart detection sensors based on vibration signals of grub activity of red palm weevil, *Rhynchophorus ferrugineus* Olivier, was found as an innovative tool for early detection of the pest.

New Neotropical palm whitefly, *Aleurotrachelusatratus* was observed on coconut from Mandya, Karnataka. In coconuts of Kerala, Bondar's nesting whitefly, *P. bondari* slowly got overpowered by rugose spiralling whitefly, *Aleurodicus rugioperculatus* by competitive displacement principle.

Spraying Azadirachtin based botanical formulation was evaluated against whitefly complex for ecological management of the pest. At 14 DAS, Neemazal (1%) caused highest mortality (40 – 50 %) and no new colony formation was noticed on the treated leaves, when compared to control and other doses tested

Simplicillium sp., an entomopathogenic fungus, for management of spiralling white fly in coconut was mass producted in soild and liquid carriers. Coconut water broth was found to give highest spore count followed by rice water broth in the different liquid carriers tested.

Association of a scolytid beetle, *Xyleborus perforans* and a tenebrionid beetle, *Corticeusfilum* Fairmaire was observed in stem bleeding disease affected coconut palms in Pollachi, Tamil Nadu, Inter-relationship observations of these beetles with the disease are under progress.

A packaging of EPN-infected *G. mellonella* cadaver using parafilm was developed which has greater ability to disperse and infect soil borne pests (*Leucopholis* spp.) in the plantation system. A low cost EPN formulation based on the principle of anhydrobiotic survival of nematode was developed.

A bacterial symbiont of entomopathogenic nematode, *Photorhabdus* H12H, was found to inhibit both of the coconut leaf rot fungi, *Colletotrichum gloeosporioides and Fusarium* sp.

Adult tea mosquito bugs with entomopathogenic fungus *Metarhiziumanisopliae* grown on the body were collected from cocoa gardens. The adult bugs were then subjected to fungal isolates resulted in complete mortality.

During January to November 2019, cocoa trees showing wilting symptoms were identified and recorded. It was confirmed that ambrosia beetles *Euwallacea fornicatus* was responsible for this.

Physiology, Biochemistry and Value Chain Management in Palms and Cocoa

In an OTC experiment with coconut seedlings, increasing CO_2 concentration increased the rate of photosynthesis (Pn) by 45% which, resulted in high biomass accumulation, thus improved the whole plant water use efficiency (WUE) of coconut. The impact of high temperature (Tmax) around 39°C in ET treatment against 36°C in chamber control is quite severe on net photosynthesis (Pn), leaf water potential (psi) and biomass accumulation.

Level of tolerance of dwarf coconut seedlings of MGD variety to sea water substitution has been studied and upto 10% substitution of sea water was found not to affect the physiology and biochemistry of seedlings and it was found to be on par with ground water irrigation.

Using a temperature and humidity controller device the *in situ* effect of different temperatures and humidity was studied on pollination biology of coconut. It was observed that compared to the ambient temperature of 29 °C, the female flower receptivity, pollen germination and pollen tube growth was greatly affected at 33 °C and 35 °C.

Biochemical information pertaining to the protoplasmic tolerance to the water-deficit stress and osmotic adjustments has been elucidated in coconut seedlings by studying the membrane-stability index (MSI). The genotypes, FMST, GBGD, JT and KD showed 48.2%, 26.47%, 17.19% and 13.81% increase in MSI upon water-deficit stress, respectively, compared to the control seedlings.

A protocol developed for the foam mat dried coconut milk powder has been upscaled. The yield of powder obtained after the addition of maltodextrin was 33±0.7%.

Preservation of coconut gratings under ambient condition revealed that without any preservatives in laminated pouch the gratings could stay free of spoilage for a maximum of 24 h in ambient and 4 days under refrigerated condition. Addition of the additives to the grated coconuts improved its shelf life to 7 days under ambient and 24 days under refrigerated conditions.

A ready to eat extrudate of coconut milk residue blended with foxtail millet flour, rice flour and corn flour was developed.

Technology Transfer, Economics and Statistical Methods

A large contingent of farmers has visited the Institute and its Regional Stations throughout the year. To make them aware of the technologies developed by the Institute, a total of 90 training programmes were organized in collaboration with Coconut Development Board, State Department of Agriculture/Horticulture, ATMA and other agencies. More than 3328 farmers were benefitted by these programmes. For extension personnel, 21 trainings were organized. With financial support from NHB, an EDP on 'Organic production of coconut and value addition' was organized for two batches of selected farmers from Lakshadweep Islands.

Frontline Demonstration on soil health management for enhancing productivity of coconut was conducted in 60 coconut gardens spread over six districts of Kerala, and the multi species cropping system in arecanut was demonstrated in Assam.

Twenty seven farmer-scientist interface meetings including video conferences were conducted in which a total of 1120 farmers have attended. Two Kisan Melas were held during the period, one at Kidu and the other at Kasaragod. Seven important publications including technical bulletins, extension folders, and e-books were brought out from the Institute.

Under 'Mera Gaon Mera Gaurav' initiative, a total of 68 villages were covered. Highlights are 141 field visits covering 1262 farmers, 29 interface programmes 108 technology demonstrations, and 35 training programmes.

The Scheduled Tribe Component (STC) activities were conducted in collaboration with ITDA, Paderu, Andhra Paradesh. One EDP on cocoa cultivation was organized at Kasaragod/Vittal and three one-day programmes at Paderu region. Critical inputs supplied the farmers include 6250 cashew grafts, 10000 cocoa seedlings, and fertilizers.

Activities under Scheduled Caste Sub Plan were carried out in 14 districts spread across six states. Two EDPs (Pre- and post-harvest equipments and Honey bee farming and Prospects) and 9 training programmes were conducted. Supply of critical inputs include coconut seed nuts for raising nursery – 58,000 (four districts); poultry birds and cages; honey bee boxes; farm implements; and planting material of other crops.

The Farmer FIRST project implemented in Pathiyoor panchayath covering an area 1627 ha and involving 1000 farm families clearly brought out the possibility of doubling farmer's income by resource integration with a scientific technology backup. It was found that 24.5% of the participating farmers doubled their income through the adoption of interventions, 37.5% increased income between 1 to 1.5 times and 38% more than 1.5 times compared to the baseline data.

The crop/yield loss in coconut arecanut due to floods in Assam during July 2019 was estimated from a field survey conducted in 13 flood affected districts. Yield loss in arecanut was worked out to be Rs.21,277 lakhs and in coconut Rs.19,793 lakhs. Crop loss in these crops would have made economic loss to the tune of Rs. 109,471 lakh in arecanut and Rs.19,793 lakhs in coconut.

Publications and Awards

The performance of the Institute in terms of publications was very encouraging with a total of 134 articles that included 23 peer reviewed research articles in high impact factor Journals. The Institute's visibility was improved with as many as six awards being bagged by its scientists in seminars and symposia including the second position award in National Coconut Challenge-2019 conducted by Kerala Startup Mission (KSUM).

V. Snapshots of the Year 2019

1. Total germplasm holdings in field gene banks: 1148
   Coconut 455
   Arecanut 178
   Cocoa 515
2. Released coconut variety 1 **Kalpa Ratna**
   CVRC Release of coconut varieties: 5
3. Total registered varieties with PPV&FRA: 8
4. Successful regeneration of coconut plantlets through immature inflorescence tissue culture.
5. Technologies commercialised 48
6. Landmark: licensed 12 coconut varieties to La Ferme de Peter Ltd., Tirunelveli
7. High quality publications: 134
   with research articles 23
8. Coveted awards bagged by the Institute: 6
9. Collaborations: 4 international and 48 national
10. Events held: 20 including International Asia Pacific Cocoa Breeders Working Group meeting
11. Trainings conducted: 170
    Persons trained: 4850
12. Planting material units supplied: 4,91,564
13. Survey of the flood affected areas in Kerala, Karnataka and Assam, and providing rehabilitation strategies by assessing croploss

VI. 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.

VII. INSTITUTE PROFILE

ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), the premier research institution in the National Agricultural Research and Education System of India, is presently mandated with three crops viz., 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.

i. Historical Perspective

The Coconut Research Station at Kudlu (Kasaragod) was taken over by the Indian Central Coconut Committee and established the Central Coconut Research Station (CCRS), Kasaragod in 1947. In 1949, CCRS, Kayamkulam was established exclusively for tackling diseases in coconut. In 1970, the Central Plantation Crops Research Institute was established under Indian Council of Agricultural Research 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.

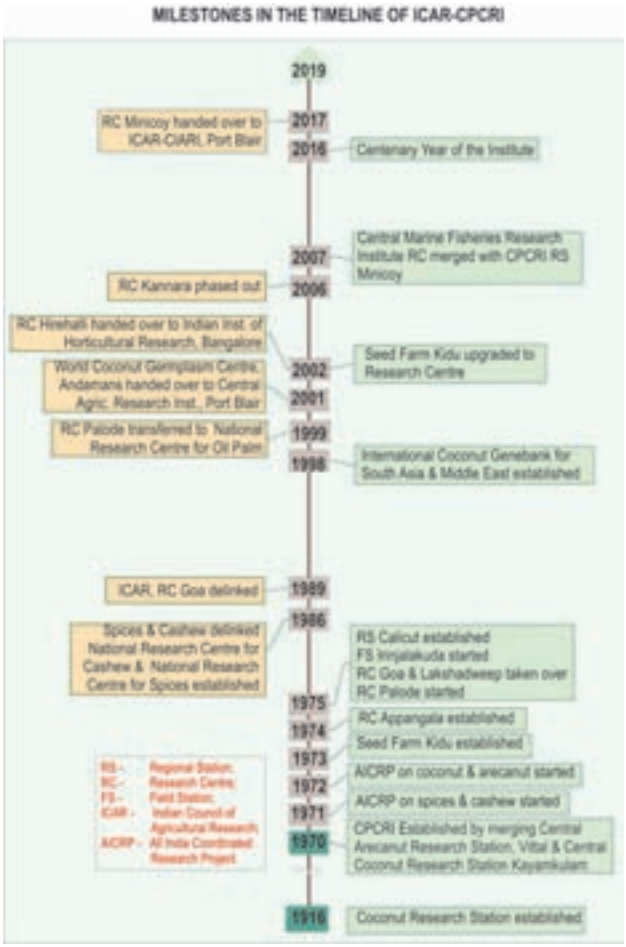
Since 1986, crops like spices, cashew, and oil palm were taken out of the purview of the institute with the formation of Indian Institute of Spices Research, Kozhikode, Directorate of Cashew Research, Puttur and Indian Institute of Oil Palm Research, Pedavegi. Some of the erstwhile Research Centres at Hirehalli, Palode, Appangala, Kannara, Port Blair and Minicoy were either handed over to sister ICAR institutions or phased out. ICAR-CPCRI now has two Regional Stations, one at Kayamkulam (Kerala) and another at Vittal (Karnataka): The former is mandated to work on pests and disease problems in coconut, and the later is for arecanut and cocoa. The Research Centres at Kahikuchi (Assam) and Mohitnagar (West Bengal) undertake location-specific research while the Research Centre at Kidu (Karnataka) hosts the National Gene Bank for coconut and cocoa and also the International Coconut Gene Bank for South Asia and Middle East (ICG-SAME) Besides, there are two KVKs (at Kasaragod and Kayamkulam) functioning under the Institute.

All India Coordinated 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. It has currently 28 centres covering for coconut (15), arecanut(4), oil palm(6), palmyrah(4) and cocoa(7).

ii. Achievements at a Glance

Plant Genetic Resources

ICAR-CPCRI maintains the world's largest germplasm repository of coconut with 455 accessions (323 indigenous and 132 exotic), 178 of arecanut (143 indigenous and 23 exotic) and 515 of cocoa. Through 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 providing 3.12 to 6.28 t copra/ha/year. In arecanut, 11 improved varieties, including nine selections and two dwarf hybrids, have been released: The annual yield ranges from 2.54 to 4.15 kg dry kernel/palm/year. Of the eight high yielding cocoa varieties released, three are clones and five hybrids having potential to provided yield up to 3 kg dry bean/ tree/year.

The Institute has been producing quality planting materials in coconut, arecanut and cocoa for distribution to farmers and other stakeholders ICAR-CPCRI nurseries at Kasaragod, Kidu, Kayamkulam and Vittal were graded with 'four-star' status in the five star scale by National Horticultural Board. Quality planting materials are produced to an extent of 1.3 lakh coconut seed nuts including 59,000 hybrids, 5.5 lakh arecanut seed nuts including 1.4 lakh seedlings and 80,000 cocoa seedlings annually. Institute has also initiated farmer participatory decentralized coconut nurseries in collaboration with different stakeholders.

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 embryo and pollen. Sequence characterized amplified regions (SCAR) markers have been developed for authenticating CGD x WCT hybrids. Transcriptome analysis of response of coconut to root(wilt) and somatic embryogenesis have been undertaken using RNA-Seq and up/down-regulated transcripts. 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 this project, 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 with nutrient management

Coconut or arecanut based inter/mixed, multi-storied and multi-species cropping systems have been developed to increase total productivity. In addition to the economic benefits, the systems ensure food and nutritional security coupled with sustainability and environmental services.

Drip irrigation in arecanut, coconut and cocoa has reduced the use of water to the extent of 35-40 per cent, with increase in yield by 30-40 per cent. Drip fertigation in these crops has reduced the use of chemical fertilizer from 50 to 75 per cent, with increase in yield by 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}). To enhance the productivity of the coconut, two nutrient mixes, 'Kalpa Poshak' and ' Kalpa Vardhini' have been developed. One is suitable for young seedlings and another for adult palm. Their application could help in reducing the duration of the juvenile phase of the coconut palms.

Bioresources utilization and organic farming

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. Technologies have been developed to utilize these wastes for production of vermicompost, vermiwash, coir-pith compost and mushrooms. The coconut leaf vermicompost has been branded 'Kalpa Organic Gold'. This vermicompost can also meet 50% of the nitrogen requirement of coconut palms grown in one hectare area saving expenditure on inorganic fertilizer. A deep metagenomic analysis of the coconut leaf vermicomposting has revealed the microbial diversity and dynamics. A simple method for harvesting the earthworms from vermicompost heaps based on push-pull technology can help farmers in making timely available of the earthworm for composting process. Vermiwash, produced from coconut waste vermicomposting unit, is a good liquid fertilizer for organic farming. A simple co-composting technology for coir-pith using organic inputs has been developed and popularized among farmers. The urea-free coir-pith compost has been branded "Kalpa Soil Care'. 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 95gN, 10g P_2O_5 and 110g K_2O $palm^{-1}$ yr^{-1} that has the potential to meet nitrogen and phosphorus requirements of arecanut. 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. An Arbuscular mycorrhizae based bioinoculant KerAM® containing the dominant *Claroideoglomus etunicatum* has been released for coconut 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. The inputs developed through recycling and microbial technologies form a major part of organic farming system developed for coconut.

Plant health management

Integrated disease management strategies developed for the major diseases coconut (bud rot, stem bleeding, basal stem rot, and root(wilt) arecanut (fruit rot, inflorescence die back and yellow leaf disease) and cocoa (black pod and stem canker).

Prophylactic application of Bordeaux mixture (1%) or placement of Trichoderma coir pith cake in the innermost leaf axils of coconut just before onset of monsoon can prevent the outbreak of bud rot disease. The role of slug *Deroceros* sp in spreading of bud rot has been studied. Basal stem rot disease caused by *Ganoderma lucidum* can be controlled by soil application of Trichoderma enriched neem cake (5 kg $palm^{-1}$) at quarterly interval. Spraying of Bordeaux mixture (1%) or mandipropamid (0.5 %) was found to be effective in control of fruit rot incidence in arecanut. In the case of YLD, scientific management of arecanut garden can ensure yield in the initial years and sustained yield when the disease advances in later stage of the crop.

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. For control of rhinoceros beetle infestation, integration of application of Oryctes nudivirus, *Metarhizium anisopliae*, leaf axil filling of botanicals and placing of aggregation pheromone embedded nanomatrix trap @ 1 trap ha^{-1} was found to be effective.

For red palm weevil, 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.

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 leaves and improving palm health is recommended.

IPM technologies eriophyid mite include spraying of 2% neem oil-garlic emulsion, root feeding of azadirachtin 10000 ppm @ 10 ml + 10 ml water and improving palm health management practices reduced pest incidence to the tune of 71.4%.

Control of white grubs could be achieved through 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 months.

Placement of the neonicotinoid, thiamethoxam (2 g) in perforated poly sachets on the innermost two leaf axils of areca palms during April-May safeguarded arecanut palms from spindle bug damage. IPM strategies, developed for phytophagous mites and pentatomid bugs, involves the spraying of neem oil emulsion (0.5%) has been found effective in controlling these sporadic pests on arecanut.

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. Across all the temperatures, WCT (58%) had high pollen germination while it was least in MYD (37%).

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 (VCO), coconut chips could improve the profitability and employment generation in coconut sector. Other novel value added products are coconut milk residue based extrudate (Kalpa Krunch), coconut sugar based dark chocolate (Kalpa Bar), and vegan frozen coconut delicacy. Various machinery and gadget for coconut processing were also designed and developed at the Institute that include, machinery for VCO and coconut chips, coconut inflorescence sap collecting box (Cocosap Chiller), coconut de-shelling and shell removing machines for copra making, testa remover, tender coconut trimming machine, snow ball tendernut making machine, and 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. Several machineries and gadgets have been developed for aiding farming operations and reducing drudgery. Tractor driven air blast sprayer for tall arecanut palms (30 m tall) and safety harness attachment for Chemberi Joseph model climbing device

for enhancing security of the coconut climbers are important contribution in the area of farm mechanization.

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. Applications of ICT tools like videoconferencing to develop linkages with various stakeholders were implemented. Activities under STP, SCSP and Farmer FIRST projects have helped to widen the outreach and capcacity building programmes of the Institute.

Socio-economic studies and policy interventions

The impact of changing trade policy environment (domestic / international) on mandate crops in terms of prices (co-integration 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. Developing crop loss data and actively supporting rehabilitation of flood/cyclone affected farmers of Kerala, Tamil Nadu, Andhra Pradesh and Odisha has improved the image of the organization and the Institute.

Statistical models to improve field experiments

Crop production model in coconut and arecanut, application of data driven techniques including robust spatial smoothing techniques, and weather based crop yield modelling were carried out. Pest and disease incidence and severity were regularly assessed employing appropriate sampling strategies in different states.

Technology commercialization

ICAR-CPCRI had commercialized 48 technologies till December 2019 for which a total of 235 licensing Agreements signed. Revenue accumulated from technology transfer is Rs. 66.9 lakhs.

Impact of CPCRI technologies

Based on the primary data collected in different projects and published reports, economic impact of technologies developed at ICAR-CPCRI was worked out to be 186,183 million rupees. Largest share is from adoption of cropping systems (39%) followed by adoption of improved varieties and scientific cultivation practices (24% each).

iii. Organogram

iv. Crops, Area, Altitude and Research Undertaken at Different Locations

Headquarters

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

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

Regional Stations

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

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

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

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

Research Centres

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

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

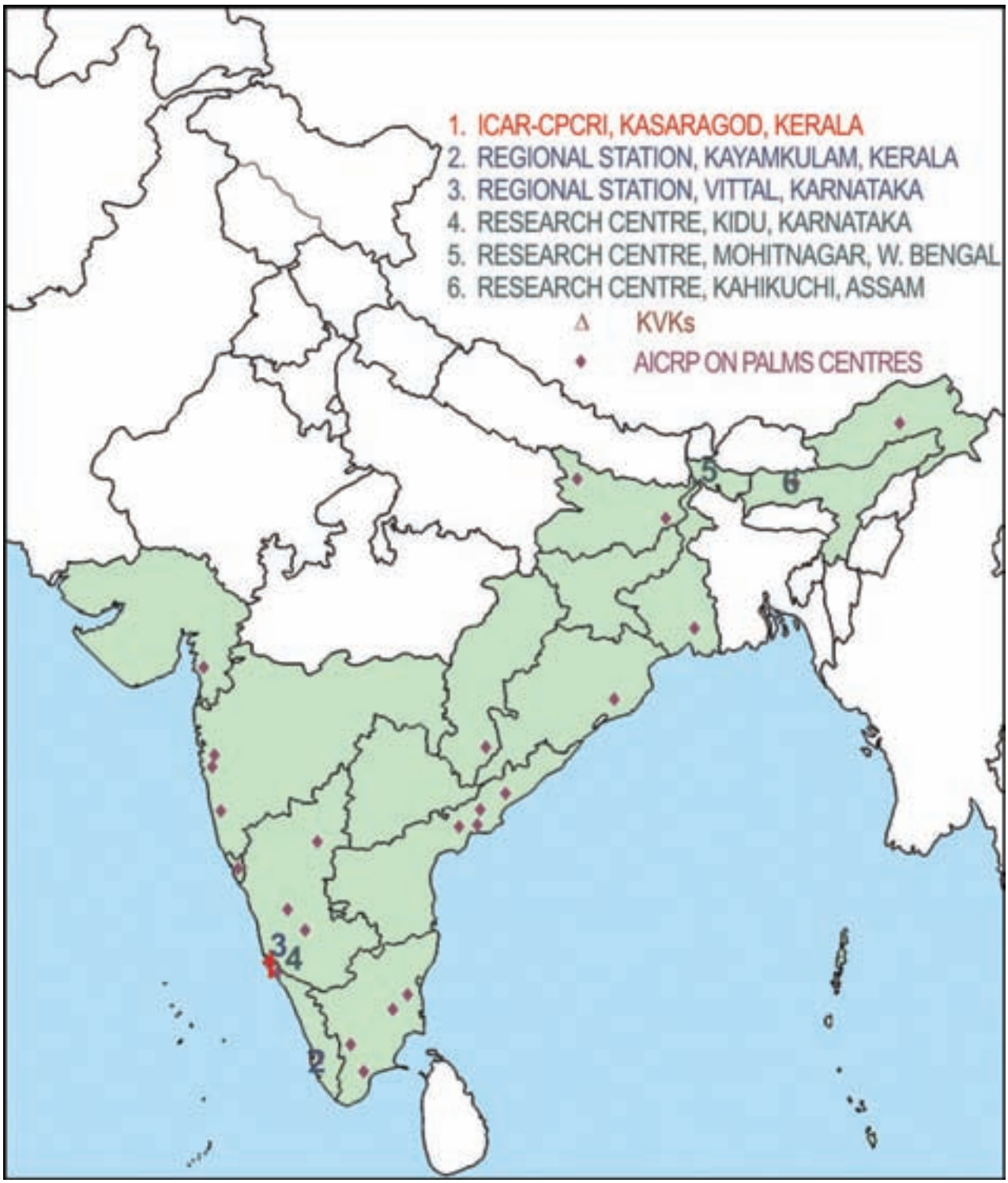
KIDU (Estd.: 1972), Crops: Coconut, Arecanut and Cocoa, Area 120 ha; 281 m MSL

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

v. ICAR - CPRCI Locations



VIII-1. Genetic Resources Management and Utilization

Germplasm Enrichment and Conservation

Field gene banks

The institute maintains field gene banks for the mandate crops at different locations. At present it has a collection of 455 accessions in coconut, 178 in areacnut, and 515 in cocoa. The coconut gene banks are at Kasaragod and Kidu. Arecanut and cocoa gene banks are at Vittal. Alternate conservation sites for coconut and arecanut are at Mohitnagar and Kahikuchi and for cocoa it is at Kidu. The institute also hosts the International Coconut Genebank for South Asia and Middle East (ICG-SAME) at CPCRI Research Centre Kidu.

Cryopreservation of germplasm

Complementary conservation of core coconut germplasm was undertaken and during the year, zygotic embryo from 14 accessions, genomic DNA from 13 accessions and desiccated pollen from seven accessions were cryostored at National Cryo Gene Bank, ICAR-NBPGR, New Delhi.

Germplasm collection

Aarecanut germplasm with small nuts was collected from Karnataka. Average weight of the nut is only 5.73g. Length and breadth of nut is 3.48 and 2.07cm, respectively.

Germplasm Characterization and Evaluation

Coconut

Annual inflorescence production, female flower and fruit yield were recorded in the conserved germplasm in different locations. Those in the juvenile phase, growth characters including initiation of flowering were recorded.

In the comparative evaluation of dwarf accessions planted, at Kasaragod, significant differences in growth characteristics were observed. Relatively higher plant height was observed in the Andaman Green Dwarf (AGD) followed by Malayan Green Dwarf (MGD). Studies on tender nut water content in 18 dwarf germplasm indicated significant variability among the accessions. Higher weight of tender fruit (2194g) and volume of tender nut water (405ml) was recorded in Surinam Brown Dwarf (SUBD). The total sugar content in tender nut water was higher in Kulasekharam Yellow Dwarf (MYD01: 6.9g/100ml), Andaman Yellow Dwarf (ANYD: 6.8g/100ml), Andaman Green Dwarf (AGD:6.8g/100 ml) and Gangabondam Dwarf (GBGD: 6.8g/100ml).

At Kidu, among the conserved germplasm, characterization for fruit component traits was undertaken in five indigenous and 19 exotic accessions. Among the 25 fruit component traits, 15 showed significant differences among the accessions. Relatively wide variation was recorded for fruit weight, husk weight, volume of the nut water, fresh endosperm weight, shell weight, copra weight and oil percentage. Higher fruit weight, husk weight as well as copra weight was recorded in the IND138, followed by the IND167 and IND173 while the IND 145 and IND151 recorded lesser values for the above traits. The oil content ranged from 56.3% in IND174 to 70% in IND069.

At Mohitnagar, the different accessions evaluated in the Sub-Himalayan Terai region varied significantly for trunk height and girth, number of leaves and number of nuts/palm/year. Among the 31 genotypes under evaluation, more number of nuts/palm/year was in BARI Narikel

1 (95) followed by Chinasukhania Tall and Agailjhara Tall (82).

Among the 15 putative cold tolerant lines from West Bengal under evaluation at Research centre Mohitnagar, significant variation was observed for almost all the juvenile growth characters recorded. Higher plant height was recorded in Lataguri-II followed by MNR-III, while higher plant height as well as trunk girth was recorded in MNR-III. Higher leaf production was recorded in MNR-II, while longer leaf length was recorded in Lataguri-II line. Longer leaflet was recorded in WCT, while higher number of leaflets per leaf was observed in ECT-Mohitnagar followed by MNR-III. Further, among the 21 conserved germplasm/elite selections under evaluation along with Mohitnagar-III as check variety, significant variation was observed among the accessions for the juvenile growth characters recorded, except for leaf petiole length.

At Kahikuchi, observations on fruit component traits were recorded on 15 coconut accessions. Fiji Tall was found to produce larger fruits with higher weight of husked fruit (662g) and fresh endosperm (312g), while copra content was found to be significantly higher in Assam Tall (179.16g). Among the 13 local coconut genotypes (KKHC 1 to 13), higher fruit weight (1110g) and fresh endosperm content (431.66g) was observed in KKHC 11.

Population studies: Population studies are in progress in Jamaican San Blas Tall population conserved in the ICG-SAME. Preliminary studies on fruit component traits indicated overall similarity for the breadth of the fruit, husk thickness, percentage of the husk to whole fruit, shell thickness as well as endosperm thickness between the first generation palms conserved at the field gene bank at Kasaragod and the regenerated population conserved at Kidu.

Response of genotypes to inflorescence sap production and quality: Nine tall accessions *viz.*, Gangapani Tall, Gonthembili Tall, Nigerian Tall, Hazari Tall, East Coast Tall, West Coast Tall, Navasi Tall, Jamaica Tall and Niu Quewen Tall were evaluated for inflorescence sap yield and quality. Average sap yield/day was the lowest for ECT (250ml) and highest in Navasi Tall (1340ml). Duration of sap production significantly varied among the accessions, with Navasi Tall producing sap for 47.8 days followed by Gangapani Tall (43.8 days). Days taken for initiation of sap flow varied from 14.25 to 23, and Hazari Tall started to trickle sap early while it was late in ECT. Biochemical parameters of sap *viz.*, total and reducing sugar, protein and amino acids were estimated. Except for reducing sugar, significant variation among accessions was observed. TSS was high in WCT (16.9 ºBrix). Total sugar content (g/100ml) varied between 10.73 (Nigerian Tall) to 12.5g (WCT). Protein content (g/100ml) varied between 456 (Navasi Tall) to 577.1 (WCT). Amino acid content (g/100ml) varied between 470.2 (Navasi Tall) to 584 (WCT). The reducing sugar content varied between 1.5 to 1.9g/100ml. Physical parameters such as length and median circumference of the spathe were assessed. Among the accessions, Navasi Tall recorded longer spathes (79cm) followed by Gonthembili Tall (77.62cm), while higher median circumference of inflorescence was observed in Gonthembili Tall (21.75cm).

Germination and seedling studies: Seed nut germination and seedling traits were investigated for 11 accessions, including five dwarf accessions. Wide variation was observed in time taken for sprouting as well as for seedling vigour. Early germination, within a month of sowing was observed in two tall accessions (FMST and SNRT), followed by MGD, which also recorded more vigorous seedling growth. The dwarf accessions KTOD, COD, LCOD02 were relatively late to germinate, and the time taken for germination ranged from two-three months.

Breeder seed and parental lines: Assisted pollination for production of breeder seed of parental lines and germplasm accessions was undertaken in selected accessions at Kasaragod and about 1236 seed nuts in 54 accessions were sown in the nursery.

Multiplication of germplasm from WCGC, Andamans: Pollen samples of Niu Leka Dwarf and Hari Papua Dwarf from WCGC, ICAR-CIARI, Port Blair and CCNT and SNRT from ICAR-CPCRI, Kasragod were exchanged for production of hybrids.

Farmer participatory evaluation trials: In the performance evaluation trial of released selections *viz.*, Kalpa Sreshta, Kalpa Pratibha, Kalpatharu, Kalpa Mitra, Kera Chandra, Kalparaksha, Kalpa Surya, Kalpa Jyothi, COD, Kalpa Ratna and the hybrids namely, COD x WAT, COD x LCT, planted during 2018 in a farmer's field in Nagercoil, Tamil Nadu, good field establishment was observed. During the current year, performance

evaluation trial of experimental D x T hybrids was established in a farmers' garden at Erode district in Tamil Nadu and Dakshina Kannada district in Karnataka.

Development of improved varieties: During the year, four coconut varieties, *viz*., Kalpa Surya, Kalpa Jyothi, Kalpa Haritha and Kalpa Sreshta were recommended by the CVRC for release and notification. The variety release proposal of Kalpa Ratna was presented in the 28th Annual Group Meeting of the All India Coordinated Research Project of Palms held at TNAU in June 2019 and recommended for submission to the CVRC. Kalpa Ratna (Fig. 1.1), is a high yielding selection, suitable for tender nut, copra and inflorescence sap production. It is recommended for cultivation in the coconut producing tracts in Western Ghats and coastal plains of Kerala, Karnataka and semi arid regions of Tamil Nadu.

Association mapping for MAS: Under association mapping studies, 216 palms from 16 accessions (eight talls WCT, LCT, ADOT, PHOT, LMT, JMT, FJT, SNRT; and eight dwarfs COD, CGD, GBGD, MOD, MYD, MGD, CRD, GDGD) were selected based on the variability for morphological, reproductive and yield parameters. During the reporting period, DNA was isolated from spindle leaf tissue of the 16 genotypes and screened with 14 SSR markers.

Arecanut

Among the evaluation of arecanut germplasm planted in different batches at Vittal, SCRDTC-18 (Fig. 1.2), Chayagaon-II, Cal-32, Kamalpur showed high yield potential.

Fig. 1.1. Kalpa Ratna, multi-purpose high yielding selection

At Mohitnagar centre, Mohitnagar(3.57 kg dry kernel/palm), Nalbari (3.548 kg/palm), VTL-27 (2.834 kg/palm) and Cal-27(2.790 kg/palm) exhibited high yield potential among the germplasm planted in different batches.

Among 18 arecanut germplasm under evaluation at Kahikuchi center Borehat was found to have higher plant height (5.47m), while Kamalpur recorded higher initial yield (2.50kg fresh kernel/palm).

Characterization of arecanut germplasm using SSR markers

Twenty five indigenous germplasam accessions were characterized by Simple Sequence Repeat markers. Three major clusters were observed in the dendrogram: Ten accessions were clustered in Cluster I, while Cluster II was the largest with 14 accessions in two sub clusters. and Cluster III with only one accession (Amchup). Highest similarity was observed between Bokul and Goralbari; Barnihat and Dhupguri; and Marigaon and Rangron. Least similarity was found between Cal-7 and Ketakibari, followed by Amchup and Ketakibari and Thirthaguni and Ketakibari.

Estimation of arecoline content from arecanut varieties/ genotypes: Arecoline content estimation in dry kernel was undertaken from 32 genotypes, including the released varieties and germplasm accessions. Arecoline content (g/100g) ranged from 0.28 (Vanand) to 2.39 (Kalirhat).

Fig. 1.2. SCRDTC-18, a potential arecanut accession under evaluation for release

Cocoa

Morphological characterization: Thirty years old mixed exotic cocoa populations of seedling progenies conserved without any overhead shade were evaluated for their bearing potential. Eight individual trees with 101 to 188 pods/ tree/ year with 25-30 m^2 canopy and high potential of 4 kg dry bean yield were identified for further clonal multiplication and utilization. Among 28 years old Upper Amazon/ Trinidad collections, 2 Trinitario selections and Scavina 6 yielded 126, 105, 105 pods, respectively with 22-23 m^2 canopy with 3- 3.5 kg dry bean yield.

Trait specific cocoa germplasm: Accessions with special traits were identified in the conserved germplasm and are under observation for development of trait specific genetic stocks, variation in pod shape was also documented in select germplasm.

Screening of clones for shade tolerance: Under 50% shade, two year old seedlings of VTLCH-4, VTLCS-1, VTLCC-1 and VTLCH-3 showed pod setting in a range of 5-10 pods/ plant with a single pod weight of 218-390g. Uunder 70% shade, VTLCS-1 started flowering and pod setting, and recorded three pods/ plant, with 383 g single pod weight. And under 90% shade level, VTLCC-1 recorded 3 pods/ plant with 400g single pod weight.

Screening of clones for black pod rot and tea mosquito bug resistance: Twelve cocoa genotypes (13 years old) were screened for tea mosquito bug (TMB) incidence in field condition during January to April, 2019. Severity was high in pods of VTLCH-3 (19.76 lesions per 2 cm^2) and low in VTLC-61(1.85 lesions per 2cm^2) and among the 12 clones tested, VTLCH-1 was severely infected with pod rot, and found to be susceptible.

Qualitative improvement: Fermentation studies on three basic types of cocoa, Criollo, Forastero, Trinitario, were carried out to check the processing ability under Vittal conditions during main season (June) and post monsoon season (October). Box fermentation of Criollo was found to take about four days with one turning, while the requirement for Forastero and Trinitario was observed to be six days with two turnings in the first season. However, the time frame for completion of fermentation in the second season was five days with one turning in the case of Criollo and seven days with two turnings in the case of Forastero and Trinitario. TSS of mucilage on the first day of fermentation was found to vary from 14-15°Brix during the main season, and the juice was sour with TSS 10-12°Brix during the second season and pH level also differed, being more acidic in October. Sun drying was faster and completed in seven days during October, whereas partial sun drying and oven drying was practiced in monsoon beans. June beans were observed to be more affected with fungal infection both during fermentation and drying process. Single bean dry weight ranged from 0.9-1.3 g and fat content ranged from 45-52% during both seasons.

Germplasm Utilization

Coconut

Hybrid evaluation trial: Observations on yield and fruit components were recorded at Kasaragod and Kidu: The Hybrids WAT x NAT, PHOT x GBGD, WCT x CRD, CGD x LCT, CGD x CRD, MYD x NLGD, MYD x GBGD were observed to be superior for bunch and nut yield for the last three seasons.

In Dwarf x Dwarf trial planted at Kasaragod in 2016, with 14 cross combinations involving seven dwarf parents, early flowering and fruit yield was recorded in 12 hybrids viz., MYD x NLGD, CGD x GBGD, MYD x CGD, MOD x GBGD, CGD x MOD, CRD x GBGD, GBGD x CRD, GBGD x COD, CGD x CRD, CGD x MYD, CRD x CGD, COD x GBGD. The average plant height ranged from 456cm (GBGD x COD) to 670cm (MOD x NLAD). In general, hybrids with NLAD as one of the parents recorded higher plant height (≥6m).

Breeding for resistance/tolerance to coconut root (wilt) disease: In the evaluation trial involving six green dwarfs, higher incidence of the root (wilt) disease was noticed in Niu Leka Dwarf and Gangabondam Green Dwarf (7.4%) and other varieties remained healthy. Biennial average nut yield was highest in Kalpasree (92.5 nuts/palm) followed by Gudanjali Green Dwarf (91.4 nuts/palm). Tender nut evaluation studies in different dwarf varieties revealed significant differences for the characters volume of water and TSS. Volume of water varied between 563ml (King Coconut) to 257ml (Gudanjali Green Dwarf). Highest TSS was recorded in Gangabondam Green Dwarf (7.120°Brix) followed by Chowghat Orange Dwarf (6.80°Brix) and the lowest in Andaman Green Dwarf (5.360°Brix). Organoleptic evaluation conducted indicated that maximum score

(4) was for Gangabondam Green Dwarf and the least preferred was King Coconut.

In the evaluation trial involving thirteen tall accessions planted during 2014, higher incidence of the root (wilt) disease was observed in Federated Malay States Tall (25%) followed by San Ramon Tall (12.5%), Philippines Lono Tall and Guam Tall (8.33%).

Evaluation of second-generation progenies of disease-free West Coast Tall (WCT) planted during 2012, root (wilt) disease was noticed in 3.9% of WCT-selfed progenies and 5% WCT-*inter se* progenies.

In the evaluation trial involving different dwarfs and its hybrids planted during 2009, the lowest root (wilt) disease continued to be recorded in CGD x WCT (15.6%) followed by CGD x MGD (17.8%) and the highest disease incidence was recorded in MYD x WCT (46.7). Average nut yield was highest in CGD x WCT (74 nuts/ palm).

Arecanut

Evaluation of arecanut hybrids: Evaluation of eight dwarf hybrids involving Hirehalli Dwarf (HD) and released varieties *viz*., Mangala, Sumangala, Sreemangala, and Mohitnagar is in progress at Vittal, Mohitnagar and Kahikuchi centers. At Vittal, maximum dry kernel yield of 1.29 kg/palm was recorded from the cross HD x Sreemangala. At Mohitnagar, higher annual dry kernel yield was recorded in HD x Mangala (1.37kg/palm). At Kahikuchi, Sumangala x HD recorded the higher dry kernel yield (2.62 kg/palm/year).

Among the 16 tall hybrids evaluated at Vittal, Mangala x Shreewardhana recorded highest dry kernel yield of 3.08 kg/palm followed by Sumangala x Mangala with dry kernel yield of 2.50 kg/palm.

Inter-specific hybridization for fruit rot and YLD screening: *Inter-specific* crossing between *Areca triandra* x *A. catechu* (Mangala) and *Areca catechu* (Mangala) x *Areca triandra* was carried out for screening against fruit rot and YLD. Total of 868 and 350 flowers were pollinated for production of *A. triandra* x Mangala and Mangala x *A. triandra* hybrid combinations, respectively.

Cocoa

Genetical investigations and breeding for improved varieties in cocoa: VTLCP-1 (NA 33 x ICS 89) continued to give high yield with 240 pods/tree/year at the age 19 years under double hedge system of planting under coconut at Vittal and 170 pods at Kidu. The clone VTLCC-1 yielded 174 pods/tree/year. The potential dry bean yield ranged from 3- 3.5 kg/ tree/ year.

Among the Malaysian cocoa hybrids planted under arecanut, 12 years old trees of MH-1-79 yielded 111 pods, MH-2-32 yielded 77 pods and MH-3-11 yielded 84 pods/tree/year. The average dry bean yield ranged from 2.5- 3 kg/tree/year.

Among the Philippines cocoa hybrids planted under coconut in a single hedge, 10 years old trees of PH-1-152 yielded 109 pods and PH-2-254 yielded 188 pods/ tree/year with an average dry bean yield ranging from 2.7- 3.2kg/tree/year.

Multi-location trial (MLT): Among the parents and progenies evaluated at Vittal under arecanut, VTLCH-2 clones yielded 123pods/tree/year. VTLCH-1 seedlings yielded 266 pods at the age of 14 years. The average dry bean yield ranged from 2.0-3.5 kg/tree/year. Among 12 years old trees planted at Kasaragod under coconut, VTLCH-3 clones yielded 141 pods VTLC-22 seedlings yielded 109 pods: Average dry bean yields ranged from 2.0 - 2.5 kg/tree/year.

After seven years of evaluation, VTLC-19 is identified as the best performer in Assam with 1.76 kg dry bean yield under arecanut condition.

Among the clones evaluated as intercrop in coconut garden at Kayakmkulam, the highest pod yield (50) in the initial year of bearing was recorded for VTLCP-21. At Mohitnagr, VTLC-5 recorded 110 pods under arecanut and VTLCH-4 recorded 95.6 pods/ tree/ year under coconut at the age of 9 years. Five year old VTLCP-16 yielded 0.97 kg dry beans/ tree/ year under coconut at Aliyarnagar.

Planting Material Production

Production of planting material of mandate crops was undertaken in different centers (Table .1.a & b). Revenue generation from sale of planting material was Rs. 222 lakhs. A view of arecanut nursery in Kahikuchi is shown in Fig. 1.3. In addition, 8720 black pepper rooted cuttings and 2500 planting material of acid lime were also distributed from Mohithnagar.

Developing soil-less media for polybag seedlings of arecanut: At Regional Station Vittal, work on development of soil-less media for production of

polybag seedlings of arecanut was initiated with four treatments *viz.*, vermicompost; coir pith compost; vermicompost + coir pith compost and soil : FYM : sand in 7:3:2 ratio. Initial results, based on seedling vigour, indicated that vermicompost media was the most suitable for production of good quality seedlings in polybags.

Table 1.a. Planting material production in coconut

Type	Kasara-god	Kayam-kulam	Kidu	Kahi-kuchi	Total
Variety seedlings	27370	15067	45735	173	88345
Hybrid seedlings	4927	2915	12578	—	20420

Table 1.b. Planting material production in arecanut and cocoa

Type	Kidu	Kahi-kuchi	Vittal	Mohit-nagar	Total
Arecanut					
Seed nuts	112255	—	—	37200	149455
Seedlings	34792	50000	88082	24400	197274
Cocoa					
Pods	2001	—	27220	—	29221
Seedlings /grafts	627	—	5748	450	6825

Fig. 1.3. Arecanut nursery at Kahikuchi

Cryo-preservatory of coconut pollen: A pollen cryo-preservatory is maintained at ICAR-CPCRI, Regional Station, Kayamkulam with a total of 600 vials of coconut pollen collected from healthy and high yielding WCT palms. Pollen germination test is routinely carried out every three months interval to ascertain the germination and viability of the stored pollen. The stored pollen was used for hybridization on 450 CGD mother palms and it yielded normal fruit setting.

Refining ground pollination technique: The modified ground pollination technique evaluated on ten parental palms (dwarfs/talls) each at different centres of ICAR-CPCRI (Kayamkulam, Kasaragod and Kidu) and three AICRP centres (Ratnagiri, Aliyarnagar and Ambajipeta) gave encouraging results. An average fruit setting of 20-22% was recorded which is comparable to the setting observed under natural pollination.

Production of elite planting material for the root (wilt) disease prevalent tract: A total of 60 Chowghat Green Dwarf (CGD) parental palms were subjected to serodiagnosis and 33 serological negative CGD palms were selected for hybridization programme. Sixty CGD parental palms from ICAR-CPCRI, Regional Station, Kayamkulam and 300 CGD palms selected from farmers' plots were used for production of Kalpa Sankara (Dx T) hybrids

Farmer participatory planting material production: Farmer participatory planting material production of dwarf/semi tall varieties and hybrids was undertaken with funding support of the Kerala state Department of Agriculture & Farmers Welfare in 12 districts of Kerala (i.e., excluding Wyanand and Idukki). A total of 8481 parental palms (4374 COD, 1633 CGD, 49 MYD, 25 MOD, 12 GBGD and 5 MGD and 2383 WCT) were located at these districts and collected 63394 seed nuts to raise community nurseries in 31 locations.

Coconut pollen processing cum storage centre was established in each district in collaboration with Department of Agriculture and Farmers' Welfare. Pollination for hybrid seed production was undertaken in 890 WCT, 290 COD and 110 CGD palms. Trainings were conducted in all the districts on nursery techniques.

DUS Centers

Coconut: Seedlings of one candidate variety received for DUS testing were planted along with three reference varieties in 4 m x 4 m spacing. Juvenile growth characters were documented. Seedlings of the varieties COD, WCT, CGD, MYD, MOD, GBGD, Kalparaksha, Kalpa Dhenu, Kalpa Pratibha, Kalpa Mitra, Chandra Kalpa, Kera Chandra, Kalpatharu, Kalparaksha were made for DUS testing.

Among the set of reference varieties under maintenance breeding, flower initiation was observed in all the varieties in 6m x 6m spacing. Due to excess shade in

4m x 4m spacing, emergence of inflorescence was found to be very scanty with negligible fruit set. Therefore, greater spacing is needed to be adopted in DUS testing for observation on fruit characters.

For widening DUS descriptor database and refining DUS test guidelines, fruit characters were recorded in seven selected germplasm (BSIT, KPDT, LFT, MVT, NLGD, LAGT and SSGT).

Cocoa: DUS guidelines for cocoa with 27 characteristics and one special trait, comprising four leaf, three flower, thirteen fruit, and eight bean characters were prepared. Six characteristics were finalized for grouping of varieties and 16 characteristics were explained with ready reckoner such as line drawings, photos, colour charts for classification (a part of it is shown in Fig. 1.4). The descriptor traits were fine tuned taking into consideration of the existing UPOV guidelines, Bioversity International Descriptor/ Field Guide and in consultation with Asia Pacific Regional Cocoa Breeders. Reference varieties of cocoa were field planted under coconut and maintained as DUS plot at CPCRI, Regional Station, Vittal.

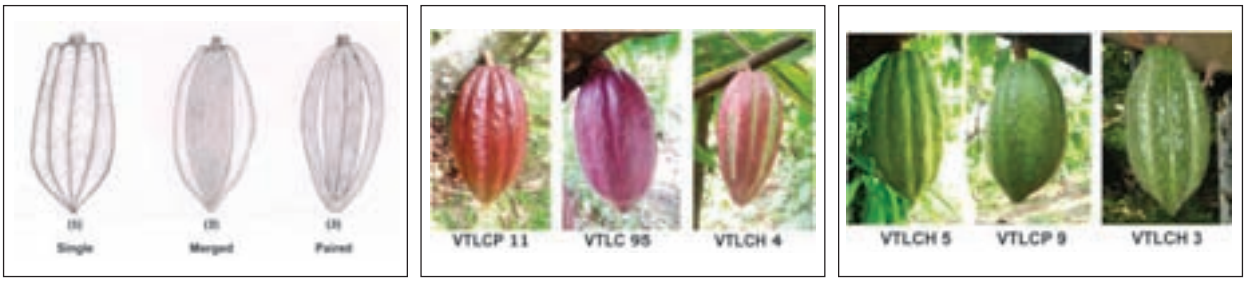
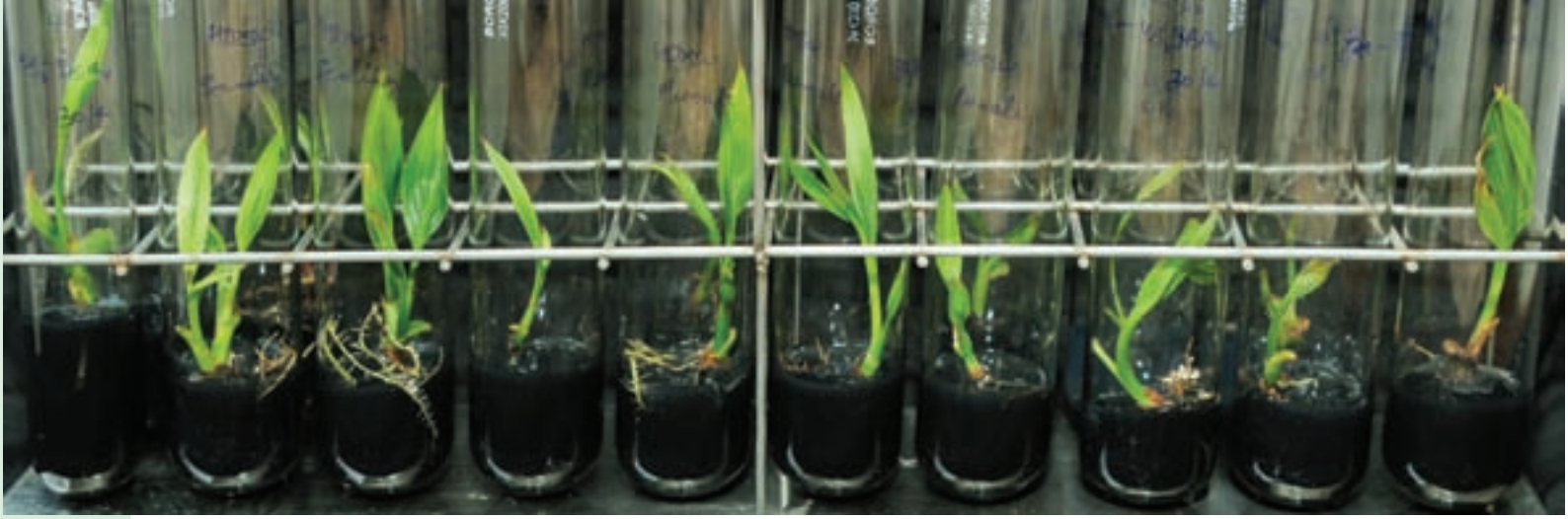


Fig. 1.4. Part of cocoa descriptor for DUS testing purpose: Pairing of ridges in cocoa pod, green and red varieties (from left to right in order)



VIII-2. Biotechnological Investigations

Coconut tissue culture

Combined effect of auxin and cytokinins on callus initiation

Different auxins (dicamba, 2,4-D, picloram and atrazin @ 100 µM and 200 µM) and cytokinins (flurprimidol, metatopoline, TDZ, zeatin and adenine sulfate @ 5 µM) were incorporated either in Y3 or M72 basal medium to initiate callus from embryonic shoot meristem explants of West Coast Tall cultivar. Better results were obtained with M72 medium supplemented with 2,4-D and flurprimidol (Callus induction 80% and somatic embryos up to eight). In the case of Y3 medium, maximum callusing (70%) was noticed in picloram and metatopolin combination, but more somatic embryos in combination was formed by picloram and TDZ (up to eight).

Experiments with growth regulators on callus initiation

Experiment involving novel chemicals such as metapoline and flurprimidol in combination with atrazine, dicamba, NAA, 2,4-D, picloram, TDZ and BAP resulted only with hard calli and subsequent growth and development leading to somatic embryogenesis was not achieved.

Thin layer sections of pre-conditioned zygotic embryo (West Coast Tall cultivar, 11 months) (*i.e.*, embryos cultured for one month in hormone free Y3 medium) were inoculated in different combinations of media involving 2,4D, picloram, BAP, TDZ, metatopoline, flurprimidol and abscisic acid. Thought Callus initiation was observed from the meristematic region of the thin sections in Y3 semi-solid medium with picloram (74.64 µM), TDZ (4.5 µM), abscisic acid (30.26 µM) and activated charcoal (1 g l^{-1}), further growth and development was not observed. In the same experiment, multiple shoot like structures were emerged from the thin sections in Y3 semi-solid media incorporated with 2,4-D (74.64 µM), TDZ (4.5 µM), flurprimidol (3.2 µM) and activated charcoal (1 g l^{-1}), but were failed to regenerate in to plantlets.

Influence of 4- Chlorophenoxyacetic acid (4 – CPA) on callus initiation

The effect of 4 - CPA in callus induction for embryonic shoot meristem (obtained from 11 month old mature nuts) and shoot meristem (obtained from one year old seeding) explants of WCT variety of coconut was studied. Two plant tissue culture media, *viz*. Y3 and M72 together with various auxin combinations of 2,4-D (9 µM), 4-CPA (10, 25and 100 µM), picloram (10µM), TDZ (4.5 µM) and charcoal (0.25g $l^{-1}$and 1g l^{-1}) was used. The study points out that at lower concentration of 4 – CPA and charcoal, callus initiation in plumular explants of coconut occurs, while a higher concentration of 4 - CPA and charcoal favours the shoot meristem culture of coconut.

Effect of nanoparticles for callus induction

Four nanoparticles, (single walled carbon nano tube (SWCNT), multi walled carbon nano tube (MWCNT), fullerene, green synthesized AgNP and other chemical compounds such as sodium selinate and calcium ionophore were used for callus initiation in embryonic shoot meristem explants of coconut (WCT). Among the treatments incorporation of green synthesized AgNP (50 and 100 mg l^{-1}) alone gave positive response on callus initiation apart from reduced bacterial contaminations.

Cell suspension from embryogenic calli

Experiments were conducted to initiate suspension cultures from plumular explants of WCT variety of coconut. Plumular explants of WCTvariety of coconut were inoculated in M72 media plates with picloram 100 µM as the auxin. Certain callus develops easily separable loose cells, which were inoculated into liquid suspension media (Y3 and M72) with varying concentrations of auxins, 2,4-D and picloram were used. Other constituents of the media include zeatin, ascorbic acid, casein, kinetin, TDZ, glutamine, biotin, malt extract and sucrose with very low concentration of charcoal @ 0.2 g l^{-1}. Of the eleven media combinations for suspension culture the suspension initiation was observed in Y3 medium with 34.2µM glutamine, malt extract 100 mg l^{-1}, biotin 40.9 µM, kinetin 9.3 µM. The viability of the suspension was tested using trypan blue and propidium iodide stain where the live cells were unstained and the dye penetrates the compromised cell membrane of the dead cells, staining it blue (Fig. 2.1).

Use of activated charcoal beads in liquid medium

An experiment was planned to find the efficiency of charcoal beads in adsorbing phenols and the efficiency of the beads in phenol adsorption in comparison with the activated charcoal powder. Charcoal balls were prepared using sodium alginate impregnated charcoal in calcium chloride solution. 10mg of charcoal was used for the preparation of beads for each replication. Gallic acid was used as the standard. 10ml of 500 ppm gallic acid was pippetted and the charcoal balls were kept overnight in gallic acid for 22 hours and then centrifuged at 5000 RPM for 10 minutes, and the volume of the gallic acid concentration was measured. Considerable differences were observed in the adsorption by activated charcoal and charcoal beads. 10 mg of activated charcoal powder absorbed 2ml of gallic acid. 10mg of charcoal impregnated in calcium alginate beads of 2mm diameter absorbed 3.16 ml of gallic acid while the same quantity of charcoal in beads of 4mm diameter absorbed 4.62 ml of gallic acid. This study supports the suitability of using calcium alginate charcoal beads in tissue suspension cultures.

Endosperm culture

Immature endosperm tissues from tall and dwarf accessions of coconut were used to initiate callus in Y3 semi-solid medium supplemented with 2,4-D (18.2 µM), NAA (21.5 µM), BAP (2.2 µM) and activated charcoal (2 g l^{-1}). Irrespective of the explants used, initiation of callus was noticed after one week of dark incubation. Multiplication of callus was achieved in Y3 medium with 2,4-D (0.45 µM) alone and multiplication occurred with a relative growth rate of 0.035 g/g/day in case of Chowghat Orange Dwarf cultivar.

Arecanut tissue culture

Immature inflorescence culture

To enhance the rooting and vigour of in *in vitro* regenerated plantlets of arecanut, two experiments were conducted by supplementing the medium with (i) ± and ² cyclodextrin (0, 10, 20 and 30 mg l^{-1}); and (ii) activated charcoal (0.1, 0.25, 0.5, 0.75 and 1 g l^{-1}). The results indicated that: (i) more than 10 mg l^{-1} ± and ² cyclodextrin is not required. (ii) Lower concentration (0.25 to 0.5 g l^{-1}) of activated charcoal has beneficial effect on growth and development of plantlets prior to *in vitro* hardening.

Different combinations of growth regulator (auxin) in basal Y3 medium were tested to initiate robust root

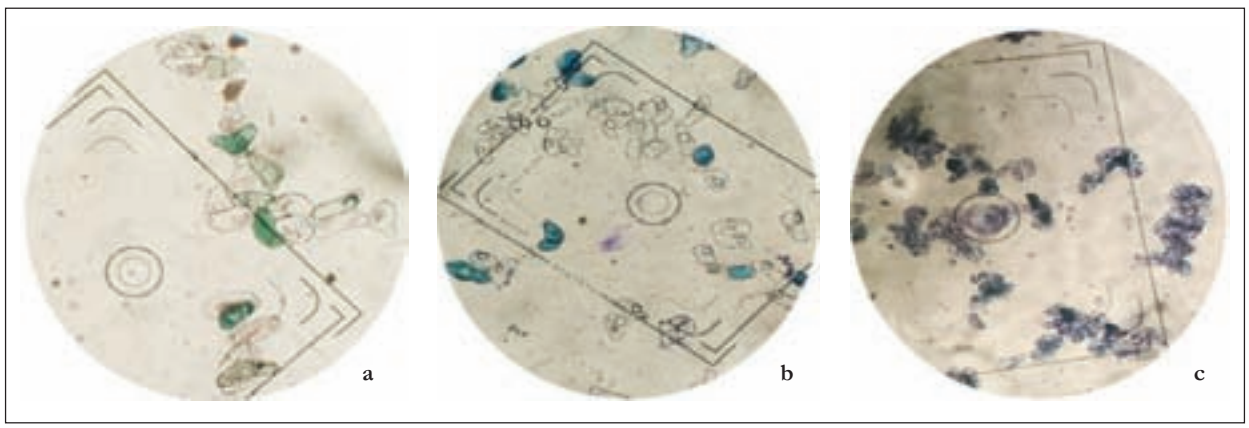


Fig. 2.1. Initiation of cell suspension in coconut.a;trypan blue staining of coconut suspension cells after one week inoculation, b; propidium iodide staining of coconut suspension cells five days after inoculation, c; dead cells stained blue after two weeks of inoculation.

system in fully grown arecanut plantlets derived from inflorescence culture. Fresh roots were produced in medium supplemented with IAA (6.58 µM) and IBA (4.9 µM) whereas medium supplemented with NAA (5.4 µM) and IBA (4.9 µM) resulted in the formation of fibrous roots. However, tip yellowing was associated with the latter combination. In an another experiment, positive effect of maltose at 20 and 30 g l^{-1} on shoot and root length of fully grown arecanut plantlets derived from inflorescence culture was noticed.

Cocoa tissue culture

Endosperm tissues from immature pods (10-14 cm long) of cocoa when cultured in MS semi-solid medium supplemented with 18.2 µM of 2,4-D shown callus induction.

Petals and staminode explants from unopened flower buds in cocoa were inoculated in three basal medium (MS, DKW and WPM) each supplemented with 9 µM 2,4-D, 0.22 µM TDZ and 246 µM 2iP. Callus growth was observed on 12th day of inoculation in MS based callogenic medium and 19th day on DKW based medium. Friable callus was noticed one month after inoculation and dark incubation.

Embryo culture

Embryos from self compatible clones of cocoa were cultured *in vitro* for regeneration. Embryos were germinated one month after dark incubation in basal MS medium with BAP (4.4 µM), NAA (5.4 µM) and kinetin (2.3 µM). *In vitro* plantlets were maintained in the same basal medium with double the concentrations of above growth regulators in light room conditions (Fig 2.2).

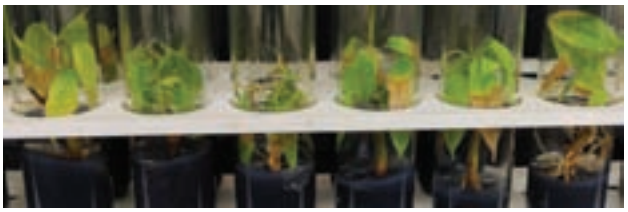


Fig. 2.2. In vitro regeneration of plantlets from zygotic embryos of self-compatible clones in cocoa

Molecular studies

In silico prediction of long non-coding RNAs (lncRNAs) associated with coconut embryogenic calli

The lncRNAs in coconut were predicted from the transcriptome data of embryogenic calli derived from plumular explants of West Coast Tall cultivar generated in an Illumina HiSeq 2000 platform. In total 6,052 putative lncRNAs were identified and some of the lncRNAs act as a miRNA precursors,potential miRNA targets and endogenous target mimics (eTMs) for miRNAs.

Silencing of highly expressed miRNA by STTM and amiRNA methods

A set of conserved and novel miRNAs were identified in embryogenic (EC) and non-embryogenic calli (NEC), derived from embryonic shoot meristem of coconut, through small RNA sequencing. Expression pattern of these miRNAs and their targets were carried out using qRT-PCR. Higher expression of a novel miRNA (cnu-miRn7, 21 bp) was observed in NEC as compared to EC. Short Tandem Target Mimic (STTM) method was utilized to silence the targeted miRNA. The STTM construct was amplified using the synthesized oligonucleotide (48 bp) as template with primer FP and RP (amplicon size of 114 bp). The recombinant pBI121-STTMn7 vector was constructed for the future transformation studies. Artificial miRNA was also constructed to silence a gene in embryogenic calli derived from shoot embryonic meristem of coconut.

Mining of transcription factors from coconut genome and their expression patterns studies

Twenty one *ARF* (Auxin Response Factor) genes were identified in coconut by aligning whole genome data of Chowghut Green Dwarf (CGD) with *ARF* coding sequences of related species available in public domain. Phylogenetic relationship, gene structure, domain prediction and expression profiles of these 21 *ARF*s were also studied. The MEME algorithm revealed the information on conserved motif in coconut *ARF*s. The MEGA7 alignment study revealed the presence of glutamine (Q), serine (S) and leucine (L) enriched zones among the eight *CnARF*s indicating their potentiality to serve as transcriptional activators (Fig. 2.3)

The expression pattern of 10 *CnARF* genes under various phyto-hormone and abiotic stress treatment in coconut zygotic embryo were obtained by real time PCR. Among the select *ARF*s, expression of *Eg_Cn_ARF4 and 7* were significantly up-regulated by salt and draught stresses whereas these stresses resulted in down-regulation of rest of the *CnARFs*.

Insect bioassay studies using diet-based siRNA delivery

Bioassay using diet-based delivery were conducted on

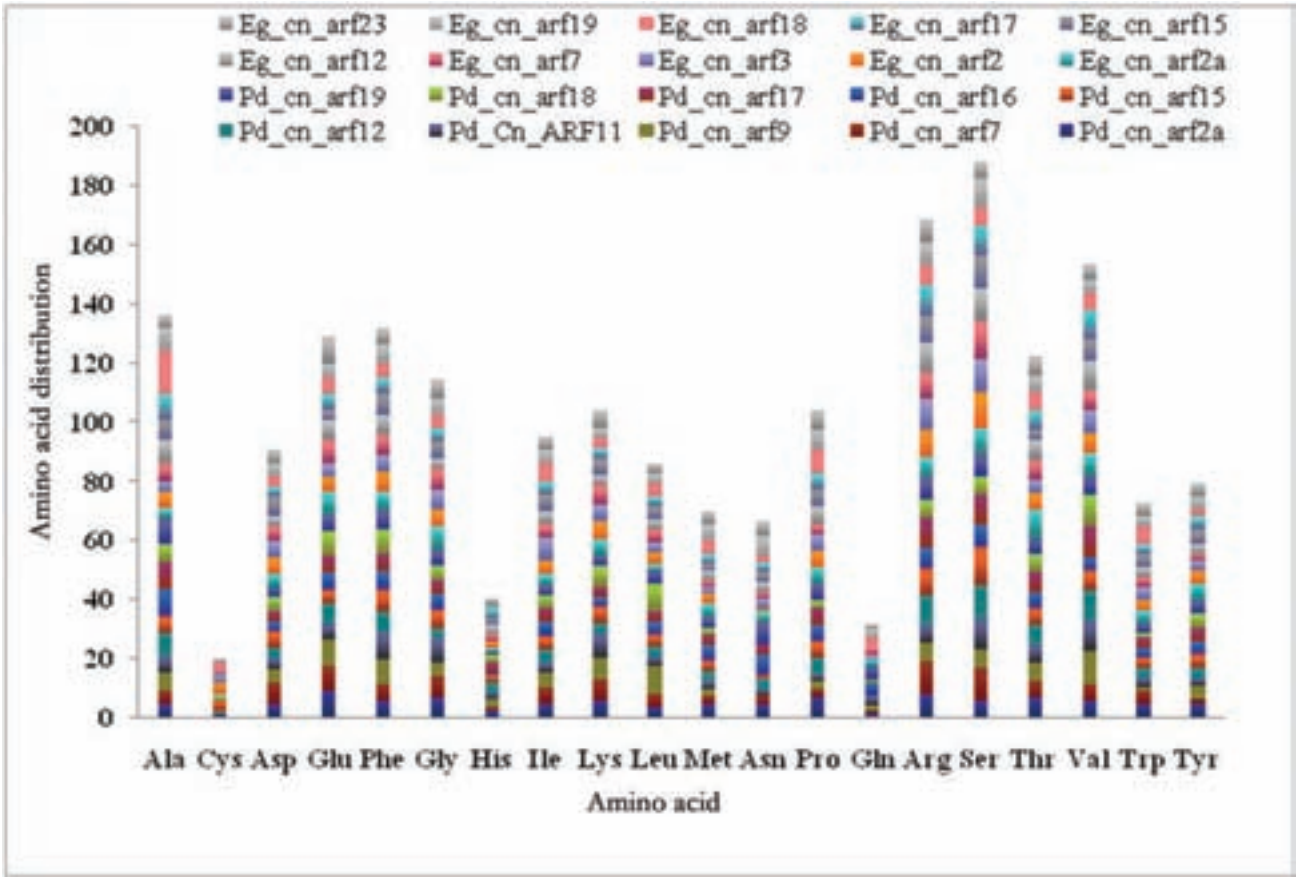


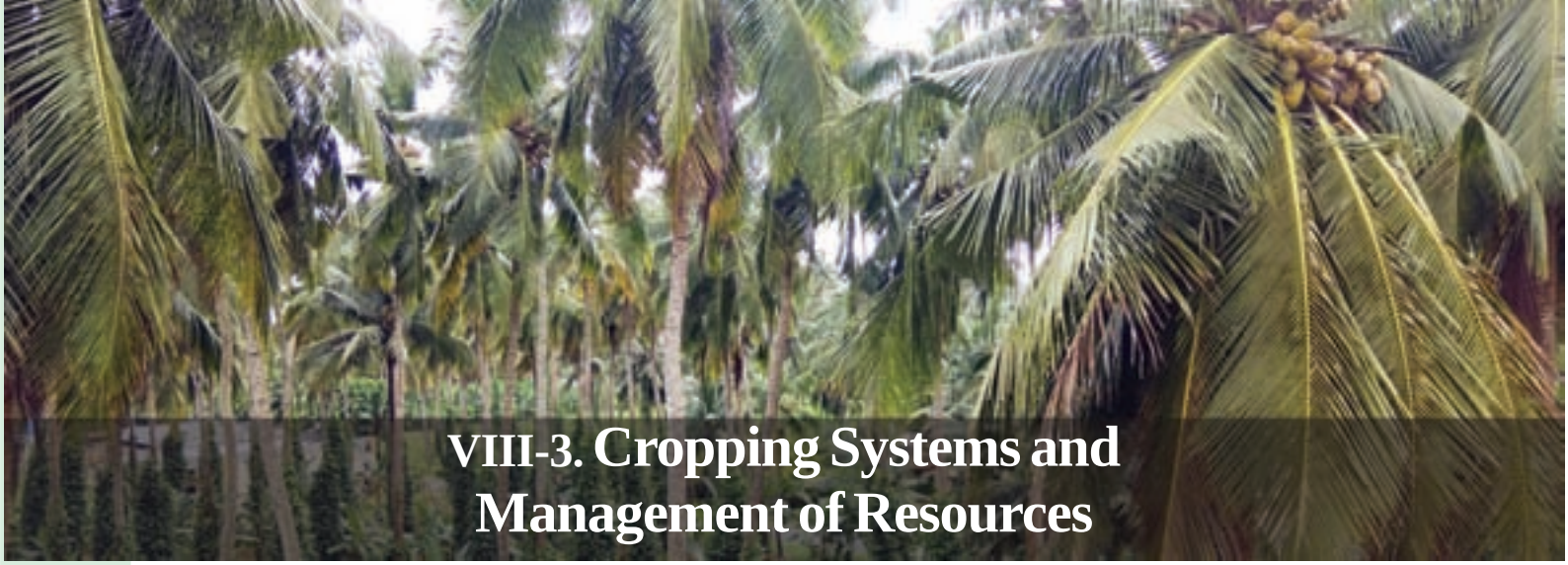
Fig. 2.3. TheMEGA7 alignment study revealing the amino acid enriched sites in CnARFs.

first instar larvae of red palm weevil (RPW) incorporating the meridic diet (20 mg/larvae/day) with different concentrations (100, 165, 500 and 1000 ng) of siRNA *viz*., *dre4* (splicing associated factor, *Rop* (Ras opposite) and *RpII140* (RNA polymerase II 140kD subunit). Inducible metalloproteinase inhibitor (*IMPI*) of greater wax moth (*Galleria mellonella*) was taken for use as non-target control. Higher concentrations (1000 ng) of *dre4, Rop* and *RpII140* could kill the larvae in 24 hrs.

Cryopreservation studies

Zygotic embryo from 14 accessions, genomic DNA from 13 accessions and desiccated pollen from seven accessions of coconut were cryostored at National Cryo Gene Bank, ICAR-NBPGR, New Delhi.

Arecanut zygotic embryos pre-grown in Y3 or MS medium supplemented with 0.2, 0.4 and 0.6 M sucrose were dehydrated following air desiccation, vitrification and encapsulation dehydration technique prior to cryostorage. Based on the preliminary survival assessment conducted using TTC staining procedure, 20% survival of explants was observed in vitrification method after two months of cryopreservation. Low concentration of sucrose (0.2 M) in preculture medium gave better survival in TTC survival assessment. In all the treatments, the post-cryopreservation recovery was not achieved warranting the requirement of more desiccation and vitrification treatments.



VIII-3. Cropping Systems and Management of Resources

Cropping / Farming System

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

The coconut based farming system comprising coconut in one ha area, pepper trailed on the coconut trunk, banana in the border of the plots, fodder grass (hybrid Bajra Napier Co 5) in the interspaces of coconut, dairy unit, poultry and aquaculture realised 18900 coconuts, 20323 litres of cow milk, 99.2 kg live weight of goat, 303.5 kg of live weight of poultry birds, 40 kg of live weight of layer birds, 1031 numbers of eggs, 2730 kg of banana and 508 kg of pepper and 77 kg of fish. The economic analysis indicated a net return of Rs. 7,67,568/- from the CBIFS receiving combined application of 50 per cent organics produced from the system and 50 per cent inorganics.

Coconut based high density multi species cropping system (HDMSCS)

The coconut based high density multi species cropping system with three treatments *viz*., 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 (*Azospririllum* and *Phosphobacterium* @ 200 g/palm) + green manuring (*in situ*) + vermiwash application (10 l/palm) and T3: recycling biomass (as vermicomost @ 30kg/palm) + biofertilizer application (*Azospririllum* and *Phosphobacterium* @ 200 g/plant) + green manuring (in situ) + vermiwash application (10 l/palm) + husk burial + mulching with coconut leaves having crop combination of coconut (WCT), black pepper (Panniyur 1 trailed on each coconut trunk), banana *cv*. Kadali and Robusta, cinnamon (in inter row space of palm) and nutmeg (between four coconut palms) is under investigation.

Biomass from HDMSCS

The recyclable biomass generated under different nutrient management systems did not show any significant difference, which ranged from 32.635 t to 34.439 t/ha (Table 3.1). Maximum recyclable biomass was produced from coconut, followed by weeds.

Coconut and intercrop yield

There is no significant difference among the treatments *viz*., palms with fully organic, palms with 1/3rd recommended chemical fertilizers (NPK @ 167:107:400 g palm^{-1}) and recycling of biomass (as vermicompost @ 30 kg palm^{-1}) + biofertilizer (200 g plant^{-1}) + green manuring + vermiwash (10 l palm^{-1}) and palms with 2/3rd (NPK @ 333:213: 800 g plant^{-1}) recommended chemical fertilizer and recycling of biomass (as vermicompost @ 30 kg palm^{-1}) with respect to nuts and copra yield and endosperm thickness (Table 3.2.). The coconut yield was in the range of 128-138 nuts/palm/year with 1.34cm kernal thickness and

Table 3.1. Effect of nutrient management on recyclable biomass (t/ha) generated under HDMSCS

Treatments	Coconut	Cinnamon	Nutmeg	Banana	Weed	Total
T1	19.490	1.595	0.462	0.821	10.268	32.635
T2	18.112	1.389	0.396	0.114	12.965	32.976
T3	17.980	1.312	0.462	1.185	13.500	34.439
CD @0.05	NS	NS	NS	NS	NS	NS

20.74-22.30 kg of copra weight. The pepper yield was not significant among treatments and ranged from 2.18 to 2.90 kg/vine. Banana *cv.* Kadali recorded significantly higher yield under T2 treatment. Banana *cv.* Robusta recorded significantly higher yield under T1 treatment (Table 3.2).

organic matter recycling in the form of vermicomposting, mulching, biofertilizers application and incorporation of husk. The added chemical fertilizer in other two treatments might have enhanced the decomposition which reduces the organic carbon content. However, the available potassium content was

Table 3.2. Effect of nutrient management on intercrops yield in coconut based HDMSCS

Treatment	Coconut (nuts/ palm)	Copra (Kg/ palm)	Endosp-erm thick-ness (cm)	Dry Bla-ck pepper (kg/vine)	Banana Kadali (kg/bunch)	Banana Robusta (kg/bunch)
T1	128	20.74	1.34	2.18	7.43	16.75
T2	138	22.25	1.33	2.37	8.43	11.21
T3	132	22.30	1.33	2.90	6.29	11.89
S Em	3.94	0.38	0.04	0.25	0.52	1.2
CD (P=0.05)	NS	NS	NS	NS	1.60	3.7

Soil nutrient status

The data on soil nutrient status revealed significant difference among the treatments for organic carbon content and available potassium (Table 3.3). High organic carbon content was recorded under the treatment T3 in which the palms and component crops were maintained under organic nutrition and was significantly different from T1 treatment. The increase in organic carbon content could be ascribed to the

low in the T3 treatment and higher potassium content was recorded under T1 treatment in which the palms received two third of recommended dose of chemical fertilizer. This showed potassium replenishment from fully organic treatment is low since most of the organic sources contain less quantity of potassium.

Leaf nutrient status

The data on leaf nutrient status revealed significant difference in potassium content (Table 3.4.). Among

Table 3.3. Effect of nutrient management on soil nutrient status

0-30 cm													
Treat-ment	**pH**	**EC (unit)**	**OC (%)**	**P (ppm)**	**K (ppm)**	**Ca (ppm)**	**Mg (ppm)**	**S (ppm)**	**Fe (ppm)**	**Mn (ppm)**	**Zn (ppm)**	**Cu (ppm)**	**B (ppm)**
T1	5.48	52.77	0.72	59.26	158	73.08	44.31	15.72	15.22	76.22	2.17	3.72	0.38
T2	5.60	48.57	0.75	69.43	133	73.00	48.86	13.54	16.24	77.34	4.23	4.55	0.38
T3	5.32	55.08	0.81	63.42	120	66.81	49.85	15.62	13.67	68.87	2.42	3.76	0.37
CD	NS	NS	0.08	NS	16.0	NS	NS	NS	NS	NS	NS	NS	NS
30-60 cm													
T1	5.22	50.04	0.60	31.12	132	62.77	49.85	20.14	13.10	74.02	1.22	0.78	0.40
T2	5.30	63.12	0.63	24.73	118	68.50	41.14	22.24	10.93	64.86	3.00	1.13	0.41
T3	5.16	54.89	0.71	24.89	103	52.43	49.29	22.44	10.97	68.52	1.45	1.10	0.41
CD	NS	NS	0.07	NS	9.8	NS	NS	NS	NS	NS	NS	NS	NS

Table 3.4. Effect of nutrient management on coconut leaf nutrient status 2019

Treatment	Total N %	Total P %	Total K %	Total Ca %	Total Mg %	Total S %	Fe (ppm)	Mn (ppm)	Cu (ppm)	Zn (ppm)	B (ppm)
T1	1.52	0.13	1.12	0.48	0.23	0.14	141.4	377.9	18.9	28.6	14.6
T2	1.55	0.12	0.96	0.51	0.23	0.13	139.6	367.7	18.3	27.2	13.2
T3	1.50	0.12	0.90	0.53	0.23	0.14	104.5	247.7	19.9	37.9	11.3
CD P=0.05	NA	NS	0.18	NS	NS	NS	NS	NS	NS	NS	NS

the treatments, palms with chemical fertilizers combined with organic manures (T1) recorded higher potassium content in leaf and it was significantly higher compared to fully organics (T3) and on par with T2. These results are clearly correlated with soil potassium where the treatment T3 recorded low available potassium. However, no significant difference was observed among the nutrient management practices with reference to all other macro and micro nutrients.

Economics

Effect of different nutrient management practices on economics for the year 2019 is presented in Table 3.5 and the treatment T3 (fully organic) recorded higher net returns compared to other treatments. The increase in net income was 3.8 fold over monocropping of coconut. This was mainly due to increase in productivity of coconut and additional returns from the component crops.

Scope of floriculture in coconut garden – A case study

Mr. Vinu Karthikeyan, a progressive farmer has shown tropical ornamental crops can be successfully grown in interspaces of coconut. He owns 2 ha coconut plantation with 400 numbers of elite WCT palms, located in Puthanthope, a coastal village of Thiruvanthapuram district, Kerala. One of the salient findings for the success of the cropping system is the wider spacing (10m x 10m) of coconut palms. The tropical ornamentals are planted considering light requirement and rooting pattern. Terrestrial orchids such as Arantheras and Arachnis are suitable for intercropping in coconut plantations. Ornamental costus and ferns are planted in the palm basin as it requires more shade and have shallow root system. Cut foliages such as dracaenas, calathias and phelodendrons are planted in the interspaces of coconut. Tropical ornamentals such as Alpinia 'Jungle King', Heliconia 'Iris' are the other crops of demand in his farming system. Cost of cultivation is reduced through recycling of coconut wastes and using low cost materials for field preparation and creating infrastructure for planting. He has a unique system of marketing where the flowers are marketed directly to the consumers and is capable of supplying the materials year around. The space constraints are managed through cluster approach where a group of 6 families are growing the plants supplied by him in their own land and supplying the produce based on demand. They are paid monthly and fetching an average of Rs. 25,000 to 35,000 per month based on the market conditions.

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

Arecanut based high density multispecies cropping system (HDMSCS) with different crop components: arecanut (Kahikuchi) + banana (Malbogh) + citrus (Assam lemon) + pineapple (Kew) + turmeric (Lakadong) with organic and integrated nutrient management was evaluated at Kahikuchi, Assam. The study indicated that intercrops treated with 2/3rd RDF + recycling of biomass showed higher yield in banana (11.07 kg/plant), pineapple (18,518 fruit/ha) and assam lemon (103 fruit/plant) as compared to other two treatments combination *viz.,* 1/3rd of RDF + recycling of biomass + biofertilizer + green manure and Recycling of biomass + biofertilizer + green manure + husk burial. The main crop arecanut is only 3 years old and observation recorded on vegetative growth showed higher plant height (3.37 m), plant base diameter (35.62 cm) and more number of leaves per palm (9.57) with recycling of biomass + biofertilizer + green manure + husk burial.

Table 3.5. Economics of HDMSCS under different nutrient management practices (Rs/ha)

Treatment	Gross cost (Rs.)	Gross return (Rs.)	Net return (Rs.)
T1: 2/3rd of recommended fertilizer NPK + recycled biomass	174619	607697	433078
T2: 1/3rd of recommended fertilizer NPK + recycled biomass + biofertiliser application + green manuring + vermiwash application	175389	616858	441469
T3: Fully organic with recycling biomass+ biofertiliser application + green manuring+vermiwash application+ husk burial +coconut leaf mulch	164077	617884	453807
Monocrop	110243	227500	117257

Intercropping of seasonal horticultural crops under arecanut at Kahikuchi

Growing of intercrops in arecanut garden not only utilizes natural resources but also gives additional income to the farmers. Keeping this in view, seasonal horticultural crops were grown under arecanut at Kahikuchi based on climate feasibility and preference of the local consumer. Summer vegetables like okra (*var.* Arka Anamika), amaranthus (Red type) and ashgourd (local type) seeds were planted. Yield obtained from the intercrops were okra (4.33t/ha), amaranthus (4.32 t/ha) and ashgourd (16.85 t/ha). The B:C ratio of the intercrops analyzed indicated that ashgourd can be the best summer intercrop with higher B:C ratio of 2.41.

Nutrient and Water Management

Site-specific soil management

To implement site specific soil management of coconut, spatial information on the soil constraints are imperative. In this line, soil constraint maps for relatively permanent soil properties for coconut cultivation were prepared for the entire Tamil Nadu state using the soil map at 1:50,000 scale developed by Tamil Nadu Agricultural University (TNAU). Soil constraints thematic maps for soil depth, soil texture, soil drainage and soil pH were developed using ArcGIS software (Fig. 3.1). Soil reaction based constraint is observed to be the major soil constraint identified for coconut in the entire Tamil Nadu state (69 % of the total geographical area), Followed by soil drainage based constraints (61 %), soil texture (49 %) and soil depth based constraint (40 %). Overall soil constraint class map for coconut was developed. All the soil series of Tamil Nadu were characterized based on the soil constraints of the studied properties. Soil management zones were delineated. These management zones are of homogeneous area in terms of soil constraints and their degree of limitation and also the management practices required.

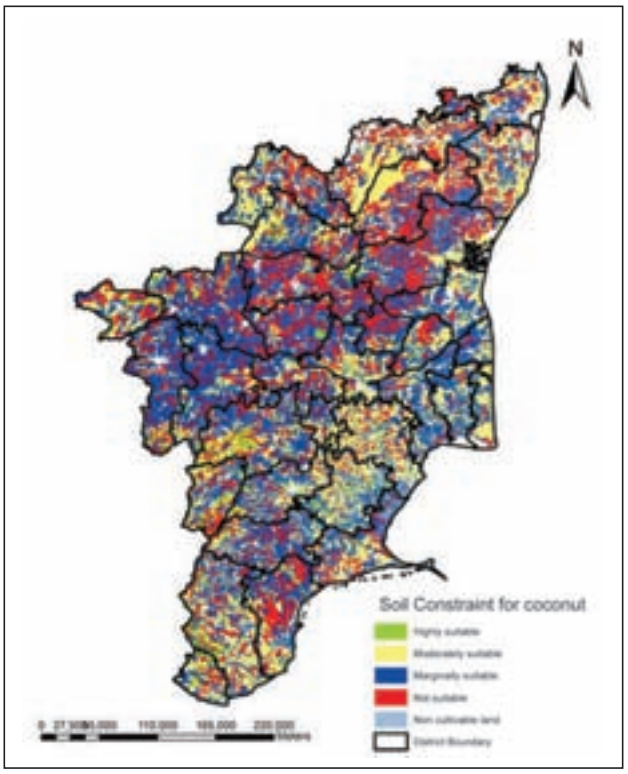


Fig. 3.1. Overall soil constraint map for coconut cultivation in Tamil Nadu

Nutrient mixtures for coconut

Two nutrient mixtures 'Kalpa Poshak' (K, S, B, Zn, Cu) - for juvenile palms and 'Kalpa Vardhini' (K, Mg, S, B, Zn, Cl) - for adult bearing palms were developed at ICAR-CPCRI RS, Kayamkulam. Field evaluation of the efficiency of 'Kalpa Poshak', indicated that sixty per cent of the palms treated with Kalpa Poshak initiated flowering and nut bearing in Kalpa Sankara hybrids at 27th month after planting. Among the treatments, the highest per cent flowering (60%) was recorded by T5 (Kalpa Poshak @120g per palm in 4 splits). However, the biometric characters such as number of leaves (19), width of longest leaf (132 cm) and collar girth (135 cm) were highest for Kalpa Poshak @ 80g per palm in 4 splits. As for the nutrient status in soil, soil application of Kalpa Poshak @ 100g per palm in 4 splits recorded the highest available K of 82.5 ppm, whereas in the leaf (4th leaf), the highest K content of 1.66% was recorded by the treatment with Kalpa Poshak @ 80 g/ palm in 4 splits.

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

A field experiment is in progress with different levels of nutrient application (5 treatments ranging from 50-200% of soil test based nutrient values) through drip fertigation and with basin application of nutrients under drip irrigation, in hybrid coconut (Kalpa Sankara). 1/3 of the dose as per treatments was applied in the second season from August 2018 to May 2019. Biometric observations were recorded and soil and leaf samples were taken for analysis from different plots after 2nd cycle of fertigation treatments, during June, 2019.

Plant height varied from 303 and 513cm amoung treatments and significant difference was observed between T_3 (150% dose) and T_5 (100% basal

application). Collar girth also showed significant difference between T_3 (100.45 cm) and T_5 (72.3 cm). Total number of active leaves also were significantly higher in T_3 compared to T_5. Length of middle leaf and length of leaflets showed no difference between treatments, but number of leaflets in the middle leaf were significantly higher in T_3 (170.25) compared to T5 (134.25). Treatment T_3 showed earlier emergence and opening of inflorescence among all treatments. Initial observations showed profuse emergence and opening of inflorescence between 18th and 22nd leaf axils in T_3 and T_4 compared to other treatments. Leaf potassium levels did not differ significantly between treatments though T_3 and T_4 showed higher values (1.61%).

Integrated nutrient management in arecanut at Kahikuchi

To work out the feasibility of recyclable organic wastes in arecanut, a trial is being conducted in arecanut at Kahikuchi with seven treatments having only organic and chemical fertilizers and their combinations as integrated nutrient management (INM) *viz.,* no fertilizer (control), vermicompost (100%), vermicompost (200%), recommended chemical fertilizers (100%), vermicompost (50%) + chemical fertilizers (50%), vermicompost (1/3rd) + chemical fertilizers (2/3rd) and vermicompost (2/3rd) + chemical fertilizers (1/3rd). Among the different treatment combinations, application of vermicompost (2/3rd) + chemical fertilizers (1/3rd) recorded the maximum dry kernel yield per palm per year (2.56 kg) followed by application of vermicompost (50%) + chemical fertilizers (50%) which recorded 2.49 kg dry kernel per palm per year.

High density planting of cocoa in arecanut

Grafts of cocoa variety Netra 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 3rd year after planting, the wet bean yield was significantly higher in closely planted cocoa grafts (465 – 629 g per plant) than normal spaced grafts (216 g per plant)(Fig.3.2). The restriction of stem height by pruning and tipping produced more primary branches and thicker main stem (17.7 – 19.8 cm) and wider canopy than wider spaced plants which contributed to higher yield in closely planted cocoa grafts. During the initial year, the wet bean yield per hectare was significantly higher in closely plated grafts (586 – 2335 kg ha^{-1}) than grafts under normal spacing (136 kg ha^{1}) due to higher plant population and higher yield per plant.

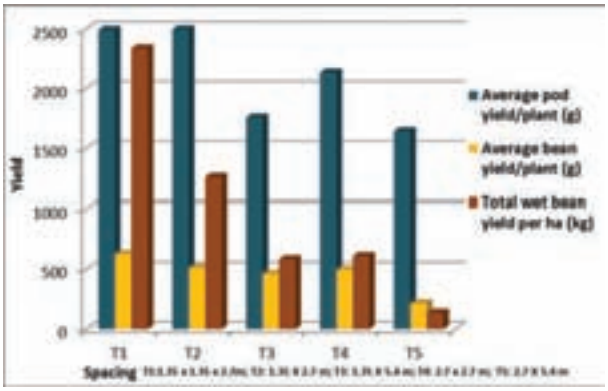


Fig. 3.2. Yield of cocoa grafts under different spacing

Yellow leaf disease management in arecanut

Field trial on management of YLD was initiated in two farmer's gardens in Sringeri and three gardens in Sullia taluk in 2015 and 2016, respectively, to demonstrate and study the nutrient aspect of YLD management strategies for arecanut in farmer's field. In 2019, the disease index (DI) ranged from 0.9 to 28.7% in different gardens. DI was higher in 3 plots compared to the pre-experimental data (2015 or 2016), but slightly lesser in 2 plots. However, mulching with mulching sheet was found to reduce the disease index and increase the yield. DI was lesser in 4 management trial plots during the experimental period (2016-2019) compared to the pre-experimental data (2015 or 2016). Higher DI was observed only in one plot (27.5%) which had DI value of 21.2% in 2015 (Fig.3.3). However, the increase in DI was much lesser compared to plot without plastic mulching which increased from 12.2% in 2015 to 28.7% in 2019. Hence, mulching the YLD plots with mulch sheets during monsoon (June-October) was found to reduce the disease symptoms (especially when the initial symptom is low), increase the yield and ease the collection of fallen nuts, and may also reduce the weed growth, deposition of copper in the basin and leaching of nutrients from the soil during monsoon. (Fig.3.4)

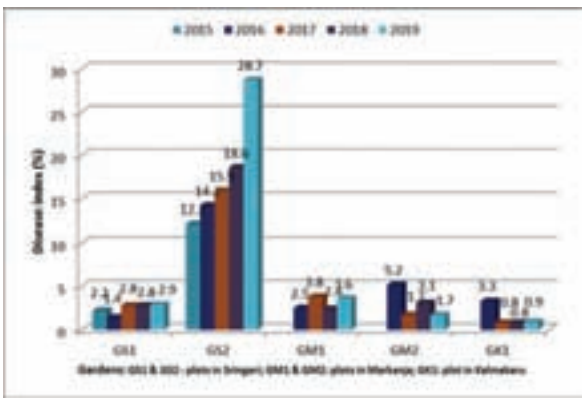


Fig. 3.3. Disease index (DI) in YLD management trial plots

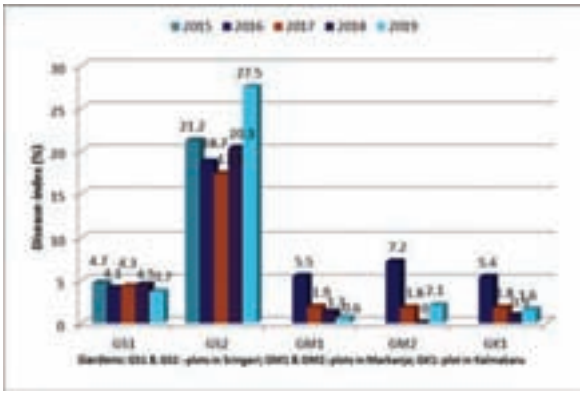


Fig. 3.4. Disease index in mulched plots

Interestingly, the crown choking symptom was reduced in the plot which had higher DI and crown choking symptom in 2015.

Bio resource management in coconut, arecanut and cocoa

Composting of cocoa wastes

Cocoa is an important perennial crop cultivated as an intercrop in coconut, arecanut and oil palm plantations in the southern states of India. The cocoa plant generates large quantities of biomass residues in the form of shed leaves, pod husks after removal of the beans, and bean shells after beans get roasted for cocoa production (Fig. 3.5). The leaves and some pods are mostly left in the field which becomes a good substrate for pathogen multiplication. It also allows habitat for poisonous reptiles and therefore becomes a hazard to farm workers. In view of this, composting of the cocoa leaves, pod husks and bean shells was initiated. All the wastes were transported from CPCRI, RS, Vittal to CPCRI, Kasaragod for the experiments.

The composting trial was initiated with different combinations of the cocoa wastes as substrates. Microbial culture and organic inputs were added to hasten the composting of the phenol-rich cocoa residues. Periodic turning was carried out to improve the decomposition. The aerobic heterotrophic microbes-driven composting of cocoa wastes generated heat. The temperature changes within the composting heaps were measured periodically. Mid-process samples of the waste undergoing composting have been drawn for nutrient and microbial analysis.

Biochar production from cocoa residues

Biochar from cocoa pod husks and bean shell wastes (Fig. 3.6) was produced using ICAR-CIAE developed simple charring kilns. The residence time needed for the cocoa pod husks to be converted to biochar was found to be on par with that of coconut husk biochar production. The nutrient contents in cocoa husk biochar are being analyzed to determine the amount of microbiota promoting carbon and potassium that can be recycled through this method.

Unraveling the microbiome of coconut husk composts

The complete microbiome dynamics of conversion of tender and mature coconut husks to composted manure was studied by analyzing the Ilumina platform output using an open-source software DADA2 pipeline. Amplicon Sequence Variant (ASV) were picked using close reference protocol against the Greengenes Database Consortium and were assigned taxonomy based on naive Bayesian classifier method. To determine the alpha and beta diversity of the microbiome contained in the composted husks vis-à-vis uncomposted ones, alpha diversity and the weighted and unweighted UniFrac beta diversity indices were calculated using the Observed, Chao1, ACE, Shannon, Simpson, Inverse Simpson, Fisher diversity indices with the help of phyloseq R package. The relationship of prevalence of bacterial taxa and total read counts after taxonomic as well as prevalence filtering across the samples is depicted below (Fig. 3.7). The data showed that Proteobacteria, Bacteroidetes, Actinobacteria and Firmicutes were the predorminat taxa in the compost samples.

Cocoa pod husks | Cocoa bean shell wastes | Cocoa leaves

Fig. 3.5. Cocoa wastes composting

Fig. 3.6. Cocoa pod husk biochar

Microbiological quality of coconut leaf vermicompost produced from palms growing in healthy and root (wilt) diseased tracts

The general and function-specific heterotrophic microbiota of vermicompost produced from coconut leaves collected from healthy palms growing in Kasaragod and Coimbatore and from those collected from root (wilt) diseased palms from Kayamkulam were analyzed. Higher population of bacteria, fungi and actinomycetes were observed in vermicompost produced from leaves of healthy palms compared to that produced from diseased palms. Key functional as microbiota involved in free-living nitrogen fixation, phosphate solubilization as well fluorescent pseudomonads in vermicompost produced from leaves of root (wilt) diseased as palms could not be detected. However, addition of higher quantities of cow dung to diseased leaves yielded vermicompost that contained free-living nitrogen-fixing bacteria and fluorescent pseudomonads, though much lesser than vermicompost produced from healthy coconut leaves.

Ecological tolerance of Cocoa Probio® bioinoculant

Cocoa Probio® is a talc-based bioinoculant of plant growth promoting *Pseudomonas putida* recommended by ICAR-CPCRI for application in cocoa seedlings to improve their health and vigour. Several environmental and soil conditions such as temperature, pH and salt levels affects its survival and performance when applied in field. Hence, tolerance range of this bioinoculant for these conditions was determined. Cocoa Probio® was able to grow at pH 5.0 to 9.0 with optimum growth at 7.0. It could grow at temperature ranging from 4°C to 35°C with optimum at 30°C, but could not tolerate NaCl concentration beyond 4%.

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

Field experiment on organic nutrient management for coconut in root (wilt) disease tracts is being conducted at farmers plot in Bharanikkav panchayath, Alappuzha district, Kerala. The experiment is laid out in RBD with five treatments and 12 replications. The treatments are *In situ* organic matter recycling, + PGPR consortia + *In situ* green manuring + husk burial (T1), *In situ* organic matter recycling, + PGPR consortia + *In situ* green manuring + 25 kg cow dung (T2), T1 + 50 % recommended $K_2$0 through the application of sulphate of potash (T3), T2 + 50 % recommended $K_2$0 through the application of sulphate of potash (T4) and conventional method or chemical fertilizer application (T5). Treatments, T3 and T4 showed maximum nut weight (1307g and 1417g, respectively), and copra content of 187g and 182g, respectively.

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

Several eudophytic bacteria were isolated from root tissues of RWD field resistant coconut palms with directed colony morphotypes for plant beneficial

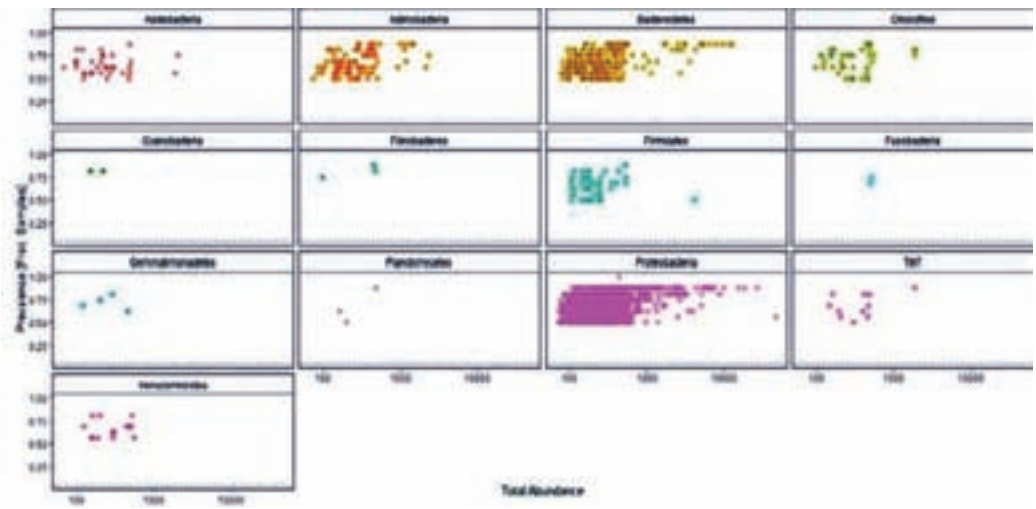


Fig. 3.7. Taxa prevalence versus total counts in husk composts

characteristics. More than 50% of the isolated exhibited strong IAA production (0.2 – 4.7 µg/ml) and 35% exhibited N-fixed capacity. Four isolated had with their important attribute three isolated CRE 2, CRE 9 and CRE 15 were further studies and based on 16s RNA analysis, CRE2& CRE 9 were identified as *Bacillus subtilis* and CRE 15 *B. Shackletonii.* (Fig.3.8)

PGPR Consortium: Based on the above studies, rhizobacterial consortium consisting of four selected strains of *Pseudomonas* sp., *Azospirillum* sp. and *Bacillus* sp., possessing multiple phytobeneficial traits was formulated. Comprising both epiphytic and endophytic microbes, isolated and screened from the rhizosphere of root (wilt) disease tolerant coconut palms, this consortium is found to have growth promoting effect in maize (Fig. 3.9). Evaluation of rhizobacterial consortia for growth promotion and disease suppression effects on coconut is in progress.

Phylloplane actinobacteria: Screening and identification

Coconut leaf samples for microbial analysis were collected from selected palms of ICAR-CPCRI, Regional station, Kayamkulam, that were categorized based on root (wilt) disease index values. Actinobacterial population was around 7 x 10^4 cfu/g in healthy leaf samples whereas the diseased leaf samples were dominated by fungal population. Phylloplane microbial plate count on Kenknight and Munaier's agar by heat shock dilution method considerably reduced interfering bacteria and fungi. Five isolates showed distinct colony characters of actinobacteria with characteristic musty odour, dimorphic mycelium, spore formation and non-motile leathery colonies. Colony surfaces were wrinkled and powdery with spore colours in shades of white to grey. Morphological characters confirmed that the five selected isolates belonged to Streptomycetaceae, a family that belonged to class Actinobacteria. Dual culture assay was done to screen five actinobacteria for antagonism against leaf rot fungus and their compatibility with biocontrol agent *Trichoderma* sp. Two isolates, *viz.*, CP1A1 and CP1A4 suppressed pathogen growth with latter recording the highest antagonistic activity (53% inhibition). All the five tested actinobacterial isolates were compatible with *Trichoderma* sp. Morphological characters indicated that they belonged to the family Streptomycetaceae of class Actinobacteria, producing aerial mycelia of spore mass colour in grey series with retinaculiaperti and spira type of spore arrangement in CP1A1 and CP1A4, respectively. 16S rDNA sequence analysis confirmed both the isolates belong to the genus *Streptomyces* with CP1A1 showing high (99.85%) similarity with type strain of *Streptomyces amphotericinicus* strain 1H-SSA8 and CP1A4 with *Streptomyces chromofuscus* strain NBRC 12851 (99.40%). These phylloplane actinobacteria from disease-free niche with antagonistic activity against coconut leaf rot pathogen can be explored further for prospective *in vivo* disease management strategies.

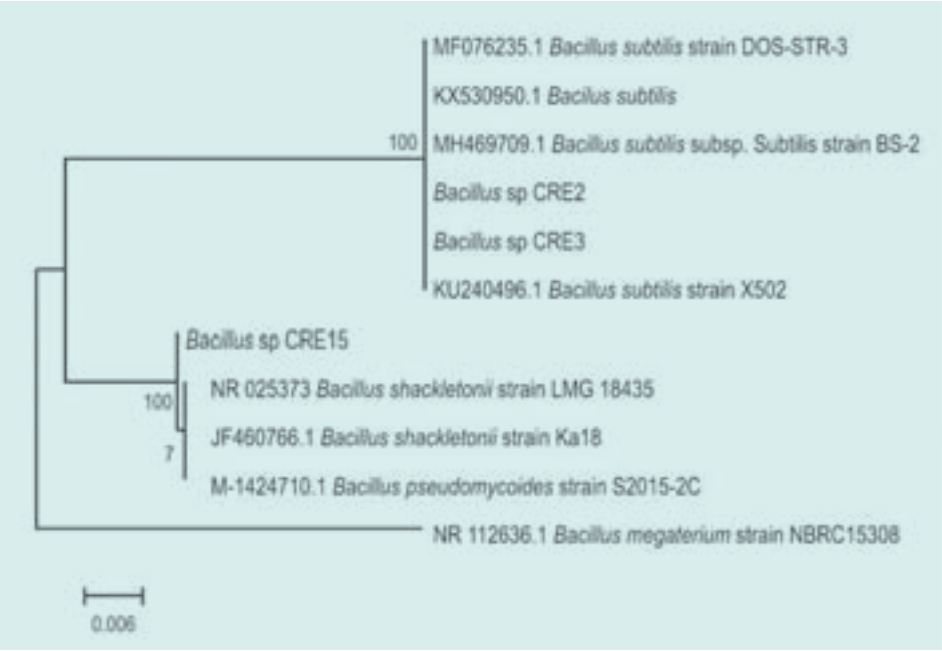


Fig. 3.8. Phylogram of the selected root endophytic isolates from RWD field resistant coconut palm

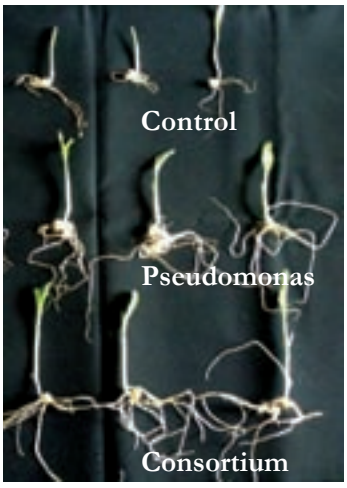


Fig. 3.9. PGPR in vitro evaluation studies

VIII-4. Integrated Management of Diseases in Palms and Cocoa

Disease management strategies need regular refinement in the changing climatic conditions. Continuous monitoring for the emergence of new diseases and pathogen strains is one of the major activities in the development of integrated disease management strategies. Hence, the diseases are being diagnosed and pathogen population is being characterized in a pursuit to improve the existing IDM strategies and develop new disease management strategies for major diseases of coconut, arecanut and cocoa.

Disease Diagnosis and Pathogen Characterization

Characterization of *Lasiodiplodia theobromae* associated with cocoa and coconut

The fungus *Lasiodiplodia theobromae* has been identified as a major pathogen in recent years causing severe leaf blight disease in coconut and dieback disease in cocoa in addition to already known diseases like coconut fruit rot and charcoal pod rot of cocoa (Fig. 4.1). In order to identify and characterize this pathogen, coconut leaf blight and fruit rot disease affected samples were collected from disease endemic areas like Pollachi and Tirupur districts of Tamil Nadu and also from Kasaragod district of Kerala. Dieback and charcoal pod rot disease affected cocoa samples were collected from disease prevalent areas of West Godavari district of Andhra Pradesh, Dakshina Kannada district of Karnataka and from Kasaragod region of Kerala. In total, 20 *L. theobromae* isolates were obtained from leaf blight affected coconut samples and 10 isolates from cocoa samples. Out of 20 isolates of coconut, 15 were characterized by dark grey colour colonies with dense aerial mycelia and remaining five shared light grey colour colonies with less aerial mycelia (Fig. 4.2). In case of cocoa, eight isolates produced light grey colour colonies with less aerial mycelia and only two with dense mycelia (Fig. 4.3). All 20 isolates produced hyaline oval-shaped conidia and later turned to brown with a single septum.

Fig. 4.1. Leaf blight and fruit rot diseases of coconut caused by *Lasiodiplodia theobromae*

Fig. 4.2. Dieback and charcoal pod rot diseases of cocoa caused by *Lasiodiplodia theobromae*

These were identified as *Lasiodiplodia theobromae* based on morphological characters and significant morphological variability has been observed among the isolates. Identification was also confirmed by sequencing internal transcribed spacer region of ribosomal RNA.

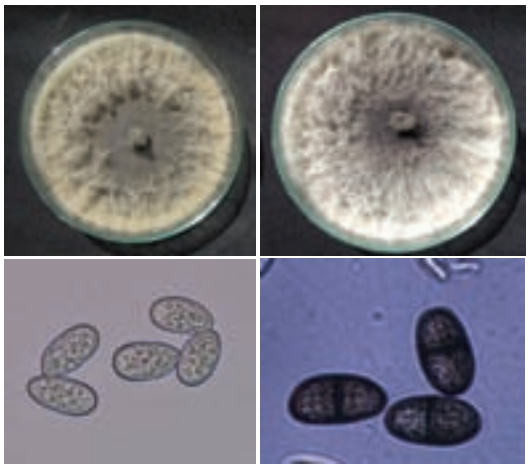


Fig. 4.3. Colony morphology of *Lasiodiplodia* from coconut: colony on potato dextrose agar plates (a & b) immature and mature conidia (c and d)

Diagnosis of flower and fruit rot disease of dragon fruit grown in coconut based cropping system

Dragon fruit, *Hylocereus undatus* (Haworth) Britton & Rose, is one of the promising and remunerative intercrops in coconut gardens. A flower and fruit rot disease observed in white-fleshed dragon fruit (Fig. 4.4) at ICAR-CPCRI, Kasargod, Kerala was studied to identify the causative agent. The symptoms included water-soaked, olive to black powdery spots to coalescing soft rot in the later stages in both flowers and fruits. The diseased fruits were then isolated for the fungal pathogen. The pathogen, isolated from desired fruit, was identified as *Curvularia eragrostidis* and its pathogenicity was confirmed by satisfying Koch's postulates. Molecular identification using internal

Fig. 4.4. Flower and fruit rot caused by *Curvularia eragrostidis*

transcribed spacer (ITS) gene amplified with ITS1 and ITS4 primers confirmed its identity as *C. eragrostidis*. *In vitro* screening with *Trichoderma harzianum* (CPTD 28) showed antagonistic activity against the pathogen by suppressing the mycelia growth in PDA. Which can be exploited further in field condition to control the disease effectively.

Identification and characterization of bacteria associated with arecanut leaf stripe disease

The leaf stripe/blight diseases caused by different fungi are very common in arecanut (Fig. 4.5) while leaf stripe disease caused by the bacteria *Xanthomonas campestris* pv. *arecae* was very sporadic and reported during 1983 in certain localities in Tumkur district of Karnataka. In later years, the incidence of this disease was very negligible in those areas. However, in recent years, a similar type of leaf stripe disease is appearing in a severe form on arecanut in certain parts of Shivamogga district of Karnataka. The characteristic symptoms observed are dark green, water soaked linear lesions or stripes alongside or parallel to the midrib of the leaflet and its main veins. The margin of the lesions is usually straight and also wavy in some leaves due to lateral spread. The lesions are covered with creamy white and slimy abundant bacterial exudates on the lower surface. After drying, it forms a waxy film on the surface which later turns to dark black stripes. The affected midrib and veins of the leaflet also get discoloured and turn black. The bacterial infection leads to partial or complete blighting of the leaves and the entire crown may get killed especially in the seedlings emitting foul smell from

Fig. 4.5. Symptoms of leaf stripe disease of arecanut

the rotten portion of the crown. Symptomatic leaf samples were collected from Kunchenahalli village of Shivamogga Taluk. Five bacterial isolates were purified from infected leaf samples. These isolates were characterized as gram-negative, bright yellow pigmented and rod shaped bacteria and identified as *Pantoea* spp. Identification was also confirmed by biochemical characterization and 16S rRNA gene sequence analyses. Pathogenicity tests also demonstrated that all the five *Pantoea* isolates were pathogenic to arecanut.

Characterization of *Trichoderma* from arecanut based cropping system

A total of 22 soil samples were collected from different arecanut based ecosystem (arecanut monocrop, Arecanut + Cocoa, Arecanut + Pepper garden) of Karnataka state. In addition to that, a total of 20 soil samples were collected from major arecanut growing tracts of Assam

state. All samples were subjected to *Trichoderma* isolation on *Trichoderma* selective media. Based on the morphological characterization (conidiophore structure, conidia shape and phialides structure) a total of 186 *Trichoderma* isolates (69 from Assam and 117 from Karnataka) were obtained from collected soil samples. PCR amplification and sequence analysis of internal transcribed spacer (ITS) region showed >99.5% similarity with *Trichoderma asperellum*, *T. hamatum*, *T. harzianum* and *T. virens* for all the Karnataka isolates. Virulence assay against *Ganoderma lucidum* of selected *Trichoderma* isolates and molecular characterization are under progress for the Assam isolates.

Management of stem bleeding disease of coconut

A field trial on the management of stem bleeding disease of coconut with different treatments involving fungicides like Hexaconazole 5 EC, Propiconazole 25 EC and *Trichoderma harzianum* (CPTD28) was conducted at Maicha in Kasaragod district of Kerala. Treatments were imposed at quarterly intervals and recorded a significant reduction in disease index was observed in all the three treatments such as Propiconazole 25 EC, Hexaconazole 5 EC and *Trichoderma harzianum* from 16.2 to 10% as compared to control (35.5%).

Management of fruit rot of arecanut using Mandipropamid

Single prophylactic spraying of Mandipropamid 23.3SC in two different concentrations (0.1% and 0.5%) was carried out during the first week of June, 2019 for the management of arecanut fruit rot disease at ICAR-CPCRI, Regional Station, Vittal. Single spraying of 0.5% Mandipropamid 23.3SC is comparatively efficient with 72.79 % disease severity as compared to 90.32 % disease severity in spray of 0.1% Mandipropamid 23.3SC and 90.174% in control (non-sprayed plots). Whereas, regular two rounds spraying of 0.5% Mandipropamid 23.3SC (one during the first week of June and the second spray after 55 days of the first spray) resulted in 47.285% disease severity. Disease severity was lowest (20.54 %) in the plots treated with two regular prophylactic sprays of 1% Bordeaux mixture. It clearly indicated that single prophylactic spray of Mandipropamid (0.1 % or 0.5 %) is not effective in reducing the arecanut fruit rot disease.

Arecanut fruit rot management using air-blast sprayer

Field trials were conducted to test the feasibility of using tractor mounted air-blast sprayer developed by ICAR-CPCRI in collaboration with ASPEE for prophylactic spray against fruit rot of arecanut. Two prophylactic sprays (first spray just before the onset of monsoon and second spray 50 days after the first spray) of four different fungicides namely Bordeaux mixture (1% and 2%), copper oxychloride (COC) (0.3%), mandipropamid 23.3SC (0.5%) and Fenamidone10% + Mancozeb 50% w/w WG (0.5%) was undertaken and the fruit rot disease incidence and severity were regularly monitored during the monsoon season from June to September, 2019.The fruit rot disease incidence in the plots sprayed manually with traditional rocker sprayer was 69.4% and 93.1% in the plots sprayed with 0.5% Mandipropamid 23.3SC and 2% Bordeaux mixture respectively. Whereas, 100% disease incidence was recorded in 1% Bordeaux mixture, 0.3% copper oxychloride and 0.5% Fenamidone10% + Mancozeb 50% w/w WG sprayed plots. In tractor mounted air blast sprayed palms, disease incidence was 91.2% in 0.5% Mandipropamid 23.3 SC, 92.5% in 0.3% COC, 96.8% in 1% Bordeaux mixture, 97.3 in 2% Bordeaux mixture spray and 100% in palms sprayed with 0.3% Fenamidone10% + Mancozeb 50% w/w WG. Lowest percentage of disease severity (20.55%) was recorded in the palms sprayed manually with 1% Bordeaux mixture, followed by 36.287% in 2% Bordeaux mixture, 47.285% in 0.5% Mandipropamid 23.3SC, 84.165% in 0.3% copper oxychloride and 91.570% in 0.5% Fenamidone10% + Mancozeb 50% w/w WG. Disease severity in all the treatments applied with tractor mounted air-blast sprayer was comparatively higher than manual spray.

Field trial on the management of inflorescence dieback disease of arecanut

Two rounds of prophylactic spraying of six selected fungicides (Carbendazim 25% EC + Flusilazole 12.5% SC, Carbendazim 25% EC + Mancozeb 63% WP, Propiconazole 25% EC, Chlorothalonil 78.12% WP, Zineb 68%WP + Hexaconazole 4%WP and Mancozeb) was carried out during first week of February and March, 2019 for the management of arecanut inflorescence dieback disease at ICAR-CPCRI, Regional Station, Vittal. The inflorescence dieback disease incidence was regularly monitored from February to May, 2019. Results showed very less disease incidence (6.12%) in Carbendazim 25% EC + Flusilazole 12.5% SC treatment followed by Propiconazole 25% EC (9.62%), Zineb 68% WP + Hexaconazole 4%WP (11.22%), Chlorothalonil 78.12% WP (12.79%), Carbendazim 12% EC + Mancozeb 63% WP (13.08%), Mancozeb (15.33%) as compared to non-sprayed plots (22.22%).

VIII-5. Integrated Management of Pests and Nematodes in Palms and Cocoa

Pest management in a perennial system coupled with weather dynamics has become so complex in the plantation sector. The advent of four neotropical exotic whiteflies on coconut in Peninsular India in a span of three years warrants strict quarantine regulations during the transboundary movement of planting materials especially ornamental palms from New World. Diagnosis of new non-native pest species and emergency preparedness module to counter their aggression has been evolved through eco-friendly and sustainable strategies. Competitive displacement and co-occurrence of different whitefly species on palm system is very unique and intriguing. Awareness campaigns and surveillance surveys have been strengthened to sensitize the stakeholders on invasive pests. Technological refinements and technical insights on key and emerging pest of palms and cocoa targeting sustainable suppressive solutions are briefed.

Coconut Rhinoceros Beetle (*Oryctes rhinoceros* Linn.)

In India, *O. rhinoceros* is a key pest on juvenile coconut palms attacking through collar region or spear leaf and on adult palms, its feeding injury is never fatal. Recently, infestation on juvenile palmyrah palms through crown entry is also observed from Tamil Nadu (Fig. 5.1).

A new coconut rhinoceros beetle (CRB)-Guam haplotype was reported from South-Pacific Guam Island which is found insensitive to the *Oryctes rhinoceros* nudivirus (OrNV). CRB-Guam strain is genetically distinct and could kill adult palms in the Pacific Islands and was reported to deter away from the pheromone traps. In order to assess the presence of CRB-Guam strain in the country, intensive surveys were undertaken in Kayamkulam and neighbouring areas. The grubs were collected from breeding sites and incubated in the laboratory for the natural occurrence of OrNV infection. (Fig.5.2). It was found that 1.5%-2.0% of grubs collected took up natural OrNV infection. In addition, 82%-85% grubs inoculated with OrNV through *per os* mode was generally found susceptible thereby indicating the absence of CRB-G strain in the country.

Fig. 5.1. Palmyrah infested by rhinoceros beetle

Fig. 5.2. Healthy and OrNV infected *O. rhinoceros* grubs

Placement of botanical pellets 5 g on top most three leaf axils and smearing botanical paste on the spear leaf could shield the juvenile palms from CRB attack for a three months period. Area-wide evaluation of botanical formulation under AICRP on Palms experiments has also proved very effective and successfully demonstrated.

Crop-habitat diversification

A systematic crop habitat diversification by cultivating Kalpa Sankara coconut hybrid [CGD x WCT and tolerant to root (wilt) disease] in synergy with compatible intercrops *viz.,* banana, nutmeg, rambuttan, curry leaf, tuber crops, turmeric and flowering plants for pest regression was under evaluation since August 2012. A bird perch and a honey bee colony formed an integral part of the system and all crop biomass were recycled through mulching. Coral vine, the eco-feast crop is another important addition that attracted honey bees. Palms were spaced at 7.5x7.5 m with leaflets in frictional contact with intercrops that are engineered ecologically for inducing volatile confusion strategy. Pest incidence was comparatively low in the ecological engineering plot,

Table 5.1. Pest incidence in mono-cropped coconut garden and ecological engineering garden

Pests	Incidence (%)	
	Monocrop	Diversified garden
Rhinoceros beetle	15.4	7.7*
Red palm weevil	1.2	0.0*
Rugose spiralling whitefly	71.8	20.5*
Eriophyid mite	38.5	28.2*

*Significantly reduced in ecological engineering garden than monocrop ($t<0.001$)

whereas, two to three fold increase was observed in the mono cropped coconut (Table 5.1).

Susceptibility of palms to pests in mono-cropped garden could be due to excessive volatile cues of coconut favouring orientation of pests to the palms, which is otherwise diminished in ecological engineering plot due to admixture of volatile cues from coconut and also from adjacent intercrops. Earthworm castings and ecological service providers such as pollinators, defenders, scavengers *etc* in this smart crop pluralism garden were found to be higher than in mono-cropped coconut garden. A sustainable mean yield of above 150 nuts/palm/year was realized in a period of five years with regular income from the intercrops and also ensured continuous employment in the intercropped coconut garden. In the present era of climate change, such a strategy of crop pluralism turn climate resilient and has the potential to withstand biotic and abiotic stresses with ease and can deliver sustainable crop yields.

Red Palm Weevil (*Rhynchophorus ferrugineus* Oliv.)

Asiatic red palm weevil, *Rhynchophorus ferrugineus* Olivier, a concealed tissue borer is the fatal enemy and destructive pest on coconut palms. Smart detection sensors based on vibration signals of grub activity was found as a non-disruptive innovative tool for sensible early detection. In this attempt, a pattern could be decoded by the typical vibration and noises produced by the feeding grubs of red palm weevil in the lower order frequencies of 10 hz to 4000 hz. A time amplitude domain waveform devoid of ambient noises and persistent signals of grub feeding could be ascertained after subjecting to reverse transformation and several modes of normalization process. Though the noise filters with state of the art DSP algorithms are developed, significant modifications on sensor hardware are also required for better signal reception. The machine learning algorithm that was formulated by training the system using data collected from infested and regular petioles were deployed on a portable hardware (Fig. 5.3). The unit was able to successfully demonstrate the detection

Fig. 5.3 Portable hardware in which the formulated algorithm was deployed to demonstrate the detection of grubs in the petiole and detection hardware set up in the field

of red palm weevil grubs in coconut petiole in most of the attempted cases and the success rate exceeding 87%.

Invasive Neotropical Whiteflies

Neotropical Palm Whitefly (*Aleurotrachelus atratus*)

A new Neotropical palm whitefly, *Aleurotrachelus atratus* was observed on coconut from Mandya, Karnataka in March 2019. This non-native whitefly was also confined on the abaxial leaf surface on palm leaflets. Eggs are stalked, elliptical, turn black before eclosion into crawlers, that are actively mobile with appendages and settles down after finding suitable feeding site. Presence of eight characteristic white fluffs on the dorsum is very important in pest identification and thereafter, the white fluff gets expanded covering most of the black body in a short period. Pupal body has the marginal spines and discontinued sub-marginal fold beyond vasiform orifice, unique to the genus *Aleurotrachelus atratus*. Adult whitefly is broadly narrow with wings held roof-like on rest having maroon eyes with no markings on wings. In many of the colonies of *A. atratus,* adults and pupae of nesting whitefly, *Paraleyrodes minei* co-existed, mimicking the adult of *A. atratus*.

In many Western countries, aggressive feeding capabilities of *A. Atratus* were reported to cause necrotic lesions on palm leaflets and significant drop in nut yield as well. However, in Mandya, Karnataka, *A. atratus* colony on palm leaflets co-existed with the life stages of *P. minei* and this competition would have probably reduced the aggressiveness of *A. atratus* in synergy with favourable weather condition of uniform distribution of rainfall experienced in the region during May-July 2019. Though the pupal colonies were inter-

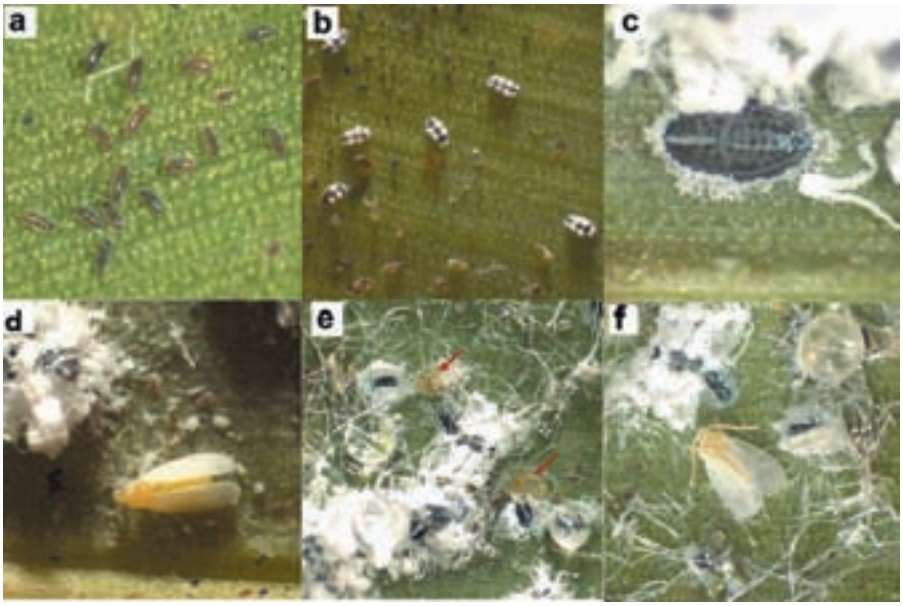


Fig. 5.4. Life stages of *A. atratus* and its co-existence with *P.minei*a-Eggs; b-Nymphs; c-Pupa d-Adult of *A. atratus*; e-*P.minei* pupae on *A. atratus* colony; f-*P.minei* adult on the pupae of *A. atratus*.

mixed, adult whiteflies were not co-living; and the *P. Minei* adults were found associated and inter-mixed with the colony *A. atratus* leading to confusion in pest diagnosis. Life stages of *A. atratus* and the co-existence of *P.minei* on the colony of *A, atratus* are presented in Fig. 5.4.

Co-existence of exotic whiteflies and competitive displacement

With the dominance of rugose spiralling whitefly, *Aleurodicus rugioperculatus* observed on coconut during the initial phase of introduction in 2017 at Kayamkulam, Kerala, co-occurrence of two nesting whiteflies *viz*., *Paraleyrodes bondari* and *Paraleyrodes minei* were also recorded in 2018. Hence, co-existence of three exotic whiteflies (*A. rugioperculatus*, *P. Bondari* and *P. minei*) was common on palm leaflets in 2018 with fluctuating population of each species in different seasons. However,

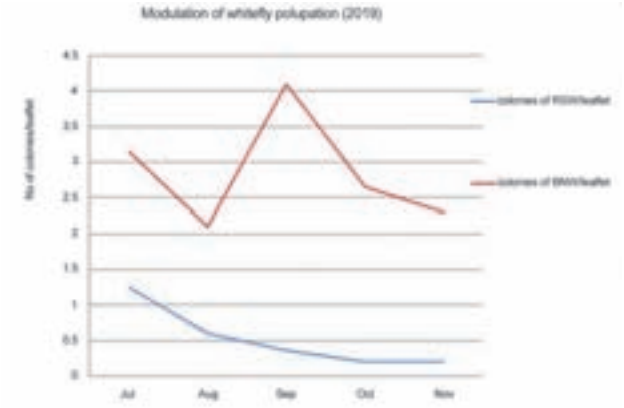


Fig. 5.5. Population of exotic whiteflies on coconut at Kayamkulam

in 2019, *Paraleyrodes minei* was significantly reduced and relatively absent. Bondar's nesting whitefly, *P. Bondari* had dominated on coconut during June –December 2019 (4.0) slowly replacing*A. rugioperculatus*(1.0) by competitive displacement (Fig. 5.5).

Morpho and molecular diagnosis of exotic whiteflies infesting coconut

Due to overlapping presence of different whitefly species on the same niche, the correct stage of identification and the characteristic features of these invasive whiteflies are very important. Distinct features in the identification of the non-native whiteflies infesting coconut are depicted in Fig. 5.6 for easy and correct identification mainly in the context of one species being found co-mingling and rest on the colony of another whitefly.

***Aleurodicus dispersus* Russell:** Spiral mode of egg laying and covered with powdery mass, prominent projections on nymphs with two tail-like structure, convex pupa, non-corrugated operculum, blunt and tongue-like lingual, thinner adult, pure white with no markings on wings and about 2.2 mm. Minor pest on coconut and guava is the preferred host.

***Aleurodicus rugioperculatus* Martin:** Spiral mode of egg laying on palm parts, milder projections on nymphs with normally one tail-like structure, convex pupa, rugose operculum, triangular and pointed lingula, robust adult, white with brown mottling on wings and measuring about 2.3 mm. Coconut is the preferred host.

***Paraleyrodes bondari* Peracchi:** Stalked eggs, nymphs

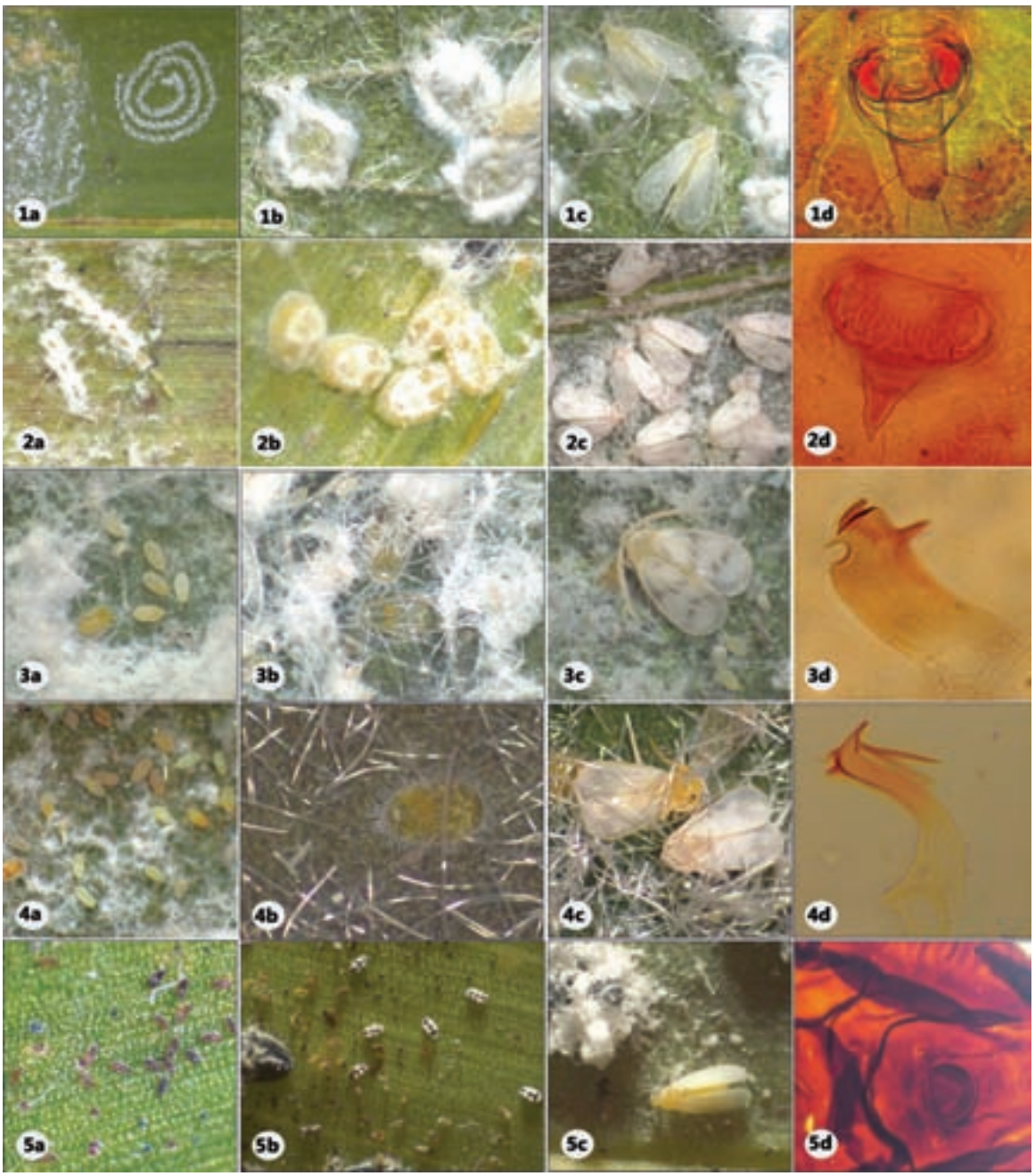


Fig. 5.6. Identification features of five invasive whiteflies infesting coconut 1a *Aleurodicus dispersus*a. Eggs 1b. Nymphs with anal fluffs 1c. Adult whiteflies pure white and translucent 1d. Tongue-like lingula 2a. *Aleurodicus rugioperculatus* a. Eggs 2b. Convex nymphs 2c. Adult whiteflies with grey mottling on wings 2d. Rugose operculum with triangular lingula 3a. *Paraleyrodes bondari* a. Stalked eggs 3b. Flat nymphs 3c. Adult whitefly with X-shaped markings 3d. Male genitalia with dorsal and ventral horn 4a. *Paraleyrode sminei* a. Stalked eggs 4b. flat nymphs 4c. Adult whitefly devoid of markings 4d. Cock-head like male genitalia 5a. *Aleurotrachelus atratus* a. Black eggs 5b. Nymphs with eight dorsal fluffs 5c. Adult wings held roof-like 5d. Interrupted sub-marginal fold near operculum.

flat with prominent silken threads from dorsum and marginal hairs, pupa flat flower-petal like compound pores, small adult on well constructed nests, X-shaped markings on wings measuring about 1.0 mm, rod-like male genitalia with anterior and posterior horn.

***Paraleyrodes minei* Iaccarino:** Stalked eggs, nymphs flat with prominent silken threads from dorsum and marginal hairs, pupa flat with flower-petal like compound pores, small adult rests on loosely constructed nests devoid of markings on wings measuring about 1.0 mm, cock-head like male genitalia.

***Aleurotrachelus atratus* Hempel:** Elliptical stalked eggs, turn black before eclosion, Eight prominent white spots on nymphs which later coalesce and partially cover the black body, marginal serrations on pupa, round lingula, sub-marginal fold interrupted at vasiform orifice.

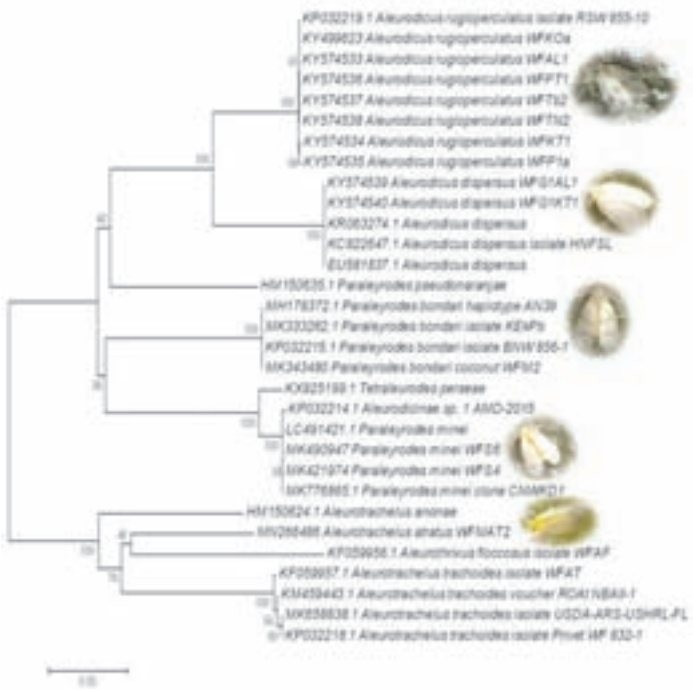


Fig. 5.7. Unrooted Phylogenetic tree and molecular lineage of invasive whiteflies infesting coconut in India

Adult longer than broad, wings held roof-like.

Molecular phylogeny also indicated the closeness and distantness of the five whitefly species (Fig. 5.7). There are three groups in which the invasive whitefly species infesting coconut could converge *viz., Aleurodicus*, *Paraleyrodes* and *Aleurotrachelus* (*Aleurothrixus*) groups. The first two groups have more intrinsic relationship than that of *Aleurotrachelus* (*Aleurothrixus*) group, which is distantly placed. *Paraleyrodes pseudonaranjae* was found to be intermediary between *Aleurodicus* and *Paraleyrodes* group with more affiliation toward *Aleurodicus* group. The close homogeneity of *Aleurotrachelus atratus* and *Aleurothrixus flocossus* and a wider linkage with *Aleurotrachelus trachoides* in this phylogenetic tree could be more clarified if more species are identified and molecular characterization undertaken. Furthermore, *Aleurotrachelus anonae* is wide apart from *A. atratus* and *A. trachoides,* indicating evolutionary among the divergence species of *Aleurotrachelus* (*Aleurothrixus*) group which needs further understanding of different whitefly species.

Conservation biological control and Bio-scavenging in the bio-suppression of rugose spiralling whitefly – A success story

Invasion of the exotic rugosespiralling whitefly, *Aleurodicus rugioperculatus* in coconut ecosystem from Tamil Nadu and Kerala during July, 2016 had initially alarmed the coconut sector by enormous population build up and deposits of sooty mould, *Leptoxyphium* sp. However, the conservation biological control strategy advised very efficiently and launched successfully by resorting to no pesticide spray (pesticide holiday) turned out to be a real success. This approach could completely subdue the pestiferous potential of *A. rugioperculatus* in a short period of five to eight months after initial report. There was tremendous build up of the aphelinid parasitoid, *Encarsia guadelo upae* Viggiani completely eliminating *A. rugioperculatus* in the region of infestation. Since no pesticides were sprayed against rugose spiralling whitefly, the population build up of parasitoids was enhanced in the natural ecosystem. Parasitism which had initially found to be 10-15% rose to as high as 70-80% in a period of five to eight months.

The natural build up of the sooty mould scavenger beetle, *Leiochrinus nilgirianus* Kaszab feeding on the sooty mould deposits on palm leaflets during morning wetness period of July-November 2019 cleansed the palm leaflets and revived photosynthetic efficiency of palms. The bio-cleansing action was prompt and timely in a niche that was experiencing non-chemical mode of pest suppression.Thus, natural bio-suppression by *E. guadeloupae* in synergy with the cleansing action by sooty mould scavenger beetle, *L. nilgiranus* could bring down the population of non-native *A.rugioperculatus* by both bio-control and bio-scavenging action. Not only the pest population diminished, but the improvement in palm health by cleansing off sooty mould is one of the

first instances of natural scavenging on economically important crop by an insect reported so far. This forms a typical example of conservation biological control coupled with bio-scavenging highlighted in a perennial plantation crop, coconut.

Effect of temperatures on growth rates of Entomopathogenic fungus, *Simplicillium* sp.(Cordycipitaceae, Hypocreales)

Laboratory temperature of 24 – 28 ± 2 °C aptly suited the growth of *Simplicillium* sp. and attained a maximum length and breadth of 4.23 ± 0.57 cm and 3.5 ± 0.34 cm, respectively.The mean biomass weights (fresh and dry weight, respectively in gms) was also found to be highest in the above temperature as 4.66 ± 0. 52 cm: 0.32 ± 0.02 gm, respectively indicating that the entomopathogenic fungus could be successfully multiplied in the laboratory in potato dextrose agar (PDA).

Mass production of entomopathogenic fungus, *Simplicillium* sp.

Mass production of entomopathogenic fungus, *Simplicillium*sp. was done on naturally available solid carrier substrates (Parboiled rice and sorghum grains) and liquid carrier substrates (PDB: Potato Dextrose broth, CWB: Coconut Water Broth and RWB: Rice Water Broth. The highest stabilization potential was recorded on coconut water broth (4.6 x 10^6 CFU/ml), followed by rice (4.5x 10^6 CFU/ml), rice water broth (4.2 x 10^6 CFU/ml) and sorghum grains (3.3 x 10^6 CFU/ml), respectively (Fig. 5.8).

Evaluation of Neemazal T/S against coconut whitefly complex

Azadirachtin based botanical formulation Neemazal T/S* (Azadiractin 1% EC) was evaluated against whitefly complex (*A. rugioperculatus*, *P. bondari*, *P. minei*) on the coconut seedlings and juvenile palms at three different doses (0.25%, 0.5%, 1%) and by comparing with water spray alone as control. Pest observation recorded at three days after spraying (DAS) resulted in very low mortality under both treated seedlings and control. At 14 DAS, Neemazal (1%) caused highest mortality (40 – 50%) and no new colony formation was noticed on the treated leaves, when compared to control and other doses tested (Fig. 5.8).

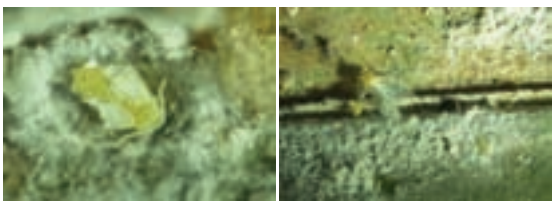


Fig. 5.8 a. Dead whitefly due to Neemazal Spray b. Few malformed adults that emerged from Neemazal (1%) spray

Conservation biological control of coconut scale insects

Coconut scale insect, *Aspidiotus destructor* Sign. is one of the diaspidid hard scales that feed from abaxial surface on palm leaflets causing typical chlorotic patches on the upper leaf surface, which subsequently turn necrotic under severe conditions. Sporadic outbreak of coconut scale insects is reported during summer period in different parts of the country and a recent emergence was observed at Vettiar, near Kayamkulam in May 2019. Though the intensity of infestation was found higher in a secluded coconut garden near an uninhabited forest area, a wide array of natural enemies were observed in the surveillance survey could naturally suppress the pestiferous potential of *A. destructor*. More than 50% of the hard scales were found parasitized by the aphelinid parasitoid, *Aphytis* sp. and the population of the parasitoid was considerably higher in the pest inflicted garden. Besides, three lady beetles, *viz., Chilocorus nigritus*, *Sasajis cymnus* sp., and *Pharoscymnus horni* and their grubs were recorded feeding voraciously on scales. *C. nigritus* was absolutely black, *Sasajis cymnus* sp. was brown in color and the grubs resemble mealy bugs whereas *P. horni* with characteristic red patches on elytron was observed for the first time in palm system (Fig. 5.9). Conservation of these natural enemies forms a very important strategy in the management of coconut scale

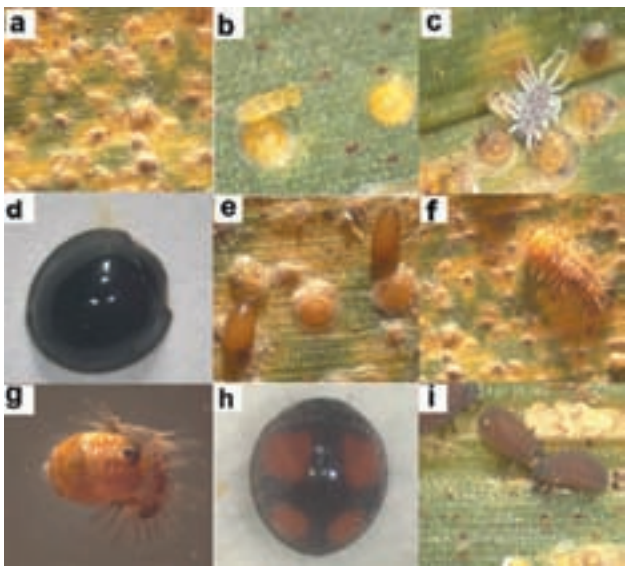


Fig. 5.9. Coconut scale insect and natural enemies a-Damage by scale insects; b-*Aphytis* sp.; c-Grub of *Sasajis cymnus* sp.; d-*Chilocorusnigritus;* e-Eggs of *C. nigritus*; f-grub of *C. nigritus*; g-Pupa of *C. nigritus*: h-*Pharoscymnus horni*; i-Grubs of *P. horni.*

insects. This natural guild of defender complex established very successfully in a period of two months could completely wipe out the entire colony of coconut scale insects by July 2019. In this conservation biological control, coconut scale population is naturally bio-suppressed by the natural enemy complex in a period of two months.

Intrinsic association of two beetles with stem bleeding disease in coconut

In a stem bleeding disease affected palm with enormous exudates from the trunk located from Pollachi, Tamil Nadu, active association of the scolytid beetle, *Xyleborus perforans* was observed in April 2019. All immature stages of *X. perforans* could also be recorded from the rotten tissues scooped out from the trunk. However, the exact role of *X. perforans* as disease carrier or further involvement in disease transmission could not be decoded. In another similar disease affected palm, a tenebrionid beetle, *Corticeus filum* Fairmaire was observed inside the trunk with shot hole symptoms either feeding on the detritus/fungal mass/ exuding sap or suspected predatory on the solytid beetle (*X. perforans*) from the same garden. Both *X. perforans* and *C. filum* could not occur simultaneously in the same diseased palm, but were observed in two different diseased palms located very close by Inter-relationship of these beetles with the disease is under progress.

Entomopathogenic Nematodes (EPN)

Packaging EPN-infected *Galleria mellonella* cadaver in parafilm enhanced shelf life

A novel technology of packaging EPN-infected *G. mellonella* cadaver using parafilm (Fig. 5.10) enhanced shelf life and delayed emergence of infective juveniles (IJs) up to 15-20 days at 25-28°C, whereas under normal parafilm-free condition, the IJs emerged in a period of 4-5 days. This technology thus augurs long-distance transport of EPN from production site to delivery point without losing virulence. Cadaver mode of EPN formulation could release the IJs slowly and has greater ability to disperse and infect soil borne pests (*Leucopholis* spp.) in plantation system.

Fig. 5.10. Emergence of IJs in parafilm-free mode and its non-emergence in parafilm-packaging technology of EPN-infected *G. mellonella* cadaver

Antagonistic interaction of bacterial symbionts associated with entomopathogenic nematodes against fungal pathogens of coconut leaf rot disease.

The bacterial symbionts of entomopathogenic nematodes, *Steinernema hermaphroditum* CPCRI0905, *Steinernema* sp. CPCRI0804, *Heterorhabditis indica* CPCRIH12H and *H. indica* CPCRI0701 was isolated using NBTA medium. Sequence analysis of 16SrRNA sequences revealed genetic relatedness of CPCRI0905 and CPCRI0804 isolates to *Xenorhabdus griffinae* with more than 99% identity. The bacterial isolate CPCRIH12H showed more than 99% identity with *Photorhabdus luminescens*. Inoculation of these bacterial symbionts to grubs of rhinoceros beetle and red palm weevil could not cause any pathological symptoms.

Bio-efficacy of these symbiotic bacteria was also evaluated against coconut leaf rot fungi as well as against fungal bioagents in the laboratory dual culture experiment. The bacterial symbiont, *Photorhabdus* H12H was found to be the best isolate to inhibit both of the leaf rot fungi, *Colletotrichum gloeosporioides and Fusarium* sp. All the four bacterial symbionts suppressed *M. anisopliae* with highest level of inhibition by *Photorhabdus* isolates. The antagonism of *Photorhabdus* isolates was observed against *T. viride* with significant level of growth suppression by the development of inhibition zone. The fungal mass over grew above the bacterial colony in both the *Xenorhabdus* isolates. The study revealed the possibility of utilizing *Photorhabdus* H12H for the management of coconut leaf rot disease as well as the incompatibility of these symbionts against other fungal bioagents.

Development of sand based low cost EPN formulation

A low cost EPN formulation based on the principle of anhydrobiotic survival of nematode was developed. The revival of EPN was observed after four months of storage under room temperature when exposed to the moisture gradually.

Effect of *Steinernema* sp. (CPCRI0804) against red palm weevil

Coconut petiole bioassay was carried out to evaluate

the bio-efficacy of the superior EPN isolate *Steinernema* sp. (CPCRI0804) against the grubs of red palm weevil. The experiment was carried out in 15 cm long coconut leaf petioles in which grubs were pre released after making small entry holes. After 5 days of releasing the grubs, the petioles were treated with three doses of EPN *viz*., 400, 800 and 1200 Infective juveniles (IJs) in 4 ml water suspension. About 88% grub/pupal mortality were observed at the lower dose of 400 IJ whereas 100% mortality was observed in both the higher doses indicating its utility in the bio-suppression of red palm weevil (Fig. 5.11).

Fig. 5.11. Petiole based bioassay and dead grub/pupae by EPN, *Steinernema* sp.

Plant Parasitic Nematodes

Organic management of root-knot nematodes infesting brinjal and okra in coconut based cropping system

Infestation by root-knot nematodes (*Meloidogyne incognita*) on brinjal and okra in coconut based cropping system induced characteristic root galls which could be effectively suppressed by soil application of *Trichoderma harzianum*(CPTD-28) and inter-planting of marigold between intercrops. Application of *T. harzianum* @ 5 g plant^{-1} alone and in combination with inter-planting of marigold between two rows of brinjal and okra showed significant improvement in crop growth and reduced gall index (0.5–2.0) over control plants (gall index 3-4) accomplished through the suppression of *M. incognita*. Incidence of wilt in brinjal was also reduced in this treatment over control. The coconut canopy could provide favorable microclimate for the good establishment of the antagonistic fungus, *T. harzianum* suppressing the root knot nematodes in the coastal belts of Kerala.

Bio-suppression of amaranth root knot nematodes

Red amaranthus (*Amaranthus viridus*), an important source of dietary fibre, was found heavily infested by root knot nematode (*Meloidogyne* sp.) impairing growth and its initial establishment in coconut gardens. About 95-175 knots / plant with gall index (5.0) and disease incidence (37%) was recorded in those nematode affected plants. Crop rotation, avoiding susceptible intercrops and interspatial planting of marigold could be viable options in nematode management encompassing agro-ecological and biodiversity principles (Fig. 5.12).

Fig. 5.12. Healthy and infected root have galls caused by *M. incognita*

Association of *Aphelenchoides* sp. with leaf rot disease in coconut

The nematode, *Aphelenchoides* sp. was found associated with the leaf rot disease affected spear leaf of coconut. The *Fusarium* sp. associated with the leaf rot disease was found to support the multiplication of the nematode in the Petri dish.

Defoliator butterfly pest on cinnamon, an intercrop in coconut system

Severe defoliation in the cinnamon seedlings intercropped in coconut based multicropping system was observed by the larvae of cinnamon butterfly *Chilasiaclytia* Linnaeus (Papilionidae: Lepidoptera) during Nov 2019. The per cent defoliation ranged from 20 to 100%. In severe infestation, the whole plant was defoliated leaving only the mid rib. Newly hatched larva are jet black in colour with yellow dorsal line and white patches while the grown up larvae are dark black and yellow colour with red spots all over the body. Pupa is elongated and brownish black and lasted for more than 10 days. Adults are large sized swallowtail black butterfly.

Identification of new insect in arecanut seedlings:

A new pest, defoliating arecanut seedlings was observed in the nursery at ICAR-CPCRI, Regional Station, Vittal. The different growth stages of the insect viz., caterpillar, pupae were collected and provided to entomologist for further studies.

Cocoa

Evaluation of entomopathogenic fungus, *Metarhizium anisopliae* against tea mosquito bug, *Helopeltis theivora*

Naturally infected tea mosquito bug (TMB) adults with the fungus grown on the body (Fig. 5.13) were collected from cocoa gardens located in Dakshina Kannada district of Karnataka. Pure culture of the fungus was isolated on potato dextrose agar (PDA) and Sabouraud dextrose agar (SDA) media (Fig. 5.14 & 5.15). Morphological identity of the fungus was confirmed by National Fungal

Fig. 5.13. Naturally infected TMB adult

Fig. 5.14. Culture plate of *M. anisopliae*

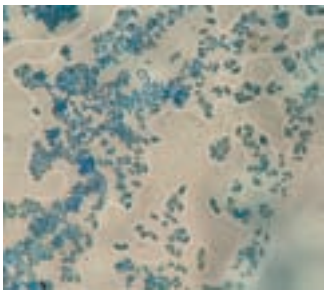


Fig. 5.15. Spores of *M. anisopliae*

Fig. 5.16. TMB adult's mortality due to *M. anisopliae* infection

Culture Collection of India (NFCCI), Agharkar Research Institute, Pune as entomopathogenic fungus, *Metarhizium anisopliae*. PCR amplification of internal transcribed spacer (ITS) gene also confirmed the same. *In-vitro* efficacy of *M. anisopliae* against laboratory reared TMB confirmed 100 per cent mortality of subjected adults (Fig. 5.16) after 72 h of inoculation. Koch postulate was confirmed by re-isolation of *M. anisopliae* from the dead cadaver.

Evaluation of different solid substrates for mass multiplication of *M. anisopliae*

M. anisopliae isolated from TMB was inoculated on different solid substrates *viz.,* sorghum, rice, wheat, bajra, paddy, neem cake, castor cake, dry arecanut husk, dry leaf sheath of arecanut, cocoa dry husk and cocoa fresh husk. Sporulation was observed throughout the study and colony forming unit (CFU) was recorded using Neubauer's chamber after ten days of inoculation. Highest numbers of CFU's were recorded in sorghum (278.6×10^6) and lowest was recorded in neem cake (1.7×10^6)

Field screening of different cocoa germplasms/ clones against *Helopeltis theivora*

A total of 12 cocoa genotypes (13 years old) were screened against TMB incidence in field condition during January to April, 2019. Severity of TMB incidence was calculated by recording the mean number of feeding lesions in 2 cm^2 area on pod. Highest TMB attack is recorded on VTLCH 3 (19.76 lesions per 2cm^2) and lowest incidence is recorded on VTLC 61(1.85 lesions per 2cm^2)

Infestation of ambrosia beetle *Euwallacea fornicatus* and associated fungus leading to wilting in cocoa

During January to November 2019, cocoa trees showing wilting symptoms were identified and recorded (Fig. 5.19a). Small pin head sized holes were observed from all the wilted trees. Perpendicular galleries (1.2-1.5 mm diameter) with blackish stain were observed throughout the heartwood of infested trees (Fig. 5.17c). Large numbers of larvae, pupae, and adults of beetle were found in the galleries of affected branches (Fig. 5.17b). Identity of beetle was confirmed as *Euwallacea fornicatus* through amplification of Mitochondrial Cytochrome Oxidise I gene (*COI*). Further, infested wood galleries and different body parts of the ambrosia beetles were subjected to fungal isolation (Fig. 5.17d & 5.17e). Morphological and molecular characterization confirmed the identity of the fungus as *Fusarium* species complex (*Fusarium solani, F. Ambrosium* and *F. euwallacea*).

Fig. 5.17 (a) Wilted cocoa tree; (b) Adult beetle observed in the galleries; (c) Insect galleries in the cocoa wood; Pure culture of Fusarium spp. isolated from the infected cocoa wood (d) and beetle (e).

VIII-6. Physiology, Biochemistry and Value Chain Management in Palms and Cocoa

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

Interaction effect of elevated CO_2 [ECO_2], elevated temperature (ET) and water deficit stress on coconut seedlings

Open top chamber (OTC) grown plants were exposed to the climatic variables such as chamber control (400 ppmCO_2), [ECO_2] 550 ppm, [ECO_2] 700 ppm, ET 3°C above chamber control and ET 3°C + [ECO_2] 550 ppm. Inside each OTC a set of plants received moisture at 100% FC, while other set was at 50% FC. Increasing CO_2 concentration increased the rate of photosynthesis (Pn) by 45% which, resulted in high biomass accumulation, thus improved the whole plant water use efficiency (WUE) of coconut. The impact of high temperature (Tmax) around 39°C in ET treatment against 36°C in chamber control is quite severe on net photosynthesis (Pn), leaf water potential (psi) and biomass accumulation. Similarly, water deficit at 50% FC resulted in significant decline of Pn, leaf area and biomass and the effect was high in interaction with high temperature. [ECO_2] could ameliorate the negative effect of high temperature and water deficit stress to certain extent. However, the relative response of coconut seedlings to [ECO_2] in improving Pn, leaf water potential, biomass and WUE was lower under 50% FC compared to plants at 100% FC, implying that additional advantage of [ECO_2] to coconut under water-limited conditions is less.

Level of tolerance of coconut to sea water substitution

The climate change scenario envisages rise in sea level that could potentially inundate large area of coconut plantations, consequently affecting its growth and production. An attempt was made to study the response of coconut seedlings to the different levels of sea water substitution. Hydroponically grown coconut seedlings of variety MGD (Malayan Green Dwarf) were exposed to various salinity treatments characterized as 0, 10, 25, 50, 75 and 100% substitution of sea water (Fig.6.1). Growth and most of the physiological and biochemical

Fig. 6.1. A view of the experiment on effect of sea water treatment on coconut seedlings

parameters were almost on par up to 10% substitution of sea water from control. At 25% and beyond, significant reduction in those physiological and biochemical parameters was recorded. Among others, photosynthesis was more sensitive and declined even at 10% substitution of sea water. Leaf water potential was not affected up to 25% of sea water substitution suggesting that the decline in photosynthesis was due to the effect of specific ions and not due to water deficit effect. In fact, there was significant accumulation of sodium, boron, chlorine and sulphur and a concomitant decline in some of the essential elements like potassium, nitrogen, phosphorus, calcium, magnesium and micro nutrients such as iron, copper, manganese and zinc. At 25% sea water treatment, biomass accumulation reduced to 46% and beyond 50% sea water substitution resulted in more than 70% reduction in biomass. The studies suggest that a dwarf variety like MGD could tolerate 10% substitution of sea water.

Effect of high temperature on female flower receptivity, pollen germination on stigma and pollen tube growth in pistil of coconut

An optimum temperature is crucial for effective fertilization of pistils. In coconut an attempt was made to study the impact of high temperature on pistil receptivity, pollen germination on stigma, pollen tube growth through the pistil till it reaches the ovule. As it is difficult to expose the entire coconut tree to a set high temperature, a device comprising heater, temperature controller with sensor and humidifier to enclose the individual inflorescence was developed. The temperature inside the chamber was set at 3°C and 5°C above the ambient temperature with and without humidity control. It was observed that during receptivity, stigmatic surface is wet and white in color under ambient condition, while at high temperature it was dry and black in color (Fig.6.2). At ambient temperature of around 29°C pollen germination on stigma required a day. Pollen tube growth required nearly four days to traverse through the pistil of length 19909µm in coconut before it reached the ovule for fertilisation. (Fig.6.3). Both at 33°C and 35°C pollen germination and pollen tube growth were found to be significantly reduced. At 33 °C and 35°C pollen tube extended by 14688.7 µm and 9882.43 µm respectively. Humidity to certain extent minimised the effect of high temperature nevertheless, it affected the fertilisation. The adverse effect of high temperature on stigmatic receptivity and pollen performance have profound implication for crop performance under unfavorable conditions and this technique is quite useful in establishing screening criterion of best-adapted genotypes.

Fig. 6.3. Pollen tube extended till ovule four days after pollination under ambient condition

Biochemical responses and osmotic adjustments

Biochemical information pertaining to the protoplasmic tolerance to the water-deficit stress and osmotic adjustments are indispensable to decipher the responses of coconut seedlings to abiotic stresses. The seedlings of the coconut genotypes, Jamaica Tall (JT), Federated Malay States Tall (FMST), Gangabondam Green Dwarf (GBGD) and Kenthali Dwarf (KD) were subjected to moisture-deficit stress. Membrane stability index (MSI)-a measure of drought tolerance was investigated. The genotypes, FMST, GBGD, JT and

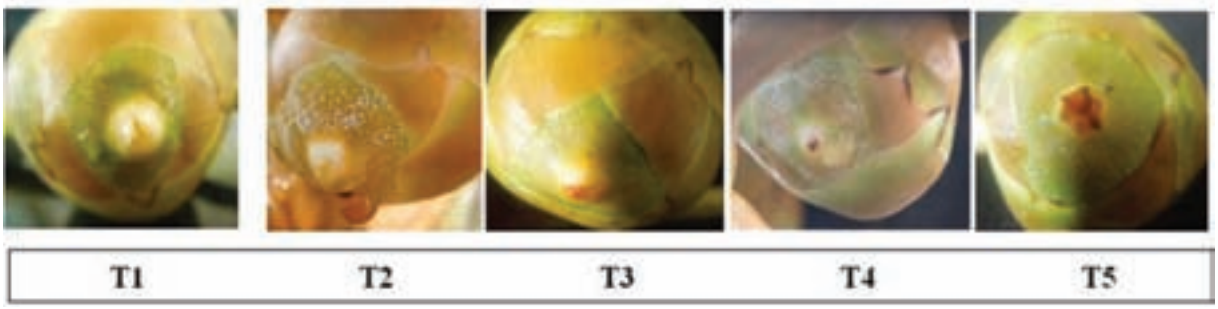


Fig. 6.2. Stigmatic surface during receptivity exposed to different temperature level. T1- ambient condition, T2- 33°C, T3 & T4- 36°C and T5 39°C

KD showed 48.2%, 26.47%, 17.19% and 13.81% increase in MSI upon water-deficit stress, respectively, compared to the control seedlings. Further, leaf cell viability was ascertained based on the activity of the enzyme dehydrogenase. Dehydrogenase activity declined with the increase in the intensity of the exposure to water-deficit stress. The genotype JT showed a decline of 57.89% dehydrogenase activity, whereas FMST registered a decline of 29.10%. Among the dwarfs, KD recorded a decline of 18.14% as against the decrease of 8.68% in GBGD.

Value-Chain Management in Palms and Cocoa

Quality evaluation and shelf life extension of tender coconut juice

Tender coconut consisting of water and pulp is highly nutritious with great health benefits. A preservation protocol for tender coconut juice with ingredients such as tender coconut water, tender coconut pulp, sugar and cardamom was developed. The effects of pasteurization temperature and time (70°C, 75°C, 80°C to 85°C for 5min to 15min), homogenization (2000 psi), cooling methods (slow and immediate cooling), class II preservatives (nisin, natamysin, polylysine and sodium benzoate), packaging (LDPE stand up pouches and LDPE cups with aluminum foil sealing) and storage conditions (refrigerated *i.e.*, 4±2°C and ambient temperature *i.e.*, 32±2°C) were studied. Quality parameters (density, pH, TSS, titratable acidity, total sugars) microbiological (total plate count) and sensory attributes (appearance, colour, flavour, taste and overall acceptability) were evaluated. Fresh and unpasteurized tender coconut juice had pH, TSS, density, flow rate, titratable acidity and total sugar of 6.15±0.55, 14.87±0.41°Brix, 1.05±0.01g/cm^3, 53.27±0.22 sec, 0.075±0.002% and 13.22±1.72%, respectively. A shelf life of fourteen days at refrigerated condition and three days under ambient condition was achieved when the juice was pasteurized (at 75°C for 15 min), homogenized (at 2000 psi), cooled (immediate cooling by circulating chilled water), with an addition of 750 ppm sodium benzoate, packaged in LDPE standing pouches and in pack pasteurization (at 80°C for 15 min). The corresponding quality attributes are shown in Table 6.1.

Preservation protocol for coconut gratings under ambient condition

Preservation of coconut kernel is challenging owing to its high fat, and moisture content. Nevertheless, there is an increasing demand for fresh coconut gratings in ready-to-use form though frozen coconut gratings are available in the market. Preservation of fresh coconut gratings was attempted using different hurdle technologies to improve its storage stability and quality. A processing protocol was standardized for grated coconuts to avoid microbial contamination. It involves dehusking of the fully matured coconut, followed by surface sterilization and removal of brown colour of coconut shell by 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 for 3 min, incorporation of additives consisting of salt (humectant), citric acid (acidulent), tri-sodium citrate (as buffer), and sodium benzoate (preservative), packaging in laminated pouches and vacuum sealing. The storage studies both under the ambient (33±2°C and refrigerated (4±2°C) conditions for 25 days were undertaken. The results revealed that coconut gratings without any preservatives in laminated pouch could stay free of spoilage for a maximum of 24 h in ambient and 4 days under refrigerated condition. Addition of the additives to the grated coconuts improved its shelf life to 7 days under ambient and 24 days under refrigerated conditions.

Biochemical qualities of frozen coconut delicacies

Standardized formulations of coconut delicacies such as vegan frozen delicacy and coconut milk delicacy were evaluated for its biochemical qualities. The vegan delicacy made of ingredients such as coconut milk, tender

Table 6.1 Physico-chemical, microbial and sensory attributes of tender coconut juice

Tender coconut juice with preservatives	Storage days	pH	TSS (R"Brix)	Density (g/cm^3)	Titrable acidity (%)	Total sugar (%)	Microbial load (log cfu /ml)	Overall sensory score
Under refrigerated condition	14	6.7 ±0.001	15.2 ±0.07	1.07 ±0.004	0.085 ±0.007	9.45 ±0.07	5.51	8.06 ±0.6
Under ambient condition	3	6.4 ±0.004	15.0.04 ±0.04	1.03 ±0.002	0.14 ±0.014	8.85 ±0.21	5.35	6.53 ±0.9

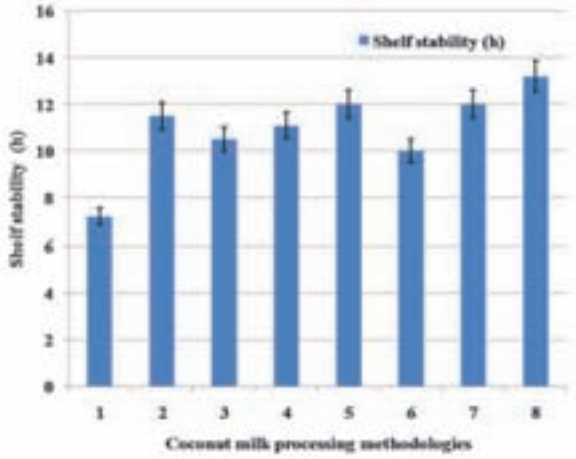
coconut pulp, tender coconut water, coconut sugar, stabilizers (E 466, E 412, and E 415) and emulsifier (E 471). It is a non dairy premium product. On the other hand, coconut milk delicacy had coconut milk, skimmed milk powder and refined sugar as the major ingredients besides potable water, stabilizers and emulsifier. Table 6.2 shows the biochemical composition of two products. pH ranged from 6.02-6.38. Vegan delicacy made of coconut products had higher total solids and ash contents. Due to the presence of skimmed milk powder, the weight per unit volume was lesser in coconut milk delicacy. Fat content was in the range of 11.00-11.05% which is falling under the category of medium fat ice creams. Delicacy made of coconut products had more total phenolics and antioxidant activities.

Table 6.2 Biochemical composition coconut delicacies

Parameter	Milk ice cream	Frozen coconut delicacy
pH	6.02 ± 0.24	6.38 ± 0.43
Moisture (%)	62.66± 4.72	56.65 ± 5.35
Total solids (%)	37.33± 2.46	43.34± 2.87
Ash content	0.52 ± 0.0023	0.64 ± 0.0042
Weight per volume (g/l)	588.23 ± 14.36	612.24 ± 12.43
Protein (%)	4.7 ± 0.65	5.0 ± 0.42
Fat (%)	11.00± 0.20	11.05± 0.56
Antioxidants		
Total Phenolics (mg/g)	20.63 ± 1.23	27.95 ±2.76
FRAP (mM TE/100g)	27.42816 ± 4.31	28.60632 ± 6.66
CUPRAC (mM TE/100g)	29.40476 ± 12.65	44.6131 ± 3.48
Vit. C (µg/g)	46.455 ± 0.084	55.338 ± 0.098

Shelf stability studies on fresh coconut milk

Freshly extracted coconut milk (with three extractions) consisted of about 53-57% moisture, 30-38% fat and 11-12% solid non-fat. Under ambient conditions rancidity sets in the freshly extracted coconut milk. Hence, a study was undertaken to uncover the critical quality parameter that determines the shelf life of coconut milk and a cost-effective processing technology for producing a shelf stable coconut milk. The most critical biochemical parameters that determine the shelf life of coconut milk are its free fatty acids and titratable acidity. Fresh coconut milk when packaged in LDPE pouches remained unspoiled for a period of 7.2 ±1.55h. However, Pasteurization extended the stability of the milk upto 11.5 ±3.12 h. Each processing interventions such as pasteurization, addition of stabilizer and or emulsifier, homogenization, in-pack pasteurization significantly influenced the shelf life and overall acceptability of the coconut milk when packed in LDPE (Fig 6.4).



[1)Packaged coconut milk 2) Packaged and in-pack pasteurized milk 3)Pasteurized and packaged milk 4)Pasteurized, packaged and in-pack pasteurized milk 5)Pasteurized, homogenized and packaged milk 6)Pasteurized, homogenized, packaged and in-pack pasteurized milk 7)Pasteurized, stabilized, homogenized and packaged milk 8)Pasteurized, stabilized, homogenized, packaged and in-pack pasteurized milk]

Fig.6.4. Effect of coconut milk processing procedures on shelf stability

Upscaling the technology for foam mat dried coconut milk powder

Protocol developed for the production of foam mat dried coconut milk powder has been upscaled for pilot level production. Coconut milk (5 L) after the addition of the foaming agent (sodium caseinate) and encapsulant (maltodextrin) was pasteurized at 75°C for 15 min followed by homogenized (at 2000 psi), whipped using an electric hand mixer and the foam was dried in a tray drier while maintaining a foam thickness of 2-4 mm at 50±5°C for 5h. Increase in percent foam volume after homogenization and whipping were 37±0.5% and 227±0.04%, respectively. The yield of powder obtained after the addition of maltodextrin was 33±0.7%.

Coconut testa oil: A rich source of phenolics and anti-oxidants

Physico-chemical properties of coconut testa oil (CTO) were studied to analyze the total phenolics content and anti-oxidant potential of the oil. The physical properties of oil were: moisture content (0.29%) and specific gravity (0.95). CTO exhibited high iodine value (12.4 g/ 100 g oil) compared to VCOs obtained from various processes (5.7 to 8.46 g/ 100g). The free fatty acids

content (0.29%) and high peroxide value (2.0 milli. eq. peroxide/kg of oil) indicate that the oil is highly prone to oxidative rancidity. Estimation of total phenolic content of CTO revealed that it has high polyphenolic fraction of 5.82 mg/100 g and total flavonoid content constitutes 0.973 mg quercetin equivalent / 100 g of oil. Consequently, the anti-oxidant potential estimated based on CUPRAC assay is as high as 11.46 mM TE/ kg of oil. These biochemical parameters indicate that CTO is rich in phenolics and it has great anti-oxidant capacity compared to VCO and hence may confer health benefits.

Multivariate analysis of the quality attributes of VCO extracted by various methods

A number of VCO production processes being followed in India and elsewhere causes variations in the physicochemical properties which in turn potentially affect the nutritional and medicinal properties. Hence, the physico-chemical properties of VCO prepared by hot process (VCO-Hot), fermentation (VCO-Fer), expelled from dried gratings (VCO-EDG), centrifugation (VCO-Cen) and conventionally prepared copra coconut oil (CCO) were investigated. Multivariate analysis (principal component analysis-PCA, cluster and correlation analysis) was used to identify the superior grade of VCO. The first principal component represented 39.64% of the total variability comprising total flavonoids, total phenols, and antioxidant activity (CUPRAC), ABTS-radical scavenging activity and mineral [Mn] are the dominant variables (Fig.6.5). The second principal component accounted for 28.30% of total variability comprising characteristics such as iodine value, free fatty acids, and acid value, whilst the third principal component represented 19.71% of total variability is dominant for [Zn], [Fe], peroxide value, and moisture content. Thus, the first three of the principal components accounted for 87.65% of the variance observed. Hierarchical clustering showed that the VCO-Hot belonged to the group 1 with high total phenolic and flavonoids content and strong antioxidant capacity.Centrifugal and fermentation methods were clustered in the second group characterized by relatively weak antioxidant capacity and low phenolic and flavonoids content. Further, the correlation analysis showed that the total polyphenolic content and its constituent flavonoids are the important components that significantly contribute to the total antioxidant profile of VCO. The highest significant ($p < 0.01$) positive correlation of r=0.99 was recorded between

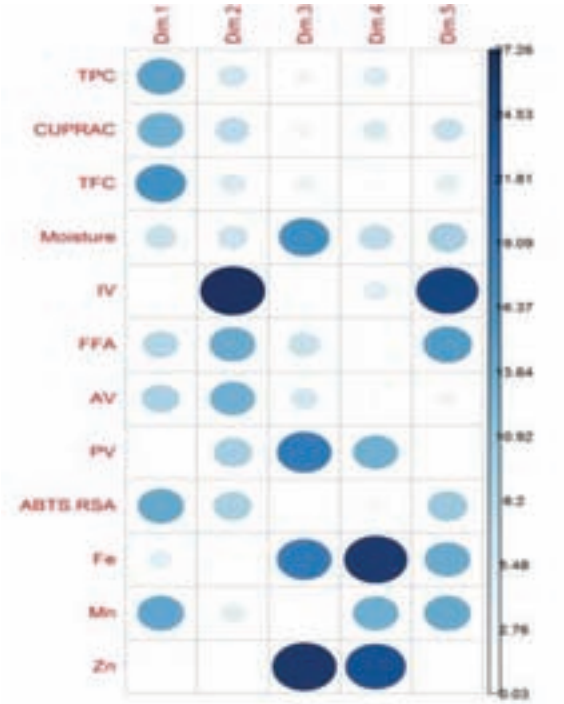


Fig. 6.5. Principal component loadings of quality attributes of virgin coconut oil

total phenol content and CUPRAC (mg Trolox/100g) and r=0.98 between FFA and acid value. These results revealed that multivariate analysis could differentiate the VCO samples based on the quality profile.

Cardio-protective effects of virgin coconut oil

The cardio-protective effects of VCO were studied in collaboration with KSHEMA, NITTE University, Mangalore. The present study investigated the effects of virgin coconut oil (VCO) in three different doses (2, 4 and 8 ml Kg^{-1} body weight) for 7 weeks on cardio-protection in male Wistar rat models fed with high fat diet (HFD). The results indicated that dietary supplementation of VCO suppresses the accumulation of body fat, resulting in improved serum lipid profiles. Based on the serum lipid profile, atherogenic indices; atherogenic coefficient (AC), atherogenic index of plasma (AIP), coronary risk indices (CRI-I and CRI-II) and CHOLINDEX were estimated. Atherogenic indices (AC, AIP, CRI-I, CRI-II) and CHOLINDEX values were significantly high in HFD-fed rats compared to normal-diet fed-rats. VCO supplementation of HFD has reduced the levels of all the atherogenic indices and CHOLINDEX in HFD-fed-rats. Lower atherogenic indices and CHOLINDEX are protective against coronary heart diseases. Similarly, HFD-VCO-fed animals exhibited percentage protection values above 60 implying the cardio-protective effects of VCO in food supplementation.

Mechanical properties of tender coconut

The mechanical properties such as punching force, cutting force, punching energy and cutting energy of tender coconut at its different orientations are pertinent for the design and development of efficient and ergonomic tender coconut processing machineries *viz*., punch and cutter, trimming machine, and snowball machine. Hence, the mechanical properties of tender coconut at six different positions were determined. Four genotypes of tender coconut such as Andaman Giant Tall (AGT), Chowghat Orange Dwarf (COD), Kulasekaram Green Dwarf (KGD), and Ganga Bondam Green Dwarf (GBGD) were investigated. A laboratory-scale texture analyzer with a customized probe for cutting and punching revealed that highest punching and cutting force was observed at the bottom section (near fruit base) followed by the middle and top section of the tender coconuts. The arrangement of fibers in the mesocarp section of tender coconut depicts that the top section of tender coconut husk (near to perianth) contains spongy tissue (absence of fiber) and middle and bottom section of the husk are composed of fibers (Fig.6.6). The maximum punching energy (2.23 J) in fruit top loading position was recorded for the genotype GBGD, whereas, the minimum punching energy (0.82 J) was observed for AGT. The highest cutting energy of 11.79 J, 15.53 J, and 16.59 J recorded for AGT at flat loading position (top, middle, and bottom, respectively). Statistical analysis indicates that genotypes and loading positions of tender coconut significantly (P£0.01) affect the punching and cutting force.

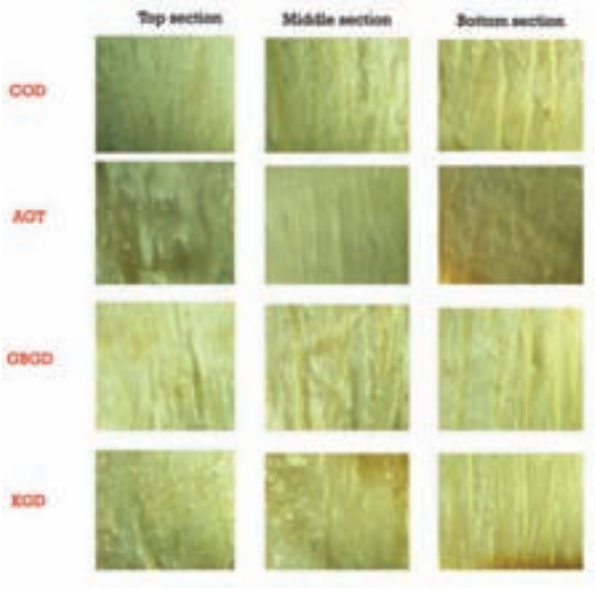


Fig.6.6. Differences in the pattern of fiber arrangement at different sections of the mesocarp of tender coconut genotypes [Andaman Giant Tall (AGT), Chowghat Orange Dwarf (COD), Kulasekaran Green Dwarf (KGD), and Ganga Bondam Green Dwarf (GBGD)]

Twin screw extrusion of coconut milk residue - foxtail millet flour-rice flour-corn flour blend

Incorporation of nutritionally rich ingredients is of prime importance for making the extrudates superior. Corn and rice are commonly used raw materials for the production of extrudates and coconut milk residue (CMR), a co-product obtained after the extraction of coconut milk from the coconut processing industries. The blend of CMR-foxtail millet flour-rice flour-corn flour was investigated for the development of ready-to-eat extrudates by using a twin-screw extrusion technique. Influence of process parameters like extrusion temperature (110–130 °C) and screw speed (240-280 rpm) on physical properties (expansion ratio, bulk density, water absorption index, water solubility index, cutting force, compression force) of extrudates were investigated and optimized using Box–Behnken designs. The textural properties of extrudates were determined using a Stable Micro Systems Texture Analyzer (Fig. 6.7). The desirable and optimal extrudates characteristics were obtained at higher extrusion temperature (130 °C) and screw speed (280 rpm), and lower ratio of foxtail millet. The effects of extreme and intermediate process conditions on nutritional characteristics of the extrudates were also evaluated. Results indicated that the addition of CMR and foxtail millet demonstrated a significant increase in the nutritional profile of the extrudates.

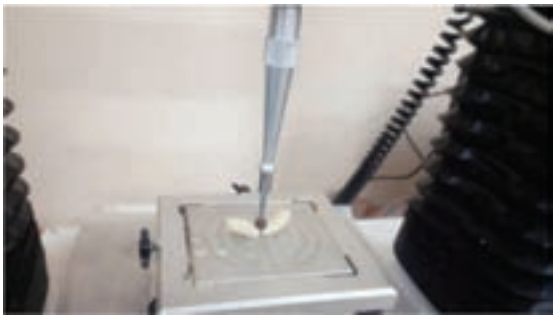


Fig. 6.7. Measurement of textural properties of extrudates

Engineering properties of the deshelled coconut

Engineering properties of the deshelled coconut such as weight, circumference at the lateral direction, and circumference at the longitudinal direction, lateral diameter, and longitudinal diameter are useful for the design and development of continuous testa removing machine. Fifty deshelled and uncracked coconuts were

selected to understand the structural variations. The weight (with coconut water), circumference at the lateral direction, circumference at the longitudinal direction, lateral diameter, and longitudinal diameter of deshelled coconuts were 286 g, 254 mm, 280 mm, 80.90 mm, and 89.17 mm, respectively. The average weight of the deshelled coconut without water was 237 g. The measurements were also taken after removing the testa. This information is imperative for the design and development of an abrasion unit (selection of abrasive roller, the thickness of the abrasive sheet, length of the abrasive roller, and speed of the abrasive roller) for removing the testa.

Design, development and field demonstration of an air blast sprayer for coconut

A prototype of an air blast sprayer mounted on a mini tractor, operated by the power taken from its PTO, has been designed and fabricated (Fig. 6.8). Air blast blower comprises 20 horizontal fins fixed on a circular frame forms the main part of the sprayer. The whole unit is enclosed in a rotomoulded plastic blower casing with an inlet at one side and outlet at the top. The blower could blow air to a height of 25m at a speed of 2200 to 3000 rpm. The sprayer is attached to a mini tractor, 20hp capacity, which is the prime mover. Power is transmitted from the PTO to the blower shaft through a gear with the provision for the speed enhancement (Gear ratio-1:4.18). A positive displacement pump directly coupled to the PTO through the power transmission unit acts as the chemical injection pump. The chemical injection pump is coupled to the PTO without any gear, change in rpm. Atomization unit is fixed inside the lance. Insecticide/ pesticide, in liquid form, are pumped in to the atomizer. The blower creates a strong air current inside the lance and the atomizer rotates with the help of the fins provided and the chemical thus gets atomized and carried along with the air current. The prototype air blast sprayer for coconut was assembled with a fixed straight lance. Height of spray and discharge rate of chemical injection of pump revealed that the spray could reach beyond a height of 25m. The chemical injection pump could be adjusted to deliver a discharge varying from 1lit/min to 36lit/min at an operating pressure of 400 psi (27.5 bar) at an RPM of 550.

Fig. 6.8. Air blast sprayer for coconut

Design, fabrication and field demonstration of a *Neera* (Kalparasa®) collection device

A blow mould and injection mould were fabricated to manufacture Coconut sap (Kalparasa®) chiller boxes as an alternative to the existing boxes which were made manually. The prototypes of the boxes (Fig. 6.9) developed and evaluated under field conditions.

Fig. 6.9. Prototype of newly developed coconut sap chiller

VIII-7. Technology Transfer, Economics and Statistical Methods

The Institute in partnership with other agencies has extended its outreach to cover different strata of the society including farmers, women, entrepreneurs and socially weaker sections by conducting various frontline extension programmes and evolving new approaches. Analytical and computational tools were refined to draw meaningful inference and communicated to relevant decision and policy making bodies. The following is a report on these activities.

Technology Transfer and Co-learning Action Research Approaches

Training programmes

Training for extension personnel: A total of 21 training programmes were organized in collaboration with various agencies which benefited 468 extension personnel. Programmes of special nature in this regard are:

- One day training programme for the Field Extension Officers, Coconut Cultivation Board, Sri Lanka (17 May 2019) in collaboration with Indian Institute of Plantation Management (IIPM) Bengaluru. (Fig. 7.1).
- Refresher training programme on hybridization technique in coconut (11-15 June 2019 at Kasaragod) for officers of DSP farms of Coconut Development Board, Kochi. (Fig. 7.2).

Fig. 7.1 Officers from Sri Lanka visiting experimental fields

Fig. 7.2 Mrs. V. Usha Rani IAS, Chairperson, CDB, Kochi addressing the officials of DSP farms

- Training programme on coconut based integrated (14-18 October 2019 at Kasaragod) in collaboration with National Institute of Agricultural Extension Management (MANAGE), Hyderabad.
- Training programme on neera value addition in two batches during November 2019 at Kasaragod in collaboration with SAMETI, Tamil Nadu.
- Training programme on hybridization techniques and nursery management in coconut at Farmers Training Centre, Pandalam (21-25 November 2019).
- Training on advances in arecanut and cocoa production and processing technology at Vittal for officers from BIRD (NABARD), Mangalore (three batches).

Entrepreneurship Development Programmes: Two programmes on 'Organic production of coconut and value addition' sponsored by NHB was organized for selected farmers from Lakshadweep Island two ASCI skill development programmes (Neera Technician and Vermicopost producter) and capacity development programme for skilled climbers on pollination technique for hybrid seed production in coconut (in collaboration with Department of Agriculture, Governement of Kerala) were conducted. (Fig. 7.3 & 7.4).

Training programmes for farmers: A total of 90 training programmes were organized in collaboration

Fig. 7.3 Participants of the ASCI skill development programmes on Neera technician

Fig. 7.4 Lakshadweep farmers attended the EDP on Organic production of coconut and value addition' supported by NHB

with Coconut Development Board, State Department of Agriculture/Horticulture, ATMA and other agencies for the benefit of 3328 farmers. Besides, training programmes were also conducted as part of externally funded projects reported elsewhere. (Table 7.1, 7.2).

Frontline Demonstrations

Demonstration on soil health management for enhancing productivity of coconut in 60 coconut gardens spread over six districts of Kerala under the Kerala State Planning Board funded project on multi-institutional farmer participatory. (Fig. 7.5).

Multi species cropping system in arecanut in Assamat Langkona village in Kamrup (Rural) distric (two plots of 1 ha each) with financial assistance from Directorate of Arecanut and Spices Development, Kozhikode. (Fig. 7.6).

STC (Scheduled Tribe Component) Activities

The activities were implemented in Paderu block, Visakhapatnam district in colloaboration with Integrated Tribal Development Agency, Paderu. (Fig. 7.7).

Training programmes conducted for the tribal farmers are: (i) Cocoa cultivation, 30 April 2919, at Chintepalle (120 participants); (ii) Cashew cultivation, 15.7.19, MPDO hall, Koyyur (100 partiicpants); (iii) Agronomic practices for juvenile coconut, 16.7.19, MPDO hall, Koyyur (70 participants).

Fig. 7.5 Demonstration on soil health management for enhancing coconut productivity (Kannur)

Supply of critical inputs arranged for the participating tribal farmer in the region are: Cashew grafts (6250) to 100 farmers; Fertilizer (N,P,K) for juvenile coconut seedlings (70 farmers); Cocoa seedlings (10000) to 50 farmers.

Mera Gaon Mera Gaurav initiative

During the year ICAR- CPCRI, Kasaragod and its regional stations and research centres have implemented the MGMG initiative in collaboration with various stakeholders *viz.,* Department of Agriculture, KVKs, LSGs, input dealers, progressive farmers, SHGs etc. A total of 68 villages were covered: Highlights are 141 field visits, covering 1262 farmers, 29 interface programmes 108 technology demonstrations, 35 training programmes.

Utilization of mass media for technology dissemination

Popular articles were published and radio and TV programmes were presented by the scientists of the institute on production, protection and processing technologies of mandate crops. Coconut cultivation practices recommended for each month are being published regularly in English through Indian Coconut Journal and in Malayalam in *Indian Nalikera Journal.*

Fig. 7.6 FLD on arecanut cropping system in Assam

SCSP (Scheduled Caste Sub Plan) Activities

Table 7.1. Training programmes conducted for the benefit of SC farmers:

District		Date	Participants
Kasragod	EDP on Pre- and post-harvest equipments	13-14 Aug. 2019	40
	EDP on Honey bee farming and Prospects	22 -23 Nov. 2019	25
Kollam	Training on honey bee rearing	13 June 2019	15
	Use of coconut climbing machine	13 June 2019	30
	Training for the apiary unit beneficiaries	9 Aug. 2019	15
	Training on poultry rearing	29 Oct. 2019	32
Kottayam	Training on poultry rearing	7 Sep. 2019	15
Chikkamagaluru	Use of coconut climbing machine	4-6 Jul 2019	20
Jalpaiguri	Cultivation of arecanut and crop diversification (4 programmes)	17 May 2019	60
		18 July 2019	41
		19 July 2019	49
		26 July 2019	50

Table 7.2. Supply of critical inputs were arranged through KVKs in the following districts

District	Inputs supplied – number of beneficieries in the paranthesis
Kollam	Climbing machine (30); Poultry shed (7); Poultry birds (13); Honeybee boxes with colonies (15); Wheel barrow (14); and sprayer (5)
Kottayam	Poultry birds and cage (15)
Ernakulam	Poultry birds and cage (45)
Thrissur	Poultry birds and cage (47)
Palakkad	2500 number of coconut seed nuts for raising nursery
Kasaragod	Coconut climbing device (35); Coconut punch and cutter (6); Honey bee boxes, stand with bees (@4) and other accessories (25); Power tiller (1); Mini-tiller (3); Sprayer (1)
Putukottai	13000 Coconut seed nuts for nursery
Thanjavur	32100 Coconut seed nuts for nursery
Visakapatnam	1000 Coconut seed nuts for nursery
Jalpaiguri	Planting material - 20 arecanut, 5 black pepper and 5 Beyleaf each (200)
Kamrup (Rural)	Planting material (arecanut, black pepper (110)
Chikkam-agaluru	Coconut climbing device (20); 9400 Coconut seed nuts

ICT initiatives for outreach activities

The mobile application 'e-Kalpa' has been steadily saying popularity as downloaded by 4609 farmers. Technology

Fig. 7.7. Beneficiary farmers with honey boxes at Chintapalli, Paderu Block, Visakhapatnam (STC programme)

Fig. 7.8. Smt. Meenarani, District Welfare Officer handing over the power tiller to the a group of SC farmers in the presence of Dr. Anitha Karun, Director (Act.) at ICAR - CPCRI, Kasaragod

snippets in Bengali language has been added for all the mandate crops. The facilities for real time problem reporting and accessing solutions were utilized by 482 farmers on an average of 4-5 queries per day.

The 'ICAR CPCRI you tube channel' initiated during June 2018 was subscribed by 1490 users and had views of 60800 at present.

Diploma in Agricultural Extension Services for Input Dealers (DAESI)

ICAR-CPCRI, Regional Station, Kayamkulam in collaboration with ATMA, Alappuzha, SAMETI, Kerala and MANAGE, Hyderabad conducted the pgoramme for the agricultural input dealers of Alappuzha District

Technology support and advisory services for strengthening of DSP Farms under CDB

Team of scientists from ICAR-CPCRI visited the farms; at Mandya, Neriamangalam, Vegiwada and Kondagao; recommendations made to strengthen the farms for enhancing the productivity of coconut palms, enhance coconut seedling production, etc..

Agricultural Technology Information Centre (ATIC):

Important activities of ATIC at CPCRI Kasaragod included sale of planting materials and other inputs worth Rs. 1,03,06,793/- and Farm Advisory Services (2961 telephone queries 257 e-mail queries and 156 postal queries were replied).

Consortium Research Platform (CRP) on Farm Mechanization and Precision Farming

Under this project, nine training programmes on operation, repair and maintenance of agricultural machines were conducted for a total of 415 farmers, NGOs and other stakeholders representing 7 districts of Assam (Kamrup, Baksa, Darang, Goalpara, Nalbari, Morigaon, and Barpeta.

Farmer FIRST programme (FFP): Participatory technology integration to empower and ensure livelihood security of farmers in Alappuzha district

The FFP in six modules consisting of crop, horticulture, livestock, entrepreneurship development, natural resource management and integrated farming systems is being implemented in 1627 hectares of area in Pathiyoor panchayath, Alappuzha district involving 1000 farm families. The activities are planned implemented, monitored and evaluated with community participation and covers individual, group and community level activities aimed at doubling the farmers' income. The output, outcome and impact of the FFP are furnished bellow.

FFP interventions

Technology interventions carried out under the project are grouped into six modules.

Crops module: Demonstrated in 237 coconut gardens covering an area of 92.1 ha. The salient changes in the cropping pattern after implementing the project are:

(i) Revival of sesamum crop (which was a traditional crop in the Onattukara area). Among the four sesamum varieties introduced, Kayamkulam -1 and Thilak were found to be performing better for yield (32% increase), oil recovery (38- 49%), and tolerance to phyllody disease (10-20% incidence). Area under these varieties increased from 1.61 ha (pre-FFP) to 54 ha during 2019-20. The production increased from 0.5 r to 10 t that generated an income of Rs.25 lakhs shared by the 34 women farmers groups and 42 individual farmers.

(ii) Area expanded under finger millet (Paiyur 2, GPU and KMR) and horse gram (var.Paiyur) increased to 20 ha; fodder varieties to 24 ha and HYV maize to 12.7 ha.

(iii) Traditional/high yielding variety of paddy cultivation revived in convergence with MGNREGS and women farmers groups (16 ha).

(iv) Integrated management of coconut root (wilt) disease was provided to all coconut palms with soil test based nutrient application and application of micro nutrients Kalpa Vardhini and Kalpa Poshak respectively for bearing coconut palms and seedlings.

Horticulture module: Introduced two turmeric varieties of ICAR-IISR (Prathibha and Pragath) in 8 ha area as inter crops in coconut gardens. The variety Pragathi was rated better than Prathibha, in terms of yield, low duration and withstanding of water logging Area under HYV varieties of tuber crops Amorphophallus (Gajendra), Dioscorea (Sreekeerthy) and colocasia was expanded to 27 ha. Among these crops, dioscorea was less preferred as it required higher number of labourers. Gajendra variety of amorphophallus was highly rated in comparison to local variety in terms of superior cooking quality and taste. Vegetable cultivation was initiated in 20 ha area following group approach.

Livestock module: Good management practices introduced through linkages with Veterinary hospital and PRA results leading to adoption of cowmat (110 cowmats) to 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. The dairy farmers (300) were provided with Mastitis kit (milk pad, California mastitis test reagent, potassium permanganate, boric acid powder, Povidone iodine) as part of Mastitis disease prevention campaign: the clinical report of the veterinary hospital indicated 78 percent reduction during the period.

Pathiyoor brand egg production and marketing as income units among selected 72 poultry farmers units produced 1500 eggs per day and earning Rs. 2.7 lakhs per month. For sustainable production, five egg incubators were provided for rural youths.

Integrated Farming System (IFS) module: The location specific integrated farming systems models were delineated for doubling farm income and increasing per unit area production. The models include coconut+poultry+livestock+pond fisheries, coconut+ poultry; coconut+ fisheries; coconut+fisheries+poultry; coconut+livestock; and coconut+poultry+ livestock+ pond fisheries+inter/mixed crops. The contribution of coconut towards income varied between 26.8 to 79.2% in different systems. Systems with livestock, it contributed substantially (53.1 to 66.4%).

NRM module: Revived 72 homestead ponds entirely by the farmers and technical and extension support under FFP continued released 67500 fingerlings Five soil testing campaigns in 19 wards (5 ha grid based soil sampling) organized in convergence with Coconut producers federation (CPF), Ward members and coconut farmers; 172 soil health cards distributed. 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.

Enterprise module: Three copra drier units of drying capacity 1500 coconuts per batch, two Virgin coconut oil (VCO) units, two coconut oil units, two coconut food products units (coconut chutney powder, coconut rice dough and namkeens, ready to use coconut curry mixes, coconut powder) were established. A total of 60000 coconuts could be processed in these units.

Turmeric powder unit for processing local turmeric grown in GAP 'Thripthi processing unit' started production and marketing from the Procurement of harvested turmeric of FFP farmers. 1.53 tons of turmeric procured during 2019. (Fig. 7.9).

Fig. 7.9 Turmeric harvest in Pathiyur (Farmer FIRST programme)

Science based rural enterprise - Kera Probio, production unit produced and marketed 5.7 t (@ Rs.100 per kilogram) produced and distributed to 1800 coconut farmers of Kollam, Alapuzha and Thiruvananthapuram districts. The unit was transferred to the Pathiyoor farmers FPO for continuation of activities.

Five egg incubator units started by rural youths and producing quality breeds of chicks, (Gramapriya, Gramasree), quail and Chara Chempalli ducklings and local breeds. Produced and distributed 3980 poultry birds to the farmers of FFP and adjacent areas.

FFP Success stories documented

Outputs and success stories of the FFP interventions were documented as 'Etching success in farming community - Pathiyoor model'. Radio documentary was made and broadcasted throughout the state by AIR in 34 episodes. Eighteen models where farmers income increased two fold or more was documented in this programme. The other innovative components of ICAR-CPCRI FFP are 'Responsible Extension Approach' (REA) for rapid adoption of HYV, ' My Coconut My Legacy' programme involving 4500 students in coconut cultivation, land consolidation model for landless and women farmers with low access to farming lands, FFP Pathiyoor facebook and WhatsApp groups for fish farmers, women groups and rural youths. The documentation indicated definite possibility of doubling of farm income through synergy of individual, group and community efforts with proper coordination and convergence.

FFP Impact

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. 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.

Participatory rejuvenation and refinement of coconut based homestead system models for food security and income – Kera Nanma project

The 'Kerananma' project envisages participatory rejuvenation of coconut cultivation through innovative concept of "coconut seedling-friendly villages" emphasizing scientific management of coconut seedlings. The components being implemented are participatory selection of WCT mother palms, community nursery for the production of 6000 WCT seedlings and demonstration plots of scientific management of coconut seedlings and integrated root (wilt) disease management. The interventions are carried out in 3 grama panchayaths of Bharanikkavu block *viz:* Chunakkara, Vallikkunnam, and Bharanikkavu. The students of VHSE (Ag.) were involved in the community nursery activities of raising bio-primed coconut seedlings in grow bags.

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

Analysis and prioritization of climate vagaries in the 4 AEUs in the district was done in a workshop attended by scientists, farmers, extension personnel and LSG representatives on 14 Oct 2019. 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 year round cultivation of intercrops under Coconut Based Farming Systems. Farmer practices identified through field data gathering, adaptations evolved through participatory assessment and refinement and climate resilient practices reported elsewhere were thoroughly analysed and prioritized for each of the selected gardens in the 4 AEUs in the workshop. Climate resilient adaptations were demonstrated in 12 model farms and their field validation is being carried out. Based on the climate vulnerabilities and soil characteristics in each of the areas, technologies were finalized for the selected gardens. Prioritized technologies are (a) selection of ideal intercrops for and crop planning for year-round cultivation of inter crops, (b) altered planting time, (c) shade regulation and moisture conservation techniques by farmers, and (d) low cost vertical gardening practice of vegetables in areas of water logging. (Fig. 7.10).

Fig. 7.10 Central and peripheral drainage systems to overcome water logging

Socio-economic dimensions and value chain dynamics in policy perspective

Trade and policy issues

The prices of coconut and coconut products of major coconut producing (and trading) countries were compared with that of India (Table 7.3). The whopping price differences on all the products of other countries *vis a vis* that of India is categorical. The higher prices of coconuts in the domestic market for a quite longer period had raised concerns for small scale entrepreneurs and exporters. The industry analysis revealed that there was a drop up to 30% in the exports of desiccated coconuts (DC) from India in 2018 comparing to the preceding year. There is obvious reason for such decline, especially when the DC prices of Vietnam and Indonesia are hovering around 50% lesser than that of India. Similarly the domestic prices of coconut oil, copra and raw coconuts too are much higher (in the range of 100 - 300%) than that of major competing countries.

Table 7.3. Price comparison of coconut and coconut products

Country	Coconut oil	Copra	DC	Coconut
Philippines	800	439	1440	119
Indonesia	807	392	1400	116
Sri Lanka	1833	1000	1712	364
India	2168	1364	1938	507

Note: Prices in USD/MT

Analytically, the issue is multifaceted wherein the higher prices of raw material would detrimentally affect the small scale coconut entrepreneurs; as their profit margin will narrow down to make them uncompetitive in the global market, as well as in domestic market (against large scale players). The above stated reasoning has been manifested in the form of surging number of applications filed by the small scale players for obtaining the Advanced Authorization Scheme (Licenses) for import of copra. Though we could not garner adequate evidence for stocking/hoarding of copra by big industrial players due to the speculation on scarcity of raw material, the issue has been endorsed by the oil merchant association of India. In the event of large scale procurement by single buyers, the market failure will be the result (it has been happening) along with increased blending and adulteration of coconut oil. The policy institutions must pay attention to these issues to come up with a trade-off measure to elevate farmer welfare along with entrepreneur welfare.

Transition towards organic farming: An innovation system perspective

In light of our field study and critical analysis of the scenario of organic transition of the Kasaragod district in a heuristic mode, a redefining of the existing system towards a reoriented and transformed innovation frame for the optimal outcomes is suggested (Fig. 7.11). For institutionalizing such a system, the formation of an 'Autonomous Council', with representations from department of agriculture, research institutions and farmer organizations etc., is proposed. The Council may work out the modalities for certification and labeling of the products and clusters of organic farmers may then be upgraded in the domestic value chain, by upward linking with the major supply chain operators.

Crop insurance in plantation crops

There are many crop insurance schemes operating in the country like Pradhan Manthri Fasal Bhima Yojana (PMFBY-2016), Coconut Palm Insurance Scheme (CPIS), Rainfall Insurance Scheme for Coffee etc. While it is heartening that annual fund allocation for crop

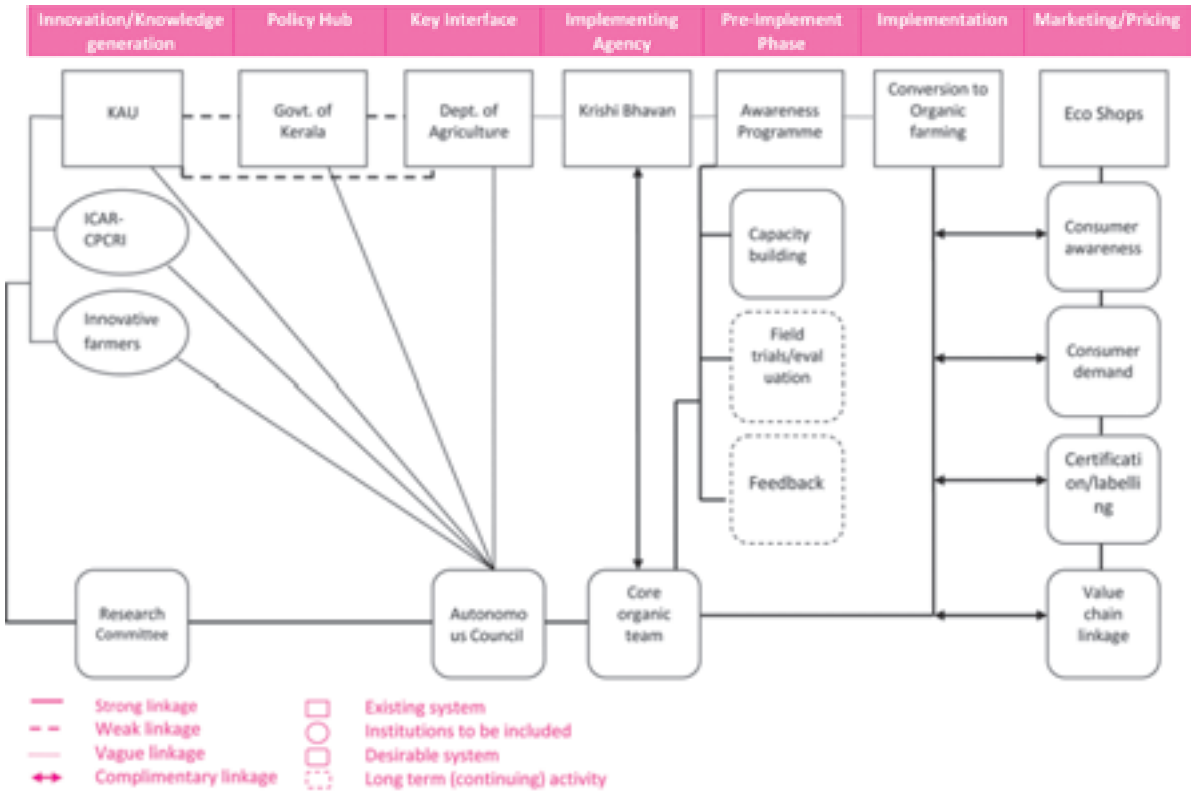


Fig. 7.11 Transition towards organic farming: A comprehensive depiction of innovation system

insurance schemes has increased to Rs. 11000 crores in 2017-18, only 29% of the cropped area is insured. Plantation crops, are often insured under Weather Based Crop Insurance Scheme (WBCIS), which uses weather indices as proxy for loss in crop production. Association of crop yield with weather parameters help us in developing weather thresholds (triggers) beyond which crop starts getting affected adversely. Here, claim process is transparent and reduces the time lag. Further, since it is based on area approach, farmers are incentivized for their efforts to reduce the loss. Major limitations are non-coverage of loss other than weather, differences in soil types & management practices, shift in climatic & weather patterns, resulting in weak correlation between the yield and the weather indices. In addition to WBCIS, Coconut Palm Insurance Scheme (CPIS) is implemented through Coconut Development Board (CDB), with a maximum coverage of Rs. 1750 at a premium of Rs. 14 per palm. Kerala, a major state growing plantation crop, has got coverage of only 2.2% of all crops under crop insurance while only 4476 ha of coconut (0.6%) in CPIS and 4822 ha of cashew (29%) and less than 1% arecanut area are covered in WBCIS. In Tamil Nadu, no plantation crops are insured in WBCIS, while in Karnataka, only arecanut was included in WBCIS recently, with a very low coverage. Reduced receptivity (less than 5%) of RISC also points to the fact that insurance coverage of plantation sector is far below the average across crops (29%) at national level. Certain limitations like sum insured being less than 30% of the maximum loss and high actuarial rates (upto 22%) and non-coverage of risks associated with price, very relevant in plantation crops, in the existing schemes needs to be addressed so as to improve the coverage and effectiveness of crop insurance schemes.

Development of Statistical and Computational Techniques for Improving Research Methodology

Analysis of arecanut statistics for the period 1971-2018

Area under arecanut in the country had increased consistently over the years from 1971 (167300 ha) to 2018 (518710ha) with a compound annual growth rate (CAGR) of 2.43%. During the same period, the production of arecanut in India increased from 141000MT to 9017800 MT with a CAGR of 4.03%.

During the year 1971, Kerala was the leading arecanut growing state with 85800 ha (51%), followed by Karnataka with 41000 ha (24.5%) and Assam with 23100 ha (13.8%). The area under arecanut in Kerala during the period 1971-2018 has increased only marginally to 94580 ha whereas in Karnataka, it increased to 2,79,260 ha and in Assam to 80810 ha. The CAGR of arecanut area for the last 10 years in Karnataka, Kerala and Assam are 4.72%, -0.51% and 1.89% respectively. The All India CAGR of area under arecanut during the last 10 years is 3.04%.

Again Kerala was in first position for arecanut production in 1971 with a share of 37.6% (53,000 MT), followed by Karnataka 50,400 MT (35.74%) and Assam 25,100 MT (17.8%). The production of arecanut in Kerala during the period 1971-2018 has increased only marginally to 108520 MT whereas in Kranataka and Assam, it has increased to 606180 MT and 77900 MT. The CAGR of arecanut production for the last 10 years in Karnataka, Kerala and Assam are 10.63%, -1.61% and 2.23% respectively. The All India CAGR of arecanut production during the last 10 years is 6.44%.

Crop and yield loss in coconut and arecanut in Assam due to floods

High rain fall and release of dam-water caused unprecedented flood situation in Assam during July 2019. In many districts, the flood occurred three times within a month and the inundated conditions prolonged for more than 10 days. Keeping in view the requirement of expertise and skill required for assessment of crop/ yield loss in perennial crops, a field survey during 19-24 August, 2019. Data from selected holdings were collected by site visit and interviewing the farmers from 13 flood affected districts where coconut and arecanut are grown (Dhubri, Goalpara, Dibrugarh, North Lakimpur, Biswanath, Sonitpur, Berpeta, Baksa, Chirang, Kamrup (R), Nalbari, Morigaon, and Darrang). A multi-stage randomized sampling design was adopted. From each district two or three flood affected revenue circles were selected in the first stage. In the second stage, two flood affected villages were selected from each of selected revenue circle. Data from four holdings per selected village were collected during the field survey.

Mortality of coconut and arecanut seedlings were observed in most of the flood affected holdings. It was estimated that 118.8 lakh arecanut seedlings, 15.62 lakh juvenile palms and 56.87 lakh bearing arecanut palms were lost due the July 2019 flood in Assam. Total amount of crop loss in arecanut in 13 districts of Assam state was worked out to be

Rs.109,471 lakhs. In the case of coconut, loss of seedlings, juvenile palms and bearing palms was estimated to be 2.37, 1.17 and 0.56 lakhs respectively. The resulting economic loss was worked out to be Rs.19,793 lakhs. In the case of arecanut the crop loss in bearing palms was mainly due to uprooting, whereas in coconut it was chiefly due to bud rot disease.

Due to severe incidence of inflorescence dieback disease, the arecanut yield would be reduced substantially (7.01% to 36.7%). Overall in the flood affected districts, there would be reduction of 60,791.12 tonnes of arecanut for the year 2019-20 that will result in an economic loss of Rs. 21,277 lakhs to the farmers. Yield loss in coconut due to pre-mature nut fall and other diseases and disorders in the selected districts would be 19,793 lakhs.

Development of software for data analysis in R

STDAPR: R cum Java graphical user interface-based statistical software, STDAPR, has been designed by integrating the programming languages R (version 3.5.2) and Java (version 7) in standalone/online mode.

Program for microbiome analysis has been developed using the open-source software package, DADA2 (Version: 1.10.1) which can be run in R software 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 cut off for further downstream analysis. The program is capable to generate reports, like alpha, beta diversity and other indices along with graphs of microbial relative abundance.

Entrepreneurship development through farmer led innovations – Study in plantation crops A total of 226 Farmer Led Innovations (FLIs) in plantation sector were listed through various secondary sources and contacts with commodity boards, KVKs etc. A workshop was organized to documentation FLIs (5-6 September 2019) in which 230 farmer innovations were presented. After preliminary evaluation 26 innovations were selected for field validation.

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

Terracing is one of the most effective soil water conservation measures practiced by farmers in the hilly tracks of Western Ghats. The impact of terracing of catchment areas on soil erosion was studied by monitoring the quantum of soil collected at the check dams. Soil accumulated in the reservoirs of temporary checkdams, was measured after three rainy seasons. Four types of catchments, based on the conservation practice adopted and land use, were taken up. The checkdams constructed in the drains belonging to forest area collected the least amount of soil at 0.07 ton/ha/yr. Soil loss from the terraced plantations also was comparatively low at 0.14 ton/ha/yr. Majority of these plantations belonged to rubber, where inward terracing was made in contour that conserved the rainwater within the terrace, thereby limiting the surface runoff to a great extent. Thick vegetation growth, especially leguminous plants in rubber plantations further reduced the soil loss. Plantations cultivated without terracing belonged mainly to coffee, tea and few rubber holdings. The soil loss from these plantations, 0.40 ton/ha/yr, was much higher than that of plantations under terracing. Maximum soil loss was observed from the terraced lands that are cultivated under annual crops, 0.44 ton/ha/yr. Crops grown in these lands were coconut with or without other intercrops, tuber crops, vegetables, banana, etc.

VIII-8: Krishi Vigyan Kendras

ICAR-Krishi Vigyan Kendra, Kasaragod

Frontline Demonstrations

ICAR KVK, Kasaragod has conducted eight Front Line Demonstrations during April to December 2019: (i) High yielding variety of paddy Pournami M O 23; (ii) Demonstration of Hybrid cashew H 130 (NRC Cashew, Puthur); (iii) High yielding variety of fodder grass Sampoorna; (iv)Demonstration of drum seeder; (v) Zero till seed cum fertilizer drill for line sowing of paddy; (vi) Coconut vinegar production technology; (vii) VCO based wheat muffins; and (viii) High yielding grain cow pea var. DC 15.

On Farm Trials

Assessment of yard long bean varieties and validation of two Farmer Led Innovations (Pepper thresher developed by Shri G.K. Sharma and Chemberi model of coconut climbing device) were carried out.

Training Programme

Fifty four non campus training programmes and 8 off campus trainings for the benefit of 888 participants (563 Male, 325 Female). Topics covered are neera processing, coconut byproducts, value addition of honey, stingless bee keeping, mechanised moconut climbing, mushroom production, jackfruit processing, value addition of seasonal fruits and spices, goat rearing, arecanut leaf sheath plate making, paddy mechanization, mat nursery preparation, and maintenance of machinery for rice cultivation.

Extension Activities

Foot and Mouth Disease Awareness Campaign was organized at Perladukkam, Bedadukka panchayat on 27 June 2019.

KissanVani – KVK Farmer profile series, in which success stories of master farmers were broadcasted from AIR, Kanur FM.

NFSM programme on Green gram: The HYV BGS 9 was demonstrated in 50 acres belonging to 55 farmers of Kolavayal, Kalluvarambath and Periya Padasekharams.

Karshika Dinam at KVK, Kasaragod

Launching of National Animal Disease Control Program for FMD and brucellosis and Artificial Insemination was held on 11 September 2019 as part of national level Launchin. Shri N.A,Nellikkunnu, Hon'ble MLA of Kasaragod inaugurated the programme and Dr. Titto Joseph presided over the function.

Orientation training for KVK Scientists was organized during 23-27 September 2019 for the newly recruited scientists of KVK from Kerala and Karnataka. The event was inaugurated by Dr.Anitha Karun, Director, CPCRI and was presided over by Dr. ChandreGowda.

Tree Planting Campaign and Kisan Ghoshti was organized on 17 September 2019 at Enmakaje panchayat by planting 350 cashew grafts in farmers' field.

Jalshakthi Abhyan Kissan mela was organized on 2 October 2019 with a participation of over 700 farmers. The programme included seminar on water harvesting and micro irrigation, exhibition, method demonstrations, film shows and field visits to the demonstration units. Dr. Anitha Karun, Director, ICAR-

Technology Week inauguration by Dr Anitha Karun, Director (Acting)

Inauguration of ASCI training at KVK, Kasaragod

CPCRI, Kasaragod inaugurated the function. The dignitaries included Shri Ashok Kumar V.M., Nodal Officer, Jal Shakti Abhiyan,Kasaragod district, Shri.P.V.Umesh, Deputy Director (Horticulture), and Shri.JyothisJagannath, DDM, NABARD.

***'Thenkurunnu'* - pilot project inauguration** was jointly organized by KVK Kasaragod and Royal Honey and Bee farm Kolichal on 21 October 2019 at 14th ward anganwadi of Mogral Puthur Panchayath. Dr. Anitha Karun, Director ICAR-CPCRI inaugurated the programme. As a pilot project the programme aims to include 10 ml honey in the daily diet of 22 kids of the anganwadi.

Fertilizer application awareness programme was organized on 22 October 2019 at College of Agriculture, Padannakkad. A live telecasting of launching programme of the event by Hon'ble Union Minister for Agriculutre and Farmers Welfare Sri.Narendra Singh Thomar ji was web streamed. Dr. P. R Suresh, Associate Dean, College of Agriculture, Padannakkad inaugurated the programme. Dr Anitha Karun, Director, ICAR CPCRI was the chief guest.

Pre Vaiga sammelan was organized on 23 November 2019 on the theme Value addition of agricultural produces and marketing.

Awareness programme on rhinoceros beetle management was organized at Eachipoyka in West Eleri panchayat.

Field day on mechanisation in paddy was conducted on 28 November 2019 at Kasaragod and demonstration on mulching cum drip laying in open precision farming was conducted on 27 December 2019 at Padannekkad.

National food security mission: Grain cowpea var. Pantalayani1 and green gram BGS 9 for 25 and 50 acres respectively was distributed under NFSM at Majibail, Meenja, Mugu, Neerchal and Badiadka.

Paramparagat Krishi VikasYojana (PKVY) was initiated in Bambrana and Sheni villages.

Production of seed, plant and livestock material

KVK Kasaragod produced 4t of HYV of paddy Shreyas, 20 kg of vegetable seeds, 9016 numbers of planting materials of various crops like Vegetable seedlings, fruits, ornamental plants, plantation crops, spices and fodder crops.

ICAR-Krishi Vigyan Kendra, Alappuzha

Frontline Demonstrations

ICAR KVK, Alappuzha has conducted thirteen Front Line Demonstrations

- Mechanization and eco friendly technologies for enhancing income in paddy cultivation
- Integrated disease management in cowpea
- Use of customized fertilizer in cassava based on soil test
- Use of PGPR bio capsules and micro nutrient mixture for enhancing income from ginger cultivation
- Eco friendly management of shoot borer in turmeric
- Demonstration of *Garcinia cambogia* paste
- Modified brining technology for shelf life enhancement of raw Jackfruit
- Integrated nutrient and disease management in banana
- ICM for enhancing productivity and income from snake gourd cultivation
- Maximization of income from cucurbitaceous vegetables through value addition
- BV 380 breeds in intensive system of rearing
- Integrating fish and duck system for the utilization of homestead pond and enhancing farm income
- Scientific rearing techniques for sustainable apiculture in rubber plantations

On Farm Trials

Four OTS conducted: (i) Assessment of eco friendly management of rice bug; (ii) Assessment of short duration turmeric variety Pragati in Onattukara region; (iii) Effectiveness of bio agents in rhizome rot management of turmeric; and (iv) Efficiency of microbial inoculums for composting of organic residues.

Training Programmes

One hundred twenty seven training programmes were organized; total number of participants was 3267 (male 1528 and female 1739). The ASCI skill training programme on 'Small Poultry Farmer' was conducted during 20 Jan - 18 Mar 2020.

Extension Activities

The following services were rendered to farmers, students and general public: Help line service (2704); Diagnostic field visits (65); KVK visitors (5639); Field days (13); Method demonstrations (27); Group meetings (11); Farmers Seminar (11); News paper coverage (17); Soil test campaigns (15); Animal Health camp (3). Live TV phone-in-programme on "Importance of Soil Health Management" (P. Muralidharan) and Rural Agricultural Work Experience (RAWE) for B Sc (Agriculture) students and one On Job Training (OJT) for VHSE students

In the year 2019-20 many programmes were conducted in the three panchayats: Thazhakkara, Chennithala and Chettikulangara (in Mavelikkara block). Launching of these activities was done by Shri K. Reghuprasad, President, Mavelikkara Block Panchayath on 11 July 2019.A Scientist – Farmer interface on 'Technologies for enhancing farmer's income" was also conducted

Tree Plantation Campaign was organized on 17 September 2019: Shri K.K. Anilkumar, Councillor, Kayamkulam Municipality inaugurated the function at GVHSS, Krishnapuram by planting fruit trees in school campus and distributed planting materials to 160 students and teachers.

Farmer-Scientist interface programme was organized in ollaboration with Directorate of Extension, KAU and Dept. of Agricultural Development and Farmers' Welfare at Mavelikkara on 26 September 2019.

External Funded Projects

National Innovations in Climate Resilient Agriculture (NICRA): Technology Demonstration Component of the NICRA was implemented in two villages: Muttar and Thalavady (Kuttanad region) under 4 modules viz; Natural Resource Management**,** Crop Production, Livestock and fisheries, and Institutional interventions. Technology demonstrations on climate resilient practices relevant to the production systems in the region were taken up in a cluster village approach.

Enhancing the economic viability of Coconut based land use systems for land use planning in Kerala State: This project was funded by Kerala State Planning Board and is implemented in two locations (1) Mayyanad Panchayath (AEU 1- Southern coastal plain) and (2) Chettikulangara Panchayath (AEU 3 - Onattukara Sandy Plain). Average yield of the palms in the demonstration plots increased from 30-40 to 50-60 nuts/palm/year

Technology backstopping to Agro-clinics of the Dept. of Agriculture (Crop Health Management Scheme): Need based awareness programmes related to nutrient, pest and disease management of important crops and field demonstrations on crop health management technologies are being taken up at Palamel and Chunakkara panchayaths.

Onattukara Spices Farmer Producer Company Ltd. (OSFPCL): KVK promotes the Farmer Producer Organization – Onattukara Spices Farmer Producer Company Limited funded by NABARD with a financial outlay of 9.06 lakhs. The OSFPCL was registered in December 2016 under Companies Act. The activities were concentrated in six panchayaths of Bharanikkavu block with 250 share holders and share capital of 2.81 lakhs. The company facilitates cultivation, procurement, processing, and marketing of the major spices *viz.*, turmeric, ginger, pepper and garcinea in the region so as to enhance the net income of the shareholder farmers.

Agro Processing Training cum Incubation Centre (APTIC): To strengthen the capacity of entrepreneurs in processing and value addition of coconut, jackfruit, and seasonal fruits and vegetables, Agriculture Development and Farmers Welfare Department, Governmnet of Kerala has sanctioned this project with a sanctioned budget of Rs.73 lakhs.

Capacity building in Value addition of Coconut: A small scale Virgin Coconut Oil production-cum-demonstration unit has been set up at the KVK for capacity building of entrepreneurs on value added coconut processing technologies. The facility was funded by '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 100 entrepreneurs, identified by the project, who are interested in coconut processing ventures have already been trained in this unit so far.

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, processed products, publications etc. The progressive closing balance of revolving fund as on 30.11.19 is Rs. 24,66,756/-

FLD on beekeeping under KVK, Alappuzha

Distribution of certificates to vocational trainees by the Dr. Anitha Karun, Director (Acting)

Paddy harvest festival at Thalavady under NICRA project

VIII-9. ICAR- All India Coordinated Research Project (AICRP) on Palms

The All India Coordinated Research Project on Palms started functioning from 1972 with an objective of conducting location-specific research in the mandate crops. At present the project has coconut, oil palm, arecanut, palmyrah and cocoa as mandate crops and it is implemented in 28 centres. Its headquarters is at ICAR-CPCRI, Kasaragod and 15 centres are conducting research on coconut, six on oil palm, four on arecanut, four on palmyrah and seven on cocoa. The coordinating centres are located in 14 states and one union territory covering 13 SAUs/SHUs, one CAU and four ICAR institutes.

Map showing coordinating centres of ICAR-AICRP on Palms

The budget for the year 2019 (April-December) was Rs. 451.67 lakhs and the scheme is implemented through the respective state Agricultural/Horticultural Universities, 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.

Crown of Kalpa Ratna

Research Achivements

Coconut

Crop Improvement

- **Kalpa Ratna:** a tall coconut variety which is a selection from Federated Malay States (IND 010 S) initially introduced to India from Malaysia during 1940. Based on the superior performance of the variety at ICAR-Central Plantation Crops Research Institute, Kasaragod, Kerala and AICRP (Palms) centre at Aliyarnagar, Tamil Nadu, it was recommended for release as Kalpa Ratna for cultivation in the coconut growing regions of the southern states of India *viz.,* Karnataka, Kerala and Tamil Nadu. This variety starts bearing from 5th year onwards and gave stabilized yield from 8 years after planting. The fruit is oval in shape, yellow to green in color with good amount of tender nut water (575 ml). It gives an average nut yield of 99.9 nuts/palm/year with a copra content of 162 g/ nut and copra yield of 12.7 kg/ palm/ year.
- Under evaluation trial, among five coconut Tall x Tall cross combinations planted during 2011 at Aliyarnagar centre, the cross combination BGR x ADOT recorded the highest nut yield (81.4 nuts/ palm/year), which was on par with WCT x TPT (70.9 nuts/palm/year).
- In the evaluation trial of five coconut Dwarf x Dwarf cross combinations planted during 2011 at Ratnagiri centre, among the hybrid combinations, the first inflorescence emergence was noticed in GBGD x MOD hybrid at 27 months after planting followed by COD x MGD (28 months) whereas, the highest quantity of tender nut water was found in MYD x CGD (463.8 ml).

Crop Production

Under coconut based high density cropping system with compatible crops, application of 50% of RDF (NPK) + 50% N through organic recycling with vermicompost + vermiwash + biofertilizer and *in situ* green manuring (T_2) recorded higher system productivity followed by 75% of recommended NPK + 25% through organic recycling with vermicompost or fully organic. The net returns obtained was higher under 50% of RDF + 50% N through organic recycling treatment which ranged from Rs. 0.94 lakhs/ha to Rs. 6.08 lakhs/ ha compared to monocrop of coconut (Rs. 0.36 lakhs/ha to Rs. 1.37 lakhs/ha).

Nut character of Kalpa Ratna

Crop Protection

Disease Management

In Aliyarnagar, 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 @ 50 g/palm + insecticide

Coconut based high density cropping system at Ratnagiri

(Imidachloprid @ 1 ml/l of water) reduced the average root (wilt) disease index of coconut in farmers field, from 15.86 (2016) to 9.95 (2019) at Coimbatore district and 16.34 (2016) to 11.94 (2019) in Tirunelveli district, respectively. The highest disease index was observed in control plot compared to demonstration plot. During the year, nut yield was higher under integrated management approach (83 nuts/ palm in Coimbatore district and 95 nuts/palm/year in Tirunelveli district, respectively) compared to farmer's practice (65 nuts/ palm in Coimbatore district and 68 nuts/palm/year in Tirunelveli district, respectively).

Sequential application of fungicides as root feeding with carbendazim @ 5g in 100 ml of water during Jan, July followed by propiconazole @ 5ml in 100 ml of water during April and October was found effective in controlling the leaf blight incidence in coconut in Aliyarnagar.

Pest Management

Management of rhinoceros beetle: A field study was carried out in Tamil Nadu (Aliyarnagar), Andhra Pradesh (Ambajipeta), Karnataka (Arsikere) and Maharashtra (Ratnagiri) during 2016-19 to evaluate the efficacy of botanical cake developed from ICAR-CPCRI and paste for the prophylactic management of rhinoceros beetle infesting juvenile palms. Botanical cake (15 g), paste (15 g), neem cake + sand (150 g each) and chlorantraniliprole 0.4% GR (in perforated sachets in the innermost leaf axils @ 6 g per palm) were added in the innermost leaf axils, once in 4 months and naphthalene balls (12 g), once in 2 months. The pre-treatment leaf and spindle damage were in the range of 14.6 to 17.2 per cent and 52.5 to 58.8 per cent, respectively. During post treatment observations, chlorantraniliprole treated palms showed minimum leaf damage in Aliyarnagar (13.1%), Ambajipeta (11.6%) and Ratnagiri (8.5%) followed by botanical cake and paste (14.6, 13.0 and 9.8%, respectively). In Arsikere, botanical cake and paste (7.0%) was found to be the best treatment followed by chlorantraniliprole (8.4%) and neem cake + sand (9.6%). Spindle damage was the lowest in botanical cake and paste treated palms in Ambajipeta (14.5%) and Arsikere (25.0%) whereas, chlorantraniliprole recorded minimum spindle damage in Aliyarnagar (35.2%) and Ratnagiri (9.5%). Based on the results, CPCRI Botanical cake + paste@ 15g each/ palm can be recommended against rhinoceros beetle in juvenile palms as it was found effective in reducing spindle damage and leaf damage in coconut.

Oil Palm

Godavari Swarna, Godavari Gold and **Godavari Ratna:** 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 choke management in Shivamogga indicated that, management practices influenced better root development as well as better uptake of nutrients by the plant resulting in reduction of the 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 (MLT) of performance of cocoa clones as inter crop under palms is in progress at different AICRP centres *viz.*, Aliyarnagar, Arsikere, Kahikuchi, Ratnagiri and Vijayarai. At Ambajipeta, VTLCH-2 recorded higher dry beans/ plant (2.1 kg) and was at par with VTLCC-1 and VTLCH-4 (1.8 kg/tree). At Navsari, VTLCH-4 registered the maximum pod weight, single dry bean weight, numbers of beans/pod and dry bean yield/tree/year.

28th Annual Group Meeting of AICRP on Palms

The 28th Annual Group Meeting of All India Co-ordinated Research Project on Palms was organized at Tamil Nadu Agricultural University, Coimbatore during 6th & 7th, June 2019. The inaugural function was presided by Dr. N. Kumar, VC, TNAU and Dr. W. S. Dhillon, Assistant Director General (Horticultural Sciences), ICAR, New Delhi was the Chief Guest. Dr. P. Rethinam, Former Executive Director, Asian and Pacific Coconut Community, Jakarta, Dr. K. Muralidharan, Director (i/c), ICAR-CPCRI, Kasaragod and Dr. R. K. Mathur, Director, ICAR-IIOPR, Pedavegi were the guests of honour. The programme had a pleasant beginning with invocation and ICAR theme song highlighting the glory of farmers. Dr. K.S. Subramanian, Director of Research, Tamil Nadu Agricultural University, Coimbatore welcomed the

Release of Publications during 28th AGM of ICAR-AICRP on Palms

gathering in which he narrated the research accomplishment of Tamil Nadu Agricultural University in taking palm research to the next level. The Project Co-ordinator of AICRP (Palms), Dr. H. P. Maheswarappa in his report briefed the mission and achievement of AICRP on five crops - coconut, oil palm, palmyrah, arecanut and cocoa, distributed across 28 centres of 14 states and one union territory covering 13 State Agricultural Universities, four ICAR Institutes and two central universities.

Dr. W. S. Dhillon, Assistant Director General (HS -I), gave a bird's eye view of the overall growth of horticultural sector and its significant contribution to GDP and nutritional security of the nation. Dr. N. Kumar, Vice Chancellor, TNAU, in his Presidential address underlined the need for the development of composite mother gardens for the production of quality seedlings and called on scientists to develop drought mitigation strategies considering the weather extremities. Horticultural Research Station, Vijayarai was adjudged the best AICRP (Palms) centre for the year 2018-19. Handful of publications which include three books on coconut and oil palm, two technical bulletins and seven folders and pamphlets were released during the meeting.

Delegates of 28th Annual General Meeting of ICAR-AICRP on Palms at TNAU, Coimbatore

IX. Publications

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X. Technologies Assessed and Transferred

Kalpa Sreshta

A hybrid between MYD x TPT, high yielding dual purpose coconut variety for tender nut and copra, suitable for cultivation in the states of Kerala and Karnataka has been notified by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties of Horticultural Crops. Dwarf x Tall coconut hybrid, Kalpa Sreshta (high yielding with average yield of 167 nuts palm^{-1} year^{-1} and an estimated copra out turn of 35.9 kg palm^{-1}year^{-1}).

Cryopreservation of coconut (V-cryo mesh and V-cryo plate method)

V-cryoplate and V- cryomesh methods was tested for cryopreservation of coconut embryonic shoot meristem. Plumule explants were pre-grown in Y3 medium supplemented with 0.2/0.4/0.6 M sucrose and 1.25 M glycerol for three days. Explants were fixed in aluminium cryoplates or cryomeshes for encapsulation with calcium alginate. Explants were then desiccated for 45/90 minutes in PVS3 solution and subjected to cryopreservation. Regeneration after cryopreservation was more in V-cryomesh (33.3%) as compared to V-cryoplate (30.5%). Mean recovery of embryonic shoot meristem was higher in 90 minutes vitrification (35%) as compared to 45 minutes (28.7%).

Red Palm Weevil control in coconut

Prophylactic leaf axil placement of citriodora oil impregnated calcium alginate beads for ecofriendly management of Red Palm Weevil using stimulo-deterrancy. Field efficacy of citriodora impregnated calcium alginate beads conducted in six years old coconut garden in Kasaragod, by leaf axil placement of 2 sachets of 5 g each and aggregation pheromone trap kept outside the garden to entrap repelled beetles reduced pest incidence from 5.1% to 1.9%, over a period of three months during the first year and from 3.2% to 1.3% during the second year.

Kalpa Sreshta hybrid coconut

Management of fruit rot of arecanut

Prophylactic spraying of 0.5 % Mandipropamid 23.3 % SC just before the onset of monsoon and one more spray after 45 days to the arecanut bunches was found as effective as spraying of 1 % Bordeaux mixture (1%) in reducing the incidence of arecaunt fruit rot. The fungicide can be used as an alternative to the Bordeaux mixture.

Ecofriendly management of Red Palm Weevil

Prophylactic leaf axil placement of 2 sachets filled each with 5 g citriodora oil-impregnated calcium alginate beads and keeping the aggregation pheromone trap outside the coconut garden to entrap repelled beetles reduced the red palm weevil incidence on coconut from 5.1 % to 1.9% during the first year (2018-2019) and 3.2% to 1.3% during the second year (2019-2020).

Aqua formulation of EPN for management of root grub (*Leucopholis* sp.) in arecanut

The inundated soil drenching of aqua suspension of entomopathogenic nematode (EPN), *Steinernema carpocapsae* (CPCRI - SC1) @ 1.5 billion IJs/ha (Approx. 40 -50 lakh IJs in 3 liters of water/palm) during June - July and September - October followed by neem cake

application @ 2 kg/palm during December - January suppresses the grub multiplication (>80%) and significantly reduce the fresh incidence of root grub infestation in the infested arecanut gardens.

View of EPN demonstration plot at Udupi district of Karnataka

EPN aqua suspension

Visitors at the exhibition stall by the entrepreneur on coconut milk products

Simplified processing protocol for the production of coconut milk powder

Foam mat drying protocol consisted of two stage drying for the production of coconut milk powder was simplified into single stage drying by incorporating the foaming agent, foam stabilizer and encapsulating agent to coconut milk during the initial whipping stage. Foam mat drying is preferred due to its simplicity, cost-effectiveness and rapid drying rate. Foam expansion of 147% 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^3, 0.49 g/cm^3, 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 two stage process) could be saved in this simplified method. The product had a Hausner ratio of 1.13±0.01 which falls under the category of powder with good flow character.

Coconut milk delicacy

Coconut milk delicacy was standardized with coconut milk, skimmed milk powder and refined sugar. The fat source was met completely from coconut milk. In view of the cost of tender nut, skim milk powder was used as source for solid non fat. Fat and protein content were standardized to get an output in the category of medium fat ice cream. The process technology was assessed by comparing it with standard vanilla ice cream, which was found better in overall sensory acceptability.

Linear actuator based tender coconut trimming machine

A simple and efficient linear actuator-based minimal processing machine has been developed to reduce the transportation cost of the tender nuts of about 7-8 months maturity. It consists of three cutting knives positioned at different angles attached with linear actuators, tender nut holder, and prime mover. Provision is given to adjust the holder based on the tender coconut shape and size. After fixing the tender coconut on the holder, the user can switch on the motor and operate the cutting knives by just pressing the appropriate buttons and can complete the minimal processing of tender nut in 30-45 s/nut. The spray gun attached with the trimming machine could prevent the enzymatic browning of the nut during trimming.

Preservation protocol for trimmed tender coconut

Shelf life of the trimmed tender nuts has been extended to five weeks using the combination of organic acids, substituted resorcinols, aromatic carboxylic acids and complexing agents. With shrink wrapping and low temperature storage (5±1°C), browning-free storage life of the minimally processed tender coconut was extended to five weeks with 10 min dipping in anti-browning solution.

Air blast sprayer for coconut

A power transmission unit has been fabricated. PTO of a mini tractor would be the power source. Power from the PTO is transmitted by the power transmission unit (Gear ratio-1:4.18) to drive the blower and the chemical injection pump simultaneously. The sprayer could also be connected to an ordinary tractor.

Self-propelled sprayer a spray height of 20 m could be achieved. In tractor mounted sprayer spray height was up to 30 m.

XI. Awards and Recognition

ICAR-CPCRI, Kasaragod has been awarded with a certificate of appreciation at the Fourth National Workshop of 'Nodal Officers- ICAR Research Data Repository for Knowledge Management' for proactively implementing ICAR Research Data Management Guidelines.

Dr. Trilochan Mohapatra, Secretary (DARE) and DG (ICAR) conferring the certificate of appreciation to Dr. S. Jayasekhar, Nodal Officer, ICAR-CPCRI, Kasaragod

Dr. Regi Jacob Thomas, Principal Scientist received second prize in National Coconut Challenge 2019 conducted by Kerala Startup Mission for the concept 'Modified ground pollination technique for hybridization in coconut'. The prize was distributed on 3rd November 2019 during International Coconut Conference & Expositionconduced at Hotel Taj Gateway, Kozhikode.

Dr. R. Pandiselvam, Scientist, was conferred with the Best Oral Paper Presentation Award in the 'Nutrition-19—An International Conference on Functional Foods and Nutraceutical' held at Bannari Amman Institute of Technology, Sathyamangalam, Erode during 2 – 3 August, 2019.

Dr. T. Sivakumar, SMS (Entomology) of the KVK was conferred with the Best Oral Presentation Award for the paper on 'Use of QR codes to facilitate the learning experience of farmers' in the International Conference on 'Extension for Strengthening Agricultural Research and Development' during 14 – 16 December, 2019 at JSS, Mysore.

Dr. Jayasekhar S., Sr. Scientist (Agricultural Economics) was awarded Dr. R.T. Doshi Best Research Paper Presentation Prize at the 27th Agricultural Economics Research Association (AERA) Conference held at PAU, Ludhiana during 17 – 19 December, 2019.

Dr. P. Muralidharan and Dr. S. Ravi were conferred with the Best Poster Presentation Award for the poster on 'Climate resilient technologies for sustainable poultry rearing in flood affected areas of Kuttanad, Kerala' in the Annual Review Workshop of Technology Demonstration component of NICRA held at ICAR-CRIDA, Hyderabad during 4 – 6 June, 2019.

Dr. R. Sudha, Dr. V. Niral, Dr. K.B. Hebbar, Dr. K. Samsudeen and Ms. Ranjini, T.N., were conferred with Best Oral Presentation Award for the paper entitled 'Evaluation of coconut genotypes for coconut inflorescence sap yield' during 9th International Conference on Agriculture, Horticulture and Plant Science organized by The Society of Tropical Agriculture, New Delhi held at Dharamshala, Himachal Pradesh during 27-28 June, 2019.

XII. Training and Capacity Building

Physical Targets and Achievements (up to 31 December 2019)

S. No.	Category	Total No. of employees	No. of Trainings Planned for each Category during 2019-20 as per ATP	No. of employees undergone training during April- December 2019	% Realization of trainings planned during 2019-20 (up to December 2019)
1	Scientific	81	23	6	26.1
2	Technical	101	15	6	40.0
3	Administrative & Finance	57	9	7	77.8
4	SSS	125	10	0	0.0
	Total	364	57	19	33.3

Financial targets and achievements (up to 31 December 2019)

RE 2018-19 for HRD (Rs. in lakhs)	Actual expenditure up to 31 December, 2020 for HRD	% Utilization of allotted budget
10.0	4.7	47.0

Category-wise Trainings Attended by Employees

Category: Scientists

S. No.	Name of Employee	Designation	Discipline/ Section	Name of Training Programme Attended
1	Dr. Rajesh M.K.	Principal Scientist	Agrl. Biotechnology	Workshop on "Fundamentals of Proteogenomics for Beginners" from 22nd to 24th July, 2019 at Centre for Systems Biology & Molecular Medicine Yenapoya University, Mangaluru.
2	Dr. Murali Gopal	Principal Scientist	Agril. Microbiology	MDP on Priority Setting Monitoring and Evaluation (PME) of Agricultural Research Projects from 18th to 23rd July, 2019 at NAARM, Hyderabad.
3	Dr. Thamban C.	Principal Scientist	Agrl. Extension	Capacity development for organizing international training programme at MANAGE, Hyderabad during 29th -31st July, 2019
4	Dr. R. Pandiselvam	Scientist	Agricultural Process Engineering	Recent Advances in Post-Harvest Fisheries Engineering at ICAR-CIFT, Cochin during 13th to 2nd November, 2019
5	Dr. Jeena Mathew	Scientist	Soil Science	Recent Advances in Soil Health Improvement and Climate Change Mitigation at ICAR-IISS, Bhopal during 10th to 19th December, 2019
6	Dr. Krishna Prakash	Scientist	Spices, Plantation and Medicinal and Aromatic Plants	Recent advances in bioinformatics in agricultural research: A practical perspective at ICAR-IASRI, New Delhi during 12th to 21st December, 2019

Category: Technical

S. No.	Name of employee	Designation	Discipline /Section	Name of training programme attended
1	Shri A.K. Ramadas	Senior Technical Assistant	Vehicles	Training on "Automobile Maintenance, Road Safety and Behavioural Skills" at ICAR-CIAE, Bhopal during 26th July to 2nd August, 2019
2	Shri K. Manikantan	Programme Assistant	Farm Manager	Training on Cashew production technology at ZAHRS Brahmavar from 31st July to 2nd August 2019
3	Shri B. Anil Kumar	Technical Officer	Farm	Training on "Farm Management" at ICAR-IIFSR, Modipuram during 17th to 23rd September, 2019
4	Dr. Saritha Hegde	SMS	Home Science	Training on "Recent technological advances in Agro processing for Entrepreneurship development" at University of Agricultural Sciences, Bangalore from 17th to 26th September, 2019
5	Smt. Jayashree M.P.	SMS	Agri. Exten sion	Training programme on Mushroom Grower orgnaised by Agriculture Skill Council of India under Central Ministry of Agriculture at GKVK campus Bengaluru from 20th to 22nd November, 2019
6	Shri M.S. Rajeev	ACTO	Agro nomy	"
7	Dr. S. Ravi	ACTO	Animal Husbandry	"
8	Shri P. Ravindran	ACTO	Farm	Capacity building programme towards a Secure and Resilient Workplace at ICAR at ICAR-CPRI, Shimla during 25th to 27th November, 2019.
9	Shri C. Purandhara	Technical Officer	Farm	"
10	Shri Jagadish Roy	Sr. Technical Assistant	Vehicles	Automobile maintenance, Road Safety and Behavioural Skills at ICAR-CIAE, Bhopal during 27th November to 3rd December, 2019
11	Shri Suvith	Technical Trainee	Lab	ICAR-ERP MIS-FMS at ICAR-IISR, Kozhikode on 13th December, 2019
12	Dr. T. Sivakumar	ACTO	Agrl. Ento mology	Fruit fly: Surveillance and Management NIPHM, Hyderabad 21 – 25 October, 2019

Category: Administrative Staff

S. No.	Name of employee	Designation	Discipline/ Section	Name of training programme attended
1	Mrs. Reetha M.	Asst. Administrative Officer	Audit and Accounts	Refresher Course on Administrative and Finance Management for Section officers/ Assistant Administrative Officers/ Assistant Finance & Accounts Officers/ Junior Accounts Officers/ Assistant of ICAR HQ/ Institutes scheduled from 13th to 17th of June 2019 at CIFT, Kochi.
2	Shri T.N. Vidyadharan	Assistant	Administration	”
3	Shri Narayana Naik	Assistant	Administration	”
4	Shri Pradeep Kumar Vasu	AAO	Administrat ion	Training on “Hospitality Management” at ICAR, NAARM, Hyderabad during 26th June 2019 to 2nd July 2019.
5	Smt. A.J. Mary	UDC	Administration	Training on “ICAR-ERP MIS-FMS” at ICAR-IISR, Kozhikode on 13th December 2019
6	Shri Fawaz C.M.O.	LDC	Administration	”
7	Shri Saji T.J.	UDC	Administration	”

XIII. Workshops, Seminars, Summer Institutes, Farmers Days Organized

Asia-Pacific Cocoa Breeders Working Group Meeting

Dr. N. Kumar, Vice Chancellor, Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, inaugurated the Asia-Pacific Cocoa Breeders Working Group meeting, which was held during 20th – 25th May, 2019. In his inaugural address, he stressed the need to evolve cocoa hybrids with higher yields and resistance to pests and diseases. The meeting was presided over by Dr. Venkatesh N. Hubballi, Director, Directorate of Cashewnut and Cocoa Development (DCCD), Kochi. In his presidential address, he informed the international community that Indian cocoa beans are the best in the world. He called for a close linkage of research and development departments to fulfil the Hon'ble Prime Minister's vision to enhance the area under cashew and cocoa, the poor man's crops.

Inauguration of APCBWG international meet at ICAR-CPCRI, Kasaragod

Participants of the APCBWG meet at ICAR-CPCRI, Kasaragod

Dr. Smilja Lambert, Cocoa Research Manager (Asia/ Pacific), Mars Inc., briefed the gathering regarding the activities and breeding programmes of Asia-Pacific Cocoa Working Group.

Shri S.N. Bhat, Vice-President, CAMPCO, Dr. H.P. Maheswarappa, Project Coordinator, AICRP (Palms), Dr. J. Dilip Babu, Director of Research, Dr. YSR Horticultural University have felicitated the meeting. CAMPCO activities were highlighted by Shri S.N. Bhat. Along with 31 delegates from ICAR-CPCRI, Kerala Agricultural University, Tamil Nadu Agricultural University and Dr.YSRHU, Andhra Pradesh, working on Cocoa research, 13 delegates from eight countries have participated in the meeting, including Australia, Indonesia, Malaysia, Philippines, Vietnam, USA, Belgium and Papua New Guinea. Region specific prospects and problems in the cocoa sector were discussed and breeding strategies in resilience with climate change perspectives were formulated during the meeting.

Workshop-cum-Training on Plant Health Management in Coconut

A Workshop-cum-Training on Plant Health Management in Coconut was organised at ICAR – CPCRI, Kasaragod on 14th May 2019 before the onset of south-west monsoon.

Release of the publication on 'Incidence and intensity of pests and diseases of coconut in North Kerala' Workshop-cum-Training on Plant Health Coconut

Farmers from Kasaragod district and extension personnel of the Department of Agriculture and Farmers' Welfare participated in the programme. Mrs. Tizamma Thomas, Principal Agricultural Officer, Kasaragod inaugurated the programme and Dr. K.B. Hebbar, Acting Head, Division of PB & PHT, presided over the inaugural function. Mr. A.A. Jaleel, President, Mogral-Puthur Grama Panchayat released the publication on 'Incidence and intensity of pests and diseases of coconut in North Kerala, and offered felicitations. Mrs. Stella Jacob, Project Director, Agricultural Technology Management Agency (ATMA), Kasaragod also addressed the gathering in the inaugural function. After the presentations, group discussion on 'Strategies for scaling up the adoption of recommended technologies by coconut growers through appropriate interventions of State Dept. of Agriculture/ATMA/ Local Self Governments' was held.

ICAR Foundation Day

The ninety first Foundation Day of Indian Council of Agriculture Research (ICAR) has been celebrated on 16th July, 2019 at ICAR-CPCRI, Kasaragod. Dr. K.M. Sreekumar, Professor, Agricultural Entomology, College of Horticulture, Kerala Agricultural University, Padannakkad was the chief guest. In his address, he narrated the history of developments in Indian agriculture. The historical famine in India in those days and the anticipation for the ship bringing ration to feed hungry mouth, the dependence on foreign food were mentioned by him. He has pointed out the contribution of ICAR for achieving self-sufficiency in food production. He informed that, we are heading towards the topmost populated country. ICAR supported the Indian farmers with technologies for improving agriculture and helping the country to become second in the world in agricultural production. Compared to China, US and Europe, our country uses a very low amount of pesticides.

ICAR Foundation Day was also celebrated at ICAR-CPCRI, Regional Station, Vittal on 16th July, 2019 and different competitions were conducted like quiz, drawing etc. for staff members, high school and higher secondary school children depicting the strength of Indian agriculture.

Address by the Chief Guest, Dr. K.M. Sreekumar during the ICAR Foundation Day at Kasaragod

A one-day thematic seminar entitled 'Converging Technologies for Inclusive Coconut Farming' was conducted on 16th July, 2019 aimed at technology dissemination for holistic farming. Around 100 farmers from *Mera Gaon-Mera Gaurav* (MGMG) villages of Bharanikavau, Chettikulangara, Kandaloor and Oachira participated in the programme. Shri K.K. Anilkumar, Councillor, Kayamkulam Municipality inaugurated the programme that was presided over by Dr. V. Krishnakumar, Head, ICAR-CPCRI, Regional Station, Kayamkulam. The technical sessions were conducted and the interaction were held. A knowledge-centric quiz competition about ICAR and CPCRI technologies and other general aspects was conducted.

Workshop and National seminar on 'Climate, flood and folklore'

A two day Workshop cum Seminar on 'Climate, flood and folklore' was organized at ICAR-CPCRI, Regional Station, Kayamkulam in collaboration with Folkland International Centre for Folklore and Culture, Kasaragod during 22nd and 23rd August, 2019. The main objective of the workshop and seminar was to bridge the gap between the scientific forecasting systems and resilience strategies and that owned by local communities. A workshop on traditional wisdom on climate, flood and adaptations was conducted on 22nd August, 2019 with local knowledge bearers. Interactions with farmers, fisher-folk, folklorists and other stakeholders were the highlight of the workshop. Dr. S. Kalavathi, Principal Scientist briefed about the programme and welcomed the gathering. Dr.V.Krishnakumar, Acting Head, ICAR-CPCRI, Kayamkulam delivered the presidential address. The programme was inaugurated by Hon'ble District Collector, Alappuzha, Dr. Adeela Abdulla, IAS. In her inaugural address, she urged that the agricultural production systems should be in synergy with soil health and human interventions should never harm the nature. Preserving the local plant varieties and animal breeds, maintenance of food chain ecosystem and balancing human activities in accordance with our bare needs are essential to conserve our nature.

The keynote address on 'Ecosystem management for climate resilience' was delivered by Dr. K.G. Padmakumar, Special Officer and Director, International Research and Training Centre for Below Sea Level Farming, Kuttanad. On 23rd August, 2019, a national seminar was conducted involving presentations from researchers, academicians, students, development workers, NGOs from agriculture and allied sectors.

World Coconut Day

The Institute also participated in the World Coconut Day celebrations organized by Coconut Development Board, Kochi at Bhubaneswar and the Kerala Agricultural University at Vellanikkara, Thrissur. Dr. Anitha Karun, Act. Director participated in the national level programme at Bhubaneswar. Shri Narendra Singh Tomar, Hon'ble Minister for Agriculture and Farmers Welfare, Government of India inaugurated the programme.

World Coconut Day was celebrated at ICAR-CPCRI, Kasaragod, Regional Station, Kayamkulam and Research Centre, Kahikuchi on 2nd September, 2019 with various programmes. At Kasaragod, a district level seminar on 'Scientific cultivation and processing technologies in coconut' was conducted in which over 100 farmers representing coconut producer Societies/Federations/ Company participated. The seminar was organized by ICAR-KVK, Kasaragod with financial assistance from Coconut Development Board, Kochi. Shri A. A. Jaleel, President, Mogral Puthur Grama Panchayat was the Chief Guest of the programme. Shri A.A. Jaleel in his inaugural address stressed that Micro-irrigation and scientific cultivation are the two aspects for increasing production and productivity. He stressed the importance of resource conservation to maintain ecological stability and sustainable development. He called for all the public to involve in the water conservation campaign by joining the Jal Shakti Abhiyan programme being implemented in the district. Dr. K. Muralidharan, Director In charge, ICAR-CPCRI presided over the function. A publication entitled "Thengu Krishi Reethikal" in Malayalam was released during the occasion.

World Coconut Day celebration at Kasaragod

At ICAR-CPCRI, Regional Station, Kayamkulam on a "grand powder carpet (*kolam*)" highlighting the ecological significance of coconut and commemorating the theme on "Coconut for Family Wellness" was made by a group of 20 women farmer-trainees from Virudhunagar, Tamil Nadu.

At Research Cente Kahikuchi, the farmer's training programme was inaugurated by Dr. D.N. Kalita, Programme Co-ordinator, KVK, Kamrup, Assam Agricultural University. Mr. Munindra Das, GVS, NGO, Kamrup was the guest of Honour. Thirty seven farmers attended the programme.

Training on coconut palm climbing at CPCRI, RC, Kahikuchi

Tree Planting Campaign at Enmakaje Panchayath in Kasaragod District

A tree planting campaign was organized by the ICAR-KVK, CPCRI Kasaragod at Enmakaje Panchayath in Kasaragod District on 17th September, 2019. This was launched in connection with the National Programme on "Tree plantation campaign and Kisan Ghoshti" organized by the Ministry of Agriculture Development and farmers welfare, Govt. of India. The event was inaugurated by Dr. Anitha Karun, Director, ICAR-CPCRI, Kasaragod and presided over by Smt. Sharadha Y., President, Enmakaje, Grama Panchayath. Around 40 farmers participated in the event. Different saplings of jack, mango, cashew and kokum were planted by farmers as part of this campaign which envisages planting of 1000 saplings of different species in the district.

National Workshop on 'Organic Farming in Plantation Crops - Present status and future Prospects'

A National Workshop on 'Organic Farming in Plantation Crops-Present Status and Future Prospects' was held at ICAR-CPCRI, Regional Station, Kayamkulam on 20th September, 2019. Dr. M.N. Sreenivasa, Professor & Head, Institute of Organic Farming, UAS, Dharward inaugurated the workshop. In his inaugural address, he emphasised to make farming holistic and inclusive to harness maximum output by optimum utilization of resources. He opined to maintain good soil health by targeting soil microbiome. He stressed to encourage balanced host-predator relationship through augmentation of defenders as the key in organic pest suppression. Dr. Anitha Karun, Acting Director, ICAR-CPCRI presided over the function. Dr. George V. Thomas, Former Director, ICAR-CPCRI, Kasaragod and Dr. R.D. Iyer, Retired

Mr. Sumit Kumar I.R.S., Commissioner of Customs–Preventive delivering the inaugural address

Head, Division of Crop Improvement, ICAR-CPCRI, Kasaragod offered felicitations.

Outreach Session on export trade facilitation measures

ICAR-CPCRI Agri Business Incubation Centre in collaboration with Federation of Indian Export Organizations and Kasaragod Chamber of Commerce conducted a programme on 'Export Trade Facilitation Measures' on 30 September, 2019. Mr. Sumit Kumar I.R.S., Commissioner of Customs-Preventive, Kochi inaugurated the programme and briefed about the measures taken by the Government to promote exports. Dr. Anitha Karun, Director mentioned about the technologies from CPCRI used by the entrepreneurs and also mentioned about certain issues specifically quarantine, export of coconut seedlings and identification of origin of arecanuts ceased by customs. Mr. K.M. Harilal, I.T.S., Joint Director General of Foreign Trade, Kochi in his key note address appraised the gathering about foreign trade policy and promotional schemes and international marketing. Mr. P.V. Narayanan, Superintendent of Customs (CGST) made a presentation on GST Refund Procedures on Exports. The topic on Baggage Rules of Customs was held by Mr. Madhusoodana Bhat I.R.S., Asst. Commissioner of Customs, Kannur International Airport and Mr. Vijaykumar M., Retd. Asst. Commissioner Customs and Central Excise gave a talk on Customs Formalities in International Trade. Pre and Post Shipment Payment Options and Foreign Exchange Risk Management aspects were covered by Mr. George Paul, Deputy General Manager, South Indian Bank Ltd. Mr. Rajeev M.C., Management Executive & Head, FIEO briefed about the activities of FIEO. More than 100 delegates including few incubatees of ICAR-CPCRI ABI were participated.

Workshop on 'Development communication-Changing platforms and new paradigms'

A workshop on 'Development communication-Changing platforms and new paradigms' was conducted at ICAR-CPCRI, Kasaragod on 31st October 2019 in collaboration with Kasaragod Press Club. Mr. G. Sajan, Deputy Director, Doordarshan, New Delhi delivered the keynote address and made presentation on the theme of the workshop. Members of Kasaragod Press Club, students and scholars of Dept. of Social Work, Central University of Kerala attended the workshop along with CPCRI personnel.

Dr Anitha Karun, Director (Acting) CPCRI presenting memento to Mr. Sajan

Visit of ICAR-CPCRI Scientists to flood affected areas of Kerala

A multi-disciplinary team of scientists of ICAR-CPCRI along with officials from Agricultural Department, Kerala State visited flood affected areas in Nileshwaram on 27th October, 2019. Local self government officials also accompanied the scientists along with the secretaries of padashekharam and a few farmers.

The team found that maximum damage occurred to paddy fields where the crop was in submerged condition for more than six days and silt got accumulated at certain points and top soil got eroded at certain other locations. Few coconut and arecanut palms were uprooted or broken. However, bud rot of coconut at various stages was observed in many gardens. Unprecedented rainfall was the major reason for the flood. However, inundation for such a long period, up to six days in certain areas, is due to poor drainage facility. The majority of the drains, especially from the paddy fields, got silted during previous years thereby reducing its carrying capacity. Width of the drains, even culverts constructed above it, was not sufficient to carry the floodwater. After the field visit a meeting was arranged to appraise the farmers the short term and long term remedial measures to be undertaken by various stakeholders to mitigate the effects of the flood.

'World Soil Day' celebrations

'World Soil Day' was celebrated at ICAR-CPCRI Kasaragod in collaboration with Department of Soil Survey, Kasaragod, Govt. of Kerala on 5th December 2019, in which soil health cards were distributed to 120 farmers. Interface programme on 'Soil health management' was organized for the benefit of more than 200 farmers and other stakeholders.

Krishi Mela and Horti Fair

A mega Krishi Mela and Horti Fair was conducted at ICAR-CPCRI Research Centre, Kidu during 12-13 October 2019. The Krishi Mela was inaugurated by Shri S.R. Satishchandra, President, Central Arecanut and Cocoa Marketing and Processing Cooperative Ltd. (CAMPCO). Dr. Anitha Karun, Act. Director, ICAR-CPCRI presided over the function. Shri Nithyananda Mundoodi, President, Committee of Management, Kukke Shree Subramanya Temple inaugurated the Horti Fair. Shri. Radhakrishna Borker, President, Taluk Panchayath, Puttur released handouts on pest and disease management of coconut, arecanut and cocoa.

Shri. Nalin Kumar Kateel, Hon'ble Member of Parliament, Dakshina Kannada and Shri Angara S, MLA, Sullia inaugurated the seminars on 13 October 2019.

Shri Shri Vidyaprasanna Teertha Swamiji, Kukke Subrahmanya Mutt was the chief guest for valedictory function.

Jal Shakthi Abhyan and Kisan Mela

ICAR KVK, Kasaragod organized Kisan Mela as part of JalShakthiAbhiyan on 2 October, 2019 at ICAR CPCRI, Kasragod wherein 700 farmers participated. Seminar on water harvesting and micro irrigation, exhibition, method demonstrations, film shows and field visits, and Farmer Scientist interface were conducted. Dr. Anitha Karun, Director, ICAR-CPCRI, Kasaragod inaugurated the Kisan Mela. The dignitaries included Shri Ashok Kumar V.M., Nodal Officer, Jal Shakti Abhiyan, Kasaragod district, Shri P.V. Umesh, Deputy Director (Horticulture), Dept. of Agricultural Development and Farmers Welfare, Kasaragod and Shri Jyothis Jagannath, DDM, NABARD. Technical sessions were held with experts in the fieldincludingDr. A.C. Mathew, Principal Scientist, ICAR-CPCRI, Kasaragod, Dr. Abdul Hakkim V.M., Professor, College of Agriculture, Padannakkad, Dr. P. Subramanian, Principal Scientist, ICAR-CPCRI and Dr. C. Thamban, Principal Scientist, ICAR-CPCRI.

Inaugural function of Kisan Mela at Kidu, Karnataka

Address by Shri. Nalin Kumar Kateel, Hon'ble MP

Valedictory address by
Shri Shri Vidyaprasanna Teertha Swamiji

XIV. Participation of Scientists in Seminar, Symposia, Conference and Workshops

Participation of Scientific Personnel

Name & Designation	Title of Programme	Place & Date
Dr. Anitha Karun, Director, Dr. K. Muralidharan, Dr. Ravi Bhat, Dr. K.B. Hebbar, Dr. Vinayaka Hegde, Acting Heads of Division, Dr. H.P. Maheshwarappa, Acting PC (Palms), Dr. C.T. Jose, Acting Head, RS, Vittal, Dr. V. Niral, Dr. M.K. Rajesh, Dr. K. Samsudeen, Dr. Elain Apshara, Dr. M.R. Manikantan, Pr. Scientists, Dr. M. Senthil Amudhan, Dr. S. Jayasekhar, Sr. Scientists, Dr. V.H. Pratibha, Dr. R. Sudha, Dr. Neema M., Dr. Nagaraja N.R. Dr. Shivaji Hausrao Thube, Dr. R. Thava Prakas Pandian, Ms. Ranjini T.N., Dr. Pandiselvam R., Dr. Krishna Prakash and Dr. Ganesh Khadke, Scientists	International Meet on Asia Pacific Cocoa Breeders Working Group	ICAR-CPCRI, Kasaragod 20th-25th May 2019
Dr. K. Muralidharan, Dr. K.B. Hebbar, Dr. Ravi Bhat, Acting Heads of Division	International Conference on Innovative Horticulture and Value Chain Management – Shaping Future Horticulture	GBPUA&T, Pantnagar, Uttarakhand 28th - 31st May, 2019
Dr. C.Thamban, Pr. Scientist	State level workshop on 'Agro-biodiversity conservation'	Kerala State, Bio-diversity Board Thiruvananthapuram 5th June, 2019
Dr. Chandrika Mohan, Pr. Scientist	28th Annual Workshop of AICRP on Biological Control of Crop Pests	Anand Agricultural University, Anand, Gujarat, 6th-7th June, 2019
Dr. Ravi Bhat, Dr. Vinayaka Hegde, Dr. K.B. Hebbar, Dr. K. Muralidharan, Acting Heads of Division, Dr. V. Krishnakumar, Dr. C.T. Jose, Acting Heads, Dr. P. Subramanian, Dr. V. Niral, Dr. ElainApshara, Dr. Josephrajkumar, Dr. Regi J. Thomas, Pr. Scientists, Dr. M. Senthil Amudhan, Sr. Scientist, Dr. Nagaraja N.R., Dr. Shivaji Hausrao Thube, Dr. R.Thava Praksh Pandian, Dr. Priya, U.K., Ms. Saneera, E. K., Ms. Suchithra, M. and Dr. Merin Babu, Scientists	28th Annual Group meeting of "All India Coordinated Research Project on Palms"	TNAU Coimbatore 6th-7th June, 2019

Name & Designation	Title of Programme	Place & Date
Dr. V. Krishnakumar, Acting Head, RS, Kayamkulam, Dr. Jeena Mathew, Scientist	National Workshop on 'Fertilizer policy for promoting balanced use of nutrients'	Thiruvananthapuram 21st June, 2019
Dr. R. Sudha, Scientist	9th International Conference on Agriculture, Horticulture and Plant Science	Dharamshala (H.P) 27th-28th June, 2019
Dr. Vinayaka Hegde, Acting Head (Crop Protection), Dr. V. H. Prathibha and Dr. M. Sujithra, Scientists	International Conference on Plant Protection in Horticulture	ICAR-IIHR, Bengaluru 24th to 27thJuly, 2019
Dr. R. Pandiselvam, Scientist	International conference on Functional foods and Nutraceuticals held at Bannari Amma Institute of Technology.	Sathyamangalam 2nd to 3rdAugust, 2019
Dr. V. Krishnakumar, Dr. C. Thamban, Dr. P. Subramanian, Dr. S. Kalavathi, Dr. Chandrika Mohan, Dr. P. Anithakumari, Dr. A. Abdul Haris, Dr. A. Joseph Rajkumar and Dr. P. Muralidharan, Principal Scientists, Dr. Merin Babu, Dr. M. Shareefa, Dr. K. Nihad, Dr. Jeena Mathew, Dr. K.M. Anes and Dr. S. Indhuja, Scientists	Workshop cum National Seminar on 'Climate, Flood and Folklore'	ICAR-CPCRI, Regional Station, Kayamkulam 22nd to 23rdAugust, 2019
Dr. A. Joseph Rajkumar, Principal Scientist	Brainstorming session on 'Development of IPDM package for emerging pests and diseases in coconut'	TNAU, Coimbatore 19th September, 2019
Dr. P. Subramanian, Principal Scientist	Global Organic Convention	Society of Agriculture Research and Development, Nagpur, during 15th -18th September, 2019
Dr. Anitha Karun, Acting Director, Dr. K. Muralidharan, Dr. K.B. Hebbar, Dr. Ravi Bhat, Dr. Vinayaka Hegde, Acting Heads, Dr. V. Krishnakumar, Acting Head, Dr. P. Muralidharan, Head, KVK Alappuzha, Dr. Murali Gopal, Dr. Alka Gupta, Dr. P. Subramanian Dr. S. Kalavathi, Dr. Chandrika Mohan,	Workshop on Organic Farming in Plantation Crops-Present Status and future perspectives	Regional Station Kayamkulam 20th September, 2019

Name & Designation	Title of Programme	Place & Date
Dr. A. Abdul Haris, Dr. Anithakumari, Dr. Regi Jacob Thomas, Dr. A. Josephrajkumar, Principal Scientists, Dr. Merin Babu, Dr. Jeena Mathew, Dr. M. Shareefa, Dr. S. Indhuja, Dr. K. Nihad, Dr. K. M. Anes, Scientists		
Dr. V. Selvamani, Scientist	8th Asian- Australasian Conference on Precision Agriculture	Punjab Agriculture University, Ludhiana during 14th -17th October, 2019
Dr. P. Subramanian, Principal Scientist	Global Organic Convention	College of Agriculture, Nagpur 10th November, 2019.
Dr. A. Joseph Rajkumar, Principal Scientist, Regional Station Kayamkulam, Jilu V. Sajan, P.S. Prathibha, Scientists,	19th International Plant Protection Conference	Convention Center, Hyderabad 10th-14th November, 2019
Dr. Jayasekhar S., Principal Scientist	The 27th Agricultural Economics Research Association Conference	Punjab Agricultural University (PAU) Ludhiana 17th-19th December, 2019
Dr. Arun Kumar Sit, Principal Scientist	4th Regional Science and Technology Congress	Alipurduar College, 18th-19th December, 2019
Dr. R. Pandiselvam, Scientist	10thInternational Conference on Agriculture, Horticulture and Food Science	New Delhi 21st – 22nd December, 2019

Participation of Technical Personnel

Name & Designation	Title of Programme	Place & Date
Dr. K. Sajnanath, ACTO	Brain storming session on "Science Communication, Popularisation and Extension in Malayalam" organised by Vigyan Prasar and SSM, Kerala	Ramanilayam, Thrissur 22ndMay, 2019
Shri M. S. Rajeev, SMS (Agronomy)	Workshop on "Establishment of Nutrigardens"	Directorate of Extension, Mannuthy 24th October, 2019
Dr. T. Sivakumar, SMS (Entomology)	International conference on "Extension for Strengthening Agricultural Research and Development"	JSS, Mysuru 14th -16th December, 2019

XV. 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	Coconut research programme 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
ICAR - Directorate of Groundnut Research,Junagadh, Gujarat	Groundnut intercropping under coconut research

Others

Agricultural Technology Management Agency	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 KSCSTE, Thiruvananthapuram	R & D collaboration 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

XVI. Research Projects

Institute Projects

Project No.	Project title	Project Leader	Project Associates
1000761028	Genetic resources management in coconut, arecanut and cocoa	V. Niral	S. Elain Apshara,K. Samsudeen, A. K. Sit, L.S. Singh, Alpana Das, N. R. Nagaraja, Ranjini T.N., Sudha R., Ganesh Kadke, Suchitra M., Regi Jacob Thomas, M. Sujithra, K.B. Hebbar, S.V. Ramesh, P. Subramanian, Saneera E.K., Shameena Beegum, C. Thamban, Senthil Amudhan, Shivaji, Chaithra M., Priya U.K., 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 N. Khadke, Sumitha S., Ranjini T.N., Alpana Das, Sudha R., Scientist from CIARI-Andaman, S. Sendur Kumaran (KVK, Kundrakudi)
1000761030	Biotechnological applications in palms and cocoa	M.K. Rajesh	Anitha Karun,N.R. Nagaraja, Neema M., Krishna Prakash, Murali Gopal
1000761031	Development of tissue culture techniques in coconut	Anitha Karun	M.K. Rajesh, Neema M., Regi Jacob Thomas, Shareefa M., Krishna Prakash
1000761032	Development of double-stranded RNA based food bait for the suppression of red palm weevil	M.K. Rajesh	A. Josephrajkumar, S.V. Ramesh, 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, P. Panjavarnam Alka Gupta, Priya U.K., A. Abdul Haris, K. Nihad, Arun Kumar Sit, S. Neenu, Anok Uchoi and L. S. Singh
1000763058	Enhancing nutrient and water use efficiency for sustained productivity in coconut, arecanut and cocoa	Ravi Bhat	P. Subramanian, H.P. Maheshwarappa, V. Krishnakumar, K. Nihad, V. Selvamani, Neenu S., A. Abdul Haris, Jeena Mathew, Priya U.K., Alka Gupta, Murali Gopal, P. Panjavarnam, Indhuja, Arun Kumar Sit, S. Paul Raj, Anok Uchoi, Merin Babu, P. Anitha Kumari

Project No.	Project title	Project Leader	Project Associates
1000763055	Bioresources management in coconut, arecanut and cocoa	Alka Gupta	Murali Gopal, P. Subramanian, H.P. Maheswarappa, V. Krishnakumar, Abdul Haris, S. Elain Apshara, Sandip Shil, S. Indhuja, K. Nihad, V. Selvamani, Jeena Mathew, Merin Babu, V.H. Prathibha, M. Sujithra
1000765039	Integrated approaches for management of fungal diseases of palms and cocoa	Vinayaka Hegde	Prathibha V.H., Daliyamol, Thava Prakasa Pandian, Rajesh M.K., Rajkumar, Ajeet Singh, Neenu S.
1000765040	Diagnostics and management of root (wilt) disease (RWD) in coconut and yellow leaf disease (YLD) in arecanut	Vinayaka Hegde	K.B. Hebbar, Murali Gopal, A. Josephrajkumar, Merin Babu, Thava Prakasa Pandian, Daliyamol, S. Indhuja, M.K. Rajesh
1000765041	Integrated management of pests and nematodes in palms and cocoa	Chandrika Mohan	A. Joseph Rajkumar P.S. Prathibha, M. Sujithra, Rajkumar, Shivaji H. Thube, Saneera E.K., Merin Babu, Anes, K.M., Thava Prakasa Pandian
1000766014	Physiological and biochemical investigations of yield and quality in palms and cocoa	K. B. Hebbar	S.V. Ramesh, Ajeet Singh, Senthil Amudhan, Elain Apshara, S Neenu, R. Surekha, A.K. Sit, B. Sravanthi
1000767018	Mechanization, processing, product diversification, and nutraceutical properties	M.R.Manikantan	Shameena Beegum, R. Pandiselvam, Senthil Amudhan, Ajeet Singh, Murali Gopal, Paul Raj, K.B. Hebbar, and Sucheta Kumari from KSHEMA, Mangalore
1000767019	Development of pilot plant for coconut milk powder using foam mat drying and ready to cook kheer mix (AICRP on PHET)	M.R.Manikantan	Shameena Beegum, R. Pandiselvam, Ajeet Singh, Paul Raj, and A.C.Mathew
1000767023	Development of process technology for minimal processing of mature coconut kernel and its value added products (AICRP on PHET)	Shameena Beegum	M.R. Manikantan and R. Pandiselvam
1000767021	Development of tender coconut trimming machine and preservation protocol for trimmed tender coconut (AICRP on PHET)	R. Pandiselvam	A.C. Mathew, M. R. Manikantan and Shameena beegum

Project No.	Project title	Project Leader	Project Associates
1000767022	Development of Continuous Type Coconut Testa Removing Machine (AICRP on PHET)	R. Pandiselvam	A.C. Mathew, M. R. Manikantan and Shameena beegum
1000769020	Technology transfer and co-learning action research approaches	Thamban. C.	S. Kalavathi, P. Anithakumari, C.T. Jose, K. Muralidharan, Chandran, K.P., S. Jayasekhar, Alpana Das, N.R. Nagaraja, Abdul Haris, A.K. Sit
1000769013	Socioeconomic dimensions and value chain dynamics in policy perspective	Jayasekhar S	Chandran K.P., C.T. Jose, Sandip Shil, K. Muralidharan, C. Thamban
1000769023	Adaptation deficit analysis and resilience strategies to climate change in coastal coconut agro-ecosystems	S. Kalavathi	A. Abdul Haris, Chandrika Mohan, C. Thamban, Murali Gopal, Regi Jacob Thomas, Chandran K.P., Anes, K.M.
1000769022	Crop - weather modelling and methodological evaluation of crop insurance in plantation crops	Chandran. K.P.	Jose C.T., Muralidharan K., Sandip Shil, Jayasekhar S., S. Kalavathi
1000769019	Development of Statistical and Computational Techniques for Improving Research Methodology	C.T. Jose	K.P. Chandran, Sandip Shill, S. Jayasekhar, K. Muralidharan Thava Praksa Pandian, Shivaji Thube

Externally Funded Projects

Project No.	Project title	Project Leader	Project Associates
1050761086	DUS Centre for coconut	V. Niral	K. Samsudeen
1050761107	Large-scale production of elite and hybrid seedlings of coconut for the root (wilt) disease prevalent tract (Plan Fund, Govt. of Kerala)	Regi Jacob Thomas	M. Shareefa, K. Merin Babu, S. Kalavathi
2010760004	Seed production in Coconut, Arecanut, Cocoa (Under ICAR project on seed production in Agricultural Crops)	K. Samsudeen	V. Niral, S. Elain Apshara, N.R. Nagaraja, Regi Jacob Thomas, M. Shareefa, Anes K.M., Ganesh N. Khadke, Sudha R., Ranjini T.N., A.K. Sit, L.S. Singh

Project No.	Project title	Project Leader	Project Associates
1050761121	Production and distribution of quality planting material of dwarf / semi tall varieties programme of the Department of Agriculture	V. Niral	K. Samsudeen, Regi Jacob Thomas, C. Thamban, Anes K.M., M.K. Rajesh
1050761122	Technology support for coconut hybridization/ production of semi tall varieties programme of the department of agriculture	K. Samsudeen	Regi Jacob Thomas, C. Thamban, M.K. Rajesh, V. Niral, M. Shareefa
1050761114	Development of DUS testing criteria and establishment of National Gene Bank for Arecanut	Nagaraja N.R.	A.K. Sit
1050761115	Development of DUS testing criteria and establishment of National Gene Bank for Cocoa	S. Elain Apshara	—
1050231012	Development of a database for plantation crops for biologists (DBT)	M.K. Rajesh	Anitha Karun, K. Muralidharan, K.P. Chandran
1050761127	Commercial production of arecanut tissue culture planting material of Yellow Leaf Disease resistant palms and dwarf hybrids (RKVY)	Anitha Karun	M.K. Rajesh, Nagaraja N.R., R. Thava Prakasa Pandian, Neema M., Krishna Prakash
1050761098	Enhancing economic viability of coconut based land use system for land use planning in Kerala (Kerala State Planning Board Project)	V. Krishnakumar	Jeena Mathew, Ravi Bhat, Selvamani V., C. Thamban, A. Abdul Haris, K.P. Chandran, S. Indhuja, S. Neenu, P. Subramanian
1050761109	Mass production of plant growth promoting microbes and biocontrol agents for sustainability of coconut based cropping system (RKVY)	Vinayaka Hegde	Prathibha V.H., Alka Gupta Murali Gopal, Thamban C. Daliyamol

Project No.	Project title	Project Leader	Project Associates
1050761128	Pest and disease surveillance on coconut palms by unmanned aerial vehicle	Vinayaka Hegde	A. Josephrajkumar, Chandrika Mohan, Prathibha P.S., Sujithra M., Prathibha V.H., Rajkumar, Merin Babu, Daliyamol, Anes K.M., Abhishek Burman, Founder Director and CEO, M/s General Aeronautics Pvt. Ltd., Bangalore
1050761123	Technology Support of Plant Protection campaign against pests and diseases of coconut	Chandrika Mohan	Joseph Rajkumar A., Prathibha P.S., Rajkumar, Sujithra M., Vinayak Hegde, Merin Babu, Prathibha V.H., Kalavathi S., Anithakumari P., Thamban C., Abdul Haris A., Anes K.M.
1050761126	Detection system for red palm weevil infesting coconut (with M/s Resnova, Kochi)	A. Joseph rajkumar	Chandrika Mohan
1050761105	Demonstration of effective and eco-friendly management of white grub using EPN in arecanut	Rajkumar	Nagraj N. R., Shivaji H. Thube
1050761133	Design, fabrication and field demonstration of a Neera (Kalparasa) collection device	K B Hebbar	-
1050761119	Development of ready to eat extruded snacks from co-products of coconut processing (CDB)	M.R.Manikantan	R. Pandiselvam and Shameena Beegum
1050761125	Standardization protocol for the preparation of frozen coconut delicacy (CDB)	Shameena Beegum	R. Pandiselvam and M.R. Manikantan
1050761112	Techno-socio-economic assessment of soil & water conservation and water harvesting structures (Dept. of soil conservation and soil survey, Govt. of Kerala)	A. C. Mathew	C. Thamban, P. Muralidharan, Jayasekhar S.
1050761120	Design, development and field demonstration of an air blast sprayer for coconut	A.C. Mathew	R. Pandiselvam

Project No.	Project title	Project Leader	Project Associates
1050761124	Geo-spatial variability in coconut productivity in kerala– an analysis of extent and determinants	Thamban. C.	Chandran, K.P., S. Kalavathi, K. Muralidharan, S. Jayasekhar
1050761130	Participatory rejuvenation and refreshment of coconut based homestead system models for food security and income	P. Anithakumari	A. Joseph Rajkumar, Indhuja S., Shareefa M., V. Krishnakumar
1050761117	Farmer FIRST Program (FFP)- Participatory technology integration to empower and ensure livelihood security of farmers in Alappuzha district	Anitha Karun/ P.Anithakumari	A. Joseph Rajkumar, Indhuja S., Shareefa M., Merin Babu, Nihad K., Jeena Mathew
2010760007	Intellectual property management and transfer/commerciali sation of agricultural technology scheme	K. Muralidharan	A.C. Mathew
1050761110	Establishment of agri-business Incubation (ABI) Centre at CPCRI, Kasaragod (NAIF)	K. Muralidharan	A.C. Mathew, Manikantan M.R., Pandiselvam R., S. Jayasekhar, Murali Gopal
1050761131	Entrepreneurship development through farmer led innovations – Study in plantation crops (NASF – ICAR)	T.S. Manojkumar	S. Jayasekhar and Sandip Shil
1050761108	Consortium Research Platform (CRP) on farm mechanization and precision farming	L.S. Singh	-

XVII. Research and Organisational Management

Institute Management Committee

The Institute Management Committee (IMC) meeting for the year 2019-20 was held at ICAR-CPCRI, Kasaragod on 21st September 2019 under the Chairmanship of Dr. Anitha Karun, Acting Director and Chairperson of IMC, ICAR-CPCRI, Kasaragod, Dr. W. S. Dhillon, Assistant Director General (HS II), ICAR, New Delhi, Dr. A. Ishwara Bhat, Principal Scientist, ICAR-Indian Institute of Spices Research, Kozhikode and Dr. T. Makesh Kumar, Principal Scientist, ICAR-Central Tuber Crops Research Institute, Thruvananthapuram were present. Shri Ram Avatar Parashar, Senior Finance and Accounts Officer attended the meeting as a special invitee. Shri Hareesh Nair, Chief Administrative Officer, ICAR-CPCRI, Kasaragod was the Member Secretary of this Committee. Action taken on the previous IMC recommendations were presented by the Member Secretary during the meeting and confirmed by the IMC. Various agenda items were discussed pertaining to ICAR-CPCRI and appropriate recommendation were evolved along the meeting. These recommendations were communicated to the Council and were vetted by the competent authorities, vide F.No. HS/6-10/2018-IAV dated 12th December, 2019.

Quinquennial Review Team

The QRT for 2014 to 2019 has been constituted by the ICAR under the chairmanship of Prof. Dr. B.M.C. Reddy, Former Director, IIHR & Former VC Dr YSRHU. Other members of QRT are given here below:

1. Dr. M.G. Bhat, Former Director, DCR, Puttur, Vanashree, Near Santhome Guru, Mandir, Mukrampady, Darbe P.O., Puttur – 574202
2. Dr. H. Hameed Khan, Former PC, AICRP on Palms, 160/14, D.B. Road, Optic Craft, R.S. Puram P.O., Coimbatore-641002
3. Dr. S. Lingaraju, Emeritus Professor, Former Director, Institute of Organic Farming
4. Dr. John Zachariah, Former Head, ICAR-IISR, Kozhikode

Institute Management Committee meeting

5. Dr. S. Arulraj, Former Director, ICAR-IIOPR, Pedavegi, Plot No. 16 B, Door No. 2/44 V. G. N. Nagar, A. N. E. Salai, Ayyappan Thangal, Chennai-600056.
6. Dr. H. P. Maheshwarappa, Project Coordinater AICRP Palms (Member Secretary).

Research Advisory Committee

The eighth Research Advisory Committee for 2020 to 2023 has been constituted by the ICAR under the chairmanship of Dr. S. P. Ghosh, Former, DDG (Hort.), ICAR. Other members of RAC are given here below:

List of members

1. Dr. K.V. Ramana, Former ADG (H.S.I), ICAR, New Delhi.
2. Dr. V. Abraham, Former Director, ICAR-NBPGR, New Delhi
3. Dr. K.V. Bhat, Former Principal Scientist, ICAR-NBPGR, New Delhi
4. Dr. B.S. Hansra, Former ADG (Agri. Extn.) ICAR, New Delhi
5. Two Non-Official members nominated by Hon'ble MoA&FW to the IMC of the Institute Director, ICAR-CPCRI, Kasaragod
6. Dr. W.S. Dhillon, ADG (H.S. II), Krishi Anusandhan Bhavan-II, ICAR, Pusa, New Delhi 110012.
7. Dr. Ravi Bhat, Acting Head Division of Crop Production and Principal Scientist (Agronomy), ICAR-CPCRI, Kasaragod (Member Secretary).

XVIII. Intellectual Property and Technology Management

Consultancy services

Consultancy services were taken up as a part of the professional service functions of the Institute during 2019 as detailed below:

Consultancy service	Client	Amount (Rs.)
Nutrient analysis of organic manure	Muhammed Runal, Nature Hug Cord, Mangalore. Agricultural Officer, Krishi Bhavan, Kuttikol. Agricultural Officer, Krishi Bhavan, Mulleria.	7,500
Nutrient analysis of fish manure	Muhammed Runal, Nature Hug Cord, Mangalore.	5,000
Nutrient analysis of charcoal	M/s Megha Industries, Kuthirapady, Patla P.O, Kasaragod.	5,000
Nutrient analysis of neem cake and bone meal Nutrient analysis of neem cake and fish meal.	Agricultural Officer, Krishi Bhavan, Muliyar.	5,000
Nutrient analysis of coir pith compost	Senior Agricultural Officer, PBS, SSF, Kasaragod	1,250
	Total	**23,750**

Technology Commercialization

During the period, 35 technologies were commercialized through non-exclusive licensing with memorandum of agreement as per the details given below. An amount of Rs. 12,92,500/- has been collected as technology transfer fees.

Technology Commercialized	Licensee	Fee (Rs.)
Technical know-how of production of virgin coconut oil (VCO)	Mr. Sreeraj K.M, Kakkadamkulam (H), Randar (P.O), Muvattupuzha, Ernakulam, Kerala – 686673. Nischal Industries, Near overhead water tank, Kittadal (Post), Mathodu (Hobli), Hosadurga (Taluk), Chitradurga (Dist), Karnataka – 577533. M/s Kerala Clays & Ceramic Products Ltd., Clay House, Pappinisseri, Kannur 670 561, Kerala. M/s Yeshua Enerprises, Rangat, Middle Andaman, Andaman & Nicobar Islands, Pin – 744 205 Administrative office at No.1, M.J. Sargunam Colony, Avarampalayam, Coimbatore – 641 006. Mr. Anoop Dominic, S/o Dominic, Kootiyanical (H), Halkal, Jadkal (PO), Kundapura (Tq), Udupi (Dt), Karnataka – 576233.	2,00,000
Matured coconut water based value added products	Mrs. Shani V, W/o. Priyesh, Priyesh Nivas, P.O Nirmalagiri, Kannur District, Kerala – 670701.	75,000

Technology Commercialized	Licensee	Fee (Rs.)
	Mr. Santhosh N, 6/19, Narayan Nagar, Nehru Nagar Extn, Ganapathy, Coimbatore – 641006, Tamil Nadu. M/s Dinesh Foods, Dinesh Bhavan, Payyambalam, Kannur – 670001, Kerala Mrs. S. Radhamani, M/s Poorna Sweets, Blue 301, Parsn Colours Apts, Nanjunda Puram Road, Coimbatore–641 036, Tamil Nadu. M/s Arun Grit Pvt Ltd., No: 15/6, South Mada Street, Mylapore, Chennai – 600004, Tamil Nadu.	
Coconut Chips	M/s Roligt Foods Pvt Ltd., Regd. Office: H.No:16-2-51/F/5 Akbar Bagh, Malakpet, Hyderabad, Telangana – 500034. Mr. Ravikumar Mangukiya, (M/s Swara Natural Food Products), 31, 32, First Floor Sai Krishna Industrial Estate, Opp- Kiran Residency, Near Dwarkesh Industrial Estate – 2, Umara gam, Sayan – Hazira Road, Umara village, Surat – 394130, Gujarat.	50,000
Trichoderma Coir Pith Cake	Secretary, Agro service Centre, Pinarayi, Kannur, Kerala Agricultural Officer, Krishi Bhavan, Anad, Thiruvananthapuram. M/s Phytotonic Private Limited, Door. No. 3/108, Raghavarajapuram (Village and Post), Railway Kodur (Mandal), YSR Kadapa District – 516105, Andhra Pradesh.	15,000
Collection of fresh and hygienic Kalparasa and production of natural coconut sugar	M/s Udupi Kalparasa Coconut and all Spices Producer Company Limited, C/o Bharathiya Kissan Sangha (Regd) Udupi, 518-A, Freds Complex, 1st Floor, Kundapura Main Road, Kundapura, Udupi, Karnataka – 576201. Deputy Director (Agri Business), Department of Agricultural Marketing & Agribusiness, Kanyakumari District, Tamil Nadu. Deputy Director (Agri Business), Department of Agricultural Marketing & Agribusiness, Kattupudukulam, Market Committee Complex, Pudukkottai – 622001, Tamil Nadu.	3,00,000
Snow ball and tender nut Machine	M/s Roligt Foods Pvt Ltd., Regd. Office: H.No:16-2-51/F/5, Akbar Bagh, Malakpet, Hyderabad, Telangana – 500034.	2,500
Machineries (Coconut Shell Removing Machine, Coconut Pulveriser, Double Screw Coconut Milk Expeller)	M/s Oscar Indus, # 1962, Opp. Stock Exchange, Trichy Road, Coimbatore – 641 005, Tamil Nadu.	45,000
Entomopathogenic nematode acqua formulation	Senior Scientist and Head, Krishi Vigyan Kendra, Brahmavar – 576213, Karnataka	25,000
Preservation protocol for trimmed tender coconut	Hemanth E.M., Green Mansion, P.O. Mamba, Paleri, Anjarkandy – 670611, Kannur	15,000
Utilisation of ABI facility for production of Coconut Sap Chiller	Kalyaniram Polyplast Pvt. Ltd., Baikampady Industrial Area, Mangalore, Karnataka	25,000
Licensing of 12 coconut varieties – Kalpa Jyothi, Chowghat Orange Dwarf, Kalpasree, Kalparaksha, Kalpa Surya, Kalpa Haritha, Kera Keralam, Kalpatharu, Kalpa Pratibha, Kera Chandra, Chandra Kalpa and Kera Bastar	M/s. La Ferme De Peter LLP, S. No. 53/2C, Moortheeswaram Road, Muvirunthali Village 627951, Sankarankovil Taluk, Tirunelveli District, Tamil Nadu	5,40,000
	Total	**12,92,500**

Sale of Technology Products

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

Item	Qty. / Nos.	Amount (Rs.)
Books	35	1,971
CD	2	600
Earthworms	4520	3,310
Vermi compost	2385	46,125
Vermiwash	2	200
Kera Probio®	144	3,600
Trichoderma	25.3	2,530
Coconut seedlings (Hybrid)	31851	79,62,750
Coconut seedlings (Dwarf)	2809	5,89,890
Coconut seedlings(WCT)	9515	9,96,650
OP/varieties Coconut seedlings	4399	4,83,890
Poly I bag coconut seedlings (Hybrid)	225	67,500
Poly I bag coconut seedlings (Tall)	320	50,200
Poly I bag coconut seedlings (Dwarf)	255	66,300
Tall inter-se coconut poly bag seedlings	183	32,940
Dwarf Inter-Se poly bag seedlings	18	5,040
Coconut seed nuts (Dwarf)	95	11,400
Coconut seed nuts (Tall)	2	140
Arecanut seed nuts	450	4,500
Arecanut seedlings	96932	35,14,370
Cocoa seedlings	30611	3,06,110
Cocoa seed pods	29220	8,76,600
Cocoa graft	137	4,110
	Total	**1,50,30,726**

XIX. Personnel

Scientific Staff		
Kasaragod		
Sl. No.	**Name**	**Designation**
1.	Dr. Anitha Karun	Director (Acting)
2.	Dr. H.P. Maheswarappa	Project Coordinator (Palms) (Acting)
3.	Dr. Ravi Bhat	HoD (Crop Production) (Acting)
4.	Dr. K.B. Hebbar	HoD (PB & PHT) (Acting)
5.	Dr. Vinayaka Hegde	HoD (Crop Protection) (Acting)
6.	Dr. K. Muralidharan	HoD (Social Sciences) (Acting)
7.	Dr. C. Thamban	Principal Scientist (Agril. Extension)
8.	Dr. Alka Gupta	Principal Scientist (Agril. Microbiology)
9.	Dr. Murali Gopal	Principal Scientist (Agril. Microbiology)
10.	Dr. V. Niral	Principal Scientist (Genetics)
11.	Dr. P. Subramanian	Principal Scientist (Agronomy)
12.	Dr. A.C. Mathew	Principal Scientist (Soil &Water Conservation Engg.)
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. R. Sudha	Senior Scientist (Fruit Science)
19.	Dr. Selvamani V	Senior Scientist (Soil Science)
20.	Dr. Neenu S.	Senior Scientist (Soil Science)
21.	Dr. S. Paulraj	Senior Scientist (Agril. Microbiology)
22.	Dr. Pratibha P.S.	Scientist (Agril. Entomology)
23.	Dr. Rajkumar	Scientist (Agril. Nematology)
24.	Dr. V.H. Prathibha	Scientist (Plant Pathology)
25.	Mrs. Surekha	Scientist (Agronomy)
26.	Dr. M. Sujithra	Scientist (Agril. Entomology)
27.	Dr. Neema M	Scientist (SPM&AP)
28.	Dr. Daliya Mol	Scientist (Plant Pathology)
29.	Dr. Sumitha S.	Scientist (SPM&AP)
30.	Dr. Krishna Prakash	Scientist (SPM&AP)
31.	Mrs. Aparna Veluru	Scientist (SPM&AP)
32.	Dr. Shameena Begum P.P	Scientist (SPM&AP)
33.	Dr. G. Panjavarnam	Scientist (Fruit Science)
34.	Dr. Jilu V. Sajan	Scientist (Agril. Entomology)
35.	Dr. R. Pandiselvam	Scientist (Agril. Process Engg.)
36.	Ms. Ranjini T.N.	Scientist (SPM&AP)
37.	Dr. Ramesh S.V.	Scientist (Agril. Biotechnology)

Sl. No.	Name	Designation
38.	Mr. Bhukya Narshima Swamy	Scientist (Veg. Science) (up to 07.12.2019)
39.	Mrs. Bandela Sravanthi	Scientist (SPM&AP)
40.	Dr. Ajeet Singh	Scientist (Biochemistry)
	KVK, CPCRI, Kasaragod	
41.	Dr. Manojkumar T. S.	Principal Scientist & Head
	Regional Station, Kayamkulam	
42.	Dr. V. Krishnakumar	Head (Acting) (up to 30.09.2019)
43.	Dr. S. Kalavathi	Head (Acting) (w.e.f. 01.10.2019)
44.	Dr. Chandrika Mohan	Principal Scientist (Agril. Entomology)
45.	Dr. P. Anithakumari	Principal Scientist (Agril. Extension)
46.	Dr. Regi Jacob Thomas	Principal Scientist (Hort.)
47.	Dr. Abdul Haris	Principal Scientist (Agronomy)
48.	Dr. Joseph Rajkumar	Principal Scientist (Agril. Entomology)
49.	Dr. Nihad. K.	Senior Scientist (Hort.)
50.	Dr. Shareefa M.	Senior Scientist (Hort.)
51.	Dr. Jeena Mathew	Scientist (Soil Science)
52.	Dr. Merin Babu	Scientist (Plant Pathology)
53.	Dr. Indhuja S.	Scientist (Agril. Microbiology)
54.	Dr. Anes K.M.	Scientist (Agril. Nematology)
	KVK, Alappuzha	
55.	Dr. Muralidharan P.	Principal Scientist & Head
	Regional Station, Vittal	
56.	Dr. C.T. Jose	Head (Acting)
57.	Dr. S. Elain Apshara	Principal Scientist (Hort. Fruit Science)
58.	Dr. M. Senthil Amudhan	Senior Scientist (Biochemistry)
59.	Dr. N.R. Nagaraja	Scientist (Plant Breeding)
60.	Ms. Chaithra M.	Scientist (Plant Pathology)
61.	Dr. Priya U.K.	Scientist (Soil Science)
62.	Mr. Bhavishya	Scientist (SPM&AP)
63.	Dr. Shivaji Hausrao Thube	Scientist (Agril. Entomology)
64.	Ms. Suchithra M.	Scientist (SPM&AP)
65.	Mrs. Saneera E.K.	Scientist (Agril. Entomology)
66.	Dr. R. Thava Prakash Pandian	Scientist (Plant Pathology)
67.	Mr. Najeeb N.	Scientist (Fruit Science) (up to 11.04.2019)
	Research Centre, Kidu	
68.	Mr. Diwakar Y.	Scientist (SPM&AP)
69.	Dr. Khadke Ganesh Navanath	Scientist (SPM&AP)
	Research Centre, Mohitnagar	
70.	Dr. Arunkumar Sit	Principal Scientist (Hort.)
71.	Dr. Sandip Shil	Scientist (Agril. Statistics)
	Research Centre, Kahikuchi	
72.	Dr. Alpana Das	Senior Scientist (Agril. Biotechnology)
73.	Dr. Anok Uchoi	Scientist (SPM&AP)
74.	Dr. Leichombam Singhajit Singh	Scientist (SPM&AP)

Technical Staff		
Kasaragod		
Sl. No.	***Name***	***Designation***
1.	Mr. H. Muralikrishna	Chief Technical Officer (Tech. Info.)
2.	Mr. John George	Chief Technical Officer
3.	Mr. Sebastian George	Chief Technical Officer
4.	Mrs. K. Shobha	Chief Technical Officer (Library)
5.	Mr. K. Devadas	Asst. Chief Technical Officer
6.	Mrs. Sugatha Padmanabhan	Asst. Chief Technical Officer
7.	Mr. P. Ravindran	Asst. Chief Technical Officer
8.	Mr. N. Ramakrishnan	Asst. Technical Officer (up to 31.12.2019)
9.	Mrs. K. Sreelatha	Asst. Chief Technical Officer (Hindi)
10.	Mr. K. Shyama Prasad	Asst. Chief Technical Officer
11.	Mr. Sadanandan A	Technical Officer (up to 31.05.2019)
12.	Mr. G.S. Hareesh	Technical Officer (Instrument Mechanic)
13.	Mr. M.P. Rajendran Nair	Technical Officer (Mechanic)
14.	Mr. K. Ajith Kumar	Technical Officer (CEA)
15.	Mr. K. Balakrishnan	Technical Officer (up to 30.04.2019)
16.	Mr. K.N. Radhakrishnan Nambiar	Technical Officer
17.	Mr. V.K. Gopalakrishnan	Technical Officer
18.	Mr. S. Manohara	Technical Officer (Vehicle)
19.	Mr. V. Balakrishnan	Technical Officer
20.	Mr. V. Suresh Kumar	Technical Officer
21.	Mr. K. Krishnan Nair	Technical Officer
22.	Mr. K.N. Pankajakshan	Senior Technical Assistant (Vehicle)
23.	Mr. A.K. Ramadas	Senior Technical Assistant (Vehicle)
24.	Mr. M.V. Sreedharan	Senior Technical Assistant
25.	Mr. Devaraj K	Senior Technical Assistant (J.E.)
26.	Dr. Muralikrishna K.S.	Senior Technical Assistant
27.	Mrs. Jesmi Vijayan	Senior Technical Assistant (Field Investigator)
28.	Mr. K. Raghavan	Technical Assistant
29.	Mr. A. Sanjeeva	Technical Assistant
30.	Mr. K. Panduranga	Technical Assistant
31.	Mr. AV Satheesh Kumar	Technical Assistant (Vehicle)
32.	Mr. Bhavani Sankar Naik	Senior Technician
33.	Mr. V. Radhakrishnan	Senior Technician
34.	Mr. A.O. Varghese	Senior Technician
35.	Mr. A. Divakaran	Senior Technician
36.	Mr. K.J. Sebastian	Senior Technician
37.	Mr. Sunil S.	Senior Technician (Electrician)
38.	Mrs. M. Vimala	Senior Technician
39.	Mr. N. Dinesh Kumar	Senior Technician
40.	Mr. A.R. Padmanabha Naik	Senior Technician (w.e.f. 05.01.2019)
41.	Mr. Arunji G.	Technical Assistant (Library)
42.	Mrs. Ashamol E.P.	Technical Trainee (FF) w. e. f. 25.04.2019
43.	Mr. Suvith P.S.	Technical Trainee (FF) w. e. f. 01.05.2019

Sl. No.	Name	Designation
44.	Mr. Ajith Kumar R	Technical Trainee (FF) w. e. f. 01.05.2019
45.	Mr. Premjith Antony	Technical Trainee (FF) w. e. f. 24.08.2019
	KVK, Kasaragod	
46.	Dr. S. Leena	Chief Technical Officer (up to 31.05.2019)
47.	Dr. Saritha Hegde	Chief Technical Officer (Home Science)
48.	Mr. R. Sanalkumar	Chief Technical Officer (up to 01.11.2019)
49.	Dr. Neelofar Illias Kutty	Assistant Chief Technical Officer (Programme Assistant) (Home Science)
50.	Mrs. Jayasree M. P.	Senior Technical Officer (Agrl. Extn.)
51.	Mr. K. Manikandan	Senior Technical Officer (Programme Assistant) (Agronomy)
52.	Mr. Lagesh K.P.	Technical Trainee (Vehicle) w. e. f. 26.04.2019
	Regional Station, Kayamkulam	
53.	Dr. C. Keshavan Nampoothiri	Asst. Chief Technical Officer (Statistics)
54.	Mr. S. Thajuddin	Asst. Chief Technical Officer (Library)
55.	Dr. M. Shanavas	Asst. Chief Technical Officer
56.	Dr. G. Rajeev	Asst. Chief Technical Officer
57.	Mr. Jacob Kurian	Asst. Chief Technical Officer
58.	Dr. C.G. Narayanan Namboothiri	Asst. Chief Technical Officer
59.	Mr. K.K. Sudhanandan	Senior Technical Officer
60.	Mr. K. Rajendran	Technical Officer
61.	Mr. B. Anilkumar	Technical Officer
62.	Mr. K.P. Udayabhanu	Technical Officer
63.	Mr. Sunny Thomas	Technical Officer
64.	Mr. P.K. Sunil Kumar	Senior Technical Assistant
65.	Mr. Jinu Sivadasan	Senior Technical Assistant
66.	Mr. V.P. Joy	Technical Assistant
67.	Mrs. Asha K. Chandran	Technical Assistant (Field/Farm)
	KVK, Alappuzha	
68.	Mr. M.S. Rajeev	Assistant Chief Technical Officer (Agronomy)
69.	Mrs. Jissy George	Assistant Chief Technical Officer (Home Science)
70.	Dr. T. Sivakumar	Assistant Chief Technical Officer (Agricultural Entomology)
71.	Mrs. Lekha G.	Assistant Chief Technical Officer (Plant Pathology)
72.	Dr. S. Ravi	Assistant Chief Technical Officer (Animal Husbandry)
73.	Mr. Sajnanath K.	Assistant Chief
74.	Mr. Ansary K.M.	Technical Officer (Computer)
75.	Mrs. Bijila P.V.	Technical Officer (Horticulture)
76.	Mr. Dayanandan Unnithan	Senior Technical Assistant (Vehicle)
77.	Mr. Sajin B.J.	Technical Trainee (Vehicle)
	Regional Station, Vittal	
78.	Dr. H. Moosa	Chief Technical Officer
79.	Mrs. Meenakshi Patil	Senior Technical Officer (Library)
80.	Mr. C. Purandhara	Technical Officer
81.	Mr. Adolphus Francis Mascarenhas	Technical Officer
82.	Mr. Abdul Aziz	Technical Officer
83.	Mr. Y. Sreenivasa Bhat	Senior Technical Assistant
84.	Mr. B. Ananda Gowda	Senior Technical Assistant

Sl. No.	Name	Designation
85.	Mr. V. Chandrasekhara Shetty	Senior Technical Assistant (Vehicle)
86.	Shri. Prakash Burman	Senior Technican
87.	Mr. Tharanath Naik B.	Technical Assistant (Vehicle)
88.	Mr. Santhosh Kumar P.	Senior Technical Assistant (Farm Assistant)
89.	Mr. Bisun Bhaskar	Technical Assistant (Laboratory)
90.	Mr. Nirmal Kumar B.J.	Technical Assistant (Field/Farm)
91.	Mr. Vineet V.S.	Technical Trainee (Field/Farm)
	Research Centre, Kidu	
92.	Mr. Chandra Nairy	Technical Officer
93.	Mr. M. Manamohan	Technical Officer (Mech.-cum-Pump Operator)
94.	Mr. A.S. Gopalakrishna	Technical Officer (Farm)
95.	Mr. M. Narayana Naika	Technical Officer
96.	Mr. Kamal Kumar	Technical Assistant (Field/Farm)
97.	Mr. Anoop Kumar P. P.	Technical Assistant (Field/Farm)
	Research Centre, Mohitnagar	
98.	Mr. Saran Kumar Rizal	Chief Technical Officer (Farm Superintendent)
99.	Mr. Avrajyothi Ghosh	Asst. Chief Technical Officer
100.	Mr. Jagadish Royburman	Senior Technical Assistant (up to 31.12.2019)
101.	Mr. Pratap Kumar Sarkar	Senior Technical Assistant
102.	Mr. Jagadish Roy	Senior Technical Assistant (Vehicle)
	Research Centre, Kahikuchi	
103.	Mr. Bikash Chowdhury	Chief Technical Officer
104.	Mr. Gopinath Malakar	Senior Technical Assistant (Vehicle)
	Administrative Staff	
	Kasaragod	
1.	Mr. Hareesh Nair	Chief Administrative Officer
2.	Mr. Ram Avtar Parashar	Senior Finance & Accounts Officer
3.	Mr. T.E. Janardhanan	Administrative Officer
4.	Mr. K.R. Nithianandan	Assistant Administrative Officer
5.	Mr. Pradeep Kumar Vasu	Assistant Administrative Officer
6.	Mrs. M. Reetha	Assistant Administrative Officer
7.	Mr. Neil Vincer	Assistant Administrative Officer
8.	Mr. T.N. Vidhyadharan	Assistant
9.	Mrs. K.S. Vishalakshi	Assistant
10.	Mr. P.M. Thomas	Assistant
11.	Ms. K.T.K. Sheenakumari	Assistant
12.	Mr. P. Narayana Naik	Assistant
13.	Mrs. Rupa Manikandan	Assistant
14.	Mrs. K. Preethi	UDC
15.	Mr. Paulson Sam George	UDC
16.	Mr. T.K. Gangadharan	UDC
17.	Mrs. Remya T.R.	UDC (on deputation to ICAR-CMFRI, Kochi)
18.	Mr. Aswin Reghunath	UDC
19.	Mr. N. Udayakumar	UDC
20.	Mrs. Jayashree K.	UDC

Sl. No.	Name	Designation
21.	Mr. P.K. Pramodkumar	LDC
22.	Mr. Jayarajan V.	LDC
23.	Mr. Dinesh	LDC
24.	Mr. Ratan Singh	LDC
25.	Mr. Sathya Bratha Moharana	LDC
26.	Mrs. K. Narayani	Private Secretary
27.	Mrs. Girija Chandran	Private Secretary
28.	Mrs. Sulochana Nair	Private Secretary
29.	Mr. K. Kunhiraman Nair	Private Secretary
30.	Mrs. Arathi A.R.	Stenographer Gr.III
	KVK, Kasaragod	
31.	Mr. Anurag Meena	Stenographer Grade-III (up to 10.02.2020)
	Kayamkulam	
32.	Mr. Baburaj S.B.	AFAO (up to 14.08.2019)
33.	Mr. Bhageerath K.G.	Assistant Administrative Officer
34.	Mr. K. Haridas	Assistant
35.	Mr. K. Venugopal	Assistant
36.	Mrs. K. Sreelatha	Assistant
37.	Mrs. V. Madhavikutty	Assistant
38.	Mr. C. Ramesh Babu	Personal Assistant
39.	Mrs. Prasanna Sarngan	Personal Assistant
40.	Mr. Arun N.K. Raj	LDC
41.	Mr. K.N. Sajeev	LDC (w.e.f. 20.09.2019)
	KVK, Alappuzha	
42.	Mrs. Rejitha K.R.	Stenographer Gr.III
	Vittal	
43.	Mr. P. Krishna Naik	AAO
44.	Mr. Sasi K.K.	AFAO
45.	Mrs. A.J. Mary	UDC
46.	Mr. T.J. Saji	UDC
47.	Mr. Mohammed Haneefa P.K.	UDC
48.	Mr. Fawaz C.M.O.	LDC (w.e.f. 13.02.2019)
49.	Mr. Vivek Singh	Stenographer Gr.III
	Kidu	
50.	Mr. M. Ravindran	AAO
51.	Mr. Lakshmi Narayana	LDC
	Mohitnagar	
52.	Mr. Subash Paul	Assistant
	Kahikuchi	
53.	Mr. Deepak Meena	LDC
54.	Mr. Umesh Kumar	LDC

Skilled Support Staff	
Kasaragod	
Sl. No.	**Name**
1.	Mr. M. Shankara
2.	Mr. P. Narayanan Nair (up to 30.06.2019)
3.	Mr. K. Baby
4.	Mr. A. Mohana
5.	Mr. K. Keshava
6.	Mr. K. Sukumaran
7.	Mr. K.V. Krishnan
8.	Mr. P.A. Chaniya Naik
9.	Mr. P. Kumaran
10.	Mr. V.S. Pakeeran
11.	Mrs. V. Thambai
12.	Mrs. G. Kamala
13.	Mr. K.G. Sureshbabu
14.	Mr. T.J. Ninan
15.	Mrs. Chithralekha K.
16.	Mr. B. Chandrahasa
17.	Mr. V.T. Rameshan
18.	Mr. K. Krishnankunhi
19.	Mrs. K. Shobhana
20.	Mr. M. Krishnan
21.	Mrs. V.A. Leela
22.	Mrs. U. Sarojini
23.	Mr. V. Krishnankutty
24.	Mr. P.P. Prabhakaran
25.	Mr. B. Ramachandran
26.	Mr. B. Sanjeeva Patali
27.	Mrs. N.V. Sasikala
28.	Mr. Lakshmana Naik
29.	Mrs. Lalitha Bai
30.	Mr. M. Velayudhan
31.	Mr. N. Bhaskaran
32.	Mr. B. Sundara
33.	Mr. K. Suresan
34.	Mr. A. Madhu
35.	Mr. K. A. Madhavan
36.	Mr. Aneesh E.M.
37.	Mrs. Vanamalini
38.	Mr. N. B. Mahesan
39.	Mr. Sarath Kumar
40.	Mr. Ashok Kumar R.
41.	Mr. Praveen Raj P. R.
Canteen	
42.	Mr. B. Balakrishnan (up to 30.04.2019)
43.	Mr. Jayaprakash. K.
Kayamkulam	
44.	Mr. M.E. Sivan
45.	Mr. K.B. Thankachan
46.	Mr. R. Ravindran
47.	Mr. K. Soman
48.	Mr. K. Omanakuttan
49.	Mr. K.C. Damodaran
50.	Mr. V.T. Unnikrishnan
51.	Mr. T.K. Mani
52.	Mr. K. Ravi
53.	Mr. K.K. Sreedharan
54.	Mr. C. Sukumaran
55.	Mr. K.V. Vijayan
56.	Mrs. K. Valsala
57.	Mr. C. Sundaran
58.	Mr. K.P. Ibrahim
59.	Mrs. N. Suma
60.	Mr. A.T. Harikuttan
61.	Mrs. K Saseendra
62.	Mr. C.R. Babu
63.	Mr. Ajith Mattappadan
64.	Mr. R. Rajesh
65.	Mrs. L. Leena
66.	Mr. Ancil Pereira
67.	Mr. S. Rajesh
68.	Mr. N. Reghu
Canteen	
69.	Mr. Justin Jayaraj Das (up to 30.05.2019)
Vittal	
70.	Mr. Harischandra
71.	Mr. Chandu Naika
72.	Mr. Sudhakara
73.	Mr. A. Gopala
74.	Mr. D. Isbu
75.	Mr. B. Dharmapala
76.	Mr. K. Vinod
77.	Mr. Ibrahim
78.	Mr. B. Choma
79.	Mr. Mohana
80.	Mr. Somappa K.
81.	Mr. M. Ananda
82.	Mr. K. Monappa Gowda (up to 30.06.2019)
Canteen	
83.	Mr. A. Shivarama Poojary (up to 30.06.2019)
Kidu	
84.	Mr. Balappa Gowda (up to 30.11.2019)
85.	Mr. S. Venkataramana (up to 31.07.2019)
86.	Mr. S. Chennappa
87.	Mrs. N. Bhavani
88.	Mrs. Susheela S.
89.	Mrs. Lolakshi
90.	Mr. S. Janardhana
91.	Mr. Dasappa Gowda,
92.	Mrs. T. Susheela
93.	Mr. Padmayya Gowda
94.	Mrs. B. Bhavani
95.	Mrs. S. Rukmini
96.	Mr. S. Bhojappa
97.	Mr. S. Narayana (up to 31.08.2019)
98.	Mrs. Komalangi
99.	Mr. V. Chennappa
100.	Mr. V. Jathappa Gowda
101.	Mr. S. Sheenappa Gowda
102.	Mr. S. Neelappa
103.	Mr. S. Regappa
104.	Mrs. S. Chandravathi
105.	Mr. M. Durgesha
106.	Mrs. Meenakshi K. (w.e.f. 04.06.2018)
Mohitangar	
107.	Mr. Sailen Seal
108.	Mr. Krishna Kumar Mandal
109.	Mr. Nripendra Chandra Roy
110.	Mr. Kartick Chandra Biswas
111.	Mr. Sushanta Burman
112.	Mr. Mahadev Misra
Kahikuchi	
113.	Mr. Sathish Baishya
114.	Mr. Pankaj Das

XX. Distinguished Visitors

Dignitory Name and designation	Place and date	Purpose of visit
Mrs. V. Usha Rani IAS, Chairperson, Coconut Development Board, Kochi	ICAR-CPCRI, Kasaragod 15th April, 2019	Refresher training programmeon 'Hybridization Technique in Coconut'
Dr. Adeela Abdulla, IAS District Collector, Alappuzha Dr. K. G. Padmakumar, Special Officer and Director, International Research and Training Centre for Below Sea Level Farming, Kuttanad	ICAR-CPCRI, Regional Station, Kayamkulam 22nd-23rd August, 2019	Workshop and National Seminar on 'Climate, flood and folklore'
Dr. W. S. Dhillon, Assistant Director General (HS II), ICAR, New Delhi	ICAR-CPCRI, Kasaragod 21st September, 2019	The Institute Management Committee (IMC) meeting
Mr. Sumit Kumar I.R.S., Commissioner of Customs – Preventive, Kochi Mr. K.M. Harilal I.T.S., Joint Director General of Foreign Trade, Kochi Mr. P.V. Narayanan, Superintendent of Customs (CGST) Mr. Madhusoodana Bhat I.R.S., Asst. Commissioner of Customs, Kannur International Airport & Mr. Vijaykumar M., Retd. Asst. Commissioner Customs & Central Excise	ICAR-CPCRI, Kasaragod 30th September, 2019	Export Trade Facilitation Measures
Shri. Nalin Kumar Kateel, Hon'ble Member of Parliament, Dakshina Kannada Shri Angara S, MLA, Sullia	ICAR-CPCRI Research Centre, Kidu 12th -13th October 2019	Krishi Mela and Horti Fair
Smt. G. Jayalakshmi, IAS, Chairperson, CDB	ICAR-KVK Alappuzha 27th December, 2019.	Visited the KVK, Alappuzha and demonstration units

XXI. Mera Gaon - Mera Gaurav

During the year, ICAR-CPCRI, Kasaragod and its regional stations and research centres have implemented the MGMG initiative in collaboration with various stakeholders *viz.,* Department of Agriculture, KVKs, LSG Institutions, input dealers, progressive farmers, SHGs, etc. A total of 68 villages were covered by 17 teams comprising a total of 63 scientists. Interventions such as 141 visits to villages covering 1,262 farmers, 29 interface programmes benefitting 1,223 farmers, 108 technology demonstrations covering 798 farmers, 35 training programmes involving 1,002 farmers and 28 extension publications distributed to 2388 farmers were taken up under MGMG initiative.

Seednut sowing for community coconut nursery at Chunakkara, Kerala

XXII. Swachh Bharat Mission

Various programmes were organized at the Headquarters and other offices (including KVKs) of ICAR-CPCRI as part of Swachh Bharat Mission. One of the regular activities of the Mission is cleaning of office premises by all staff on every Friday. Swachhta Pakhwada was observed during 16-31 December 2019 with the focal theme 'Plastic Se Raksha – Swachhata Hi Suraksha'. As part of it, various activities such as taking pledge, conducting awareness programmes, cleaning drive, display of technologies on utilization of organic wastes/generation of wealth from waste etc. were conducted. All the staff members actively participated in these programmes.

As part of Swachh Bharat Abhiyan, ICAR-CPCRI, Regional Station Kayamkulam organized a one day Seminar for school students on the theme 'Save Nature through Cleanliness and Scientific Waste Management' to observe 'World Nature Conservation Day - 2019' on 27th July, 2019.

Dr. Anitha Karun, Director (Actg.) and staff carrying out Swacch Bharat activities by the side of NH-66 near the campus

Staff of ICAR-CPCRI, Regional Station, Kayamkulam at Government High School, Krishnapuram, Kerala conducting Swacch Bharat Mobile Campaign

XXIII. Women's Welfare Committee Activities

Dr. Anitha Karun, Director (Actg.) interacting with women enterprenuers trained under KVK Kasaragod during exhibition of their value added products

XXIV. Major Events and Other Information

World Environment Day

KVK in collaboration with Social Forestry Division of Kasaragod celebrated the World Environment Day at Kolavayal and Karicheri villages. The programmes were inaugurated by Dr Anitha Karun, Director, ICAR CPCRI, Kasaragod and Dr. Ravi Bhat, Head, Crop Production Division, ICAR CPCRI, Kasaragod respectively. During the programmes 2000 saplings of various fruit and shade trees were distributed to 250 farmers.

World Environment Day was celebrated ICAR-CPCRI

Dr. Anitha Karun, Acting Director inaugurating World Environment Day by planting a seedling at Kolavayal, Kasaragod

with a seminar on 'Organic connection with coconut fostering ecological sustainability and air purification" on 14thJune, 2019 at Regional Station, Kayamkulam, supported by KSCSTE, Thiruvananthapuram. About 80 students from ten colleges participated in the programme. Dr. V. Krishnakumar, Acting Head inaugurated the seminar in which Dr. R.C Pandalai, Former Head, KFRI, Peechi was the Chief Guest. Shri. G.S. Hareesh Nair, CAO distributed tree saplings to the student participants.

International Yoga Day

International Day of Yoga was celebrated at ICAR-CPCRI, Kasaragod on21st June 2019. On the occasion, Dr. Pramod Tadapatri, Physics lecturer, PU College,Alike and Shri.Shameer, Ayurveda and Spa

Inauguration of World Environment Day at ICAR-CPCRI, RS, Kayamkulam

Trainer at Hybusak University, Armenia have demonstrated yoga. Yoga Day was also celebrated at ICAR-CPCRI, RS, Vittal, Regional Station, Kayamkulam, ICAR-CPCRI, Research Centre, Mohitnagar and ICAR-CPCRI, RC, Kahikuchi

ICAR-Foundation day celebration

A one-day thematic seminar entitled 'Converging Technologies for Inclusive Coconut Farming' was conducted on 16th July, 2019 aimed at technology dissemination for holistic farming. Around 100 farmers from *Mera Gaon-Mera Gaurav* (MGMG) villages of Bharanikavau, Chettikulangara, Kandaloor and Oachira participated in the programme.

Independence Day

The Institute has celebrated 73rd Independence Day of our nation. Dr. Anitha Karun, Acting Director hoisted the National Flag and delivered Independence Day address at Kasaragod on 15th August, 2019. Independence Day was also celebrated in the Regional Stations at Kayamkulam, Vittal and Research Centres at Kahikuchi, Kidu and Mohitnagar.

Sadhbhavana Diwas

Sadhbhavana Diwas was celebrated on 20th August, 2019 in memory of our late Prime Minister Rajiv Gandhi and all staff members pledged both in Hindi and English to practice unity and harmony in work place and in the country.

Library Holdings 2019

Station	Journals	Books	Back volumes	Other Publications
Kasaragod	24	7322	13364	7780
Kayamkulam	1	3570	6259	3971
Vittal	3	5299	5801	3031
Mohitnagar	2	533	-	11
Kahikuchi	2	134	-	-

XXV. Budget and Expenditure 2019-20

The Budget and Expenditure for the period 1 April 2019 to 31 March 2020

(Figures in Rupees Lakhs)

Budget Head	Plan Budget	Expenditure
Revenue		
Estt. Charges	3134.22	3065.33
OTA	0	0
Pension	3199.58	3199.33
TA	51.13	52.61
Research & Operational expenses	340.21	343.42
Works: Repair & Maintenance		
Office Buildings	101.50	101.50
Residential Buildings	20.88	20.69
Minor Works	29.25	29.25
Other Administrative Charges	515.61	515.50
Total	**667.24**	**666.94**
Miscellaneous Expenses (including HRD)	20.42	20.32
Tribal Sub Plan - General	12.75	9.12
Scheduled Cast/ Scheduled Tribe-General	40.00	19.52
Total	**73.17**	**48.96**
Total	**7465.55**	**7376.59**
Capital		
Equipments	5.60	2.41
Information Technology	2.25	0.48
Library	3.00	2.95
Furniture & Fixtures	0.85	0.33
Livestock	0.30	0.00
Works	30.00	0.00
Minor Work	8.23	0.00
Tribal Sub Plan - Capital (20.00)	10.00	2.20
NEH (30.00	10.00	0.00
Total	**70.23**	**8.37**
TOTAL	**7535.78**	**7384.96**
Other Projects		

	Opening Balance	Receipts	Expenditure	Refund
Other Plan Schemes	14.43	641.91	609.80	7.38
Deposit Schemes (Externally funded)	528.82	322.59	367.65	22.16
KVK, Kasaragod	14.45	129.27	121.38	0.00
KVK, Alappuzha	-	227.60	209.75	0.00

Revenue receipts

Head	Target	Achievement
Income from sales/ services (Shedule-8)	439.50	215.79
Fee/Subscription (Shedule-10)		7.82
Income from Royalty, Publication etc. (Shedule-12)		0.05
Other Income (Shedule-14)		235.85
STD Interest		25.36
Recoveries on Loans & Advances		9.58
TOTAL		**494.45**

XXVI. Weather Data 2019

ICAR-CPCRI, Kasaragod

Month	Temp. (°C)		RH %		Wind velocity (km/h)	Sunshine (h)	Evaporation (mm)	Rainfall (mm)	No. of Rainy days
	Max	Min	FN	AN					
April 2019	34.1	23.2	63	59	2.6	7.8	4.9	16.6	2
May 2019	33.9	24.3	64	63	2.2	8.1	4.8	48.0	4
June 2019	31.8	22.7	69	71	3.4	4.2	3.4	520.0	18
July 2019	29.0	22.5	81	80	3.4	1.9	2.3	1252.2	28
Aug. 2019	29.0	23.4	88	85	3.1	1.8	2.2	1157.7	28
Sept. 2019	30.2	23.5	82	78	2.2	4.4	2.9	475.2	20
Oct. 2019	31.1	23.1	77	75	2.4	5.2	3.2	567.6	17
Nov. 2019	32.6	23.1	73	68	2.0	8.3	3.2	61.6	3
Dec. 2019	33.2	21.8	73	60	1.8	6.9	3.4	66.8	3

ICAR-CPCRI, Regional Station, Kayamkulam

Month	Temp. (°C)		RH %		Wind velocity (km/h)	Sunshine (h)	Evaporation (mm)	Rainfall (mm)	No. of Rainy days
	Max	Min	FN	AN					
April 2019	34.1	24.4	92	64	2.2	8.7	4.3	70.3	6
May 2019	33.6	25.2	93	65	2.1	8.5	4.4	67.8	2
June 2019	31.7	24.7	94	77	2.0	3.9	3..9	349.5	17
July 2019	30.8	24.4	94	75	1.8	5.2	3.5	311.8	14
Aug. 2019	29.8	23.7	95	78	1.7	3.2	3.3	720.9	22
Sept. 2019	31.3	24.4	94	75	1.8	5.4	3.4	324.6	19
Oct. 2019	31.1	23.6	95	75	1.5	5.7	3.5	383.7	18
Nov. 2019	33.0	24.0	95	67	1.3	8.0	3.8	159.8	10
Dec. 2019	32.9	22.6	94	64	1.1	7.5	3.8	82.6	4

ICAR-CPCRI, Regional Station, Vittal

Month	Temp. (°C)		RH %		Wind velocity (km/h)	Sunshine (h)	Evaporation (mm)	Rainfall (mm)	No. of Rainy days
	Max	Min	FN	AN					
April 2019	36.2	23.7	90.2	51.5	3.4	7.0	5.1	32.8	3
May 2019	35.5	24.7	89.5	54.0	3.8	6.4	4.9	37.2	3
June 2019	31.9	23.8	94.7	75.1	3.0	3.5	2.8	446.3	19
July 2019	29.1	23.1	96.8	84.2	2.9	1.9	2.0	1104.5	28
Aug. 2019	28.9	23.1	98.3	87.7	3.2	1.8	1.9	1290.8	29
Sept. 2019	30.1	23.6	96.7	80.6	2.5	3.5	2.3	652.9	20
Oct. 2019	31.9	23.4	94.7	75.6	2.3	4.9	3.1	467.2	14
Nov. 2019	34.1	22.9	93.0	58.9	2.1	7.4	3.2	103.2	2
Dec. 2019	33.6	22.1	91.6	54.3	2.1	6.4	2.9	14.2	2

ICAR-CPCRI, Research Centre, Kidu

Month	Temp (°C)		RH%		Evaporation (mm)	Sunshine (h)	Rainfall (mm)	No. of Rainy day
	Max	Min	FN	AN				
April 2019	37.3	24.2	92	48	6.4	8.2	120.2	8
May2019	43.3	25.4	93	51	5.4	7.1	36.8	5
June 2019	33.6	24.1	94	74	5	3.2	360.8	22
July 2019	30.0	26.3	95	87	2.8	0.6	846.8	29
Aug. 2019	29.3	22.8	97	93	2.4	1.0	1643.5	30
Sept. 2019	30.4	23.1	97	79	3.2	2.3	902.2	28
Oct. 2019	32.1	22.3	95	75	2.8	4.7	589.1	30
Nov. 2019	34.4	21.5	92	55	3.6	8.4	114.4	5
Dec. 2019	34.0	20.7	86	49	3.4	7.2	0	5

XXVII. राजभाषा कार्यान्वयन

राजभाषा विभाग, गृह मंत्रालय के वार्षिक कार्यक्रम के अनुसार निदेशक महोदय की अध्यक्षता में गठित राजभाषा कार्यान्वयन समिति की प्रत्येक तिमाही की बैठक नियमित रूप से आयोजित की जा रही है। अधीनस्थ प्रादेशिक केन्द्रों / अनुसंधान केन्द्रों को समय-समय पर राजभाषा कार्यान्वयन समिति की बैठकों के आयोजन एवं राजभाषा कार्यान्वयन कार्य की ओर दिशा निर्देश दिया जाता है। और अधीनस्थ केंद्रों से प्राप्त राजभाषा कार्यान्वयन की प्रगति रिपोर्ट और बैठकों के कार्यवृत्तों की समीक्षा की जाती है। तदनुसार निदेशक महोदय के अनुमोदन के साथ आवश्यक मार्ग निर्देश दिया जाता है।

बैठक में राजभाषा अधिनियम 1963 धारा 3(3) के अनुपालन की अनिवार्यता पर बल देकर मुख्यालय तथा अधीनस्थ स्टेशनों/केंद्रों की ओर से जारी किए जा रहे संविदा एवं निविदा प्रपत्रों, नोट एवं परिपत्रों/कार्यालय आदेशों को द्विभाषीकरण कर राजभाषा अधिनियम और नियमों का अनुपालन शत प्रतिशत सुनिश्चित किया जाता है।

संस्थान की ओर से आयोजित समारोह / बैठकों के बेनर, प्रदर्शनी बोर्ड एवं संगोष्ठी का निमंत्रण पत्र समय-समय पर द्विभाषा में तैयार कर राजभाषा नियम 1976 नियम 11 और नियम 5 का अनुपालन सौ प्रतिशत सुनिश्चित किया जाता है और क्षेत्रीय केन्द्रों / अनुसंधान केन्द्रों को इसके अनुपालन पर सख्त आदेश दिया जाता है और आवश्यक सामग्रियों की तैयारी की मदद दी जाती है।

आज का शब्द प्रदर्शनी

प्रतिदिन एक नया हिंदी शब्द और उसका अंग्रेज़ी रूपांतरण के साथ साथ आज का विचार और आज का प्रश्न की प्रदर्शनी रंगीन और आकर्षक बनाकर हिंदी भाषा के प्रति रूचि बढ़ाया जाता है।

हिंदी चेतना मास समारोह

राजभाषा के प्रति जागरूकता पैदा कराने हेतु हिंदी चेतना मास समारोह का आयोजन मुख्यालय के अतिरिक्त अधीनस्थ क्षेत्रीय केंद्रों और अनुसंधान केंद्रों में विभिन्न कार्यक्रमों के साथ मुख्यालय में उद्घाटन समारोह की मुख्य अतिथि डॉ (श्रीमती) सीमा चन्द्रन, सहायक प्रोफसर (हिंदी एवं तुलनात्मक साहित्य), केरल केन्द्रीय विश्वविद्यालय ने 'हिंदी भाषा की व्यावहारिकता' पर प्रेरणादायक भाषण दिया। इस

हिंदी चेतना मास समारोह, कासरगोड़

समारोह की अवधि पर मुख्यालय के अधिकारियों /कर्मचारियों के लिए अनुवाद एवं टिप्पण लेखन प्रतियोगिता, हिंदी टंकण, स्मरण परीक्षा, अन्ताक्षरी प्रतियोगिता, कुशल सहायक कर्मचारियों के लिए प्रत्येक रूप से चित्र पर अधारित लेखन प्रतियोगिता, स्मरण परीक्षा और सुंदर लिखावट प्रतियोगिताएँ आयोजित की गई।

केंद्रीय विद्यालय नं 1 केंरोफअसं, कासरगोड़ और केंद्रीय विद्यालय नं 2 विद्यानगर, कासरगोड़ के छात्रों के लिए सातवीं कक्षा से दसवीं कक्षा के छात्रों के लिए दो समूहों में हिंदी कवितापाठ, आशुभाषण और कविता रचना प्रतियोगिताएँ आयोजित की गई। इस समारोह के मुख्य अतिथि श्री के. हरीष कुमार, मण्डल प्रम्रंधक, युनाइटेड इंडिया इन्शोरेंस कंपनी लिमिटेड, कासरगोड़ के कर कमलों द्वारा प्रतियोगिताओं के विजेताओं को पुरस्कार वितरण किया गया और छात्रों को पुरस्कार के अतिरक्ति प्रमाण पत्र भी प्रदान किया गया। सरकारी काम काज में हिंदी का अधिकाधिक प्रयोग करने वाले 9 कर्मचारियों को निदेशक महोदया ने प्रोत्साहन योजना के अधीन नकद पुरस्कार प्रदान किया।

उपलब्धियाँ

- नगर राजभाषा कार्यान्वयन समिति,गुवाहटी की ओर से आयोजित राजभाषा प्रदर्शनी में हिंदी के काम काज में उत्कृष्ट प्रदर्शनी के लिए केंरोफअसं, अनुसंधान केंद्र, काहिकुची को प्रथम पुरस्कार स्वरूप दो हज़ार रुपए एवं प्रमाणपपत्र प्राप्त हुआ।

- केंरोफअसं, अनुसंधान केंद्र, गुवाहटी, काहिकुची में आयोजित हिंदी सप्ताह गतिविधियों / प्रतियोगिताओं के लिए भारत सरकार, गृह मंत्रालय, राजभाषा विभाग की ओर से प्रम्रधाई तथा सराहना पत्र प्राप्त किया गया।

हिंदी प्रबोध प्रवीण, प्राज्ञ एवं हिंदी टंकण प्रशिक्षण

केंद्रीय हिंदी प्रशिक्षण संस्थान, पत्राचार पाठ्यक्रम द्वारा प्रायोजित प्रबोध, प्रवीण एवं प्राज्ञ प्रशिक्षण के लिए इस संस्थान से हिंदी का कार्यसाधक ज्ञान न रखनेवाले 3 अधिकारियों को प्रबोध और 2 अधिकारियों को प्रवीण के लिए नामित किया गया है।

हिंदी टंकण प्रशिक्षण के लिए इस संस्थान से 1 अवर श्रेणी लिपिक को और 1 आशुलिपिक को भी नामित किया गया।

हिंदी कार्यशाला

सरकारी काम काज में हिंदी का प्रयोग बढ़ाने एवं हिंदी कार्य का उपयोगी ज्ञान प्राप्त कराने हेतु इस संस्थान में श्रीमती मिनी अगस्टिन, वरिष्ठ प्रबंधक (राजभाषा), कैनरा बैंक, क्षेत्रीय कार्यालय, कोट्टयम के मार्गदर्शन में अभिमुख कार्यक्रम के रुप में संयुक्त हिंदी कार्यशाला आयोजित की गई जिसमें नराकास, कासरगोड़ के सदस्य कार्यालयों के अधिकारीगण एवं केंरोफअसं के वरिष्ठ अधिकारियों ने भाग लिया। प्रत्येक तिमाही की अवधि में प्रशासनिक कर्मचारियों के लिए हिंदी टिप्पण लेखन /पत्राचार/यूनिकोड के उपयोग पर कार्यशाला के रूप में डेस्क टू डेस्क कार्यक्रम आयोजित कर मार्गदर्शन दिया जाता है।

भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा राजभाषा कार्यान्वयन कार्य का निरीक्षण

श्री मुरारी लाल गुप्ता, उप निदेशक (राजभाषा) और श्री मनोजकुमार, सहायक मुख्य तकनीकी अधिकारी, भाकृअनुप, नई दिल्ली द्वारा दिनांक 18.12.2019 को इस संस्थान के राजभाषा कार्यान्वयन का निरीक्षण किया गया।

अधीनस्थ क्षेत्रीय केंद्रों का राजभाषा निरीक्षण एवं मार्गदर्शन

- अधीनस्थ क्षेत्रीय केंद्र, कायम्कुलम का राजभाषा कार्यान्वयन का निरीक्षण दिनांक 24 जुलाई 2019 को इस संस्थान का सहायक मुख्य तकनीकी (राजभाषा) ने किया और दोपहर के सत्र में राजभाषा कार्यान्वयन को कारगर ढंग से लागू करने के लिए स्थापित किए गए जांच बिन्दुओं पर आधारित कक्षा चलायी।

- दिनांक 27.09.2019 क्षेत्रीय केंद्र, विट्टल में यूनिकोड़ की सक्रियता एवं उपयोग सुनिश्चित की गई और पत्राचार प्रतिशत

संयुक्त हिंदी कार्यशाला में श्रीमती मिनी अगस्टिन, वरिष्ठ प्रबंधक (राजभाषा), कैनरा बैंक, क्षेत्रीय कार्यालय कोट्टयम अभिमुख चर्चा करती हुई

प्राढ़ाने हेतु हिंदी पत्रों का टेंप्लेट जैसे नेमी पत्रों का जवाप्र, अग्रेषण पत्र, आवरण पत्र, पावती कंप्यूटर में अपलोड करवाया गया। दोपहर के सत्र में कार्यकारी प्रमुख की अध्यक्षता में केन्द्र की राजभाषा कार्यानव्यन की प्रैक में आवश्यक मार्गनिर्देश दिया गया।

- दिनांक 02.10.2019 अनुसंधान केंद्र, किडु में राजभाषा कार्यान्वयन से संबंधित विभिन्न मुद्दो पर मार्गदर्शन दिया गया और हिंदी दिवस के रूप में केंद्र के अधिकारियों एवं कर्मचारियों के लिए विभिन्न प्रतियोगिताएँ आयोजित की गई। दोपहर के सत्र में मुख्य मार्गदर्शक के रूप में हिंदी समारोह के समापन में पुरस्कार वितरण किया गया।

नगर राजभाषा कार्यान्वयन समिति, कासरगोड़

नराकास, कासरगोड़ के संयोजक रूप में कार्यरत इस संस्थान द्वारा नराकास की तैंतीसवीं अर्धवार्षिक बैठक 21 अगस्त 2019 को डॉ अनिता करुण, कार्यकारी निदेशक, केंरोफअसं, कासरगोड़ की अध्यक्षता में आयोजित की गई। श्रीमती मिनी अगस्टिन, वरिष्ठ प्रप्रंधक (राजभाषा) कैनरा बैंक, क्षेत्रीय कार्यालय, कोट्टयम के मार्गदर्शन में राजभाषा कार्यान्वयन की तिमाही प्रगति रिपोर्ट भरने की विधियों पर अभिमुख चर्चा आयोजित की। श्री के. राजेश, प्रबंधक (राजभाषा) कोर्पोरेशन बैंक, कोची ने राजभाषा कार्यान्वयन की सरल विधियों पर मार्गदर्शन दिया। केरल केंद्रीय विश्वविद्यालय, पेरिया,कासरगोड़ की ओर से दिनांक 11-12 मार्च, 2019 को छात्रों के लिए आयोजित साहित्य के विविध विमर्श राष्ट्रीय संगोष्ठी में छात्रों द्वारा प्रस्तुत उत्तम शोध लेख के लिए नगर राजभाषा कार्यान्वयन समिति, कासरगोड़ की ओर से शील्ड प्रदान किया गया।


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