वार्षिक प्रतिवेदन

2022

ANNUAL REPORT

भाकृअनुप-केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड़

ICAR- Central Plantation Crops Research Institute, Kasaragod

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January, 2023

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ICAR-CPCRI


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CENTRAL PLANTATION CROPS RESEARCH INSTITUTE

प्रस्तावना

भा.कृ.अनु.प.- केंद्रीय रोपण फसल अनुसंधान संस्थान, नारियल, सुपारी, और कोको फसलों में चुनौतियों का मुकाबला करने के लिए प्रौद्योगिकी निर्माण और प्रसार के लिए प्रयास करता है और कमजोरियों को क्रियात्मक तरीके से अवसरों में परिवर्तित करने का प्रयास करता है। नारियल और सुपारी के उत्पादन में भारत का विश्व में प्रथम स्थान है। भारत ने वर्ष 2021-22 में 2.198 मिलियन हेक्टेयर से 20736 मिलियन नारियल और 0.730 मिलियन हेक्टेयर क्षेत्र से 1.208 मिलियन टन सुपारी का उत्पादन किया है। देश में कोको उत्पादकता विश्व औसत से ऊपर है, और यह 97,563 हेक्टेयर क्षेत्र से 27,072 टन सूखे बीजों के उत्पादन के साथ विश्व स्तर पर एक उभरता हुआ प्रतियोगी है। व्यापार के स्तर पर, नारियल क्षेत्र में रूपये 3236.8 करोड़ के निर्यात में प्रभावशाली, जो पिछले वर्ष की तुलना में 40% की वृद्धि हासिल की है। इसके अलावा, 2021-22 में कॉयर क्षेत्र ने 3236 करोड़ रूपये की निर्यात आय प्राप्त की है।

यह वास्तव में एक प्रशंसनीय उपलब्धि है कि संस्थान देश के सभी भा.कृ.अनु.प. संस्थानों के बीच आईसीएआर रैंकिंग में 16वें स्थान पर है। 20 संस्थान परियोजनाएं और 30 बाह्य वित्तपोषित परियोजनाएं चल रही हैं। वर्ष में सबसे उल्लेखनीय अनुसंधान उपलब्धियों में तीन नई किस्मों (नारियलः कल्प वज्र; फॉरेस्टरो कोको I-14; और ट्रिनिटारियो कोको संकर I-14XI-56) के विमोचन के लिए सिफारिश/पहचान शामिल हैं; नारियल के तहत दालचीनी और गेंदा फूल के अंतर-फसल खेती पद्धतियां; सुपारी के पत्ते के आवरण का उपयोग करके ट्राइकोडर्मा हर्जियानम (CPTD28) का बड़े पैमाने पर उत्पादन; और विद्युत चालित निविदा नारियल पंचिंग मशीन का विकास, जो महत्वपूर्ण उपलब्धियाँ है।

हमने 2022 में कई महत्वपूर्ण कार्यक्रम आयोजित किए थे, जिनमें रूरल इंडिया बिजनेस कॉन्क्लेव 2.0 भी शामिल है (9-13 जून 2022) और रूरल इनोवेटर्स मीट (25-27 नवंबर 2022)। भा.कृ.अनु.प.- के.रो.फ.अ.सं. क्षेत्रीय स्टेशन, कायंकुलम के प्लेटिनम जयंती समारोह और भा.कृ.अनु.प.- के.रो.फ.अ.सं. अनुसंधान केंद्र, किडू के स्वर्ण जयंती समारोह के संबंध में विभिन्न कार्यक्रमों के अलावा, एक मेगा किसान मेला और एग्री एक्सपो (19-23 नवंबर 2022) भी आयोजित किया गया था।

एससीएसपी, एसटीसी और एनईएच जैसे विशेष कार्यक्रमों के तहत देश के विभिन्न हिस्सों में आउटरीच कार्यक्रम आयोजित किए गए। राजस्व सृजन के लिए 15 प्रौद्योगिकियों पर कुल 35 समझौता ज्ञापनों पर हस्ताक्षर किए गए और राजस्व में 5.75 लाख प्राप्त हुआ। इस वर्ष 11 बाह्य वित्तपोषित परियोजनाओं को भी मंजूरी मिली, जिनके लिए 3.15

करोड़ रुपये की राशि आबंटित की गयी है। इसके अलावा 2022 में, संस्थान ने देशीय सुपारी किसानों की सुरक्षा के इरादे से 351 रुपये प्रति किलोग्राम के न्यूनतम आयात मूल्य (एमआईपी) के निर्धारण में महत्वपूर्ण भूमिका निभाई है । यह उल्लेखनीय है कि संस्थान वर्ष 2022 में 4.99 करोड़ रुपये का कुल राजस्व अर्जित कर सका है। ।

संस्थान में डॉ. ए.के. सिंह, उप महानिदेशक (बागवानी विज्ञान), डॉ. ए.के. मल्होत्रा (परियोजना निदेशक, डीकेएमए) सहित कई राष्ट्रीय और अंतर्राष्ट्रीय गणमान्य लोगों ने दौरा किया, और कोजेंट के अंतर्राष्ट्रीय विशेषज्ञ (आईसीसी- कोजेंट कोकोनट टिश्यू कल्चर के संबंध में) ।

प्रोत्साहन और सहायता प्रदान करने के लिए हम भा.कृ.अनु.प. मुख्यालय के बहुत आभारी हैं। डॉ. हिमांशु पाठक, महानिदेशक, हमेशा से धैर्य के स्तंभ रहे हैं। इसके अतिरिक्त, हम पूर्व महानिदेशक डॉ. त्रिलोचन महापात्र द्वारा प्रदान किए गए प्रोत्साहन की सराहना करते हैं। डॉ. ए.के. सिंह, उप महानिदेशक, बागवानी विज्ञान; डॉ. वी.बी. पटेल, सहायक महानिदेशक (फल और बागान फसलें); डॉ. बी.के. पांडे, पूर्व सहायक महानिदेशक (एचएस-II), डॉ. विक्रमादित्य पांडे, प्रधान वैज्ञानिक (एचएस); और डॉ. मनीष दास, प्रधान वैज्ञानिक (एचएस), हमारे लिए संपर्क के बिंदु थे, जिन्हें हम विभिन्न गतिविधियों के लिए और इस रिपोर्ट के तहत प्राप्त हुई उपलब्धियों के सफलता के कारण होने के लिए धन्यवाद देना चाहते हैं।

इस वार्षिक रिपोर्ट को तैयार करने में संपादकीय बोर्ड के प्रयासों की सराहना की जाती है।

स्थानः कुडलू
दिनांकः 31.01.2023

के बी हेब्बार

निदेशक

PREFACE

The ICAR-Central Plantation Crops Research Institute strives for technology generation and dissemination to address the challenges in the coconut, arecanut, and cocoa sectors and convert the weaknesses into opportunities in a concerted and synergized fashion. India stands first in the world in the production of coconut and arecanut. India, has produced 20736 million coconuts from 2.198 million ha and 1.208 million tonnes of arecanut from an area of 0.730 million ha,in the year 2021-22. The cocoa productivity in the country is above the world average, and it is an emerging player globally with a production of 27,072 tonnes of dry beans from an area of 97,563 ha. On the trade front, the coconut sector realised impressive growth in exports to the tune of Rs. 3236.8 crore, which is an increase of 40% compared to the previous year. In addition to this, the coir sector fetched export earnings of Rs. 3236 crore in 2021–22.

It is indeed a praiseworthy achievement that the Institute ranked 16th in the ICAR ranking among all the ICAR institutes in the country. There are 20 institute projects and 30 externally funded projects in operation. Most remarkable research achievements in the year include recommendation/identification for the release of three new varieties (coconut: Kalpa Vajra; forastero cocoa I-14; and Trintario cocoa hybrid I-14XI-56); intercropping cultivation practices for cinnamon and marigold under coconut; mass production of *Trichoderma harzianum* (CPTD28) using arecanut leaf sheath; and development of an electrically operated tender coconut punching machine.

We have organised several important events in 2022, including the Rural India Business Conclave 2.0 (9–13 June 2022) and the Rural Innovators Meet (25–27 November 2022). Besides various events in connection with the Platinum Jubilee celebration of ICAR-CPCRI Regional Station, Kayamkulam, and the Golden Jubilee celebration of ICAR-CPCRI Research Centre, Kidu, including a mega Kisan Mela and Agri Expo (19–23 November 2022) and Outreach programmes were conducted in different parts of the country under special programmes like SCSP, STC, and NEH. A total of 35 MoUs were signed on technologies 15 to realise Rs. 5.75 lakh in revenue. The year also marked the sanctioning of 11 externally funded projects with a funding

amount of Rs. 3.15 crore. Also in 2022, ICAR-CPCRI, assumed a key role in the fixation of the minimum import price (MIP) of Rs 351 per kg, arecanut intending to safeguard domestic arecanut farmers. It is noteworthy that the institute could generate a total revenue of Rs. 4.99 crore in the year 2022.

The institute received many national and international visitors, including Dr. A. K. Singh, DDG (Hort. Sci.), Dr. A. K. Malhotra (Project Director, DKMA), and international experts from COGENT (in connection with the ICC-COGENT coconut tissue culture workshop).

We are extremely grateful to the ICAR headquarters for providing us with encouragement and assistance throughout. Dr. Himanshu Pathak, Director General, has always been a pillar of fortitude. Additionally, we appreciate the support provided by the former Director General, Dr. Trilochan Mohapatra. Dr. A.K. Singh, Deputy Director General, Horticulture Sciences; Dr. V.B. Patel, ADG (Fruits & Plantation Crops); Dr. B.K. Pandey, former ADG (H.S.-II), Dr. Vikramaditya Pandey, Principal Scientist (HS); and Dr. Manish Das, Principal Scientist (HS), were the points of contact for us, whom we would also like to thank for the interventions for various activities to materialise and find a place under this report. The editorial board's efforts in preparing this annual report are greatly appreciated.

Place: Kudlu
Date: 31.01.2023

Director

कार्य सारांश

आनुवंशिक संसाधन प्रबंधन और उपयोगीकरण

भा.कृ.अनु.प.- केंद्रीय रोपण फसल अनुसंधान संस्थान में, नारियल (455 नं.), सुपारी (178 नं.) और कोको (530 नं.) का सबसे बड़ा जर्मप्लाज्म संरक्षित किया गया है। इसमें बड़ी बीजों के साथकर्नाटकके पश्चिमी घाट की पहाड़ियों से बालेहोन्नूर और भद्रावती नदी तट के 15 नए कोको संग्रह भी शामिल हैं। जर्मप्लाज्म के प्रक्षेत्र संरक्षण के अलावा, राष्ट्रीय क्रायो जीन बैंक भा.कृ.अनु.प.-एन.बी.पी.जी.आर., नई दिल्ली, के सहयोग से 30 जाइगोटिक भ्रूण, 15 पराग और नारियल के 16 डीएनए सामग्री के रूप में क्रायो-संरक्षण किया गया है।

सीडीबी फार्म, नेरियमंगलम और भा.कृ.अनु.प. - कें.रो.फ.अ.सं., स्थानीय केंद्र, कायमकुलम में प्रदर्शन मूल्यांकन परीक्षणों के आधार पर, उपज में श्रेष्ठता और जड़ (मुर्झा) रोग के प्रति सहनशीलता के आधार पर पहचाने गए डब्ल्यूसीटी इंटर से किस्म को पारित किया गया। उत्पादित संकर को एआईसीआरपी (ताड़) द्वारा ए.जी.एम. के दौरान 'कल्पा वज्र' नाम से विमोचित करने के लिए सिफारिश की गई, जो एक ऊँची किस्म है, और जड़ (मुरझा) रोग प्रचलित क्षेत्र में खेती के लिए उपयुक्त है।

बौने नारियल के पेड़ों के मूल्यांकन परीक्षण के तहत, अंडमा नग्रीन ड्वार्फ और गंगाबोन्डम ग्रीन ड्वार्फ को आशाजनक पाया गया। पुष्पक्रम रस नीरा उपज का मूल्यांकन करने के लिए किए गए अध्ययनों से पता चला है कि लगुना टाल किस्म प्रतिदिन 2.04 लीटर तक उत्पादन करती है, इस के बादकप्पाड़म टाल प्रतिदिन 1.81 लीटर उत्पादन करती है।

एनईएच क्षेत्र से प्राप्त 15 सुपारी किस्मों की गुठलियों में वसा की मात्रा के अनुमान ने परिवर्तन शीलता का संकेत दिया है, जिस से पता चलता है कि सबसे अधिक वसा की मात्रा 34% बोरिहाट के गुठलियों में थी, इसके बाद बदरपुर में 29.5% थी। मोहितनगर में, बौनी संकर मोहितनगर HD में 2.291 किलोग्राम चाली/ ताड़/वर्ष का उत्पादन हुआ, जबकि मूल लाइन मोहितनगर टाल से 4.061 किलोग्राम चाली/ ताड़/वर्ष का उत्पादन प्राप्त हुआ।

कोको में, मलेशियाई फोरास्टेरो, I-14को 2 से 3.5 किलोग्राम सूखी बीन उपज/वृक्ष/वर्ष के साथ एक आशाजनक क्लोन के रूप में पहचाना गया। यह सूखापन, बीमारियों और कीटों के प्रति सहनशील पायी गयी।

केएचआईसी-4 में प्रति वर्ष 1.85 किलोग्राम प्रति पेड़की उच्च सूखे बीज की पैदावार दर्ज की गई, इसके बाद असम के काहिकुची मेंकेएचआईसी-13 में 1.33 किलोग्राम/पेड़/वर्ष दर्जकी गई।

डीयूएस वर्णन प्रयोग के तहत, 6 मीटर 6 मीटर की दूरी वालेनारियल के पेड़ 4 मीटर 4 मीटर के लगाए गए ताड़ों की तुलना में बेहतर उपज दे सकते हैं। 15 किस्मों के साथ सुपारी का डीयूएस वर्णन प्रगति पर है। कोको के डीयूएस दिशानिर्देश पीपीवी एवं एफआरए, नई दिल्ली के माध्यम से प्रकाशित किए गए थे।

इस अवधि के दौरान गुणवत्ता पूर्ण रोपण सामग्री का उत्पादन और वितरण किया गया, जिस में किसानों और विकासात्मक एजेंसियों के लिए 1,56,009 नारियल, 7,85,613 सुपारी और 56,015 कोको शामिल थे।

जैव प्रौद्योगिकी जांच

एडेनिन सल्फेट और पिक्लोरम के साथ पूरक Y3 मीडिया मेंनारियल के प्लूम्यूलर एक्सप्लांट में अनेक अंकुरोंकी शुरुआतदेखी गई।

नारियल और सुपारी में पराग और ज़ाइगोटिक भ्रूण के दीर्घकालिक भंडारण के लिए क्रायो प्रिजर्वेशन प्रोटा`कॉल विकसित किया गया। नारियल और सुपारी में मार्कर सहायता प्राप्त वर्णन और चयन प्रोटोकॉल भी विकसित किया गया। 83,000 एसएनपी का उपयोग करके जीनोम-वाइड एसोसिएशन अध्ययन (जीडब्ल्यूएएस) किया गया। मिक्स्ड लीनियर

मॉडल (एमएलएम) विश्लेषण का उपयोग करके एक जैसे एसएनपी मार्करों की पहचान की गई।

वीसीओ के साथ क्रायो प्रिज़र्व्ड सुपारी पराग के साथ सामान्य नट सेटिंग देखी गई। तरल नाइट्रोजन में भंडारण के 24 घंटे के बाद, पराग का 90% अंकुरण पाया गया।

नारियल कली सड़न रोग ज़नक़, पी. पाल्मिवोरा के मायसेलियल प्रोटिओम डेटा का उपयोग करके, 2467 प्रोटीनसिग्नलिंग प्रक्रिया, जैसे फॉस्फेटिडिल-इनोसिटोल, सीए२अ और एमएपीके, ऑटोफैगी और कोशिकाचक्र की सटीक व्याख्या की सकी।

फ़सल उत्पादन

कासरगोड़ में एक हेक्टेयर नारियल आधारित कृषि प्रणाली मॉडल, जिस में नारियल, नारियल के तने पर काली मिर्च, भूखंडों की सीमा मेंकेला, नारियल के अंतराल में चारा ज्वार (सीओ 31- मल्टी कट चारा ज्वार) शामिल है, डेयरी इकाई, बकरी इकाई और कुक्कुट पालन से 6,01,194/- रुपये का कुल आय मिली। कासरगोड़ में नारियल आधारित उच्च घनत्व बहु प्रजाति फसल प्रणाली, जिस में नारियल, काली मिर्च (नारियल के तने पर चढ़ी), केला की किस्में, बायोमास के पुनर्चक्रण, जैव उर्वरक अनुप्रयोग और हरी खाद के साथ-साथ विभिन्न पोषक तत्व प्रबंधन तरीके के तहत कदली, रोबस्टा (ताड़ों की अंतर पंक्ति स्थान), दालचीनी (ताड़की अंतर पंक्ति स्थान) और जायफल (4 नारियल पेड़ोंके बीच) के परिणामस्वरूप, एचडीएमएससी में नारियल की मोनोक्रॉप की तुलना में 6.3 गुना अधिक कुल आय (रु. 6,17,162/-) प्राप्त हुई।

नए रोपे गए नारियल पारिस्थिति की तंत्र में गेंदा की किस्मों, पूसा बसंती गैं डागेंदा पेरियाकुलम येलो की खेती के परिणामस्वरूप 57.9 क्विंटल/हेक्टेयर और 57.6 क्विंटल/हेक्टेयर की उपज हुई, जिस से वृक्षारोपण के किशोर चरण के दौरान क्रमशः 1.59 लाख और 1.52 लाख रुपये की अतिरिक्त आय, बीसीआर 2.18 और 2.13 के साथ प्राप्त हुई।

नारियल में दालचीनीकी अंतर फसल खेती 0.6 मीटर 1.2 मीटर कीदूरी (प्रतिगड्ढे में 5 पौधे) के साथ रोपण की पंचकोणीय विधिके साथ 631.92 किलोग्राम/हेक्टेयर की काफी अधिक सूखी क्विल उपज दर्ज की गई और प्रणाली का लाभ लागत अनुपात 1.84 था।

फार्म खाद के साथ संयोजन में ह्यूमिक एसिड पोषक तत्वों की उपलब्धता को बढ़ाने, मिट्टी की पोषक तत्वधारण क्षमता में सुधार करने और दोनों घटकों के बीच एक सहक्रियात्मक संबंध देखा गया।

कल्पा पोषक से उपचारित कल्पा संकर, संकर ताड़ के साठ प्रतिशत पौधे रोपण के 26 वें महीने में फूलने लगे। 30 वर्ष पुराने वेस्ट कोस्ट टाल ताड़ में, 250 ग्राम प्रति खुराक दर से 500 ग्राम कल्प वर्धिनी के प्रयोग से प्रति ताड़ 67 फलों की औसत वार्षिक पूर्व उपज बढ़कर 81 फल प्रति ताड़की बढ़ोतरी प्राप्त हो सकी।

राइजोबैक्टीरिया के विशिष्ट पृथक्करण जैसे *बर्कहोल्डरिया* स्पीशीज़। (ARsB7, ARsB9) *एसिनेटोबैक्टर* एसपी। (ARsB4), *बैसिलस* एसपीपी। (ARsB8, RBC18-5), *स्यूडोमोनास* एसपी। (RBC 18-25), हानिकारक नहीं थे और जंगली सुपारी के पौधों में उच्च बायोमास, जड़ की लंबाई, अंकुर की लंबाई और पार्श्व जड़ें दर्ज की गईं।

650 से 3712 पौधे/ हेक्टेयर के बीच रोपण घनत्व के साथ 5 अलग-अलग रिक्तियों के साथ कोको किस्म के नेत्रा सेंचुरा के ग्राफ्ट लगाए गए, जिस के परिणाम स्वरूप सामान्यदूरी (186 किलोग्राम प्रति हेक्टेयर) के तहत लगाए गए ग्राफ्ट की तुलना में निकट से लगाए गए ग्राफ्ट (370 - 809 किलोग्राम प्रति हेक्टेयर) में सूखी बीजों की पैदावार काफी अधिक हुई।

जैविक पोषक तत्व प्रबंधन रीतियों के तहत नारियल की खेती में अन्य रीतियों की तुलना में 174 ग्राम खोपरा भार/फल के साथ 102.4 फल/ताड़/वर्ष की उच्च उपज दर्ज की गई।

विस्तारित गैर-अवक्रमण के साथ बायो डिग्रेडेबल सुपारी पत्ती आधारित नर्सरी कंटेनर का विकास प्रगति में है।

नारियल के पत्तों, को कोके पत्तों, कोको फली काछिलका और सुपारी के छिलके सहित, ताड़ और कोको के संयुक्त बायोमास अवशेषों को वर्मीकम्पोस्ट में बदलने की तकनीक को सीपीसीआरआई केंचुआ, *यूड्रिलस* जातिका उपयोग प्राइड नारियल छिलका बायोचार के साथ करके एक नवीन घट क के रूप में मानकीकृत किया गया है।

कोको फली के छिलका के अपशिष्टों को 38-42% की दर के साथ बायोचार में परिवर्तित करने के लिए आदर्श पाया गया। परिणामी उत्पाद में क्षारीय पीएच लगभग 10 और कुल पोटेशियम 7-10% के बीच था, इसका 60% पानी में

घुलनशील था और 70% विनिमेय पोटेशियमथा। कोको पॉडछिलका बायोचार जैविकखेती में पोटेशियम आवश्यकता की अलभ्यता को कमकरने में मददकर सकता है।

नारियल गिरी प्रसंस्करण उद्योगों में भारी मात्रा में बर्बाद होने वाले परिपक्व नारियल पानी (तरल भ्रूणपोष) कोसिरके, 'नाटा'/बैक्टीरियल सेल्युलोज में बदलने की तकनीक को नारियल के सिर के सेनिकाले गए स्वदेशी बैक्टीरिया का उपयोग कर के मानकीकृत किया गया है।

आरडब्ल्यूडी प्रदेश के लिए मानकसिफारिशों के अनुसार पीजीपीआर उपभेदों और कंसोर्टिया के साथ उर्वरकों और जैविकखाद (लोबियाके साथ हरी पत्तीखाद और बेसिन प्रबंधन सहित) के साथ बायोप्राइमिंग नेजड़ (मुर्झा) रोग अनुक्रमण विधि के अनुसार अंकुरों को 'स्पष्ट रूप से स्वस्थ' रखा।

ताड और कोको में रोगों का समग्र प्रबंधन

सुपारी पत्ती धब्बा रोग के कारण बहु-जीन फाइलोजेनी का उपयोग कर के रूपात्मक और आणविक लक्षण वर्णन पर आधारित कारण की स्थापित की गई और संबंधित रोग ज़नक़ को *कोलेटोट्राइकम कहावे* सिगारो के रूप में पहचाना गया।

उभरती हुई बीमारियों के कारक जीवों की पहचान, जैसे नारियल का क्राउन रॉट *नियोडाइटोनिया फोनीकम*, नारियल आधारित फसल प्रणाली में जायफल और सेम्पेडक का डाइ बैक रोग क्रमशः *लेसीओडिप्लोडिया थियोब्रेमे* और *कोलेटोट्राइकम ग्लियोस्पोरियोइड्स* के रूप में की गई और पुष्टि की गई।

बढ़ी हुई जैव प्रभाव कारिता और चौबीस महीने तक की शेल्फ लाइफ के साथ *ट्राइकोडर्मा हार्ज़ियानम* (CPTD28) आधारित एरेका लीफ शीथ फॉर्मूलेशन विकसित किया गया। इस फॉर्मूलेशन का उपयोग नियमित गुणन के लिए और *टी. हर्ज़ियानम* के न्यूक्लियस कल्चर के दीर्घ कालिक संरक्षण के लिए भी किया जा सकता है।

उभरते हुए सुपारी पत्ती धब्बा रोगके खिलाफ रोग ग्रसित क्षेत्र में कवक नाशी मूल्यांकन से पता चला है कि 25 दिनों के अंतराल पर प्रोपिकोनाज़ोल 25% ईसी और टेबुकोनाज़ोल 38.9% एससी के दो दौर का छिड़काव पत्ती धब्बा रोग कीतीव्रता और गंभीरता को कम करने में बहुत प्रभावी पाया गया।

सुपारी के फल सड़न रोग के खिलाफ मैंडिप्रोपामिड 23.3% एससी कवक नाशी स्प्रे की प्रभावकारिता का कर्नाटक के दक्षिण कन्नड़ जिले और केरल के कासरगो ड़जिले में तीन प्रदर्शन क्षेत्रों में सफलता पूर्वक प्रदर्शित किया गया।

भारत के पांच प्रमुख नारियल उत्पादक राज्यों (तमिलनाडु, केरल, कर्नाटक, आंध्र प्रदेश और असम) में बेसल स्टेम रॉट रोग पर एक व्यापक सर्वेक्षणकिया गया और रोगकी व्यापकता 4.25 से 16.46% तक दर्ज़ की गयी।

ताड और कोको मेंकीट और नेमाटोडका संघटित प्रबंधन

माइटोकॉन्ड्रियल साइटोक्रोम सी ऑक्सीडेज सबयूनिट 1 जीन (*सीओआई*) के विश्लेषण सेकेरल, भारत में ओआरएनवी असंवेदनशील गुआम हैप्लोटाइप (सीआरबी-जी) की अनुपस्थिति का संकेत मिला।

ओरिक्टस राइनोसेरोस के प्रजनन क्षेत्र में *एम. मेजस* और *एस. कार्पोकैप्से* के एक साथ प्रयोग करने के साथ सहक्रियात्मक अंतःक्रिया देखी गई, जो नारियल गैंडा भृंग नियंत्रण में पारिस्थिति की तंत्रके प्रबंधन के लिए एक कुशल और पर्यावरण के अनुकूल कार्यनीति होगी।

कन्नूर जिले के पुलिंगोम और चेस्पुझा और कासरगोड जिले के बायार गांवों में ताड़ सफ़ेद मक्की (*अल्युरोट्रकिलस एट्राटस* हेम्पेल) की उपस्थिति देखी गई। ताड़ के पत्तों पर इस सफेद मक्खी से ग्रसित, और उसके साथ देखे गए प्रिडेटर, साइबोसेफालस और एंटोमोपैथोजेनिक कवक, *एशर्सोनिया* स्पीशीज़ द्वारा प्राकृतिक संक्रमण का संकेत देते है।

रूगोस सफेद मक्खी, *ए. रूगियोपरकुलैटस* से बचाव के लिए पांच अलग-अलग आवश्यक तेलों (500 पीपीएम) की जांच की गई। उनमें से, सिट्रियोडोरा तेल (94.2%) और काली मिर्च तेल (92.5% ने अधिक तम विकर्षक उत्पन्न किया।

अधिकतम एन्ट्रॉपी मॉडल (संस्करण 3.3.3) के माध्यम से नवीनतम युग्मित मॉडल इंटर कंपेरिसन प्रोजेक्ट चरण 6 (सीएमआईपी 6) डेटा सेट ने वर्तमान उपयुक्त क्षेत्रों के परिदृश्यों की तुलना में भविष्य के जलवायु परिवर्तन परिदृश्यों के तहत 2050 और 2070 में उपयुक्त वास क्षेत्र के विस्तार और *ए. रूगियोपरकुलैटस* के प्रसार का संकेत देता है।

पेंटाटोमिड बग, *हेलीओमोर्फे पिकस* के पालन को विभिन्न माध्यमों का उपयोग कर के सफलता पूर्वक मानकीकृत किया गया। उनमें अन्य माध्यमों की तुलना में लोबिया पर समग्र औसत उत्तर जीविता प्रतिशत अधिक (>80%) था।

देशी ईपीएन आइसोलेट्स से जुड़े जीवाणु सहजीवन के आणविक विश्लेषण से सीपीसीआरआईएस 2101, सीपीसीआरआईएस 0804 और सीपीसीआरआईएसबी 25 की जेनोरहाबडस ग्रिफिनाई से आनुवंशिकता का पता चला।

किसान भागीदारी से एकीकृत पादप पर जीवी नेमाटोड प्रबंधन से अमोर्फोफेलस में नेमाटोड संक्रमण में उल्लेखनीय कमी देखी गई। मॉनसून से पहले और मॉनसून सीज़न के बादका ट्राइकोडर्मा हार्ज़ियानम (सीपीटीडी-28) समृद्ध नीम केक (1:100) 1.0 किग्रा/बेल की दर से मिट्टी में लगाने से रूट-नॉट नेमाटोड, मेलोइडोगाइन इन्कॉग्निटा संख्या में काफी कमी आई और लताओं का पीला पन कम हुआ।

शरीर क्रियाविज्ञान, जीव रसायन और फसलोत्तर प्रौद्योगिकी

पोषक तत्वों के उपयोग पर जलवायु कारकों का प्रभाव, और हाइड्रोपोनिक से उगाए गए नारियल के पौधों की संपूर्ण जल उपयोग दक्षता (डब्ल्यूयूई) से पता चलता है कि उच्च तापमान और कम आर्द्रता पर, नारियल का डब्ल्यूयूई कम है और विशेष रूप से बौनी किस्में शुष्क मौसम वाले क्षेत्रों के लिए उपयुक्त नहीं हैं तथा भविष्य में जलवायु परिदृश्य के तहत क्षेत्रों के शुष्क होने की आशंका है।

सुपारी की अनुकूलन शीलता पर जलवायु परिवर्तन के प्रभाव का पूर्वानुमान लगाने के लिए नियोजित प्रजाति वितरण मॉडलिंग के लिए एक समूह मंच, बायोमॉड 2 से पता चलता है कि देश के पश्चिम और दक्षिण आंतरिक क्षेत्रके कुछ हिस्सों में भविष्य के जलवायु परिवर्तनके अनुकूलन होने के लिए तुरंत सोच-विचार की आवश्यकता है। उत्तर पूर्व के कुछ हिस्सों में भविष्य मेंखेती की संभावना है।

वर्जि ननारियल तेल और नारियल तेल में मिलावट का पता लगाने के लिए केमोमेट्रिक कार्यप्रणाली से पता चला है कि जांच किए गए विभिन्न मापदंडों में, तेलोंकी कुल पॉलीफेनोल सामग्री (टीपीसी) और फैटी एसिड प्रोफाइल उत्कृष्ट सूचक हैं।

नवीनखाद्य उत्पादों के विकास में, एक्सट्रूडेट्स में नीरा शहद के मिश्रण ने एंटीऑक्सीडेंट गतिविधि के साथ-साथ उनके पोषण गुणोंको बढ़ाया, जिस में कैल्शियम, पोटेशियम और सोडियम के स्तर के साथ-साथ विटामिन सी भी शामिल है। पके हुए पौष्टिक, बढ़िया रंग के, बनावट वाले और कुरकुरे नारियल के चिप्स तैयारी के लिए एक उपयुक्त प्रोटोकॉल मानकीकृ तकिया गया।

एर्गोनॉमिक रूप से बेहतर मशीनरीजैसे मोटर चालितनारियल पंचिंग मशीनजो 600-700 फल प्रति घंटे कीक्षमता पर चलनेवाली और एक स्टेनलेस स्टील, सौर ऊर्जा-संचालित टेंडर नारियल काटनेकी मशीनविकसितकी गई। इसके अलावा, लाल सुपारी के लिए सुपारी के प्रसंस्करण में सहायक एक टेंडर सुपारी छिलकानिकालने वाली मशीनविकसितकी गई, जो प्रति घंटे 200 किलोग्राम सुपारी कीक्षमता पर कामकरती है।

प्रसार गतिविधियाँ, सामाजिक- आर्थिक दृष्टिकोण और सांख्यिकीय पहलू

संस्थान में किसानों के लिए विभिन्न संस्थागत और ऑफ-कैंपस प्रशिक्षणकार्यक्रम आयोजित किए गए। वर्ष में किसानों के लिए कुल 180 विशिष्ट प्रशिक्षण कार्यक्रम और अन्य हितधारकों के लिए 8223 प्रशिक्षण आयोजित किए गए। इसके अलावा, चयनित प्रौद्योगिकियों पर 411 एफएलडीकिए गए। यह भी उल्लेखनीय है कि, 2022 केदौरान, देश के विभिन्न हिस्सों में मुख्य रूप से पौध संरक्षण पहलुओं पर 100 से अधिक परीक्षणनार्थ प्रक्षेत्र दौरे आयोजित किए गए।

भा.कृ.अनु.प.-के.रो.फ.अ.सं., अनुसंधान केंद्र, किदु में 'स्थिरता के लिए कृषि जैवविविधता' विषय के तहत पांच दिवसीय मेगा किसान मेला और कृषि एक्सपो का आयोजन किया गया।

सीबीबीओ की भूमिका मानते हुए, दो एफपीओ का गठन किया गया और सोसायटी अधिनियम के तहत पंजीकृत किया गया। संस्थान केरल, कर्नाटक और तमिलनाडु में कई एफपीओ को प्रौद्योगिकी सहायता प्रदान कर चुका है। इस वर्ष के दौरान, कृषि सलाहकार सेवाओं के हिस्से के रूप में फसल प्रबंधन के विभिन्न पहलुओं पर कुल 19,084 किसानों के प्रश्नों का उत्तर दिया गया।

एनईएच कार्यक्रम के तहत हस्तक्षेप के हिस्से के रूप में, असम के तीन जिलों के 10 पहचाने गए पिछड़े ब्लॉकों और गांवों में प्रशिक्षण और इनपुट वितरण कार्यक्रम आयोजित किए गए। एससीएसपी के तहत, 20 प्रशिक्षण और इनपुट वितरण कार्यक्रम आयोजितकिए गए, जबकि ओडिशा में कल्पबृख्या फाउंडेशन के सहयोग से एसटीसी गतिविधियां आयोजित की गईं।

पत्तियूर ग्राम पंचायत में किसान प्रथम कार्यक्रम से प्रति महिला किसान की 2.3 गुना औसत आय में वृद्धि हासिल की गई। नारियल विपणन के मूल्य प्रसार विश्लेषण से पता चला है कि लगभग 70% किसान अपनी उपज को गाँव के व्यापारियोंके माध्यम से कच्चे नारियल के रूप में बेचते हैं। उपभोक्ता स्प्ये में उत्पादक की हिस्सेदारी लगभग 64% पाई गई। एक अच्छी तरह से प्रबंधित नारियल उद्यान के आंकड़ों के आधार पर, केरल में नारियल के उत्पादन की लागत 9.93 स्प्ये प्रति नारियल है; 60% श्रम शुल्क के लिए लगता है।

रोपण फसल रोगों के स्थानिक प्रसार का अध्ययन करने और उच्च जोखिम वाले रोग-प्रवण क्षेत्रों की पहचान करने के लिए, 'आर' का उपयोग करके एक सामान्य प्रोग्राम विकसित किया गया है। कार्यक्रम को सुपारी में फल सड़न रोग से जुड़े रोग जोखिम क्षेत्रोंकी पहचान करने के लिए सफलतापूर्व नियोजित किया गया है। कटे हुए कोमल हरे नारियल से मिले जमे हुए गोल और नरम एंडोस्पर्म (कर्नेल) के रूप में नारियल पानी के जीवाणु रहित निष्कर्षण की विधि के लिए एक राष्ट्रीय पेटेंट संस्थान को प्राप्त हुआ है।

वर्ष के दौरान, 42 समझौता ज्ञापनों पर हस्ताक्षर हुए और 19 प्रौद्योगिकियों का व्यावसायीकरणकिया गया। प्रौद्योगिकी हस्तांतरण शुल्क के रूप में 5,75,000 आय प्राप्त हुई।

भा.कृ.अनु.प.-के.रो.फ.अ.सं. केंद्र को लगातार तीसरे वर्ष पीएचईटी केंद्र पर सर्व श्रेष्ठ एआईसीआरपी का पुरस्कार मिला। डॉ. एम.आर. मणिकंठन, प्रधान वैज्ञानिक, एएस एंड पीई को भारतीय बागवानी विज्ञान अकादमी, नई दिल्ली द्वारा बागवानी फसलों के कटाई के बाद प्रबंधन - 2022 में डॉ. जे.सी. आनंद पुरस्कार भी मिला। उन्हें विश्व नारियल दिवस पर नारियल विकास बोर्ड से सर्वश्रेष्ठ नारियल अनुसंधान कार्यकर्ता का पुरस्कार भी मिला, साथ ही डॉ. टी. शिवकुमार, एसएमएस (कृषि कीट विज्ञान), केवीके-अलाप्पुझा को सर्वश्रेष्ठ नारियल विस्तार कर्मी के रूप में चुना गया। डॉ. आर. पांडीसेल्वम को वर्ष के दौरान NAAS एसोसिएट 2022 के रूप में चुना गया है।

वर्ष केदौरान, चार प्रमुख वैज्ञानिकों और एक वरिष्ठ वैज्ञानिक को अंतर्राष्ट्रीय सम्मेलनों में भाग लेने के लिए विदेश का दौरा करने का मौक़ा मिला।

इस अवधि के दौरान 57 शोध पत्रों सहित कुल 300 प्रकाशन प्रकाशित किए गए, जिन में से 29 का NAAS स्कोर ०था। इसके अलावा, संस्थान ने इस वर्ष में 87 लोकप्रिय लेख, 25 कांफ्रेंस लेखा, 58 पुस्तक अध्याय, 6 पुस्तक, 4 प्रशिक्षण मेनुअल, 29-प्रकाशन, 7 वीडियो, एक तकनीकी बुलेटिन, 24 एसटेंशन फ़ोल्डर और दो रेडी रेकनर प्रकाशित किए।

16 से 20 मई 2022 के दौरान कासरगोड़ में एक अंतरराष्ट्रीय प्रशिक्षण कार्यक्रम 'आईसीसी-कोजेंट को कोनट टिश्यू कल्चर वर्कशॉप' आयोजित किया गया, जिसमें 14 देशों के प्रतिनिधियों ने भाग लिया।


भाकृअनुप
ICAR


के रो फ अ सं
CPCRI

III.

EXECUTIVE SUMMARY

Genetic Resources Management and Utilization

ICAR-CPCRI maintains largest germplasm collection of coconut (455 Nos.), arecanut (178 Nos.) and cocoa (530 Nos.). It includes 15 new cocoa collections from Western Ghat hills of Balehonnur and Bhadravati River basin of Karnataka with bigger beans. In addition to the on-field preservation of germplasm, 30 zygotic embryos, 15 pollen and 16 DNA samples from coconut accessions were cryo-preserved, in collaboration with National Cryo Gene Bank, ICAR-NBPGR, New Delhi.

Based on performance evaluation trials at CDB Farm, Neriamangalam and ICAR-CPCRI, RS, Kayamkulam, WCT progenies were crossed for their superiority in yield and tolerance to root (wilt) disease. The hybrid 'Kalpa Vajra', a tall variety, was recommended by the AICRP on Palms for release as suitable for cultivation in root (wilt) disease prevalent tracts.

Dwarf coconut palm evaluation trial indicated, Andaman Green Dwarf and Gangabondam Green Dwarf were found promising. Studies to evaluate inflorescence sap yield indicated Laguna Tall variety producing as high as 2.04 l/day followed by Kappadam Tall with 1.81 l/day.

Fat content in nuts from 15 arecanut accessions from NEH region indicated highest (34%) in Borihat, followed by Badarpur (29.5%).At Mohitnagar, dwarf hybrid Mohitnagar x HD produced 2.291 kg chali/palm/year while the parental line Mohitnagar tall yielded 4.061 kg chali/palm/year.

In cocoa, Malaysian Forastero, I-14, was identified as a promising clone with 2 to 3.5 kg dry bean yield/tree/year. It was found to be tolerant to drought, diseases and pests.

In evaluation trials for suitability of cocoa cultivation in the North East Region, higher dry bean yield of 1.85 kg per tree per year was recorded in KHIC – 4 followed by KHIC – 13 having 1.33 kg/tree/year at Kahikuchi, Assam.

Quality planting materials were produced and distributed during the period, which included, 1,56,009 coconut, 7,85,613 arecanut and 56,015 cocoa for farmers and developmental agencies.

Biotechnological Investigations

For improving tissue culture plantlet production in coconut, better multiple shoot initiation was observed in plumular explants of coconut in Y3 media supplemented with adenine sulphate and picloram.

Developed cryopreservation protocols for long-term storage of pollen and zygotic embryos in coconut and arecanut. Also developed marker assisted characterization and selection protocols for coconut and arecanut. Genome-wide association studies (GWAS) were carried out using 83,000 SNPs. Consistent SNP markers were identified using mixed linear model (MLM) analysis.

In arecanut, nut setting percentage increasedby utilizing arecanut pollen cryopreserved with virgin coconut oil. After 24 hours of storage in liquid nitrogen, 90% germination of pollen was observed.

Using mycelial proteome data of the coconut bud rot pathogen, *P. palmivora*, 2467 proteins signalling pathways, such as phosphatidyl-inositol, Ca2+ and MAPK, autophagy, and cell cycle could be annotated.

Crop Production

One hectare of coconut-based farming system model at Kasaragod, comprising coconut, pepper trailed on the coconut trunk, banana in the border of the plots, fodder sorghum (CO 31- multi cut fodder sorghum)

in the interspaces of coconut, dairy unit, goat unit and poultry realized a net returns of Rs. 6,01,194/-.

Coconut based high density multi species cropping system at Kasaragod, comprising coconut, pepper (trailed on the coconut trunk), banana cv. Kadali, Robusta (inter row space of palms), cinnamon (inter row space of palm) and nutmeg (between 4 coconut palms) under different nutrient management practices along with recycling of biomass, biofertilizer application and green manuring resulted in 6.3 times higher net returns (Rs. 6,17,162/-) in HDMSCs compare to monocrop of coconut.

Cultivation of marigold varieties, Pusa Basanti Gainda and Periyakulam Yellow in the newly planted coconut ecosystem resulted in a yield of 57.9 q/ha and 57.6 q/ha fetching an additional income of Rs. 1.59 lakhs and Rs.1.52 lakhs during juvenile phase of the plantation with BCR 2.18 and 2.13, respectively.

Cinnamon intercropping in coconut with pentagonal method of planting with 0.6 m x 1.2 m spacing (5 plants per pit) recorded significantly higher dry quill yield of 631.92 kg/ha and benefit cost ratio of the system was 1.84.

Humic acid in combination with farmyard manure was found to enhance the availability of nutrients, improve the nutrient holding capacity of soil and a synergistic relationship was observed between the two components.

Studies to develop nutrient management for dwarf coconut varieties showed sixty per cent of the Kalpa Sankara hybrid palms treated with KalpaPoshak flowered at 26th month after planting. In the 30 year old West Coast Tall palms, the average annual pre treatment yield of 67 nuts per palm increased to 81 nuts per palm with application of 500 g KalpaVardhini @ 250 g per dose.

The elite isolates of rhizobacteria *viz., Burkholderia* spp. (AREB7, ARsB9) *Acinetobacter* sp. (ARsB4), *Bacillus spp.* (ARsB8, RBC18-5), *Pseudomonas* sp. (RBC18-25), were not deleterious and, recorded higher biomass, root length, shoot length and lateral roots in wild areca seedlings.

Grafts of cocoa variety Netra Centura planted with 5 different spacing with planting density ranging from 650 to 3712 plants ha^{-1} resulted in significantly higher dry bean yield in closely planted grafts (370 – 809 kg ha^{-1}) than grafts under normal spacing (186 kg ha^{-1}).

Cultivation of coconut under organic nutrient management practices recorded higher yield of 102.4 nuts/palm/year with 174g of copra weight/nut over other treatments.

Biodegradable arecanut leaf base nursery containers with extended non-degradation were under development.

A technology to convert combined biomass residues of palms and cocoa including coconut leaves, cocoa leaves, cocoa pod husks, and arecanut husks to vermicompost has been standardized using CPCRI earthworm, *Eudrilus* sp. with primed coconut husk biochar as a novel component.

Cocoa pod husk wastes were found to be ideal for conversion to biochar with a conversion rate of 38-42%. The resultant product had alkaline pH of around 10 and total potassium ranging from 7-10%, 60% of it being water-soluble and 70% as exchangeable potassium. Cocoa pod husk biochar could help reduce K-requirement gap in organic farming.

Technology to convert mature coconut water (liquid endosperm) which is wasted in huge quantities from coconut kernel processing industries to vinegar, 'nata'/bacterial cellulose has been standardized using indigenous bacteria isolated from coconut vinegar.

Biopriming with PGPR strains and consortia combined with fertilizers and organic manures (including green leaf manure and basin management with cowpea) as per the standard recommendations for RWD tract kept the seedlings 'apparently healthy' as per the root (wilt) disease indexing method.

Integrated Management of Diseases in Palms and Cocoa

Etiology of arecanut leaf spot disease was established and identified the associated pathogen as *Colletotrichum kahawae* subsp. ciggaro based on morphological and molecular characterization

using multi-gene phylogeny.

Identified and confirmed the causal organism of emerging diseases such as crown rot of coconut as *Neodeightoniaphoenicum,* dieback disease of nutmeg and cempedak in coconut based cropping systemas *Lasiodiplodiatheobromae* and *Colletotrichum gloeosporioides* respectively.

Developed a *Trichoderma harzianum* (CPTD28) based areca leaf sheath formulation with enhanced bio efficacy and shelf life of up to twenty four months. The formulation could be used for regular multiplication and also for the long term preservation of nucleus culture of *T. harzianum.*

Field evaluation of fungicides against emerging arecanut leaf spot disease revealed, two rounds of spraying of Propiconazole 25% EC and Tebuconazole 38.9% SC at 25 days intervals were found very effective in reducing leaf spot disease intensity and severity.

Efficacy of Mandipropamid 23.3% SC fungicide spray against fruit rot disease of arecanut was successfully demonstrated in three demonstration plots at Dakshina Kannada district of Karnataka and in Kasaragod district of Kerala.

An extensive roving survey on basal stem rot disease was conducted in five major coconut growing states of India (Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Assam) and the disease incidence ranged from 4.25 to 16.46 %.

Integrated Management of Pests and Nematodes in Palms and Cocoa

Analysis of mitochondrial cytochrome c oxidase subunit 1 gene *(COI)* indicated the absence of OrNV insensitive Guam haplotype (CRB-G) in Kerala, India.

Synergistic interaction was noticed with simultaneous application of *M. majus* and *S. carpocapsae* in the breeding niches of *Oryctus rhinoceros* would be an efficient and environmentally friendly strategy to manage coconut rhinoceros beetle in palm ecosystem.

Occurrence of the palm whitefly *(Aleurotrachelus atratus* Hempel*)* was noticed in the villages of Pulingome and Cherupuzha, Kannur district and Bayar, Kasaragod district. Simultaneously observed predator, *Cybocephalus* sp. and natural infection by the entomopathogenic fungus, *Aschersonia* sp. on the palm leaflets infested by palm whitefly.

Five different essential oils (500 ppm) were screened for repellence against rugose spiralling whitefly, *A. rugioperculatus.* Among them, Citriodora oil (94.2%) and black pepper oil (92.5%) induced maximum repellency.

The latest Coupled Model Intercomparison Project phase 6 (CMIP6) dataset through maximum entropy model (version 3.3.3) indicated the expansion of suitable habitat area and spread of *A. rugioperculatus* in 2050 and 2070 under future climate change scenarios over the present suitable areas scenarios.

Rearing of Pentatomid bug, Halyomorphapicus was successfully standardised using different substrates. Among them overall mean survival percentage was higher (>80%) on cowpea as compared to other substrates.

Molecular characterization of bacterial symbionts associated with native EPN isolates revealed genetic relatedness of CPCRIS2101, CPCRIS0804 and CPCRISB25 to *Xenorhabdus griffinae.*

Farmer participatory integrated plant parasitic nematodes management showed significant reduction in the nematode infestation in amorphophallus. Soil application of *Trichoderma harzianum* (CPTD-28) enriched neem cake (1:100) @ 1.0 kg/vine during pre-monsoon and post-monsoon season significantly suppressed the build-up of root-knot nematode, *Meloidogyne incognita* population and reduced yellowing of vines.

Physiology, Biochemistry and Post Harvest Technology

The influence of climatic factors on nutrient use, and whole plant water use efficiency (WUE) of hydroponically grown coconut seedlings suggests that at high temperatures and low humidity, WUE of coconut is low and especially dwarfs are not suitable for those regions with dry weather or regions expected to become dry under future climate scenarios.

An ensemble platform for species distribution modelling, Biomod2, employed to forecast the

impact of climate change on adaptability of arecanut reveal that that some parts of west and south interior region of the country warrant immediate consideration in order to adapt to future climate change, whereas some parts of north east can be considered for future cultivation.

Chemometric approach to detect adulteration in virgin coconut oil and coconut oil divulge that among the various parameters examined, total polyphenol content (TPC) and fatty acid profile of the oils are excellent candidate markers.

In the development of novel food products, *neera* honey infusion in the extrudates enhanced antioxidant activity as well as their nutritional qualities, including the levels of calcium, potassium, and sodium as well as vitamin C. A suitable protocol has been standardized for the preparation of baked nutritious, fine colored, textured, and crispy coconut chips.

Ergonomically superior machineries such as a motorized coconut punching machine which operates at a capacity of 600–700 nuts per hour and a stainless steel, solar-powered tender coconut cutting machine have been developed. Also, a tender arecanut dehusking machine, which works at a capacity of 200 kg of arecanuts per hour, helpful in the processing of arecanut for red supari has been developed.

Outreach activities, socio-economic perspectives and statistical aspects

Institute has organised a total of 180 institutional and off-campus training programmes benefitting 8223 farmers and other stakeholders. Besides, five workshops on specific aspects of crop management and value addition were also conducted. As part of the interventions under the NEH programme, training and input distribution programmes were conducted in backward blocks and villages of Assam. Under the SCSP, 20 training and input distribution programmes were organised, while STC activities were conducted in Odisha in collaboration with the Kalpabrukhya Foundation.

A total of 411 FLDs were carried out in different regions. During 2022, more than 100 diagnostic field visits were conducted in different parts of the country, mainly on plant protection aspects.

A five-day Mega Kisan Mela and Agri Expo under the theme "Agro-biodiversity for Sustainability" was organised during 19-23 November 2022 at the ICAR-CPCRI Research Centre, Kidu.

Assuming the role of CBBO/POPI, three FPOs were nurtured by the Institute. Besides, technology guidance was provided to FPOs in Kerala, Karnataka, and Tamil Nadu.

The Farmer FIRST Programme (FFP) is being implemented in Alappuzha district of Kerala. Interventions on root (wilt) disease management resulted in 42% yield increase in the project area. Introduction of HYV Groundnut (G2-52 of UAS Dharwad) in coconut gardens provided 1.06t/ha yield and Rs. 60,000/ha additional income. Women farmers could increase their income by 2.3 times due to farming interventions and convergence of MGNREGS.

A price spread analysis of coconut marketing revealed that about 70% of the farmers sell their produce through the village traders as raw coconuts. The cost of production of coconut in Kerala is Rs. 9.93 per nut of which, 60% is accounted for labour charges.

Spatial spread of arecanut fruit rot disease was studied to identify disease prone areas for which a generic model was proposed.

The second edition of Rural India Business Conclave was conducted during 9-13 June 2022 in collaboration with Kerala Startup Mission and Central University of Kerala with multiple events like rural agri-tech hackathon, startup pitch and founder's talk.

During the year, 19 technologies were commercialized by signing 42 MoAs and a sum of Rs. 5,75,000 was realized as technology transfer fee. A national patent was received for a method for aseptic extraction of tender nut water as frozen ball and soft endosperm (kernel) from trimmed young coconut.

Awards and Recognitions

The Best AICRP on PHET centre award was bagged by the CPCRI Centre for the third consecutive year. Dr. M.R. Manikantan, Principal Scientist, AS&PE also received Dr. J.C. Anand Award in Post-harvest

Management of Horticultural Crops – 2022 by Indian Academy of Horticultural Sciences, New Delhi. He also received Best Coconut Research Worker Award from Coconut Development Board on the World Coconut Day along with Dr. T. Sivakumar, SMS (Agrl. Entomology), KVK-Alappuzha adjudged as the best coconut extension personnel. Dr. R. Pandiselvam has got selected as NAAS Associate 2022 during the year.

During the year, four principal scientists and a senior scientist have visited abroad to take part in international conventions.

A total of 304 publications were brought out around including 57 research papers during the period out of which 29 were having >7.0 NAAS score.

An international training programme 'ICC-COGENT Coconut Tissue Culture Workshop' was conducted at Kasaragod during 16-20 May 2022 which was attended by delegates from 14 countries.

IV.

VISION, MISSION AND MANDATE

Vision

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

Mission

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

Mandate

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

V. INSTITUTE PROFILE

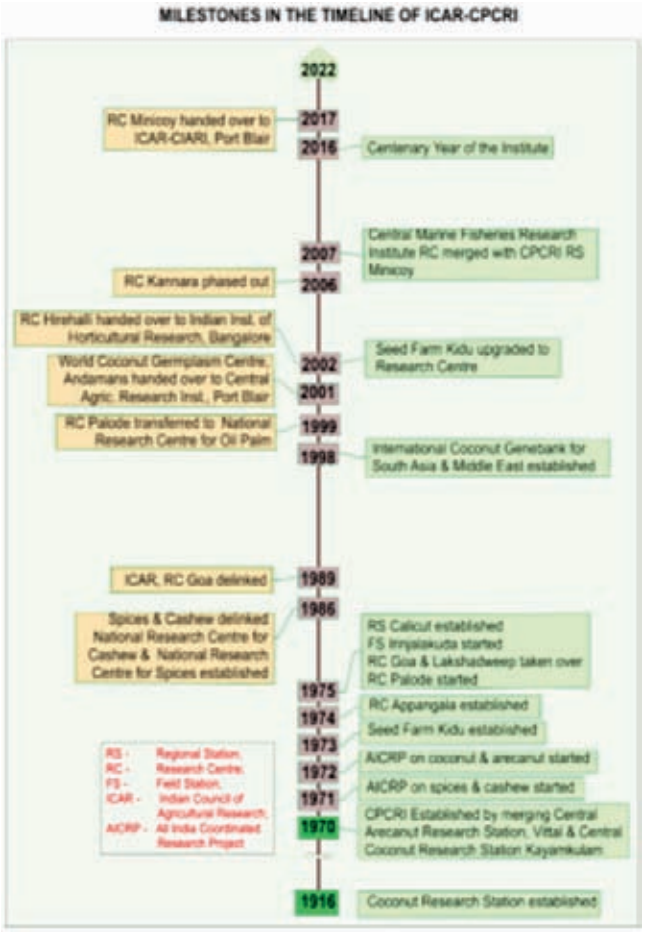
ICAR-Central Plantation Crops Research Institute (ICAR-CPCRI), the premier research institution in the National Agricultural Research System of India, is presently mandated to research plantations crops (coconut, arecanut and cocoa). It had a modest beginning as Coconut Research Station in 1916 under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

Historical Perspective

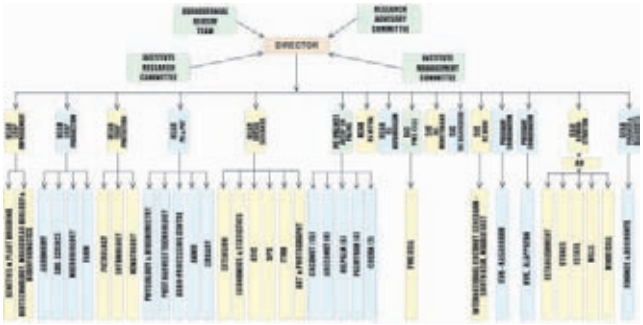
The Coconut Research Station at Kudlu (Kasaragod) was taken over by the Indian Central Coconut Committee and established the Central Coconut Research Station (CCRS), Kasaragod in 1947 and 1949, the Central Coconut Research Station (CCRS) at Kayamkulam was also established exclusively for tackling diseases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

Since 1986, crops like spices, cashew, and oil palm were taken out of the purview of the institute with the formation of dedicated research institutions like Indian Institute of Spices Research, Kozhikode, Directorate of Cashew Research, Puttur and Indian Institute of Oil Palm Research, Pedvegi. Some of the erstwhile Research Centres at Hirehalli, Palode, Appangala, Kannara, Port Blair and Minicoy were either handed over to sister ICAR institutions or phased out. At present, the mandated crops are limited to coconut, arecanut and cocoa and the research and frontline extension aspects of these crops are undertaken under five divisions viz., Crop Improvement, Crop Production, Crop Protection, Physiology, Biochemistry and Post-Harvest Technology and Social Sciences at the Institute. The Regional Station at Kayamkulam (Kerala) is mandated to work on pests and disease problems in coconut, while the Regional Station at Vittal (Karnataka) caters to research and extension in arecanut and cocoa. The Research Centres at Kahikuchi (Assam) and Mohitnagar (West Bengal) undertake location-specific research in these crops, while the Research Centre at Kidu (Karnataka) hosts the National/ International Coconut Gene Bank for South-Asia (ICG-SA) and also caters to the large-scale production of quality planting materials in the mandate crops. Besides, there are two KVKs (at Kasaragod and Kayamkulam) functioning under the Institute.

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



Organogram



Achievements at a Glance

Plant Genetic Resources

ICAR-CPCRI maintains the world's largest repository in coconut with 455 accessions (323 indigenous and 132 exotic genotypes) from 28 countries, 172 germplasm collections in arecanut of which 23 are exotic and 159 indigenous and 530 cocoa germplasm collections. International Coconut Genebank for South Asia (ICG-SA) was established under a tripartite agreement among ICAR-FAO-ITPGRFA. The Institute also hosts the national coconut genebank (NCGB) and serves as the National Active Germplasm Site (NAGS) for coconut, arecanut and cocoa.

Through intensive breeding and evaluation, 21 improved coconut varieties including six hybrids involving talls and dwarfs as parents have been released for commercial cultivation. The high yielding varieties are capable of yielding 3.12 to 6.28 tonnes of copra ha^{-1} annually, as compared to 2.96 t copra ha^{-1} in West Coast Tall local. Kalpa Raja a tall variety of coconut developed by hybridization (WCT x WCT) was recommended specifically for the root (wilt) disease prevalent tract. It has an average yield of 91 nuts/palm/year compared to WCT with a yield of 69 nuts/palm/year in the region. Kalpa Raja is also suitable for tender nut, copra and inflorescence sap production. Eleven improved varieties of arecanut, including nine selections and two dwarf hybrids, have been released. The improved varieties with annual average yield of 2.54 to 4.15 kg dry kernel $palm^{-1}$ yr^{-1} and higher dry kernel recovery, in comparison to South Kanara Local (2 kg dry kernel $palm^{-1}$ yr^{-1}), have significantly improved arecanut productivity in the country. In cocoa, eight high yielding varieties have been released from the Institute, which include three elite clones and five hybrids, which yield up to 3.0 kg dry bean $tree^{-1}$ yr^{-1} with varying processing qualities, as compared to 1.0 kg dry bean $tree^{-1}$ yr^{-1} in existing cocoa plantations. High yielding clone VTLCC-11 has been found suitable for high density planting. For Assam, VTLC 19 and VTLC 20 which are high yielding under multi location trials have been recommended for cultivation.

The Institute has been producing quality planting materials annually in coconut, arecanut and cocoa to the tune of 1.2 lakhs, 5 lakhs and 0.5 lakhs respectively, for distribution to farmers and other stakeholders. Seed gardens of improved varieties have been established in the Institute as well as in farmer's fields to augment planting material production. ICAR-CPCRI nurseries at Kasaragod, Kidu, Kayamkulam and Vittal were graded with 'four-star' status in the five star scale by National Horticultural Board.

Biotechnology and Bioinformatics

Achievements under biotechnology include standardization of embryo culture protocol for germplasm exchange, standardization of regeneration protocol for inflorescence tissues of arecanut and cryopreservation of coconut DNA, embryo and pollen. In arecanut, the protocol developed for somatic embryogenesis and plantlet regeneration from immature inflorescence explants has been commercialized. A simple and easy vitrification protocol has been developed for cryopreservation of coconut zygotic embryos from both tall and dwarf accessions. The protocol developed for cryopreservation of coconut pollen for the first time by ICAR–CPCRI, has been commercialized; this would be instrumental in enhancing hybrid seed production as it facilitates year round availability of coconut pollen for all stakeholders across the coconut growing states of India. The safe movement of coconut germplasm through embryo cultures, instead of seed nuts, is recommended by FAO/ IPGRI.

Sequence characterized amplified regions (SCAR) markers have been developed for confirming the hybridity at seedling level in both coconut and arecanut. A panel of SSR markers has been identified for confirming the hybridity of D x T hybrids (CGD x WCT) which will ensure supply of genuine hybrid material to farmers. In coconut, DNA fingerprint profiles have developed for 25 each of tall and dwarf accessions using polymorphic SSR and EST-SSR markers. Transcriptome analysis of response of coconut to root (wilt) disease and somatic embryogenesis have been undertaken using RNA-Seq and transcripts up/ down-regulated have been identified. Many of transcripts down-regulated in root (wilt) diseased palms were primarily involved in defense responses, signaling pathways, cellular transport and other metabolic processes. Transcriptome analysis of coconut embryogenic calli, derived from plumular explants of West Coast Tall, resulted in the identification of 14 genes with important roles in somatic embryogenesis. Work on deciphering the genome sequence of Chowghat Green Dwarf has been initiated.

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

Cropping and Farming Systems

Coconut based farming system comprising coconut, pepper trailing on the coconut trunk, banana in the border of the plots, fodder grass (hybrid Bajra Napier Co 5) in the interspaces of coconut, dairy unit and poultry could fetch net returns of Rs. 6,53,853/- per year. Groundnut intercropping under coconut by following integrated nutrient management and application of farmyard manure recorded a higher pod yield of 2189 kg and 1932 kg of Girnar-2 and Girnar-3 varieties, respectively. Compared to coconut mono-cropping, the cropping system can provide more than three times farm income. In the case of arecanut, the income enhancement through intercropping would be 75% to 130%.

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

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

Bioresources Utilization

Recycling crop wastes in coconut, arecanut and cocoa through vermicomposting and mushroom production helps in disposing of wastes, improving soil fertility, reduction in use of chemical fertilizers and sustaining the yield besides enhancing nutritional security. Coconut gardens of one hectare area can generate up to eight tonnes of leaf biomass residues every year. Technology has been developed to utilize these wastes for production of vermicompost, vermiwash, compost and mushrooms. From about eight tonnes of leaf residues, 3-4 tonnes of vermicompost could be produced annually using the local isolate of *Eudrilus* sp. or 1,660 kg of fresh mushroom. The coconut leaf vermicompost can also meet 50% of the nitrogen requirement of coconut palms grown in one hectare area saving expenditure on inorganic fertilizer. After coconut leaves are vermicomposted, earthworms are to be separated for which a 'push-pull' strategy was successfully adopted to harvest earthworms from vermicompost heaps through the use of behaviour-modifying stimuli. Vermiwash, produced from coconut waste vermicomposting unit, is a good liquid fertilizer for organic farming. On farm coir pith composting technology has been developed to produce organic input to the plantation as well as use as soil-less medium for production of quality planting material. Efforts are on to standardize composting of immature coconut husk, which otherwise accumulates in heaps outside tender nut parlours along the roadside.

Arecanut and cocoa gardens generate biomass of 4-5 and 0.7-0.8 million tonnes ha^{-1} respectively and these wastes could be effectively utilized for production of oyster mushroom and livestock feed, in addition to vermicompost. Recyclable biomass in arecanut supplies approximately 95 g N, 10 g P_2O_5 and 110 g K_2O palm^{-1} yr^{-1} that has the potential to meet nitrogen and phosphorus requirements of arecanut, which can save the cultivation cost to the extent of Rs. 5,200 ha^{-1}. Arecanut leaf sheath and bunch waste can result in production of 643 kg fresh mushroom. Biochar production units by gasification and pyrolysis has also been developed.

In the area of microbial bioresources, plant growth promoting rhizobacteria (PGPR) based bioinoculant products, 'Kera Probio®' containing Bacillus megaterium and 'Cocoa Probio®' containing *Pseudomonas putida* have been released for production of healthy and vigourous coconut and cocoa seedlings. The genes involved in the plant growth promoting properties and other important metabolic functions of three PGPRs, one each from coconut, arecanut and cocoa, have been identified through whole genome sequencing. An efficient zinc solubilizer has been identified from alkaline soil which could not only increase availability of soluble zinc in soil, but also its electrical conductivity. This bioresource could prove to be useful in regions where zinc availability is a problem.

Reducing Crop Losses

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

The role of slug *Deroceros* sp. in spreading of bud rot has been confirmed by observing the presence of sporangia of *P. palmivora* in faecal matter of the slugs collected from bud rot affected garden and proving its pathogenicity on coconut. Prophylactic treatments of Bordeaux mixture (1%) or placement

of two perforated sachets containing mancozeb (5g) or Trichoderma coir pith cake in the innermost leaf axil of coconut with the onset of monsoon (first week of June) can prevent the appearance of bud rot in disease endemic areas. Basal stem rot disease caused by Ganoderma lucidum is another major disease of coconut and soil application of Trichoderma enriched neem cake (5 kg palm^{-1}) at quarterly interval was found very effective in reducing the disease incidence. Stem bleeding disease of coconut could be effectively controlled using fungicides (Hexaconazole 5EC and Propiconazole 25 EC).

Root (wilt) disease of coconut caused by phytoplasma is another major disease and efforts were made to improve the PCR-based diagnostic techniques for reliable early detection of phytoplasma. A package of practice for the disease affected regions had been recommended.

Spraying of Bordeaux mixture (1%) or mandipropamid (0.5%) was found to be effective in reducing the fruit rot disease of arecanut. Among the foliar fungal diseases, inflorescence die back of arecanut caused by *Colletotrichum* spp. and leaf blight of coconut caused by *Lasiodiplodia* spp. were the major diseases observed. Inflorescence dieback of arecanut could be effectively managed using Propiconazole 25% EC @ 3 ml per litre. *Lasiodiplodia theobromae* causing cocoa leaf die back disease was prevalent in Andhra Pradesh, which could be controlled by removal of symptomatic branches and applying 10% Bordeaux paste on cut branches.

Clean and green innovative pest management technologies have been developed and field validated for the bio-suppression of rhinoceros beetle, red palm weevil, leaf eating caterpillar and eriophyid mite infesting coconut. IPM module for the management of rhinoceros beetle through integration of biocontrol agents *viz.,* Oryctes rhinoceros Nudivirus (OrNV), Green Muscardine Fungus (GMF), Metarhizium anisopliae, botanicals (leaf axil filling with neem/ marotti/ pongamia cake @ 250g mixed with equal volume of sand) and aggregation pheromone embedded nanomatrix trap @ 1trap ha^{-1} has been developed. Area-wide (1575 ha) farmer-participatory experiments undertaken at Krishnapuram (Kerala), Semanampathy (Tamil Nadu), Voodimudi (Andhra Pradesh) and Doddenhally (Karnataka) significantly reduced the spear leaf and inflorescence damage to an extent of 81.2%. Recently, an agro-ecosystem based pest regression strategy through ecological bio-engineering has been designed for managing rhinoceros beetle, exploiting the interplay of mixed-volatile cues of crop plurality of coconut with spices and fruit trees.

Integrated management technologies involving complete destruction of infested palm, close monitoring and sustained surveillance for early diagnosis, leaf axil filling of chlorantraniliprole sachet, curative management with imidacloprid (0.02%) and pheromone trap @1 trap ha^{-1} were found effective in the management of red palm weevil. Community level technology convergence and large-area adoption of IPM technologies conducted in 2150 ha in Bharanikavu (Kerala), Palladam (Tamil Nadu), Ambajipet (Andhra Pradesh) and Bidramamandi (Karnataka) could reduce the pest incidence to 56.8%. An acoustics-sensor based red palm weevil detector in coconut was developed with 80% accuracy.

Rugose Spiralling Whitefly (RSW) (Aleurodicus rugioperculatus Martin) invading coconut palms in all South Indian States. Aphelinid parasitoid, *Encarsia guadeloupae* Viggiani as natural enemy was successful in controlling the larvae of white flies; conservatory bio-suppression successful by pesticide holiday. Subsequent development of sooty mould was completely devoured by *Leiochrinus nilgirianus* Kaszab beetles.

For the bio-suppression of leaf eating caterpillar, augmentative release of stage-specific parasitoids viz., *Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids per palm, removal of heavily damaged outer three leaves and improving soil and palm health of infested palms reduced the leaf damage to 95.3% in a period of 12-15 months. Area-wide field validation and demonstration experiments conducted at Kasaragod (Kerala), Sethumada (Tamil Nadu), Matlapalem (Andhra Pradesh) and Arsikere (Karnataka) in an area of 550 ha recorded a minimal pest incidence of 2.4% from an initial

damage level of about 73.4% indicating the success of the technology.

IPM technologies for the suppression of eriophyid mite developed by ICAR-CPCRI involving 2% neem oil-garlic emulsion spray, root feeding of azadirachtin 10000 ppm @ 10 ml + 10 ml water and soil and palm health management practices reduced pest incidence to the tune of 71.4%. From an initial pest incidence of 58.6% observed in Krishnapuram (Kerala), Kottur (Tamil Nadu), Ambajipet (Andhra Pradesh) and Boranakoppalu (Karnataka), the pest incidence was reduced to 16.3% in a period of two years indicating the success of the technology at national level.

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

Climate Resilient Technologies

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

At the reproductive phase, pollen germination was found to be very sensitive to high temperature. It was 63% at 30°C and got drastically reduced to 14% at 45°C. A clear contrast was observed between talls and dwarfs in terms of pollen germination at high temperatures, which can be an important selection criterion in evolving varieties with tolerance to high temperature.

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

Product Diversification, Value Addition and Mechanization

Value addition and product diversification can ensure the sustainable livelihood of plantation farmers and entrepreneurs. In this context, the recently developed 'coco-sap chiller' technology for collecting fresh, hygienic and unfermented coconut inflorescence sap (Kalparasa) is very promising. Other value added products like virgin coconut oil, coconut chips could improve the profitability and employment generation in coconut sector. In an effort towards product diversification and value addition, collection of fresh coconut inflorescence sap (`Kalparasa®') using a simple patented device paved the way for preparation of coconut palm sugar from the inflorescence sap and preparation of confectioneries. Cookies were developed – coconut milk residue and jackfruit seed powder enriched biscuits, coconut milk residue based extrudate,

'Kalpa Krunch', coconut sugar based dark chocolate 'Kalpa Bar', 'Kalpa Drinking Chocolate' and coconut milk based 'Frozen coconut delicacy' using tender coconut water and pulp also have been developed. Bean-to-bite cocoa dark chocolate using coconut palm sugar could grab the attention of entrepreneurs.

Farm mechanization and various processing machineries developed at the institute could contribute substantially in reducing the production cost, increased labour efficiency and enhanced product output and quality. The safety attachment incorporated by ICAR-CPCRI to Chemberi Joseph model of climbing device has become an effective solution since it could be operated even by women with proper training. This gives much required confidence to the climbers, especially the beginners. Apart from this, machineries and gadgets developed for labour saving and gender main streaming viz., power operated coconut and arecanut husking machines, coconut de-shelling and shell removing machines for copra making and wet processing respectively, tender coconut punch and cutter, copra and coconut chips dryers of varying capacities and using different fuel sources, testa remover, manual and power operated coconut slicing machines, coconut milk expellers of various capacities, VCO cookers, VCO fermentation tank and copra moisture meter are the other major contributions from the institute. A recent addition to this impressive array of gadgets is the gender-friendly self-loading arecanut dehusking device (with dust control) along with the arecanut grading attachment. So far the institute could obtain national patents for seven of its technology devices.

Shelflife of coconut gratings can be extended with additives upto 3 week. Coconut milk peda, tender coconut juice, tender coconut dessert and jaggery based coconut chips developed.

Capacity Building Programmes

For technology transfer, efforts have been made to adequately promote the mandate crops of the institute through effective extension activities including trainings, farmer participatory approaches in technology development and dissemination, participation in exhibitions and conducting Kisan Melas, and production and distribution of planting materials of mandate crops. Training and frontline demonstrations on selected technologies, institutional and off campus training programmes for extension personnel and farmers and research-extension-farmer interface programmes have been conducted. Besides, the institute has participated in exhibitions, radio talks, television interviews, phone-in programme and press meets. Mega Expo and Kisans Mela were organized in addition to release of various publications and documentation farmers' experiences and felicitation of the innovative farmers across the country.

Applications of ICT tools like videoconferencing to conduct trainings, conferences and interaction workshops with various stakeholders were utilised. Statistical Databases created, technical bulletins, CD ROMs, extension pamphlets, information brochures published. Krishi Vigyan Kendras under the institute catered to the training needs of farmers of Kasaragod and Alappuzha Districts in Kerala State. Cyber extension programmes were further strengthened with the addition of mobile video conferencing unit. Mobile video conferencing unit is being utilized for facilitating the Research-Extension-Farmer interfaces. The Institute website (https://cpcri.icar.gov.in) is being updated regularly with latest information. Besides, several innovative steps were taken to meaningfully engage the visual and print media for disseminating the research accomplishments to the farming community.

Socio-Economic Studies and Policy Interventions

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

Minimum import price of arecanut was arrived at for providing better market price for indigenous growers.

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

Statistical Models to Improve Field Experiments

Analysis of covariance technique in field experiments is made more robust/flexible by taking the relationship between the response variable and covariate as non-parametric instead of linear. Semi-parametric additive regression model has been proposed to estimate/eliminate the positional effect in field experiments, when the number of experimental units is comparatively small. Crop production model in arecanut was developed based on the semi parametric regression technique. A data driven technique was developed to estimate the trend and relative growth rate of time series data. The method was extended for handling sudden shifts or changes in the trend or growth rate functions by adding dummy variables for the jumps. It has been applied to estimate trend and growth rate of area, production and yield of major crops in India. Robust spatial smoothing technique was developed to estimate the spatial effect of a field in the presence of outliers or extreme observations. It is based on fitting M-type robust nonparametric spatial regression following iterative kernel weighted local regression surface technique. Yield prediction in cocoa was done using biometrical/partial harvest data. Besides, weather based crop yield modelling was carried out in mandate crops. Pest and disease incidence and severity were regularly assessed employing appropriate sampling strategies in Kerala and Karnataka.

Technology Commercialization

The Institute Technology Management Committee is responsible for protection of IP assets and commercialization. Till now, the Institute has commercialized more than 55 technologies, signed 321 MoAs for transfer of technology know-how and realized a revenue of Rs. 82,17,500.

CROPS, AREA, ALTITUDE AND RESEARCH UNDERTAKEN AT DIFFERENT LOCATIONS

Headquarters

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

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

Regional Stations

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

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

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

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

Research Centres

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

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

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

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

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

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

Location of Stations / Centres under CPCRI

Staff Strength as on 31-12-2022

ICAR-CPCRI, KASARAGOD

Category	Sanctioned	In position	Vacant
Scientific	65	60	5
Technical	113	60	53
Administrative	89	47	42
Supporting	131	63	68
Total	398	230	168

ICAR-KVK, KASARAGOD

Category	Sanctioned	In position	Vacant
Scientific	1	1	–
Technical	11	6	5
Administrative	2	1	1
Supporting	2	–	2
Total	16	8	8

ICAR-KVK, ALAPPUZHA

Category	Sanctioned	In position	Vacant
Scientific	1	1	--
Technical	11	10	1
Administrative	2	1	1
Supporting	2	--	2
Total	15	12	4
Grand Total	430	250	180

Details in chapter XVII – Personnel

Budget and Expenditure

(Rs. in Lakhs)

Head	Allocation	Expenditure
Budget	8345.18	8345.18
Revenue generation	429.65	

Details in chapter XXIII – Budget and Expenditure.

VI . RESEARCH ACHIEVEMENTS

1.

GENETIC RESOURCES MANAGEMENT

Germplasm conservation

Coconut

An exploration to Kurmadera coconut plantation in Andamans, comprising old palms, suggested scope of collection of novel accessions for husk traits and high wind tolerance. The fruit characteristics of the population showed wide diversity. Mark Bay, Long Island localities and Kamorta Island of Andaman and Nicobar are identified for further exploration.

The International Coconut Genebank for South Asia and Middle East (ICG-SAME) hosted by India is located at CPCRI Research Centre Kidu (Karnataka). *Ex situ* conservation of the 455 accessions is carried out at field gene banks of Kasaragod and Kidu, along with duplication of selected accessions at ICAR-CPCRI, Research Centres (Mohitnagar, West Bengal) and (Kahikuchi, Assam). The Institute is also undertaking complementary conservation of coconut genetic resources, through cryo-conservation of 30 core germplasm, encompassing accessions from South East Asia, South Asia, Africa, Pacific Ocean, Indian Ocean region, in collaboration with ICAR-NBPGR, New Delhi. Zygotic embryo (30 accessions); pollen (20 accessions) and DNA (16 accessions) are being cryo-conserved at ICAR-NBPGR, New Delhi.

Arecanut

Conservation of 172 accessions of arecanut collected till date is carried out at field gene banks ofICAR-CPCRI, Regional Station, Vittal. Safety duplication of the germplasm is undertaken in the alternate field gene banks established in the Research Centres at Kahikuchi (Assam) and Mohitnagar (West Bengal).

Cocoa

Cocoa germplasm (six Forastero, eight Trinitario and one Green Criollo type) were collected from high hills of Balehonnur (elevation of 800-1000 m MSL) and Bhadravathy river basin of Karnataka state for superior bean traits and resistance to biotic and abiotic stress. Till date, the 530 cocoa accessions collected are conserved in the field gene bank at ICAR-CPCRI Regional Station Vittal. Safety duplication of core germplasm is undertaken in the alternate gene banks maintained at Karnataka (CPCRI Research Centre, Kidu), Tamil Nadu (TNAU) and Andhra Pradesh (YSRHU).

Germplasm characterization and evaluation

Coconut

Characterization and evaluation of coconut germplasm is in progress at Kasaragod (Kerala), Kidu (Karnataka), Mohitnagar (West Bengal) and Kahikuchi (Assam).

	Coconut	
Centre	**Traits**	**Varieties**
Field gene bank ICAR-CPCRI, Kasaragod	High fruit yield	Benalium Tall, Fiji Ringed Nut Tall, Kaithathalli Tall, Niu Leka Dwarf, Lifou Tall, Kappadam Tall, Laguna Tall, Jamaica Tall, Nigerian Dwarf, Fiji Longtongwan, Andaman Ordinary Tall, Palawan Tall, Fiji Tall, Nugli Tall, Samoan Tall and Dhanei Tall.
	Fruit component traits in 12 conserved germplasm:	

	Hazari Tall, Philippines Kalambhahim Tall, Nuwallis Tall, Nu HimiKupien Tall, Laccadive Green Tall, Guam III Tall, Gangabhavani Tall, Fiji Ringed Nut Tall, West Coast Tall, Laccadive Orange Dwarf, Gudanjali Green Dwarf and Chowghat Orange Dwarf	
	Lesser mean fruit weight	Gudanjali Green Dwarf
	Higher fruit weight, endosperm weight, copra weight, husk weight and oil content	Guam III Tall followed by Nuwallis Tall
	Highest mean values for fruit length,breadth, husked fruit weight, shell thickness, shell weight	Philippines Kalambhahim Tall
	Higher fruit to husk ratio	West Coast Tall
ICAR-CPCRI, Research Centre, Kidu	Lowest fruit to husk ratio	Laccadive Orange Dwarf
	Higher female flower production	Laccadive Micro Tall, Andaman Ordinary Tall, Rotuma Tall, Ghaigaita Tall, Karkar Tall, New Guinea Tall, Spicata Tall, Standard Kudat Tall
	76 traits representing tree morphology, reproductive, tender nut and fruit component traits.	597 palms representing 13 accessions viz., Barajaguli Tall, Borneo Tall, Chandra Nagar Tall, Fiji Rotuma Tall, Guam Tall I, Jamaican San Blas Tall, Kulasekharam Yellow Dwarf, Niu Hake Tall, Panama Tall, Pao Pao Tall, Sendegan Tall, Tinnesira Tall, West African Tall
	Reproductive traits and breeding behaviour	30 indigenous accessions, collected from Kerala, Lakshadweep and Andaman & Nicobar Islands
	Low setting percentage	Spicata Tall
	Higher setting percentage	Laccadive Ordinary Tall
	Good tender nut water quality and higher tender nut water content	Selection from the GBGD population
	Fruit morphology in indigenous coconut germplasm	
	Highest whole fruit weight	Tamaloo Tall (IND120)
	Husked fruit weight	Auckchung Tall (IND119)
	Longer fruits with thick husk	Kodiaghat Brown Tall (IND241)
	Higher husked fruit weight,husked fruit length, polar circumference of husked fruit, fruit cavity, endosperm content, copra weight and shell weight	Auckchung Tall followed by Tamaloo Tall
	Higher oil yield per nut	Tamaloo and Auckchung Tall
	Higher percentage of oil in copra	Laccadive Ordinary Tall - Agatti (IND222) followed by Kodiaghat Brown Tall
ICAR-CPCRI, Research Centre, Mohitnagar	Higher annual nut yield under North Himalayan Terai region	BARI Narikel 1, followed by Agailjhara Tall, Chinasukhania Tall, Laccadive Micro Tall, Philippines Ordinary Tall, Adirampatnam Tall.
	Mean annual copra yield	Agailjhara Tall followed by BARI Narikel 1 and Adirampatnam Tall
	Higher fruit weight	Kappadam Tall followed by Agailjhara Tall and Chinasukhania Tall

ICAR-CPCRI Research Centre, Mohitnagar	Higher stem circumference	Nigerian Green Dwarf, Niu Leka Dwarf, Palawan Tall, San Ramon Tall, Markham Tall, Mohitnagar Tall III, Laccadive Orange Dwarf and Kalpatharu.
ICAR-CPCRI Research Centre, Kahikuchi	Higher annual fruit yield	Kera Sankara and Chandra Sankara
	Higher endosperm content	Assam Tall
	Higher fruit length/circumference, husk thickness and husk content	Fiji Tall
	Fruit component characters in local genotypes (KKHC 1-13)	
	Higher annual fruit yield	KKHC 4
	Higher fruit and husked fruit weight	KKHC 12 followed by KKHC 6
	Higher fresh endosperm content	KKHC 6
ICG-SAME, Kidu	Higher yield potential (Tall accessions)	Laccadive Micro Tall, Tiptur Tall, West Coast Tall, Benaulim Tall, Philippines Ordinary Tall, West African Tall, Sambava Green Tall, Tiptur Tall, Andaman Ordinary Tall, San Ramon Tall, Federated Malay States Tall, Comoros Madagascar Tall
	Higher yield potential (Dwarf accessions)	Kulashekaram Green Dwarf, Kulashekaram Yellow Dwarf, Malayan Orange Dwarf, Malayan Yellow Dwarf, Malayan Green Dwarf, Cameroon Red Dwarf, Sri Lanka Red Dwarf

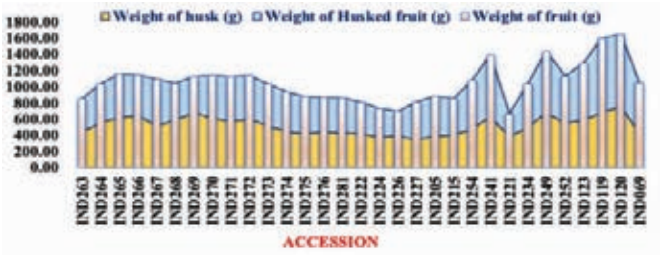


Fig. 1. Fruit morphology in indigenous coconut germplasm conserved at RC, Kidu

Screening against abiotic/biotic stress and studies on pest dynamics

Plant reproductive development is more sensitive to environmental stress, such as drought, compared to vegetative growth. Pollen germination and pollen tube growth of nine genotypes viz., COD x WCT, COD x ADOT, COD x WAT, COD x LCT, MYD x WCT, MYD x ADOT, MYD x WAT, MYD x LCT and WCT were screened at temperature levels from 20°C to 50°C at an interval of 5°C for identifying varieties suitable for mitigating adverse effects of climate change.

Pollen Characteristics	Variety	Temperature
Highest pollen germination	MYDxWCT	25°C
Highest pollen tube length (773µm)	CODxWCT	25°C
Least pollen germination		50°C
Lowest pollen tube length		50°C
Topt		26.1°C to 28.5°C
Tmin		6.0°C to 10.7°C
Tmax		45°C to 48.3°C

Pollen Nutrient Profiling

Nutrient (Highest content in %)	N (5.94)	P (1.07)	Ca (1.00)	Mg (0.36)	K (0.96)	S (0.52)	B (26.5)	Na (0.74)	Cu (122.7)	Zn (248.5)	Fe 327.2 ppm
Variety	MYD x WCT	MYD x WCT	MYD x DOT	MYD x DOT	COD x LCT	COD x LCT	MYD x WCT	MYD x WCT	MYD x ADOT	COD x ADOT	MYD x WAT

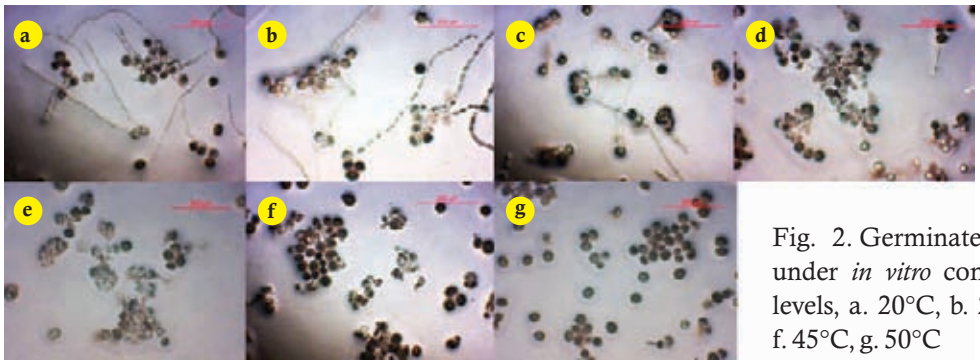


Fig. 2. Germinated pollen grains of MYD x WCT under *in vitro* condition at different temperature levels, a. 20°C, b. 25°C, c. 30°C, d. 35°C, e. 40°C, f. 45°C, g. 50°C

At Mohitnagar, during the last winter season, none of the palms showed cold induced leaf injury symptoms. Among the 15 putative cold tolerant lines, annual growth parameters varied significantly. Mohitnagar-III showed relatively high plant height and vigour, while Mohitnagar-II recorded higher leaf production and longer leaflets. Lataguri-II recorded longer leaves with higher number of leaflets.,

At Kasaragod, fortnightly observations in selected palms on incidence of rugose spiralling whitefly, indicated lower infestation index in West Coast Tall (0.52 scale), while the infestation index was higher in the dwarfs *viz.,* Chowghat Orange Dwarf, Malayan Yellow Dwarf and Chowghat Green Dwarf (2.48, 2.38 and 2.21, respectively).

Population studies

ICAR-CIARI found significant variation in leaf morphology, inflorescence traits, and fruit production in the Ordinary Tall population at Sipighat farm in Andaman. Thirty two palms were selected for crop improvement based on desirable and typical traits, including high fresh endosperm content. These palms had an average estimated annual fruit yield of 110-152 with a mean of 126 fruits, 219 g copra content and an average estimated copra outturn of 27.6 kg per palm year with per fruit under rainfed conditions of Andaman.

Varietal development

ICAR-CIARI approved the release of two dwarf coconut varieties, Dweep Haritha and Dweep Sona, which were selected from Andaman Green Dwarf and Andaman Yellow Dwarf, respectively. These varieties are high yielders suitable for tender coconut purpose under Island conditions. Andaman Yellow Dwarf was found to be robust, while CIARI Omkar seedlings were slow-growing. The SSR-based molecular fingerprints of the dwarf coconut varieties were completed in collaboration with ICAR-CPCRI, Kasaragod.

Comparative evaluation of dwarf accessions

Evaluation of 28 dwarf coconut accessions for higher fruit yield potential is ongoing in Kasaragod. Andaman Green Dwarf and Gangabondam Green Dwarf showed the highest fruit yield, with good yield potential along with Andaman Yellow Dwarf, Malayan Orange Dwarf, Cameroon Red Dwarf, Malayan Green Dwarf, Kulashekaram Yellow Dwarf, Chowghat Orange Dwarf, Laccadive Orange Dwarf, Pemba Orange Dwarf, Surinam Brown Dwarf, and Andaman Orange Dwarf. Inflorescence characteristics varied among accessions, with longer inflorescence in Malayan Green Dwarf, stouter inflorescence in Niu Leka Dwarf, and higher female

flower production in Spicata Yellow Dwarf, although fruit setting percentage was poor in this accession. LCOD 02, a population of Laccadive Orange Dwarf, showed a relatively higher fruit setting percentage.

Evaluation of germplasm for industrial applications/ product diversification

Evaluation of coconut germplasm for processing and product diversification is underway at Kasaragod. The evaluation for inflorescence sap yield and quality in eight accessions showed that Laguna Tall had the highest sap yield (2.04 l/day) followed by Kappadam Tall (1.81 l/day). Endosperm quality evaluation, focusing on endosperm content, milk yield, and quality parameters, was done on 16 genotypes. The endosperm content ranged from 43.17 to 376.67g (15.54-29.6%). Coconut milk yield, pH, fat, protein, and ash content varied among the genotypes, with West Coast Tall, Niu Lekha Dwarf, St. Vincent Tall, Chandra Sankara, and King Coconut showing higher fat and protein content, indicating their suitability for milk extraction and value addition. Testa oils of select genotypes were analyzed for their antioxidant potential and phytosterol content. Cameroon Red Dwarf x Gangabondam Green Dwarf had the highest antioxidant activity, while West Coast Tall had the highest phytosterol content.

Production of planting material for conservation and multi location evaluation

Interse pollination activities were carried out at Kidu, where 35 palms, of 10 accessions, were used to pollinate 2341 female flowers in 159 inflorescences. This generated planting material for conservation or gap filling. At Kidu, a total of 173 interse mated seed nuts from six accessions were sown in the nursery for gap filling purposes. At Kasaragod, 112 nuts from 12 accessions were sown to generate seedlings for gap filling in the germplasm plots.

WCGC, Andamans multiplication of germplasm

Thirty accessions, representing 24 Pacific germplasm collected from Solomon Islands, Fiji, Papua New Guinea, French Polynesia, American Tonga and Samoa and six indigenous Nicobar accessions areconserved at WCGC Sipighat. Inter se mating, pollen collection and selfing for germplasm multiplication and crossing programme are undertaken in selected accessions.

Palm morphology characterization was continued in six accessions at WCGC Sipighat *viz.,* Rennel Tall, Katchal Tall, Auckchung Tall, Tahiti Tall, Tamaloo Tall and Pao Pao Tall, which were identified as potential accessions for utilization in crop improvement programme considering the desirable traits such as higher fruit yield, endosperm content and higher recovery of virgin coconut oil. Besides, the palms in the Pacific germplasm *viz.,* Acc 21, Acc 11, Acc 9, Acc 2, Acc 1, Acc 24, Acc 14, Acc 5, Acc 18 were identified for seed nut production for germplasm multiplication and use in crop improvement programme. Observations were continued in Niu Leka Dwarf population to define the features for selection of mother palms for use in breeding for compact dwarfs in coconut.

On farm trials

Performance evaluation trial of released varieties and selections/hybrids identified for release *viz.,* Kalpa Sreshta, Kalpa Pratibha, Kalpatharu, Kalpa Mitra, Kera Chandra, Kalparaksha, Kalpa Surya, Kalpa Jyothi, Chowghat Orange Dwarf, Kalpa Ratna, COD x WAT, COD x LCT, is in progress in farmer's field in Tamil Nadu.

Arecanut

Evaluation of arecanut germplasm at Vittal, Mohitnagar and Kahikuchi:

Yield evaluation is in progress in the arecanut germplasm conserved in different batches in the field gene banks at ICAR-CPCRI, Vittal, Mohitnagar and Kahikuchi.

At Vittal, among the germplasm collected from Karnataka, Maharashtra and Gujarat, Kodinar recorded higher chali yield with dry kernel yield of 2.75 kg/palm/year followed by Ganapathipule with 2.61 kg dry kernel per palm per year. Among the North Eastern collections, Birubari recorded highest chali yield of 2.32 kg/palm/year followed by K & J Hills with 2.28 kg dry kernel per palm per year. In another batch of North Eastern-III collections, Darangiri recorded dry kernel yield of 1.09 kg/palm/year. Among the collections from

Andaman and Nicobar Islands, higher chali yield of 2.81 kg/palm/year was observed in Cal-29 followed by Cal-6 with 1.90 kg/palm/year. Among the Konkan collections, M. Raigad showed high yielding tendency with dry kernel yield of 2.90 kg/palm/year followed by Shrivardhan-M (2.19 kg/palm/year). In another indigenous collections batch, Thirthahalli-OB recorded higher chali yield with 2.30 kg/palm/year.

At Mohitnagar centre, among the 1988 batch planting (14 accessions), higher number of inflorescence was recorded in Mohitnagar, with chali yield of 3.72 kg/palm/year. The accessions VTL-17(c) and VTL-5 produced chali yield of 1.94 kg/palm/year. In 1990 batch planting, among the eight accessions, three inflorescenceswereproduced in all accessions, except in Areca triandrawhere>12 inflorescence was recorded. Higher chali yield per palm per year was recorded in Sweet Arecanut (1.39 kg) followed by VTL-29 (1.25 kg). In 1991 batch planting encompassing 12 accessions, more inflorescences (5.1) and higher chali yield (4.09 kg) was produced by VTL-27 followed by VTL 29(b) (2.08 kg). Among the 1992 planted accessions, higher chali yield of 2.77 kg/palm/year was recorded in VTL18 (c). Among the 19 NE collection planted during 1994, Nalbari recorder higher inflorescence production (4) and higher chali yield (3.56 kg/palm/year), followed by Kahikuchi (3.10 kg) and K & J (2.92 kg), respectively. Among the different Calicut accessions planted in 1997, average number of inflorescences ranged between 3.0-3.5, with higher chali yield (3.42kg/palm/year) recorded in Calicut-27, followed by Calicut-20 (3.30 kg/palm/year).

At Kahikuchi centre, among the 18 conserved accessions *viz.,* Bongera, Borehat, Kamalpur, Moralpara, Auniati-2, Chaygoan-1, Auniati-1, Kahikuchi, Saragoan-1, Panicha, Chayagoan-2, Saragaon-2, Nalbari, Dongapara, Thargira, Birubari, Shell Shella, K & J Hills, the accession Shell Shella recorded higher chali yield (2.8 kg/palm/year) with higher mean single fresh and dry kernel weight of 14.56 g and 8.53 g, respectively.

Estimation of fat content in arecanut germplasm

Fat content was estimated in nuts of 15 accessions namely, Saragoan, Chaygoan-II, Moralpara, Shell Shella, Bongera, Kahikuchi-I, Borihat, Kamalpur, K & J Hills, Auniati-I, Auniati-II, Birubari, Dauki Hills-I, Dauki Hills-II and Badarpur. Highest fat content of 34% was recorded in Borihat, followed by Badarpur (29.5%) and the lowest fat content of 10% was observed in Bongera.

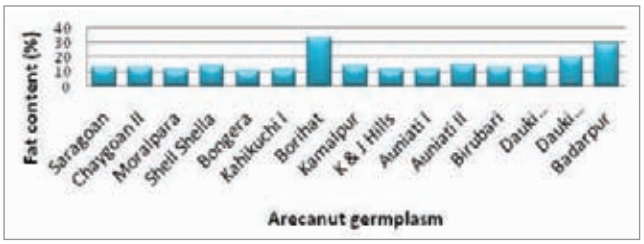


Fig. 3. Variations for fat content among arecanut germplasm

Development of arecanut mapping populations:

Parents with contrasting traits Hirehalli Dwarf (short stature), Sumangala (tall type from Indonesia), and Mohitnagar (high yield potential from West Bengal) were selected for the development of mapping population. Controlled crosses between Hirehalli Dwarf x Sumangala and Hirehalli Dwarf x Mohitnagar were made to obtain the mapping populations.

HD x Sumangala *HD x Mohitnagar*

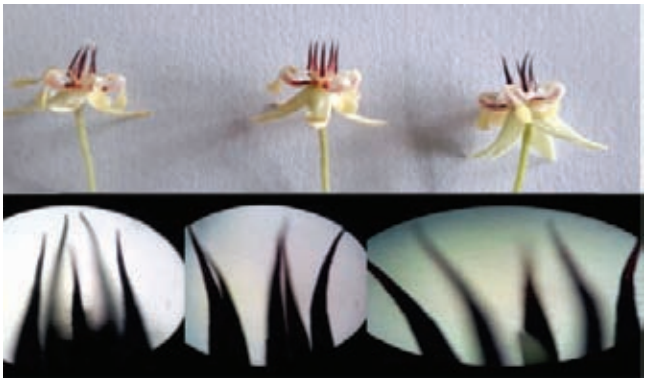
Fig. 4. Arecanut hybrid seedlings

Cocoa

Diversity in staminodes of cocoa flowers:

Cocoa flowers have ten stamens in two whorls, with five fertile and five sterile staminodes. This makes them less adapted for self-pollination. Pollinating midges are attracted to the pigmentation in the staminodes and petals. Different types of staminodes, including converged, parallel, and splay types, were observed among 12 clones at Vittal, with

some trees exhibiting no fruit set, partial set, and full set. In addition to genetic factors, floral structure may also affect the entry of insects and the percentage of natural fruit setting.



Converged Staminode | Parallel Staminode | Splay Staminode

Fig. 5. Types of staminodes in cocoa flower

Evaluation of cocoa clones

Among 14 year old trees of 15 Ghana collections, 30-105 pods were recorded from 13-15 m2 canopy area. VTLC 87 and VTLC 100 recorded higher yield of 2 kg dry beans/tree/year. Among 40 Amazon collections, with a canopy area of 15-20 m2, yield ranged from 13 to 55 pods. VTLC 145, 156, 151 recorded 2 kg dry bean yield/tree/year. Among 12 year old trees of 30 Peruvian collections, 10-56 pods were observed in 12-14 m 2 canopy. VTLC 233, 205, 210 recorded 2 kg dry bean yield/tree/year. Evaluation of old cocoa collections at Kahikuchi, indicated dry bean yield ranging from 0.58 to 1.85 kg per tree per year. Higher pod weight (690 g), beans per pod (41) and dry bean yield (1.85 kg) was recorded in KHIC–4 followed by KHIC–13 (1.33 kg/tree/year).

Promising cocoa clones

Amalaysian Forastero, I-14, is identified as apromising clone with 2.0-3.5 kg dry bean yield/tree/year. Pod yield ranged from 50-65/tree in an optimal canopy of 15-18 m^2 both under arecanut and coconut in Karnataka and Kerala. Having green to yellow, smooth pods weighing 380-400 g, comprising of 41-43 beans/pod with a single bean weight of 1.0-1.2 g, 13% shelling, 85% nib recovery and 50% fat. This clone exhibited field tolerance to black pod rot, tea mosquito bug, mealy bugs, marginal management and water limited conditions. It is better combiner for hybrid development and suitable for high density cropping models as well.

Fig. 6. Forastero cocoa clone I-14 with pod cluster

Performance of cocoa genotypes at Kahikuchi

Evaluation of old cocoa collections at Kahikuchi indicated that total dry bean yield ranged from 0.58 to 1.85 kg per tree per year. Among the collections, higher pod weight (690 g), higher number of beans per pod (41) and higher dry bean weight per tree per year (1.85 kg) was recorded with KHIC – 4 followed by KHIC – 13 (1.33 kg/tree/year).

Fig. 7. Promising cocoa accession KHIC-4 at Kahikuchi

Biochemical characterization of cocoa accessions

Fat content in 64 germplasm collections comprised of Malaysian, Nigerian and Wayanad at Vittal, ranged from 38 to 52%.

Evaluation of regional cocoa beans for qualitative improvement

Beans were collected from farmers' gardens and multilocation trial plots and assessed for regional diversity and quality. In Andhra Pradesh, single dry

bean weight varied from 0.80-1.62 g with 34.9-64% fat. In Karnataka, bean weight ranged from 1-1.56 g with 51-52% fat. In Kerala, bean weight was 1-1.66 g with low fat of 42-47% and in Tamil Nadu, beans were of 1-1.2 g size with fat of 42-50%. These variations were observed in bulk cocoa grown under normal environment and following farm level primary processing of fermentation and drying methods.

Tolerance to black pod rot disease

Among Nigerian collections, VTLC 35 was found to be tolerant to black pod rot. Among hybrids VTLCH 2 showed <5% damage at Vittal, Kidu and Kasaragod and the parental clones VTLC 61 and VTLC 66 showed 10% and 3% infection under arecanut and coconut at Vittal and Kasaragod. DNA extraction was done from the resistant hybrid VTLCH 2 and the tolerant parent VTLC 66 and susceptible parent VTLC 61 for further molecular analysis.

Coconut

Hybrid evaluation trial

Several hybrid evaluation trials are in progress at different locations. In the 1996 trial at Kidu, WAT x NAT and WAT x RET performed well for yield, on par with COD x WCT. In the 1998 Kidu trial, CGD x LCT had the highest mean number of female flowers, while COD x WCT had the highest mean number of nuts per bunch. In a different trial, PHOT x CGD had higher fruit weight, breadth, circumference, and husked fruit weight. In the 2013 DxT trial at Kasaragod, MYD x CCNT had relatively higher yield, and GBGD x CCNT and CRD x CCNT also performed well. GBGD x CCNT had the highest number of female flowers, followed by CGD x SNRT, MYD x SNRT, COD x CCNT, and COD x CCNT.

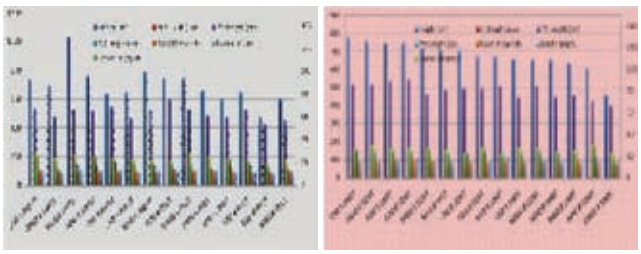


Fig. 8. Palm characters in DxT hybrids (2013 Planted at Kasaragod)

Three different hybrid evaluation trials were conducted in Kidu and Kasaragod. In the 2014 Kidu trial, where 26 different hybrid combinations were evaluated, GBGD x PHLT had the highest number of female flowers per inflorescence, while MYD x SNRT had the highest number of nuts per inflorescence. MGD x CCNT had the highest weight of tender nut, while COD x SNRT had the highest liquid endosperm content. GBGD x SNRT had higher values for fruit weight, length, polar and equatorial circumference, and copra recovery per husked fruit. GBGD x CCNT combination also had higher values for husked fruit weight, fresh endosperm weight, shell weight, and copra per nut. In the 2003 Kidu trial, MOD x NLAD recorded the highest fruit weight, polar circumference of fruit, and weight of husked fruit compared to other combinations. MOD x HPOD had the highest copra weight per nut and copra recovery. COD x CGD combination had the highest mean number of female flowers per inflorescence and nuts per bunch. In the 2016 Kasaragod trial, higher fruit production was observed in several D x Dhybrid combinations involving seven dwarf parents. These hybrids also recorded positive heterosis for nut yield over the standard check variety COD. Studies on tender nut and fruit component traits indicated significant differences between the treatments, with higher fruit weight and greater tender nut water content in MYD x NLAD. Higher tender nut water content was also recorded in GBGD x COD and MOD x NLAD

Development of coconut in breds

In the inbred development programme, 117 S3 seedlings from six S2 families along with 33 palms of WCT S2, WCT (OP), WCT S2 x GB, WCT S1, GB x WCT S2, and MYD x WCT S2 have been established in the field. Differences in growth characters were observed in S3 seedlings. This year 41 palms have started flowering. Among the yielding palms, palm number 172 recorded highest tender nut water (430 mL) with TSS of 5.8°Brix , followed by palm number 149 with 420 mL of tender nut water with TSS of 5.0°Brix.

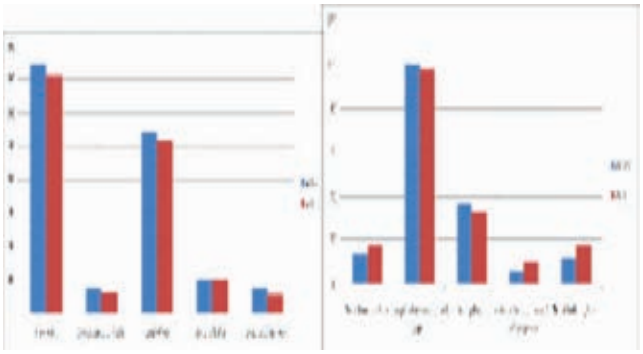


Fig. 9a. Palm characters in WCT S3 and WCT
b. Reproductive characters in WCT S3 and WCT

Genetic investigations

Pollination for new hybrid combinations, to produce self and inter se progenies was continued at Kidu. For progeny studies, selfed nuts were harvested from MYD x NLAD (80) and MYD x CGD (27) and sown in the nursery at Kidu. Selfing was continued in palm 285-D of MYD x NLAD palm 18-D in MYD x CGD. Genotyping of LMT x COD progenies produced at Kasaragod is in progress to facilitate marker trait association studies.

A collection of 96 palms, representing 16 diverse coconut accessions from the International Coconut Genebank for South Asia and the Middle East (ICG-SAME) and National Gene Bank, Kidu, India, was analysed using 35 simple sequence repeat (SSR) loci. The accessions exhibited high genetic diversity, with the number of alleles ranging from 2 to 22, and an average of 6.2 per locus. Hierarchical clustering analysis grouped the genotypes into two major clusters with two sub-groups, which corresponded with the geographic origins. The first cluster comprised the dwarf accessions, and the second cluster comprised all the tall accessions. Population structure analysis using STRUCTURE software showed two major populations (P1 and P2). Principal coordinate analysis (PCoA) based on Nei's unbiased genetic distance showed the separation of all the Tall and Dwarf accessions on the first axis, and distinguished the South East Asian and South Asian accessions from Indo-Atlantic and African accessions on the second and third axes. The first, second, and third axes showed 18.7%, 7.69%, and 6.27% variation, respectively, and the first three axes accounted for a total cumulative variation of 33%.

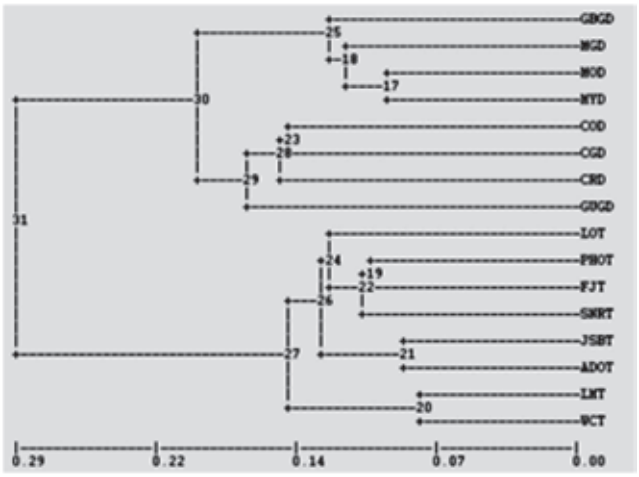


Fig.10. UPGMA phenogram based on Nei's (1973) genetic distance showing the relationships among the coconut accessions

A unique dwarf palm identified among seedlings of Lakshadweep population collected and sown at Kidu was planted at Kasaragod. The palm started flowering but no fruit set was observed for three consecutive years. Pollen collected from the palm was used to pollinate one COD palm and progeny of 54 seedlings were planted in the field at Kasaragod during 2018. Morphological observations on these seedlings were recorded this year also. The unique dwarf is continuously observed for fruit set. Height of the seedlings in third year varied from 179 to 434 cm. Three seedlings of unique dwarf palm progeny have flowered this year.

Breeding for resistance to root (wilt) disease

In the evaluation trial involving 13 tall accessions planted during 2014, highest incidence of root (wilt) disease after eight years of planting was recorded in Andaman Ordinary Tall (25%) followed by Federated Malay States Tall (20.8%). The average nut yield was highest in St. Vincent (72.3 nuts/palm/year) followed by Kalpa Haritha (63.2 nuts/palm/year).

After ten years of planting, the second generation *inter se* mated progenies of healthy and disease-free WCT palms recorded higher root (wilt) disease incidence (9.1%) compared to the selfed progenies (5.0%). Selfed progenies recorded higher average nut yield (60 nuts/palm/year) compared to *inter se* mated progenies (39 nuts/palm/year).

In the evaluation trial involving six green dwarfs planted in 2013, the highest root (wilt) incidence after nine years of planting was in Andaman Green Dwarf (22.2%) followed by Gangabondam Green Dwarf (18.6%) and Niu Leka Dwarf (18.6%). Kalpasree and Gudanjali Green Dwarf remained disease-free even after nine years of planting. During the reporting period, average yield was highest in Andaman Green Dwarf (106.5 nuts/palm/year). Artificial pollination was carried out on 55 CGD palms at CPCRI RS, Kayangulam for production of CGD x WCT, CGD x ADOT, CGD x MGD and CGD x AGD hybrid combinations for evaluation in the root (wilt) disease prevalent tract.

Release of Kalpa Vajra coconut variety

'Kalpa Vajra', a new and improved tall variety of coconut was produced by crossing high yielding and root (wilt) disease-free WCT palms, selected after serological testing from farmer's plots located in 'hotspots' of root (wilt) disease. Compared to WCT (OP) and WCT (Self), 'Kalpa Vajra' has high yield and low incidence of root (wilt) disease. It also has superior nut quality. The average yield of 'Kalpa Vajra' was 80 nuts/palm/year, and in performance evaluation trials at CDB Farm, Neriamangalam, it yielded 94 nuts/palm/year compared to 69.4 nuts/palm/year for WCT (OP). Root (wilt) disease incidence of 'Kalpa Vajra' was less than 20%. Because of its superior performance, 'Kalpa Vajra' is recommended for cultivation in areas with root (wilt) disease.

Cytological and anatomical studies on twin coconut seedlings

Leaf and root samples were collected from an abnormal twin coconut seedling for molecular and cytological studies. Mitotic chromosome number from root tip cells was found to be 32 and 16 in the root samples collected from the twin seedlings. Stomatal density, length and width of guard cells were recorded from leaf epidermal cells. Ploidy of the seedlings was checked and fluorescence intensity of putative haploid was found to be half of the reference sample which confirmed the haploid nature of one of the twin seedlings.

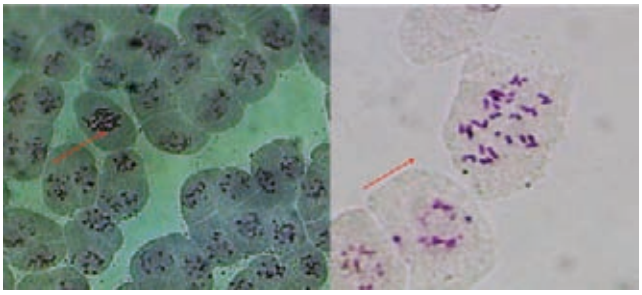


Fig. 11. Cell with haploid (n=16) and diploid (2n=32) set of chromosomes

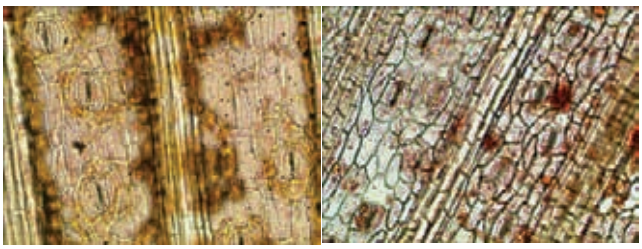


Fig. 12. Leaf section withless dense, small stomata in diploid and dense, large stomata in haploid cococnut seedling

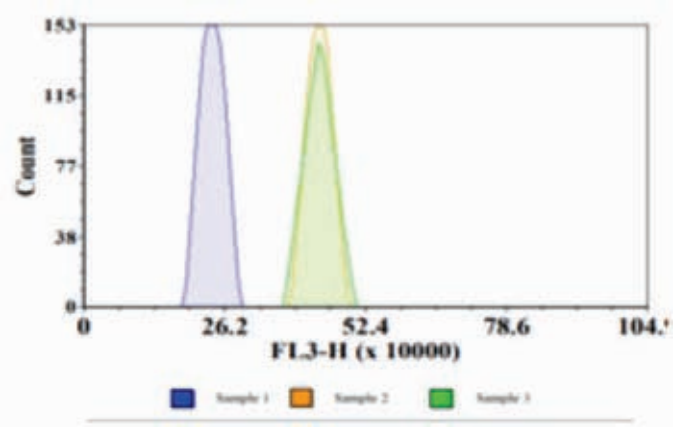


Fig. 13. Histogram of ploidy analysis of leaf samples sample1: Putative haploid twin seedling, sample2: Diploid reference sample, sample 3: Diploid twin seedling

Floral visitors associated with dwarf varieties of coconut

From the observations recorded for nearly five years (2016-2020), about 35 insect species were found associated with coconut inflorescence in dwarf cultivars, of which, 30 insects could be identified taxonomically by experts. Based on abundance, bulk of the floral visitors belonged to the family Formicidae followed by Curculionidae (Fig. 14). Among the identified insects, order Hymenoptera

especially ants were found dominant over the Coleopterans. Among the insect species, Formicidae (mostly ants) followed by Curculionidae (weevils) and Apidae (bees) were the major and dominant floral visitors. Ants though recorded as major floral visitor could be visiting the coconut inflorescence for feeding on the nectar source and may not carry sufficient pollen grains on their body parts. Presence of a small curculionid weevil (*A. coimbatorensis*) was frequently noticed in large numbers on male flowers of coconut inflorescence. *Braunsapis* sp. and *eratina* sp. were also recorded from the inflorescence of dwarf varieties of coconut. Thus, coconut inflorescence attracts and sustains a wide array of insect fauna providing pollen and limited nectar throughout the year constituting an important ecosystem service provider in this current world of diminishing foragers for lack of food reserves.

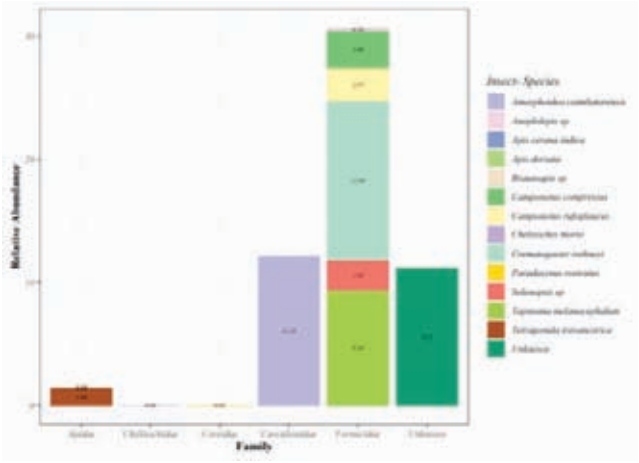


Fig. 14. Family and species-wise relative abundance of floral visitors on coconut

In general, the species richness was significantly higher during first seven months (January to July) of the year compared to the next five months (August-December) coinciding with second phase of monsoon and post-monsoon period. The maximum species richness/diversity was noticed during the month of February followed by May and June and the lowest was during the month of September.

The insect activity recorded during different time periods of a day revealed that maximum insect activity happened during forenoon (Shannon index-1.89) compared to after noon (Shannon index-1.79). During forenoon, the maximum insect activity is recorded during 10.00 hrs compared to 12 noon. Hence, the insect activity has correlation with the anthesis time of coconut which is mostly during 7.00-11.00 hrs.

Establishing seed gardens of released varieties along with government agencies

Seedlings of released varieties of coconut were supplied from ICAR-CPCRI Regional Station, Kayamkulam to District Agricultural Farm-Kollam (150 nos.), Coconut Development Board-Ernakulam (100 nos.), Kerafed-Karunagapally, Kollam (50 nos.), Krishi Vigyan Kendra-Pattambi, Palakkad (25 nos.), District Agricultural Farm-Kottayam (80 nos.), District Agricultural Farm-Thiruvananthapuram and Banana Nursery-Thiruvananthapuram (175 nos. each).

Arecanut

Evaluation of dwarf hybrids

The evaluation of eight arecanut hybrids involving Hirehalli Dwarf and other released varieties was conducted at Vittal, Mohitnagar, and Kahikuchi centres. The highest dry kernel yield of 1.41 kg/palm/year was recorded in HD x Mohitnagar at Vittal station. Kahikuchi variety produced the maximum chali yield (2.65 kg/palm/year) among the parental lines at Kahikuchi Centre, while Sreemangala x HD recorded the highest chali yield (2 kg/palm/year) among the hybrid combinations. Mohitnagar variety produced the maximum nuts per palm per year (414.4) and chali yield/palm/year (4.061 kg) among the parental lines at Mohitnagar Centre, while Mohitnagar x HD recorded the highestdry kernel yield (2.291 kg/palm/year) among the hybrids.

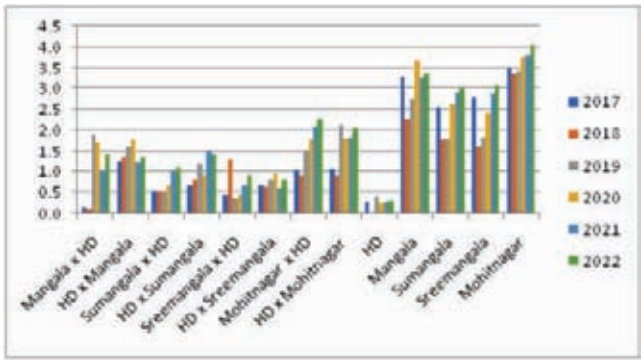


Fig. 15. Yield performance of dwarf hybrids along with parental lines (Mohitnagar Centre)

Six years average yield data showed that cross combination Mohitnagar x HD and HD x Mohitnagar produced maximum chali/palm/year (1.6 kg) followed by HD x Mangala (1.4 kg), Mangalax HD (1.1 kg) and HD x Sumangala(1.1 kg).

Inter-specific hybridization for fruit rot and YLD screening

Interspecific crossing was done between *Areca triandra x A. catechu and Areca catechu x A. triandra* to screen forfruit rot incidence and yield. Nearly 1200 and 1075 flowers were pollinated in each cross respectively, with nut setting percentage of 16.58% and 45.12%. A total of 204 seedlings of Areca catechu x A. triandra were obtained with 85.6% germination rate and will be screened for fruit rot resistance before planting in YLD hot spot areas.

Cocoa

Compatibility studies in cocoa with natural fruit set

The study assessed 235 grafted and 169 seedling trees of 12 cocoa genotypes for flower cushions, flowers per cushion, and compatibility reactions. Flower cushions ranged from 20 to 230, flowers per cushion from 8 to 24, and cherelle set from 5-10 per cushion. Precocious and profuse flowering was observed in red genotypes, and partial cherelle set was observed in 16 trees. Three trees were observed as both self and cross incompatible and will be utilized for molecular studies.

Fig. 16. Flowering branches of cocoa at RS, Vittal

Promising Cocoa Hybrid

A Trinitario hybrid between I-14 x I-56 is found to be promising with 2.0-3.5 kg dry bean yield/tree/year. Pod yield ranged from 60-65/tree in a canopy of 18-20 m2 under arecanut and coconut in Karnataka. Having red to orange smooth pods weighing 350-380 g with 40-42 beans with a single bean weight of 1.0-1.15 g, 15% shelling, 85% nib recovery and 50% fat. It also exhibited field tolerance to black pod rot, tea mosquito bug and mealy bugs. Suitable for high density cropping under arecanut and coconut with recommended fertilizer and irrigation schedules.

Fig. 17. Promising Trinitario hybrid I-14xI-56 pods

Performance of cocoa genotypes in Mohitnagar

The performance of different cocoa genotypes at ICAR- CPCRI RC Mohitnagar is depicted in the figure given below. It was found that different cocoa genotypes performed differently in both the conditions. Most of the genotypes performed well under arecanut. Among the 14 cocoa genotypes, the performance of VTLC-5 VTLCC-11, VTLCH-1 and VTLC-5 is better and is on par in terms of dry bean yield/ tree/ year under arecanut garden, however, the performance of VTLCH-4, VTLC-5, VTLC-11 and VTLCH-1 was better under coconut.

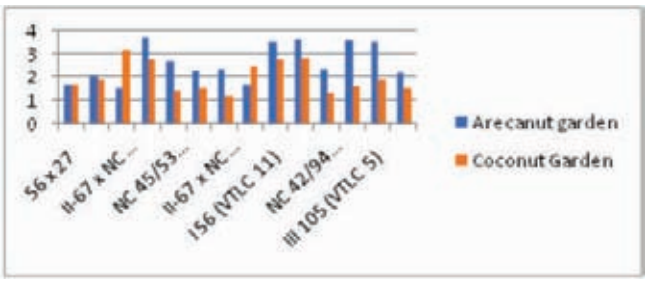


Fig. 18. Dry bean yield/tree/year of different cocoa genotypes at different conditions

Planting Material Production

Kasaragod

In coconut, 14493 hybrid seed nuts were produced and sown in the nursery from the flowers pollinated last year. This year 118271 female flowers from 500 WCT and 20 LCT palms were pollinated. About 26805 seed nuts of other coconut varieties were produced and sown in the nursery for seedling production.

Breeder seed production was undertaken in released varieties like Kera Chandra, Kalpa Prathiba, Kalparaksha, Kera Bastar, Kera Keralam, Chandra Kalpa, Kalpatharu, Kalpa Ratna, Kalpa Haritha, Kalpasree, Kalpa Surya, Kalpa Jyothi and Chowghat Orange Dwarf, both at Kasaragod and Kidu.

Observations on characters of polybag and nursery seedlings were recorded to develop seedling standards for six,nine and twelve month old seedlings.

Kidu

In coconut, 30509 hybrid seed nuts from COD-assisted pollination and 28331 nuts from tall and dwarf varieties were sown in the coconut nursery last year. This year, 69,604 female flowers from 2596 inflorescences of 417 WCT palms were pollinated with COD pollen, along with other pollination activities across various palms. In Arecanut, 50,313 seedlings, 4,03,325 seed nuts, and 94 VTLAH-2 hybrid seedlings were produced. Manual pollination was done on Hirehalli dwarf palms and other palms for VTLAH-1 and VTLAH-2 hybrid seed nut production and inter-se planting material. Additionally, 1507 cocoa seed pods were produced and sold during the period.

Vittal

In Arecanut, 2,10,683 (1,19,638 seed nuts, 87,275 seedlings and 3,770 sprouts) planting materials were distributed during the period. This year, 8220 female flowers of various varieties were pollinated for production of hybrid seed nuts.

Based on observations during previous year (2020-21), arecanut leaf sheath eco grow bags treated with 1% Bordeaux mixture did not rot for up to three months. For further increasing the shelf life, arecanut leaf sheath bags were coated with eco-friendly resins/gums/wax. Ecopots were prepared from arecanut stem and bamboo culms for raising arecanut seedlings as alternative to polythene bags and also to add value to arecanut stem.

Fig. 19. Biodegradable grow bags and pots made from arecanut leaf sheath and stem

In Cocoa, 14252 cocoa seed pods and 32084 seedlings were produced and distributed. Budding in cocoa is standardized with 75% success.Top working methodologies were tested on old trees to rejuvenate unproductive and incompatible trees.In situ grafting methodology was tested on young seedlings planted in the plot to increase anchorage, to avoid orthotropic shoots/ chupons arising frequently from rootstocks and to increase the percentage of true to type clones in plots.

Fig. 20. *In situ* grafting in seedlings planted in plot

Kayamkulam

About 36404 seed nuts of coconut were produced from mother palms in the centre and from mother palms from farmer's field in participatory mode and sown in the nursery at Kayamkulamcentre including 3721 artificially pollinated (CGD xWCT) seed nuts. Artificial pollination was carried out on 213 dwarf parental palms involving 7430 inflorescences and 19011 female flowers.

Pollination using modified ground pollination technique was carried out on 102 parental palms (39 dwarf and 63 tall mother palms) at three centres of ICAR-CPCRI (Kasaragod, Kayamkulam and Kidu) and at two AICRP (Palms) Centres during December 2020 to April 2021. In total, the modified ground pollination was attempted on 579 inflorescences covering 12157 female flowers. Based on the nuts harvested during the period December 2021 to April 2022, the technique resulted in a setting percentage of 24% which was comparable with the fruit set obtained with normal manual pollination.

Mohitnagar

About 93400 seed nuts and 29524 seedlings of arecanut, 113 seedlings of coconut, 230 cocoa seedlings, 2874 black pepper cuttings and 437 acid lime seedlings were produced.

Kahikuchi

A total of 38,105 arecanut seed nuts and 2,562 cocoa seeds were sown in the nursery for production of quality planting material at Research Centre, Kahikuchi.

Evaluation farmer's variety MM 20 of betel vine

A trial of betel vine farmer's variety MM 20, was planted during the year at Mohiutnagar centre, along with 10 other betel vine varieties *viz.,* T1- Gole Bhavana, T2- Bagherhat, T3- Bhavna, T4-Gayasukh, T5-Chalani Bangla, T6-KAtki, T7-Kamundali, T8- Mohitnagar Local, T9- Bidhan Pan 1, T10-Kalibangla, for evaluation and validation.

DUS Characterization

DUS Centre for coconut

Candidate variety (REG/2015/415) under DUS testing at ICAR-CPCRI, Kasaragod,showed higher palm height, longer petiole and leaves than reference varieties. Flower initiation was observed in 33% of palms in the candidate variety. DUS descriptor data was recorded for the farmer's variety (Reg/2014/1949) of Edava long fibre coconut. Growth characteristics were recorded for extant/reference/example varieties of coconut, with Chandra Kalpa showing higher trunk length, leaf length, leaflet length and leaf production under 4m x 4m spacing, while KalpaDhenu showed broader leaflet and Kalpa Pratibha showed longer leaflet under 6m x 6m spacing. Higher fruit yield was recorded under 6m x 6m spacing.

DUS Centre for Arecanut

Morphological traits were recorded in reference varieties of arecanut at ICAR-CPCRI, Vittal, including plant height, stem height, crown length, crown shape, girth, internodal length, number of leaves, number of leaflets, and fresh/dry nut characteristics. At Mohitnagar, plant height, girth, number of leaves, leaf length, leaf sheath length, and number of leaflets were recorded in reference varieties. Fifteen arecanut varieties were studied for vegetative growth under Assam conditions, with Kahikuchi recording the highest seedling height (171 cm) at 18 months after germination and VTLAH-1 recording the highest girth at collar (2.83 cm). VTLAH-2 recorded the highest number of leaves (5.00), followed by VTLAH-1 (4.57).

Cocoa DUS Guidelines

Guidelines for conduct of test for distinctiveness, uniformity and stability (DUS guidelines) onCocoa with 25 characteristics were published in December 2022 by the PPV & FRA, New Delhi.

2.

BIOTECHNOLOGICAL INVESTIGATIONS

Coconut Tissue Culture

Improved callus induction, formation of embryogenic calli and somatic embryos

Plantlets obtained from plumule in Y3 media supplemented with serially reduced concentrations of picloram and meta-topolin, are now in the pot acclimatization stage. Embryogenic calli were obtained from plumular explant in Y3 media with picloram and supplemented with flurprimidol and spermidine. Multiple shoot initiation was observed in plumular explants of coconut in Y3 media supplemented with adenine sulphate and picloram.

Fig. 21. Plantlets obtained from plumular explants of coconut from medium supplemented with meta-topolin.

Methylation / metabolome in somatic embryogenesis

Thin layer sections of mature zygotic embryos (WCT cv.) inoculated in Y3 medium supplemented with 16.5 mg L^{-1} 2, 4-D, 1 mg L^{-1} TDZ, and four concentrations of azacytidine (0, 10, 15 and 20 µM) yieldedenhanced somaticembryos and plantlet regeneration. Y3 media supplemented with 15 µM 5-azacytidine resulted in an average of 3±2 somaticembryos per embryo. Somatic embryos were germinated, with shoot and root development.

Fig. 22. Influence of 5-azacytidine on somaticembryogenesis and plantlet development from plumular explant of coconut

Immature inflorescence culture

Rachillae bits from immature inflorescences with outer spathe lengths of 2–12 cm from 25 to 30 year old palms (WCT cv.), were inoculated on to different media (Y3, MS or WPM) combinations, supplemented with 2,4-D (1 mg L^{-1}; 100 mg L^{-1}); 2iP (3 mg L^{-1}), picloram (36 mg L^{-1}; 72 mg L^{-1}) or TDZ (5 mg L^{-1}). The basal media also contained 40 g L^{-1} sucrose, 1 g L^{-1} charcoal and agar 6 g L^{-1}. The cultures were incubated in the dark at 27±2°C for eight months. The explants in media containing Y3 with 2,4-D (1 mg L^{-1}) swelled rapidly, whereas those in Y3 media supplemented with picloram turned brown. The cultures in picloram-supplemented media turned brown immediately after inoculation. The cultures in Y3 with 2,4-D 1 mg L^{-1} media remained fresh even after 3 months (Fig. 23a & b), indicating that this medium is best suited for culture initiation using immature inflorescences explants.

For studying the effect of the size of inflorescences, inflorescences were grouped into four categories, *i.e.* those with outer spathe lengths of less than 5 cm, 5 cm to 10 cm, 10.5 cm to 15 cm and more than 15 cm and the rachillae bits were inoculated in Y3 with 2,4-D and incubated under dark conditions. Maximum shoot regeneration was recorded when

Fig. 23. Immature inflorescence culture in coconut. a & b: rachillae bits in WPM supplemented with TDZ

explants were taken from 5-10 cm inflorescence, followed by 10.5 to 15 cm. There was no shoot regeneration in explants from the larger inflorescence of more than 15 cm. Rachillae bits from smaller inflorescence produced calli, whereas larger inflorescences formed floral structures. The correct developmental stage of inflorescence is, therefore, important for the success of direct organogenesis.

In the culture initiation stage, the parameters like browning and hyperhydricity were influenced by the type of gelling agents. In contrast, during the shoot multiplication phase, the gelling agent used in the medium significantly influenced the parameters like the number of shoots per explant and the quality of cultures. Among different gelling agents, gellan gum at 2.5 g L^{-1} resulted in more multiple shoots (6.2), followed by Clerigar (5.77) at 5 g L^{-1}, which was on par. However, there were more vitrified shoots in cultures grown in media containing gellan gum (3.9) followed by Clerigar (1.87). The effective number of shoots was highest in Clerigar (3.9), followed by agar (3.5) and was lowest in gellan gum (2.3).In the shoot elongation stage, the individual shoots were separated and cultured in media containing Y3 supplemented with 2iP and NAA and various gelling agents. The results show that the quality score (3) was highest in Clerigar, and the lowest hyperhydricity was recorded in agar (21%), followed by Clerigar (25%). The quality score was determined based on the number of hyperhydric shoots, brown shoots and normal green leaves.

Seven tissue culture coconut seedlings were planted in Block VII of ICAR- CPCRI, Regional Station Kayamkulam.

Arecanut Tissue Culture

In vitro multiplication of arecanut

Immature inflorescence from arecanut varieties, VTLAH-1, VTLAH-2, Hirehalli Dwarf (HD), Shatamangala and Yellow Leaf Disease resistant palms (S-18, S-34, S-42) were collected from Regional Station, Vittal and Sampaje-Sullia regions of Karnataka. The explants were inoculated for callus induction and somatic embryogenesis. The immature inflorescence collected by non-destructive sampling was inoculated in Y3 media supplemented with a high auxin concentration (picloram). After two weeks, they are sub-cultured at monthly intervals to serially reduced concentration of picloram, i.e., P100, P50 and P25. Callus initiation percentages were as follows: VTLAH-1:12.5%, Shatamangala: 10.86%, S-18:32.43%, S-34:2.12%, S-42: 7.14% and VTLAH-2:13.15%. No callus initiation was observed in HD cultures.

Effect of polyamines on somatic embryogenesis

The effect of exogenously added polyamines in somatic embryogenesis in arecanut cv. Shatamangala was examined. Spermine and spermidine (10 and 20 µM) and picloram 200 µM were tested for callusing and somatic embryogenesis from immature inflorescence cultures of arecanut. Explants were serially sub-cultured from higher to lower concentrations of picloram (from 200 to 2.5 µM). The concentrations of polyamines were reduced to half during the first subculture (10 and 5 µM) and maintained constant until the somatic embryogenesis process. Browning of explants varied from 60-100% in different treatments. Callusing (2.89-3.15%) and direct somatic embryogenesis (2.64%) from inoculated explant tissues were noticed in picloram + spermidine (10 and 20 µM) media. In contrast, used concentrations of picloram alone and picloram + spermine (10 and 20 µM) were ineffective for induction of callusing and somatic embryogenesis from immature inflorescence culture of arecanut cv. Shatamangala.

Embryo rescue of inter-specific hybrids in arecanut

Zygotic embryos from immature nuts of Areca *triandra* × *Areca catechu* (Shatamangala) were rescued successfully and cultured in to a Y3 medium supplemented with glutamine since mature nuts of

this cross rarely germinate in nature. Cultures wereincubated in the dark at 27±100C for germination and shifted to light after germination.

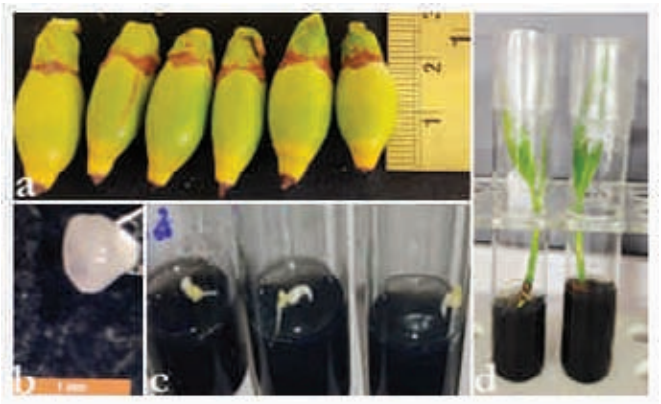


Fig. 24. Embryo rescue in interspecific hybrids of arecanut. a: seven months old nuts of *Areca triandra* × *Areca catechu* (Shatamangala); b:microscopic view of the zygotic embryo; c:germination of embryos in *in vitro* medium; d: rooted plantlets.

Cryopreservation Studies

Effect of nanoparticles on coconut plumule cryopreservation

The v-cryomesh method assessed the effect of single-walledcarbon nanotubes, SWCNTs (@ 0.25 and 0.5%, on plumule cryopreservation. Plumule explants from the WCT cultivar were pre-cultured on 0.4 and 0.5 M sucrose containing Y3 medium for three days. Explants were treated with loading solution (with 0, 0.25 and 0.5% SWCNTs), encapsulated in sodium alginate upon sterile cryomesh and treated in PVS3 (with 0, 0.25 and 0.5% SWCNTs) for 30 and 60 min. Cryomesh and the explants were cryostored in a cryo vial containing fresh respective PVS3. Cryo preserved explants were fast-thawed and treated with an unloading solution to subculture in a recovery medium. Recovery was highest (42%) in explants pre-culturedin 0.5 M, followed by treatment with 0.25% SWCNTs and 30 min. dehydration in PVS3.

Long-term conservation of arecanut pollen and its viability and fecundity

Arecanut pollen was collected from male flowers (cv. Mangala) after desiccating at 35°C for 24 hrs. Desiccated male flowers (15 g) were mixed with 15 mL of fresh virgin coconut oil (VCO) in a sterile graduated conical centrifuge tube. The VCO and pollen grains (P-VCO) were pipetted to a vial. Results demonstrated an easy method of pollen extraction from arecanut since they have sticky pollen grains. The germination per cent was quite high, and pollen grains were viable for a week at room temperature. Satisfactory germination of pollen was also noticed after cryopreservation. Normal nut setting was noticed with cryopreserved arecanut pollen extracted with VCO (P-VCO) after 24 hours of storage in liquid nitrogen. Further, 90% germination of the nuts was observed.

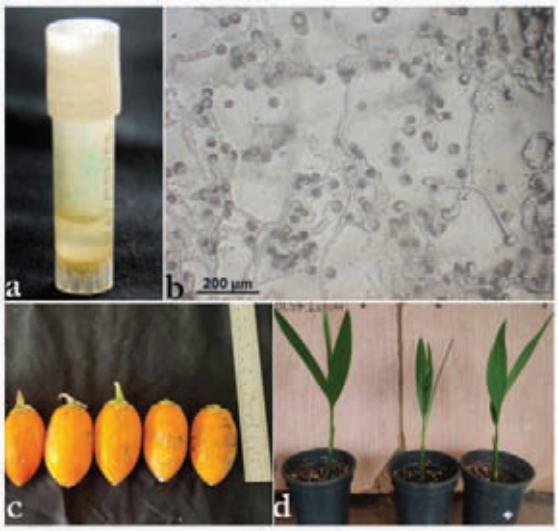


Fig. 25. Arecanut pollen extraction and cryopreservation using virgin coconut oil. a: virgin coconut oil consisting of desiccated arecanut pollen; b: *in vitro* germination of pollen grains; c & d: nuts obtained and plants developed after pollination with cryopreserved pollen extracted using VCO.

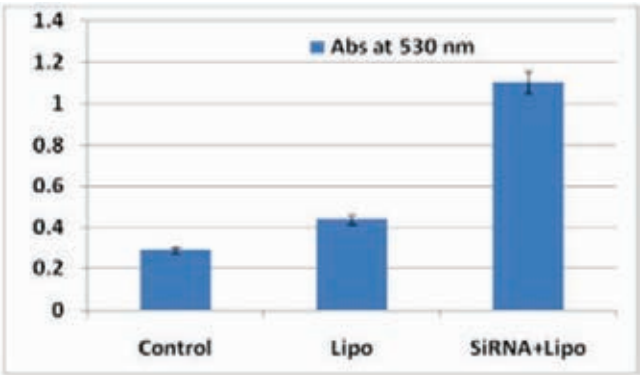


Fig. 26. Absorbance of endosperm calli extract at 530 nm

Molecular Studies

Silencing specific genes in coconut calli - siRNA delivery technique

Yakima yellow-tagged siRNA (Target-*WRI*) was delivered to the desiccated endosperm callus using Lipofectamine 2000. Calli were ground to a fine powder and treated with 2% SDS for 15 min. After centrifugation, the absorbance of the supernatant was read at 530 nm (absorbance maxima of Yakima yellow). Absorbance was found to be more in callus treated with siRNA + Lipofectamine 2000 than in control, indicating successful delivery of the complex.

Association mapping for select traits using SNPs

An association mapping panel, consisting of 96 palms, was evaluated for the following 19 yield contributing traits and vegetative traits, viz., Total leaves on the crown; girth at 1.5 m; total leaf length; length of petiole; length of leaflet bearing portion; breadth of leaflet; length of leaflet; leaf scars in 1 m; length of inflorescence; spikelets/in flore scence; female flowers/inflorescence; female flowers /spikelet; nuts/bunch; fruit weight; fruit length; hus kthickness; nut weight; shell thickness and copra weight. Phenotyping data was collected for two years. Genome-wide association studies (GWAS) were carried out using 83,000 SNPs. Significant SNP markers were identified using mixed linear model (MLM) analysis.

Expression profiling of specific miRNAs and their targets of interest

The expression patterns of six miRNAs (cnu-miR166a, cnu-miR167c, cnu-miR169a, cnu-miR171a, cnu-miR397 and cnu-miR535a) and their corresponding putative targets, which were randomly selected, were observed in three stages of somatic embryogenesis (initial plumular explant, EC and NEC) and different stages of zygotic embryos by stem-loop qRT-PCR. The expression level of each miRNA and their targets from various tissues were compared against the plumular explant, which was taken as the reference sample. Among six conserved miRNAs, three (cnu-miR166a, cnu-miR167c and cnu-miR171a) showed the highest expression in the 10-month zygotic embryo. Two miRNAs, *viz.,* cnu-miR169a and cnu-miR535a, displayed the highest expression in a 12-month zygotic embryo compared to other tissues. Among the miRNAs studied, cnu-miR397 showed the highest expression in NEC, followed by the 8-month zygotic embryo. All the miRNAs except cnu-miR397 showed relatively high-level expression in zygotic embryo stages compared to somatic embryo stages. The expression level of 10 targets corresponding to miRNAs was also analysed in three stages of somatic embryogenesis (initial plumular explant, EC and NEC) and mature zygotic embryo by qRT-PCR. We found that the expression levels of all the targets showed an inverse correlation with the expression level of their corresponding miRNA.

Proteomes of phytopathogens

The mycelial proteome data of the coconut bud rot pathogen, *P. palmivora,* was obtained using high-resolution mass spectrometry analysis.A total of 8073 proteins wereidentified. Gene ontology based functional classification of detected proteins revealed 4884, 4981 and 3044 proteins, respectively, with roles in biological processes, molecular functions, and cellular components. Proteins such as P-loop, NTPase and WD40 domains were identified, which possess key roles in signal transduction pathways. KEGG pathway analysis annotated 2467 proteins to various signalling pathways, such as phosphatidyl-inositol, Ca2+ and MAPK, autophagy, and cell cycle. These molecular substrates might possess vital roles in filamentous growth, sporangia formation, degradation of damaged cellular content and recycling of nutrients in *P. palmivora.*

3. CROPPING AND FARMING SYSTEMS, NUTRIENT AND WATER MANAGEMENT, AND BIORESOURCES MANAGEMENT

Cropping/Farming approaches for improving soil health and system productivity in coconut, arecanut and cocoa

Coconut based farming systems for sustainable productivity

One hectare of coconut based farming system model at Kasaragod, comprising of coconut, pepper trailed on the coconut trunk, banana in the border of the plots, fodder sorghum (CO 31-multi cut fodder sorghum) in the interspaces of coconut, dairy unit, goat unit and poultry yielded 20,186 coconuts, 16,298 litres of cow milk, 322.9 kg live weight of goat, 163.2 kg of live weight of poultry birds, 3,045 kg of banana and 358.8 kg of pepper and 185 kg of fish. The system was economical with net returns of Rs. 6,01,194/- and energy efficient with higher energy output (884.9 KJ ha^{-1}). Coconut monocropping could produce lower energy output (259.8 KJ ha^{-1}). Similar trends were noticed for net energy, energy use efficiency, energy productivity and energy profitability.

Coconut based high density multi species cropping system under organic and integrated management

Coconut based high density multi species cropping system at Kasaragod, initiated in 2007 comprising coconut, pepper (trailed on the coconut trunk), banana cv. Kadali, Robusta (inter row space of palms), cinnamon (inter row space of palm) and nutmeg (between 4 coconut palms) under different nutrient management practices (two third dose, one-third and non-application of chemical fertilizers) along with recycling of biomass, biofertilizer application and green manuring resulted in non-significant difference among the treatments with respect to nut and copra yield (147-159 nuts/palm/year with 3828 to 4280 kg/ha of copra yield). Similarly, there was no significant yield difference among treatments for banana cv. Kadali (7.5-8.5 kg/bunch), Banana cv. Robusta (10.5 to 12.1 kg/bunch) and cinnamon (62.7 to 66.8 kg/ha). However, pepper yield was significantly higher with only organics application (562.1 kg/ha) compared to two-third chemical fertilizer with waste recycling (515.4 kg/ha). But it was on par with one-third chemical fertilizer application with waste recycling (549.6 kg/ha). The additional returns from the component crops and increased nut yield with lesser external inputs resulted in 6.3 times higher net returns (Rs. 6,17,162/-) in HDMSCs compare to monocrop of coconut. The energy output (375.9 KJ ha^{-1}) was higher with one-third chemical fertilizer with crop waste recycling over two-third chemical fertilizer with crop waste recycling (343.1 KJ ha^{-1}) and only organics application (349.1 KJ ha^{-1}). However, higher net energy, energy use efficiency, energy productivity and energy profitability recorded under only organics application over two-third and one-third chemical fertilizer application with crop waste recycling.

Fig. 27. Coconut based multi species cropping system

Coconut based multi species cropping system under coastal littoral sandy soils

In coastal littoral sandy soil, coconut + sapota (Var. DHS 2) intercropping under integrated nutrient management *i.e.,* application of green manuring + biofertilizers + organic recycling + FYM@10 t/ha + 150 % recommended dose of fertilizer, resulted in significantly higher sapota fruit yield of 47 kg per tree (7332 kg/ha), nut yield (101 nuts/palm) and copra weight (173 g/copra). With regard to economics of the system, coconut + sapota intercropping under green manuring + biofertilizers + organic recycling + FYM@10 t/ha + 150% fertilizer inclusive nutrient management could generate higher net return of Rs. 1,98,225/- which is four times higher than the monocropping of coconut (Rs. 49,098/-).

Arecanut based high density multispecies cropping system

The trial on arecanut based high density multispecies cropping system (HDMSCS) at Kahikuchi, with different crop components: arecanut (var. Kahikuchi) + banana (var. Malbogh) + citrus (Assam lemon) + pineapple (Kew type) + turmeric (var. Megha Turmeric 1) and with organic and integrated nutrient management, indicated that 2/3rd fertilizer + recycling of biomass resulted in higher yield in banana (2151.18 kg/ha), Assam lemon (32,705 fruits/ha), pineapple (2,022 fruits/ha) and turmeric (1345.68 kg fresh rhizome/ha).

Intercropping of seasonal horticultural crops under arecanut

Intercropping of seasonal vegetables under arecanut at Kahikuchi during winter and summer-cabbage (var. Rare Ball), cauliflower (var. Madhuri), brinjal (var. Rani), okra (var. Gunjan), ridge gourd (var. Malobika), bitter gourd (var. Palee) and ash gourd (var. Benyue) crops were grown profitably as intercrops under arecanut with yield of 29.4 t/ha, 13.3 t/ha, 6.5 t/ha, 12.1 t/ha, 31.3 t/ha, 5.4 t/ha and 42.9 t/ha respectively.

Fig. 28. Intercropping of summer vegetables under Arecanut

Fig. 29. Intercropping of winter vegetables under Arecanut

Marigold as intercrop in newly planted coconut gardens

Field experiment was conducted at the Regional Station, Kayamkulam, during 2020-22 for evaluating the performance of six commercial varieties of marigold in the newly planted coconut ecosystem to identify compatible and profitable variety for coastal humid tropics. Varieties under this study include ICAR-IARI varieties such as Pusa Deep (dark red flower), Pusa Basanti Gainda (lemon yellow), Pusa Narangi Gainda (deep orange), Pusa Arpita (light orange) and two local types from Tamil Nadu; Periyakulam Yellow (dark yellow), Periyakulam Orange (dark orange). Seedlings were raised during 2020-21 and 2021-22. The plants were cultivated based on the INM standardised for intercropping marigold in coconut gardens of coastal humid tropics. Seedlings were planted in

Fig. 30. Pusa Basanti Gainda as intercrop in juvenile coconut garden

beds of size 3.1 m x 2.4 m at spacing of 60 cm x 60 cm. Among the varieties, Pusa Basanti Gainda and Periyakulam Yellow were found to be potential intercrops (25% area) in coconut gardens. They produced a yield of 57.9 q/ha and 57.6 q/ha fetching an additional income of Rs. 1.59 lakhs and Rs.1.52 lakhs during juvenile phase of the plantation with BCR 2.18 and 2.13, respectively. Pusa Deep with a short flowering period (25 days) was found seasonal (November to February), Pusa Arpitha with prolonged vegetative phase (>120 days) had low yield, whereas Pusa Narangi Gainda was highly prone to lodging during rains.

Cinnamon intercropping in coconut garden

Cinnamon intercropping in coconut with pentagonal method of planting in different spacing revealed that spacing had significant influence on growth and yield of cinnamon. Among the different spacing treatments tried, cinnamon planted with 0.6 m x 1.2 m by following pentagonal method of planting (5 plants per pit) recorded higher height (429.4 cm) and higher number of branches (22.2). However, higher girth of stem was recorded under wider spacing i.e., 2 m x 2 m (16.4 cm) over other treatments. Higher individual plant quill yield was recorded in widely spaced (2.0 × 2.0 m) trees (229.3 g/plant) over other treatments. However, cinnamon planted with closer spacing 0.6 x 1.2 m recorded significantly higher dry quill yield of 631.92 kg/ha over other spacing treatments. The results on quality parameters revealed that, there is no significant influence of plant spacing on the essential oil and oleoresin content. The essential oil content ranged from 1.12 to 1.42 % and the oleoresin content ranged from 8.11 to 8.34 %. With regard to economics of the system, considering the yield obtained as 632 kg/ha, the cost of cultivation has been worked out to be Rs. 382/kg. The benefit cost ratio of the system was 1.84, which categorically indicates the profitability of the system.

Fig. 31. Demonstration of Cinnamon intercropping in coconut garden

Nutrient and Water Management in Palms

Fertigation studies in hybrid coconut

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). Fourth cycle of fertigation was completed in May 2022. Plant height, collar girth and number of leaves were not significant among the treatments. Leaf production rate was significantly higher with 150% (14.25) and 200% (14.75) of soil test based nutrient application through fertigation than other treatments (50% fertigation-12.25, basin application of nutrients under drip irrigation-12). Below fist size and above fist size nuts and thereby nut yield was higher with 150% and 200% fertigation, with latter recording maximum of 135 nuts/palm/year. Harvest of mature nuts alone was 91 and 72 respectively with 200% and 150% fertigation treatments, significantly higher than with basin fertilizer application with drip irrigation.

Fertigation schedule for tender nut production in dwarf coconut

Experiment on standardizing fertigation schedule for tender nut production in sandy loam soils of root (wilt) disease prone areas was initiated during 2019 at ICAR-CPCRI, RS, Kayamkulam using the dwarf variety Chowghat Orange Dwarf.

Nutrients are supplied in 20 equal splits at fortnightly intervals during August to May and irrigation scheduling was done during dry spell of the year. At 2/3rd level of irrigation (PE), palm height increased with increased dose of nutrients *i.e.,* 3.54m < 3.88m < 4.13m. But with full irrigation, there was no difference in the palm height with increased levels of nutrients whereas, at 166% of irrigation the palm height recorded a declining trend with increase in nutrients 3.85m>3.58 m≈ 3.59m. The collar girth of palms increased with increased nutrient levels at first and second levels of irrigation where as it showed a declining trend at third level of irrigation. Irrespective of irrigation levels, nitrogen fixing bacterial count was lower (16.5 to 21.29 x 10^5) at third level of nutrients. First flowering was recorded in third level of nutrients (806 to 855 days after transplanting) under three levels of irrigation. The first harvest was recorded at 33 months after transplanting in palms supplied with 166% irrigation and 200% N&K (soil test-based nitrogen recommendation).

Fig. 32. COD variety under full irrigation and double-dose nutrient scheduling

Nutrient management and total micronutrient status of the soils under coconut

Total micronutrient status of the soils under 2/3rd RDF, 1/3rd RDF and fully organic nutrient management were assessed in High Density Multi Species Cropping system (HDMSCS) and the results showed that there is no significant difference among the treatments for total Fe, Mn, Zn and Cu content. Hence, fully organic management is sustainable in terms of micronutrient management for coconut cultivation under HDMSCS in red sandy loam soils of humid tropics. Percentage of available micronutrients of total micronutrient content was ranging from 0.08-0.15 for Fe, 0.74-1.48 for Mn, 0.22-0.49 for Zn and 1.53-2.93 for Cu. No tillage showed lower total Fe content at 0-30cm soil depth. Tillage showed higher Fe content. No Tillage and INM practices showed high Mn content than tillage treatment at 30-60cm soil depth. There is no significant difference observed in the Zn content at different depths. INM and No tillage with chemical fertilizer showed low total Cu content at 0-30cm and high content in 30-60cm depth.

Silica and essential nutrients on coconut palm health

A field experiment was initiated in 2021 at the Agro Ecological Unit-3 (Onattukara sandy plain) to evaluate the effect of silica along with the essential nutrients such as N, P, K, Ca, Mg, S, Zn and B on the palm health and productivity of coconut. There were 12 treatments involving the various nutrient combinations applied in 180 palms with three replications. The percentage of palms in the root (wilt) disease early, middle and advance category were 5.83%, 58.33% and 35.83% respectively. The surface pH at the basin and interspace was 5.26 and 4.82 respectively. The content of organic carbon, available P, K, Ca, Mg and B at 25cm were 0.65%, 11.61 ppm, 169.42 ppm, 36.77 ppm and 0.08 ppm respectively. At 50cm depth, the values were 0.64%, 45.04 ppm, 8.04 ppm, 136.42 ppm, 28.44 ppm and 0.07 ppm respectively. The total nutrient content in the leaves were N (1.2%), P(0.14%), K (0.69%), Ca (0.30%), Mg (0.20%), Fe (100.07mg/kg), Mn (217.36 mg/kg), Cu (18.51mg/kg), Zn (31.64mg/kg) and B (9.65 mg/kg).

Humic acid and farmyard manure on soil quality attributes of sandy soil

A laboratory incubation study was conducted to understand the cumulative effect of adding humic acid and farmyard manure on the soil health attributes in sandy soils. There were five levels of humic acid (H_0(0), H_1(1%), H_2(5%), H_3 (10%) and

H_4 (20%) and three levels of farmyard manure (F_0 (0 kg/palm), F_1 (25 kg/palm) and F_2 (50 kg/palm) with 15 treatment combinations and three replications. It was concluded that humic acid in combination with farmyard manure can enhance the availability of nutrients, improve the nutrient holding capacity of soil and a synergistic relationship was observed between the two components. 50 kg of FYM in combination with 10 and 20% of humic acid can facilitate the slow release of nutrient ions. The release of nutrientions was maximum between the 60th and the 75th day of incubation. The combination also facilitated the improvement in the active pool fraction of the organic matter status.

Kalpa Poshak and Kalpa Vardhini for coconut palms

Nutrient mixtures *viz*., KalpaPoshak for juvenile palms and KalpaVardhini for adult palms were evaluated for the growth and productivity of coconut palms grown in acid soils. The mixtures were applied ten days after the application of recommended dose of major nutrients. Sixty per cent of the Kalpa Sankara hybrid palms treated with KalpaPoshak flowered at 26th month after planting. In the two year old hybrid Kalpa Sankara palms, the average number of leaves, height, collar girth and number of split leaves after the application of Kalpa Poshak @ 100g in two splits were 14.1, 4.01m, 96.4cm and 12.6 respectively.

In the 30 year old West Coast Tall palms, the average annual pre treatment yield of 67 nuts per palm increased to 81 nuts per palm with application of 500 g Kalpa Vardhini @ 250 g per dose. The average content of available potassium, calcium, magnesium, boron and zinc in the soils of the treated palms at 25cm depth were 351.1 ppm, 244.65 ppm, 33.48 ppm 2.25 ppm and 0.35 ppm respectively. At 26-50 cm depth the values of K, Ca, Mg, B and Zn were 55.45 ppm, 111.48 ppm, 20.22 ppm, 12.4 ppm and 0.20 ppm respectively. The total content of P, K, Ca, Mg, Zn and B in the Kalpa Vardhini treated palms were 0.119%, 1.72%, 0.371%, 0.280%, 22.46mg/kg, 12.4 mg/kg respectively.

Fig. 33. Kalpa Vardhini treated palms

Characterizing the palms of the different yield levels

Soil and leaf samples were collected from the palms of three yield levels: Low (<60 nuts), medium (60-100 nuts) and high (>100 nuts). As for the total potassium status in the index leaf samples, the content in the low, medium and high yielding category palms were 0.883%, 1.03% and 1.05% respectively. The total Mg in the index leaf samples of the three category palms were 0.338%, 0.26% and 0.380% respectively. The total calcium in the low, medium and high yielding category palms were 0.451%, 0.470% and 0.570% respectively. Among the micronutrients copper and zinc showed significant relation between the three category palms. The total copper content in the index leaf samples of low, medium and high yielding category palms were 3.56 mg/kg, 5.2 mg/kg and 7.42 mg/kg respectively, whereas the concentration of total zinc in the index leaf samples were 18.7mg/kg, 17.91 mg/kg and 23.47mg/kg respectively. Decision tree diagram was constructed using R software to determine the course of action for getting possible response from a set of variables. Among the machine learning algorithms, the Random Forest was showing the highest accuracy and was clearly classifying the high, medium and lower yield levels as compared to Support Vector Machine (SVM) and K-Nearest Neighbor Algorithm (KNN).

Integrated nutrient management in arecanut at Kahikuchi

To study the effect of organic and inorganic components in an integrated manner, a trial was taken up in Kahikuchi, Assam with seven treatments

having only organic and chemical fertilizers and their combinations as Integrated Nutrient Management (INM). Among the different treatment combinations, application of vermicompost (2/3rd) + fertilizers (1/3rd) recorded the maximum chali yield of 2.43 kg per palm per year.

Biological studies of YLD affected soil

The growth promoting potential of the elite isolates, their *in vitro* compatibility and *in vivo* growth promotion of the elite plant growth promoting rhizobacteria *viz.*, *Burkholderia* spp. (AREB7, ARsB9) *Acinetobacter* sp. (ARsB4), *Bacillus* spp. *(*ARsB8, RBC18-5), *Pseudomonas* sp. (RBC18-25) were studied. The elite isolates are not deleterious and, recorded higher biomass, root length, shoot length and lateral roots in wild areca seedlings.

Fig. 34. *Acinetobacter* sp. (ARsB4)*; 2 & 3. Bacillus* spp. *(*ARsB8, RBC18-5)*;4 & 5 Burkholderia*spp. (AREB7, ARsB9); *6 Pseudomonas* sp. (RBC18-25)

High density planting of cocoa in arecanut

Grafts of cocoa variety NetraCentura were planted with 5 different spacing with planting density ranging from 650 to 3712 plants ha^{-1}. During 6thyear after planting, the dry bean yield per plant was similar among different spacing, however, the dry bean yield per hectare was significantly higher in closely planted grafts (370 – 809 kg ha^{-1}) than grafts under normal spacing (186 kg ha^{-1}) due to higher plant population.

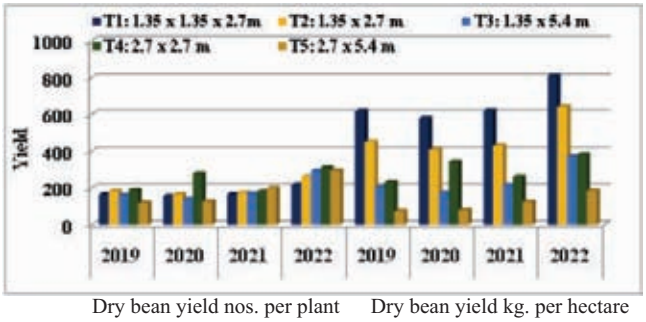


Fig. 35. Yield of cocoa grafts in different spacing

Genotypic variability in nutrient use efficiency in cocoa and partitioning of copper towards bean

Eight cocoa varieties and hybrids were hydroponically grown under varied levels of nitrogen. The dry biomass increased with increase in nitrogen concentration in the medium. Among different hybrids/varieties, VTLCS1, VTLCH1 and VTLCC 1 genotypes were found to be nitrogen use efficient genotypes. Copper in cocoa beans was found higher in cocoa plants inter planted with arecanut, which is a matter of concern. In order to know the genotypic variation in partitioning of copper towards nib, its content in the nibs of 21 cocoa genotypes was assessed. The average Cu content in the nib was 49.7 ppm. Significantly lower copper content was observed in Amazon genotype VTLC 154 (44.7 ppm), whereas, significantly higher Cu was observed in the nibs of Amazon genotype VTLC 174 (60.4 ppm).

Nutrient disorders in arecanut

Field survey was conducted in 200 arecanut gardens in different taluks of Dakshina Kannada district to assess the incidence of nutrient disorders, pest and diseases. Zinc deficiency was observed in 31% gardens. About 4% of the palms were having zinc deficiency symptom. The incidence was more in high yielding varieties with improper nutrient management. Since deficiency was noticed in many gardens, zinc nutrition may be included as a general recommendation along with NPK.

Role of boron in arecanut quality

Arecanut kernel quality was assessed in boron deficiency and sufficiency condition. Percentage of

patora (cracked arecanut) and *ulligadde/sippegotu* (husk stuck to dry kernel) was more under boron deficiency condition, whereas, percentage of good *chali* was more under boron sufficiency condition.

Slow release fertilizer preparations

New slow release fertilizer materials were prepared using different carriers like biochar, talc and neem cake. The fertilizer materials of two different concentrations (20 & 40 %) were used for the preparation of slow release fertilizers. Coconut husk biochar from the Institute, commercially available talc and neem cakes were used as carrier materials. The new fertilizer products were made into pellets using indigenous methods and the prepared products were used for studying nutrient release patterns using column leaching method.

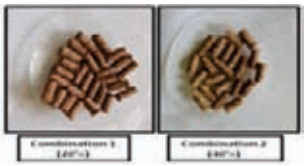


Fig. 36. Neem based formulation

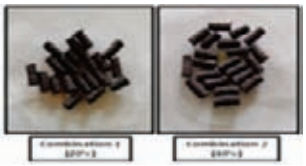


Fig. 37. Biochar based formulation

Fig. 38. Talc based formulation

Bioresources Management in Coconut, Arecanut and Cocoa

Organic cultivation in coconut-based farming system under coastal agro-ecosystem

Cultivation of coconut under organic nutrient management practices revealed that in situ organic matter (frond, leaf, inflorescence waste, husk) recycling in trenches (15 m length, 1.2 m width and 60 cm depth) made in the interspaces of 6 coconut palms + insitu green manuring in the basin +PGPR consortia in the basin + cowdung + 50% recommended K_2O using sulphate of potash recorded higher yield of 102.4 nuts/palm/year with 174g of copra weight/nut over other treatments. Data on cocoa yield and yield parameters, when intercropped under coconut, have shown that the above inputs could result into significantly higher pod we (360g), single bean weight (1.08g) and dry bean yield (893 kg/ha). Higher net returns of Rs. 2,05,848/- /per ha (on matured nut basis) and Rs. 2,92,878/-/ ha (on copra yield basis) earned from the above system.

Alternative microbiological uses for waste mature coconut water

Mature coconut water (liquid endosperm) which is wasted in huge quantities from coconut kernel processing industries has an immense potential for biovalorisation through microbial process for the production of vinegar, 'nata'/bacterial cellulose (BC), probiotic beverages, etc. Autochthonous bacterial isolates from traditional coconut vinegar were isolated and screened for cellulose synthesis in mature coconut water and synthetic media. Of the twenty nine bacterial isolates, twelve isolates produced cellulosic pellicles in synthetic broth, of which ten bacteria produced cellulose in mature coconut water with yield ranging from 15 to 198 g/L on wet weight basis (Fig. 39). Isolates with distinct morphotypes that produced surface pellicle in coconut water were characterized for cultural, biochemical and microscopic features and are being maintained at the Regional Station, Kayamkulam for further studies. The isolates recorded MALDI-ToF MS scores <1.7, hence could not be reliably identified using Bruker taxonomy database (biotyper 3.1), however, comparison of the peptide mass fingerprint revealed the distinctiveness of the isolates (Fig. 40).

Four isolates were screened for their maximum efficiency to convert mature coconut water (MCW)/MCW-based media to BC/'nata' pellicle. Pre-optimization of culture conditions in synthetic BC/nata production medium with respect to pH and carbon source indicated the suitability of wider pH range (3.0 to 8.0) and carbon sources (monosaccharaides to polymeric forms) for 'nata' production by the selected isolates. Efficient BC/'nata' conversion occurred in the pH range from 3.5-4.5 and with sucrose/glucose/glycerol as carbon

source. Around 50% yield increase of 'nata' pellicle indicates the scope of increasing conversion efficiency to increase the 'nata' yield utilizing mature coconut water. Pre-optimization studies with the selected bacterial isolate BC4 indicated the suitability of wider pH range (3.5-8.0) for BC production and glycerol (1%) enhanced yield of 57% over glucose. BC4 is a gram negative rod with oxidase, alkaline phosphatase activity and ability to form acid from glucose, fructose, sucrose, trehalose and xylose. 16S r DNA analysis indicated that the strain BC4 belonged to *Komagataetibacter* sp. showing 99.30% similarity with *K.intermedius* TF2. Initial results indicated that this indigenous bacterium can be explored for cost effective production of 'nata-de-coco' and other high value BC products of industrial applications using mature coconut water.

Fig: 39. Bacterial Cellulose/'nata' cubes obtained from different strains of BC-synthesizing bacteria

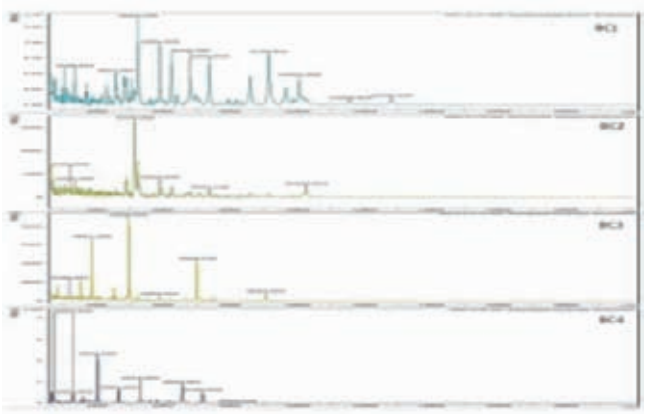


Fig. 40. MALDI-ToF peptide mass fingerprint of BC bacterial isolates

Cocoa pod husk biochar particles for phosphorus sorption-desorption

The effect of cocoa pod husk biochar of different particle size on phosphorus sorption-desorption capacity of a tropical acidic soil was studied by conducting an incubation experiment in which three particle size of the biochar— 0.5-1.0 mm (S1), 1-2 mm (S2) and 2-4.75 mm (S3), @ 10 g/kg (B1) were amended with soil and incubated at 50% field capacity (and at room temperature of 28°C) for 30 days. Soil-biochar mixture samples were collected after 1, 15 and 30 days of incubation and used for the sorption study. Standard isotherm equations - the Freundlich equation and the Langmuir equation, were employed for the Phosphorus sorption-desorption study. Soil-biochar mixtures were analyzed for phosphorus sorption capacity by fitting the equilibrium solution and sorbedconcentrations of phosphorus using adsorption isotherms.

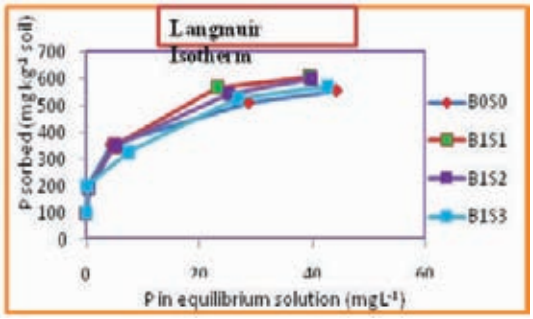


Fig. 41. Phosphorus sorption First day after incubation

Phosphorus adsorption was increasing with increased phosphorus addition irrespective of the presence of biochar. The highest phosphorus adsorption was recorded with lowest-sized biochar particle after each period of incubation compared to other sized biochar. The lowest adsorption was recorded by the control during the entire incubation period. Similarly, the phosphorus desorption was found to decrease with the increase in particle size after each incubation.

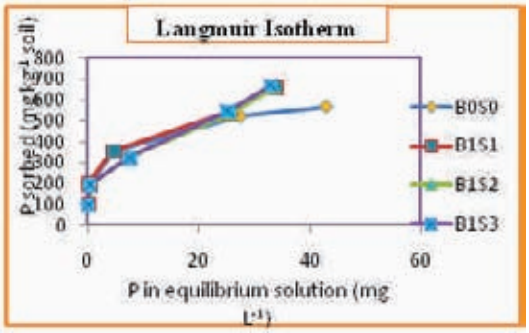


Fig: 42. Phosphorus sorption 15th day after incubation

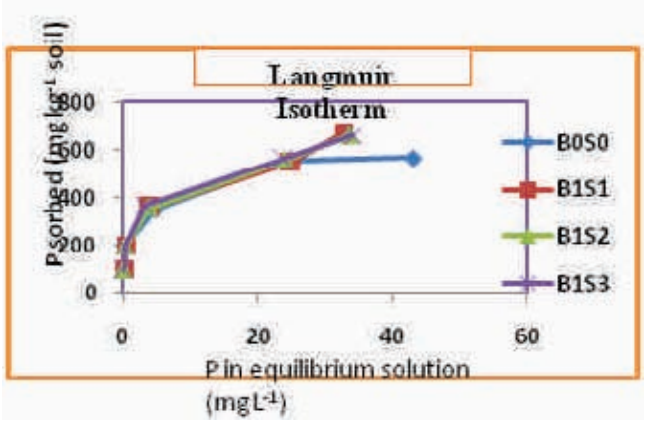


Fig. 43. Phosphorus sorption 30th day after incubation

Dynamics of potassium fractions in soil amended with cocoa pod husk biochar

An incubation study was conducted in which soils from cultivated fields were amended with cocoa pod husk (CPH) biochar, prepared in CIAE developed kiln, @ 0, 5, 10, 20 and 40 g kg^{-1}. The soil alone and soil–biochar mixtures were incubated at 60% field capacity at room temperature for a period of 30 days. After incubation, all the soil and soil–biochar mixtures were air-dried and analyzed for various fractions of potassium.

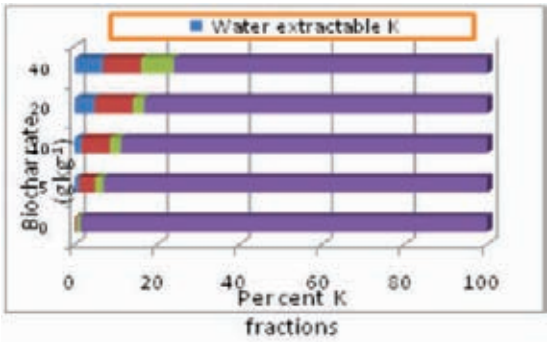


Fig. 44. Percent potassium fraction in cocoa biochar applied soil

It was found that as the rate of application of biochar increased, all the fractions of potassium also increased along with the total potassium; but by calculating the per cent improvement in each fraction to the total K, it was very clear that the per cent of water extractable, exchangeable and non exchangeable fractions showed an increasing trend and the lattice (fixed) potassium showed a reverse trend. Since the available potassium is directly related to the water extractable, exchangeable and non exchangeable fractions of soil K, the addition of cocoa pod husk biochar can increase these fractions in soil and hence the K availability.

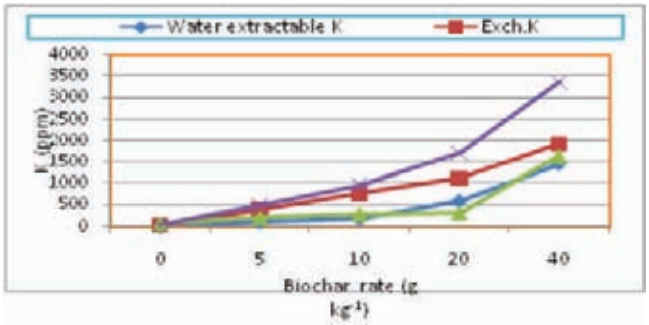


Fig. 45. Increase in biochar increases potassium fraction

Macrofungal diversity in coconut gardens

Coconut gardens enriched with organic biomass often hosts a variety of mushrooms during monsoon such as *Agaricus, Termitomyces, Macrocybe, Trametes, Leucocoprinus, Volvariella, Polyporus, Ganoderma etc.*, establishing different kinds of saprophytic /symbiotic/ parasitic associations with the coconut plantations, as has been reported at ICAR-CPCRI (Kasaragod and Kayamkulam) earlier. The descriptions of the two mushrooms collected during 2021-23 from coconut experimental plots maintained at Regional Station, Kayamkulam are given below.

Chlorophyllum molybdites

Chlorophyllum molybdites has shown frequent occurrence (during the rainy months of May and July, 2022) in coconut gardens and specimens were collected from the palm basins of COD (Chowghat Orange Dwarf) plot of Block IV at ICAR-CPCRI (Kayamkulam), in richly manured coconut basin mulched with coconut leaf fronds. *Pileus was* 12.5-19.5 cm in diameter with white, soft fleshy, plano-convex (globose in bud) shape with slight umbo and non-striate margin

Fig. 46. (Clockwise) *Chlorophyllum* (in pair) spotted in coconut basin mulched with coconut leaf fronds; *Pileus* with squamules on surface; Lamellae with pale green spore print (alongside) and stipe (below) with double edged annulus

Macrocybe sp.

*Macrocybe*is a pantropicalgenus, belonging to giant edible mushrooms that are currently focused for numerous applied studies. Characterized by large white basidiomes with cyanic odour, they are found either solitary or in groups on grounds with buriedrotten wood Occurrence of a few species of *Macrocybe* were noticed in coconut gardens where the coconut crowns had been buriedpreviously in connection with palm uprooting for new planting. Previous mushroom collections from block 3A of ICAR-CPCRI, Regional Station, Kayamkulam during July,2015 and July, 2018 were identified belonging to *Macrocybe* based on morphological and microscopic features. Recent collection of *Macrocybe* sp. (Oct, 2021) from 2 year old coconut palm basin occurred in clusters bearing large and smooth pileus with thick white flesh. The mycelial culture was isolated and grown in artificial media which when inoculated, colonized and covered the sterile moistened substrates of fresh/dried coconut leaflet and petiole bits (Fig 47).

Fig: 47 (from left) View of *Macrocybe* sp. (Pileus); Mycelial growth in Malt Extract Agar media; Mycelial growth in coconut leaflet + petiole (1:1) substrate

Biopriming effects of PGPR strains and consortia on coconut seedling:

Biopriming effects of PGPR strains and consortia on biotic stress (RWD) tolerance are being studied in field planted coconut seedlings treated/bioprimed with different PGPR strains and consortia (Table 1) (planted in Block V, CPCRI, Regional station, Kayamkulam during March, 2021). Pre-treatment analysis of the soil fertility parameters indicated that the soil was very strongly acidic (4.61) with moderate amounts of organic carbon. The available phosphorus was very high, but the contents of exchangeable K, Ca and Mg were extremely low (43.03ppm, 90.5 ppm and 27.31 ppm respectively). Available Zn (0.68 ppm) and B (0.34 ppm) were also deficient in the soil. Microbial analysis of soil indicated higher population count ofactinomycetes, fungi and free-living nitrogen fixers. Fluorescent pseudomonads were in the range of 0-300 CFU/g soil. Phosphate solubilizing bacteria were not detected in the samples through plate count method. Booster dose of bioinoculant treatments were imposed on 7 monthsafter planting. Fertilizers and organic manures (including green leaf manure and basin management with cowpea) were applied as per the standard recommendations for RWD tract. Maximum collar girth (43.67 cm) and seedling height (3.28 m) on 15 MAP (Fig.48-49) was observed due to all these four microbial strain consortia. All the seedlings were found 'apparently healthy' as per the root (wilt) disease indexing method. Treatments are being imposed at 6 month interval for further experimental observations.

Table 1: PGPR strains/consortia as bioinoculants for coconut

Organism	Organism	Functions	Class/Order
Pseudomonas migulae	*Pseudomonas migulae*	Multiple nutrient (P, Zn, K, Si) solubilizer IAA production	Gamma proteobacteria Pseudomonadales
Bacillus subtilis	*Bacillus subtilis*	ACC deaminase Diazotrophic	Bacilli Bacillales
Margalitiasha ckletonii	*Margalitia shackletonii*	ACC deaminase Diazotrophic	Bacilli Bacillales
Azospirillum sp.	*Azospirillum* sp.	IAA production Diazotrophic	Alphaproteobacter ia Rhodospirillaes

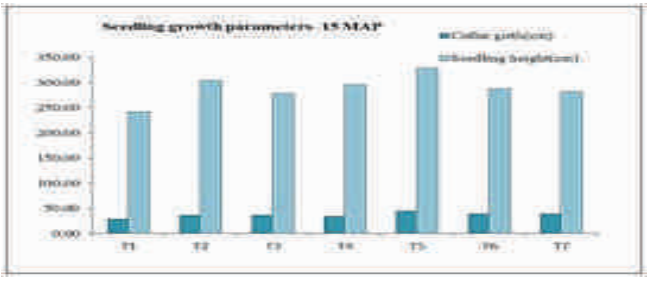


Fig. 48. Growth parameters of field planted coconut seedlings subjected to bioinoculant treatments

Bioinoculant treatments: T1- *Pseudomonas* sp.- KH3PSB2 (multiple nutrient solubilizing rhizobacteria); T2-*Bacillus* sp.- CRE-9 (Root endophyte); T3- *Margalitia* sp.- CRE-15 (Root endophyte); T4-*Azospirillum* sp.-AzoL8;

T5-Consortium (of above 4 strains), T6-Control and T7- Fungicide (Hexaconazole-5% EC) drenching

Fig. 49. Field view of coconut biopriming experiment

Soil and Water Conservation

Impact of water/ soil moisture conservation

A baseline survey was conducted in Kasaragod District of Kerala and Tiruppur District of Tamil Nadu prior to the implementation of water conservation techniques. The baseline survey revealed that the average yield of coconut in Kasaragod District of Kerala and Tiruppur District of Tamil Nadu was 11375 nuts/ha/year and 19250 nuts/ha/year respectively. Rain fed coconut gardens present in Kerala state and deficit irrigated farms were located in Tamil Nadu. Interventions specific to rainfed coconut gardens having mild to moderate slopes are half moon bund, trench and mulching and the gardens are located in midland and hilly areas in Kasaragod District. Coconut gardens in coastal areas in Kasaragod and areas in Tiruppur Districts are mostly in plain areas. Interventions taken up in these gardens are trench and mulching. The interventions using three water conservation techniques, mulching coconut basin with bio materials from farm itself, half-moon bund around coconut basin and trench filled with farm bio materials, were taken up in six gardens covering 428 palms in Kerala and 19 gardens covering 1330 palms in Tamil Nadu state. It is presumed that the trench which is filled with coconut husk and other bio wastes would be able to retain water during this water scarcity period which could save coconut palms. The organic matter would turn to manure after composting. Water stagnation for two to three weeks during rainy days is a common problem in certain coconut gardens in Tiruppur District which was under either paddy or sugarcane cultivation earlier. Two such gardens, one with less than one year old seedlings and the other with mature palms, were selected to study the efficacy of broad-based ridges and furrows to provide well drained soil to coconut roots at least to a depth of 60cm.

Fig. 50. Half moon bund

Fig. 51. Trench filled with coconut husk

Fig. 52. Trench filled with coconut husk

4.

INTEGRATED MANAGEMENT OF DISEASES IN PALMS AND COCOA

I. Disease Diagnostics

Identification of causal organism of leaf spot disease of arecanut

During 2018 post-monsoon season (October-November), severe outbreak of leaf spot disease was reported from the farmer's gardens located in Kalasa hobli, Chikkamagaluru, Karnataka where arecanut is cultivated along with coffee plantation. Leaf spot symptoms started as small, irregular, light to dark brown spots with yellow halo which gradually extended to form irregular lesions, and finally, become necrotic with grey center and brown margin with yellow halo. Spots on leaves coalesce to form blight appearance. Cultural, microscopic, molecular characterization using multi-gene phylogeny [calmodulin, glutamine synthetase, glyceraldehyde-3-phosphate dehydrogenase, □-Tubulin, and Apn2-Mat1-2 intergenic spacer and partial mating type gene (Ap-Mat)] and pathogenicity assays with Koch's postulates established the association of Colletotrichum kahawae subsp. ciggaroas the causal agent of arecanut leaf spot disease. To the best of our knowledge, the current investigation confirms the first report of leaf spot disease caused by C. kahawae subsp. ciggaroin arecanut from India.

Fig. 53. a) Light to dark brown spots with yellow a halo on leaves; b) Severely leaf spot affected leaves showing blight appearance; c) & d) Severely infected palm showing blighted leaves hanging around; e) Spots observed on nuts; f) Nut splitting observed on the spot affected areas; g) & h) Spots observed on leaf sheath; i) Severe leaf spot affected garden shows burnt appearance.

Identification of *Neodeightonia phoenicum* causing crown rot of coconut

During February-March 2022 there have been many reports from the farmer's side about rapid drying and death of coconut palms in and around Kannur–Kasaragod districts of Kerala. The disease affects palms with an age of more than 30 years. The symptoms include drying and drooping of leaves, sudden nut fall, rotting followed by toppling of crown portion. Severe nuts fall in all stages are observed followed by rotting can also be observed on nuts, inflorescence and spathe. The palm succumbs to death in 3-4 months' time. Extensive surveys in 12 different Panchayats of the two districts having crown rot disease were carried out and average disease incidence was recorded as 11.2%. The first growth phase for the fungal isolates purified from infected samples gave rise to white colonies, followed by dense, black mycelium. Black pycnidia without paraphyses, conidiogenous cells were hyaline, cylindrical, and swollen at the base. Conidia were thick-walled, ovoid to ellipsoid, with a rounded apex and base and 15.4 ± 0.3 × 11.2 ± 0.2 □ m, later becoming dark brown with striations. Further sequenced ITS region of selected isolates and the sequences were found to be 99.39% identical to *Neodeightoniaphoenicum* (GenBank Accession Nos. ON954594 and ON954595). A series of cultural, morphological and molecular characterization using multi-gene phylogeny confirmed the association of *N. phoenicum* as the causal organisms of crown rot disease.

Fig. 54. Symptoms of crown rot: 1) Drying of outer whorls of leaves 2) Skirting of all dried leaves 3) Toppling down of inner whorls and death of the palm 4 and 5) Rotting of the petiole, spathe, inflorescence and internal tissues 6) leaf blight and drying symptoms on leaflets 7) sudden nut fall.

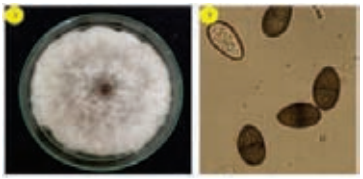


Fig. 55. The fungal pathogen *Neodeightonia phoenicum* isolated from coconut crown rot disease: 1) 4 days old mycelial culture of *N. phoenicum* grown on PDA plate 2) microscopic view of two-celled, dark brown, striated conidia of *N. phoenicum.*

Dieback disease of nutmeg in coconut-based cropping system

Dieback disease was observed in nutmeg planted in coconut-based cropping system during October 2021. Characteristic symptoms of the disease were drying of leaves from the tip and drying of young twigs, branches and general decline of the trees. The pathogen was isolated from the symptomatic leaves and branches and purified the culture. Fungal isolates were consistently obtained from the infected samples and were characterized as greyish-black colony with woolly mycelia, black pigment on the reverse side and covered 90 mm diameter within four days of incubation. Conidia were ellipsoidal in shape and hyaline (26-28×10-13 µm) formed from conidiogenous cells with aseptate paraphyses. Later turned to brown with longitudinal striations on maturity. In order to confirm the identity of the pathogen, *ITS* and *β-tubulin* gene regions were sequenced. Combined analysis of gene sequences and phenotypic characterization, the associated pathogen was confirmed as *Lasiodiplodiatheobromae* based on phenotypic and genotypic analysis. Pathogenicity test also demonstrated that *L. theobromae* was pathogenic to nutmeg.

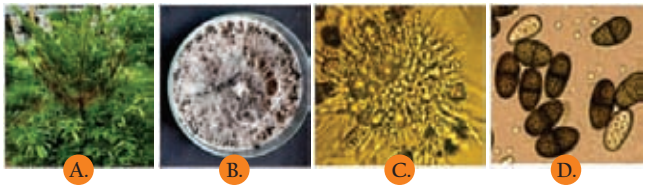


Fig: 56. Dieback disease affected nutmeg, colony, conidiogenous cells and conidia of *L.theobromae*

Dieback disease in chempedak intercropped in the coconut plantation

Artocarpus integer, commonly known as chempedak or cempedak, is a tree species belonging to Moraceae family. About four years back cempedak was introduced as an intercrop in the coconut system at ICAR-CPCRI, Kasaragod. During August 2022, drying and drooping of leaves from the branch tips were initially noticed in cempedak trees of 3 years old. In later stages, the drying of leaves extended to the bark portion and the dieback of branches was noticed. When the infected bark is removed, a brown discoloured patch can be observed underneath. As the disease spreads between the branches, the whole tree leaves dries and withers out leading to wilting and death of the tree. The resultant fungal colony from the infected samples on PDA media displayed radial growth with grey-colored colony throughout the incubation period (Fig 57-60. Based on morphological characters the pathogen was identified as *Colletotrichum* sp. The pathogenicity was also established on three year-old plants. Molecular characterization using multi-gene viz., I*TS, Actin and β-tubulin* confirmed the identity of the pathogen as *Colletotrichum gloeosporioides*.

Fig. 57. Symptoms of dieback disease in chempedak (*Artocarpus integer)*

II. Disease Management

Development of promising *Trichoderma harzianum* (CPTD28) areca leaf sheath formulation

Developed a *Trichoderma harzianum* based areca leaf sheath formulation with enhanced bio-efficacy and shelf life. White color mycelial growth of *T. harzianum* was observed on the inoculated areca leaf sheath bits on the third day after inoculation. Later, it turned to a luxuriant green mat of mycelial growth both on the upper and underside of the bits after seven days of incubation (Figure 7 and 8). The mean population of *T. harzianum* (CPTD 28) differs in different dilutions. It was 235.5×10^7 cfu g^{-1} during the first month, a significant increase in colony forming units (cfu g^{-1}) was recorded till seven months of incubation (600×10^7) and then slowly declined each month while, cfu (34.7×10^7) and viability of *T. harzianum* (CPTD28) was detected up to 24 months of incubation. Areca leaf sheath substrate could be used for regular multiplication and also for the long-term preservation of the nucleus culture of *T. harzianum.* For further multiplication of *T. harzianum* (CPTD28) at the farmer's level, nucleus culture maintained in the areca leaf sheath can be directly used as an inoculum without using mycelial disc from the Trichoderma culture grown on synthetic media. In addition, by the maintenance of *T. harzianum* in the areca leaf sheath we could retain its virulence because by frequent sub-culturing in the synthetic media there might be chances of loss of virulence.

Fig. 58. Proving pathogenicity of *Colletotrichum gloeosporioides* on chempedak

Assessment of plant growth promotion activity of *T. harzianum* (CPTD 28) in coconut

Trichoderma sp. are well known for their ability to enhance seeds germination and plant growth. In the rhizosphere they stimulate plant growth by colonizing root surfaces and help to enhance root growth, plant productivity, resistance to abiotic stress and uptake of various nutrients that can be unavailable to plants. *Trichoderma* strain, *T. harzianum* (CPTD 28, accession number LC155111), maintained in the culture collection of the Institute was found very effective against basal stem rot, stem bleeding and also bud rot of coconut and cocoa stem canker disease. The potential native isolate, *T. harzianum* (CPTD 28) was tested for plant growth promotion activity in coconut by inoculating talc and direct spore suspension @10^6/ml in tall variety (West Coast Tall), dwarf (Malayan Yellow Dwarf) and variety (Kalpa Haritha). Early germination of WCT, MYD and Kalpa Haritha was observed in *T. harzianum* (CPTD 28) spore suspension treated nuts @ 10^6/ml with and without tween 20 compared to talc formulation and control nuts. Recorded very good growth and highest plant height in MYD, WCT and Kalpa Haritha treated with *T. harzianum* (CPTD 28) spore suspension + tween treatment (T2) followed by only spore suspension (T1) and talc formulation (T3).

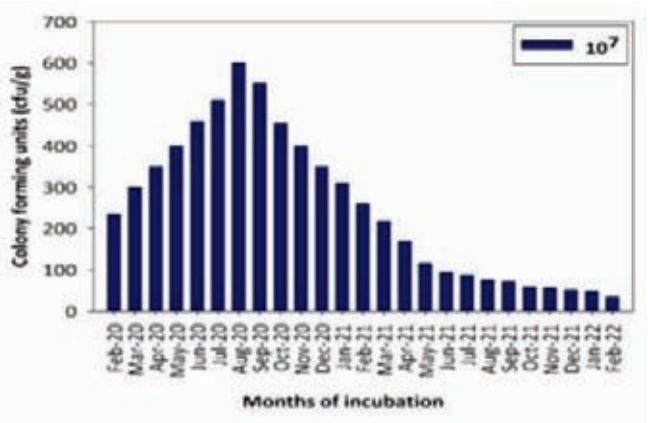


Fig. 59. Assessment of shelf life of *T. harzianum* (CPTD 28) enriched areca leaf sheath

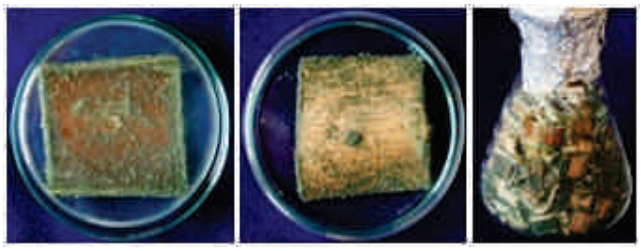


Fig. 60. Close-up view of *T. harzianum* (CPTD 28) growth on the upper and underside of the areca leaf sheath bits

Fig. 61. Germination and growth rate of Kalpa Haritha in T. harzianum (CPTD 28) treatment

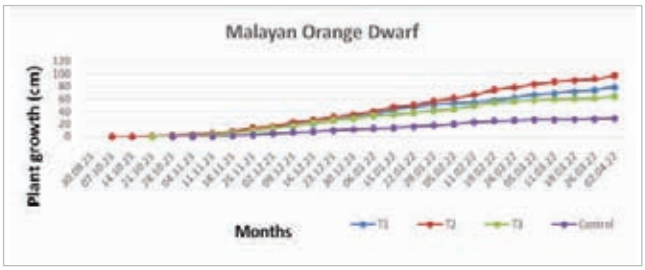


Fig. 62. Germination and growth rate of Malayan Orange Dwarf in *T. harzianum* (CPTD 28) treatment

Field evaluation of novel fungicides against emerging arecanut leaf spot disease

Field evaluation of newer fungicides *viz.,* Hexaconazole 5% EC (0.1%), Propiconazole 25% EC (0.1%), Tebuconazole 38.9% SC (0.1%), Carbendazim 12% + Mancozeb 63% WP (0.2%), Copper Sulphate 47.15% + Mancozeb 30% WDG (0.2%) and Mancozeb 75% WP (0.3%) were conducted against arecanut leaf spot disease in farmer plot, Swarga, Kasaragod District, Kerala from September-October, 2022. Two rounds of spraying of fungicides at 25 days intervals (the first round during September and the Second during October) were followed. Disease intensity (%) and disease severity (%) were recorded and found that disease severity was reduced to 37% and 35.5% in Propiconazole 25% EC and Tebuconazole 38.9% SC sprayed palms as compared to control (Table 2).

Table: 2. Filed evaluation of fungicides against arecanut leaf spot caused by *C. kahawae* sb. sp. *ciggaro*

Treatment	Fungicides	Disease severity (%)		Percent reduction over control
		Pre-treatment	Post treatment	
T1	Hexaconazole 5% EC	47.2	35.8	27.6
T2	Propiconazole 25% EC	49.3	26.4	37
T3	Tebuconazole 38.9% SC	52.8	27.9	35.5
T4	Carbendazim 12% + Mancozeb 63% WP	51.3	44.3	19.1
T5	Copper Sulphate 47.15% + Mancozeb 30% WDG	54.8	49.5	13.9
T6	Mancozeb 75% WP	52.5	55.8	7.6
T7	Control	53.1	63.4	0

Demonstration of arecanut fruit rot disease management using Mandipropamid 23.3% SC fungicide

Arecanut gardens each consisting of one-acre area were selected for demonstration of fruit rot disease. Recorded previous year incidence of fruit rot disease as 50 to 55% in arecanut garden in Kotekarvillage, Mangalore Taluk and 30 to 40% at Belvai village, Moodbidri Taluk, Dakshina Kannada district, Karnataka. Fruit rot incidence of 40-45 % in Kodimoole, Enmakaje, Kasaragod district of Kerala. Implemented phytosanitary measures such as removal of old infected dried bunches and dead palms and also provided proper drainage channels in the three demonstration trials from April to May of 2021. Laid out experimental trial in three demo plots and recommended dose of integrated nutrients were applied to experimental gardens. Prophylactic

treatments of 0.5% Mandipropamid 23.3% SC fungicide and standard check 1% Bordeaux mixture with pH7 were imposed in all the demo plots from the last week of May to the first week of June 2021. The second round of treatments with 0.5% Mandipropamid 23.3% SC and 1% Bordeaux mixture were induced during the second week of July (45 days interval). Recorded observations on the incidence and severity of fruit rot disease from June to December 2021 at alternate day intervals in all the demo gardens. Noticed 20% incidence of fruit rot disease and severity of 45% in 1% Bordeaux mixture sprayed areca palms at Belvai village, Moodbidri taluk of Dakshina Kannada district of Karnataka during October 2021. Two per cent incidence and 10% severity of fruit rot disease at Kodimoole, Enmakaje of Kasaragod district. Fruit rot disease was not recorded in 0.5% Mandipropamid 23.3% SC fungicide sprayed in all three demonstration plots. Very good challi (dry dehused arecanut) yield (1400 to 1450 kg/acre) was recorded in Mandipropamid 23.3% SC sprayed palms in all the three demo plots.

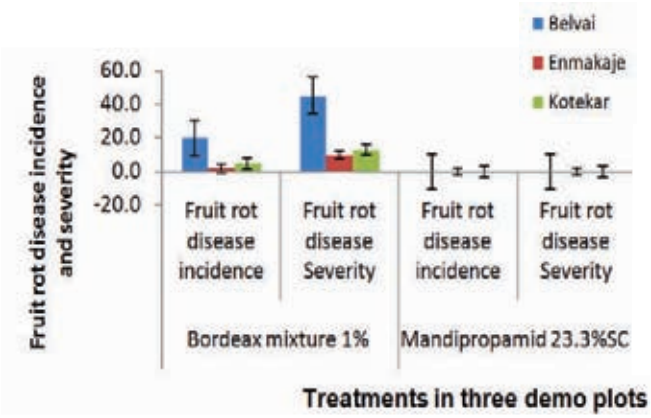


Fig. 63. Comparision of prophylactic spraying of Mandipropamid and Bordeaux Mixture for management of fruit rot disease of arecanut

Fig. 64. Very good yield in Mandipropamid 23.3%SC fungicide sprayed palms

Diversity analysis of *Ganoderma* sp. infecting coconut and their eco-friendly management

An extensive roving survey was conducted during 2022-2023 in five different coconut-growing states where basal stem rot disease is a major problem. *i.e.*, Tamil Nadu, Kerala, Karnataka, Andhra Pradesh and Assam. Andaman and Nicobar Islands were also surveyed. In Kerala, northern districts like Kannur, Kasaragod, Kozhikode and Malappuram showed the highest disease severity. The disease was severe in East Godavari, West Godavari and Krishna districts of Andhra Pradesh. East Godavari recorded a maximum mean per cent disease incidence of 16.46 followed by West Godavari. In Karnataka, Hassan, Tumkur and Tiptur districts showed higher disease severity. Thanjavur, Thiruvarur and Coimbatore districts recorded the highest disease severity in Tamil Nadu with a maximum mean disease incidence of 9.45 in Thanjavur district. In Assam, Kamrup district recorded a maximum mean per cent disease incidence of 4.25. In Andaman, Port Blair district recorded maximum mean per cent disease incidence of 9.25. Sporocarps from all the surveyed places were taken and individual fungal isolates were further taken after isolation from sporocarps. A total of 60 isolates of *Ganoderma* were collected and isolated from all the hot spot areas. Morphological and molecular analysis revealed the identity of the isolates as *Ganoderma* spp. Species-level identification and characterization are under process.

Fig. 65. Germination and growth rate of Malayan Orange Dwarf in *T. harzianum* (CPTD 28) treatment

Diagnostics and management of root (wilt) disease (RWD) in coconut and yellow leaf disease (YLD) in arecanut

Isolation and characterization of endophytes from arecanut palms for YLD management

Arecanut endophytic bacteria were isolated from apparently healthy arecanut root samples and screened against *Fusarium* spp. (Host: Arecanut) under *in vitro* conditions following dual plate assay. A total of twelve isolates were screened and found that SAR1A (36.80%) and SAR-2 (34.71%) exhibited maximum inhibition. In the phosphate (P) solubilization test among twelve isolates, isolates *viz.*, SAR-1-1, SAR-3A, KAR-P-21, SAR-2, KARP-12 and KAR-P-21A were found positive ('P' solubilization) by forming a clear halo zone around it (Fig. 67).

Fusarium spp. + SAR1A *Fusarium spp.* + SAR-2

Fig. 66. *In vitro* screening of endophytic bacteria against *Fusarium* spp.

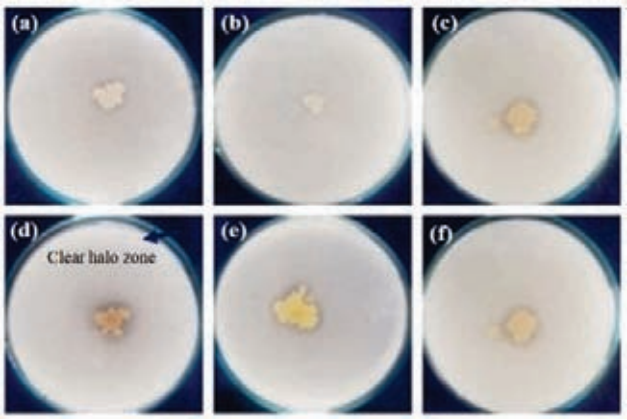


Fig. 67. 'P' solubilization in Pikovskaya's medium, (a) SAR-1-1 (b) SAR-3A (c) KAR-P-21 (d) SAR-2(e) KARP-12 (f) KAR-P-21A.

5.

INTEGRATED MANAGEMENT OF PESTS AND NEMATODES IN PALMS AND COCOA

Management of Coconut Pests

Coconut rhinoceros beetle (CRB), *Oryctes rhinoceros*

Determination of OrNV-resistant Guam haplotype

In order to determine the occurrence Guam haplotype, insensitive to Oryctes rhinoceros nudivirus (OrNV),the mitochondrial cytochrome c oxidase subunit 1 gene (COI) was analysed from OrNV escaped coconut rhinoceros beetle emerged in the laboratory that are initially fed to the grubs, field-collected beetles as well as those beetles collected from the cow dung pits and presented in Fig. 68. Transition of A to G at nucleotide position 288 on MSe1 restriction site allows the identification of the CRB-G haplotype.

Fig: 68 *COI* gene analysis of coconut rhinoceros beetle

No A to G transition at 288 nucleotide position could be observed in OrNV escape beetles, field-collected beetles, as well as beetles, that emerged from the breeding pits (cow dung) indicating the absence of OrNV insensitive Guam haplotype (CRB-G) in Kerala, India. In addition, natural infection by OrNV on the grubs of the coconut rhinoceros beetle was observed to the tune of 1.4% with more than 92% infectivity observed in the laboratory bioassay.

Heterogenous landscaping for pest regression and doubling income

The average nut yield for the past seven years of Kalpa Sankara hybrid planted in August 2012 in crop-pluralistic diversification plot was found as 158 nuts palm^{-1} year^{-1}. The damage by coconut rhinoceros beetle, red palm weevil, as well as rugose spiralling whitefly was found to be 60-75% lesser than in mono-cropped gardens. Soil temperature was also found to be at least 6-7^{o}C lesser during the summer period. Continuous income is generated in the system through the sale of tender nuts, banana bunches, spices and fruits. Eco-feast and flowering plants enhance pollinators and provide habitat for defenders. This diversified system is more robust, climate-smart, pest regressive and sustainable in the root (wilt) disease tract of the country.

Green muscardine fungus (GMF), and entomopathogenic nematodes (EPN) against CRB

In the laboratory and semi field trials, the efficacy of the combination of native isolates of *M. majus* with *S. Carpocapsae* (CPCRI – Sc1) was assessed against the grubs of CRB. Five treatments were used in which the grubs of CRB were exposed to *M. majus* and with *S. Carpocapsae* (CPCRI – Sc1) either individually or in combination at time interval of seven or 14 days. The combined application of *M. majus* and *S. Carpocapsae* resulted in higher mortality of CRB (100%) in a shorter time period (Fig. 69 & 70). An additive effect was seen with simultaneous application of *M. majus* and *S. carpocapsae*. Synergistic interaction was noticed with *M. majus* when combined with *S. carpocapsae* when applied at 7 and 14 days after application of the *M. Majus* (Table 1). The results indicated that the combined

application of *M. majus* and *S. carpocapsae* in the breeding niches would be an efficient and environmentally friendly strategy to manage CRB in palm ecosystem.

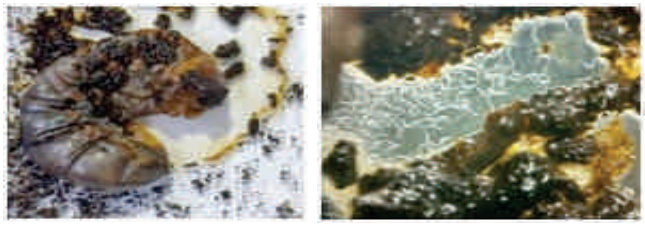


Fig: 68 *O. rhinoceros* cadaver infected with EPF and EPN application; Presence of live IJs in the EPF + EPN infected grub

Push-pull strategy for CRB management

The push-pull strategy of pest management was evaluated by placing aggregation pheromone (ethyl 4-methyl octanoate) trap outside the coconut garden and repellent citriodora (5%) impregnated calcium alginate beads on leaf axils surrounding spear leaf to ward off CRB (Fig 70 b). Results indicated that the spear leaf damage was reduced from 50% to 42.2% over a period of three months (n=90). Three aggregation pheromone traps kept on the garden periphery could also capture a total of 267rhinoceros beetles over a period of three months.

Fig. 70a. Leaf axil filling of citriodora impregnated calcium alginate beads; b. Pheromone trap on the periphery of the coconut garden

a) Water-dispersible granule formulation of *Beauveria bassiana*

A native entomopathogenic fungus isolated from larval cadavers of RPW was identified as *Beauveria bassiana* (CPCRI Strain – BB – 04). Water dispersible granule (WDG) formulation of CPCRI Strain – BB – 04 (Fig. 71.) was developed by using materials such as a water-soluble carrier, binding agent and wetting agent along with fungal spores (1:1 w/v). Bioassay trials revealed that the formulation is effective against early and late larval instars of RPW.

Fig. 71. WDG formulation of CPCRI strain – BB - 04

Exotic whiteflies

a) Morphological characterization of *Aleurodicus rugioperculatus*

Ultrastructural morphological characterization of rugose spiralling whitefly, *Aleurodicusrugioperculatus* Martin was performed using scanning electron microscope (SEM). The characteristic rugose pattern in the operculum was made of irregular ridges which are arranged in a semi-circular fashion. Dagger-shaped processes of the compound pores have several serially arranged longitudinal grooves resembling fluted appearance at ultra-structural level. The anterior wax plates in the adults are comprised of templates of 'T' shaped microtrichia, whereas, the posterior wax plates have rosette-like clusters of sub-triangular microtrichia (Fig.72.).

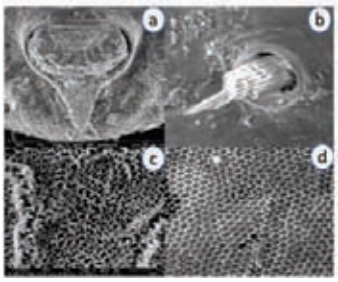


Fig: 72. Ultrastructural features of *A. rugioperculatus* a) vasiform orifice b) compound pre with dagger-shaped processes c) T-shaped microtrichia d) sub-triangular microtrichia

b) Puparium and adult features of *Aleurodicus rugioperculatus* and *Paraleyrodes bondari*

Characteristic features on puparium and adult whiteflies of *A. rugioperculatus* and *P. bondari* that are commonly prevalent in coconut-growing tracts at this point of time are recorded through a research microscope and presented in Fig. 73.

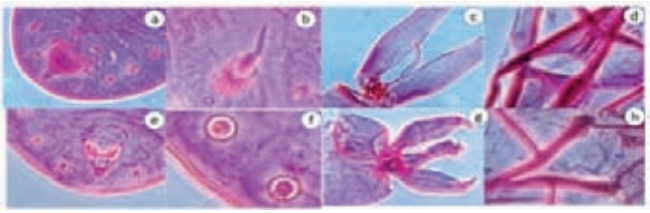


Fig.73. Puparium and adult features of *A. rugioperculatus* (a-d) and *P. bondari* (e-f) a-vasiform orifice, compound pore with dagger shaped process c) male genitalia d) cement gland e) vasiform orifice f) compound pores with flower-petal like structure g) male genitalia and h) cement gland

c) Palm whitefly (*Aleurotrachelus atratus* Hempel) in Kerala

Despite the prevalence of all exotic whiteflies on coconut, the palm whitefly (*Aleurotrachel us atratus* Hempel) was not reported from Kerala. During the surveillance, *A. atratus* was recorded from the villages of Pulingome and Cherupuzha, Kannur district and Bayar, Kasaragod district. The palm whiteflies were also recorded from ICAR-CPCRI, Research Centre, Kidu, Karnataka where they were found co-existing with areca whitefly, rugose spiralling whitefly and Bondar's nesting whitefly. *A. atratus*is identified by morphology (Fig. 74). Though palm whiteflies are known to cause necrotic lesions on palm leaflets elsewhere in the world, such extensive damage was not visualized on the infested palms. Occurrence of the predator, *Cybocephalus* sp. and natural infection by the entomopathogenic fungus, *Aschersonia* sp. were observed on the palm leaflets infested by palm whitefly.

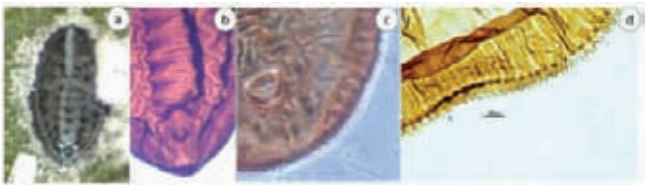


Fig.74. Puparium of *A. atratus* a) Black puparium b) Submarginal fold interrupted at vasiform orifice c) round setaceous exposed lingula d) toothed marginal crenulation

d) Isolation of an entomopathogenic fungus (*Aschersonia* sp.) against palm whitefly

At Kidu, natural infection of *Aschersonia* sp. was recorded in nearly 42.28 per cent *A. atratus* colonies. It is the first record of *Aschersonia* sp. infecting palm whiteflies. The entomopathogenic fungus was isolated and identified as *Aschersonia* sp. based on the spore characters. The infection starts from the tip of old leaves and spread towards the base. The entomopathogenic fungus was recorded on WCT, CGD, COD and GB varieties of coconut. *Aschersonia* sp. was also observed on nutmeg and guava at Kayamkulam (Fig.75). These natural bioagents are found effective in the bio-suppression of the pest and arrested the pest population escalation beyond the action threshold.

Fig. 75. Entomopathogenic fungus *Aschersonia* sp. infesting palm whiteflies
a) Coconut b) nutmeg c) spore

e) Essential oils against *A. rugioperculatus*

Five different essential oils (500 ppm) were screened for repellence against rugose spiralling whitefly, *A. rugioperculatus*. All the essential oils tested were found superior to control in reducing the pest population. Though citriodora oil (94.2%) and black pepper oil (92.5%) induced maximum repellency, there was no significant difference among the essential oils tested against RSW.

f) Predicting the risk of exotic *A.rugioperculatus* under changing climate

The latest Coupled Model Intercomparison Project phase 6 (CMIP6) dataset through maximum entropy model (version 3.3.3) was used to evaluate the possible geographical distribution of *A. rugioperculatus*in the present and under changing climate change scenarios in 2050 and 2070s using four futures shared socioeconomic pathways (SSP126, SSP245, SSP370 and SSP585) selected from sixth Assessment of the Inter-Governmental Panel for Climate Change (IPCC). MaxEnt model performed well in predicting the potential distribution for *A. rugioperculatus* with training AUC values of 0.98 (range 0.97–0.98) and test AUC values

of 0.97 (range 0.93–0.99), respectively. Northern parts of Kerala and southern parts of Karnataka found as the most suitable habitat, whereas western parts of Tamil Nadu and eastern parts of Karnataka recorded as moderately suitable habitat. The northern parts of India are predicted with very low to nil risk area for *A. rugioperculatus* infestation. Among the bioclimatic variables, precipitation of the coldest quarter (BIO19; 56.4%) and Isothermality (Bio03; 42.6%) alone contributed 99% to the model. Results suggested that the suitable habitat area for *A. rugioperculatus* is predicted to expand and the highest probability of invasion and spread in 2050 and 2070 under future climate change scenarios over the present suitable areas scenarios is depicted in Fig. 76 & Fig. 77.

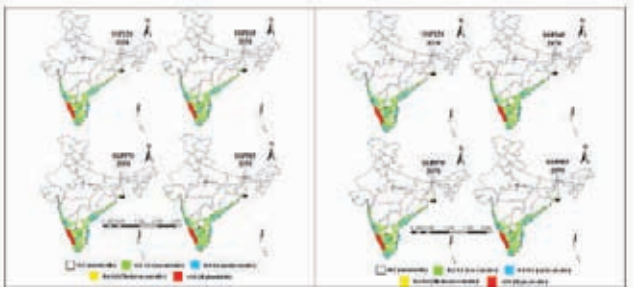


Fig. 76. Projected changes in the distribution map of *A. rugioperculatus* in India during 2050

Fig. 77. Projected changes in distribution map of *A. rugioperculatus* in India during 2070

g) Biological control of RSW in coconut

Evaluation of biorationals on the bio-suppression of RSW was conducted using four treatments *viz.,* conservation biological control, *Isariafumosorosea*, neem oil (0.5%) and water spray superimposed on ten palms per treatment. Under good nutrition management, it was found that palms treated with neem oil (0.5%), water spray and *Isariafumosorosea* could reduce the RSW population significantly ranging from 0.78 to 1.08 from the initial population of 1.51 to 3.01. Palms maintained under conservation biological control registered the highest RSW population (1.51) after two-month of treatment. However, the highest reduction of RSW population was recorded on neem oil-treated palms followed by palms under conservation biological control and water spray. The least reduction was observed on palms exposed to *Isariafumosorosea* (42.6%), whereas, neem oil treated palms registered the highest pest reduction of 58.8% (Table 2). Good health management practices are very much important in recouping palm health and thus reducing the pest impact. After the receipt of monsoon showers all palms became free of pest infestation and BNW is overriding in certain leaflets.

Table 3. Efficacy of biorationals on the bio-suppression of rugose spiralling whitefly

Treatments	RSW population (No.)					Parasitism (%)
	Pre-treatment	After one month	Reduction (%)	After two months	Reduction (%)	
Conservation biological						
control	3.01 (1.67)	2.72(1.64)^{c}	9.7	1.51(1.17)^{b}	49.8	38.5
Isariafumosorosea	1.88 (1.47)	1.61(1.37)^{b}	14.4	1.0.8 (1.04)^{ab}	42.6	31.9
Neem oil 0.5%	1.98 (1.41)	1.11(1.08)^{a}	43.9	0.83 (0.95)^{ab}	58.8	37.9
Water spray	1.51 (1.30)	1.02(1.01)^{a}	32.5	0.78 (0.91)^{a}	48.3	40.1
CD(P=0.05)	ns	0.227		0.243		

h) W**oolly whitefly, *Aleurothrixus floccosus***

Adult features of the exotic woolly whitefly, *Aleurothrixus floccosus* Maskell on guava in the coconut system was characterized and presented in Fig 78. These characteristics are found typical to that of *Aleurothrixus floccosus* found on guava in the coconut system.

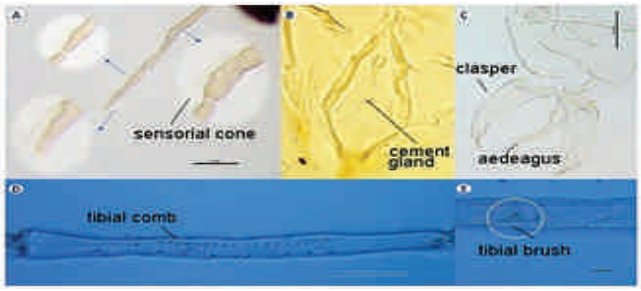


Fig. 78. Adult features of the woolly whitefly, *Aleurothrixus floccosus*

Nut crinkler coreid bug, *Paradasynus rostratus* Distant

Coreid bug, *Paradasynus rostratus* (Dist.) is an emerging pest of coconut especially in Southern Kerala. It causes deep furrows, crinkles and gummosis on the nut surface, severe infestation leads

to button shedding and complete drying of bunches, which directly affect coconut yield. The pest incidence ranged from 23.4% to 40.6% causing heavy crop loss ranging from 18.2% to 66.4%. The bugs lay eggs in clusters in coconut and alternate crops. The eggs hatch in 8-9 days. The first instar nymphs are orange in colour which turns to deep red during later instars. The important diagnostic features of the nymphs of coreid bugs are the presence of a pairs of black spots on the abdomen, leaf-like modification of the 3rd flagellomere and two pair of spines on pro and meta thorax up to 3rd instar nymph. All the nymphal instars are gregarious and feed on developing immature nuts and alternate hosts. The adults are brownish in colour with red prominent ocelli (Fig. 79).

Fig. 79. Different stages of *P. rostratus*
a) 1st instar b) 2nd instar c) 3rd instar d) 4th instar
e) 5th instar f) adult

b) New egg-laying hosts of the coreid bug, *P. rostratus*

In addition to guava, tamarind, cashew, cocoa, mango, passion fruit, *Garcinia,* tapioca, neem and black pepper as alternate hosts of coconut coreid bug, *P. rostratus*, four new egg-laying hosts were identified *viz*., sour sop (*Annona muricata*), nutmeg (*Myristica fragrans*), mangosteen (*Garcinia mangostana*) and rose apple (*Syzygium samarangense*) (Fig. 80) from Kayamkulam, Kerala. The nymphs emerge by removing a flap from the dorsal surface of the egg (Fig. 81).

Fig. 80. Coreid eggs on different hosts a) sour sop b) nutmeg c) rose apple d) mangosteen

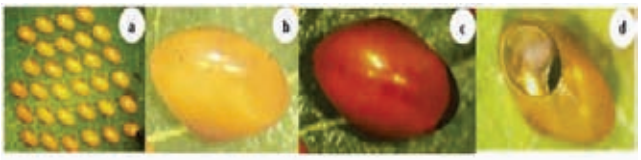


Fig. 81. Eggs of coreid bug a) egg cluster b) freshly laid egg c) just before hatching d) chorion after hatching

c) Identification of an egg parasitoid (*Anastatus* sp.) of coreid bug:

An egg parasitoid observed to be parasitizing coreid eggs was identified as *Anastatus* sp. based on the morphological characters (Fig. 82).

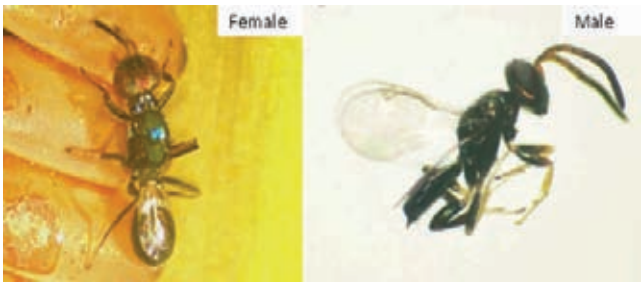


Fig. 82. Egg parasitoid (*Anastatus* sp.)

Management of Arecanut and Cocoa Pests

The stink bug, *H. picus* (Fabricius) is considered a serious pest on arecanut since 2018. Different substrates including arecanut, French bean, carrot and cow pea were used as food for *H. picus* in the laboratory under choice and no-choice conditions. Of these, all stages of *H. picus* preferred to feed on cowpea pods, completed its life cycle within 60-70 days and laid at least 3-4 egg masses/female (Fig. 83. a & b). Furthermore, the overall mean survival percentage was higher (>80%) on cowpea as compared to other substrates. Only 4th, 5th instars nymphs and adults preferred tender arecanut; whereas, the carrot was least preferred.

Fig. 83. Rearing of *H. picus* using different hosts; b. The life cycle of *H. picus*

***Spodoptera litura* (Fab.) - A new insect pest of cocoa**

In September 2022, a sudden occurrence of a defoliator on cocoa saplings causing extensive defoliation was observed at Regional Station, Vittal, Karnataka, India. Both morphological and molecular investigation revealed the cause of defoliation due to the noctuid caterpillar, *Spodoptera litura* (Fig. 84). Previously, the presence of *S. litura* has been documented on *Leucaena leucocephala,* which is a shade tree of *cocoa* plantations in Indonesia (CABI, 2018). However, no other studies have reported its occurrence on cocoa. To the best of our knowledge, this is the first record of infestation by tobacco cut worm on cocoa in India.

Fig. 84. *Spodoptera litura* larvae on cocoa causing extensive defoliation (A & B), adult moth (C).

Plant Parasitic and Entomopathogenic Nematodes

a) Meloidogyne enterolobii infesting guava
Severe infestation by root-knot nematode was observed with wilting and dying of guava (*Psidium guajava* L.) intercropped in coconut garden at Kayamkulam. The nematode was isolated from infested guava roots and subjected to morphological and molecular characterization. The morphological identity was confirmed by typical morphological and morphometric features of second-stage juveniles as well as the characteristic perineal pattern of adult females (Fig.85). Sequencing of 28S ribosomal RNA gene using D2a and D3b primers as well as cytochrome c-oxidase subunit-1 (COI) gene showed more than 99% identity with Meloidogyne enterolobii. Molecular identity was further confirmed with M. Enterolobiispecific SCAR marker (MeF&MeR) which yielded a positive amplification of nucleotide having approximately 236 bp size band in the agarose gel. The presence of M. enterolobii also from a guava seedling collected from a private nursery located about 40 km from Kayamkulam warrants the adoption of strict quarantine measures to halt the further spread of this exotic nematode in to new areas. This is a new record of *M. enterolobii* from Kerala.

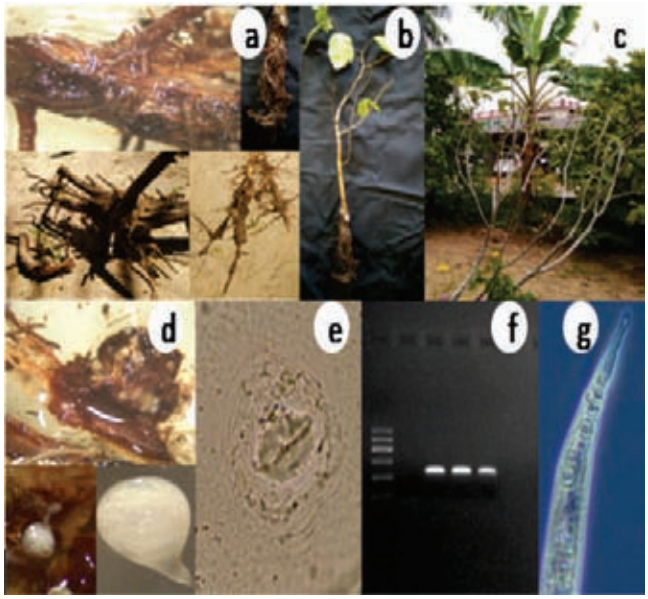


Fig 85. *M. Enterolobii* infesting guava a) root damage b) seedling attack c) wilting of guava plant d) Females of *M. enterolobii* inside the gall e) unique perineal pattern f) amplification by specific SCAR marker g) constriction at tip

b) Molecular characterization of bacterial symbionts associated with native EPN isolates

The bacterial symbionts of local EPN isolates namely, *Steinernema* sp. CPCRIS2101, *Steinernema* sp. CPCRIS0804, and *Steinernema* sp. CPCRISB25 was isolated using NBTA medium and all the cultures exhibited the typical colony morphology of *Xenorhabdus* spp. Gram staining of the symbiotic bacteria resulted in pink/red colour bacterial cells, thus each isolate are confirmed to be Gram-negative. Genomic DNA was isolated from the bacterial symbionts, 16S rRNA gene region was sequenced and phylogenetic tree was constructed for the identification of the bacterial isolates. Analysis of 16S rRNA sequences revealed genetic relatedness of CPCRIS2101, CPCRIS0804 and CPCRISB25 to *Xenorhabdus griffinae* with 99.86%, 98.99% and 98.92% identity, respectively (Fig.86).

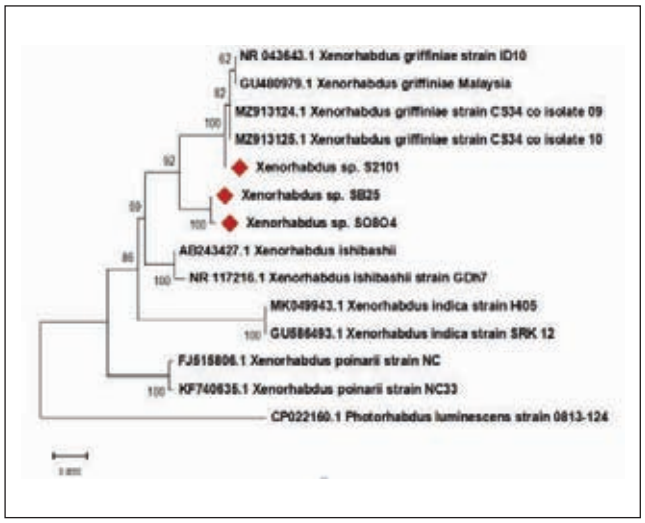


Fig. 86 Phylogenetic tree of bacterial symbionts associated with native EPN

Demonstration of IPM

Area-wide Integrated Pest Management (IPM)

Area-wide IPM of red palm weevil was conducted in a coconut-based mixed farming system at Bayar in Paivalike Panchayat of Kasaragod District in an area of 35 acres of hilly region. The farm holds 550 coconut palms (Planted in 2016), 225 coconut seedlings (planted in 2021) intercropped with fruit trees such as rambutan, jack-fruit, star apple, banana, etc. The dairy component has 19 cows and poultry with 10000 birds. RPW incidence was found to be very high 6.4% and 11.5% during 2019 and 2020, respectively. Crown attack as well as bole entry by red palm weevil was observed in the farm even on three year-old palms. Systematic IPM intervention was undertaken during 2021 and 2022 which included the destruction of toppled palms, prophylactic treatment with neem cake admixed with sand and curative treatment with imidacloprid (0.02%) at the appropriate time. In addition, prophylactic intervention to arrest bole entry of the pest was also ensured by the root zone application using chlorpyrifos 20 EC @ 5ml / L @ 5- 8 L /palm. With the timely intervention of both rhinoceros beetle and red palm weevil, the pest incidence was drastically reduced to about 0.73% in 2022 (n=500 palms) with more than 87.3% palm recovery. Critical monitoring and timely intervention of both prophylactic and curative interventions are very important in the overall recovery of palms infested by red palm weevil.

On Farm Trial (OFT) of citriodora oil impregnated calcium alginate beads

An OFT to validate the efficacy of citriodora oil (5%) impregnated calcium alginate beads@ 5g/ palm on 3-5 years old coconut palms was conductedat Panayal village in Kasaragod during the months of June to September in 2020 and 2021 (10 farm units each with 50 palms). RPW incidence was reduced from 0.6% to 0.4% in the first year and further suppressed to 0.2% in 2022 (Fig 87 a & b). It could provide prophylactic protection for a period of three and four months during the first and second year, respectively.

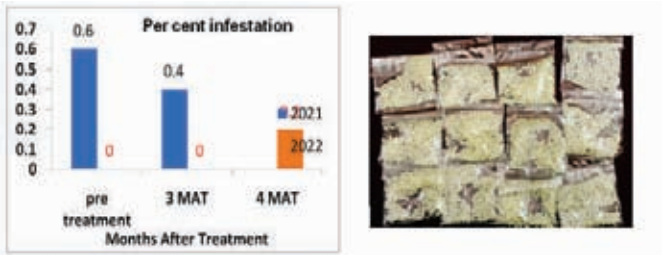


Fig. 87a. Influence of citriodora oil-impregnated calcium alginate beads on RPW.
b. citriodora oil impregnated calcium alginate beads

Farmer participatory integrated plant parasitic nematodes management

Awareness was created among the farming community regarding the plant parasitic nematode infestation and strategies to be followed for their integrated management. Integrated nematode management strategies and use of *Trichoderma* and *Pochonia* enriched neem cake and organic manures and crop rotation with the least preferred host plants like tapioca were demonstrated in the farmers' fields at Pathiyoor, Krishnapuram and Vallikunnam Panchayaths. A significant reduction in the nematode infestation (up to 70 to 100%) was realized in the demonstration plots as compared to the neighbouring farmers.

The amorphophallus varieties were screened against root-knot nematode in the coconut garden at four

selected farmer fields in Pathiyoor and Krishnapuram Panchayath. Gajendra and Sree Padma varieties are observed to be highly susceptible with a gall index of 3 to 5, whereas, the local variety is observed to be highly tolerant with a gall index of 0 to 1 (Fig. 88).

Field demonstration of *Trichoderma harzianum* for eco-friendly management of root-knot nematode in black pepper under coconut/ arecanut system

Soil application of *Trichoderma harzianum* (CPTD-28) enriched neem cake (1:100) @ 1.0 kg/vine during pre-monsoon and post-monsoon season significantly suppressed the build-up of root-knot nematode, *Meloidogyne incognita* population to the tune of 56.2% and reduced yellowing of vines to 6.1% from 20% in treated coconut/arecanut garden at Ajekar village of Karkala Taluk of Karnataka. Regular application of *T. harzianum* enriched neem cake improved the health of vines and enhanced yield by reducing the damage caused by *M. incognita*.

Fig. 88. Reaction of different yam varieties to PPN a-c) Nematode tolerant yam varieties.

6.

PHYSIOLOGY, BIOCHEMISTRY AND VALUE CHAIN MANAGEMENT IN PALMS AND COCOA

Climate Change Impact: Prediction of Production, Vulnerability Assessment and Adaptation Strategies

Water use efficiency (WUE) of coconut

Climatic factors influence the nutrient use and whole plant water use efficiency (WUE) of hydroponically grown coconut seedlings. A couple of dwarf (Chowghat green dwarf, CGD and Malayan yellow dwarf, MYD) and tall (Kalpa Pratibha and Kalpatharu) coconut genotypes were analyzed for water use and biomass production across the seasons (Fig. 89). Increasing vapour pressure deficit on leaf surface (VPDL) directly influenced daily water consumption, which was significantly high during the summer (3.14 L) compared to the monsoon (1.83 L), but the difference in biomass gain was insignificant. Hence, the WUE was only 3.35 g L^{-1} during the summer as against 6.6 g L^{-1} during the monsoon. The interaction effect of season and genotype was significant on water use, biomass gain, and WUE. WUE during the summer was 33% and 65% less for talls and dwarfs, respectively, compared to the monsoon. Water use of both talls and dwarfs increased by 81% and 90%, respectively, but on the other hand, biomass increased in talls by 13% while it was sensitive in dwarfs and reduced by 31% from the monsoon season (Fig.89b). The sensitive stomata of tall palms could conserve water and maintain a significantly high WUE, while the passive stomata of dwarfs allowed greater water loss without a concomitant increase in biomass, resulting in a low WUE. The early photosynthetic light saturation at 1400 µ mole photon m^{-2} s^{-1} had also contributed to low biomass production in dwarfs. Thus, at high temperatures and low humidity in general, coconut WUE is low, and especially dwarfs are not suitable for those regions with dry weather or those expected to become dry under future climate scenarios.

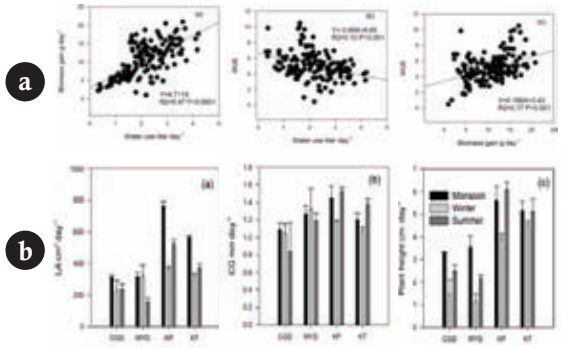


Fig. 89a. Correlation between water use vs. biomass gain per day, water use vs. WUE (g L^{-1}) and biomass gain vs. WUE (n =144).

b. Seasonal influence on morphological characters of two year old coconut seedlings of CGD, MYD, KalpaPrathibha (KP) and Kalpatharu (KT) grown in hydroponics; (a) Leaf area per day (LA day^{-1}) (b) collar girth (CG day^{-1}) (c) and plant height (pht day^{-1}).

Current and future climate suitability for arecanut (*Areca catechu* L.) in India

An ensemble platform for species distribution modeling, Biomod2, was employed to forecast the impact of climate change on adaptability of arecanut crop. The study region was grouped into five categories: very high, high, moderate, low, and very low and the change in each category from the current to two future scenarios (shared socio-economic pathways SSP 2-4.5 and SSP 5-8.5 of 2050 and 2070) was evaluated (Fig. 90). A shift in the climate suitability area from 'very high' and 'high' categories to 'moderate' or 'very low' categories suggest the need for adaptive strategies to sustain the current yield levels. Amongst the regions of

Karnataka, is highly vulnerable and more area is falling under 'very low' and 'low' categories from eastern side. Meanwhile, in north eastern part of the country a shift in high suitable region from north west to southwest is observed. Overall, the model prediction suggests that some parts of west and south interior region warrant immediate consideration in order to adapt to future climate change, whereas some parts of north east can be considered for future cultivation.

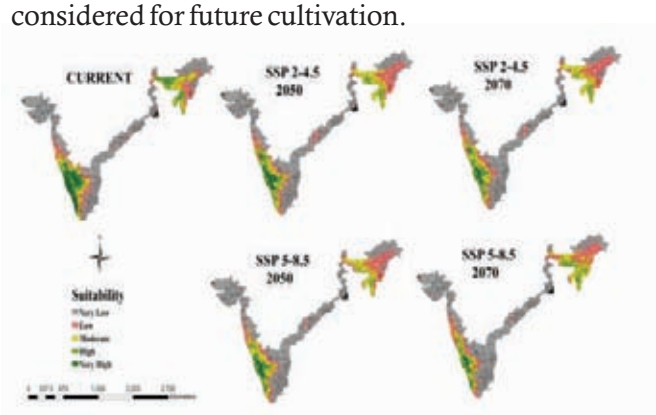


Fig. 90. Climatically suitable regions for Areca nut production in India for SSP 2-4.5 and SSP 5-8.5 under current and predicted climate in the 2050s and 2070s with ensemble model

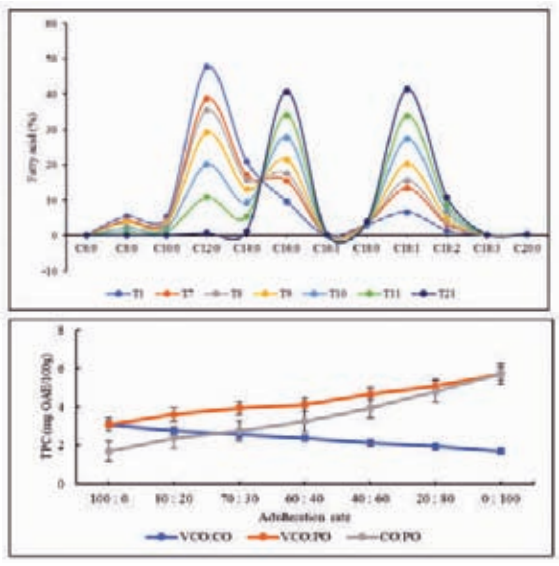


Fig. 91. Changes in total polyphenol content (TPC) among the different VCO, CO, and PO blends. Fig. b. Variation in the fatty acid profile of different VCO and PO blends **(**T_1- 100 VCO : 0 CO : 0 PO; T_7- 80 VCO: 20 PO; T_8- 70 VCO : 30 PO; T_9- 60 VCO : 40 PO; T_{10}- 40 VCO: 60 PO ; T_{11}- 20 VCO : 80 PO; T_{21}- 0 VCO : 100 PO**)**

Increased adulteration of PO in VCO and CO resulted in a significant increase in TPC whereas; TPC of VCO+CO blend showed significant decrease with an increase in CO concentration where the adulteration levels exceeded the threshold of 20 percent. At an adulteration level of 10 per cent in VCO and CO with mineral oil, a significant decrease in TPC was observed. Increase in the concentration of PO in VCO: PO, and CO: PO blends, witnessed a significant decrease in fatty acids *viz.*, C12:0 and C14:0 whereas the concentration of C16:0 and C18:1 increased significantly. The concentration of all the fatty acids in 90VCO+10PO and 90CO+10PO was significantly lower than VCO and CO, respectively.

Value Chain Management in Palms and Cocoa

Neera honey infused extrudates

Neera honey was utilized as a bio-fortifying ingredient in the production of ready-to-eat extrudates (Fig. 4). A blend of 60% rice flour, 25% corn flour, and 15% coconut milk residue enriched with neera honey up to 16% (w.b.) feed moisture was found to be acceptable. Neera honey infusion boosted the extrudates' antioxidant activity as well as their nutritional qualities, including their levels of calcium, potassium, and sodium as well as vitamin C.

Fig. 92. Extrudates prepared with rice flour, corn flour, coconut milk residue and *neera* honey **(1)**100% RF + 16% FM (water), **(2)** 100% RF + 16% FM (NH), **(3)** 100% CF + 16% FM (water), **(4)** 100% CF +16% FM (NH), **(5)** 50%

RF + 50% CF + 16% FM (NH), **(6)** 50% RF + 50% CF + 16% FM (water), **(7)** 60% RF + 25% CF + 15% CMR + 16% FM (NH), **(8)** 100% RF + 20% FM (NH),**(9)** 85% RF + 15% CMR + 20% FM (NH)

Baked coconut chips

The baking protocols for the nutritious coconut chips were standardized. Coconut meat of two distinct thicknesses (0.75 and 1.5 mm) was sliced and subjected to osmotic dehydration process. The resultant samples were baked at 160 °C to obtain the chips with a fine colour, texture, and crispness (Fig. 93).

Fig. 93. Baked coconut chips
(a) 0.75 mm thickness (b) 1.5 mm thickness

Machineries for tender coconut processing

A motorized coconut punching machine with a platform, slider crank punching unit, motor, gear reduction assembly, and limit switch was developed. To provide a high torque during punching, the device contains a single-phase, 0.5 HP motor with a 30:1 speed reduction ratio. The equipment costs ₹25,000/- and has a capacity to punch 600–700 nuts per hour (Fig 93). Also, a stainless steel, solar-powered tender coconut cutting machine has been developed. It requires 12V DC of power to operate at a speed of 5 mm/s. The tender nut cutting operation is performed in a minute and the machinery costs approximately ₹ 70,000/- (Fig. 94).

Fig. 94. Motorized tender coconut punching machine Solar assisted tender coconut cutting machine

Tender Arecanut de-husking machine

The husk of tender arecanuts (6-7 months old) warrants mechanical removal while processing for red *supari*. Hence, an arecanut dehusking machine has been developed (Fig.94). Arecanuts placed on the front end of a container are transported to the inlet of the de-husking device on a twin conveyer belts having cups. A hook-tooth cutting blade, the main component of the device, that is mounted to the surface of a cutting wheel penetrates and removes the husk. The tender arecanuts are forced against the spinning cutting wheel. The rotating wheel, which forces the arecanut downward, ensures that the husk is separated from the kernel. At the bottom of the cutting blade, a vibrating deck of trays is equipped to deliver and collect the partially dehusked and dehuskedarecanuts separately. The main power source is a 3 HP electric motor. The machine operates at a capacity of 200 kg of arecanuts per hour.

Fig. 95. Tender arecanut de-husking machine

7.

TECHNOLOGY TRANSFER, ECONOMICS AND STATISTICAL METHODS

Extension Activities

Training Programmes: Institutional and off campus training programmes for farmers and other stakeholders on technologies pertaining to coconut, arecanut, and cocoa were conducted in all units of ICAR-CPCRI. The majority of the programmes is of one-day duration and is part of exposure visits organised by development departments (Table 4, Fig. 96). Programmes organised by the institute include capacity building programme on production and processing aspects for FPOs (Kasaragod, Kayamkulam, Vittal, Kidu, and Kavarati); programme for pollination workers; micro irrigation techniques; interactive meetings in four islands of Lakshadweep; farm mechanisation (Kahikuchi); and crop diversification in plantations with spices (Mohitnagar). Besides, training programmes were also conducted as part of SC/ST sub-plans and externally funded projects.

Table 4. Capacity development programmes

Station/ Centre	Number of programmes	Number of participants
Kasaragod	84	2982
Kayamkulam	19	770
Vittal	40	3000
Kidu	7	349
Mohitnagar	7	420
Kahikuchi	23	702
Total	**180**	8223

Fig. 96. Dr Anitha Karun, Director (Acting) addressing the interns of LSG institutions

Fig. 97. Capacity development programme at Kottiyoor

Fig. 98. Training on coconut inflorescence sap collection at Lakshadweep

Workshops: The Institute has conducted five workshops on specific aspects of crop management and value addition (Table 5).

Table 5. Workshops conducted during 2022

Programme	Collaborating Agency
Decentralised planning for sustainable development (4 Jan 2022)	Kerala Institute for Local Administration (KILA), Thrissur
Coconut based enterprises (2-3 Mar 2022)	District Industries Centre, Kerala
Coconut based enterprises (7 July 2022)	District Industries Centre, Kerala
Technologies for Eco-friendly and sustainable agriculture (30 Jul 2022)	Mathrubhumi Daily
Arecanut Processing (2 Dec 2022)	Institute of Co-operative Management, Kannur

Front Line Demonstrations:

FLDs on selecte dtechnologies in progress (undersponsored and institutional projects) are listed in Table 6. Demonstrations under SCSP/STC were not included here.

Table 6. Front Line Demonstrations in progress

Technology	No
Soil and water conservation techniques in coconut gardens (CDB project)	40
Kalpa EPN (CPCRI – SC1) application for the management of white grub (DASD project)	2
Integrated Root (wilt) disease management practices (FFP)	165
Intercrop diversification for income enhancement from coconut gardens	55
ICAR-CPCRI nutrient mixture Kalpa Vardhini	70
Integrated nematode management of Amorphophallus for planting material production (Var: Gajendra) as intercrop in coconut gardens	10
Millets in coconut gardens	60
Arecanut based multi-species cropping systems	6
Five coconut varieties viz., Kera Chandra, Kalpatharu, Kalpa Prathibha, Kalpa Mithra and Kera Keralam at District Jail campus, Palakkad	1
Arecanut dwarf hybrids	2

Diagnostic field visits: During 2022, more than 100 diagnostic field visits were conducted in different parts of the country, mainly on plant protection aspects (yellow leaf disease of arecanut, coconut root (wilt) disease) and integrated nutrient management.

Kisan Mela: A five-day Mega Kisan Mela and Agri Expo under the theme "Agrobiodiversity for Sustainability" was organised at the ICAR-CPCRI Research Centre, Kidu, as a Dept. of the golden jubilee celebration of the Centre during November 19–23, 2022.

Exhibitions: Participated in 12 exhibitions conducted at various places in the country.

Agriculture Technology Information Centre: Various farm advisory services were offered to farmers and other stakeholders through ATIC. A total of 19084 farmer queries on various aspects of crop management were answered as part of farm advisory services through ATIC.

Utilisation of mass media and extension literature: Six radio programmes and one television programme were presented in the year 2022. Scientists published 33 popular articles in farm journals on various aspects of crop management technologies and value addition pertaining to mandate crops. One technical bulletin, 23 extension folders, and five ready reckoners were brought out.

Formation of FPOs: As CBBO, two FPOs were formed and registered under the Societies Act: Mullasseri (368 shares) and Chavakkad (280 shares). The Mullasseri FPO received their matching grant (6.4 lakhs – 320 shares). The Odanadu Farmer Producer Company LTD (OFPC) was formed at FFP Pathiyoor, aggregating FFP farmers with ICAR-CPCRI as POPI. Presently, OFPC has 368 shareholders who are coconut farmers.

Cyber Extension Activities: An online training programme for extension personnel on 'Integrated management of new fungal disease in coconut gardens of Northern Kerala' was organised on July 1, 2022. Online lectures on various topics were delivered by scientists as part of different programmes organised by other agencies. The Institute website and agribusiness site were updated.

TOT interventions under the NEH programme: Training cum input distribution were conducted in 10 identified backward blocks and villages in three districts of Assam. The number of beneficiary farmers is 300.

Inputs supplied:

- Arecanut seedlings: 30400 benefiting 1010 farmers of Assam, Tripura, and Mizoram.
- Coconut seedlings: 5000 (Mizoram)
- Vegetable seeds to 360 farmers in Assam and Tripura.
- Black pepper rooted cuttings: 500 (50 farmers in Assam)

The Institute had signed an MOU with the Central Agricultural University for conducting programmes in Tripura. A large scale coconut nursery was established at Mohitnagar (30000 WCT seed nuts) for distribution in the NE region.

Fig. 99. DASD sponsored training programme for farmers from Boko village in Assam

Fig. 100. Training and input distribution in Dima Hasao district in Assam

Fig. 101. Training programme at Tuichakma, Tripura

Scheduled Caste Sub Plan (SCSP): Training programmes were conducted in Thiruvanantha puram, Kasaragod, Dakshina Kannada, and Jalpaiguri districts. A total of 20 training programmes were conducted to benefit 332 SC members. Critical inputs like planting material (302 coconut and 500 arecanut seedlings), vegetable seeds of released varieties (1148 kg to over 9000 families through KVKs of Kerla, Tamil Nadu, and Karnataka), bee hives (650 among 95 beneficiaries), sugar for feeding bees during the lean period (1500 kg), and poultry birds and cages (45 families) were distributed.

Scheduled Tribe Component (STC): STC activities were conducted in Odisha and Kerala. Programmes in Odisha were conducted in collaboration with the Kalpabrukhya Foundation. A total of 12,000 West Coast Tall (WCT) coconut seed nuts were made available among tribal farmers to establish small scale coconut nurseries in villages namely, Chandka (Khordha district); Radhakrishnapur, and Raja Athagarh (Cuttack district); and Kalikaprasad and Bandana (Dhenkanal district). On the occasion of the oath-taking ceremony of the Honourable President of India, Smt. Draupadi Murmu, ICAR - CPCRI, Kasaragod organised a training programme on coconut nursery management for the tribal farmer beneficiaries on July 25, 2022, at Radhakrishnapur village. Two thousand coconut seedlings were distributed to the participants on that day. Coconut seedlings were distributed to tribal families in Wayanad district in collaboration with ARS (KAU), Ambalavayal.

Fig. 102. Group meeting to form a cluster SC honey farmers at Kasaragod

Fig. 103. Training programme at Vittal

Technology assessment

I) Participatory analysis of performance of arecanut varieties

Through scientist-farmer interaction sessions utilising field visits and PRA techniques, the experiences of selected farmers in cultivating different arecanut varieties were analysed, along with the adoption of recommended crop management practises. Mangala scored highly on attributes related to early flowering and the availability of planting material. Mohitnagar scored high on nut yield, had less alternate bearing, and was less susceptible to pests and diseases. South Canara local scored high on nut quality, amenability for mixed cropping, and being less susceptible to pests and diseases. The dwarf hybrid variety scored high on the low requirement for skilled labour but scored the lowest on all other attributes (Table 7).

The areca dwarf hybrids started flowering four years after being planted in farmers' fields. The perceived advantages of cultivating dwarf hybrids included: i) skilled labour is not required; (ii) easy to maintain; and iii) more plants can be accommodated due to the smaller canopy. The disadvantages as perceived by areca growers include: i) alternate bearing; ii) dropping of nuts from the middle of the bunches due to compactly arranged nuts in the bunches iii) nut quality is inferior to the popular local varieties like South Canara Local iv) abnormal growth; and v) susceptibility to bud rot, collar rot, and spindle bug. Major suggestions for arecanut research put forth by areca growers included: i) evolving areca varieties with uniformity among the palms in a population in terms of yield and other characters, bolder nuts and short stature ii) evolving appropriate management practises for disease management, including YLD.

Table. 7. Participatory analysis of the performance of arecanut varieties

Sl No	Attributes	Score obtained (1 to 10)			
		Mangala	Mohitnagar	Dwarf Hybrid	South Canara Local
1	Availability of seedlings	8	7	1	6
2	Earliness in flowering	8	7	4	5
3	Low requirement of skilled labour	7	6	8	5
4	High uniformity of palms in the field	5	7	2	6
5	High nut yield	7	8	2	6
6	Less alternate bearing	6	8	3	7
7	Good nut quality	5	7	4	8
8	High feasibility for mixed cropping	4	6	2	8
9	Less susceptible to pests and diseases	6	8	4	8
10	Response to low input management	6	5	3	7
11	Amenability of nut for mechanical dehusking	7	7	4	6
12	Long economic life	7	6	2	8
	Total score	**76**	**82**	**39**	**80**

ii. Profile analysis of coconut based enterprises

A study was conducted to analyse the profile of coconut based enterprises (CBEs) in the Kasaragod district of Kerala state. The geographical spread, types of products handled, constraints to the efficient management of enterprises, and other relevant profile features of CBEs were studied. The study revealed that there were 142 CBEs in the district, with the highest number (38%) located in Parappa block panchayat and the lowest (11%) in Karadka and Manjeswar block panchayats. The vast majority of CBEs handled activities pertaining to the production and marketing of coconut oil, which is perceived as involving low risk in marketing. It was

followed by copra making (7%). Other products included virgin coconut oil, coir pith manure, coconut chips, coconut ice cream, etc. Thirty nine percent of CBEs had availed credit to initiate their enterprises, and 14% of CBEs had received subsidies from government agencies. Major constraints experienced by CBEs to effectively manage their enterprises included marketing difficulties (36%), lack of raw materials (27.5%). Financial constraints, inadequate infrastructural facilities, and cumbersome licencing procedures were other important constraints faced by CBEs.

Consultancy

As per the request from Lakshadweep Development Corporation Limited (LDCL), U.T. of Lakshadweep, a team of scientists from ICAR-CPCRI Kasaragod comprising Dr. A.C. Mathew, Dr.Thamban. C., Dr. P. Subramanian, and Dr. Shameena Beegum visited the coconut oil unit in Amini Island, on February 8, 2022, and submitted a report to LDCL on measures to revive the unit into a state-of-the art coconut oil unit.

Radio programmes

During the year, a total of 15 radio programmes were presented on various topics pertaining to improved technologies by scientists of the institute.

Farmer FIRST Program (FFP)

The ICAR-CPCRI'S Farmer FIRST Programme (FFP) is implemented in six modules in Pathiyoor Grama panchayath, Alappuzha district in an area of 1627 ha since 2016 and the programme interventions are upscaled in Devikulangara Gramapanchayath (Alappuzha district) and OchiraGramapanchayath (Kollam district) extending the area under FFP to 2430 ha during 2021-22.

Table 8. The total activities in six modules during the period are as follows:

Module	No. of technologies	No. of farmers benefitted
Crop	12	629
Horticulture	6	205
Livestock and poultry	6	153
Natural resource management	4	217
Value addition and entrepreneurship	6	21 units
Integrated farming Systems (IFS)	1	136 farm families

Impact of FFP interventions in root (wilt) diseased coconut tract

The total area of the demonstration of integrated root (wilt) diseased gardens was 139 acres (55.65 ha), involving 142 farmers for 6450 bearing palms. Preliminary analysis for the period 2018 to 2021 indicated that there was a 43.09% improvement in the number of marketed nuts and a 61.74 % improvement in domestic coconut oil production from their own harvest, which was due to the improvement in production of coconut over the period.

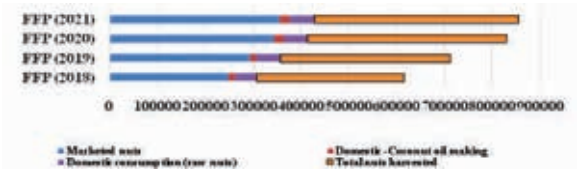


Fig. 104. Coconut production and consumption

High yielding varieties (intercrops) in coconut gardens (2021–2022)

Farmer participatory assessment of HYV of various intercrops in coconut gardens was one of the major interventions in the FFP location. The total area under demonstration was 49.9 hectares in farmer fields, involving 511 farmers, comprising women SHG farmers and coconut farmers.

Success story of the introduction of HYV groundnut (G2-52 of UAS Dharwad) in coconut gardens: The variety was introduced on 17 acres and assessed as suited for intercropping in coconut gardens on the Onattukara sandy loam tract. The variety was semi spreading with three months duration. The average number of pods per plant was 90 to 110, with a range of 52 to 237. The yield obtained was encouraging, with 400 to 450 kg per acre. They could realise an additional income of Rs. 24000 per acre besides fodder and home consumption.

Demonstration of KalpaVardhini in farmer gardens: The nutrient mixture for bearing coconut palms was demonstrated in 170 palms of selected gardens. The data indicated a significant increase in the average yield of coconut palms.

Farmer participatory integrated nematode management in the coconut intercrops (FFP): The biomanagement package effectively demonstrated a

70% to 100% reduction in nematode infestation in Amorphophallus (intercrop).

Income and employment generation for women farmer SHGs (21 groups-1100 women farmers)

The improved income of women realised from MGNREGS (as wages) and FFP group farming interventions stand as an innovative extension strategy of ICAR CPCRI FFP. The average increase of income per women farmers was 2.3 fold. (Fig. 105).

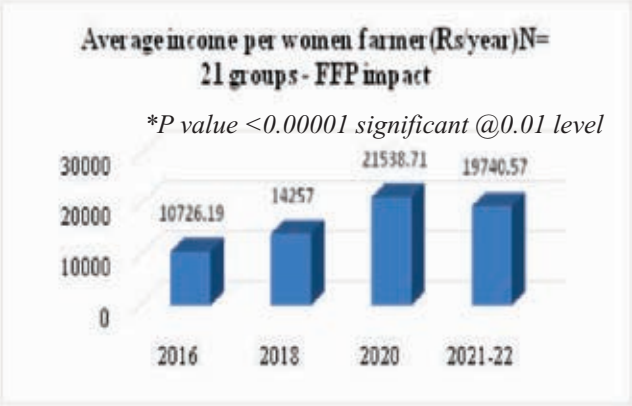


Fig. 105. Additional income and employment generation through FFP

Impact of FFP interventions in improving IFS systems in homesteads: The changes in farming system combinations due to FFP interventions showed that coconut based farming systems integrating fish, poultry, and both improved in the FFP location. Also, IFS systems with coconut, intercrops, poultry, livestock, and fish in ponds improved from 15.92% to 24.28%, indicating IFS towards improving income and nutrition from each homestead. Coconut-poultry combinations improved from 21.23% to 38.7%, coconut and pond fisheries combinations improved significantly from 1.7% to 23.15%; and coconut, pond fisheries, and poultry combinations improved from 0.77% to 5.6% after FFP interventions in the panchayath.

Farm income analysis (0.4 ha model) of IFS gardens provides potential for achieving maximum efficiency of resource utilisation in income generation. The total annual net income obtained from this IFS model was Rs. 2,08,681.83. (Table. 9)

The total income of the FFP panchayath increased due intensification of intercrops in coconut gardens. The total improvement income from each intervention over the years is depicted in the Fig. 106.

Table. 9. Farm income analysis of coconut based IFS garden

Sl.No	Farm components / interventions	Average annual net income (Rs)	Percentage share (%)
1	Coconut	49,766.25	23.84
2	Intercrops	15,271.83	7.31
3	Poultry	13,850.00	6.60
4	Fisheries	25,406.25	12.17
5	Dairy /livestock	1,04,387.5	50.02

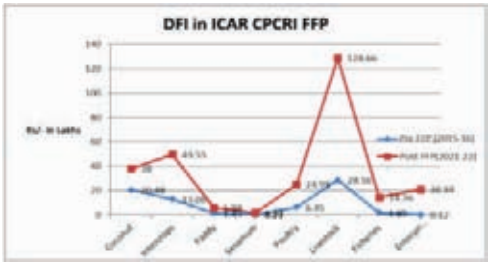


Fig. 106. Enhancement of farm income through FFP interventions

Indirect impact: Improving the diet diversity in households

The most notable indirect impact of FFP was the improvement in nutritious food consumption through achieving diet diversity from local farming. The frequency of diverse diet items such as vegetables, tubers, pulses, millets and sesamum (oil seeds) improved from their own farming in consolidated lands with technology adoption besides the usual consumption followed.

Training programs: During the period 14 on-farm training programs in which a total of 309 farmers participated (134 men and 175 women).

Content Mobilization under FFP

Active outreach and knowledge dissemination programs were implemented through FFP such as 8 programs in All India Radio programs of success stories, innovations and impact. Total of 71 field visits, 104 advisory services, 16 press reports in print and TV, Farmer first, CPCRI You tube channel, uploaded 3 videos during the reporting period with total 11.7K views.

Agri-Business Incubation (ABI) Center at CPCRI, Kasaragod

Rural India Business Conclave 2022 (RIBC 2.0) was organised during 9-13 June 2022 Kerala Startup Mission with the perspective to transfer rural areas to more developed environment and favourable for livelihood and entrepreneurship. Twenty two trainings and four EDPs were conducted. incubatees were provided with various platforms for networking: On an average three incubatees were invited to showcase their products in exhibitions at different locations.

Intellectual Property and Technology Management

The application 'method for aseptic extraction of tender nut water as frozen ball and soft endosperm (kernel) from trimmed young coconut' was granted patent no.403090 on 5th August 2022. The trademark Kalpa renewed on 23rd April 2022. During the period, 19 technologies were commercialized by entering into 42 Memorandum of Agreements and realised a sum of Rs.5,75,000/- as technology transfer fee.

Price and value chain analysis of arecanut

The arecanut prices in India have shown an increasing from April 2020 onwards, and have reached the historical high figure in October 2021 (around Rs 515/kg for old supari). Like any other long term plantation, arecanut market is also affected by the cyclical price boom and price crash periods. This has been categorically reflected in the 1970s, 1990s and early 2000s, wherein the prices were nosedived and autonomous committees were set in to enquire about the reasons/suggestions. The recommendations unequivocal on the prohibition of arecanut expansion on non-traditional arecanut tracts. Nevertheless, the area expansion continued, whenever the prices were favourable. The current situation is also in favour of the area expansion as the prices are unprecedentedly higher levels. From the policy perspective, it is pertinent to investigate the real causes of the price rise regime. Through the selective interviews of the stakeholders and critical analysis of the secondary sources, a pragmatic cause-reason relation has been elucidated. It is critical that, there has been a reduction in arecanut (chali) production to the tune of 11 per cent in 2021, which support the theory of demand-supply equations on price fluctuation. It is also noteworthy that from January- to July 2021, there has been a 24 per cent reduction in arecanut imports in comparison with the previous year (same period). On the other hand, there was an increase of 198 per cent in arecanut export. These figures imply a huge shortage of arecanut in the domestic market that would have caused the price increase. The primary data sources indicate the increase in the number of middlemen in the arecanut trade (in Kerala and Karnataka) and market hoarding which eventually resulted in panic sales by the small holders. The value share of the farmer has come down to 52 per cent in recent times. In the case of arecanut, as of now the share of cooperatives in the trade is less than 10 per cent, and to ensure the optimal share for the farmer in the arecanut value chain, it is of paramount importance to increase the share of cooperatives at least up to 30 per cent.

Trade, price and value chain analysis of coconut

To cope with market fluctuations, there is a need for product diversification and by-product utilization. India, of late, has been making a concerted effort to penetrate its products in the high-value export segments. The desiccated coconut industry in the country is a vibrant sector. The growth rate in exports of the DC powder for the last five years stands at a stupendous 26.8 per cent. The Europe and USA together account for 72 per cent import share of the DC and in the recent times, due to stringent food safety norms in these countries, the consignment rejections of the products from the Philippines and Indonesia have increased up to 32 per cent and 28 per cent (last five years) respectively. In this scenario, there exists a huge potential for India to increase the global market share of DC and VCO by ensuring the stipulated quality and safety requirements of the products for the high-value market. The domestic market provides much scope for these crops as the lion's share of production is being consumed within the country. However, in the recent past, exports of India's selected coconut products are gaining momentum. Important export destinations of coconut products from India are UAE (fresh coconut 55.5%; coconut oil 50.2%; and desiccated coconut 18.2%), other Middle East

countries (fresh coconut 30%; refined oil 27%), Malaysia (dried coconut 43.7%), Sri Lanka (shell charcoal 43.5%) and EU (shell charcoal 39%). In this scenario, it is imperative plan out and implement a plausible export promotion strategy to selected markets with selected commodities wherein India has a comparative advantage. The potential of products such as VCO as an export earner is true, and to have premium access in the high-value markets of the EU and USA, we need to take utmost care in positioning the VCO from our country as a super-food complied with all food safety standards.

Price spread analysis of coconut marketing revealed that near about 70 per cent of the farmers sell their produce through the village traders as raw coconuts. Less marketable surplus due to small and marginal holding size is the major reason for the farmers not undertaking copra or oil for sale. In Kerala conditions, which are the same in many countries with predominantly smallholder coconut gardens, the producer share in consumer rupee was found to be around 64 per cent and the market chain consumes as much as 36 per cent share in the total value chain. Satellite micro-level procurement hubs to be established (that are connected to big hubs at the district/region level) for both raw coconuts and copra utilising the existing three-tier FPO system in the coconuts wherein an autonomous council including representatives from Krishi Bhavan, Cooperatives and CPSs will be responsible/ accountable for the efficient procurement. Streamlined tender coconut market outline with a common brand and assured high-tech hygienic/food safety measures across Kerala wherein enterprising youths (collectives) are to be encouraged.

Production economics of mandate crops/systems

The cost of production of coconut in Kerala based on data from a well-managed coconut garden is Rs 9.93 per nut. In this scenario, about 60 per cent of the total cost is incurred due to labour charges. This shows the higher per-unit labour charges prevailing in Kerala, which can be attributed to higher labour demand and higher cost of labour in Kerala. In addition, the lack of availability of sufficient skilled labourers for harvesting of coconut leads to a higher cost of cultivation of coconut in Kerala. Currently, the wage rate prevailing in Kerala is around Rs 750 per day, which is one of the highest costs prevailing for agricultural labour in India. The total cost of cultivation per hectare is Rs.1,56,380, with average productivity of 90 nuts per palm per year.

Statistical and Computational Techniques

Spatio-temporal analysis of disease spread and risk prediction using geo-statistical tools

In order to study spatial spread of plantation diseases and identify the high risk disease prone area, a generic program has been developed using R. Geospatial approaches such as inverse distance weighting and ordinary kriging are used to interpolate and predict the disease spread pattern. Further, indicator kriging was used to identify the hotspot and cold spot areas within the study area. The program is successfully employed to identify disease risk area associated with Fruit Rot Disease (FRD) in arecanut.

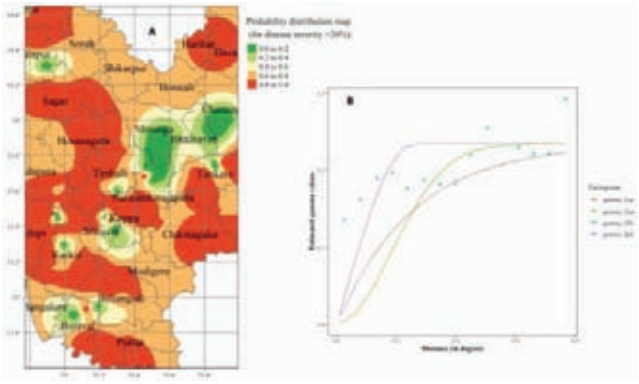


Fig. 107. Probability distribution map and semivariogram of FRD of Areca catechu L in Karnataka predicted using Indicator Kriging. A color-coded map (red to green) portrays the probability (high to low) of risk-prone areas infected with FRD causing pathogen.

Kalpa digital data register (Kalpa-DDR) - An application for automation of field data entry

An digital application for on field recording of field data in online and offline mode was developed for mobile and desktop usage using PHP MVC Codeigniter and android studio. Users can have their data downloaded in excel format. Basic data unit is individual tree (uniquely numbered in a plot). Major advantages are i) Saves time ii) Improves data

integrity, iii) serve as the data repository of the trees over the years at one click, iv) Maintains uniformity of data across the locations. The application can be used for data recording of the experiments across institutions and AICRP centres.

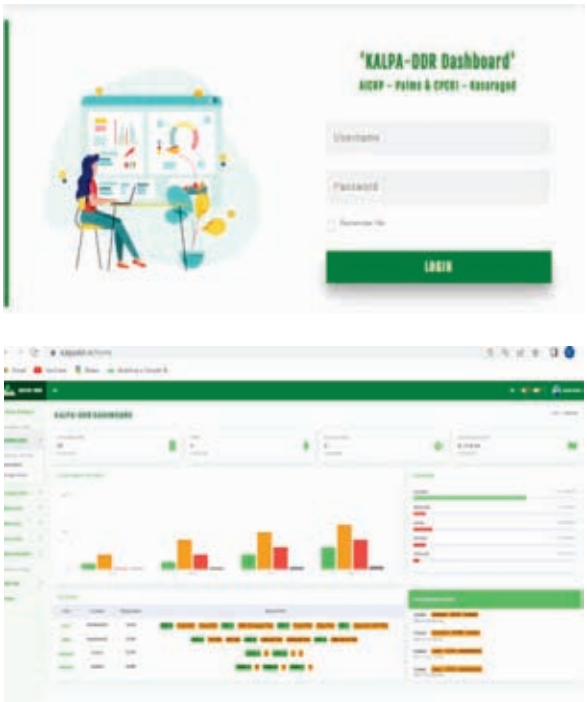


Fig.108. Screen shot of Login page and Dashboard of Kalpa DDR Development of customized computational tools/database

- To study on temporal variation and insect diversity analysis in coconut palm-pollinators, an analysis script using R was developed and also, network interactions among the plant-pollinators was explored using bipartite (two-mode) networking model.
- Linux based bioinformatics pipeline tool was implemented for conducting cocoa transcriptomic data analysis.
- To determine the genetic diversity and population structure in worldwide coconut germplasm using microsatellite markers and Aus Rice, analysis script was implemented using R/ GenAlEx/ Admixture and Smart PCA toolkit.
- Implementation of a number of computer programs in R/ python for visualization of research data (viz. circle packaging diagram, word cloud diagram, sunburst chart, krona chart, PCA bi-plots and so on) and also the computational script for estimating reaction kinetics of physico-chemical attributes in coconut inflorescence sap.

8.

ICAR-ALL INDIA COORDINATED RESEARCH PROJECT ON PALMS

The All India Coordinated Research Project on Palms (AICRP on Palms) started functioning from 1972 with the objective of conducting location-specific research on 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. The AICRP (Palms) has 15 centres conducting research on coconut, six on oil palm, four on arecanut, four on palmyrah, and seven on cocoa, with headquarters at ICAR-CPCRI, Kasaragod. 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 2022 (January -December) was Rs. 714.86 lakhs and the schemes are implemented through the respective state Agricultural/Horticultural Universities on 75:25 basis, with 75% share from ICAR and 25% share from State Agricultural Universities. The centers of Central Agricultural Universities and ICAR Institutes have 100% funding from ICAR.

RESEARCH ACHIVEMENTS

COCONUT

CROP IMPROVEMENT

•At Veppankulam centre, the nut yield varied from 55.60 to 97.00 nuts in COD and GBGD x MOD, respectively. The setting percent varied from 21.59% (COD) to 33.78% (CGD x MGD). The whole fruit weight varied from 766.00 g to 1180.33g. The average was 928.85 g, with a deviation of 140.37g. The tender nut volume was higher in GBGD x MOD (603.83 ml/nut) and lower in COD (326.40 ml/nut). Assuming 175 palms per hectare, the tender nut yield was higher in GBGD x MOD (10,250 litres) and lower in COD (3,175.97 litres). The average yield of tender nut water was 6,336.87 litres.

Field view of D x D hybrids trial in Veppankulam

• Among the Dwarf x Dwarf combinations planted during 2011 at Ratnagiri, hybrid GBGD x MOD is a promising cross for the earliness. The hybrid COD x MYD recorded the highest tender nut yield (76.7 nuts), followed by the hybrid GBGD x MOD (68.3 nuts) among the entire Dwarf x Dwarf coconut hybrids. The hybrid COD x MYD recorded the maximum volume of tender nut water (602.7 ml/nut), whereas, the hybrid GBGD x MOD recorded the maximum TSS with a score of 5.7 0 Brix.

CROP PRODUCTION

- Integration of coconut with pasture crops (Cumbu Napier hybrid + Desmanthus), fodder trees *(Sesbania grandiflora* + *Leucaena leucocephala* + *Glyricidia),* and Telicherry breed of goats recorded a net income of Rs. 2,18,650 per ha as compared to Rs. 1,17,600 per ha in the monocrop of coconut. Nutrient monitoring was done employing the NUT MON Tool Box. Under the coconut monocropping system and cropping system I with balanced fertilisation (application of N, P, and K), there was a positive balance for P and K and a negative balance for nitrogen, whereas in cropping system II with imbalanced fertilisation, there was a negative balance for N, P, and K. Greenhouse gas (GHG) emissions were estimated in the Integrated Farming System trial employing the IFS-GHG Estimation Tool obtained from the Project Directorate of Cropping Systems Research, Modipuram. GHG emissions from the integrated farming system were negative, and hence it is environmentally safe.
- Evaluation of Coconut based multispecies cropping systems under coastal littoral sandy soil indicated maximum nut yield in Coconut + *Garcinia indica* + Pineapple cropping system with recommended nutrient application. The vegetable (snake guard) yield was maximum in Coconut + *Garcinia indica* + Vegetable crops cropping system with green manuring + biofertilizers + organic recycling +100% recommended dose of fertilizer (RDF). The maximum pineapple (var. Kew) yield was recorded in coconut + *Garcinia indica* + pineapple cropping system with green manuring + biofertilizers + organic recycling + soil test based nutrient application. Maximum height and girth of *Garcinia indica* was recorded in coconut + *Garcinia indica* + vegetable Crops cropping system with green manuring + biofertilizers + organic recycling +100% RDF.

CROP PROTECTION

Management of leaf blight disease

- Root feeding with propiconozole (5 ml in 100 ml of water) at three-month intervals during January, April, July, and October reduced the leaf blight incidence by 27.0 percent after 36 months of treatment. This treatment also recorded the highest nut yield of 138 nuts per palm per year and a B:C ratio of 3.7 as against 97 nuts per palm per year in the untreated control.

Pest Management

- The IPM strategies (installation of yellow sticky traps in the garden, three rounds of neem oil spray 0.5% at a 15-day interval, and three rounds of jet water spray 10 days after spraying neem oil) for the management of rugose spiralling whitefly were started during the month of November 2018 in the COD palms (15 years old) at Aliyarnagar centre. The results revealed that the application of IPM strategies significantly reduced the incidence and intensity of rugose spiralling whitefly from 52.2% to 22.5% and 48.2% to 20.5%, respectively, when compared to the natural control, where the incidence and intensity increased from 45.2% to 56.2% and 50.5% to 58.5%, respectively.
- A total of 7000 numbers of Bracon hebetor, 1,87,050 numbers of nephantidis, 17100 numbers of *P. imbrues,* 275 Tricho cards, and 32,61,100numbers of *P. astur* eggs were supplied to the farmers of East Godavari, West Godavari, Visakhapatnam, and Srikakulam districts of Andhra Pradesh, Bhadradri Kothagudem, Medchal, and Khammam districts of Telangana, from Ambajipeta centre. Coconut fronds or leaflets containing parasitized puparia were collected from the affected ecosystem and released in newer areas of infestation. At Aliyarnagar centre, a total of 13,165 packets of Encarsia parasitoid were distributed to about 4000 farmers.

OIL PALM

- Seven different intercrops were evaluated in the oil palm garden at Mulde. The maximum yield of oil palm was recorded in the treatment Oil Palm + Red Ginger + Black Pepper, with a bunch yield of 166.2 kg /palm. The bush pepper recorded a maximum yield of 0.726g per plant, and the maximum yield of dry berries was 1.05 kg/plot.

COCOA

- Cocoa genotypes are under evaluation in 8 AICRP (Palms) centres covering the west coast, east coast, and NE regions and different cropping systems, including arecanut, coconut, and oil palm gardens.

In the 12-year-old trial at Kasaragod (Kerala), Ambajipeta (AP), and Veppankulam (TN), VTLCH-2, VTLCH-2, and VTLCH-1 were identified as the best performers, respectively, in the regions under coconut. From the initial years of evaluation, it was observed that among 8 year old trees in Aliyarnagar (TN), Ratnagiri (Maharashtra), and Kahikuchi (Assam), VTLCP-16, VTLC-17, and VTLC-20 were found to be the best performing, respectively, whereas VTLC-57 was high yielding at Vijayarai (AP) under oil palm.

PALMYRAH

- Jaggery powder prepared from fresh neera (collected as per the CPCRI method) gives good colour and shelf life up to one year, whereas jaggery from the traditional method turns dark and spoils within 3 months at room temperature with normal packing. The palmyrah tender fruit processing machine developed by CIAE was evaluated, and it reduced the drudgery and time for endosperm separation. It was also observed that the machine is useful for both skilled and unskilled people at the cottage level in the sale of endosperm. Dehydrated tuber and tuber flour were commercialised, and one consignment was sent to the UK through an NGO (ASHA Chinturu, AP), generating income for tribal people.

Meetings Held:

Golden Jubilee and XXXI Annual Group Meet of All India Co-Ordinated Research Project on Palms'

The 31st Annual Group Meeting of the All India Co-ordinated Research Project on Palms was conducted at the Central Plantation Crops Research Institute, Kasaragod, during September 16–18, 2022, which coincided with the Golden Jubilee Year of the AICRP (Palms). The meeting was inaugurated on September 16, 2022, by Dr. V. Geethalakshmi, Vice Chancellor, Tamil Nadu Agricultural University, Coimbatore. The former project coordinators, Dr. P. Rethinam, Dr. S. Arulraj, Dr. H. Hameed Khan, and Dr. H.P. Maheswarappa, were the guests of honour.

Dr. V. Geethalakshmi, Vice Chancellor, TNAU, Coimbatore, delivering inaugural address

Dr. Anitha Karun, Director, CPCRI, and Project Coordinator (Acting), AICRP (Palms), in the Presidential Address, extended profuse gratitude to the entire palm scientists for the achievements of AICRP (Palms). Dr. Ravi Bhat, Acting Head (Crop Production), ICAR-CPCRI, Kasaragod, welcomed the gathering, and Dr. P. Subramanian, Principal Scientist (Agronomy), CPCRI, Kasaragod, proposed a vote of thanks. About 100 participants from different AICRP centres across the nation attended the annual group meet. Navsari Centre, Gujarat, received the Best AICRP (Palms) Centre Award for the year 2021. A bouquet of publications in the form of technical bulletins, booklets, and folders prepared by the palm scientists were released at the event. The inaugural session was followed by technical sessions on genetic resources and crop improvement, crop production, crop protection, and post-harvest technology.

During the meeting three coconut varieties were recommended for release.

- Dweep Haritha - Dwarf tender nut variety with green coloured fruits for cultivation in Andaman and Nicobar Islands and Kerala
- Dweep Sona - Dwarf tender nut variety with yellow coloured fruits for cultivation in Andaman and Nicobar Islands and Kerala
- Kalpa Vajra (WCT x WCT) Hybrid - The WCT x WCT progenies are superior in terms of higher yield (80.1 nuts/palm/year) and have recorded less root (wilt) disease incidence (<20%) as compared to WCT (OP) and WCT (Self) progenies.

Inaugural session of 31th Annual Group Meeting of AICRP on Palms

Brainstorming Session on Coconut and Arecanut Pest and Diseases

A brainstorming session on 'Coconut and arecanut pests and diseases in different regions of Karnataka' was jointly organised by Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, and ICAR-AICRP on Palms, ICAR-CPCRI, Kasaragod, on October 12, 2022, at Shivamogga. Dr. R.C. Jagadeesha, Vice Chancellor of KSNUAHS, Shivamogga, mentioned in the inaugural session the rapid and devastating climate change and the need for proper planning and preparedness to tackle emerging new pest and disease management. The programme was attended by about 30 officials from the university and the Department of Horticulture, Government of Karnataka.

Brainstorming on coconut and arecanut pest and diseases

Palmyrah Breeders Meet

A palmyrah breeders meet was organised in the AICRP palms centre, Killikulam, on October 28, 2022, to prepare the Road Map for Palmyrah breeding. The programme was attended by about 30 members, including farmers, officials from the university, and the Department of Horticulture, Government of Tamil Nadu. Model descriptors were prepared in the technical session of the meeting.

A snap shots of palmyrah breeders meet

ICAR-KRISHI VIGYAN KENDRA KASARAGOD

9A.

The KVK activities revolve around coconut, arecanut, cashew, rubber, paddy-based monocropping, and cropping/farming systems.

Thrust areas

The KVK has three OFTs, viz., value addition, black pepper, and pulses. A total of 10 FLDs are functional under coconut, cashew, field crops, arecanut, paddy, cassava, mussels, fruits, and vegetables.

Major Achievements

1. Assessment of foam mat drying for fruit pulps

Foam mat drying of locally available fruits and vegetables such as papaya, pineapple, banana, cucumber, and jackfruit was assessed. The recovery of fruit juice is 5%–8% higher than the original fruit pulps, depending on the fruits used. The advantages over traditional sun-drying methods include uniform drying, high efficiency, and cost effectiveness.

2. Assessment of black pepper varieties

The Black pepper varieties Arka Coorg Excel, Vijay and P-5 were planted in farmer fields in Munnad, Parappa and Sheni villages. The vines were established well and growth parameters were recorded.

3. Assessment of blackgram HYV suitable for summer rice fallows

The programme is initiated in farmers plots with three HYV of black gram VBN-6, VBN-8 from TNAU and LBG-791 from GKVK,Bengaluru.

4. Promotion of value added products from mussels

Value added products from mussels like pickles, arikadkka, soup powder, mussel roast and sauce were popularized among SHGs and FPO groups under ODOP programme

5.Training on home scale oilseed enterprises

Two skill-oriented trainings have been conducted for SHG units of Kudlu village of Mogral Puttur panchayat on hygienic oil extraction and value addition of de oiled copra. Value added products from de oiled copra cake using functional ingredients in production of chutney powders, prawn chutney powder ladoos and burfi was demonstrated to promote small scale enterprise through home scale production.

6.EDP on scientific methods of processing of fruits and vegetables

As a part of ODOP activity scientific techniques for dehydration of jackfruit bulbs and jackfruit seed were disseminated to SHGs through Kudumbashree and Krishi Bhavans. Value added products from Jackfruit seed were popularized. Around 17 programmes were conducted on scientific processing of fruits and vegetables for production of value added products with a total participation of 163 farmers including 122 women.

7.Training on nutri garden

Twenty-five households (20-SC, 1-ST) were selected from Kasaragod. Training was imparted to 28 beneficiaries on Nutri Garden. Vegetable seed kits, Passion fruit seedling and inputs such as neem oil, pseudomonas, coirpith, and dolomite were distributed to each household.

Demonstrations organized

Demonstration	Beneficiary
Coconut milk residue based pasta	Entrepreneurs from Badiadka and Periye
Integrated Management of Tanjore wilt in coconut	Farmers from Kolichal and Ajanur villages of Kasaragod

Drone technology in rice	Members of Bambrana Padasekhram in Kumbla Panchayath
Short duration cassava varieties	Farmers of Enmakaje panchayat of Kasaragod district
HYV of Okra Phule Vimukti	Ten farmer's plots in Chengala and Periya panchayats
Scientific dehydration techniques for locally available fruits & vegetable	SHG groups of Kasaragod
High-density planting in cashew	Selected farmers of Mogral Puttur, Kudlu and Bedadka

Capacity development programmes

A total of 89 training programmes were conducted, benefitting 1108 women and 947 men.

Otherprogrammes

Celebration of International Women's Day

The International Women's Day was celebrated at KVK Kasaragod on 8th March 2022 in which more than fifty farm women participated. The state award winning farmer Smt. Sreevidya was honoured.

Kisan Bhagidari Prathmikta Hamari Campaign

KVK Kasaragod organized the Kisan Bhagidari Prathmikta Hamari campaign on 26th April 2022 in collaboration with ATMA Kasaragod and the Department of Agriculture Development and Farmers Welfare. A total of 20 stalls were organized as part of the exhibition in which various government departments, companies and entrepreneurs demonstrated latest technologies for improving the production and productivity in crops. During the event four state level award winning farmers and two innovative farmers from the Kasaragod district were felicitated. The farmer – scientist interface was also conducted. The meeting was attended by more than 500 farmers and farm women.

Gareeb Kalyan Sammelan

Gareeb Kalyan Sammelan was organized on 31st May 2022 in which 50 farmers participated directly and around 500 through various online modes. In this programme various developmental programmes of the Central Government were explained to the beneficiary farmers. The interaction Hon'ble Prime Minister with farmers was shown through web casting which was part of the nationwide campaign.

Azadi Ka Amrit Mahotsav

As a part of nationwide programme on "Azadi Ka Amrit Mahotsav" ICAR-KVK carried out an orientation programme on 21stJune 2022. A session on "Importance of soil testing and balanced use of fertilizers" was organized and 51 farmers have attended.

Farmers Day celebrations

The ICAR-KVK Kasaragod in collaboration with the Department of agriculture development and farmers welfare, Kasaragod organized the Farmers Day on 17th August 2022 at KVK Kasaragod. Around 60 farmers participated and the lead farmers were felicitated during the event and a 'Vilambara jatha' was also carried out as a part of the state level launching of the programme' njagalum krishiyilekku'.

Poshan Abhiyan and Tree Planting Campaign

ICAR-KVK Kasaragod celebrated "Poshan Abhiyan and Vriksharopan Karyakram" campaign on 17th September 2022 to commemorate the birthday of Shri Narendra Modiji, Hon'ble Prime Minister of India. Dr. Anitha Karun, Director, ICAR-CPCRI inaugurated the campaign. A total of 47 farmers have participated in the function.

Poshan Maah

As a part of Poshan Abhiyan, different training programmes like, nutrition education on nutraceutical food preparation, effective use of food sources in up scaling nutritional status and a class on Nutritional security for mothers and children were conducted during the month of September. A training program was organized on Nutrition and health for differently abled children at Mahatma Model School, Pullur, Periya Panchayat in which 20 mothers participated. The ICAR-KVK, Kasaragod developed a special supplementary food named "Sampoorna Special Supplementary food" as a part of OFT Programme. The KVK distributed the supplementary food and biscuits made up of this nutrimix to fifty differently abled children.

Jal shakti Abhiyan

Two training programmes were carried out as part of the Jal shakti abhiyan by ICAR-KVK, Kasaragod during month of October 2022.

1. Climate change and improved practices- Kuttikol in which 31 farmers participated.
2. Training on agronomy practices in water shed- Paduppu wherein 22 farmers participated.

Promotion of Vegetable cultivation under SCSP programme

To promote vegetable cultivation among the scheduled caste community,two training programmes were conducted on 17th and on 21st October 2022. A total of 72 trainees attended the programme.

Kisan Diwas Celebrations 2022

Kisan Diwas was jointly organized by ICAR-KVK, Kasaragod and Green Chandragiri FPO, at Padne Village, Nileshwar, Kasaragod on 23rd December 2022.. A total of 85 farmers participated in the programme.

ICAR-KRISHI VIGYAN KENDRA ALAPPUZHA

9B.

Major Achievements

1. Large-scale demonstration of aerial spraying of nutrients in paddy using drones

The use of drones (UAV) for large-scale aerial spraying of nutrients was demonstrated in a total of 175 acres of paddy fields in three villages, viz., Edathua, Muttar, and Puliyur, by KVK-Alappuzha in the first fortnight of February. Foliar nutrition using the multi-nutrient mixture 'Sampoorna' of KAU (containing B, Cu, Mn, Fe, Zn, and Mo) through aerial spraying using the drone was done as a component technology in 125 acres.

2. District-level farmer-scientist-extension official interface

A district-level farmer-scientist-extension official interface was organised by KVK-Alappuzha on March 9, 2022, in collaboration with the agricultural development and farmers' welfare department. Farmers shared their newer experiences, followed by interactions from farmers from different parts of the district. About seventy people participated in the programme.

3. Harvest festival of the demonstration on 'Climate resilient technologies in paddy'

A large-scale demonstration on 'climate resilient technologies for paddy' under the NICRA project implemented by the KVK in Edathua and Muttar panchayaths of Kuttanad proved to be an encouraging experience for the farmers of the region. A package of technologies was demonstrated in an area of 50 ha in the unique wetland ecosystem where farming below sea level is practised. The demonstration was carried out by 45 farmers. The harvest festival was conducted at Vadakara padasekharam of Edathua panchayath with more than 30 farmers.

4. 'Kisan Bhageedari Prathamikatha Hamari"—Kisan Mela and Seminar

KVK-Alappuzha organised a Kisan Mela in connection with Azadi Ka Amrut Mahotsav and the Kisan Bhageedari Prathamikatha Hamari campaign of the Government of India. The programme was held as a joint venture with ATMA-Alappuzha. Various farmer benefit schemes of the GOI were deliberated on in the seminar attended by more than 500 farmers from different blocks of Alappuzha district. An exhibition on various technologies and products was also arranged, which attracted the participants.

5. World Bee Day

'World bee day' was celebrated with different activities on May 20th. A quiz programme on bees and a talk on "bee diversity and beekeeping systems' were organised in collaboration with Bishop Moore College, Mavelikkara. About 50 students participated in the event.

6. World Environment Day

In collaboration with the NSS Unit at MSM College, Kayamkulam, KVK organised World Environment Day celebrations on the college campus on June 6th. An awareness talk on "good farming practises for environmental protection", highlighting the relevance of conserving natural resources through different agricultural practises, was given by the KVK resource person. The 75 NSS volunteers who participated in the programme planted vegetable seedlings for a campus vegetable garden after the function.

On Farm Testing: Five OFTs were taken up in Kandallur and Muthukulam panchayaths.

Frontline Demonstrations: Seventeen front line demonstrations were taken up in Muthukulam and Chengannur blocks.

One hundred and fifty seven training programmes were organized during 2022 for a total of 5175 participants as detailed below.

Training	No. of Programmes	Participants
Farmers/Farm women	102	3203
Rural Youth	29	1023
Extension Officials	1	18
Vocational/ Skill	5	130
Sponsored	20	801
Total	**157**	**5175**

7. Awareness Programme on 'Balanced Use of Fertilisers'

As part of the "Azadi ka Amrut Mahotsav' celebrations of the Govt. of India, an awareness programme on 'Balanced Use of Fertilisers' was organised in association with department of agricultural development and farmers' welfare on June 21st. The relevance of balanced nutrition to crops, following good agricultural practises, and maintaining natural resources in healthy condition for a healthy society was conveyed to about 60 farmers gathered at the Yoga Training Hall in Kandalloor Grama Panchayath.

8. ICAR foundation day

ICAR Foundation Day was celebrated in a befitting manner on 16th July with the participation of several women farmers from Kayamkulam municipality, Krishnapuram and Muthukulam Grama Panchayaths. ICAR Foundation Day and Award Ceremony programme was webcasted for the benefit of participants.

9. Brainstorming cum capacity building programme

A brainstorming session cum capacity building programme on 'Sustainable management of mosaic disease in bitter gourd' was organized on 28th September, 2022 against the background of commercial farmers in the district abandoning bitter gourd cultivation due the severity of the problem.

10. Webcasting of Hon PM's address to farmers

Address of Sri. Narendra Modi, Hon. Prime Minister of India to thousands of farmers and entrepreneurs participated in the Agri Start up Conclave and PM Kisan Samman Sammelan held at ICAR-IARI, New Delhi was webcasted to selected farmers of the district by KVK-Alappuzha on 17.10.2022. A total of 65 farmers including 25 DFI documented farmers attended the programme. Five selected farmers from different sectors whose cases have been documented under DFI shared their experiences for the benefit of other participants.

11. Launching of'Homestead organic vegetable cultivation' under SCSP of CPCRI

As part of the Scheduled Caste Sub Plan (SCSP) programme of ICAR- CPCRI, organic cultivation of vegetables in homesteads of 1000 SC families in Kayamkulam Municipality was initiated by KVK-Alappuzha. Distribution of good quality seeds of five vegetable crops bought from ICAR-IIHR, Bengaluru to these families was done on 26.10.22. An orientation on homestead vegetable cultivation was also conducted for fifty selected farmers from different wards.

12. Mahila Kisan Diwas

Mahila Kisan Diwas was celebrated by KVK-Alappuzha with vivid programmes at Thrikku nnapuzha grama panchayath. Mrs. Ammini M., a septuagenarian farm woman who was engaged in coir making from coconut fibre for over six decades, was honoured in the function. About 65 farm women representing different JLGs actively participated in the programme.

13. Animal health campaigns organized at NICRA village

As part of the NICRA project implemented in the

Kuttanad region of Alappuzha district, three animal health campaigns were conducted in Edathua village on 28th October, 3rd and 10thNovember, 2022. A total of 75 farmers with 500 poultry, 75 goats and 53 dairy animals attended in the campaigns.

Radio programmes

Sl. No.	Name and designation of officer	Title of the Programme	Station and Date
01.	Dr. T. Sivakumar SMS (Ag Ent.)	Integrated Pest Management in Mango	AIR, Thiruvananthapuram on 07.02.22
02.	Dr. T. Sivakumar SMS (Ag Ent.)	Management of rainy season pests and diseases in coconut	AIR, Thiruvananthapuram on 13.06.22.
03.	Dr. P. Muralidharan, Principal Scientist and Head	Soil and water conservation practices during summer season	AIR, Thiruvananthapuram on 9.12.22
04.	Sri. Rajeev M.S. SMS (Agronomy)	Scientific cultivation of sesame and its pest, disease management	AIR, Thiruvananthapuram on 12.12.22

Externally funded projects

1.National Innovations in Climate Resilient Agriculture (NICRA): Phase II

Technology demonstrations under the project "National Innovations in Climate Resilient Agriculture' (NICRA) Phase II are being implemented at Edathua village in Kuttanad Taluk. A 'Village Climate Risk Management Committee (VCRMC) is formed with the participation of members from the LSG to oversee and institutionalise the programme on a long-term basis in the village.

2.Onattukara Spices Farmer Producer Company Ltd. (OSFPCL)

KVK promotes the Farmer Producer Organisation, Onattukara Spices Farmer Producer Company Limited, registered in December 2016 with grants from NABARD. The company facilitates cultivation, procurement, processing, and marketing of the major spices, viz., turmeric, ginger, pepper, and garcinia, in six panchayaths of Bharanikkavu block so as to enhance the net income of the shareholder farmers. At present, it has 350 shareholders and a share capital of 3.91 lakh.

3.Mushroom Spawn Production Unit

With aid from the State Horticulture Mission, a mushroom spawn production unit is being established in the KVK to meet the demand for spawn from the mushroom entrepreneurs trained by the KVK and from adjoining districts.

4.Natural Farming Project (NFP)

This national network project, funded by ICAR through ATARI, was initiated in 2022–23. The project activities are initiated in Cheppad panchayath. The selection of farmers for the demonstration component was done after field visits. Awareness programmes are being conducted in different panchayats.

5.Revolving fund activities of KVK

Different inputs were made available to the farmers of the district (as a resource centre) through revolving fund activities, viz., vegetable seeds and seedlings, planting materials, bio-agents, methyl euginol, cue lure, yellow sticky traps, layer chicks, mushroom spawn, mother spawn, multi-nutrient mixtures for banana and vegetables, azolla, processed products, publications, etc. A custom hiring centre is also functioning to provide farm implements like tractor-mounted rotavators and transplanters to farmers on hire for land preparation, paddy transplanting, etc. The progressive closing balance of the revolving fund as on 31.12.22 is Rs. 26,14,981/-.

PUBLICATIONS

VII

Research Article

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Aparna, V., Bhat, K.V., Janakiram, T., Prasad, K.V., Raju, D.V.S, Namita, Sapna Panwar and Singh, K.P. 2022. Molecular characterization and relationship among wild and partially cultivated Rosa species. Indian J. Hortic., 79 (4): 387-393(NAAS Score:6.00).

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VIII TECHNOLOGY ASSESSED AND TRANSFERRED

Kalpa Vajra variety of coconut

Performance evaluation trials at CDB Farm, Neriamangalam and ICAR-CPCRI, RS, Kayamkulam, identified that WCT X WCT progenies, produced by crossing high yielding and root (wilt) disease-free West Coast Tall (WCT) palms, superior in terms of higher yield and recorded less root (wilt) disease incidence and recommended by the AICRP on Palms for release as 'Kalpa Vajra', a tall variety suitable for cultivation in root (wilt) disease prevalent tract.Thevariety could yield on an average 158 nuts per palm per year.

High yielding Kalpa Vajra variety of coconut

Farmer-friendly technology for mass production of *Trichoderma harzianum* (CPTD28)

The success of biological control mainly relies on bio-efficacy, shelf life, easy availability of cost effective substrates and simple preparation procedure and delivery system. T. harzianum (CPTD 28) has already been found very effective in the management of majority of soil borne pathogens and in addition the isolate possesses growth promotion activity. Arecanut leaf sheath is easily available for free of cost to farming community and also as by-product from plate and bowl production unit. Developed an easy, economically feasible and farmer-friendly technology for mass production of a potential native isolate of Trichodermaharzianum (CPTD 28) using an areca leaf sheath with higher population and extended shelf life up to two years. Even it can be used for long term storage of Trichodermanucleusculturewithout losing its virulence and used for direct inoculation for further multiplication. Trichoderma - leaf sheath formulation wastested against stem bleeding and Ganoderma wilt disease of coconut and also for the management of other soil borne diseases such as damping off and wilt in vegetable cropsand sudden wilt in black pepper grown in coconut based cropping system. This is very simple, cost effective and eco-friendly technology especially for farmers and startup groups. This technology is in demand and within a year transferred this tofive stakeholders consisting of farmers and farm women groups.

Exchange of MoA on mass production technology of *Trichoderma* to entrepreneurs.

Foam mat dried coconut milk powder and Ready-to-cook kheer mix

Coconut milk processing industries require a suitable technology for production of coconut milk powder. Coconut milk powder is used in curry or gravy and in sweets. Foam mat drying is a process of drying liquid-solid foods by mixing with foaming agent to produce stable foam and foam stabilizers. Hence, the foam mat drying-based technology was developed for the production of coconut milk powder and ready-to-cook kheer mix. It is suitable for small and cottage scale industries. It does not

require high investment similar to spray dryer. The technology was refined with 4% sodium caseinate, 5% malto dextrin and 0.5% CMC in order to reduce the total drying time to 2 hours. An average of 33% recovery of milk powder was obtained by adopting this technology. This foam mat dried coconut milk powder technology was transferred to three entrepreneurs. This powder produced was used for the preparation of ready-to-cook kheer mix along with vermicelli, coconut sugar and cardamom. The ratio of water and ingredients mixture for reconstituting the kheer was standardized as 6:1. The milk powder and kheer mix developed were found to be safe under refrigerated storage for three months with respect to moisture content, flowability, bulk density, particle density, interstitial air content, pH, titrable acidity and free fatty acids.

Foam mat dried coconut milk powder

AWARDS AND RECOGNITION

IX

Dr. M.R. Manikantan, Principal Scientist received Dr. J.C. Anand Award in Post-Harvest Management of Horticultural Crops – 2022 by Indian Academy of Horticultural Sciences, New Delhi on 02 December 2022 at IARI, New Delhi.

Dr. M.R. Manikantan, Principal Scientist received CDB Best Coconut Research Worker Award for his findings on coconut products during the world coconut day function on 02.09.2022 organized by Coconut Development Board.

Dr. R. Pandiselvam, Scientist, ICAR-CPCRI received the NAAS Associateship.

Dr. T. Sivakumar, SMS (Agrl. Entomology), KVK-Alappuzha received the 'National Award for the best coconut extension personnel' instituted by Coconut Development Board, Ministry of Agriculture and Farmers' Welfare, in the World Coconut Day function held at Kochi on September 2. The award comprising of cash prize, certificate and memento was bestowed to him on his meritorious extension work in supporting the coconut farming community through various activities like FFS, demonstrations of technologies, trainings, publications etc.

Dr. S. Elain Apshara, Principal Scientist (Hort.), CPCRI, RS, Vittal bagged the best oral presentation award in the session on Technological Challenges and Approaches for Climate Resilient Development of Horticulture for the paper 'Cocoa-the agro forestry crop and its resilience to palm based cropping systems' presented in the National Conference on Climate Resilient and Sustainable Development of Horticulture 28-31 May, 2022 CSAUA & T, Kanpur, UP.

Best Poster paper award for the paper titled 'Direct organogenesis from immature inflorescence explants of coconut *(Cocos nucifera L.)* for production of true-to-type plants' by Shareefa, M., Sreelekshmi, J.S., Thomas R.J., Rajesh, M.K. and AnithaKarun presented at 2nd Tissue Culture Symposium 2022' conducted by ICC and COGENT 4-6 May 2022. This award money of 300 US Dollars was presented to Dr. M. Shareefa at ICAR-CPCRI, Kasaragod.

Dr. Rajkumar, Scientist was awarded "Best Poster Presentation" for his poster presentation on "Field evaluation of EPN based formulation against lepidopteron caterpillars infesting cauliflower and cabbage grown as intercropped with coconut cropping system" in the National e - conference on 'Biotic stress management strategies for achieving sustainable crop production and climate resilience' held at ICAR - NRCIPM, New Delhi, during 19 - 21 May, 2022.

The paper entitled 'First record of Amitus sp. (Hymenoptera: Platygastridae) parasitizing exotic Acacia whitefly, Tetraleurodesacaciae (Quaintance) [Hemiptera: Aleyrodidae] from India' presented by Logeshkumar P., Srinivasan G., Shanthi M., Chinnadurai S., Josephrajkumar A., Poorani J., Venkatesh K. and Murugan M. during the Seventh National Conference on Biological Control on 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward held at ICAR-NBAIR, Bengaluru during 15-17December, 2022 was adjudged as the best poster paper in the session VI on Alien invasive pests & prospects of classical biological control.

Dr. Jilu V. Sajan received 'Reviewer Excellence Award' as reviewer of 'Bhartiya Krishi

AnusandhanPatrika' by Agricultural Research Communication Centre Journals on 10 October 2022.

Dr. Ramesh S.V. Sr. Scientist, secured DST-SERB sponsored ITS, travel award to attended the 2nd international symposium on Cocoa Research (ISCR-2022) held at Montpellier France, from | 5-8, December 2022.

TRAINING AND CAPACITY BUILDING

X

Scientific

Name & designation	Title of the programme	Organising agency & date
Dr. Vinayaka Hegde, Principal Scientist & Head, Dr. Josephrajkumar, Dr. K.P. Chandran, Principal Scientists, Dr. Merin Babu, Dr. Selvamani V., Sr. Scientists, Dr. R. Pandiselvam, Dr. Daliyamol, Dr. T. Madhu, Dr. Thava Prakasa Pandian, Sri Bhavishya, and Dr. Chaithra M, Scientists	Online program on Drones for agricultural development	MANAGE, Hyderabad, 11-15, July 2022
Dr. Alka Gupta, Principal Scientist (Microbiology) Dr. S Paulraj, Sr. Scientist (Microbiology) Dr. Merin Babu, Sr. Scientist (Plant Pathology) Dr. Induja S., Scientist (Microbiology)	Online training programme on metagenomic data analysis	Organized by ICAR-IASRI during 19-24 January, 2022
Dr. Chandran K.P., Principle Scientist (Agr. Statistics) Dr. Selvamani V., Sr. Scientist Dr. Sandip Shil, Scientist, RC, Mohitnagar	Online training programme on geospatial analysis using QGIS& R"	Organized by ICAR- National Academy of Agricultural Research management (NAARM), Hyderabad during February 14 - 19, 2022
Dr. Neema M. Sr. Scientist	Online training program on data science and machine learning for bioinformatics- using R	Organized by Decodelife, Garhi Bohar, District Rohtak, Haryana during 19 February, 2022 to 18 March, 2022.
Dr. Chandran K.P., Principal Scientist (Agr. Statistics)	Online training programme on competency enhancement programme for effective implementation of training functions by HRD Nodal Officers of ICAR 21 - 23 February, 2022.	Organized by ICAR-National Academy of Agricultural Research management (NAARM), Hyderabad during 21 - 23 February, 2022.

Dr. M.K. Rajesh, Principal Scientist (Ag. Biotechnology)	Virtual training program on Phytophthora: Isolation to functional genomics	Organized by ICAR- IISR, Kozhikode during 02-11 March 2021.
Dr. Nagaraja, N. R. Scientist	Online Demo on STATCRAFT- A Statistical Data Analysis Software	ICAR-CPCRI, Kasaragod, Kerala 15 July 2022
Dr. K.M. Anes, Scientist	Massive Open Online Course on Farmer Producer Organizations (FPO).	BIRD, Lucknow 4 July 2022
Dr. Ravi Bhat, Principal Scientist	Online training Workshop on Response Surface Methodology	ICAR-NAARM, Hyderabad 18-20, August 2022
Dr. R. Pandiselvam, Scientist	Mechanical Processing Natural Fibre	ICAR-National Institute of Natural Fibre Engineering and Technology, Kolkata, 11-20 October, 2022
Dr. Merin Babu, Sr. Scientist, Dr. Indhuja S., and Dr. Chaithra, Scientists	Metagenomic Data Analysis	ICAR-IASRI, New Delhi,18-21 October, 2022

Technical

Name & designation	Title of the programme	Organising agency & date
Dr. B.J. Nirmal Kumar, Technical Assistant, ICAR-CPCRI, RS, Vittal	Online training programme on analysis of experimental data	Organized by ICAR- NAARM, Hyderabad during 17- 22 January, 2022.
Sri H. Muralikrishna, CTO (Tech. Info)	Online workshop on Science writing	5 March to 5 June 2022 Current Science Association, Bangalore.
Rajeev M.S., SMS	Online training on Natural farming for sustainable agriculture	EEE, Southern Region, Hyderabad 19-22 April 2022.
Sri Arunji G., TA (Library)	Computer Applications for Technical personnel of ICAR	ICAR-IASRI, New Delhi, 15-21, December, 2022
Sh. Benjamin Mathew, SMS, KVK Kasaragod	Two days workshop on 'Energy transition in agricultural sector-Kerala: Towards energy efficiency & climate resilience'	Energy Management Centre (EMC), Thiruvananthapuram 28 & 29th December 2022

Administrative

Name & designation	Title of the programme	Organising agency & date
Mr. Paulson Sam George, Assistant Smt. Preethi K., Assistant	Online training programme on "Pension & retirement benefits" for officers and staff of ICAR	Organized by ICAR-NRRI, Cuttack during 12-14 January, 2022.

XI

WORKSHOPS, SEMINARS, SUMMER INSTITUTES, FARMERS DAYS ORGANIZED

ICC-COGENT Coconut Tissue Culture Workshop

The workshop was conducted during 16-20 May 2022 with a participation ofresearchers from ten countries: India, Sri Lanka, Indonesia, Malaysia, Belgium, France, Côte d'Ivoire, Vietnam, Papua New Guinea, and the Philippines. It was conducted in collaboration with International Coconut Community (ICC), International Coconut Genetic Resource Network (COGENT); Australian Centre for International Agricultural Research (ACIAR); and Coconut Development Board (CDB).

The Workshop was inaugurated by Dr. A. K. Singh, Deputy Director General (Horticulture Science), ICAR, New Delhi on 16 May 2022 at The LaLiT Resort & Spa, Bekal, Kasaragod. Dr. Singh mooted the need for an international collaborative network research programme under the aegis of ICC to improve the success of coconut tissue culture. During the inaugural session, an overview of COGENT as ICC programme was presented by Dr. Jelfina C. Alouw, Executive Director, ICC. A presentation on coconut conservation strategy was made by Mrs. Erlene Manohar, Coordinator, COGENT. The keynote address on 'Research Achievements in Biotechnology at ICAR-CPCRI' was given by Dr.Anitha Karun, Director, ICAR-CPCRI. The technical sessions and demonstrations were conducted in the Institute.

Dr.Anitha Karun (Director, ICAR-CPCRI), Dr. Cristeta Cueto (Philippine Coconut Authority, the Philippines), Dr. Sundar Kalaipandian (University of Queensland, Australia), Dr. Quang Nguyen (Vietnam National University, Vietnam), Dr. Vijitha Vidhanaarachchi (Coconut Research Institute, Sri Lanka), Dr. Bart Panis (Alliance Bioversity and CIAT, Belgium), Dr. M.K. Rajesh (ICAR-CPCRI) and Dr.Shareefa M. (ICAR-CPCRI) handled the training sessions and demonstration classes.The Workshop was followed by project formulation activities and country presentations on coconut tissue culture and cryopreservation, which were moderated by Mr. Vincent Johnson (ICC-COGENT).

Dr. A. K. Singh, Deputy Director General (Horticulture Science), ICAR, New Delhi delivering inaugural address

Training session of the workshop

National Conference on Enhancing Competitiveness of Horticulture through Technology Innovations

Dr. V.A. Parthasarathy, the former director of ICAR-IISR in Kozhikode, inaugurated the two-day National Conference on "Enhancing Competiti veness of Horticulture through Technology Innovations" on November 17–18, 2022, and noted that science, like recorded history, has many distortions. Experienced scientists were urged by

him to re-examine studies from India that had previously mentioned the contribution from the West.

Horticulture and quality of life are inextricably intertwined, and as Dr. Nirmal Babu, a former director of the ICAR-IISR, emphasised in his lecture, excellence and quality are necessary to stay competitive.

Dr. V.A. Parthasarathy, Former Director, ICAR-IISR addressed the gathering

The ICAR-CPCRI Director, Dr. Anitha Karun, examined the advancement of various Indian horticultural sub-sectors. Scientists now have a greater responsibility to maintain the trend and the nation's competitiveness with other producer nations because the nation has recently broken records of year-to-year growth in horticulture production.

Dr.Vikramaditya Pandey, Asst. Director General (Hort. Sci. – I) delivered his plenary lecture on 'Technology innovations on fruits and vegetables' (online). Experts from different fields of horticulture science participated in the Conference that include, Dr. S.K. Malhotra, Project Director, Directorate of Knowledge Management in Agriculture, ICAR, New Delhi, Dr Ajit Kumar Shasany, Director, National Institute for Plant Biotechnology, New Delhi, Dr. James Jacob, Managing Director, Plantation Corporation of Kerala, Ernakulam, Dr. C.K. Thankamani, Director ICAR-IISR, Kozhikode, Dr. T.N. Raviprasad, Director, ICAR-DCR-Puttur, Dr. B.A. Jerard, Head, Division of Hort. & Forestry ICAR- CIARI, Port Blair, Dr. P.E. Rajasekharan, Principal Scientist, ICAR-IIHR, Bengaluru, Karnataka, and Dr. C.A. Jayaprakash Head, Division of Crop Protection, ICAR-CTCRI, Thiruvanathapuram, Dr. K. Subaharan, Principal Scientist (Entomology), ICAR-NBAIR, Bengaluru and Dr. T. Vanaja, Professor (Plant Breeding & Genetics), Kerala Agril University. The delegates offered felicitations to Dr. Anitha Karun on her superannuation on 30 November 2022.

On the same day, as part of the Conference, a special session, 'Stakeholders meeting on technology innovations to improve horticulture competitiveness' was held. Dr. P. Chowdappa, the former Director of ICAR-CPCRI, chaired the inauguration ceremony, which was graced by Sri. M. Devaraj IAS, CMD of Uttar Pradesh Power Corporation Ltd. Personalities form agriculture, software startup, coconut nurseries, NGO, and agri-inputs shared their perspectives in the meet organized by the Kalpa Agri Business Incubator.

Kisan Samman Sammelan

A Kisan Sammelan was organised at CPCRI Kasaragod on 17 October 2022 in connection with the PM Agri Startup Conclave and Kisan Samman Sammelan held at New Delhi. Sri. N. A. Nellikunnu, Hon'ble MLA, Kasaragod was the Chief Guest.

The honourable MLA expressed his happiness that the young entrepreneurs from the Kasaragod district have been invited to be recognised at the PM Kisan Samman Sammelan, held in New Delhi on October 17–18, 2022. He used the adage "Jai Jawan, Jai Kisan" and emphasised that this level of respect towards farmers is necessary for our nation to continue to exist. He hoped that the recently established FPOs will be able to turn the innovations available at the Institutes into successful business ventures.

Shri N.A. Nellikkunnu, MLA addressing the gathering at Kasaragod

Dr. K. Muralidharan, Director in-charge presided over the function. He mentioned the important announcements by the Hon'ble Prime Minister, 'one nation - one fertiliser' and upscaling of fertiliser

depots into "Kisan Samruddhi Kendras," which supply all necessary information for farming, including soil testing.

The need of continuous programmes for empowering FPOs was emphasised by Dr. Anitha Menon, Deputy Director (Agriculture).

Dr. T. S. Manojkumar, Head, KVK appraised the gathering on training of selected SC families on vegetable cultivation and providing them with seeds under SCSP activities of ICAR-CPCRI. He also mentioned the potential areas for FPOs in the district. More than 100 farmers from different FPOs and 55 SC farmers attended the programme.

Address of Sri Narendra Modi, Hon. Prime Minister of India to the nation during the Agri Start up Conclave and PM Kisan Samman Sammelan held at ICAR-IARI, New Delhi was webcasted by KVK-Alappuzha on 17 October 2022. A total of 65 farmers including 25 DFI documented farmers attended the programme.

Smt. Binu Ashok, Councilor, Kayamkulam Muncipality felicitated the function and handed over the technology input kit to the participant farmers. She highlighted the importance of various government schemes to continue agricultural practices at farm and homestead level in the present scenario. Five selected farmers from different sectors whose cases have been documented under DFI viz., Sri. K.M. Salim (crop diversification), Smt. Rajamma Bhaskaran (integrated farming system), Smt. K. Radhamani (mushroom as an enterprise), Smt. Mariyamma John (value addition) and Smt. Sridevi (woman entrepreneur) shared their experiences.

Rural Innovators Meet 2022

The ICAR-Krishi Vigyan Kendra Kasaragod, ICAR-CPCRI and Kerala State Council for Science Technology & Environment (KSCSTE) jointly organized 'Rural Innovators Meet (RIM)-2022' at ICAR-CPCRI, Kasaragod from 25th to 27th November 2022. During the event, 34 innovations by rural innovators across Kerala were demonstrated. The event was inaugurated by Dr. B. Ashok, Secretary, Kerala State Agriculture Department and was presided over by Dr. K. P. Sudheer, Executive Vice President, KSCSTE and Secretary, Science Technology & Environment Department, Government of Kerala. The exhibition of innovations and agri. expo 'Krishi Darpan-2022' was inaugurated by Dr. V. Venkatasubramanian, Director, ICAR-ATARI, Bengaluru and organized up to 30 November 2023. Dr. K. Muralidharan, Head, Social Sciences division, ICAR-CPCRI delivered the special address. Sri Shaji Vargese and Joseph Peechanattu bagged 'The NABARD Rural Innovation Award' comprising of Rs. 25,000/- and a certificate for two best innovations. Sri Shaji Vargese got the award for his invention of organic seed tray and the machinery for making it. Sri Joseph Peechanattu invented an easy paper bag machine which can hold 10 kg of materials for easy transport as is an alternative for polyethylene bags.

Four special awards worth Rs. 5,000/- each and certificates were presented to innovators. An invention of three in one table top unit for making noodles, coconut oil and coconut scrapper for home scale use made by Sri. P. P. Shyju and Ramya Shyju won the special award. Sri Joshi Joseph won the special award for his invention of Renov crushing machine for powdering fodder, dried dungs and goat manure. Sri K. Joy Augustine won the award for 'Kera peeler', a device for easy de-husking of coconuts. Sri K.B. Anoop, Manju Suresh, Srijith S. Nair and S. Gokul Krishnan won the special award for their invention of Asegurarvida for screening eggs for viability which can be used in hatcheries. The awards were given away by Dr. Gopakumaran Nair, Chief General Manager, NABARD, Kerala Region during the valedictory function. Dr. Anitha Karun, Acting Director, ICAR-CPCRI chaired the function and Dr. K Muralidharan, Head Social Sciences division delivered a special address. A patent clinic was also organized as part of the event for providing assistance to the rural innovators to file patent applications.

Dr. B. Ashok, Secretary, KSCSTE, inaugurating RIM 2022 at Kasaragod

Platinum Jubilee Celebrations of ICAR-CPCRI, Regional Station, Kayamkulam

Inauguration of Kalpa Vajra

ICAR-CPCRI Regional Station Krishnapuram, Kayamkulam launched a yearlong programs as part of its Platinum Jubilee celebrations on 24-04-2022, inaugurated by Shri P. Prasad, Hon'ble Minister for Agriculture, Govt. of Kerala. Adv A.M Arif, Hon'ble Member of Parliament, Alappuzha stressed the importance of improving the productivity of coconut and bringing our innovations and processing avenues of coconut, coir and other industrial products from coconut besides food security through coconut and homestead farming systems. Dr. Anitha Karun, Director (Acting), ICAR-CPCRI, Kasaragod highlighted the science journey of the institute since 1947. Smt. P. Sasikala, Chairperson, Kayamkulam Municipality released the coffee table book on "ICAR-CPCRI, Regional Station, Kayamkulam @75-Serving Coconut Farmers since 1947" Dr. An exhibition was conducted with participation of different Government agencies as well as the Farmer's group under the Farmer-FIRST programme, Mera Gaun-Mera Gaurav (MGMG) marking smart technological display for effective dissemination. Sri. Shani Kurumbolil, President, Krishnapuram Grama Panchayat honoured Sri. P.M. Mathew, Kera Kesari Award Winner from Agali, Palakkad District planted the tissue culture coconut seedling in the experimental plot at Kayamkulam and offered felicitations.P.Anithakumari, Head (Acting), ICAR-CPCRI, Regional Station, Kayamkulam welcomed the gathering. Dr. Regi Jacob Thomas, Principal Scientist and Chairman, Programme Committee proposedvote of thanks.

A farmers' seminar was also organized on the occasion chaired by Dr. George V. Thomas, Director (Retired), ICAR-CPCRI. In the technical session Mr. P.M. Mathew, Kera Kesari Award winner, Mrs. Leenamol M.A., Market Promotion Officer, CDB, Kochi, Mrs. Renu P. Viswam, Statistical Investigator, CDB, Dr. S. Radhakrishnan, Senior Scientific Officer, CCRI, Kalavoor, Dr. A. Abdul Haris, Principal Scientist, ICAR-CPCRI, RS, Kayamkulam and Dr. P. Subramanian, Principal Scientist, ICAR-CPCRI, Kasaragod gave lectures on various topics. More than 750 farmers, women farmers, extension officials and entrepreneurs participated in the program.

Kalpa Vajra celebrations at ICAR-CPCRI, RS, Kayamkulam

Special Postal Cover and Postal Stamp release

ICAR-CPCRI, Regional Station, Kayamkulam commemorated 75 years as Kalpa Vajra Platinum Jubilee celebrating it with the release of a Special Postal Cover and My Stamp on 12 August 2022.

Shri P. Prasad, Hon'ble Minister for Agriculture, Government of Kerala inaugurated the programme. Smt. Sheuli Burman, IPoS, Chief Post Master General, Kerala Circle released the special postal cover and stamp by handing it over to the Hon'ble Minister for Agriculture, Kerala. The programme was chaired by Adv. U. Prathibha, Hon'ble MLA, Kayamkulam.

A philately exhibition was organized on the occasion that attracted more than 2000 students.

Smt. Sheuli Burman, IPoS, Chief Post Master General, Kerala Circle releasing the special postal cover & My Stamp and handing it over to Shri P. Prasad, Hon'ble Minister for Agriculture, Kerala

A view of philately exhibition on agriculture related stamps

Kalpa Sangamam - An assemblage of 75 years of service to coconut community

ICAR-CPCRI Regional Station, Kayamkulam organized Kalpa Sangamam- a grand communion of staff and officers reminiscing 75 years of service to coconut community. Celebrating the legacy of 75 years, Kalpa Sangamam was organized on 20 September 2022, wherein an assemblage of about 250 ICAR family members including staff, officers and scientists who had served this Institute converged and shared the past. This communion is unique and first of its kind in the history of any ICAR Institute.

Royal prince His Highness AvittamThirunal Aditya Varma inaugurated the KalpaSangamam by lighting the Kalpadeepam. Earlier he was given a rousing reception in a traditional style of flower carpeting and lamps carried by women. Dr. K. Muralidhran, Acting Director (i/c) presided over the function. Former Directors of ICAR-CPCRI Dr. K.U.K. Nampoothiri, Dr. George V. Thomas, former Heads/Acting Heads of the Regional Station Dr. V.K. Koshy, Dr. C.P.R. Nair Dr. P.M. Jacob, Dr. Mathew George. Dr. V. Krishnakumar, Dr. S.Kalavathi and former Heads of Division Dr. R.D. Iyer, Dr. Chandramohanan and other distinguished former scientists, technical and administration personal, skilled supporting staff and family members of departed colleagues glorified the occasion by their elegant presence.

His Highness Avittam Thirunal Aditya Varma delivering inaugural address

Participants of Kalpa Sangamam at ICAR-CPCRI, RS, Kayamkulam

Golden Jubilee Celebrations of ICAR-CPCRI Research Centre, Kidu

Launching programme

ICAR-CPCRI, Research Centre, Kidu, established in 1972, launched the Golden Jubilee celebrations of the Research Centre on 10th January 2022, with a Farmer-Interface programme, presided by Dr. Anitha Karun, Director, ICAR-CPCRI, Kasaragod. The president of Kukke Sree Subrahmanya Temple, Shri Mohan Ram S. Sulli inaugurated the programme by lighting the lamp. Shri Sulli, in his inaugural address, appreciated the contributions of the ICAR-CPCRI Research Centre which is unique in hosting the International Coconut Gene Bank for South Asia & Middle East, and stressed the need to strengthen it further to meet the requirements and expectations of various stakeholders. Dr. Anitha Karun, in her presidential address, presented in brief the developmental journey of the Kidu Centre over the 50 long years and highlighted the service rendered by the Centre to the farming community of the country. Dr. N. Yadukumar, Retd. Principal Scientist, ICAR-DCR, Puttur, who had earlier served at ICAR-CPCRI Research Centre Kidu was the guest of honour and shared his reminiscences about the Centre during his service in the 1980s. During the programme, kitchen garden kit for promoting nutritional security was distributed to 30 beneficiaries under the SCSP programme. This was followed by Scintist-Farmer Interface.'

Mega Kisan Mela and Agri Expo held at Kidu, Karnataka

A five-day Mega Kisan Mela and Agri Expo were organized as part of the Golden Jubilee celebrations of ICAR-CPCRI, Research Centre, Kidu, Karnataka from 19 to 23 November 2022. The focal theme was Agrobiodiversity for sustainability.

Sh. Kishore Kumar Kodgi, President, CAMPCO, inaugurated the five days programme. He called upon the scientists to work for time bound solutions on problems faced by the farmers, especially on management of newly emerged leaf spot disease of arecanut.

Dr. S.K. Malhotra, Project Director, DKMA, ICAR, New Delhi flagged many pertinent researchable issues including label claim of chemical recommended for use in plantation sector.

Dr. Homey Cheriyan, Director, DASD, Kozhikode briefed about the action plan suggested by the Scientific Committee on Arecanut on value chain management and control of disease.

Sh. Dadasaheb Desai, Deputy Director, DCCD, Kochi and Sh. K. Shivashankar, President, Grama Panchayat, Bilinele offered felicitations.

The Padma Shri awardees from Dakshina Kannada district Sh. Mahalinga Naik and Sh. H. Hajabba were felicitated in the function.

Three publications were released including the 'Indian Horticulture – Special Issue on Plantation Crops'.Dr.Anitha Karun, Director (Acting), ICAR-CPCRI presided over the function.

Sri Angara, Hon'ble Minister for Fisheries, Ports and Inland Transport, Government of Karnataka inaugurated the Naree Shakti Mela on cocoa production and processing on 21 November 2022.

Inauguration of Kisan Mela by President, CAMPCO, and inauguration of Naree Shakti Mela by Sri Angara, Hon'ble Minister, Govt. of Karnataka

Kisan Mela

Other events organized in the Mega Kisan Mela include (i) Bio-diversity conservation fair; (ii) Demonstration of drone technology; (iii) Farmer scientist interface programme; (iv) Sustainable arecanut farming and plant protection technologies; (v) Hi-tech horticulture technologies; (vi) Natural resources management; (vii) Value addition and mechanization in plantation crops and spices; (viii) Farmers Producer Organizations – Scope and opportunities; and (ix) Awareness on protection of plant varieties and farmers rights.

The Biodiversity Fair showcasedagro-biodiversity to promote in situ conservation and exchange of seeds as well as indigenous technical knowledge. In line with the growing recognition of the importance of millets as a healthy food, the exhibition also showcased millets diversity in nine different millets.

The Agri Expo had a participation of 120 exhibitors and over 15,000 visitors. Number of farmers registered for the programmes was 5430. Cultural programmes were organized every evening from 19-22 November, 2022.

Valedictory function of the Mega Kisan Mela and Agri Expo was held on the 23 November 2022, in the presence of Sri SriSri Vidya Prasanna Teertha Swamiji (Sri Subrahmanya Mata, Kukke Subrahmanya). Dr. Anitha Karun, Director ICAR-CPCRI presided over the function; Dr. V. Niral, Principal Scientist proposed vote of thanks. In-service and retired staff members of the Centre were facilitated during the programme.

Valedictory programme of Golden Jubilee Celebration

As valedictory programme of Golden Jubilee Celebrations of ICAR-CPCRI Research Centre, Kidu an awareness cum training programme on 'Varietal wealth and importance of improved quality planting materials in coconut, arecanut and cocoa' was conducted along with Hybrid Coconut Seedlings distribution to SC farmers at ICAR-CPCRI Research Centre, Kidu on 30 December 2022. Smt. Vidhya Ratna, Head Mistress of Kumaraswamy High School, Subrahmanya as Chief Guest inaugurated the programme. Sh. Esho. Philip, Head Master, St. Mary's School as Guest of Honour was present in the function. Mr. Diwakar, Y., SIC presided over the function. During the presidential address the SIC of the centre briefed all the guests, participants and students about CPCRI RC Kidu and the series of events conducted under golden jubilee celebrations of the centre. The chief guest of the programme congratulated CPCRI RC Kidu for 50 years of committed service and requested all the participants to make best use of the training programme. The guest of honour also a farmer, upon sharing his experience about this centre addressed the participants and requested them to use good quality planting materials from a known source especially in perennial crops. About 100 farmers had participated in the programme. Mr. Diwakar, Y. SIC of the Centre, educated the farmers about the varietal wealth and importance of improved quality planting materials in coconut, arecanut and cocoa. During the valedictory function, Kera Sankara hybrid coconut seedlings were distributed to the SC farmers under SCSP programme.

Horticulture Fair

Horticulture Fair was conducted at CPCRI, RS, Vittal, Karnataka with DCCD funding on 7 March 2022. Shri Amai Mahalinga Naik, Padmashree awardee inaugurated the program. Mr. Shankar Bhat Badnaje, progressive farmer who developed various value added products from arecanut and Mr. Rajaram of EcoBlizz Areca plate making industry were felicitated. Fourteen exhibition stalls were arranged, where ICAR institutes, Coffee Board, CAMPCO chocolate factory, private nurseries participated and 200 farmers and students benefited.

Glimpses of horticulture fair at ICAR-CPCRI, Regional Station, Vittal

Glimpses of horticulture fair at ICAR-CPCRI, Regional Station, Vittal

Rural India Business Conclave

Rural India Business Conclave 2022(RIBC 2.0) was organised during 9-13 June 2022 by the Kalpa Agri-Business Incubator, ICAR-CPCRI Kasaragod jointly with Kerala Startup Mission. The programme was conducted with multiple events collaborating with different partners. The formal inauguration of RIBC was held on 11 June 2022 at ICAR-CPCRI. Shri Rajmohan Unnithan, Hon'ble MP, Kasaragod was the chief guest to inaugurate the conclave. The session was chaired by Shri N.A. Nellikunnu, Hon'ble MLA, Kasaragod. Prof. H. Venkateshwarulu, Vice Chancellor, Central University of Kerala was the guest of honour. Dr. Anitha Karun, Director, ICAR-CPCRI welcomed the gathering. Mr. Mohammed Riyas, Project Director, Kerala Startup Mission; Mrs. Deepti Nair, Deputy Director, Coconut Development Board, Kochi and Mr. Ashok Kurien, Kerala Startup Mission offered felicitations. Dr. K. Muralidharan, Head (Acting), Div. Social Science, presented a brief account of RIBC 2.0.

The prime event of RIBC 2.0 was the Rural-Agri Tech Hackathon in which 19 teams participated. The 30 hour hackathon was supported by 15 mentors, 12 startup founders and 10 scientists from ICAR-CPCRI. The team from Christ College of Engineering, Thrissur was adjudged as the winners to receive a cash prize of Rs.50,000.

During the conference, five startup founders, Sri Mathew Joseph, Co-Founder & CEO, Fresh to Home, Sri Kishore Indukuri, Founder & CEO, Sid's Farm, Sri Mohammed Hisamudheen, Co-Founder & CEO, Entri App, Er. Abhishek Burman, Founder & CEO, General Aeronautics and Sri Manjunath Marappan, CEO, Happy Hens, delivered Founder's Talks. There were five expert talks by Dr. C. Thamban, Principal Scientist, CPCRI, Dr. Elain Apshara, Principal Scientist, CPCRI, Shri Rupesh Kumar K., Coordinator, Responsive Tourism Mission, Kerala and Shri K.T. Thomas, Director, ESAF beside the online address by Dr. Saji Gopinath, Hon'ble Vice Chancellor, Digital University of Kerala.

Two MoUs were exchanged during the inaugural programme: One with Arable Labs India (P) Ltd, Bangalore for incubation at CPCRI for developing sensor applications. The other was with Amitav Rural Empowerment Charitable Agricultural and Religious Trust, Punalur for jointly conducting activities under SCSP in Thiruvananthapuram district.

Shri Rajmohan Unnithan, Hon'ble MP, Kasaragod inaugurating the Conclave

Dr. K. Srinivas, ADG (IPTM), ICAR, inaugurating Dream Big Kalpa

Dr. Anitha Karun inaugurating the Rural-Agri Tech Hackathon

Participants at the 30 hour non-stop hackathon venue

There were three panel discussions during the programme. AStartup Pitch conducted by Social Alpha in which five startups participated. An interactive meeting with scientist of ICAR-CPCRI and Kerala startup mission was also conducted on 11 June 2022.A meeting was hosted by Hon'ble Vice Chancellor, Central University of Kerala for the business men participated in the Conclave. Vice Chancellor Prof. H. Venkateshwarlu, remarked that the University is open to entrepreneurs for making the best use of business knowledge.

Dream Big Kalpa

The 2022 edition of Dream Big Kalpa was held on 12th June 2022 the presentations on ICAR technologies from seven ICAR institutes (CTCRI, CIFT, IISR, SBI, DCR, IIHR and CPCRI) on 12 June 2022. It was inaugurated by Dr. K. Sreenivas, ADG (IPTM), ICAR, New Delhi. Dr. Anitha Karun, Director (Acting), ICAR-CPCRI presided over the function and Dr. Sudha Mysore, CEO, Agrinnovate India was the moderator. Er. Abhishek Burman, Founder & CEO, General, Aeronautics, Bangalore was felicitated in the function for the success of the company in entering to defence applications as part of Adani Defence. ICAR-CPCRI is a partner of General Aeronautics for developing UAV applications in plantation sector.

Plant Health Management in Arecanut

Training cum interface programme on 'Plant health management in arecanut' was organized at ICAR-CPCRI, Regional Station, Vittal on 27 August 2022. The program was inaugurated by Shri Mahesh Puchchappady, Secretary, All India Arecanut Growers Association. The inaugural session was presided over by Dr. Ravi Bhat, Head, Crop Production Division, ICAR- CPCRI.

Farmers shared their experience on phytosanitation using CFT pole, underground drainage system, Scientist - Farmer interface program was coordinated by Dr. C. Thamban. management of root grub and inflorescence die back disease of arecanut.

Dr. C.T. Jose was felicitated by the farmers in view of his retirement from ICAR service on 31 August 2022 and for his contribution to arecanut and cocoa research. Sri Shri Padre, Executive Editor, AdikePatrike, Shri Santhosh Kuthamotte, President, Primary Credit Cooperative Society, Arabthodu-Thodikana, Shri Pradeep D'Souza, SADH, Bantwal were the guests graced the occasion. More than 110 farmers attended the training program.

A view of the dignitaries attending the interface programme at ICAR-CPCRI, RS, Vittal

Training programme impact assessment for technology refinement

A training programme on 'Statistical & socio economic methods and impact assessment for technology refinement in agriculture' was conducted for the benefit of Subject Matter Specialists of KVKs under ATARI, Bengaluru during 11-12 August 2022 at ICAR- CPCRI Kasaragod. Dr.Anitha Karun, Director (Act.), ICAR- CPCRI Kasaragod inaugurated the programme in which Dr. B.T. Rayudu, Principal Scientist, ATARI, Bangaluru was the guest of honour. Dr. C.T. Jose, Head ICAR- CPCRI RS Vittal, was felicitated during the function.

Training programme focussed on giving exposure to basic statistical techniques and software, along with economic tools and impact assessment. Valedictory function was presided over by Dr. K. Muralidharan, Head, Social Sciences. 51 participants from 38 KVKs participated in the programme.

Dr. B.T. Rayudu, Principal Scientist, ATARI, Bangaluru, addressing the participants

XII

PARTICIPATION IN CONFERENCES, MEETINGS, WORKSHOPS AND SYMPOSIA

Deputation Abroad

Dr. Anitha Karun, Director (Acting), Dr. Vinayaka Hegde, Head (Acting), Div. of Crop Protection and Dr. V. Niral, Principal Scientist (Genetics), Dr. Rajesh M.K., Principal Scientist (Biotechnology) participated in the 50th International Cocotech Conference, held at Kuala Lumpur, Malaysia from 7 to 12 November 2022 and presented invited papers.

Dr. S.V. Ramesh, Sr. Scientist (Biotechnology), Div. of PB & PHT participated in the International Symposium on Cocoa Research (ISCR) at Montpellier, France,during 5-7 December 2022. Dr. Ramesh S.V., Senior Scientist also attended INCOCOA Workshop "Building cocoa collaborations to deliver research impact on climate change, deforestation and living income" at Montpellier, France on 8 December, 2022.

Participation in webinars conducted by foreign agencies

Name & Designation	Title	Place and Date
Dr A. Josephraj Kumar Principal Scientist	International webinar on Rugose Spiralling Whitefly and delivered a talk on 'Rugose Spirallingwhitefly-Bionomics, Defenders, Hosts and Management' for the Bangladesh experts	USAID, FAO and Virginia Tech, USA on 24th January 2022
Vinayaka Hegde, Principal Scientists & Heads (Acting), Dr. M. Shareefa Senior Scientist, Dr. Aparna Veluru and Dr. Neema M., Scientist	2nd Tissue Culture Symposium 2022	ICC and COGENT, Jakarta, Indonesia (Online) 4-6 May 2022
Dr. K. Nihad, Senior Scientist	XXI Conference of the Heliconia Society International, USA (online)	Quindío Botanical Garden, Colombia, USA 5-6 December 2022
Dr. S. Elain Apshara, Principal Scientist (Hort.)	INCOCOA- INGENIC group meeting (online)	CIRAD, France, 8 December 2022

Participation within India

Name & Designation	Title	Place and Date
Dr. Neenu, S., Sr. Scientist, Aparna V., Scientist	International conference on Advanced Biology 2022 (icab 2022) organized by Inter University Centre for Evolutionary and Integrative Biology (iceib)	University of Kerala, Thiruvananthapuram, Kerala 23-25 February 2022

Dr. Neenu, S., Sr. Scientist, Aparna V., Scientist	International conference on Advanced Biology 2022 (icab 2022) organized by Inter University Centre for Evolutionary and Integrative Biology (iceib)	University of Kerala, Thiruvananthapuram, Kerala 23-25 February 2022
Sandip Shil, Scientist,	National webinar on 'Emerging techniques in molecular biology for Crop Improvement'	National Academy of Sciences & Centre for Plant Biotechnology and Molecular Biology, KAU on 16, February 2022
Dr. Vinayaka Hegde, Principal Scientists & Head (Acting), Dr. VH Prathibha and Dr. Daliyamol, Scientists,	Indian Phytopathlogical Society Platinum Jubilee 8th International Conference; Plant Pathology - Retrospect and Prospects	SKN Agriculture University, Jobner, Jaipur, Rajasthan on 23-26 March 2022
Dr. A. Josephrajkumar, Principal Scientist	Annadata Devo Bava lecture on 'Bioagents in coconut pest management' (online)	ICAR-CPCRI, RS, Kayamkulam 25 April 2022
Dr. Aparna Veluru, Scientist	2nd Indian Horticulture Summit-2022	Navsari, Gujarat 27-29 April 2022
Navsari, Gujarat 27-29 April 2022	International Symposium on "Advances in Plant Biotechnology and Nutritional security" APBNS-2022	ICAR-NIPB, New Delhi- 28-30 April, 2022
ICAR-NIPB, New Delhi-110012 28-30 April, 2022	ICC-COGENT International Coconut Tissue Culture Workshop	ICAR-CPCRI, Kasaragod 16th to 20th May 2022
Dr. Regi Jacob Thomas Principal Scientist	ICC-COGENT Tissue Culture Workshop and delivered lecture on 'Farmer Participatory Pollen Conservation'	ICAR-CPCRI Kasaragod 17-18 May 2022
Dr. Rajkumar, Scientist	National e - conference on 'Biotic stress management strategies for achieving sustainable crop production and climate resilience'	ICAR-NARCIPM, New Delhi 19 - 21 May, 2022
Dr. S. Elain Apshara, Principal Scientist (Hort.)	Webinar on prospects of Varieties/ Crops Developed through Genome Editing (regulatory framework, technologies and experience)	PPV & FRA, New Delhi, 24 May 2022
Dr. Rajkumar, Scientist	Crop life India virtual Symposium on" Roadmap for sustainable management of empty pesticides containers (EPC) in India	New Delhi 25 May 2022
Dr. Sandip Shil, Scientist	National Seminar on 'Horticulture for sustainable development, nutritional and livelihood security'.	UBKV, Pundibari, West Bengal 26-27 May 2022
Dr. K.M. Anes, Scientist	Regional conference of Cluster Based Business Organizations (CBBOs) & Farmer Producer Organizations (FPOs)	GKVK Campus, UAS Bengaluru 27 May 2022

Dr. Anitha Karun, Director (Acting), Dr. Muralidharan K. and Dr. K B Hebbar, Principal Scientists & Heads (Acting)	National Conference on Climate Resilient and Sustainable Development of Horticulture	CSAUA & T, Kanpur, Uttar Pradesh 28-31 May 2022
Dr. S. Elain Apshara, Principal Scientist (Hort.)	National Conference on Climate Resilient and Sustainable Development of Horticulture	CSAUA & T, Kanpur, Uttar Pradesh 28-31 May 2022
Dr. P. Muralidharan, Principal Scientist and Head, KVK	ICAR-National Conference of KVKs	YSPUHF, Solan, Himachal Pradesh to 3 June, 2022
	Annual Zonal Workshop of ATARI, Zone XI	UAS, Dharwad 19 -22nd June, 2022
Ms. Chaithra M, Scientist	6th Dr. Y. R. Sharma Memorial Lecture	ICAR-IISR, Kozhikode 20 June 2022.
Dr. Jeena Mathew, Sr.Scientist	International conference on water and environmental management	CWRDM, Kozhikode 22 -24 June, 2022
Dr. S. Elain Apshara, Principal Scientist (Hort.)	Management options for Helopeltis in Cashew, Tea and Eucalyptus	ICAR-DCR, Puttur 23 July 2022
Dr. S. Elain Apshara, Principal Scientist (Hort.)	Intellectual Property Rights Awareness Webinar Series	NIPAM, 1-5 Aug. 2022
Dr. A. Josephrajkumar, Pr. Scientist, Dr. Jilu V. Sajan, Scientist	Advanced Microscopic Workshop and delivered a talk on "Microscopy and Coconut Research"	ICAR-CPCRI, Regional Station, Kayamkulam 16 July 2022
Dr. A. Josephrajkumar, Pr. Scientist,	KDISC meeting on YIP programme	Secretariat Annexe, Thiruvananthapuram 20 July 2022
Dr. P. Anithakumari, Head (Acting)	Attended FFP annual review meeting and presented progress report and action plan for 2022-23	ATARI, Bengaluru 17-18 August 2022.
Dr. V. Selvamani Senior Scientist	International Conference on Advances in Agriculture & Food System Towards Sustainable Development Goals.	University of Agricultural Sciences, Bangalore during Aug. 22 - 24th, 2022. (On line)
Dr. Regi Jacob Thomas, Pr. Scientist	World Coconut Day-2022 & delivered lecture 'Breeding for disease resistance and innovations in planting material production in coconut'	Dept of Spices & Plantation Crops, TNAU, Coimbatore on 2 September 2022
Dr. A. Josephrajkumar, Pr. Scientist	International Webinar on Growing coconut for prosperity	Coconut Research Station, Aliyarnagar, TNAU, on 2 September 2022

Dr. K.M. Anes, Scientist	International Workshop on Good Agricultural Practices in Coconut and World Coconut Day Celebration	Hotel Le Meridian, Kochi on 2 September 2022
Dr. Ramesh S.V. Senior Scientist	International Conference on Biotechnology-Trends and future Prospects	Department of Plant Biotechnology, University of Agricultural Sciences, GKVK, Bengaluru from 13-15th September, 2022
Dr. A. Josephrajkumar, Pr. Scientist	Brainstorming session on Exploring the Researchable Issues in Agricultural Entomology	TNAU, Coimbatore on 14 September 2022
Dr. Anitha Karun, Director (Acting) & PC Palms I/c, Dr. Ravi Bhat, AICRP (Palms), Dr. K. Muralidharan, Dr. K. B. Hebbar, Dr. Vinayaka Hegde, Heads (Acting), Dr. Alka Gupta Dr. P. Subramanian, Dr. (Mrs.) V. Niral, Dr. K. Samsudeen, Dr. M.K. Rajesh, Dr. S. Elain Apshara, Dr. A. Josephrajkumar, Dr. M.R. Manikantan, Dr. K.P. Chandran, Principal Scientists, Dr. S. Jayasekhar, Dr. S. Paulraj, Dr. Neenu S., Sr.Scientist, Dr. V. Selvamani, Dr. Neema M., Mrs. Aparna Veluru, Dr. R. Sudha, Dr. S.V. Ramesh, Dr. Shameena Beegum, P.P., Dr. Prathibha P.S., Dr. Pratibha V.H., Dr. Rajkumar, Dr. Surekha, Dr. G. Panjavarnam, Dr. Nagaraja N.R., Dr. Sumitha S., Dr. M. Sujithra, Dr. Daliya Mol, Mr. Diwakar Y. and Mrs. Ranjini T.N., Scientists.	30th Annual Group Meeting of AICRP (Palms)	Organized at ICAR-CPCRI, Kasaragod, Kerala during 16th to 18th September 2022
Dr. V. Selvamani Senior Scientist	International Conference on Advances in Agricultural, Veterinary and Allied	ICAR-IGFRI, NADC Ltd., ICAR-NAHEP and Birsa

	Sciences for Improving Livelihood and Environmental Security (AAVASILES-2022).	Agricultural University, Ranchi, Jharkhand, University of Kashmir during 28 to 30 September, 2022. (On line)
Dr. A. Josephrajkumar, Principal Scientist	Entomology Society of India Annual Meeting and Award distribution	ICAR-IARI, New Delhi on 14-10-2022
Dr. A. Josephrajkumar, Principal Scientist, Dr. K.M. Anes, Scientist	Annual Group Meeting, AICRP on Biocontrol	ICAR-NBAIR, GKVK campus, Bengaluru during October 20-21, 2022
Dr M R Manikantan, Principal Scientist	56th Annual Convention of Indian Society of Agricultural Engineers on "Agricultural Engineering Innovation for Global Food Security" and International Symposium on "India@2047: Agricultural Engineering Perspective"	Indian Society of Agricultural Engineers, New Delhi and Agricultural Engineering College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 9-11 November 2022
Dr. Sandip Shil, Sr. Scientist	73rd Annual Conference of Indian Society of Agricultural Statistics, Statistics and Machine Learning for Big Data Analytics	Sher-E-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-K) Srinagar, J&K during November 14-16, 2022
Dr. K.M. Anes, Senior Scientist	International workshop on 'Complementing current techniques with next generation technology for crop health improvement' in online mode	Aligarh Muslim University, Aligarh 14-19, November, 2022
Dr. K. Muralidharan, Dr. K.B. Hebbar, Dr. Ravi Bhat, Dr. Vinayaka Hegde, Dr. Thamban C., Dr. P. Anitha Kumari, Dr. Regi J. Thomas, Dr. P. Muralidharan, Dr. Elain Apshara, Dr. Subramanian P, Dr. Murali Gopal, Dr. Alka Gupta, Dr. Samsudeen K, Dr. Niral V, Dr. M K Rajesh, Dr. M R Manikantan, Dr. Chandran K P, Principal Scientists,	National Conference on in Enhancing competitiveness of horticulture though technology innovation	ICAR-Central Plantation Crops Research Institute, Kasaragod 17-18 November 2022

Dr. Jayasekhar S., Dr. Sudha R, Dr. Neenu S. Dr. Selvamani V, Dr. Paulraj S, Dr. Ramesh S.V., Dr. Prathibha P.S., Dr. Rajkumar, Dr. Shareefa M, Dr. Jeena Mathew, Dr. Nihad K, Dr. Sujithra M, Dr. N R Nagaraja, Dr. Prathibha V H, Sr. Scientists Dr. Neema M, Dr. Aparna V, Dr. Induja S, Dr. Shameena Beegum, Dr. Panjavarnam, Dr. Daliyamol, Dr. Surekha R, and Mrs. Ranjini T N, and Dr. Diwakar Y, Scientists and Dr. K.S. Muralikrishna, Senior Technical Assistant		
Dr. A. Josephrajkumar, Principal Scientist	Third National Conference on Oil Palm-Way Forward for increasing vegetable oil pool through AtmaNirbhar Bharat for doubling the income and social security to farmers	Society for Promotion of Oil palm Research and Development, ICAR-IIOPR at Vijayawada during November 23-25, 2022
Dr. V. Selvamani and Dr. Nagaraja, N. R. Senior Scientists	National Symposium on Horticultural crops of humid tropics for nutritional and livelihood security	Hotel Crystal Court, Madikeri 2-3 December 2022
Dr. A. Josephrajkumar, Principal Scientist	National Conference-Bioinvasions: Trends, Threats and Management	Kerala State Biodiversity Board at Kerala Arts and Crafts village, Vellar, Thiruvananthapuram during December 3-4, 2022,
Dr. A. Josephrajkumar, Principal Scientist	Seventh National Conference on Biological Control on 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward	Society of Biocontrol Advancement, ICAR-NBAIR, Bengaluru during December 15-17, 2022

XIII 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
International Coconut Genetic Resource Network (COGENT)	Biotechnological activities related to coconut genetic resources

National ICAR Institutes

ICAR-Sugarcane Breeding Institute, Coimbatore	Cytological studies of in vitro cultures of coconut and arecanut and Food processing R&D
ICAR Central Island Agriculture Research Institute, 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-Central Institute of Post - Honest Engineering, and Technology, Ludhiana	Agricultural pre- and post-harvest machinery
ICAR-Central Research Institute for Dry Land Agri Culute Hyderabad	Climate change network and NICRA
ICAR-Directorate of Mushroom Research 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-National Bureau of Agriculture Important, Insects, Bengaluru	Biological control R&D

National Bureaus of Auricularly Important Microbes	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	

Others

K.S. Hegde Medical Academy, NITTE – Deemed to be University, Deralakatte, Mangalore	Deciphering the biochemical machinery underlying in vitro regeneration in coconut and arecanut
Agricultural Technology Management Agency (ATMA)	ToT activities
ICAR- Central Institute of Fisheries Technologies (CIFT), Kochi	Food processing R&D collaboration
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 (CDB), 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 (DASD), 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
National Institute of Food Technology, Entrepreneurship and Management (NIFTEM), Thanjavur, Tamil Nadu	R & D collaboration in PHT

IIPM, Bengaluru	Technology programmes in plantations management
KCAET, KAU, Tavanur	Technology programmes
Kerala Agricultural University	R & D collaboration
Kerala State Council for Science Technology & Environment (KSCSTE), Thiruvananthapuram	R & D collaboration
Kerala State Planning Board	R & D collaboration
KVASU, Wayanad	Technology programmes
National Bank for Agriculture and Rural Development (NABARD), Mumbai	Developing/ demonstrating model coconut clusters in root (wilt) affected areas
National Innovation Foundation (NIF), Gandhinagar, Gujarat	Evaluation of innovator's technology
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
Rashrtiya Krishi Vikas Yojana (RKVY)	R & D collaboration
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

ACADEMIC INSTITUTIONS

- Alvas College, Modbidri
- Amrita Viswavidyapeetham, Kollam
- BAM College, Thuruthicad
- BCM College, Kottayam
- Christ (Deemed University), Bengaluru
- College of Indegenous Food Technology, Konni
- Dr. YSR Horticulture University, Andhra Pradesh
- Hindustan College of Arts & Science, Coimbatore
- Kannur University
- Kelappaji College of Agricultural Engineering and Technology, Tavanur, Malappuram
- Khansa Women's College, Kumbla, Kasaragod
- KUFOS, Kochi
- Lovely Professional University, Punjab
- Mangalore University, Mangalore
- Mar Athanesious College of Advanced Studies, Thiruvalla
- Marthoma College, Thiruvalla
- Marthoma College of Science and Technology, Kollam
- MES MK Mackar Pillay College for Adnanced Studied, Aluva
- National Center for Aquatic Animal Health, CUSAT, Kochi
- Nehru Arts and Science College (Autonomous), Coimbatore
- NIFTEM, Haryana
- PA First Grade College, Mangalore
- Sacred Heart College Thevara, Kochi
- SAFI Institure of Advanced Study, Vazhayur, Kozhikode
- St. Agnes College Autonomous, Mangalore
- St. Aloysius College (Autonomous), Mangaluru
- St. George College, Aruvithura, Kottayam
- St. Mary's College of Women, Thiruvalla
- PGP College of Arts & Science, Namakkal
- TNAU, Coimbatore
- University of Agricultural Sciences, Raichur
- University of Calicut, School of Health Science
- Vimala College, Thrissur

XIV

RESEARCH PROJECTS

Institute Funded Projects

Project No.	Project Title	Project Leader	Associate (s)
1000761028	Genetic resources management in coconut, arecanut and cocoa	V. Niral	S. Elain Apshara, N. R. Nagaraja, K. Samsudeen, A. K. Sit, L.S. Singh, Alpana Das, Sudha R., Diwakar Y., Ranjini T.N., Suchithra, M., M. Sujithra, V.H. Pratibha, K.B. Hebbar, SV Ramesh, P. Subramanian, Shameena Beegum, M.R. Manikantan, R. Pandiselvam, C. Thamban, T.N. Madhu, E.K. Saneera, R. ThavaPrakas Pandian, M. Chaithra, AnokUchoi B.A. Jerard, ICAR-CIARI, Andamansand Babli Mog, ICAR- DCR, Puttur
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, Diwakar Y., Sudha R., Ranjini T.N., Alpana Das, Sumitha S., Sandip Shil, Madhu, T.N., Saneera E.K., Suchithra M., S. Sendur Kumaran (KVK, Kundrakudi, TN), Scientist from CIARI
1000761031	Development of tissue culture techniques in coconut	Anitha Karun/ Neema M.	M. K. Rajesh, Neema M. and Aparna V.
1000761030	Biotechnological applications in palms and cocoa	M.K. Rajesh	Anitha Karun, Neema M., Aparna V., K.B. Hebbar, Murali Gopal and Alpana Das
1000761032	Development of double-stranded RNA based food bait for the suppression of red palm weevil	M.K. Rajesh	Josephrajkumar A., Ramesh S.V., M. Sujithraand Aparna V.
1000763057	Cropping/ farming approaches for improving soil health and system productivity in coconut, arecanut and cocoa	P. Subramanian	Ravi Bhat, V. Selvamani, Surekha, P. Panjavarnam, Alka Gupta, U. K. Priya, Bhavishya, A. Abdul Haris, K. Nihad, Arun Kumar Sit, S. Neenu, Anok Uchoi, S. Paulraj, Indhuja. S and Jeena Mathew

1000763058	Enhancing nutrient and water use efficiency for sustained productivity in coconut, arecanut and cocoa	V. Selvamani	P. Subramanian, Surekha, K. Nihad, Ravi Bhat, Neenu, A. Abdul Haris, Jeena Mathew, U. K. Priya, Bhavishya, P. Panjavarnam, Indhuja, Arun Kumar Sit, S. Paul Raj, Anok Uchoi, Merin Babu, P. Anitha Kumari, R. ThavaPrakasaPandian, Jilu V. Sajan and S. V. Ramesh
1000763055	Bioresources management in coconut, arecanut and cocoa	Alka Gupta	Murali Gopal, P. Subramanian, Ravi Bhat, Surekha, Elain Apshara, Rajkumar, Sandip Shil, S. Neenu, Selvamani, UK Priya, A. Bhavishya, S. Indhuja, Abdul Harris, K. Nihad, Jeena Mathew, Merin Babu
1000765039	Integrated approaches for management of fungal diseases of palms and cocoa	Vinayaka Hegde	Prathibha V.H., Daliyamol, R. ThavaPrakasa Pandian, Chaithra M., Rajesh M.K., Bhavishya, Madhu T. N. and Rajkumar
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, M.K. Rajesh, Ramesh S.V., Merin Babu, Daliyamol, S. Indhuja, Thava Prakash Pandian, M. Chaithra, Bhavishya, Jilu V. Sajan, Saneera E.K. and Madhu, T. N.
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, M.K. Rajesh, Ramesh S.V., Merin Babu, Daliyamol, S. Indhuja, Thava Prakash Pandian, M. Chaithra, Bhavishya, Jilu V. Sajan, Saneera E.K. and Madhu, T. N.
1000765041	Integrated management of pests and nematodes in palms and cocoa	A. Josephrajkumar	P. S. Prathibha, Rajkumar, M. Sujithra, Jilu V. Sajan, Saneera E. K., Madhu, T. N., Merin Babu, Anes, K. M., Chaithra, M., ThavaPrakasa Pandian R., Daliyamoland Bhavishya
1000766014	Physiological and biochemical investigations of yield and quality in palms and cocoa	K.B. Hebbar	S.V. Ramesh, Elain Apshara, S Neenu, Surekha, A.K. Sit, Nagaraja N.R., Pandiselvam R., M.R. Manikantanand B. Sravanthi

1000767018	Mechanization, processing, product diversification and nutraceutical properties	M.R. Manikantan	Shameena Beegum P.P., R. Pandiselvam, Murali Gopal, S. Paul Raj, S.V. Ramesh, A.C. Mathew and K.B. Hebbar
1000767022	Development of continuous type coconut testa removing machine	R. Pandiselvam	M.R. Manikantan, A.C. Mathew and Shameena Beegum P.P.
1000767023	Development of process technology for minimal processing of mature coconut kernel and its value added products	Shameena Beegum P.P.	M.R. Manikantan and R. Pandiselvam
1000767024	Hyper spectral imaging based detection system for identification of adulteration in desiccated coconut powder	M.R. Manikantan R.	Pandiselvam, Shameena Beegum P.P. and Subir Kumar Chakraborty (ICAR-CIAE)
1000767025	Development of linear actuator-based tender coconut punching and cutting machine	R. Pandiselvam	A.C. Mathew, M.R. Manikantan and Shameena Beegum
1000767027	Development of process technology for coconut milk based dairy analogues	Shameena Beegum	M.R. Manikantan, R. Pandiselvam, Murali Gopal and Suresha K.B. from UAS, Bangalore
1000769020	Technology transfer and co-learning action research approaches	C. Thamban	K. Muralidharan, P. Anithakumari, Chandran, K.P., S. Jayasekhar, Prathibha P.S., Daliyamol, Bhavishya, ThavaPrakas Pandian, Alpana Das, A.K. Sit, Sandip Shill and Sudha R.
1000769013	Socio-economic dimensions and value chain dynamics in policy perspective	S. Jayasekhar	Chandran K.P., Thamban C., Muralidharan K., Jose C.T., Sandip Shil
1000769019	Development of statistical and computational techniques for improving research methodology	Jose C.T./ Chandran K.P.	Muralidharan K., Chandran K.P., Sandip Shil, Madhu T.N., Thavaprakash Pandian, Jayasekhar S., Bhavishya and Saneera E.K.

Externally Funded Projects

Project No.	Project Title	Project Leader	Associate (s)
1050761086	DUS Centre for coconut	V. Niral	K. Samsudeen
1050761114	Development of DUS testing criteria and establishment of genebank for arecanut	Nagaraja N.R.	A.K. Sit and L.S. Singh

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., Diwakar Y., Sudha R., A.K. Sit, L.S. Singh and Ranjini T.N.
1050761127	Commercial production of arecanut – tissue culture of planting material of yellow leaf disease resistant palms and dwarf hybrids	Anitha Karun / Neema M.	M.K. Rajesh, R. ThavaPrakasaPandian, Neema M. and Aparna V.
1050761140	Evaluation of stage-specific modulation of specific miRNAs during zygotic and somatic embryogenesis in coconut and their functional validation	M.K. Rajesh	K. Samsudeen and S.V. Ramesh
1050761142	Refinement of *in vitro* immature inflorescence culture of coconut for multiplication of true-to-type planting materials	Shareefa M.	Anitha Karun, Regi J. Thomas and M.K. Rajesh
1050761148	Establishment of a molecular marker based accreditation laboratory for coconut hybrids	M.K. Rajesh	K. Samsudeen, Regi Jacob Thomas
1050761150	Identification of drought tolerant coconut palms in Tamil Nadu and utilization for developing adaptive gene pool	Samsudeen K.	Subramanian P., Niral V.
1050761151	Evaluation of farmer's 'MM 20' betelvine variety	Arun Kumar Sit	V. Niral
1050761156	Cocoa seed gardens / clonal orchards – Establishment and enrichment	S. Elain Apshara	Chaithra M.
1050761138	Participatory Demonstration Plots of Cinnamon intercropping in coconut	Ravi Bhat	P. Subramanian, Surekha and V. Selvamani
1050761143	Impact of water/ soil moisture conservation to enhancing production of coconut under rainfed and deficit irrigated farms	P. Subramanian	Ravi Bhat, Thamban C., A. C. Mathew, Paulraj, S. and Surekha
1050761146	Establishment of advanced facilities for measuring physiological processes	K. Nihad	A. Abdul Haris
1050761128	Pest and disease surveillance on coconut palms by unmanned aerial vehicle	Vinayaka Hegde	A. Josephrajkumar, Chandrika Mohan, Prathibha P.S., Prathibha V.H., Rajkumar, Merin Babu, Daliyamol, Anes K.M., Abhishek Burman

1050761139	Establishment of FLDs on arecanut root diseases management using mandipropamid fungicide	Prathibha V.H.	Vinayaka Hegde, ThavaPrakas Pandian and Rajkumar
1050761141	Formulation development of entomopathogenic fungus Simplicillium sp. and its utilization in the management of coconut invasive whiteflies	Sujithra M.	Prathibha V.H.
1050761137	Farmer Producer Organization-Odanadu farmer producer Company Ltd. - ICAR-CPCRI FFP as POPI	P. Anithakumari	-
1050761117	Participatory technology integration to empower and ensure livelihood security of farmers in Alappuzha district (Farmer FIRST Programme)	P. Anithakumari	A. Josephrajkumar, Merin Babu, JeenaMathew, Nihad K., Shareefa M., Indhuja S. and Anes K.M.
2010760007	Intellectual property management and transfer/ commercialization of agricultural technology scheme	K. Muralidharan	M.R. Manikantan and A.C. Mathew
1050761110	Establishment of Agri-Business Incubation (ABI) Center at ICAR-CPCRI, Kasaragod	Muralidharan K.	Mathew A.C., Manikantan M.R., Pandiselvam R., S. Jayasekharand Shameena Beegum
1050761135	Establishing Demonstration Plots on Arecanut Based Multispecies Cropping System	N.R. Nagaraja	C.T. Jose, Rajkumar and U.K. Priya
1050761136	Establishing Demonstration Plots on Arecanut Dwarf Hybrids	N.R. Nagaraja	C.T. Jose
1050761145	Demonstration of integrated management of inflorescence dieback disease in arecanut	R. Thava Prakasa Pandian	Bhavishya, Chaithra M., Rajkumar, Prathibha V.H., Madhu T. N.
1050761147	Development of biodegradable plate from tender coconut husk	R. Pandiselvam	M.R. Manikantan and Anjineyulu Kothakota
1050761149	Diversity analysis of *Ganoderma* sp. infecting coconut and their eco-friendly management	Daliyamol	Prathibha V.H., Vinayaka Hegde, L.S. Singh
1050761152	Frontline demonstration of biointensive integrated pest management strategies against coconut white grub *Leucopholis coniophora* Burmeister	Prathibha P.S.	Jilu V. Sajan, Thamban C., Rajkumar, Neenu S.

1050761153	Demonstration of effective and eco-friendly management of white grubs using entomopathogenic nematodes in arecanut	Rajkumar	Sujithra, M., Pratibha, V.H., Madhu, T. N., Nagaraj, N. R., Bhavishya, Thava Prakasa Pandian R.
1050761154	Technology dissemination through demonstration – Horticulture based crop cafetaria for nutritional and livelihood security of marginal farmers	K. Nihad	A. Abdul Haris
1050761155	Demonstration of Kalpa Vardhini as a component of integrated nutrient management for sustained soil and palm health of coconut	Jeena Mathew	A. Abdul Haris, S. Indhuja
1050761157	Establishment of centre of excellence of biotechnology for plantation crops breeding	N.R. Nagaraja	S. Elain Apshara

RESEARCH AND ORGANISATIONAL MANAGEMENT

XIV

Research Advisory Committee

The 24th Research Advisory Committee meeting was held on 4thJuly 2022 at ICAR-CPCRI, Kasaragod. Following members attended the meeting.

1. Dr. S.P. Ghosh, Former DDG (Hort.), ICAR, New Delhi, Chairman
2. Prof. B.S. Hansra, Former ADG (Extn.), ICAR, New Delhi
3. Dr. K.V. Ramana, Former ADG (Plantations), ICAR, New Delhi
4. Dr. V. Abraham, Former Director, ICAR-NBAIR, Bengaluru
5. Dr. K.V. Bhat, Emeritus Scientist, ICAR, New Delhi
6. Dr.Anitha Karun, Director (Act-ing), ICAR-CPCRI
7. Shri Suresh Kumar Shetty, Farmer Member
8. Shri K. Sadananda Shetty, Farmer Member
9. Dr. Ravi Bhat, Head, Division of Crop Production, ICAR-CPCRI, Member Secretary, RAC.

Dr. Anitha Karun, Director, presented salient achievements of the Institute under the various research programmes and the major advancements at the Institute. This was followed by presentation of progress of research by seven programme leaders and heads of KVK. The members of RAC had a field visit on 5thJuly 2022 to monitor ground level activities.

Based on the presentations and the existing farm level challenges, RAC has recommended, upscaling of tissue culture in coconut and arecanut for mass production, utilization of exotic germplasm for applied breeding, evaluation of multi-tier cropping system model with coconut in east coast and north eastern states, revalidation of disease and pest forewarning models, characterization of bioactive ingredient in value added products, and disseminate pro-poor technologies on IT platforms.

Dr. S.P. Ghosh, Chairman, RAC addressing the participants

Institute Research Committee

The 50th Annual Institute Research Committee (IRC) Meeting of the ICAR-Central Plantation Crops Research Institute, Kasaragod was held at ICAR-CPCRI Kasaragod during 25th–29th July 2022. The progress of research programmes and achievements under the ongoing projects under crop improvement, biotechnology, crop production, integrated disease management, integrated pest management, physiology & biochemistry, value chain management and social sciences including transfer of technologies were presented by the respective Principal Investigators. During the meeting, all the ongoing research projects (including externally funded projects) under seven research programmes were discussed and the technical programme for the year 2022–23 was finalized. Dr.Anitha Karun, Director (Acting) was the General Chairperson and Dr. Murali Gopal, Principal Scientist was the Member Secretary for IRC.

Dr. K.M. Sreekumar, Professor & Head, Padannakkad delivering plenary lecture during IRC meeting

Institute Management Committee

Institute Management Committee has met, on 7th March 2022 and on 2nd November 2022 in a hybrid mode and considered various aspects of progress of activities and utilization of funds at the Institute.

Following members attended the meetings:

Dr. Anitha Karun, Director (Acting), ICAR-CPCRI, Kasaragod & Chairperson, IMC,

Dr. Vikramaditya Pandey, ADG (H.S.) I/c, ICAR, New Delhi & member,

Shri Suresh Kumar Shetty, Farmer & member,

Shri Sadananda Shetty, Farmer & member, and

Shri Hareesh Nair G.S., Chief Administrative Officer (Sr. Grade) & Member Secretary

INTELLECTUAL PROPERTY AND TECHNOLOGY MANAGEMENT

XVI

Patents obtained

Three national patents were granted to the Institute:

Title	Patent No.	Granted date	Inventor's
Method for aseptic extraction of tender nut water as frozen ball and soft endosperm (kernel) from trimmed young coconut	403090	05-08-2022	Dr. K.B. Hebbar

Consultancy services

S.N.	Date	Consultancy service	Client	Amount (Rs.)
1	05-04-2022	Analytical charges for analysing NPK organic	Sreelatha T.K. Proproetor, Sreekrishna Agrofert, Ananthapuram D.P., P.O. Kannur, Via Kumbala, Kasaragod	2500.00
2	25-05-2022	Analytical charges for analysing NPK organic carbon including Fe, Mn, Cu, Zn for HARITHA PLANT GROWTH BOOSTER and HARITHA ORGARICH	Sreelatha T.K. Proproetor, SreekrishnaAgrofert, ananthapuram D.P., P.O. Kannur, Via Kumbala, Kasaragod	5000.00
3	10-08-2022	Analytical charges for compatibility test of HARITHA ORGARICH (organic fertiliser) with Trichoderma	Sreelatha T.K. Proproetor, SreekrishnaAgrofert, ananthapuram D.P., P.O. Kannur, Via Kumbala, Kasaragod	5000.00
4	10-08-2022	Testing of Oischer shell for Calcium carbonate	Surendran K. Amritham, Poinachi, Nelliyadukam, Thekkil post, Kasaragod - 671541	200.00
5	13-12-2022	Analytical charges for analyzing NPK ENKJ 01/22-23 ENKJ 02/22-23 ENKJ 03/22-23	Agriculture Officer, Krishi Bhavan, Enmakaje.	3750.00
6	30-12-2022	Consultancy services 1. IT00LQDLA8 2. IT00OWILQ6	Institute of Applied Dermatology, Uliyathadka, Kasaragod.	26550.00

Commercialization of Technology

During the period from January to December, 2022, total 35 technologies were commercialized by the Institute through MoA as per the details given below, an amount of Rs. 5,75,000/- has been collected as technology transfer fees.

Technology	Date of licensing	Transfer fees (Rs.)	Entrepreneurs
Technical knowhow of production of virgin coconut oil	23-02-2022	40,000	South Canara Coconut Farmers Producer Company Limited, 1-101, Near Mangala Mantapa CPCRI, Vittal, Dakshina Kannada, Karnataka – 574243.
Coconut Chips	12-01-2022	25,000	Mr. Naveen Poojary, 11-18-6, Manikanta Nilaya, Kemmade, Mooru Kaveri, Menna Bettu, Kinnigoli, Dakshina Kannada, Karnantaka – 574150.
	25-01-2022	25,000	Mr. Venkata Vikas Vepuri Vepuri Agro Products Pvt. Ltd., F203, Gananada heights apartments, Paramata, Vijayawada, Krishna Dist, Andhra Pradesh – 520007.
	08-03-2022	25,000	Praveen Jacob, CEO Alpha Natural, Misgar Complex, Keregundi road, Sirsi, Uttara Kannada, Karnataka – 581402.
	19-05-2022	25,000	Mr. Abdul Gafoor Chalil, M/s GJ Enterprises, Ground 16/330, Palapetty, Perumpadappu – 679579, Malappuram, Kerala
	20-05-2022	25,000	Raam Mohan N.U., 4/22, Umapathy coconut hybrid Nasuvanpalayam, Pollachi Road, Venkittapuram Post, Palladam (TK), Tirupur, Tamil Nadu
	16-08-2022	25,000	M/s Distinct origins Pvt. Ltd., Kamavarapukota Mandal Tadikalapudi Village, West Godavari Andhra Pradesh - 534452
	17-11-2022	25,000	The Managing Partner Green Valley Oils, Irumpakachola PO, Kanjirapuzha 678591, Palakkad, Kerala
Kalpa Vardhini	18-03-2022	25,000	ESAF Swasraya Producers Company Ltd., TC/10/121/1, Santhi Nagar, Ollukkara, Mannuthy, Thrissur – 680651, Kerala.
Kalpa Poshak and Kalpa Vardhini	10-05-2022	15,000	ESAF Swasraya Producers Company Ltd., TC/10/121/1, Santhi Nagar, Ollukkara, Mannuthy, Thrissur – 680651, Kerala

Aqua formulation of EPN Kalpa EPN (CPCRI-SC1)	03-02-2022	25,000	South Canara Coconut Farmers Producer Company Limited, 1-101, Near Mangala Mantapa CPCRI, Vittal, Dakshina Kannada, Karnataka – 574243.
	08-03-2022	25,000	M/s Sahasra Crop Science (P) LTD, Hyderabad, Telangana.
	17-03-2022	10,000	The Senior Scientist and Head ICAR – KVK, Mitraniketan, Vellanad, Trivandrum, Kerala – 695543.
Preservation of carbonated tender coconut water	15-09-2022	25,000	Ms. Jasmine P. Chemmalappadi, Kerala Estate P.O., Malappuram - 676523
	07-12-2022	25,000	Mr. Ajas Parambath Konolly Foods International, Kanoor, Vakkad P.O., Tirur, Malappuram, Kerala – 676502
Kalpa Organic Gold (Coconut Leaf Vermicomposting technology)	03-02-2022	20,000	Mr. Rajesh S., Namaste Agri Marketing, Thenku Kajekar Village, Bantwal, D.K, Karnataka.
Trichoderma Coir Pith Cake	17-03-2022	5,000	The Associate Director of Research Regional Agricultural Research Station, Kerala Agricultural University, Ambalavayal, Wayanad, Kerala – 673593.
	17-03-2022	5,000	The Senior Scientist and Head ICAR – KVK, Mitraniketan, Vellanad, Trivandrum, Kerala - 695543.
	21-04-2022	5,000	M/s Deejay Coconut Farm Pvt. Ltd., 3rd floor, St Patricks Complex Brigade Rd, Bangalore – 560025
	14-08-2022	5,000	Professor and Head Communication Centre Directorate of Extension, Mannuthy Thrissur - 680651
	18-08-2022	5,000	The Programme Coordinator Krishi Vigyan Kendra, Ambalavayal Wayanad-673593, Kerala
Technology for mass production of *Trichoderma harzianum* using arecanut leaf sheath	06-04-2022	5,000	Mrs. Asha Rai K. 1-132, Kalai House, Punchappady Post and Village, Kadaba Taluk - 574202 Dakshina Kannada District, Karnataka
	06-04-2022	5,000	Mr. B. Balakrishna Poojary Manager, Agriculture Division Sri Kshethra Dharmasthala Temple, Dakshina Kannada District, Karnataka

	11-05-2022	5,000	M/s Deejay Coconut Farm Pvt. Ltd. 3rd floor, St Patricks Complex Brigade Rd, Bangalore – 560025
	14-11-2022	5,000	Mr. Sathish Balyaya K., Kannadakumeru, Savanur 574202 Dakshina Kannada, Karnataka
Trichoderma harzianum (CPTD – 28) culture	13-06-2022	5,000	Mr. Raju P. S/o R. Ponnudurai, 31/24 Balasubramanian Street K.K. Pudur, Coimbatore – 36, Tamil Nadu
Know-How on utilization of *Metarhizium anisopliae* culture	21-04-2022	5,000	M/s Deejay Coconut Farm Pvt. Ltd. 3rd floor, St Patricks Complex Brigade Rd, Bangalore – 560025
Metarhizium anisopliae TMBMA1, *Metarhizium anisopliae* ABMA1, *Cordyceps javanica* CPCRICJ1 and *Beauveria bassiana* BBTMB1	08-09-2022	-	ICAR-Central Institute of Cotton Research, Nagpur
Knowhow for production of bean to bite chocolate	28-04-2022	10,000	Mr. Bobby Mookanthottathil Chairman, Hill Grown Farmers Producer Company Ltd., Chathangottunada P.O., Kavilumpara – 673513, Kerala
	02-09-2022	-	M/s Ushas Food Products P.O. Kudlu, Kasaragod – 671124, Kerala, India
	28-12-2022	10,000	Mrs. Dhanalakshmi R., Unique Victuals, M.K.K. Road, Opp. Mariyappanapalya Park Gate, 2nd Stage, Rajajinagar, Bengaluru-560010, Karnataka
Preservation protocol for trimmed tender coconut	16-06-2022	15,000	Mr. Shafeeque V., C/o. Wadi Zamzam Tender Coconut, Karoth Thazhath (H), Vaidyarangadi (PO), Ramanattukara, Calicut – 673633, Kerala
Coconut sugar	14-07-2022	-	Council of Industrial Research, Anusandhan Bhawan, New Delhi - 110001
Collection of fresh and hygienic Kalparasa and production of natural coconut sugar	02-09-2022	1,00,000	Hallikar Tattva Farmer Producer Company Limited, APMC Yard, Dhabbeghatta Road, Turuvekere, Tumkur District – 572227
Bacillus megaterium (*Priestia megaterium*) and *Bacillus subtilis*	02-09-2022	-	Bio-Concrete Lab, Department of Civil Engineering, National Institute of Technology Karnataka, Srinivasnagar PO, Surathkal, Mangalore, Karnataka 575025
	Total	**5,75,000**	

XVII

SCIENTIFIC STAFF

Sl. No.	Name	Designation
Kasaragod		
1.	Dr. (Mrs.) Anitha Karun	Director (Acting) & I/c PC (Palms) (up to 30.11.2022)
2.	Dr. K. Muralidharan	Director (Acting) (w.e.f. 1.12.2022) / HoD, (Social Science)(Acting)
3.	Dr. H.P. Maheswarappa	Project Coordinator (Palms) (Acting) (On deputation to UAHS, Bagalkot)
4.	Dr. Ravi Bhat	HoD (Crop Production) (Acting) (SIC, AICRP (Palms))
5.	Dr. K.B. Hebbar	HoD (PB & PHT) (Acting)
6.	Dr. Vinayaka Hegde	HoD (Crop Protection) (Acting)
7.	Dr. C. Thamban	Principal Scientist (Agril. Extension)
8.	Dr. (Mrs.) Alka Gupta	Principal Scientist (Agril. Microbiology)
9.	Dr. Murali Gopal	Principal Scientist (Agril. Microbiology)
10.	Dr. (Mrs.) 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. Structure & 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. S. Paulraj	Senior Scientist (Agril. Microbiology)
21.	Dr. (Mrs.) Neenu S.	Senior Scientist (Soil Science)
22.	Dr. (Mrs.) Pratibha P.S.	Senior Scientist (Agril. Entomology)
23.	Dr. Rajkumar	Senior Scientist (Nematology)
24.	Dr.(Mrs.) V.H. Prathibha	Senior Scientist (Plant Pathology)
25.	Dr.(Mrs.) M. Sujithra	Senior Scientist (Agril. Entomology)
26.	Dr. Ramesh S.V.	Senior Scientist (Agril. Biotechnology)
27.	Mrs. Surekha	Scientist (Agronomy)
28.	Dr.(Mrs.) Neema M.	Scientist (SPM & AP)
29.	Dr. (Mrs.) Daliyamol	Scientist (Plant Pathology)
30.	Dr. (Mrs.) Sumitha S.	Scientist (SPM & AP)
31.	Mrs. Aparna Veluru	Scientist (SPM & AP)
32.	Dr. (Mrs.) Shameena Beegum P.P.	Scientist (SPM & AP)

33.	Dr. (Mrs.) G. Panjavarnam	Scientist (Fruit Science)
34.	Dr. R. Pandiselvam	Scientist (Agril. Structure & Process Engg.)
35.	Mrs. Ranjini T.N.	Scientist (SPM & AP)
36.	Mrs. Bandela Sravanthi	Scientist (SPM & AP)
37.	Sri Bhavishya	Scientist (SPM & AP)
KVK, CPCRI, Kasaragod		
38.	Dr. Manojkumar T.S.	Principal Scientist & Head, KVK
39.	Dr. (Mrs.) S. Kalavathy	Head (Acting) (Ag. Extension) (up to 01.03.2022)
40.	Dr. (Mrs.). P. Anithakumari	Principal Scientist (Ag. Extension)
41.	Dr. Regi Jacob Thomas	Principal Scientist (Hort.)
42.	Dr. Abdul Haris	Principal Scientist (Agronomy)
43.	Dr. Josephrajkumar A.	Principal Scientist (Ag. Entomology)
44.	Dr. (Mrs.) Nihad K.	Senior Scientist (Hort.)
45.	Dr. (Mrs.) Shareefa M.	Senior Scientist (Hort.)
46.	Dr. (Mrs.) Merin Babu	Senior Scientist (Plant Pathology)
47.	Dr. (Mrs.) Jeena Mathew	Senior Scientist (Soil Science)
48.	Dr. Anes K.M.	Senior Scientist (Agril. Nematology)
49.	Dr. (Mrs.) Indhuja S.	Scientist (Agril. Microbiology)
50.	Dr. (Mrs.) Priya U.K.	Scientist (Soil Science)
51.	Dr. (Mrs.) Jilu V. Sajan	Scientist (Agril. Entomology)
KVK, CPCRI, RS, Kayamkulam		
52.	Dr. Muralidharan P.	Principal Scientist & Head, KVK
Vittal		
53.	Dr. C.T. Jose	Head (Acting) (Agril. Stat.)(up to 31.08.2022)
54.	Dr. S. Elain Apshara	Principal Scientist (Hort-Fruit Science)
55.	Dr. N.R. Nagaraja	Scientist (Plant Breeding)
56.	Dr. Chaithra M.	Scientist (Plant Pathology)
57.	Dr. Shivaji Hausrao Thube	Scientist (Agril. Entomology) (up to 26.03.2022)
58.	Dr. Madhu T.N.	Scientist (Agril. Entomology) (w.e.f. 02.04.2022)
59.	Mrs. Suchithra M.	Scientist (SPM & AP)
60.	Mrs. Saneera E.K.	Scientist (Agril. Entomology)
61.	Dr. Thava Prakasa Pandian R.	Scientist (Plant Pathology)
Kidu		
62.	Sri Diwakar Y.	Scientist (SPM & AP)
Mohitnagar		
63.	Dr. Arunkumar Sit	Principal Scientist (Hort.)
64.	Dr. Sandip Shil	Senior Scientist (Agril. Stat.)
Kahikuchi		
65.	Dr. (Mrs.) Alpana Das	Senior Scientist (Agril. Biotechnology)
66.	Dr. Anok Uchoi	Scientist (SPM & AP)
67.	Dr. Leichombam Singhajit Singh	Scientist (SPM & AP)

TECHNICAL STAFF

Sl. No.	Name	Designation
Kasaragod		
1.	Sri H. Muralikrishna	Chief Technical Officer (Tech. Info.)
2.	Smt. K. Shobha	Chief Technical Officer (Library)(up to 31.07.2022)
3.	Smt. Sugatha Padmanabhan	Chief Technical Officer (Lab)
4.	Dr. P. Ravindran	Chief Technical Officer(up to 31.05.2022)
5.	Sri K. Shyama Prasad	Chief Technical Officer (Field Farm)
6.	Sri G.S. Hareesh	Senior Technical Officer (Instrumentation Engineering)
7.	Sri K.N. Radhakrishnan Nambiar	Technical Officer(up to 31.03.2022)
8.	Sri V.K. Gopalakrishnan	Technical Officer (Civil Engineering)
9.	Sri S. Manohara	Technical Officer (Vehicle)
10.	Sri K. Krishnan Nair	Technical Officer (Field/Farm)
11.	Sri A.K. Ramadas	Technical Officer (Vehicle)
12.	Sri M.V. Sreedharan	Technical Officer (Field/Farm) (up to 31.05.2022)
13.	Sri Devaraj K.	Technical Officer (Jr.Engineer)
14.	Dr. Muralikrishna K.S.	Senior Technical Assistant (Lab)
15.	Sri K. Raghavan	Senior Technical Assistant (Field/Farm)
16.	Sri A.V. Satheesh Kumar	Senior Technical Assistant (Vehicle)
17.	Sri K. Panduranga	Technical Assistant (Field/Farm)
18.	Sri Bhavani Sankar Naik	Technical Assistant (Field/Farm)
19.	Sri A. Divakaran	Technical Assistant (Field/Farm)
20.	Sri Sunil S.	Technical Assistant (Electrical Engineering)
21.	Sri A.O. Varghese	Technical Assistant (Field/Farm) (upto 30.06.2022)
22.	Sri K.J. Sebastian	Senior Technician (Field/Farm)
23.	Sri Anoop Kumar P.P.	Technical Assistant (Field/Farm) (w.e.f. 23.12.2022)
24.	Smt. M. Vimala	Senior Technician (Field/Farm) (up to 31.05.2022)
25.	Sri N. Dinesh Kumar	Senior Technician (Field/Farm)
26.	Sri A.R. Padmanabha Naik	Senior Technician (Field/Farm)
27.	Sri Arunji G.	Technical Assistant (Library)
28.	Mrs. Ashamol E.P.	Technician (Field/Farm)
29.	Sri Suvith P.S.	Technician (Field/Farm)
30.	Sri Ajith Kumar R.	Technician (Field/Farm)
31.	Sri M. Krishnan	Technician (Field/Farm)
32.	Smt. U. Sarojini	Technician (up to 30.04.2022)
33.	Smt. V.A. Leela	Technician (up to 31.03.2022)
34.	Smt. Chithralekha Kodoth	Technician (Field/Farm)
35.	Sri B. Sundara	Technician (Field/Farm)
36.	Sri B. Chandrahasa	Technician (Field/Farm)
37.	Sri V.T. Rameshan	Technician (Field/Farm)
KVK, Kasaragod		
38.	Dr. (Mrs.) Saritha Hegde	Chief Technical Officer (SMS-Home Science)

39.	Dr. (Mrs.) Neelofar Illias Kutty	Chief Technical Officer (Programme Assistant) (Home Science)
40.	Mrs. Jayasree M.P.	Assistant Chief Technical Officer (SMS - Agrl. Extn.)
41.	Sri K. Manikandan	Senior Technical Officer (Programme Assistant) (Agronomy)
42.	Dr. Benjamin Mathew	Senior Technical Officer (w.e.f. 19.10.2022)
43.	Sri Lagesh K.P.	Technician (Vehicle)
Kayamkulam		
44.	Dr. G. Rajeev	Chief Technical Officer (Lab) (up to 31.01.2022)
45.	Dr. C.G. Narayanan Namboothiri	Asst. Chief Technical Officer (Field/Farm)
46.	Sri K.K. Sudhanandan	Asst. Chief Technical Officer (up to 28.02.2022)
47.	Dr. Mayalekshmi	Technical Officer (Field/Farm)
48.	Sri K. Rajendran	Technical Officer (up to 31.01.2022)
49.	Sri B. Anilkumar	Asst. Chief Technical Officer (Field/Farm)
50.	Sri K.P. Udayabhanu	Technical Officer(Field/Farm) (expired on 15.09.2022)
51.	Sri Sunny Thomas	Technical Officer (Field/Farm)
52.	Sri Jinu Sivadasan	Senior Technical Assistant(Field/Farm) (expired on 15.09.2022)
53.	Sri V.P. Joy	Senior Technical Assistant (Field/Farm)
54.	Mrs. Asha K. Chandran	Technical Assistant (Field/Farm)
55.	Sri Premjith Antony	Technician (Field/Farm)
KVK, Kayamkulam		
56.	Sri M.S. Rajeev	Chief Technical Officer (SMS-Agronomy)
57.	Smt. Jissy George	Chief Technical Officer (SMS- Home Science)
58.	Smt. Lekha G.	Chief Technical Officer (SMS-Plant Pathology)
59.	Dr. T. Sivakumar	Chief Technical Officer (SMS- Agricultural Entomology)
60.	Dr. S. Ravi	Chief Technical Officer (SMS- Animal Husbandry)
61.	Sri Sajnanath K.	Assistant Chief Technical Officer (SMS-Soil Science)
62.	Sri Ansary K.M.	Technical Officer (Computer)
63.	Smt. Bijila P.V.	Technical Officer (Horticulture)
64.	Sri Dayanandan Unnithan	Technical Officer (Vehicle)
65.	Sri Sajin B.J.	Technician (Vehicle)
Vittal		
66.	Smt. Meenakshi Patil	Assistant Chief Technical Officer (Library) (up to 31.05.2022)
67.	Sri K. Ajith Kumar	Technical Officer (Civil Engineering)
68.	Sri C. Purandhara	Technical Officer (Field/Farm)
69.	Sri Abdul Aziz	Technical Officer (Field/Farm)
70.	Sri V. Chandrasekhara Shetty	Technical Officer (Vehicle) (up to 31.05.2022)
71.	Sri Santhosh Kumar P.	Senior Technical Assistant (Field/Farm)
72.	Sri Tharanatha Naik B.	Senior Technical Assistant (Vehicle)
73.	Sri Bisun Bhaskar	Technical Assistant (Laboratory)
74.	Sri Nirmal Kumar B.J.	Technical Assistant (Field/Farm)
75.	Sri K. Sukumaran	Technician (Field/Farm)
76.	Sri Vinod K.	Technician (Field/Farm) (up to 31.05.2022)

77.	Sri B. Dharmapala	Technician (Field/Farm)
78.	Sri Mohana	Technician (Field/Farm)
79.	Sri Isubu D.	Technician (Field/Farm)
Kidu		
80.	Sri M. Manamohan	Senior Technical Officer (Mechanical Engineering)
81.	Sri A.S. Gopalakrishna	Technical Officer (Field/Farm)
82.	Sri M. Narayana Naika	Technical Officer (Field/Farm)
83.	Sri Kamal Kumar V.	Technical Assistant (Field/Farm)
84.	Sri V. Chennappa	Technician (Field/Farm)
85.	Sri S. Chennappa	Technician (Field/Farm)
86.	Sri Jathappa Gowda	Technician (Field/Farm)
Mohitnagar		
87.	Sri Jagadish Roy Burman	Senior Technical Assistant (Vehicle)
88.	Sri Pratap Kumar Sarkar	Technical Officer (Field/Farm)
89.	Sri Jagadish Roy	Technical Officer (Vehicle)
90.	Sri Prakash Burman	Sr. Technician (Field/Farm)
91.	Sri Kartick Chandra Biswas	Technician (Field/Farm)
Kahikuchi		
92.	Dr. Bikash Chowdhury	Chief Technical Officer (Field/Farm)
93.	Sri Gopinath Malakar	Technical Officer (Vehicle)

TECHNICAL STAFF

Sl. No.	Name	Designation
Kasaragod		
1.	Sri Hareesh Nair G.S.	Chief Administrative Officer (Sr. Grade)
2.	Smt. Jessymol Antony	Finance and Accounts Officer (w.e.f. 06.11.2021)
3.	Smt. Jenny C.M.	Administrative Officer (w.e.f. 15.11.2021) (up to 10.06.2022)
4.	Sri P. Krishna Kumar	Administrative Officer (w.e.f. 30.01.2022)
5.	Sri K.R. Nithianandan	Assistant Administrative Officer
6.	Sri Pradeep Kumar Vasu	Assistant Administrative Officer
7.	Smt. M. Reetha	Assistant Administrative Officer(up to 31.10.2022)
8.	Sri A. Neil Vincer	Assistant Administrative Officer
9.	Smt. K. Narayani	Principal Private Secretary
10.	Smt. Girija Chandran	Private Secretary
11.	Smt. Sulochana Nair	Private Secretary
12.	Sri K. Kunhiraman Nair	Private Secretary(up to 31.01.2022)
13.	Sri T.N. Vidhyadharan	Assistant(up to 31.07.2022)
14.	Sri P.M. Thomas	Assistant
15.	Smt. K.T.K. Sheenakumari	Assistant

16.	Sri P. Narayana Naik	Assistant
17.	Smt. Rupa Manikandan	Assistant
18.	Smt. Jayashree K.	Assistant
19.	Smt. K. Preethi	Assistant
20.	Sri Paulson Sam George	Assistant
21.	Sri T.K. Gangadharan	Upper Division Clerk
22.	Sri. Aswin Reghunath	Upper Division Clerk
23.	Sri. N. Udayakumar	Upper Division Clerk
24.	Smt. A.J. Mary	Upper Division Clerk
25.	Smt. Arathi A.R.	Stenographer Gr.III
26.	Sri. P.K. Pramodkumar	Upper Division Clerk
27.	Sri. Jayarajan V.	Lower Division Clerk
28.	Sri K.P. Ibrahim	Lower Division Clerk
29.	Sri. Dinesh	Lower Division Clerk (on deputation to IASRI, New Delhi)
30.	Sri. Ratan Singh	Lower Division Clerk (on deputation to IASRI, New Delhi)
31.	Sri. Satyabrata Moharana	Lower Division Clerk (on deputation to NRRI Cuttack)
Kayamkulam		
32.	Sri K.G. Bhageerath	Assistant Administrative Officer(up to 31.07.2022)
33.	Sri K. Haridas	Assistant
34.	Sri K. Venugopal	Assistant
35.	Smt. K. Sreelatha	Assistant
36.	Smt. V. Madhavikutty	Assistant
37.	Smt. Prasanna Sarngan	Personal Assistant
38.	Smt. Deepa T.	Upper Division Clerk
39.	Sri Arun N.K. Raj	Lower Division Clerk
40.	Sri C.R. Babu	Lower Division Clerk (up to 31.10.2022)
KVK, Kayamkulam		
41.	Smt. Rejitha K.R.	Personal Assistant
Vittal		
42.	Sri P. Krishna Naik	Assistant Administrative Officer (up to 31.01.2022)
43.	Sri Sasi K.K.	Assistant Finance and Accounts Officer
44.	Sri Mohammed Haneefa P.K.	Upper Division Clerk
45.	Sri Vivek Singh	Stenographer Gr. III
46.	Sri Lakshmi Narayana	Upper Division Clerk
47.	Sri K.N. Sajeev	Lower Division Clerk
48.	Sri Choma	Lower Division Clerk
49.	Sri Chandu Naik	Lower Division Clerk
Kidu		
50.	Sri M. Ravindran	Assistant Administrative Officer
51.	Sri Durgesha M.	Lower Division Clerk
Mohitnagar		

52.	Sri Subash Paul	Assistant
Kahikuchi		
53.	Sri. T.J. Saji	Upper Division Clerk
54.	Sri Deepak Meena	Lower Division Clerk (on deputation to IARI, New Delhi)
55.	Sri Umesh Kumar	Lower Division Clerk (on deputation to IARI, New Delhi)

TECHNICAL STAFF

Sl. No.	Name
Kasaragod	
1.	Sri A. Mohana (up to 31.01.2022)
2.	Sri M. Shankara (up to 30.04.2022)
3.	Sri P.A. Chaniya Naik
4.	Sri V.S. Pakeeran
5.	Smt. V. Thambai
6.	Smt. G.Kamala
7.	Sri K.G. Sureshbabu
8.	Sri T.J. Ninan (up to 31.01.2022)
9.	Smt. K. Shobhana (up to 28.02.2022)
10.	Sri V. Krishnankutty
11.	Sri P.P. Prabhakaran
12.	Sri B. Ramachandran
13.	Sri B. Sanjeeva Patali
14.	Smt. N.V. Sasikala
15.	Sri Lakshmana Naik
16.	Smt. Lalitha Bai
17.	Sri M. Velayudhan
18.	Sri N. Bhaskaran
19.	Sri K.Sureshan
20.	Sri A. Madhu
21.	Sri K.A. Madhavan
22.	Sri Aneesh E.M.
23.	Smt. Vanamalini
24.	Sri Sarath Kumar
25.	Sri Ashok Kumar R.
26.	Sri Praveen Raj P.R.
27.	Sri Jayaprakash K. (Canteen)
28.	Smt. Rohini N.
29.	Sri Kripesh Kumar
Kayamkulam	
30.	Sri M.E. Sivan
31.	Sri R. Ravindran (up to 30.06.2022)
32.	Sri K. Soman
33.	Sri K. Omanakuttan
34.	Sri V.T. Unnikrishnan
35.	Sri K. Ravi
36.	Sri C. Sukumaran
37.	Smt. K. Valsala
38.	Sri C.Sundaran
39.	Smt. N. Suma
40.	Sri A.T. Harikuttan
41.	Sri Ajith Mattappadan (up to 02.03.2022)
42.	Sri R. Rajesh
43.	Smt. L. Leena
44.	Sri S. Rajesh
45.	Smt. Arathy R. Pillai
46.	Smt. Aswathy A.S. (w.e.f. 02.03.2022)
Vittal	
47.	Sri Sudhakara (up to 30.04.2022)
48.	Sri A. Gopala (up to 31.07.2022)
49.	Sri Ibrahim
50.	Sri Somappa K.
51.	Sri M. Ananda
Kidu	
52.	Smt. N.Bhavani
53.	Sri Dasappa Gowda
54.	Smt. T. Susheela
55.	Sri Padmayya Gowda
56.	Smt. B.Bhavani
57.	Smt. S. Rukmini
58.	Sri S. Bhojappa
59.	Smt. Komalangi
60.	Sri S. Sheenappa Gowda
61.	Sri S. Neelappa
62.	Sri S. Regappa
63.	Smt. S. Chandravathi
64.	Smt. Meenakshi K.
Mohitangar	
65.	Sri Sailen Seal
66.	Sri Krishna Kumar Mandal
67.	Sri Nripendra Chandra Roy
68.	Sri Sushanta Burman
69.	Sri Mahadev Misra
Kahikuchi	
70.	Sri Sathish Baishya
71.	Sri Pankaj Das
72.	Sri Tanka Bahadur Thapa

DISTINGUISHED VISITORS

XVIII

Study Visit of the Parliamentary Standing Committee on Agriculture, Animal Husbandry and Food Processing

Director, ICAR-CPCRI along with HoDs and other senior officials interacted with the members of PSC on Agriculture, Animal Husbandry and Food Processing under the chairmanship of Shri. P. C. Gaddigoudar during their study visit in Gangtok, Siliguri and Guwahati during 20-25 May 2022. On 23 May 2022, the PSC visited Siliguri and held discussions. Delegations accompanying the PSC including Dr. Subrata Gupta, Principal Secretary, Dept. of Agric, Govt. of West Bengal, Smt. Gita Rani, Joint Secretary, MIDH, Dr. Samuel Rai, Director, Dept. of Cinchona and Medicinal Aromatic Plants, Govt. of West Bengal, others official of Horticulture Dept. Govt of West Bengal, Dr. Bhaskar, ADG (CS), and Dr. B.K. Pandey, ADG (Hort-II), ICAR visited Mohitnagar on 23 May 2022. Director made a presentation on programmes conducted by ICAR-CPCRI Research Centers at Mohitnagar and Kahikuchi on 24 May 2022 at Guwahati and submitted a detailed report to the Chairperson, PSC.

Director welcoming Chairman, PSC in the meeting held at Guwahati

Dr. Subrata Gupta, Principal Secretary, Dept. of Agric, Govt. of West Bengal, and Smt. Gita Rani, Joint Secretary, MIDH during their visit to ICAR-CPCRI RC, Mohitnagar

Review of Second Sub-Committee of Parliamentary Committee on Official Language

Dr. P. Anithakumari, Acting Head presented the use and promotion of Hindi at ICAR-CPCRI, Regional Station, Kayamkulam before the Hon'ble Second Sub-Committee of Parliamentary Committee on Official Language at Thiruvananthapuram on 27 September 2022. The Committee appreciated the activities at Kayamkulam Regional Station and put forward valuable suggestions for improving the use of official language in day-to-day office proceedings. Dr. Anitha Karun, Acting Director, ICAR-CPCRI, Mr. G.S. Hareesh Nair, CAO (Sr. Grade), Dr. K.M. Anes, Scientist attended the review meeting held at Thiruvananthapuram.

ICC-COGENT Appraisal of the International coconut genebank for South Asia and Middle East (ICG-SAME)

The ICG appraisal team visited ICAR-CPCRI Kasaragod as well as CPCRI, Research Centre, Kidu during 20-22 May 2022. Dr. V. Niral, Principal

Scientist, ICAR-CPCRI and Curator, ICG-SAME made a brief presentation on the Current status of ICG-SAME hosted by India at ICAR-CPCRI Research Centre Kidu, Karnataka. Following in the visit, the team had a wrap up meeting with the Director and Head of Divisions.

Horticulture Commissioner Visits Vittal

Dr. S. K. Malhothra, Agri. & Horti. Commissioner, Ministry of Agriculture and Farmers Welfare visited CPCRI, RS, Vittal on 7 January 2022, reviewed the DCCD / DASD programs and interacted with scientists on the GOI policies.

Dr. S.K. Malhothra visiting hi-tech nursery at ICAR-CPCRI, Regional Station, Vittal

Prof. H. Venkateshwarlu, Vice-Chancellor, Central University of Kerala visited ICAR-CPCRI, Kasaragod on 3 March 2022 and interacted with the scientists.

Goa Governor Visits Kayamkulam

Shri Sreedharan Pillai, Hon'ble Governor of Goa visited ICAR-CPCRI, Regional Station, Kayamkulam on 28 November 2022.

Shri Sreedharan Pillai, Hon'ble Governor of Goa planting of Kalpa Vajra coconut seedling at Kayamkulam and interacting with the scientists.

MERA GAON – MERA GAURAV PROGRAMME

XIX

Scientists of ICAR-CPCRI have regularly visited the selected villages under MGMG programme and provided advisories on crop production and protection. Specific programmes conducted are: Training programme on 'Quality Planting Material Production in Coconut', and 'Cultivation of fruits and vegetables in the coconut ecosystem', and distribution of vegetable seeds.

Training on scientific cultivation of vegetables and fruits at Kidu

As part of MGMG programme farmers training on 'Scientific cultivation of vegetables and fruits in coconut eco-system' was conducted for the Scheduled Caste farmers at ICAR - CPCRI, Research Centre, Kidu, Karnataka on 10.01.2022 followed by distribution of vegetable seeds of 68 kits containing long beans, brinjal, okra, cucurbits, amranthus, etc. The seeds were procured from ICAR - IIHR, Bengaluru under SCSP. More than 70 farmers participated in the programme.

Vegetable seed distribution to SC communities at ICAR - CPCRI, Kidu, Karnataka

Women farmer training on vegetable cultivation under SCSP

A training and distribution programme on vegetable seeds was organized by the ICAR - CPCRI for scheduled caste women farmers in MGMG adopted village Kilingar of Kasaragod district on 01.11.2022 under SCSP. Smt. Jayashree, ward member of Badiadka Panchyath distributed seeds and appreciated the project and appealed the beneficiaries to take maximum benefits when scientists at their door step. Dr. Rajkumar delivered lecture on vegetable cultivation and root-knot nematode management strategies and eco-friendly management of insect pests using entomopathogenic nematodes (EPN) followed by field demonstration. More than 25 women farmers participated in the training cum seed distribution programme

Smt. Jayshree, ward member of Panchayath distributing kitchen kit to the Scheduled caste benefecieries

SWACHCH BHARAT CAMPAIGN

XX

Swachatha Pakhwada Campaign

Swachhata Pakhwada programmes were conducted at the headquarters, Regional Stations and Research Centres. From 16 December 2022 various activities were conducted as a part of the Pakhwada.

Awareness on Sanitation drive conducted in MGMG adopted village of Kambar in Kasaragod district on 18 December 2022. More than 15 villagers were participated in the cleanliness drive as part of Swacchata Pakhwada.

View of villagers participating in cleaniness drive at Kambar

Smt. Shameera Faizal, President of Mogral Panchyath addressing staff members on Swacchta Pakhwada

WOMEN'S CELL ACTIVITIES

XXI

International Women's Day

International Women's Day was celebrated under the theme 'Gender equality today for a sustainable tomorrow' # Break The Bias 2022 at ICAR – CPCRI Kasaragod on March 8 2022. The programme was presided by Dr. Anitha Karun Director, CPCRI. Dr. Anitha Karun highlighted the significance of celebrating International Womens' Day. She added this day is important to call the action for accelerating gender parity. Smt. Girija Pathekara, renowned Malayalam poet was the chief guest. Smt. Girija Pathekara spoke about the issues faced by women at work place.

Women cell of ICAR-CPCRI Regional Station, Kayamkulam organized a thematic talk on 'Alzheimer's and female brain' on 8th March, 2022 in hybrid mode as part of International Women's Day 2022 celebrations.The Programme started by 2.30 pm in the institute auditorium. The key speaker was Dr. SheejaNavakkode Gangadharan, Senior Research Fellow, Nanyang Technological University, Singapore. The session dealt with the aspects on global scenario of Alzheimer's disease, synaptic features associated, difference of incidence and severity among genders, methodologies adopted in the experiment, nuances and features of brain function in memory and memory loss and socio-economic factors related to Alzheimer's diseases. The meeting was attended by 38 online and 22 offline participants including staff of ICAR-CPCRI Regional Station, Kayamkulam and ICAR-KVK, Alappuzha.

A Kisan Goshti organised at Kolathur on 8 March 2022. Dr. Prathibha P.S., Scientist, CPCRI Kasaragod delivered a speech on women empowerment in agriculture. Around 23 attended the programme. Field visit and latest scientific technology on agriculture, fish farming and green house were demonstrated.

International Women's day was celebrated on 8th March with the participation of women and men farmers, entrepreneurs, and students along with staff members of the KVK Alappuzha. Dr. P. Anithakumari, Acting Head, ICAR-CPCRI, RS, Kayamkulam delivered the keynote address in the function presided by Dr. P. Muralidharan, Head, KVK. Mrs. Radhamani Rajan, Member, Krishnapuram Grama Panchayath distributed turmeric and vegetable seeds to women farmers. A training programme on 'Scientific turmeric cultivation' was also organized for the women farmers on the occasion. A total of about 45 persons attended the programme.

As a part of International Women's Day Celebration at KVK, Kasaragod, training programme on "Technology options for women for Entreprenurship" was conducted. Around 25 women entrepreneurs participated.

Smt. Girija Pathekara, addressing the gathering

MAJOR EVENTS AND OTHER INFORMATION

XXII

Republic Day

ICAR - CPCRI, Head Quarters, Kasaragod, celebrated the 73rd Republic Day on 26thJanuary, 2022, strictly following all Covid 19 protocols. The program started with flag hoisting by Dr. K.B. Hebbar, Director in-charge followed by salutation of the national flag and thereafter the national anthem. Dr. Hebbar, delivered the republic day message highlighting that though agricultural research was hampered to a certain extent due to Covid 19 pandemic, various seminars/programmes could be conducted online and scientists could obtain recognitions/awards during the period. At RS, Kayamkulam, the program started with flag hoisting by Dr. Abdul Haris, Principal Scientist followed by salutation to the national flag. Republic Day was also observed at all the ICAR-CPCRI locations with patriotic furor.

World Environment Day

World Environment Day was celebrated on 6 June 2022 at ICAR- CPCRI, RS, Kayamkulam. KVK–Alappuzha in collaboration with NSS Unit, MSM College, Kayamkulam organized the World Environment Day celebrations in the college campus on 6th June 2022. An awareness talk on 'Good farming practices for environmental protection' highlighting the relevance of conserving natural resources through different agricultural practices was delivered. More than 75 students participated in the programme.

International Yoga Day

Yoga Day celebration was held on 21 June 2022. A lecture-cum-demonstration session on yoga was conducted by Smt. Kala Damodar, renowned yoga instructor at Kasaragod. At ICAR-CPCRI, RC Kidu a yoga session was organized under the expert guidance of Master Sh. Vijesh Kumar. At ICAR-CPCRI, Regional Station, Kayamkulam lecture on 'Yoga in Human Development' and a practical demonstration were held. It was also celebrated at Mohitnagar and Vittal.

Independence Day

ICAR-CPCRI, Kasaragod celebrated 76th Independence Day of the nation. Dr. Anitha Karun, Director (Acting), hoisted the National Flag and delivered Independence Day address at Kasaragod on 15 August, 2022. As a part of 'Azadi ka Amrutha Mahotsav', a unique way of planting 75 coconut seedlings of var. Kera Chandra was performed at the ICAR-CPCRI headquarters on Independence Day, the 15 August 2022. To commemorate the nation's 75 years of independence, Dr. Anitha Karun, Director (Acting) led the staff members by planting of one seedling each by individuals during the occasion. Independence Day was also celebrated in the Regional Stations at Kayamkulam, Vittal and Research Centres at Kahikuchi, Kidu and Mohitnagar in a befitting manner.

Dr. Anitha Karun, Director (Acting) planting Kera Chandra coconut seedling during Independence Day

'Azadi ka Amruth Mahotsav'
coconut seedling planting

Mahatma Gandhiji's Birthday

As part of the Mahatma Gandhi Jayanti Celebrations and as per the directives from the Government of India and the Ministry of Youth Affairs and Sports, Fit India Freedom Run 3.0- Azadi ka Amrut Mahotsav was organized at ICAR-CPCRI, Kasaragod. Institute and KVK staff as well as their family members including students took part in this on the launch day of 2nd October 2022. A plog run was held in the CPCRI main campus. Around 40 members actively participated in the event.

Fit-India freedom run 2.0 at Kasaragod

Mahila Kisan Diwas

KVK-Alappuzha celebrated Mahila Kisan Diwas (15th October) at Thrikkunnapuzha grama panchayath with various programmes. The programme was launched by Sri. S. Vinodkumar, President of the Grama Panchayath. The keynote lecture was given by Dr. P. Muralidharan, Head of KVK. The event was presided over by Mr. S. Sujith, Chairman of the Development Standing Committee. The event honoured Mrs. Ammini M., a septuagenarian farmer who has worked for more than 60 years manufacturing coir from coconut fibre. A total of 65 farm women participated in the programme.

World Soil Day

ICAR-KVK, Kasaragod observed World Soil Day on December 5, 2022, under the theme "Soil: Where Food Begins" at Mundiathaduka village of Badiadka Grama Panchayat, Kasaragod.

Vigilance Awareness Week

In connection with the observance of the Vigilance Awareness Week on theme "Corruption Free India for Developed Nation" from 31th October to 6th November 2022, various activities were conducted at ICAR-CPCRI, Kasaragod, Regional Stations at Vittal and Kayangulam and research centres at Kidu, Mohitnagar and Kahikuchi to create awareness among various stakeholders, employees, citizens, especially youth and students to promote and uplift ethical values for building an environment of cultural honesty and integrity.

National Farmers Day

ICAR-CPCRI, RC, Kidu, celebrated National Farmers Day in Bilinele school premises on 23 December 2022. Sh. Aanjaneya Reddy, Sub Inspector of Police, Kadaba Circle as chief guest inauguratedthe programme. Sh. Gopala Krishna Sharma, Retd. Principal was present as guest of honour. As part of the programme, Speech competition was organized for high school and college students on topic "Importance of farmers for sustainable and healthy future". Soil health cards were also distributed to farmers during the programme. The valedictory function of Swachhta Pakhwada and the golden jubilee celebration were held on 30 December 2022.

XXIII

BUDGET AND EXPENDITURE

The Budget and Expenditure for the period 1 April 2022 to 31 March 2023

(Figures in Rupees Lakhs)

Budget Head		
	Budget	**Expenditure**
Revenue		
Estt. Charges	2993.39	2993.39
OTA		0
Pension	4210.95	4210.95
TA		43.39
Research & Operational expenses		277.68
Works: Repair & Maintenance		**0**
Office Buildings		1.36
Residential Buildings		0.43
Minor Works		71.80
Other Administrative Charges		427.00
Total	**8026.00**	**8026.00**
Miscellaneous Expenses (including HRD)	44.18	44.18
Tribal Sub Plan - General	40.00	40.00
Scheduled Cast/ Scheduled Tribe-General	45.00	45.00
Total		**129.18**
Total	**8155.18**	**8155.18**
Capital		
Equipments		78.55
Information Technology		5.25
Library		0.63
Furniture & Fixtures		1.96
Livestock		0
Vehicles		21.01
Works		12.60
Minor Work		0.00
Total	**120.00**	**120.00**
Tribal Sub Plan - Capital		0.00
NEH	70.00	70.00
Total	**190.00**	**190.00**
TOTAL	**8345.18**	**8345.18**

Other Projects (in Rupees)

	Opening Balance	Receipts	Expenditure	Refund
Other Plan Schemes	626816.00	82032631.00	118860638.00	1677807.00
Deposit/Externally funded	32168710.00	30757510.00	30757510.00	5377042.00
KVK,s	-1374592.00	40265375.00	79377406.00	37500.00

Revenue receipts (in Rupees)

Head	Achievement
Income from sales/ services (Schedule-8)	36038417.00
Fee/Subscription (Schedule-10)	60000.00
Income from Royalty, Publication etc. (Schedule-12)	2146.00
Other Income (Schedule-14)	4050248.00
STD Interest/Loans & Advances	2568119.00
Recoveries on Loans & Advances	246046.00
TOTAL	**42964976.00**

XXIII WEATHER DATA

Kasaragod

Month	Temp:Max (Celsius)	Temp:Min (Celsius)	RH (%) (FN)	RH(%) (AN)	Rainfall (mm)	Rainy Days (No.)
January	32.3	18.8	65.2	57.9	0	0
February	32.2	20.1	70.3	62.4	0	0
March	33.6	23.8	77.6	62.6	032.6	2
April	33.7	24.5	79.6	66.0	111.2	7
May	30.7	23.8	84.7	77.5	215.1	17
June	30.5	23.6	85.5	76.7	515.6	23
July	27.9	23.5	89.8	87.3	1249.0	28
August	28.5	23.2	90.8	83.2	763.8	28
September	29.5	23.4	86.8	81.9	225.8	19
October	30.6	23.8	88.8	77.1	102.4	8
November	32.1	23.6	87.1	64.8	86.2	4
December	31.8	22.4	84.8	61.5	39.4	4

Regional Station, Kayamkulam

Month	Temp (°C)		RH %		Wind Velocity (km/h)	Sun shine (h)	Evaporation (mm)	Rainfall (mm)	Rainy days
	Max °C	Min °C	FN	AN					
January	33.5	22.4	92	58	1.6	9.4	4.0	02.0	0
February	34.8	22.9	91	57	1.7	8.4	3.9	08.5	2
March	34.7	24.9	92	61	2.0	8.1	3.9	62.2	2
April	33.3	24.6	93	68	1.7	7.5	3.8	282.5	12
May	30.8	23.8	94	76	1.5	5.5	3.5	388.4	20
June	30.9	24.0	94	75	1.0	6.0	3.6	354.2	18
July	29.5	23.9	94	77	1.6	5.2	3.4	338.2	17
August	30.0	23.8	94	76	2.0	5.6	3.5	369.3	16
September	31.0	24.1	94	73	1.6	7.4	3.8	102.3	8
October	31.1	23.6	93	71	1.1	6.5	3.6	324.3	12
November	31.6	23.0	93	69	0.6	6.1	3.6	237.4	10
December	32.1	22.3	94	66	0.3	6.7	3.6	78.9	5

Regional Station, Vittal

Month	Temp (°C)		RH %		Wind Velocity	Sun shine	Evaporation	Rainfall	Rainy days
	Max °C	Min °C	FN	AN	(km/h)	(h)	(litre)	(mm)	
January	32.2	18.2	93	51	1.6	7.2	3.1	43.3	3
February	33.1	17.5	91	48	2.3	6.5	3.6	25.2	5
March	34.2	21.1	94	52	2.1	6.7	4.7	15.2	4
April	35.3	24.2	95	51	3.2	5.6	3.8	374.4	19
May	32.3	22.1	94	59	2.4	1.7	2.0	1246.2	27
June	28.4	23.1	96	73	1.6	3.1	2.4	456.2	21
July	29.1	22.7	94	86	2.1	1.9	1.9	1413	25
August	29.2	23.5	93	62	2.3	1.5	1.0	958	18
September	27.5	21.5	92	59	2.0	1.0	1.4	374.5	14
October	31.3	23.5	93	57	2.6	3.4	2.2	388.3	17
November	31.7	21.0	95	73	1.7	1.9	2.7	237	14
December	32.5	22.5	93	67	1.3	2.0	3.0	14.5	2

Research Centre, Kidu

Month	Temp (°C)		RH %		Wind Velocity (km/h)	Rainfall (mm)	Rainy days
	Max °C	Min °C	FN	AN			
January	33.6	18.3	89.9	43.2	0.8	0	0
February	35.3	19.8	90.6	37.9	1.1	5	1
March	36.2	21.7	87.7	41.1	1.1	85.4	5
April	35.5	23.2	90.0	55.7	0.9	153.6	12
May	31.5	22.6	93.1	72.2	0.4	501.8	20
June	31.1	22.8	90.5	72.2	0.3	602.8	27
July	28.1	22.8	97.9	91.6	0.4	1999	31
August	29.8	23.1	98.1	83.2	0.05	1151.2	28
September	30.2	23.1	94.7	76.7	0.08	327	20
October	31.7	22.3	94.1	66.6	0.03	433.2	13
November	33.6	22.4	93.2	57.4	0.02	41.20	4
December	32.7	19.0	91.5	56.3	0.02	83.6	7

राजभाषा कार्यान्वयन

XXV

केंद्रीय रोपण फसल अनुसंधान संस्थान, कासरगोड में 14 सितम्बर 2022 से 28 सितम्बर 2022 तक हिंदी पखवाड़ा का आयोजन किया गया। इसका उद्घाटन समारोह 14 सितम्बर 2022 को अपरान्ह 3 बजे डॉ अनीता करुण, निदेशक महोदया की अध्यक्षता में हुआ। आई सी ऐ आर गीत के उपरांत कुमारी अश्विता ने सर्वशक्ति मान का आह्वान किया। डॉ. अलका गुप्ता, प्रधान वैज्ञानिक ने अतिथियों का स्वागत किया और हिंदी पखवाड़े के बारे में महानिदेशक महोदय की अपील को सुनवाय। डॉ. अनीताक रुण ने आयोजन के महत्व के बारे में जानकारी दी और कर्मचारियों से पूरेदिल से समर्थन देने और आधिकारिक कर्तव्यों का निर्वहण करते समय अधिक हिंदी शब्दों को शामिल करने की अपील की। श्रीमती लिशा, हिन्दी अध्यापिका, केन्द्रीय विद्यालय नंबर 1 ने अपने भाषण में नियमितकार्य में हिन्दी के महत्व और इसकेकार्यान्वयन के तरी के पर जोर दिया। कार्यक्रमके अंतर्गत श्री अश्विन रघुनाथ और श्री एन उदयकुमार ने अपने मधुर गीतों से सभी का मनोरंजन किया । श्रीमती प्रीति नेध न्यवाद ज्ञापि तकिया।

हिंदी पखवाड़े के अवसर पर कर्मचारियों के लिए शब्द निर्माण, हिंदी सुलेख, स्मरण परीक्षा, अंताक्षरी, हिंदी कविता पाठ, देशभक्ति पूर्ण समूह गान, मौके पे बोलो, चित्र देखो लिखो, निबंध लेखन एवं समाचार पत्र पढना जैसे प्रतियोगिवोंका आयोजन किया गया।

प्रभारी निदेशक डॉ मुरलीधर नके अध्यक्षता में हिन्दी पखवा ड़ेका समापन समारोह 28 सितंबर 2022 दोपहर 3 बजे संपन्न हुआ। श्रीमती यशोदा, हिंदी विभाग, चिन्मय विद्यालय,कासरगोडइस कार्यक्रम की मुख्य अतिथि थीं। समारोप समारम्भ में विविध प्रतियोगितावों के विजेतावों को पुरस्कार प्रदा नकिया गया।

श्रीमती यशोदा, हिंदी विभाग, चिन्मय विद्यालय,
कासरगोड समापन समारोह के दौरान बोलते हुए

श्रीमती लिशा, हिन्दी अध्यापिका, केन्द्रीयविद्यालयनंबर 1 उद्घाटन

प्रतियोगितावों के विजेतावों का पुरस्कार प्रदान

भाकृअनुप
ICAR

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

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